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Natural Resource Stewardship and Science

Vegetation Classification and Mapping

Niobrara National Scenic River

Natural Resource Report NPS/NIOB/NRR—2019/2040

ON THIS PAGE
Herd of bison on The Niobrara Preserve
(Matt Ley, CEMML)

ON THE COVER
Niobrara River near Norden Bridge
(Tom Baldvins, CNHP)

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Executive Summary

The vegetation inventory project at Niobrara National Scenic River (NIOB) classified and mapped vegetation within the park administrative boundary and estimated thematic map accuracy quantitatively. The project was conducted over a four year period from the summer of 2015 to the winter of 2019. Located in north-central Nebraska, approximately 76 miles of the park is designated as a wild and scenic river. The vast majority of land within the NIOB administrative boundary is private or state-owned.

The project follows guidance provided by the National Park Service (NPS) Vegetation Mapping Inventory (VMI) Program. The overall process includes initial planning and scoping, imagery procurement, field data collection, data analysis, imagery interpretation and classification, and accuracy assessment (AA). The initial planning and scoping meetings to develop the study plan took place in December 2009 in Valentine, Nebraska, and included representation by Niobrara National Scenic River (NIOB), NPS Northern Great Plains Network, Colorado State University, and other interested agencies and organizations.

New imagery was acquired for the NIOB mapping project in early October 2015. This imagery was delivered as 30 cm 4-band (RGB and CIR) high-resolution orthoimages. Additional imagery supplementing the interpretation phase included current and historic true-color Google Earth and Bing Maps imagery.

Prior to field work, the preliminary classification of the vegetation associations included 82 United States National Vegetation Classification (USNVC) associations; 36 were known to occur in the project area while the other 46 associations were potentially located in the area. Existing vegetation and mapping data combined with field-collected vegetation plot data contributed to the final vegetation classification. Vegetation data collections by field crews at 156 NIOB subjective plot locations over the summer of 2015 supported vegetation classification using hierarchical clustering and professional expertise. Other types were identified in the course of additional field work and photointerpretation reconnaissance. The final vegetation classification includes 46 USNVC associations and 13 park special types. Types include 24 forest and woodland types, 8 shrubland types, 21 herbaceous types, and 6 sparse vegetation types.

The final mapping classification, which cross walks vegetation type(s) present with what can be consistently classified and mapped (i.e., interpreted), consists of 35 map classes within NIOB. Of these 35 map classes, 6 represent land use cover classes (cultivated crops, pasture/hay ground, non-vegetated barren land or borrow pit, developed open space, developed low, medium, or high intensity, and water). Of the 29 non-land use map classes, 17 map classes represent a single USNVC association or park special, five map classes represent two USNVC associations or park specials, three map classes represent three USNVC associations or park specials, two map classes represent four USNVC associations or park specials, one map class represents six USNVC associations or park specials, and one map class represents nine USNVC associations or park specials.

Species dominating in forest and woodland types include eastern redcedar (*Juniperus virginiana*), bur oak (*Quercus macrocarpa*), green ash (*Fraxinus pennsylvanica*), hophornbeam (*Ostrya virginiana*), Virginia wildrye (*Elymus virginicus*), and Kentucky bluegrass (*Poa pratensis*). Dominant species in shrubland types found in NIOB are false indigo bush (*Amorpha fruticosa*), Kentucky bluegrass (*Poa pratensis*), cuman ragweed (*Ambrosia psilostachya*), eastern redcedar (*Juniperus virginiana*), and smooth sumac (*Rhus glabra*). Other, less extensive shrubland types are dominated by western snowberry (*Symphoricarpos occidentalis*). The most common species within herbaceous types include cuman ragweed (*Ambrosia psilostachya*), Heller's rosette grass (*Dichanthelium oligosanthes*), little bluestem (*Schizachyrium scoparium*), white sagebrush (*Artemisia ludoviciana*), switchgrass (*Panicum virgatum*), and blue grama (*Bouteloua gracilis*).

The final NIOB vegetation map consists of 2,762 polygons totaling 29,081 acres (11,768 ha). Mean polygon size for vegetated types is 8.2 acres (3.32 ha). Of the total area, 20,878 acres (8,449 ha) or 72% represent natural or ruderal vegetation map classes. Agricultural vegetation, such as cultivated crops and pasture, account for approximately 3,267 acres (1,322 ha) or 11% of the total mapped area. Non-vegetated barren land is rare and only accounts for 520 acres (210 ha) or 1.8%. Open water is the most widespread land cover class with an area of approximately 4,415 acres (1,786 ha) or 15% of the total mapped area. Within the total area occupied by vegetation map classes, forest and woodland types were the most extensive (12,278 acres (4,969 ha) or 42%), followed by herbaceous types (7,021 acres (2,841 ha) or 24%), shrubland types (1,134 acres (532 ha) or 4.5%), and sparse types (265 acres (107 ha) or 0.9%).

A total of 755 accuracy assessment (AA) samples were collected to evaluate the thematic accuracy of the vegetation polygon data. As a simple proportion, the final thematic accuracy was 84.5%. When map class accuracies were weighted in proportion to the area they occupy within NIOB, the overall accuracy was 87.8%. Two map classes were retained that still fell below the 80% thematic accuracy threshold. Of these two retained map classes, one had accuracy close to 80%, and the other was a map class represented by only a few polygons (i.e., a map class with three polygons in which only one was mapped incorrectly).

In addition to the vegetation polygon database, the project delivered several other products to support park resource management. A geodatabase links the vegetation data layer to other feature classes, such as vegetation classification and AA plots and associated sampling data from the PLOTS database, plot photos, and project boundary extent. The database includes tables documenting the USNVC hierarchy and allows for spatial queries of data associated with a vegetation polygon or sample point. All geospatial products are projected using North American Datum 1983 (NAD83) in Universal Transverse Mercator (UTM) Zone 14 North. Other products include ArcGIS .mxd files for each of the maps along with the aerial imagery acquired for the project. The final report includes methods and results, descriptions for each vegetation type, a dichotomous field key to vegetation types, contingency tables showing AA results, field forms, a species list, and a guide to imagery interpretation. These products provided NIOB with an array of tools to assist in managing park resources and making informed resource management decisions.

The use of standard national vegetation classification and mapping protocols facilitates effective resource stewardship by ensuring compatibility and widespread use of the information throughout the NPS as well as by other federal and state agencies. This comprehensive geospatial database and associated information support a wide variety of resource assessment, park management, and planning needs. In addition, the associated information provides a structure for framing and answering critical scientific questions about vegetation communities and their relationship to environmental processes across the landscape.

Acknowledgments

The authors wish to thank all who contributed to the success of the project. We would like to thank NPS staff at Niobrara National Scenic River and at the Vegetation Mapping Inventory Program for providing support and guidance for this project. We would also like to thank The Nature Conservancy staff at the Niobrara Valley Preserve and the United States Fish and Wildlife Service for support and access. Helpful review comments were provided by Isabel Ashton (Northern Great Plains Inventory and Monitoring Network) and Billy Schweiger (Rocky Mountain Inventory and Monitoring Network).

1 Introduction

1.1. NPS Vegetation Mapping Inventory Program

In 1994, the National Park Service (NPS) initiated a program to inventory and map vegetation of the national parks in the United States using the United States National Vegetation Classification (USNVC). The goals of the NPS Vegetation Mapping Inventory (VMI) Program are to provide baseline vegetation data for park resource managers, create data in a regional and national context, and provide opportunities for future inventory, monitoring, and research activities (FGDC 1997, Grossman et al. 1998).

The VMI program brings botanists, imagery interpreters, cartographers, and ecologists together during a multi-year project to describe and map existing vegetation types within park boundaries. The preliminary map product is then statistically evaluated to assess thematic accuracy before releasing a final map product that provides a comprehensive classification and map.

The NPS Inventory and Monitoring (I&M) program has developed general guidelines for the development and deliverables of vegetation map products. The guidelines are detailed in the "12-Step Guidance for NPS Vegetation Inventories" (NPS 2013a) and include the following:

1) Review existing data and "best practices" to develop a brief proposal (1-5 pages).
2) Plan and scope to gather the detailed information needed to develop the study plan.
3) Develop and submit a detailed study plan for approval of funding.
4) Collect field plot data (for the ecological classification).
5) Develop vegetation classification, vegetation type descriptions, and field key.
6) Develop mapping model (calibration).
7) Acquire and prepare imagery.
8) Analyze and classify imagery.
9) Prepare GIS database.
10) Validate thematic accuracy of map products.
11) Conduct formal thematic accuracy assessment (AA).
12) Deliver final reports, GIS database, and required products.

A study plan (steps 1-3) was prepared for the Niobrara National Scenic River (NIOB) vegetation inventory project by Colorado State University (CSU) in 2009. This project supports the remaining steps. All final products are consistent with the following VMI Program standards and guidance:

- National Vegetation Classification Standard (FGDC 1997, FGDC 2008)
- Spatial Data Transfer Standard (FGDC 1998a)
- Content Standard for Digital Geospatial Metadata (FGDC 1998b)
- United States National Map Accuracy Standards (USGS 1999)

- Integrated Taxonomic Information System
- Program-defined standards for map attribute accuracy and minimum mapping units (MMU)
- Vegetation Mapping Inventory Program 12-Step Guidance

Products derived from these efforts include:

- Spatial Data
    - Map classification data
    - Spatial database of vegetation communities
    - Field plot data from the classification and AA phases from over 2000 locations
    - Metadata for spatial databases
    - Map files to produce maps at various scales/size and levels of thematic detail
    - Quantitative AA of spatial data
- Vegetation Information
    - Vegetation classification and description of each community present
    - Dichotomous field key of vegetation community
    - Ground photos of vegetation community

NPS vegetation inventory projects classify and map park vegetation using a combination of plot and observation point data, legacy plot data and imagery, field reconnaissance, and photo/image interpretation. The specific protocols and standards used are those for large parks described in NPS program documents (TNC and ESRI 1994, NPS 2013a).

1.2. The United States National Vegetation Classification (USNVC) and National Vegetation Classification Standard (NVCS)

Use of the U.S. National Vegetation Classification (USNVC) (USNVC 2017) is central to fulfilling the goals of this national program. The USNVC uses a systematic approach to classify a continuum, emphasizes natural and existing vegetation, uses a combined physiognomic-floristic hierarchy, identifies vegetation units based on both qualitative and quantitative data, and is appropriate for mapping at multiple scales.

The use of standardized national vegetation classification and mapping protocols facilitates effective resource stewardship by ensuring compatibility and widespread use of the information throughout the NPS as well as by other federal and state agencies. This comprehensive geospatial database and associated information support a wide variety of resource assessment, park management, and planning needs. In addition, the associated information provides a structure for framing and answering critical scientific questions about vegetation communities and their relationship to environmental processes across the landscape.

The USNVC was primarily developed and implemented by The Nature Conservancy (TNC) and the network of state Natural Heritage Programs between 1980 and 2000. More recently, the USNVC is

maintained and updated by the joint efforts of NatureServe, the Federal Geographic Data Committee (FGDC), and the Ecological Society of America (http://usnvc.org/). Refinements to the classification occur when examined by all agencies, leading to ongoing proposed revisions that are reviewed both locally and nationally.

In 2008, the FGDC released Version 2 of the National Vegetation Classification Standard (NVCS), representing a major revision to the standard (FGDC 2008). This project uses Version 2 as its classification standard. Version 2 of the USNVC treats natural/ruderal vegetation and cultural vegetation as two separate hierarchies.

In the USNVC Version 2, the three upper levels of the natural and semi-natural hierarchy emphasize physiognomy, the three middle levels integrate biogeography and floristics, and the two lowest levels are based solely on floristics. Figure 1 depicts the relationship of the hierarchy levels and classification criteria (USNVC 2017).

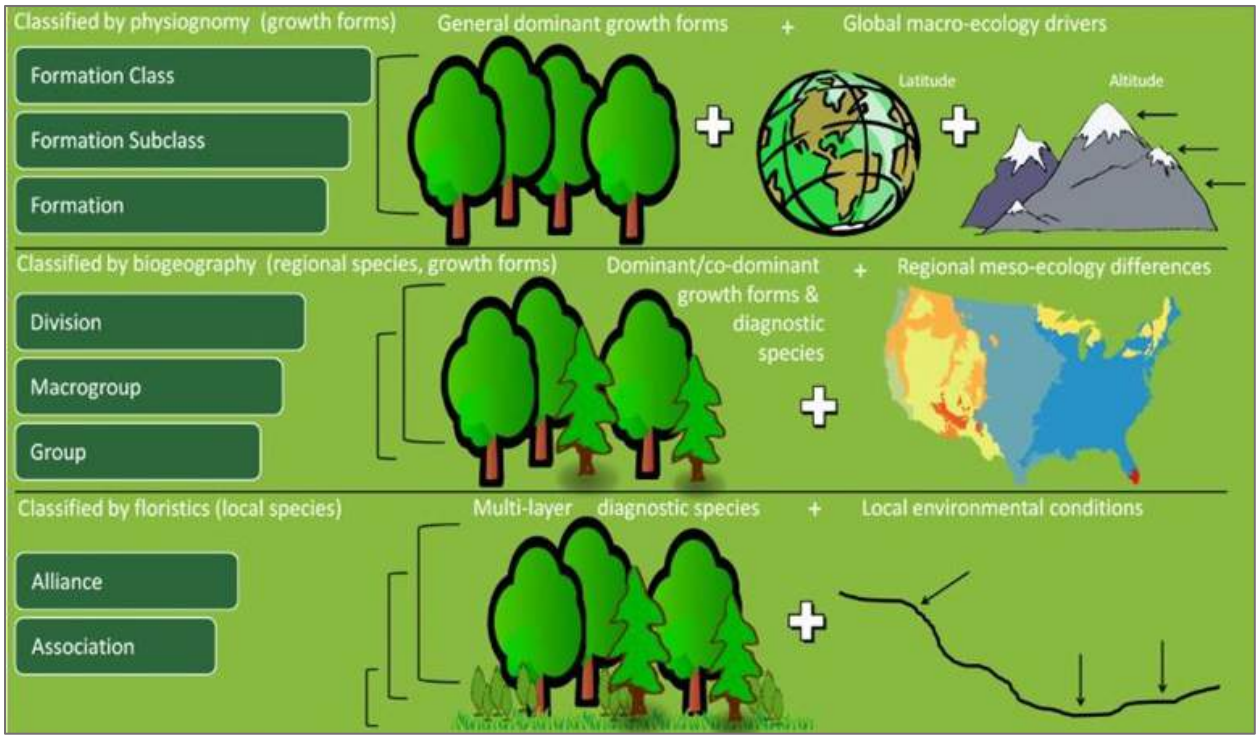

Figure 1. USNVC hierarchy and classification criteria (USNVC 2017).

Alliances and associations are based on both the dominant (greatest canopy cover) species in the upper strata of a stand as well as on diagnostic species (those consistently found in some types but not others). Associations are the most specific classification unit and are hierarchically subsumed in the alliances. Each association is included in only one alliance, while each alliance typically includes many associations. Alliance names are generally based on the dominant/diagnostic species in the uppermost stratum of the vegetation, though up to four species may be used if necessary to define the type. Associations define a distinct plant composition that repeats across the landscape. They are

generally named using both the dominant species in the uppermost stratum of the vegetation and one or more dominant species in lower strata, or a diagnostic species in any stratum. The species nomenclature for all alliances and associations follows that of Kartesz (1999). Documentation from NatureServe (2006) describes the naming and syntax for all USNVC names:

- A hyphen ("-") separates names of species occurring in the same stratum.
- A slash ("/") separates names of species occurring in different strata.
- Species that occur in the uppermost stratum are listed first, followed successively by those in lower strata.
- Order of species names generally reflects decreasing levels of dominance, constancy, or indicator value.
- Parentheses around a species name indicate the species is less consistently found either in all associations of an alliance, or in all occurrences of an association.
- Association names include the dominant species of the significant strata, followed by the class in which they are classified (e.g., "Forest," "Woodland," or "Herbaceous" vegetation).
- Alliance names also include the class in which they are classified (e.g., "Forest," "Woodland," "Herbaceous"), but are followed by the word "Alliance" to distinguish them from associations.

Table 1 provides criteria and examples of vegetation classification using the 2008 hierarchy for natural vegetation (USNVC 2017).

Table 1. USNVC (2017) hierarchy criteria and examples of classified types.*

Category	Category Criteria	Vegetation Classification	Vegetation Classification Criteria	Ecological Context	Scientific Name	Colloquial Name
Upper Levels	Predominantly physiognomy	1 Formation Class	Broad combinations of general and dominant growth forms	Basic temperature (energy budget), moisture, and substrate/aquatic conditions.	Mesomorphic Tree Vegetaion Class	Forest & Woodland
	Predominantly physiognomy	2 Formation Subclass	Combinations of general and diagnostic growth forms	Global macroclimatic factors driven primarly by latitude and continental position, or overriding substrate/aquatic conditions	Temperate and Boreal Forest & Woodland Subclass	Temperate and Boreal Forest & Woodland
	Predominantly physiognomy	3 Formation	Combinations of dominant and dagnostic growth forms.	Global macroclimatic factors as modified by altitude, seasonality, precipitation, substrates, and hydrologic conditions.`	Cool Temperate Forest & Woodland Formation	Cool Temperate Forest & Woodland
Middle Levels	Physiognomy, biogeography, and floristics	4 Division	Combinations of moderate sets of diagnostic growth forms that reflect biogeographic differences.	Contenental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	*Pseudotsuga menziesii – Tsuga heterophylla – Tsuga mertensiana Vancouverian* Forest & Woodland Division	Vancouverian Cool Temperate Forest & Woodland
	Physiognomy, biogeography, and floristics	5 Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences.	Sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	*Calocedrus decurrens – Pinus jeffreyi – Abies concolor* var. *lowiana* Forest Macrogroup	Southern Vancouverian Dry Foothill Forest & Woodland
	Physiognomy, biogeography, and floristics	6 Group	Combinations of relatively narrow sets of diagnostic plant species, including dominants and co-dominants, broadly similar composition, and diagnostic growth forms.	Regional mesoclimate, geology, substrates, hydrology and disturbance regimes.	*Quercus garryana – Pinus ponderosa – Pseudotsuga menziesii* Forest & Woodland Group	Cascadian Oregon White Oak – Conifer Forest & Woodland

*For more information on the USNVC, see Grossman et al. (1998). For more information about the NPS Vegetation Mapping Inventory Program, see the NPS Vegetation Mapping Inventory Program website. Additional information is also available at the FGDC National Vegetation Classification Standard website and the NatureServe Explorer website.

Table 1 (continued). USNVC (2017) hierarchy criteria and examples of classified types.*

Category	Category Criteria	Vegetation Classification	Vegetation Classification Criteria	Ecological Context	Scientific Name	Colloquial Name
Lower Levels	Predominantly floristics	7 Alliance	Diagnostic species, including some from the dominant growth form or layers, and moderately similar composition.	Regional to subregional climate, substrates, hydrology, moisture/nutrient factors, and disturbance regimes.	*Quercus garryana* – *Pinus ponderosa* / *Balsamorhiza sagittata* Woodland	Oregon White Oak – Ponderosa Pine / Geyer's Sedge Woodland Alliance
	Predominantly floristics	8 Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition.	Topo-edaphic climate, substrates, hydrology, and disturbance regimes.	*Pinus ponderosa* – *Quercus garryana* / *Balsamorhiza sagittata* Woodland	Ponderosa Pine – Oregon White Oak / Arrowleaf Balsamroot Woodland

*For more information on the USNVC, see Grossman et al. (1998). For more information about the NPS Vegetation Mapping Inventory Program, see the NPS Vegetation Mapping Inventory Program website. Additional information is also available at the FGDC National Vegetation Classification Standard website and the NatureServe Explorer website.

1.3. Niobrara National Scenic River Vegetation Inventory and Mapping Project

Vegetation inventory and mapping is one of the 12 basic inventories mandated by the NPS Natural Resources Inventory and Monitoring Guidelines issued in 1992. In 2009, the NPS awarded a cooperative agreement to CSU's Center for Environmental Management of Military Lands (CEMML) and the Colorado Natural Heritage Program (CNHP) to develop a study plan for NIOB and implement the inventory described in the study plan. Expertise provided by CNHP, CEMML, and staff from NIOB, the Northern Great Plains Inventory and Monitoring Network (NGPN), and the NPS VMI Program ultimately contributed to the successful completion of the project.

The project was awarded to CSU in 2015. CNHP was primarily responsible for collecting standardized field data, classifying data into vegetation types through analysis and expert opinion, managing plot data, performing the AA, and report writing. CEMML was responsible for acquiring imagery of NIOB, collaborating with CNHP staff on classification issues, developing a mapping model based on limitations of the imagery and interpretation, classifying and delineating vegetation polygons from imagery, developing an imagery interpretation guide, performing informal map validation prior to AA, report writing and database development. NIOB is administratively within the NGPN. Staff from NIOB, NGPN, and the VMI Program provided logistical and technical support, helped coordinate and facilitate fieldwork, and reviewed and evaluated draft data and reports.

1.3.1. Location and Administrative Setting

NIOB is located in north-central Nebraska near the town of Valentine, Nebraska (Figure 2). The Scenic River extends for 76 miles along the Niobrara River, ending at Nebraska State Highway 137. The NIOB boundary contains about 11,768 ha, but the NPS owns only a small portion of this (320 ha) (Narumalani et al. 2010).

The NPS oversees management of the Scenic River by facilitating cooperation between the U.S. Fish and Wildlife Service (USFWS), Nebraska Game and Parks Commission (NGPC), Niobrara Council, The Nature Conservancy (TNC), local governments, and private landowners. Interpretive and access points along the river are operated largely by non-NPS entities. While NPS does have a small office in Valentine, river access sites are managed by Fort Niobrara National Wildlife Refuge (USFWS), Smith Falls State Park (NGPC), and the Niobrara Valley Preserve (TNC).

The park is considered non-traditional because of the large proportion of private lands within the administrative boundary. Approximately 9,500 acres within NIOB are considered "protected" under state, federal, and private ownership and easements. The vision and goals of NIOB are realized through partnerships with private, federal, and state agencies and other stakeholders (Stevens et al. 2010).

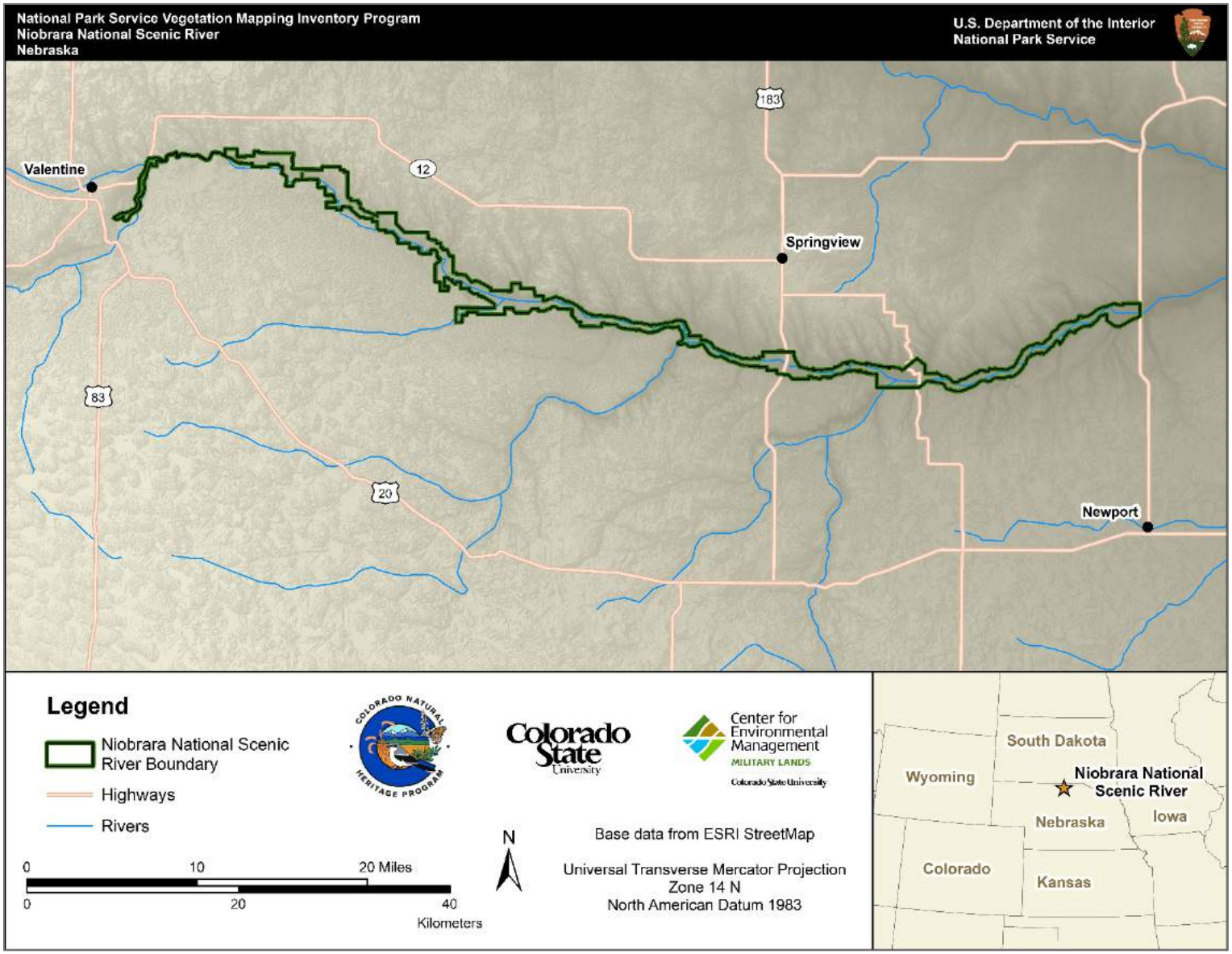

Figure 2. Administrative boundary of NIOB.

The 76-mile reach of the Niobrara River that makes up NIOB was established by a 1991 act of Congress that amended the Wild and Scenic Rivers Act of 1968. Public Law 102-50, which established NIOB, states:

> *Niobrara, Nebraska. (A) The 40-mile segment from Borman Bridge southeast of Valentine downstream to its confluence with Chimney Creek and the 30-mile segment from the river's confluence with Rock Creek downstream to the State Highway 137 bridge, both segments to be classified as scenic and administered by the Secretary of the Interior. That portion of the 40-mile segment designated by this subparagraph located within the Fort Niobrara National Wildlife Refuge shall continue to be managed by the Secretary through the Director of the United States Fish and Wildlife Service (USFWS).*

The USFWS is charged with management of the approximately nine-mile segment that flows through the Fort Niobrara National Wildlife Refuge (NWR), with the NPS managing the remainder of the park's length (Narumalani et al. 2010). The river is heavily used by the public for canoeing, fishing, and summer recreation.

1.3.2. Physiographic Setting

The Niobrara River, as it flows through NIOB, is known for its beauty, biological significance, and paleontological resources. Due to its location within the Nebraska Sandhills region, hundreds of springs emerge from the springbranch canyons along the river, adding substantially to the flow of the river.

NIOB is within the Northwestern Great Plains and Nebraska Sandhills Level III ecoregions (USEPA 2013) (Figure 3). USEPA (2013) describes the ecoregions:

> *The Northwestern Great Plains ecoregion encompasses the Missouri Plateau section of the Great Plains that is mostly unglaciated. It is a semiarid rolling plain of shale, siltstone, and sandstone punctuated by occasional buttes and badlands. Rangeland is common, but spring wheat and alfalfa farming also occur; native grasslands, persist in areas of steep or broken topography. Agriculture is restricted by the erratic precipitation and limited opportunities for irrigation.*
>
> *The Nebraska Sandhills comprise one of the most distinct and homogenous ecoregions in North America. One of the largest areas of grass stabilized sand dunes in the world, this region is generally devoid of cropland agriculture and, except for some riparian areas in the north and east, the region is treeless. Large portions of this ecoregion contain numerous lakes and wetlands and have a lack of streams. The area is sparsely populated; however, large cattle ranches are found throughout the region.*

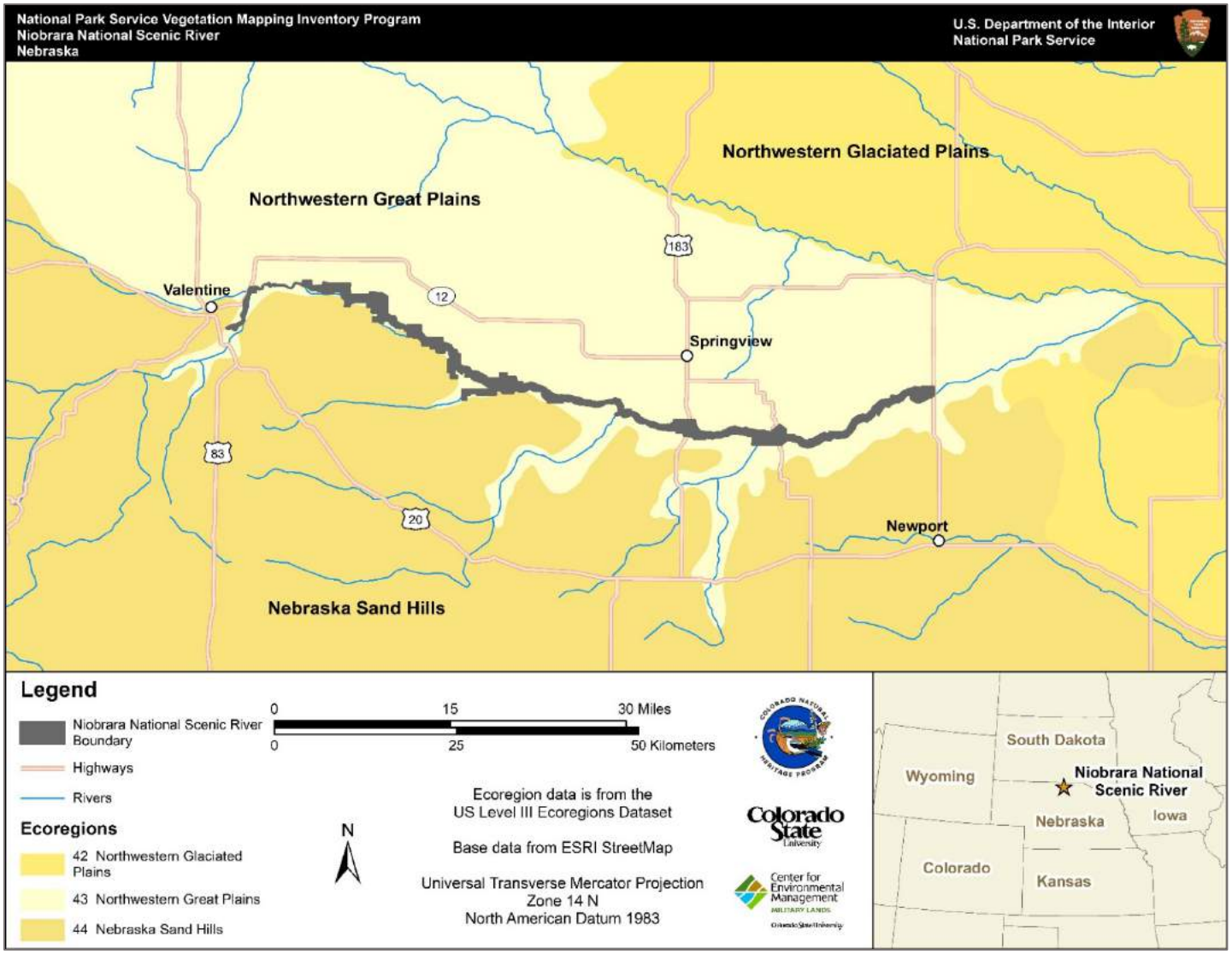

Figure 3. Level III Ecoregions at NIOB (USEPA 2013). NIOB is located at the northern edge of the Nebraska Sandhills within the Northwestern Great Plains.

The overall landscape consists of plains and low hills of gentle relief to steep canyons and cliffs along the river. Vegetation in theses sections is predominantly herbaceous with woodlands along riparian areas. NIOB is located where six broad ecological systems - northern boreal forest, ponderosa pine forest, eastern deciduous forest, tallgrass prairie, mixedgrass prairie, and shortgrass prairie - converge and overlap (NPS 2013b). Generalized land cover is mainly grasslands and forests, with scattered and linear water bodies and wetlands. Developed, cultivated, and barren land comprised <5% of the land cover in 2011; privately held agricultural/pasture land is a common land cover type in NIOB (24%) (NPS 2013b).

1.3.3. Climate

Average annual precipitation is 51 cm with 75% falling as rain during the growing season from April to September (Narumalani et al. 2010). In the winter, there is usually about 94 cm of snow

(Narumalani et al. 2010). The lowest average monthly temperature occurs in January (-6.2˚C), and the highest average monthly temperature occurs in July (23.3˚C) (Fisichelli et al. 2014). Temperatures could increase by 2.3˚C-8.0˚C by the year 2100 (Fisichelli et al. 2014). Winds are usually stable and range from 8-24 km/h all year. The wind blows from the north in the winter and the south in summer (Narumalani et al. 2010).

Severe droughts affect the Central Plains on approximately a 20-year (bi-decadal) and a 40-year (multi-decadal) cycle. Many minor droughts may also occur within these cycles (Hayes et al. 2005). The lack of precipitation during periods of drought can have a significant effect on agriculture and native flora in the NIOB area (Wilhelmi and Wilhite 2002). Nebraska was heavily impacted by severe drought in 2013 and experienced a minor drought in 2017 (NOAA 2018).

1.3.4. Geology

The landscape of NIOB is striking due to the influence of the river on vegetation and contrasts between the north and south-facing valley slopes. One characteristic feature of this area is steep slopes from the Sandhills down to the river. This has been caused by recent erosion of unconsolidated sediments ~27,000 years ago (Larson 2001, Jacobs et al. 2007). There are four distinct geologic layers within the middle Niobrara River Valley (Diffendal and Voorhies 1994).

The bedrock of the valley is composed of the Rosebud formation. The Valentine formation forms gentle slopes on the north side of the river. Above the Valentine formation, the Ash Hollow formation forms a grayish cap-rock that is present on the hills on the rim of the valley (Joeckel et al. 2015). To the south of the river, the Rosebud Formation is overlain by recent aeolian sands from the Nebraska Sandhills (Narumalani et al. 2010). Downstream in the lower Scenic River, the Pierre Shale may be seen as large outcrops on either side of the river (Diffendal and Voorhies 1994).

1.3.5. Soils

The majority of soils within NIOB are mainly aeolian sand from the Nebraska Sandhills to the south. Soil development is mainly restricted to the river terraces and is poor to absent on the cliffs (Layton 1956). In the river valley, loamy fine sands occur along the bottomlands while fine sandy loams occur on the terraces (Layton 1956). To the south, the soil is dominated by aeolian sand, and sandy to loamy soils dominate to the north of the river (Joeckel et al. 2015).

1.3.6. Hydrology and Water Resources

The Niobrara River begins near Lusk, Wyoming, flowing over 535 miles across north-central Nebraska to its confluence with the Missouri River near Niobrara, Nebraska. The river drains approximately 7,456 square miles (19,312 km^2) of northwestern Nebraska and east-central Wyoming (Istanbulluoglu 2008). The Niobrara River is considered a major tributary to the Missouri River.

The main tributaries of the Niobrara River include the Snake River, Minnechaduza Creek, Keya Paha River, and Long Pine Creek (Narumalani et al. 2010). Merrit Dam and Reservoir, Cornell Dam, and Spencer Dam divert irrigation water from the Niobrara (Narumalani et al. 2010). The Niobrara relies mainly on ground water from the Ogallala Aquifer to support flows (Joeckel et al. 2017). Extensive ground water seepage from the Nebraska Sandhills discharges into numerous springbranch canyons on the south side of the river. Springbranch canyons occur along north-facing slopes along the river where water from the Sand Hills emerges as springs (Narumalani et al. 2010). These springbranch canyons provide unique microclimates for vegetation, and over 230 waterfalls have been found within these canyons at NIOB. The western portion of the river is more entrenched within the valley (Mason 2005), while the eastern portion of the river widens and slows, creating a meandering channel with numerous sandbars (Narumalani et al. 2010). Much of the middle portion of the river flows directly over bedrock creating numerous riffles and rapids (Johnsgard 2007).

1.3.7. Flora and Fauna

The Niobrara River Valley hosts a variety of unique and unusual ecosystems that are often regarded as occurring outside of their normal geographic range. Plant communities represented in eastern deciduous forest, northern boreal forest, and Rocky Mountain coniferous forest all converge with grassland communities from Sandhill prairies, mixedgrass prairie, shortgrass steppe, and eastern tallgrass prairies to form a truly unique assemblage of vegetation communities (Kaul et al. 1988, Johnsgard 2007). As early as 1887 botanists have been interested in this unique landscape (Bessey 1887).

South of the river valley, relict sand dunes support a diverse assemblage of prairie communities, with dominant species including *Andropogon hallii* and *Calamovilfa longifolia*. The springbranch canyons along the south slope of the valley contain permanently flowing springs and seeps, which provide a unique microclimate that supports relict flora not found elsewhere in the local region. These relict communities include small stands of remnant paper birch (*Betula papyrifera*) and aspen hybrids (*Populus* x *smithii* (*P. grandidentata* x *P. tremuloides*)) that are hypothesized to have been prevalent in the area during the Pleistocene glacial period and have since persisted due to the unique microsites where they occur. Birch and aspen communities at NIOB are believed to be largely in decline due to a host of factors including climate, pest and pathogens, loss of genetic diversity, and a lack of disturbance events favoring regeneration (Steuter and Steinauer 1993, Stroh and Miller 2009, Narumalani et al. 2010).

There are no federally listed endangered or threatened plants documented at NIOB (U.S. Department of Interior 2006). There is one species considered at-risk by the Nebraska Game and Parks Commission (NGPC) within the central Niobrara River Valley—the small white lady's-slipper orchid (*Cypripedium candidum*) (Narumalani et al. 2010).

An example of a springbranch canyon. (CSU photo)

Non-native invasive plant species found at NIOB include purple loosestrife (*Lythrum salicaria*), leafy spurge (*Euphorbia esula*), Canada thistle (*Cirsium arvense*), spotted knapweed (*Centaurea maculosa*), and common reed (*Phragmites australis* var. *australis*) (Narumalani et al. 2010). Eastern redcedar (*Juniperus virginiana*), which is a native species originally found further east of NIOB, has become common and invasive in grasslands and other ecotypes in the NIOB area due to lack of fire.

During the summer of 2012, a large fire burned through the Niobrara River Valley (Hefner 2014). The fire burned 76,242 acres and killed a majority of the mature ponderosa pine stands within NIOB (Hefner 2014). This fire has resulted in a "burnt disturbed forest" map class. With the available imagery, individual species that were burned could not be identified; the "burnt disturbed forest" map class tries to capture all the area impacted by the fire and currently regenerating.

The Niobrara River Valley supports a diverse fauna. There are a total of 185 species of birds known from the Niobrara River Valley (Narumalani et al. 2010). Many of these species are resident, but NIOB also provides critical habitat for migrating birds (Narumalani et al. 2010). Federally listed species include the least tern (*Sternula antillarum athalassos*), piping plover (*Charadrius melodus*), and whooping crane (*Grus americana*).

Historically, there was a variety of large mammals within the valley, including bison (*Bison bison*) and elk (*Cervus elaphus*) (Narumalani et al. 2010). These species were extirpated in the 1800s and now only exist on ranches, refuges, and TNC lands, largely as managed herds (Narumalani et al. 2010). A small population of wild/escaped elk are reported within the Fort Niobrara NWR. The main predator in the region is the coyote (*Canis latrans*); however, recent sightings suggest that a resident population of mountain lion (*Felix concolor*) may be present in NIOB (NGPC 2018). Mammals of interest include eastern woodrat (*Neotoma floridana baileyi*), which is a distinct subspecies disjunct from its core range by ~190 km (Narumalani et al. 2010), bog lemming (*Synaptomys* sp.), a

Pleistocene relict, and the river otter (*Lontra canadensis*), which is a state-listed species (Narumalani et al. 2010).

Twenty-two species of reptiles and amphibians are found within NIOB (Fogell and Cunningham 2005). Herpetological surveys at NIOB have been difficult in the past due to challenges surveying the extensive private land, so additional species may be present and undocumented within the park (Fogell and Cunningham 2005). Thirty species of fish have been reported from the Niobrara River Valley (Narumalani et al. 2010). Several state-listed species of fish may occur within NIOB, including blacknose shiner (*Notropis heterolepsis*), finescale dace (*Phoxinus neogaeus*), and northern redbelly dace (*Phoxinus eos*).

2. Vegetation Inventory and Classification

2.1. Methods

Vegetation classification was conducted following NPS methodology in Vegetation Classification Guidelines (Lea 2011).

2.1.1. Legacy Data

The vegetation inventory study plan for NIOB identified a variety of legacy datasets and base spatial data to support vegetation classification and mapping at NIOB (Stevens et al. 2010). Legacy data were evaluated using the TNC and NPS (2009) evaluation framework (Table 2, Table 3).

Table 2. Summary of legacy data evaluation using TNC and NPS (2009) criteria.

Legacy Data Category	Description
I	Data are adequate for classification and mapping (i.e., the data are georeferenced, represent existing vegetation, and contain sufficient structural, compositional and site information to place the sample within the standard classification framework).
II	Data are adequate to assist in photo interpretation, photographic signature key development, or map accuracy assessment (i.e., the vegetation and site information are of lower quality, but the samples represent existing vegetation and are georeferenced with reasonable confidence).
III	Data can be used for vegetation classification and characterization of a vegetation type within the park, but not for mapping or analysis because the sample is not adequately georeferenced, contains inadequate detail in the vegetation information, and/or may not represent existing vegetation at the sample location.
IV	Data were found to be not useful at any level.
V	Data set was not available for assessment.

Table 3. Legacy data ratings from Stevens et al. (2010).

Legacy Data Category	Data Source Citation
II	Steuter and Steinauer (1993)
	Stroh and Miller (2009)
III	INHS (2010)
IV	CALMIT (2003)
	Kantak (1995)
	Kaul et al. (1988)
	Steuter et al. (1990)
	USGS (2003)

Table 3 (continued). Legacy data ratings from Stevens et al. (2010).

Legacy Data Category	Data Source Citation
V	Narumalani (2009a)
	Narumalani (2009b)
	Narumalani and Swain (2009)
	Rolfsmeier (2001)
	Schlarbaum (2008)

Preexisting data were mostly ranked in Categories III, IV and V, and could not replace vegetation plots for the classification component. However, Steuter and Steinauer (1993) and Stroh and Miller (2009) provided excellent data and helped identify areas where springbranch communities supporting paper birch (*Betula papyrifera*) were likely to exist. These studies also helped inform local descriptions for these communities.

2.1.2. Sample Design

Planning and Scoping

For the initial planning and scoping meetings CSU staff traveled to Valentine, Nebraska, and met with NPS NIOB staff, NPS NGPN staff, NPS VMI program managers, and other interested agencies and subject matter experts. A field tour of NIOB took place on December 9, 2009, and a scoping meeting with park staff and other stakeholders took place December 10, 2009. The participants, and affiliations of each, are shown in Table 4 below.

Table 4: Participants and affiliations of the December 9, 2012 planning and scoping meeting.

Name	Affiliation
Joe Stevens	CSU, CNHP
David Jones	CSU, CEMML
Dan Foster	NIOB, Superintendent
Pamela Sprenkle	NIOB, Chief of Resources
Stuart Schneider	NIOB, Chief Ranger
Gerry Steinauer	Nebraska Natural Heritage Program
Jim Luchsinger	Nebraska TNC
Mike Bynum	NPS, NGPN
Todd Frerichs	Fort Niobrara NWR
Levi Feltman	Fort Niobrara NWR
Kathy McPeak	Fort Niobrara NWR

Group discussion at the scoping meetings included defining the project area boundary, evaluating existing sources of vegetation data, evaluating availability of existing imagery and maps, and evaluating various logistical issues such as the potential schedule for the work, land access, other stakeholders, and opportunities for in-kind support from NIOB.

Sample Size

Based on the estimated 45 vegetation types identified by the preliminary classification (Stevens et al. 2010) and a minimum sample of three plots per type, an idealized total of approximately 150 plots was needed to support the classification. However, in practice, the number of vegetation types encountered tends to increase with increasing effort. Moreover, some types are oversampled, while others are undersampled. Therefore, an additional 150+ potential plot locations were allocated subjectively in areas of interest to the photo interpreters. These plots could be treated as either vegetation classification plots (more detail) or observation points (less detail). Opportunistic plot sampling was also carried out in the course of field work. As the field season progressed, if a crew found a good example of a type not on the preliminary list, either a vegetation plot or an observation point was collected. Although some plots were allocated in a stratified random fashion, all classification plots should be treated as subjective or non-random.

The preliminary classification list containing known, potential, and ruderal types is presented in Appendix G, which provides USNVC Alliance name, USNVC Association global name, name assigned by Steinauer and Rolfsmeier (2003), wetland status, the probability of the type occurring on NIOB, and the NatureServe element code or ELCODE.

Photo showing the diversified landscape along the Niobara River.

Sampling Strata

For the vegetation classification sampling design, a sample frame was developed using a combination of U.S. Geological Survey (USGS) Gap Analysis Project (GAP) ecological systems and

land cover classes from GAP maps, a landform data layer reflecting slope steepness and aspect, a cost/safety layer and a geomorphic layer derived from United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) soil survey data. No other vegetation maps exist for NIOB. The primary objectives of the sampling design were to disperse samples across the landscape and to include as many different ecological communities as possible. Development of the input layers is described below.

GAP Land Cover Data Layer

Raster GAP Project data for Nebraska were used as the primary sampling stratum. Land cover classes were drawn from the Ecological System Classification developed by NatureServe (Comer et al. 2003) and land cover classes developed by Anderson et al. (1976). Land cover layers were clipped to the NIOB study boundary. After removing developed classes, open water, and cultivated cropland classes, as well as any vegetation classes occupying less than 1 acre, a total of 12 unique ecological systems remained within NIOB (Table 5). A *3 x 3 Majority Filter Neighborhood* and a *Clump and Eliminate* procedure were run in ERDAS IMAGINE software to generalize the data layer and eliminate small clusters of pixels.

Table 5. NIOB ecological systems and other mapped land use classes based on Nebraska GAP data.

Vegetation Class	Ecological System/Land Use	#Acres Classified on Niobrara	% of Park
Forest & Woodland	Western Great Plains Wooded Draw and Ravine	278.7	0.96%
	Northwestern Great Plains - Black Hills Ponderosa Pine Woodland and Savannah	1278.3	4.39%
	Western Great Plains Dry Bur Oak Forest and Woodland	5363.1	18.42%
Shrubland & Grassland	Western Great Plains Floodplain Systems	3882.8	13.34%
	Introduced Upland Vegetation - Perennial Grassland and Forbland	70.3	0.24%
	Western Great Plains Sand Prairie	5944.8	20.42%
	Western Great Plains Tallgrass Prairie	154.8	0.53%
	Central Mixedgrass Prairie	3590.6	12.34%
	Western Great Plains Depressional Wetland Systems	8.2	0.03%
	Eastern Great Plains Wet Meadow, Prairie and Marsh	417.0	1.43 %
	Northwestern Great Plains Mixedgrass Prairie	1442.7	4 .96%
Agricultural Vegetation	Pasture/Hay	350.5	1.20 %
	Cultivated Cropland	774.4	2.66%

Table 5 (continued). NIOB ecological systems and other mapped land use classes based on Nebraska GAP data.

Vegetation Class	Ecological System/Land Use	#Acres Classified on Niobrara	% of Park
Developed & Other Human Uses	Developed, Medium Intensity	1.8	0.01%
	Developed, Low Intensity	9.1	0.03%
	Developed, Open Space	482.6	1.66%
Other	Open Water (Fresh)	5038.8	17.31%
	Disturbed, Non-specific	19.3	0.07%

Landform Data Layer

A modeled landform data layer was created from a 30 m digital elevation model (DEM) from the USGS National Elevation Dataset (1999). An ArcInfo Macro Language (AML) script, developed by Southwest GAP Regional Land Cover mapping project and Utah State University, was applied to the DEM resulting in a landform dataset displaying topographic position, relative moisture, and slope gradient (Manis et al. 2002). The ten landform classes are: 1) valley flats; 2) gently sloping toe slopes, bottoms and swales; 3) gently sloping ridges, fans and hills; 4) nearly level terraces and plateaus; 5) very moist steep slopes; 6) moderately moist steep slopes; 7) moderately dry steep slopes; 8) very dry steep slopes, cool aspect scarps, cliffs and canyons; and 10) hot aspect scarps, cliffs and canyons. A *3 x 3 Majority Filter Neighborhood* and a *Clump and Eliminate* procedure were run ln ERDAS IMAGINE to generalize the landform data layer and eliminate small clusters of pixels.

Geomorphology Class Based on Soils Data

NRCS soil survey data were downloaded for the project area, including data from numerous counties in Nebraska. A variety of soil attributes were evaluated for inclusion in the sampling strata. Ultimately, it was decided that the geomorphic description attribute from the Soil Survey Geographic (SSURGO) database would help target some of the less common landscape ecosystems within NIOB. In addition to the plots allocated randomly and subjectively using the land cover and landform combined classes, 25 of the least common geomorphic classes found on less than 100 acres within NIOB were identified, and approximately 50 plots were subjectively placed in polygons that, based on examination of imagery, appeared to support non-cultural vegetation. Examples of these classes include moraines on till plains, swales on floodplains on river valleys, valley sides on uplands, swales on flood plains on valleys, channels on drainageways on uplands, and valleys on fills.

Accessibility and Safety Layer

Areas having steep terrain and cliffs were considered inaccessible or too hazardous for field work. A cost surface using a threshold of 40+ degrees or 89 percent slope was developed using a 10 m DEM data layer.

Plot Allocation

Sample locations included both randomly allocated points and subjectively located points. Extra points were also allocated to accommodate limited access. The ten-category landform data layer was intersected with the ecological system data layer containing 22 classes to create strata characterized by vegetation and a dominant landform. Paved and unpaved roads were buffered 25 m from the road center line and clipped from the allocation layer to avoid allocation of samples in disturbed roadside areas. Areas with slope of 40 degrees or more were then removed, resulting in the final allocation. The final allocation layer was overlaid on the land ownership layer to create unique combinations. For the stratified random allocation, approximately 70 plots were allocated to both private and publicly accessible land (total of 140 plots), approximately 50 plots were randomly allocated across the landform layer, and another 60 plots were subjectively located across private and publicly accessible lands (total of 60 plots) using remotely-sensed imagery.

Opportunistic plot sampling was also carried out in the course of the field work. As the field season progressed, if a crew found a good example of a type not on the preliminary list, either a vegetation plot or an observation point was collected. When planning field work, three "target destinations" were selected by examining the imagery for the area before going into the field. Randomly assigned points were treated as either vegetation classification plots (more detail) or observation points (less detail). Additionally, data from 150 to 200 observation points were targeted to support the mapping process. Some of these observation plots also supported classification and development of local descriptions.

2.1.3. Vegetation Data Collection

Sampling of vegetation classification plots was conducted over the summer of 2015 by two two-person crews and a crew leader. Crews were housed for the duration of the field effort in a private rental house near Valentine. Field sampling locations were accessed from roads using four-wheel drive vehicles and from the river using canoes.

2.1.4. Plot Sampling

The goal of the vegetation classification sampling was to survey a minimum of three plots per vegetation association, and to document as many vegetation types as possible within NIOB. The study plan had previously identified 82 potential vegetation types for NIOB (Stevens et al. 2010). NIOB is a long, diverse area with few access points, so crews were hired for their ability to work in variable outdoor conditions, to work while hiking, and to make careful and effective choices as to best access routes to plots.

Crew members were provided with a field manual describing the field forms and plot sampling methodology, as well as supplemental information on NIOB, backcountry safety, plant species lists, and accepted plant species codes. Data were collected using Garmin Global Positioning System (GPS) units and paper field forms. Crews were provided with maps and GPS units loaded with random and subjective plot locations to help disperse the efforts across ecological types and gradients.

The field forms document the plot location, environmental attributes, vegetation attributes, and comments/notes (Table 6). A representation of the field form is included in Appendix E.

Table 6. Specific attributes recorded on the vegetation plot form.

Section	Attributes
Location Information	Plot code, plot type, survey date, surveyors, provisional community name, UTM zone and coordinates, GPS accuracy, comments, plot shape, plot dimensions, camera number, photo numbers, representativeness of the vegetation to the provisional association, and representativeness of the plot within the stand.
Environmental Attributes	Slope, aspect, topographic position, landform, surficial geology, Cowardin class, hydrology, soil texture, soil drainage, percent ground cover, and environmental comments.
Vegetation Attributes	Leaf phenology, leaf type, physiognomic class, height class, cover class, dominant species by strata, vegetation comments, species list for all species in the plot indicating stratum and cover class, and any additional species outside the plot.

Plots were all located in front-country (less than ~3 hours travel time from vehicle to accessible points); no back-country areas were sampled as none truly exist in this park. To minimize travel time, crews occasionally camped within state recreation areas to sample the easternmost reaches of NIOB. Camping was usually only for several days at a time. Additionally, since this work occurred along a river, many of the sites were reached by canoe. A shallow-bottom canoe was necessary to reach most of the areas on the eastern end of the river where the river becomes shallower and more braided.

Overview of the data collection and plot sampling process

Prior to leaving for the field each day, and before each multi-day trip, the crew leader and field crew would plan a strategy for sampling plots most efficiently. Planning took into consideration the proximity of roads, trails, topography, and vegetation in the area to be visited. Using these considerations, crews planned routes to collect the most plots in the most different potential vegetation types without excessive travel time. Crew members would then gather all field equipment and personal gear needed for the duration of the trip.

Navigation to plots was accomplished through the use of GPS units as well as maps and compasses via motor vehicle, boat, and foot travel. After arriving at a selected site, crews would walk through the area to understand the vegetative characteristics of the plot. Crews would also try to determine whether the plot was representative of the vegetation as a whole, and whether the plot met the minimum mapping unit size of 0.5 hectare (5000 m^2).

If the plot was too heterogeneous or too close to an ecotone, crews would move the plot center (within the standards of project methodology) to a position having more homogenous structure and/or composition. If the plot was an opportunistic plot, crews determined whether or not the plot represented a provisional community type still needing to be sampled, and if so, the crew sampled it using either a classification plot or an observation point. An observation point documents the structure, dominant species, and environmental attributes of a dimensionless plot. Observation point

data can be collected using the same forms and instructions as for full vegetation plots, but the information gathered is less detailed. Observation points are very useful for the photo interpreters as training/reference sites.

While navigating to and from selected plots, crew members paid attention to the vegetation types they were passing through. If they observed other different vegetation types or found possible new vegetation types (undocumented vegetation composition that repeated on the landscape), an opportunistic vegetation plot could be established.

At each sampling location, plot layout and data collection followed the NPS VMI Program protocols. Since much of NIOB is privately owned, the field crews did not leave permanent plot markers. Plot locations were recorded using a Garmin Oregon 650 GPS. Crews recorded the UTM coordinates on the physical field form and, using the plot center as a reference, laid out the plot using measuring tapes and flagging according to the size and shape specified in the field manual for that vegetation type (most plots were 400 m^2). Forests, woodlands, and shrublands typically had a 20x20 m square plot, but the plot shape was adapted to best fit the existing vegetation as needed (e.g., 10x40 m linear plots in riparian area). Circular plots with an 11.3 m radius were used for areas with dwarf shrub and herbaceous vegetation.

Following plot setup, crews analyzed the structure by visually dividing the vegetation into strata/layers corresponding to varying heights and recording the dominant species and percent cover in each stratum. Crews would then develop a comprehensive species list for the plot by recording the species name and canopy cover class for each stratum. The cover scale used for the plot sampling is provided in Table 7. The midpoint of each cover class is used for quantitative analysis.

Table 7. Cover classes used for plot sampling.

Cover Class	Cover Range	Mid-point
Trace	0-1	0.5
Present	1-5	3.0
1	5-15	10.0
2	15-25	20.0
3	25-35	30.0
4	35-45	40.0
5	45-55	50.0
6	55-65	60.0
7	65-75	70.0
8	75-85	80.0
9	85-95	90.0
10	>= 95	97.5

A relative measure of how well the vegetation within the plot represented the vegetation of the surrounding landscape was recorded, along with other data describing the environmental characteristics of the site (slope, aspect, topographic position, soil texture, and percent ground cover).

All data were collected using paper field forms. Photos were taken using a camera on the Garmin GPS unit. Photos were taken of each cardinal direction (north, east, south, and west, in that order) from the plot center.

Before breaking down the plot, crews attempted to assign one of the preliminary vegetation types to the plot. If the plot did not fit into a vegetation type, the crew assigned a type based on the dominant species in the top two strata. When the plot information was complete, crews navigated to the next nearest plot.

Private Landowners

Since most of the land within NIOB's administrative boundary is owned privately, vegetation field crews were required to find landowners and ask permission for access. This was done through either locating a phone number and calling or knocking on doors. Unfortunately, many landowners could not be contacted and a majority of those that were contacted declined requests for access. Only a small portion of landowners contacted actually granted field crews permission to access their property. The denial of access to a majority of the NIOB acreage restricted vegetation field crews from reaching many of their randomly allocated vegetation plot points. Subsequently, crews focused more on The Nature Conservancy property and public lands such as state parks. The general distribution of plots sampled is shown in Figure 4. Areas with relatively poor access include much of the eastern half of the NIOB. The impact on this sampling constraint on the area of inference and thematic map class accuracies is unknown. There may be additional communities on inaccessible private lands. In general, we feel that the park's vegetation type diversity is well represented on the lands that were sampled. It's possible that the accuracy of polygons on inaccessible lands is lower than on accessible lands because no samples or reconnaissance data were collected there.

2.1.5. Vegetation Classification

Data Management

At the end of the field season, data were entered from the field forms into NPS PLOTS database version 4.0 (CNHP 2015). Once all data were in PLOTS, the data were examined to eliminate any remaining errors. This quality control process involved examining, sorting, and querying data to locate missing or erroneous information such as misspellings, duplicate entries, or typographical errors. Plant names were entered into the database using the USDA NRCS PLANTS Database (USDA NRCS 2018) approved names and plant codes. Recorded species lists for each plot were compared to assigned vegetation type to ensure congruity.

Each plot or observation point was labeled with the preliminary classification name the crews assigned in the field. That name was taken from the preliminary classification and was based on their subjective classification of the plot vegetation composition and structure. Data in the database designated whether the record was for an observation point (plot type=1) or a vegetation plot (plot type=0).

Photos collected at vegetation and observation plots were uploaded to the NIOB vegetation inventory folder and renamed using a naming convention indicating the park name, plot number and cardinal direction in which the photo was taken.

Vegetation Classification

Vegetation plot data were classified to plant community using a combination of quantitative multivariate analysis and expert opinion. The quantitative analysis was completed using the data from the 156 vegetation classification plots that were exported from the PLOTS 4 database. For simplicity, since most species tend to dominate in a single stratum, for a given plot, the cover values for all strata were combined for each species present, with a maximum cover of 100%. The cover class midpoints were used for all quantitative and descriptive uses of the data. The data were organized into a plot x species matrix containing canopy cover values for all strata combined. Text files were then imported into the multivariate statistics software package PC-ORD version 6.0 (McCune and Mefford 2011).

Because the range of communities and ecological zones sampled was very diverse, we created *a priori* breaks in the dataset based on the physiognomy (e.g., wooded, shrubland, herbaceous, etc.) of the dominant species of the plots, with dominance determined by the uppermost strata. The separate analysis of these physiognomic groups simplified the analysis and helped to prevent ecologically unrelated community types from being compared. Plots that had only one or two strongly dominant species and that did not relate to other plots (e.g., cattail marsh with 90% *Typha latifolia*) were separated out for analysis using qualitative expert review.

Each of the groups was analyzed using hierarchical cluster analysis applying the Sorenson (Bray-Curtis) distance measure method and group average linkage method (McCune and Grace 2002). The output of the analysis suggested natural groups of plots for comparison with the concepts of the USNVC associations in the preliminary classification. For making decisions on refinement of the dendrograph, natural groupings were identified, and data behind the plots in the groupings were manually analyzed. This analysis took into account environmental characteristics of the plot and species composition, as well as the provisional community name given to the plot by the field researchers. Where necessary to reach the association level, further division of the groups involved examining plot data such as species composition, environmental data, and plot notes using Microsoft (MS) Access and MS Excel. Using these combined data, plots were assigned existing USNVC associations or given provisional names. Classification of observation point data to USNVC types was also based on this approach. Provisional associations, or “park specials,” were created to represent associations for which we could not confidently assign an existing USNVC type. Park special types are not currently part of the USNVC.

Field visits to verify map classes also identified existing USNVC associations that were not captured during the classification field data collection phase. These associations were documented in the field by mappers in the course of conducting reconnaissance and verification and added to the list of associations classified in NIOB.

Association Descriptions

Brief narratives that describe each classified type as it is expressed at NIOB were written from the plot data used in the type's classification. These are referred to as the "local descriptions." They include a discussion of the placement of the type within the USNVC hierarchy, a description of the environmental setting where the type usually occurs, a description of the composition and structure of the vegetation, stratum, and lifeform of the most abundant vegetation, and the plots from which it was sampled.

The "global descriptions" incorporate all known plot data from across the entire range over which the type is known to occur. Because the geographic distances over which the type is described is broader, so too is the range of characteristics broader. The range-wide global vegetation and environmental descriptions were compiled for the NIOB project when available. In addition to these global descriptions, descriptions from cross-walked Nebraska Natural Heritage Program (NNHP) descriptions were compiled for each applicable association. The local, global, and NNHP descriptions for NIOB associations are provided in Appendix A.

Field Key to the Community Types

A field key to the communities classified at NIOB was developed using the vegetation plot data and the local descriptions. The key is stratified by physiognomy (sub-keys) and is dichotomously structured within each sub-key. The key was written to be nominally redundant for those types with confusing physiognomy and classification (e.g., is box elder (*Acer negundo*) a shrub or a tree?). In that way, starting to key from either sub-key should reach the same conclusion. The NIOB Key to the associations is included in Appendix B.

2.2. Results

A total of 59 distinct vegetation communities, including USNVC associations and park specials, were identified within NIOB. The most common communities that occurred in NIOB are Forest and Woodland, and Herbaceous types. The most common species are weedy and include *Juniperus virginiana*, *Ambrosia psilostachya*, and *Dichanthelium oligosanthes*.

2.2.1. Vegetation Data Collection

The preliminary classification produced in the spring of 2015 prior to field sampling included 82 USNVC vegetation types, which local experts had reasonable certainty would occur within NIOB. The preliminary classification was used to target locations where field data collection took place.

Over the course of the field sampling season, a total of 156 vegetation plots and observation points were established within the NIOB project area (Figure 4). Of these, 87 were full vegetation plots and 69 were observation points. Access to areas of NIOB were restricted due the extensive range of private landownership.

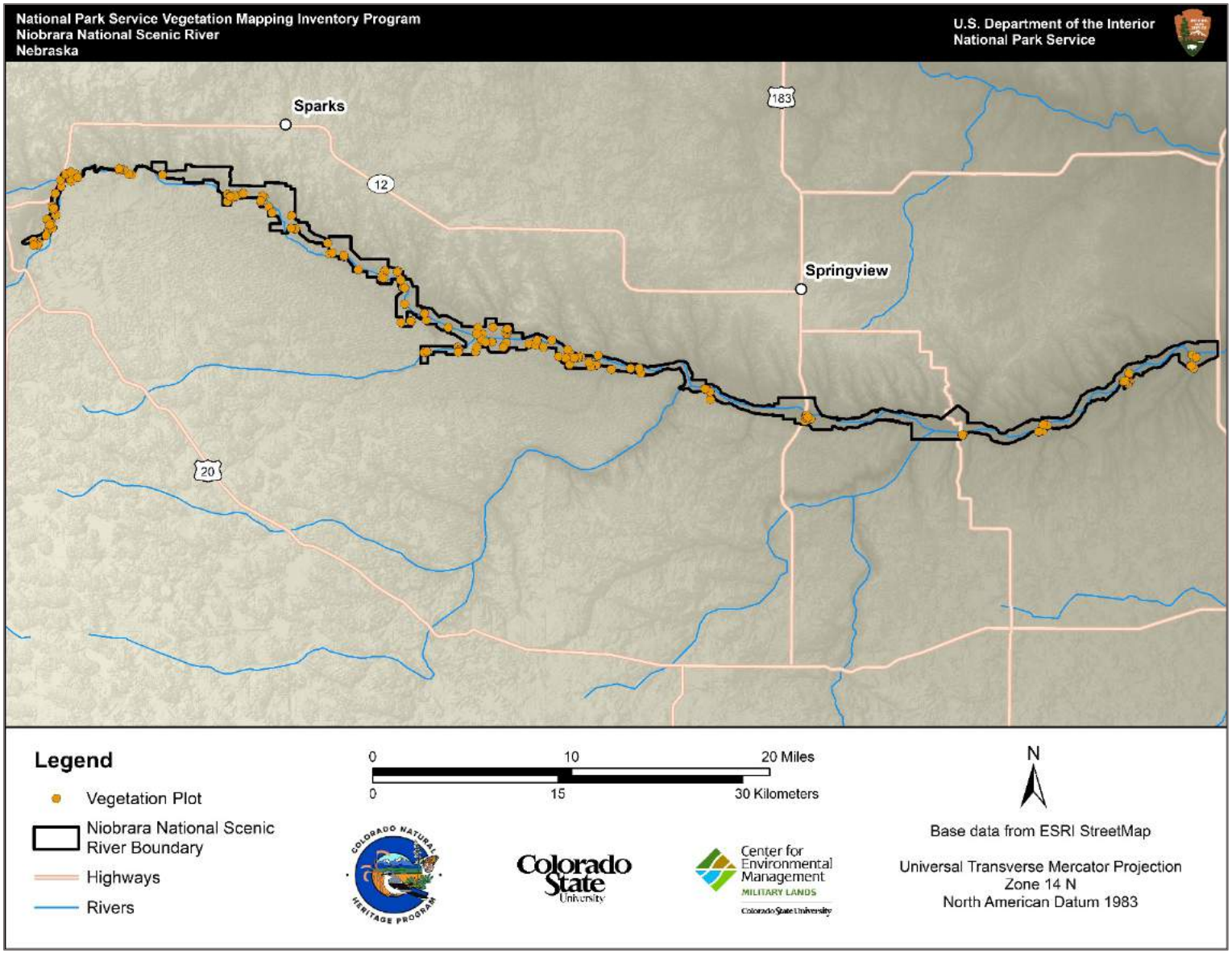

Figure 4. Distribution of vegetation classification plots.

A total of 333 plant species were encountered at NIOB. The most common species encountered at NIOB included *Juniperus virginiana* (82 plots), *Ambrosia psilostachya* (72 plots), *Dichanthelium oligosanthes* (52 plots), *Quercus macrocarpa* (50 plots), *Poa pratensis* (49 plots), *Fraxinus pennsylvanica* (46 plots), and *Schizachyrium scoparium* (45 plots). Eighty-nine species were only encountered in a single plot. Thirty-one associations from the preliminary community list were found within NIOB.

The most dominant species encountered at NIOB in forest and woodland types include *Juniperus virginiana*, *Quercus macrocarpa*, *Fraxinus pennsylvanica*, *Ostrya virginiana*, *Elymus virginicus*, and *Poa pratensis*. The dominant species of the shrubland types found in NIOB were *Amorpha fruticosa*, *Poa pratensis*, *Ambrosia psilostachya*, *Juniperus virginiana*, and *Rhus glabra*. Other, less extensive shrubland types were dominated by *Symphoricarpos occidentalis*. The most common species within herbaceous types include *Ambrosia psilostachya*, *Dichanthelium oligosanthes*, *Schizachyrium scoparium*, *Artemisia ludoviciana*, *Panicum virgatum*, and *Bouteloua gracilis*.

2.2.2. Vegetation Classification

The vegetation classification at NIOB consists of 59 associations, alliances or park specials, including 24 forest or woodland types, 8 shrubland types, 21 herbaceous types, and 6 sparse types. Thirteen of these types are not currently in the USNVC and were classified as park specials. Of the 148 classification points, 67 points were classified as forest or woodland types, 27 points were classified as shrublands, 47 points were classified as herbaceous types, and 7 points were classified as sparse types. The complete list of vegetation classification plots and their classification type is included in Appendix D. The descriptions for all NIOB vegetation types are provided in Appendix A.

Forest and woodland types composed the large majority of associations at NIOB (Table 8). The uppermost strata of these communities were mainly dominated by *Pinus ponderosa*, *Populus deltoides*, *Quercus macrocarpa*, *Fraxinus pennsylvanica*, and *Juniperus virginiana*.

Table 8. Forest and woodland types documented at NIOB.

ELCODE	Association Name
NPSNIOB009	Burnt Disturbed Forest
CEGL000201	*Pinus ponderosa* / *Schizachyrium scoparium* Open Woodland
NPSNIOB012	*Pinus ponderosa* / *Juniperus virginiana* Woodland
CEGL000873	*Pinus ponderosa* / *Quercus macrocarpa* Open Woodland
NPSNIOB010	*Populus deltoides* Ruderal Forest
CEGL000658	*Populus deltoides* - *Fraxinus pennsylvanica* Floodplain Forest
CEGL002152	*Populus deltoides* / *Juniperus scopulorum* Floodplain Forest
CEGL001454	*Populus deltoides* / *Panicum virgatum* - *Schizachyrium scoparium* Floodplain Woodland
CEGL000659	*Populus deltoides* - (*Salix amygdaloides*) / *Salix* (*exigua*, *interior*) Floodplain Woodland

Table 8 (continued). Forest and woodland types documented at NIOB.

ELCODE	Association Name
CEGL000947	*Salix amygdaloides* Riparian Woodland
CEGL002014	*Fraxinus pennsylvanica* - *Ulmus* spp. - *Celtis ocidentalis* Floodplain Forest
CEGL005400	*Fraxinus pennsylvanica* - *Ulmus americana* - (*Acer negundo*, *Tilia americana*) Great Plains Floodplain Forest
CEGL000628	*Acer negundo* / *Prunus virginiana* Floodplain Forest
CEGL000643	*Fraxinus pennsylvanica* - *Ulmus americana* / *Prunus virginiana* Woodland
CEGL005239	*Fraxinus pennsylvanica* - *Ulmus americana* - (*Juglans nigra*, *Celtis occidentalis*) Ruderal Forest
CEGL002593	*Juniperus virginiana* Midwest Ruderal Forest
CEGL005269	*Elaeagnus angustifolia* Ruderal Riparian Woodland
NPSNIOB013	*Quercus macrocarpa* / *Juniperus virginiana* / *Elymus virginicus* Woodland
CEGL000555	*Quercus macrocarpa* / *Ostrya virginiana* Forest
CEGL002013	*Betula papyrifera* - (*Tilia americana*, *Quercus macrocarpa*) Canyon Forest
CEGL002012	*Tilia americana* - (*Quercus macrocarpa*) / *Ostrya virginiana* Forest
NPSNIOB003	*Quercus macrocarpa* / *Juniperus virginiana* Ruderal Forest
NPSNIOB006	*Quercus macrocarpa* - *Populus* x *smithii* (*Populus grandidentata* x *tremuloides*) Relict Woodland
CEGL002052	*Quercus macrocarpa* / *Andropogon gerardii* - *Panicum virgatum* Woodland

Shrublands only represent a small portion of the NIOB. The uppermost strata of these communities were dominated by *Rhus glabra*, *Symophoricarpos occidentalis*, and/or *Prunus virginiana* (Table 9).

Table 9. Shrubland types documented at NIOB.

ELCODE	Association Name
NPSNIOB001	*Amorpha fruticosa* / *Solidago* spp. Wet Shrubland
CEGL008562	*Salix interior* Wet Shrubland
CEGL005282	*Salix interior* / *Pascopyrum smithii* - *Equisetum hyemale* Wet Shrubland
NPSNIOB004	*Rhus glabra* Mixedgrass Shrubland
CEGL005219	*Cornus drummondii* - (*Rhus glabra*, *Prunus* spp.) Shrubland
CEGL005453	*Prunus virginiana* Great Plains Shrubland
CEGL001131	*Symphoricarpos occidentalis* Shrubland
CEGL002177	*Artemisia filifolia* / *Calamovilfa longifolia* Shrubland

Herbaceous types were highly variable and included riparian, upland, and disturbed types (Table 10). The dominant species include *Ambrosia psilostachya*, *Dichanthelium oligosanthes*, and *Schizachyrium scoparium*.

Table 10. Herbaceous types documented at NIOB.

ELCODE	Association Name
CEGL005264	*Bromus inermis* - (*Pascopyrum smithii*) Ruderal Grassland
CEGL003019	*Bromus tectorum* Ruderal Grassland
CEGL003081	*Poa pratensis* Ruderal Marsh
NPSNIOB002	Weedy Forb Ruderal Herbaceous Vegetation
NPSNIOB005	Ruderal Herbaceous Grassland
NPSNIOB007	*Juniperus virginiana* Ruderal Shrub Invaded Grassland
A4042	*Schizachyrium scoparium* - *Bouteloua curtipendula* Central Great Plains Grassland Alliance
CEGL005221	*Schizachyrium scoparium* - *Aristida basiramea* - *Sporobolus cryptandrus* - *Eragrostis trichodes* Grassland
CEGL002023	*Andropogon gerardii* - *Panicum virgatum* Sandhills Grassland
CEGL002025	*Andropogon gerardii* - *Sorghastrum nutans* - *Hesperostipa spartea* Loess Hills Grassland
CEGL001473	*Calamovilfa longifolia* - *Hesperostipa comata* Grassland
A4033	*Hesperostipa comata* Northwestern Great Plains Grassland Alliance
CEGL002034	*Pascopyrum smithii* - *Hesperostipa comata* Central Mixedgrass Grassland
CEGL001467	*Andropogon hallii* - *Calamovilfa longifolia* Grassland
A1193	*Andropogon hallii* Sand Prairie Alliance
CEGL001474	*Phalaris arundinacea* Western Marsh
CEGL002389	*Typha* spp. Great Plains Marsh
CEGL002030	*Schoenoplectus acutus* - *Typha latifolia* - (*Schoenoplectus tabernaemontani*) Sandhills Marsh
CEGL001475	*Phragmites australis* Western Ruderal Wet Meadow
NPSNIOB008	Seasonally Flooded, Early Successional Herbaceous Sandbar
CEGL005272	*Carex* spp. - (*Carex pellita*, *Carex vulpinoidea*) Wet Meadow

Sparse communities are separated into two groups: exposed rock outcrops and riverine sandbars (Table 11). The extent and composition of the sandbars are highly seasonal and subject to constant change.

Table 11. Sparse vegetation types documented at NIOB.

ELCODE	Association Name
CEGL002049	Riverine Sand Flats - Bars Sparse Vegetation
NPSNIOB011	Bare Alluvial Depositional Bar
CEGL002294	Shale Barren Slopes Sparse Vegetation
CEGL002047	Siltstone - Sandstone Rock Outcrop Sparse Vegetation
CEGL002046	Limestone - Dolostone Great Plains Xeric Cliff Sparse Vegetation
CEGL005257	Sandstone Great Plains Dry Cliff Sparse Vegetation

2.2.3. Photographic Database Results

There were 624 vegetation plot photos taken during the field sampling. Vegetation plot photos were collected over the summer of 2015, while AA point photos were collected over the summer of 2017. Both vegetation plot and AA points included four photos at each site. Photos were taken facing each cardinal direction from the center of the plot, beginning with the north, followed by east, south, and west orientations in that order.

Each photo is georeferenced and can be accurately projected in ArcGIS, Google Earth, or another program capable of projecting features with georeferenced coordinates. The photos for this project have also been incorporated into a database accessible through ArcMap. This allows the user to access photos and some plot data when viewing the point in ArcMap.

3. Vegetation Mapping

The mapping phase of the project included image acquisition, examination of legacy data and other information, development of a mapping model that accommodates existing vegetation types within interpretable map classes, field reconnaissance, polygon classification and delineation, field verification, and database development.

3.1. Methods

3.1.1. Map Specifications

Map specifications were a product of details included in the study plan, the scope of work associated with the cooperative agreement, and discussions with NPS staff during the scoping process. These include:

Map extent. The area mapped included all areas inside the NIOB administrative boundary. Polygons outside the boundary were not mapped, visited, or sampled.

Minimum Mapping Unit (MMU). A minimum mapping unit (i.e., polygon size) of 0.5 ha (1.24 ac) was used by the image interpreter. Polygons below the minimum mapping unit were mapped as the predominant adjacent map class. Areas of significant management importance (e.g., aspen communities) were mapped below the MMU threshold for NIOB.

Thematic Accuracy: The desired minimum class users' accuracy goal across all vegetation and land cover classes is 80%.

3.1.2. Imagery Acquisition and Data Management

Remotely-sensed imagery provides the foundation for mapping vegetation types and other land cover classes. New imagery was acquired from Cornerstone Mapping Inc. for the Niobrara River, since there was not suitable existing imagery available for NIOB at the start of the mapping phase of the project. The product was delivered as individual 30 cm 4-band (RGB and CIR) high-resolution orthoimages. The imagery has a positional accuracy of <2 m. Specifications for the Cornerstone Mapping Inc. acquisition included the following:

- Total area for new collection of 479 square kilometers
- 10% or less cloud cover
- 0-20 off-nadir angle guarantee
- Acquisition date October 13th, 2015

Imagery satisfying the requirements was successfully acquired for the NIOB project area on October 13, 2015, and delivered to CSU in December 2015. Each image was delivered as an individual georeferenced high-resolution orthoimage. The acquisition intentionally provided 4-band imagery during the fall senescence period, capturing variation in different species' canopy tone and texture not observable during other times of the year. A variety of other existing imagery sources were utilized to supplement the NIOB mapping project. Table 12 describes specifications for all imagery

used for the project. Additional imagery supplementing the interpretation phase included current and historic true-color Google Earth and Bing Maps imagery viewed using their respective online viewer.

Table 12. Specifications for imagery used for the NIOB vegetation mapping project.

Product	Data Source	Year	Bands	Resolution (cm)
2016 NAIP	USDA-FSA	2016	RGB	60
2015 Cornerstone	Cornerstone Mapping Inc.	2015	RGB, CIR	30
2014 NAIP	USDA-FSA	2014	RGB, CIR	100

3.1.3. Legacy Data

The vegetation inventory study plan for NIOB identified a variety of legacy datasets and base spatial data to support vegetation classification and mapping at NIOB. Legacy data were evaluated using the TNC and NPS (2009) evaluation framework (see section 2.1.1). Previously-published data and reports provided a baseline for birch communities at NIOB and proved helpful in validating and complementing the vegetation classification produced during the vegetation inventory phase of the project. In the context of vegetation mapping, the Stroh and Miller (2009) report provided location information for birch stands at NIOB and provided a general area to search for additional stands. Based on the NPS guidance for evaluating legacy data (TNC and NPS 2009), Stroh and Miller (2009) is classified as Category II for this project (Table 2). Roberston (2015) provided location information for aspen stands at NIOB and provided a general area to search for additional stands. Based on the NPS guidance for evaluating legacy data (TNC and NPS 2009), Robertson (2015) is classified as Category II for this project (Table 2).

3.1.4. Map Classes and Mapping Model

The conceptual mapping model is a crosswalk between mapping classes used by the image interpreter and the natural and ruderal (semi-natural) USNVC vegetation associations and other types documented in the project area. The choice of an appropriate mapping model has important implications for the utility and accuracy of the final map. The optimized mapping model provides the highest thematic detail while meeting required standards of accuracy. The idealized model would have the most detailed desired level of the USNVC (e.g., association or alliance) represented by a single map class.

From the outset, it was important for image interpreters to become familiar with the vegetation types and recurring patterns on the landscape. During the first phase of the project, ecologists and image analysts reviewed the preliminary vegetation classification and began building an understanding of the vegetation types and patterns as well as the complexities associated with certain types. Consideration was also given to the semi-natural or ruderal vegetation types and other non-vegetated land use types that were being identified both in the field and through imagery interpretation. The preliminary vegetation classification assembled as part of the study plan provided a starting point for identifying the types that were likely present at NIOB, and became the foundation for the early

development of map classes and the nesting of different communities within them. By the winter of 2016, the classification of vegetation communities using quantitative vegetation plot inventory data collected in summer 2015 was complete and the list of NIOB community types became firmer. Numerous discussions between the plot and vegetation classification team (Joe Stevens and Tom Baldvins) and the interpretation team (Dave Jones and Matt Ley) occurred during mapping model development. These discussions continued following all mapping reconnaissance efforts, and were used to refine the map classification and document any communities that were not sampled by the vegetation inventory crews.

The mapping model reflects the limitations of consistent and accurate interpretation given the available data, imagery, time, and other resources available for field reconnaissance and verification. It incorporates challenges and limitations related to distinguishing vegetation communities and other land cover classes. Some of these challenges include the following:

- Interpreting thresholds between non-vegetated and sparse vegetation types, where sand and bare ground may dominate the type and "wash out" the vegetation photo signature (e.g., sandbars).
- Interpreting thresholds in structural components (e.g., the difference between herbaceous and shrub herbaceous communities).
- Interpreting the abundance of a structural component or taxon that is difficult to see (e.g., dwarf-shrubs and saplings in a productive herbaceous tallgrass community).
- Interpreting understory differences in non-herbaceous communities (e.g., understory components of *Populus* or *Quercus* forest and woodlands).
- Any case where vegetation classification identification (e.g., herbaceous vs. shrub herbaceous vegetation) was difficult and inconsistent in the field.

Additional challenges influencing map class development are discussed in Section 3.1.7 (Interpretation Challenges). Following the AA in the summer of 2017, the AA contingency table (i.e., the confusion matrix) was examined to determine the need to modify the mapping model where accuracies were low and there was clear confusion among types. This process, which led to the consolidation or aggregation of some preliminary map classes, is discussed in detail in Section 4 (Accuracy Assessment). Final map classes and the vegetation types they represent are discussed in Section 3.2 (Results).

3.1.5. Imagery Interpretation

Classification and delineation of polygons was an iterative process involving the development of preliminary map classes, field reconnaissance, review of classified plot results and legacy data. The preliminary polygon line work was then completed and classified, followed by additional field reconnaissance efforts, map refinement, fine-tuning of line work and the mapping model, and finally, field verification, validation, and finalization of the map layer. This process began by initially mapping the vegetation physiognomy, which produced a crude division showing areas dominated by trees, shrubs, herbaceous vegetation, sparse vegetation, and open water. This initial physiognomic map was refined using field GPS tablets and paper maps to produce georeferenced observations and

photos of targeted points and patterns across the landscape. These data, along with vegetation inventory plot data, photos, and legacy data, were used to identify unique vegetation photo-signatures for each map class. Photo signatures were then used to begin classifying and delineating polygons at a finer level of detail, until a balance between robustness of the map and ability to achieve thematic accuracy requirements was reached. Field reconnaissance for map development occurred throughout the summer and fall of 2016 and in the spring and early summer of 2017, prior to AA fieldwork commencing. Reconnaissance allowed mappers to become familiar with the area's local taxa and ecology, and to better understand subtle landscape patterns and other environmental site factors influencing vegetation. Soils/geology, elevation, and landform (aspect, slope) data were all incorporated into the mapping process to help identify communities with evident affinities or repeating patterns on the landscape.

Given the moderate size of NIOB, the intricacies of the classification, and the ability to define classes visually, manual on-screen digitizing was used to delineate polygons. Both 60 cm resolution true color imagery and 30 cm 4-band imagery were used for interpretation. Vegetation class boundaries were distinguished using differences in pattern, color, texture, and tone observed in the imagery. Vegetation plot, legacy data, and observation point data were used to classify map units and assign appropriate map class labels to each digitized polygon. A minimum mapping unit of 0.5 ha was used for a majority of the map classes at NIOB. Areas of significant management importance (e.g., aspen communities) were mapped below the MMU threshold for NIOB. Three-dimensional visualization on Google Earth was used to better see vegetation structure and composition, especially in the steep terrain in and around the springbranch canyons. Different combinations of imagery bands were used to differentiate some types. Interpretation notes for NIOB map classes are summarized in Appendix I.

3.1.6. Validation of Map Thematic Accuracy

Whereas AA is a considerable investment in time and effort, validation is a process of more limited scope. The objective of validation is to determine whether a final draft map is accurate enough to justify field-based thematic AA of individual map classes. The results of validation address primarily the immediate needs of the map production team and project oversight team to evaluate the overall product before conducting a formal quantitative AA. Map thematic validation is important to ensure that errors in the map, the association key, and the classification are corrected before the AA phase of the project begins.

The NPS (2013a) 12-Step Guidance document strongly recommends independent third party validation of the map and key prior to the AA. Map class validation is completed by image analysts and ecologists visiting the site together and briefly testing the map and key in the field. For the NIOB project, a quantitative, third-party validation was not a planned phase of the project. The imagery interpretation team conducted three validation trips to NIOB to examine certain map classes and polygons—one in summer of 2016, one in early fall of 2016, and one in spring of 2017. The field validation effort was not quantitative and did not involve random sampling across all map classes, but rather focused on those classes considered to have the lowest accuracy by interpreters. Field data collected resulted in some modifications to individual polygon boundaries, additional refinements to

the map classification, and a higher level of comfort with certain classes and the map as a whole. These efforts met the intent of the guidance, and the decision was then made within the CSU team to proceed with the AA phase.

The CSU team validating the draft map in the spring of 2017 prior to the AA phase of the project.

3.1.7. Interpretation Challenges

Sparse Vegetation Types

Sparse vegetation types by definition may have 1-10% total plant cover. At the upper end of the scale, these types can be difficult to distinguish from grasslands and shrublands with low total cover. At the lower end of the scale, these types can be confused with, and intergrade with, non-vegetated surfaces. Sparse vegetation types at NIOB were primarily found on dynamic riverine sandbars. These areas tend to be constantly reworked by changing river flows, resulting in a dynamic environment that proved difficult to map consistently over time. In addition, sparsely vegetated areas were often difficult to view on imagery due to temporal variation in the community and the tendency for the sand substrate to over-saturate the image, obscuring the vegetation photo-signature (Figure 5). To account for this challenge, the Riverine Sparse Bar map class was broadened to include bare sand, non-vegetated areas that had recently been reworked by riverine processes.

Figure 5. Examples of a dynamic riverine sandbar at NIOB. The photo on the left was taken during the summer of 2016 on the same sandbar as is shown in the aerial image on the right. Note the over-saturation of the aerial image which has obscured the vegetation photo-signature of the sparse sandbar vegetation (CSU).

Changes in Vegetation

In some areas of NIOB, changes in vegetation occurred during the project due to changes in river flows, weed spraying, mechanical removal of eastern redcedar and Russian olive trees, and land use conversion. The primary impact to the NIOB vegetation inventory project was the removal of eastern redcedar trees and shrubs. Active removal was occurring throughout the duration of the project, altering communities and changing map classes (Figures 6 and 7). Some of these changes were captured by the mapping team during the validation phase of the project but others were likely not captured.

Figure 6. Examples of pre (left) and post (right) eastern redcedar removal at NIOB. Mechanical removal altered communities and resulted in different map class designation. Some of these changes were captured by the mapping team during the validation phase of the project but others were likely not captured (CSU).

Figure 7. Example of pre (left) and post (right) eastern redcedar removal at NIOB. Mechanical removal altered communities and resulted in different map class designation. Some of these changes were captured by the mapping team during the validation phase of the project but others were likely not captured.

Dynamic Upland Grassland Environments

Upland grassland communities at NIOB proved exceptionally difficult to map due to the dynamic nature of the ecosystems as well as seasonality differences within each vegetation type. Numerous USNVC types (e.g., CEGL002023: *Andropogon gerardii* - *Panicum virgatum* Sandhills Grassland; CEGL001467: *Andropogon hallii* - *Calamovilfa longifolia* Grassland; CEGL005221: *Schizachyrium scoparium* - *Aristida basiramea* - *Sporobolus cryptandrus* - *Eragrostis trichodes* Grassland) often occurred together as a "patchwork" complex across the landscape.

Example of a dynamic upland grassland community at NIOB. This photo shows 2-3 USNVC types occurring below the MMU in a complex of vegetation (CSU).

Patchiness within this system was especially prominent within the Nebraska Sandhills portion of NIOB, where minor topographic differences on the relict dunes resulted in completely different communities occurring below the MMU within the crest, slope, and interdunal areas. Difficulties were compounded by seasonal differences within each USNVC type. Warm-season grass-dominated communities often looked significantly different in August-September compared to May-June. Dominance by cool-season grasses earlier in the season sometimes impacted field validation efforts. Additional impacts from a severe drought during the AA phase of the project (summer of 2017) further impacted map class accuracy for these vegetation types. The productivity of warm season grasses was severely inhibited by the drought, resulting in dramatically different species composition for the same areas in 2016 vs. 2017. All of these difficulties together resulted in relatively low map accuracies for individual USNVC types within this complex.

Private Land Access

Given that a majority of NIOB is privately owned, access depended on private landowners granting permission for vegetation sampling and mapping efforts. A majority of landowners declined our request to access their land for this project. Additionally, several landowners that had allowed vegetation plot sampling to occur declined our request for access for mapping and AA work. This general lack of access made map validation difficult and likely led to reduced overall map accuracy.

3.2. Results

3.2.1. Map Classes

The project objective was to map vegetation communities to the association level of the USNVC where possible. In some cases, consistent interpretation to the association level was not possible, and the interpreter was obliged to include more than one association in a map class. The initial map classification going into the AA phase consisted of 29 natural and ruderal vegetated map classes, along with 6 sub-map classes, representing 59 USNVC associations, alliances, and park specials.

The final map classification consists of 33 map classes for NIOB. Of these 33 map classes, 27 represent 43 natural/ruderal associations within the USNVC, 3 represent natural/ruderal alliances within the USNVC, 13 types represent unpublished park specials, 2 types represent cultural vegetation (i.e., agricultural vegetation), and 4 types represent National Land Cover Dataset (NLCD) Level II land cover classes (Water; Barren; Developed, Open Space; and Developed, Low-High Intensity). Final map classes and their relationship to USNVC associations, alliances, and park specials are shown in the lists below. The vegetation map is not shown as a figure in this report due to the size of NIOB and small size of many polygons.

Herbaceous vegetation:

- NIOB MC101 Ruderal Herbaceous Grassland
    - CEGL005264: *Bromus inermis* - (*Pascopyrum smithii*) Ruderal Grassland
    - CEGL003019: *Bromus tectorum* Ruderal Grassland
    - CEGL003081: *Poa pratensis* Ruderal Marsh
    - NPSNIOB002: Weedy Forb Ruderal Herbaceous Vegetation

- NPSNIOB005: Ruderal Herbaceous Grassland
- NPSNIOB007: *Juniperus virginiana* Ruderal Shrub Invaded Grassland

- NIOB MC102 Upland Mixedgrass Grassland
  - 1) Sub MC102a *Schizachyrium scoparium* - *Bouteloua* (*curtipendula, gracilis*) Mixedgrass Grassland
    - A4042: *Schizachyrium scoparium* - *Bouteloua curtipendula* Central Great Plains Grassland Alliance
    - CEGL005221: *Schizachyrium scoparium* - *Aristida basiramea* - *Sporobolus cryptandrus* - *Eragrostis trichodes* Grassland
  - 2) Sub MC102b *Andropogon gerardii* Tall Grass Prairie Grassland
    - CEGL002023: *Andropogon gerardii* - *Panicum virgatum* Sandhills Grassland
    - CEGL002025: *Andropogon gerardii* - *Sorghastrum nutans* - *Hesperostipa spartea* Loess Hills Grassland
  - 3) Sub MC102c *Hesperostipa comata* - *Pascopyrum smithii* Mixedgrass Grassland
    - CEGL001473: *Calamovilfa longifolia* - *Hesperostipa comata* Grassland
    - A4033: *Hesperostipa comata* Northwestern Great Plains Grassland Alliance
    - CEGL002034: *Pascopyrum smithii* - *Hesperostipa comata* Central Mixedgrass Grassland
  - 4) Sub MC102d *Andropogon hallii* - *Calamovilfa longifolia* Grassland
    - CEGL001467: *Andropogon hallii* - *Calamovilfa longifolia* Grassland
    - A1193: *Andropogon hallii* Sand Prairie Alliance
- NIOB MC103 Marsh Complex
  - CEGL001474: *Phalaris arundinacea* Western Marsh
  - CEGL002389: *Typha* spp. Great Plains Marsh
  - CEGL002030: *Schoenoplectus acutus* - *Typha latifolia* - (*Schoenoplectus tabernaemontani*) Sandhills Marsh
  - CEGL001475: *Phragmites australis* Western Ruderal Wet Meadow
- NIOB MC104 *Carex* spp., *Juncus* spp., *Eleocharis* spp. Wet Meadow
  - NPSNIOB008: Seasonally Flooded, Early Successional Herbaceous Sandbar Complex
  - CEGL005272: Carex spp. - (Carex pellita, Carex vulpinoidea) Wet Meadow

Shrublands:

- NIOB MC201 *Salix interior* - *Amorpha fruticosa* Wet Shrubland
  - NPSNIOB001: *Amorpha fruticosa* / *Solidago* spp. Wet Shrubland
  - CEGL008562: *Salix interior* Wet Shrubland

    - CEGL005282: *Salix interior* / *Pascopyrum smithii* - *Equisetum hyemale* Wet Shrubland
- NIOB MC202 *Rhus glabra* Mixedgrass Shrubland
    - NPSNIOB004: *Rhus glabra* Mixedgrass Shrubland
- NIOB MC203 *Cornus drummondii* - *Prunus* spp. – *Symphoricarpos occidentalis* Shrubland
    - CEGL005219: *Cornus drummondii* - (*Rhus glabra*, *Prunus* spp.) Shrubland
    - CEGL005453: *Prunus virginiana* Great Plains Shrubland
    - CEGL001131: *Symphoricarpos occidentalis* Shrubland
- NIOB MC204 *Artemisia filifolia* / *Calamovilfa longifolia* Shrubland
    - CEGL002177: *Artemisia filifolia* / *Calamovilfa longifolia* Shrubland

Woodland and forest:

- NIOB MC301 Burnt Disturbed Forest and Woodland
    - NPSNIOB009: Burnt Disturbed Forest and Woodland
- NIOB MC302 *Pinus ponderosa* Mixedgrass Open Woodland
    - CEGL000201: *Pinus ponderosa* / *Schizachyrium scoparium* Open Woodland
- NIOB MC303 *Pinus ponderosa* / *Juniperus virginiana* Woodland and Forest
    - NPSNIOB012: *Pinus ponderosa* / *Juniperus virginiana* Woodland
- NIOB MC304 *Pinus ponderosa* / *Quercus macrocarpa* Open Woodland and Forest
    - CEGL000873: *Pinus ponderosa* / *Quercus macrocarpa* Open Woodland
- NIOB MC305 *Populus deltoides* Ruderal Forest and Woodland
    - NPSNIOB010: *Populus deltoides* Ruderal Forest
- NIOB MC306 *Populus deltoides* - *Fraxinus pennsylvanica* Floodplain Forest and Woodland
    - CEGL000658: *Populus deltoides* - *Fraxinus pennsylvanica* Floodplain Forest
- NIOB MC307 *Populus deltoides* / *Juniperus virginiana* Floodplain Forest and Woodland
    - CEGL002152: *Populus deltoides* / *Juniperus scopulorum* Floodplain Forest
- NIOB MC308 *Populus deltoides* - *Salix amygdaloides* Floodplain Woodland and Forest
    - CEGL001454: *Populus deltoides* / *Panicum virgatum* - *Schizachyrium scoparium* Floodplain Woodland
    - CEGL000659: *Populus deltoides* - (*Salix amygdaloides*) / *Salix* (*exigua*, *interior*) Floodplain Woodland
    - CEGL000947: *Salix amygdaloides* Riparian Woodland
- NIOB MC309 *Fraxinus pennsylvanica* - *Ulmus* spp. - *Celtis occidentalis* Floodplain Forest and Woodland

    - CEGL002014: *Fraxinus pennsylvanica* - *Ulmus* spp. - *Celtis occidentalis* Floodplain Forest
    - CEGL005400: *Fraxinus pennsylvanica* - *Ulmus americana* - (*Acer negundo*, *Tilia americana*) Great Plains Floodplain Forest
    - CEGL000628: *Acer negundo* / *Prunus virginiana* Floodplain Forest
    - CEGL000643: *Fraxinus pennsylvanica* - *Ulmus americana* / *Prunus virginiana* Woodland
- NIOB MC310 *Fraxinus pennsylvanica* Ruderal Forest and Woodland
    - CEGL005239: *Fraxinus pennsylvanica* - *Ulmus americana* - (*Juglans nigra*, *Celtis occidentalis*) Ruderal Forest
- NIOB MC311 *Juniperus virginiana* Midwest Ruderal Forest and Woodland
    - CEGL002593: *Juniperus virginiana* Midwest Ruderal Forest
- NIOB MC312 *Elaeagnus angustifolia* Ruderal Riparian Woodland and Forest
    - CEGL005269: *Elaeagnus angustifolia* Ruderal Riparian Woodland
- NIOB MC313 *Quercus macrocarpa* Dry Upland Forest and Woodland
    - NPSNIOB013: *Quercus macrocarpa* / *Juniperus virginiana* / *Elymus virginicus* Woodland
    - CEGL000555: *Quercus macrocarpa* / *Ostrya virginiana* Forest
- NIOB MC314 *Tilia americana* - (*Betula papyrifera*) Springbranch Canyon Forest
    - 1) Sub MC314a *Betula papyrifera* - (*Tilia americana*, *Quercus macrocarpa*) Canyon Forest
        - CEGL002013: *Betula papyrifera* - (*Tilia americana*, *Quercus macrocarpa*) Canyon Forest
    - 2) Sub MC314b *Tilia americana* - (*Quercus macrocarpa*) / *Ostrya virginiana* Forest
        - CEGL002012: *Tilia americana* - (*Quercus macrocarpa*) / *Ostrya virginiana* Forest
- NIOB MC315 *Quercus macrocarpa* / *Juniperus virginiana* Ruderal Forest and Woodland
    - NPSNIOB003: *Quercus macrocarpa* / *Juniperus virginiana* Ruderal Forest
- NIOB MC316 *Quercus macrocarpa* - *Populus* x *smithii* (*Populus grandidentatum* x *tremuloides*) Relict Woodland
    - NPSNIOB006: *Quercus macrocarpa* - *Populus* x *smithii* (*Populus grandidentatum* x *tremuloides*) Relict Woodland
- NIOB MC317 *Quercus macrocarpa* Woodland and Wooded Grassland
    - CEGL002052: *Quercus macrocarpa* / *Andropogon gerardii* - *Panicum virgatum* Woodland

Sparse vegetation:

- NIOB MC401 Riverine Sparse Bar Vegetation
    - CEGL002049: Riverine Sand Flats - Bars Sparse Vegetation
    - NPSNIOB011: Bare Alluvial Depositional Bar
- NIOB MC402 Sparse Cliff Vegetation
    - CEGL002294: Shale Barren Slopes Sparse Vegetation
    - CEGL002047: Siltstone - Sandstone Rock Outcrop Sparse Vegetation
    - CEGL002046: Limestone - Dolostone Great Plains Xeric Cliff Sparse Vegetation
    - CEGL005257: Sandstone Great Plains Dry Cliff Sparse Vegetation

Land cover:

- LC001 Agricultural Vegetation, Cultivated Crops
- LC002 Agricultural Vegetation, Pasture/Hay Field
- LC003 Non-vegetated, (Barren Land, Cut Bank, Borrow Pit)
- LC004 Developed, Open Space
- LC005 Developed, (Low, Medium, High) Intensity
- LC006 Water

Of the 27 vegetated map classes, 15 map classes represent a single USNVC association/park special, 4 map classes represent two USNVC associations, 3 map classes represent three USNVC associations/park specials, 3 map classes represent four USNVC associations, 1 map class represents six USNVC associations/park special, and 1 map class represents nine USNVC associations/alliances/park specials. Two map classes were mapped at the sub-map class level (i.e., MC102 Upland Mixedgrass Grassland and MC314 *Tilia americana* - (*Betula papyrifera*) Springbranch Canyon Forest). Where a map class represents a single USNVC type, the map class name is the same as the USNVC name. Where the map class represents more than one USNVC type, the map class name reflects the types included within it, and is weighted toward the type or types believed to occupy the largest acreage. Descriptions of map classes representing USNVC floristic types (e.g., associations and alliances) can be derived from the descriptions of associations, alliances, and park specials presented in Appendix A.

3.2.2. Summary Statistics

The NIOB vegetation map consists of 2,762 polygons totaling 29,080.78 ac (11,768 ha) (Table 13). Mean polygon size for vegetated types was 8.20 ac (3.32 ha). Of the total area, approximately 20,878 ac (8,449 ha) or 72% represented natural or ruderal vegetation.

Table 13. Map statistics by map class for the Niobrara National Scenic River vegetation map.

Vegetation Type	Map Class	Number of Polygons	Minimum size (ha)	Maximum size (ha)	Mean size (ha)	Total area (ha)
Herbaceous Vegetation	MC101 Ruderal Herbaceous Grassland	313	0.50	76.59	3.38	1,087.42
	MC102 Upland Mixedgrass Grassland	332	0.50	107.01	4.53	1,532.59
	MC103 Marsh Complex	49	0.50	8.81	2.18	112.27
	MC104 *Carex* spp., *Juncus* spp., *Eleocharis* spp. Wet Meadow	65	0.50	7.27	1.68	108.95
Shurblands	MC201 *Salix* interior - *Amorpha fruticosa* Wet Shrubland	152	0.51	16.54	2.16	341.64
	MC202 *Rhus glabra* Mixedgrass Shrubland	122	0.50	20.41	1.35	170.67
	MC203 *Cornus drummondii* - *Prunus* spp. - *Symphoricarpos occidentalis* Shrubland	12	0.52	4.69	1.36	16.30
	MC204 *Artemisia filifolia* / *Calamovilfa longifolia* Shrubland	2	1.50	1.83	1.66	3.33
Woodland and Forest	MC301 Burnt Disturbed Forest	88	0.55	87.64	6.13	552.26
	MC302 *Pinus ponderosa* Mixedgrass Open Woodland	80	0.51	10.85	2.47	197.45
	MC303 *Pinus ponderosa* / *Juniperus virginiana* Woodland and Forest	94	0.52	49.02	5.01	497.87
	MC304 *Pinus ponderosa* / *Quercus macrocarpa* Open Woodland and Forest	85	0.51	79.44	5.39	460.29
	MC305 *Populus deltoides* Ruderal Forest	6	0.74	4.23	2.65	16.92
	MC306 *Populus deltoides* - *Fraxinus pennsylvanica* Floodplain Forest and Woodland	100	0.51	21.83	3.42	345.01

* The *Elaeagnus angustifolia* patch was mechanically removed during the duration of the project. The map class was retained within the NIOB mapping model given the strong likelihood that the community may be present at NIOB in the future.

Table 13 (continued). Map statistics by map class for the Niobrara National Scenic River vegetation map.

Vegetation Type	Map Class	Number of Polygons	Minimum size (ha)	Maximum size (ha)	Mean size (ha)	Total area (ha)
Woodland and Forest (continued)	MC307 *Populus deltoides* / *Juniperus virginiana* Floodplain Forest and Woodland	98	0.53	16.35	3.90	420.45
	MC308 *Populus deltoides* - *Salix amygdaloides* Floodplain Woodland and Forest	38	0.50	7.33	1.61	61.25
	MC309 *Fraxinus pennsylvanica* - *Ulmus* spp. - *Celtis occidentalis* Floodplain Forest and Woodland	87	0.50	16.94	2.56	225.50
	MC310 *Fraxinus pennsylvanica* Ruderal Forest and Woodland	76	0.51	34.77	2.20	167.47
	MC311 *Juniperus virginiana* Midwest Ruderal Forest and Woodland	262	0.50	17.56	1.95	567.04
	MC312 *Elaeagnus angustifolia* Ruderal Riparian Woodland and Forest*	0				
	MC313 *Quercus macrocarpa* Dry Upland Forest	93	0.52	19.58	2.99	280.71
	MC314 *Tilia americana* - (*Betula papyrifera*) Springbranch Canyon Forest	65	0.51	18.69	3.18	209.65
	MC315 *Quercus macrocarpa* / *Juniperus virginiana* Ruderal Forest and Woodland	205	0.51	40.50	3.90	867.75
	MC316 *Quercus macrocarpa* - *Populus* x *smithii* (*Populus grandidentata* x *tremuloides*) Relict Woodland	7	0.13	0.56	0.40	2.82
	MC317 *Quercus macrocarpa* Woodland and Wooded Grassland	59	0.50	8.40	1.57	96.48
Sparse Vegetation	MC401 Riverine Sparse Bar Vegetation	32	0.53	12.25	2.66	85.10
	MC402 Sparse Cliff Vegetation	23	0.31	3.48	0.96	22.00

* The *Elaeagnus angustifolia* patch was mechanically removed during the duration of the project. The map class was retained within the NIOB mapping model given the strong likelihood that the community may be present at NIOB in the future.

Table 13 (continued). Map statistics by map class for the Niobrara National Scenic River vegetation map.

Vegetation Type	Map Class	Number of Polygons	Minimum size (ha)	Maximum size (ha)	Mean size (ha)	Total area (ha)
Cultural Vegetation	LC001 Agricultural Vegetation, Cultivated Crops	1	6.12	6.12	6.12	6.12
	LC002 Agricultural Vegetation, Pasture Land/Hay Field	103	0.55	87.95	12.78	1,316.12
Land Cover	LC003 Non-vegetated, (Barren Land, Cut Bank, Borrow Pit)	11	0.51	1.40	0.74	8.18
	LC004 Developed, Open Space	66	0.51	10.06	1.79	118.08
	LC005 Developed, (Low, Medium, High) Intensity	23	0.51	27.97	3.66	84.17
	LC006 Water	13	0.38	410.13	161.72	1,786.74
Totals	**–**	**2,762**	**–**	**–**	**–**	**11,768.58**

* The Elaeagnus angustifolia patch was mechanically removed during the duration of the project. The map class was retained within the NIOB mapping model given the strong likelihood that the community may be present at NIOB in the future.

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Barren and developed areas occupied approximately 520 ac (210 ha) or 1.8% of NIOB. Agricultural vegetation accounted for 3,267 ac (1,322 ha) or 11% of the park. Water was mapped on 4,415 ac (1,786 ha) accounting for 15% of the park area. Of the broad physiognomic groupings, woodland and forest types were the most extensive at 12,278 ac (4,969 ha) or 42% of NIOB, followed by herbaceous vegetation at 7,021 ac (2,841 ha) or 24% of the park, shrublands at 1,314 ac (532 ha) or 4.5% of NIOB, and sparse vegetation at 265 ac (107 ha) or 0.9% of the park (Figure 8).

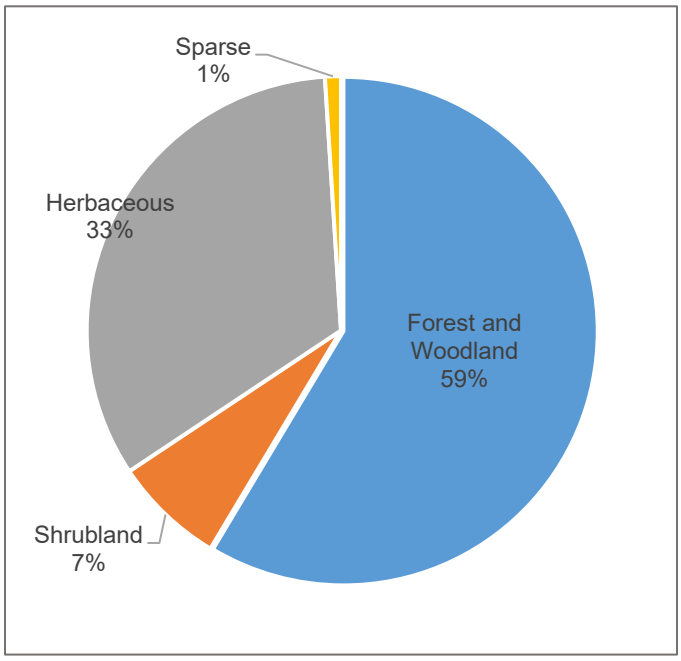

Figure 8. Percent of acreage for natural and ruderal types by physiognomic class at NIOB.

3.2.3. Herbaceous Vegetation

Herbaceous vegetation map classes occupied 24.1% (7,020 ac; 2841 ha) of NIOB area and accounted for 27.0% (759 polygons) of the mapped polygons. The Upland Mixedgrass Grassland Complex map class (MC102) represented the largest component of herbaceous vegetation at NIOB occupying 3,787 ac (1,532 ha) or 13.0% of the NIOB area. This map class was mapped as a complex and included nine USNVC associations or alliances. Sub-map classes were delineated for this map class, where applicable, and include the *Schizachyrium scoparium* - *Bouteloua* (*curtipendula*, *gracilis*) Mixedgrass Grassland (MC102a), the *Andropogon gerardii* Tall Grass Prairie Grassland (MC102b), the *Hesperostipa comata* - *Pascopyrum smithii* Mixedgrass Grassland (MC102c), and the *Andropogon hallii* - *Calamovilfa longifolia* Grassland (MC102d). The second most abundant herbaceous vegetation type was the Ruderal Herbaceous Grassland map class (MC101). This type occupied 2,687 ac (1,087 ha) and represented 9.2% of the NIOB area. Other herbaceous vegetation types (i.e., MC103 Marsh Complex, MC104 *Carex* spp., *Juncus* spp., *Eleocharis* spp. Wet Meadow) occupied only 1.9% (547 ac; 221 ha) of NIOB (Table 13)

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3.2.4. Shrublands

Four shrubland map classes at NIOB account for 4.5% (1,314 ac; 532 ha) of the park area and 10.4% (288) of the mapped polygons. The most common type, the *Salix interior* - *Amorpha fruticosa* Wet Shrubland (MC201) accounts for 844 ac (341 ha) or 2.9% of the park area. The second most abundant shrubland type was the *Rhus glabra* Mixedgrass Shrubland map class (MC202). This type occupied 421 ac (170 ha) and represented 1.5% of the NIOB area. The other two map classes (MC203 *Cornus drummondii* - *Prunus* spp. - *Symphoricarpos occidentalis* Shrubland; MC204 *Artemisia filifolia* / *Calamovilfa longifolia* Shrubland) occupy a total of 48.5 ac (19.6 ha) or 0.2% of the park (Table 13).

Example of a *Rhus glabra* Mixedgrass Shrubland (MC202) at NIOB. The red fall foliage provided an excellent photo-signature to support mapping this common shrubland type. (CSU photo)

3.2.5. Woodland and Forest

Sixteen woodland and forest vegetation map classes occupy 42.2% (12,278 acres; 4,968 ha) of NIOB's area and account for 52.2% (1,443) of the mapped polygons. The most abundant type was *Quercus macrocarpa* / *Juniperus virginiana* Ruderal Forest and Woodland (MC315) which represented 2,144 acres (868 ha) or 7.4% of NIOB. The next most common types included the *Juniperus virginiana* Midwest Ruderal Forest and Woodland (MC311), the Burnt Disturbed Forest (MC301), and the *Pinus ponderosa* / *Juniperus virginiana* Woodland and Forest (MC303), which occupied 4.8% (1,401 acres; 567 ha), 4.7% (1,364 acres; 552 ha), and 4.2% (1,230 acres; 498 ha), respectively (Table 13).

3.2.6. Sparse Vegetation

Sparse vegetation map classes comprise 0.9% (264 ac; 107 ha) of the NIOB park area, with the Riverine Sparse Bar Vegetation (MC401) map class representing a majority of the coverage at 210 ac (85 ha) or 0.7% of NIOB (Table 13).

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3.2.7. Map Class Layer Development

Following the AA and final aggregation of several preliminary map classes, several fields were added to the feature class layer attribute table to facilitate basic query and display for the map data. Attribute fields in the vegetation polygon layer table include the following:

- Map class code (map_class_code)
- Map class name (map_class_name)
- Map class translated name (map_class_translated)
- Preliminary map class name (prelim_map_class_name)
- Vegetation physiognomy (physiognomy)
- Polygon size (hectares)
- Polygon size (acres)
- Notes (for some polygons)
- Sub map class code (sub_map_class_code; for polygons in MC102 Upland Mixedgrass Grassland Complex and MC314 *Tilia americana* - (*Betula papyrifera*) Springbranch Canyon Forest)
- Sub map class name (sub_map_class_name; for polygons in MC102 Upland Mixedgrass Grassland Complex and MC314 *Tilia americana* - (*Betula papyrifera*) Springbranch Canyon Forest)
- Sub map class name translated (sub_map_class_translated; for polygons in MC102 Upland Mixedgrass Grassland Complex and MC314 *Tilia americana* - (*Betula papyrifera*) Springbranch Canyon Forest)
- Polygon perimeter (i.e., shape_length)
- Polygon area in square meters (shape_area)

The geodatabase also links the vegetation layer to other feature classes, such as vegetation classification and AA plots with associated sampling data from the PLOTS database, plot photos, and project boundary extent. The database includes tables documenting the USNVC hierarchy and allows for spatial queries that show the multitude of data associated with a vegetation polygon or sample point. All geospatial products are projected using NAD83 in UTM Zone 14N.

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4. Accuracy Assessment

4.1. Introduction

Accuracy assessment is a statistical analysis of the thematic accuracy of the vegetation map. It does not evaluate the spatial accuracy of map polygon boundaries. The AA measures the degree of confusion or error between map classes presented on the map and the vegetation as sampled on the ground. It tests the ability of the map to accurately identify the patterns of the map classes on the landscape. The AA provides map users with information on the limitations of the map and its suitability for particular applications, and informs map producers of potential sources of error and how to improve the mapping procedure (Lea and Curtis 2010). The results provide measures of overall accuracy as well as a class-by-class estimate of the users' and producers' accuracy. Users' accuracy is the probability that map polygons correctly classify the vegetation communities as they occur on the ground. Producers' accuracy is the probability that a vegetation community is correctly identified on the map. The Kappa coefficient is a statistical measure that provides a statistical measure of accuracy.

4.2. Methods

In order to produce a quantitative estimate of accuracy, random sample points stratified by map class area and frequency are distributed over the map surface. Vegetation at each of these survey points is classified in the field and assigned a USNVC-recognized vegetation type or other local type (i.e., park special) by a field crew using the dichotomous key to plant associations of NIOB. The field classifications are then compared to the associated map class designation for each location. Using these data, different analyses can estimate overall accuracy and the users' and producers' accuracy of the map. Together, these identify the "confidence" of the map for the user.

Some types with lower accuracy may represent types of management interest, and park staff may recommend aggregating types that have similar management concerns or needs. These aggregations can improve per-class accuracy. This process of aggregating low accuracy classes was completed for the NIOB map and is described below. The sample design, field methods, and methods of analysis were conducted in accordance with *Thematic Accuracy Assessment Procedures* (Lea and Curtis 2010).

4.2.1. Sample Design

A stratified random sampling approach was used to determine AA sampling locations. The area of inference was developed by applying several constraints to the map layer. Excluded classes, buffers applied and other allocation adjustments are described below.

- **Map Classes Included/Excluded.** All developed and agricultural land uses, cultural vegetation, and non-vegetated classes, including water, were excluded from the plot allocation.
- **Land Ownership.** AA plot locations were limited to public and private lands with prior permission (e.g., NPS, State, and TNC lands) within the NIOB administrative boundary.

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- **Accessibility and Safety Cost Surface Layer.** Areas having steep terrain and cliffs were considered inaccessible or too hazardous for field work. A cost surface using a threshold of 40+ degrees or 89 percent slope was developed using a 10 m DEM data layer.
- **Buffers to Avoid Road Shoulders and Associated Disturbance.** Paved and unpaved park roads were buffered 25 m from the center line and clipped from the allocation layer to avoid allocation of samples in disturbed roadside areas.
- **Buffers to Promote Homogeneity within Samples.** Transitional or otherwise atypical vegetation should not be chosen for thematic AA. Polygon boundaries form discrete boundaries that in the real world often consist of transitional zones (i.e., ecotones) between distinct vegetation types. A 5-45 m buffer was applied to polygon edges, depending on community type.
- **Buffers to Maintain Independence Among Observations.** A minimum buffer between AA plots equivalent to 80 m, or twice the radius of a circular area of observation, or 0.5 ha MMU was applied.

Sample sizes for each evaluated map class were selected using guidance from Lea and Curtis (2010) (Table 14). Most map classes were allocated 30 points using a simple random allocation. After the plots were allocated to each map class, the points were combined into a single data layer that tracked the mapped class for each point. A total of 740 AA points and an additional 313 alternate points for each class were allocated among the vegetated map classes. In cases where it was physically impossible to reach the AA point (i.e. in dangerous or inaccessible areas such as steep cliffs with slopes >50%), field crews recorded offset GPS locations and observed vegetation through binoculars. In the event that a primary sample point was inaccessible and/or not visible, alternate points were sampled instead, chosen from a sequential list of alternate points for the same type. Spatial coordinates for all AA points were downloaded to GPS receivers for field sampling and provided on field maps.

Table 14. Standard sample size allocations for NPS Vegetation Mapping Inventory thematic accuracy assessment, based on map class area (from Lea and Curtis 2010).

Map Class Abundance	Map Class Total Area[1] (hectares)	Number of Observations per Map Class[2]
Abundant	> 50	30
Relatively Abundant	8.33 to 50	0.6 (per hectare)
Relatively Rare	< 8.33	5

[1] As measured before buffering for cost surface (access buffer) or for map class boundary buffer.

[2] Or as many spatially independent (non-overlapping) observation sites as map class area, MMU size, and other considerations will allow.

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Overall, 740 primary sample points were allocated across the map classes (Figure 9). A list of 313 alternate sample points was also generated in the event that some primary plots could not be accessed or did not meet the selection criteria in the field. If a primary plot was rejected and could not be moved, a random alternate plot of the same map class was selected to replace it. Open water was also excluded. Areas having steep terrain and cliffs were considered inaccessible or too hazardous for field work. In these cases, crews were permitted to take an offset point, noting their distance and bearing to the randomly selected point, provided they were able to confidently identify the type from the offset.

4.2.2. Field AA Data Collection

Field staff for AA data collection consisted of two two-person crews and a crew leader that worked from August 8th through September 26th of 2017. All crew members had backgrounds in botany and ecology sampling techniques, but had limited familiarity with the vegetation present at NIOB. Before field sampling began, all crew members were trained in species identification, field methods and protocols, and use of the vegetation classification key.

For the AA, field crews used Collector for ArcGIS to collect points and record data. Collector was created by ESRI to help smooth the workflow between data collection and office analysis by allowing data to be digitally captured on a tablet. Collector allows the user to record data in the form of points, polygons, or lines using a mobile device in the field. The app syncs up with ArcGIS online allowing multiple people to view and edit the data in real time. Each map can be customized to fit the needs of the project through dropdown menus and georeferenced photos. Additionally, the maps are easy to create once the user is familiar with Collector. When finished with field work, the data may either remain in ArcGIS online or be exported for local use.

Prior to the start of field work, CNHP created a digital data sheet in Collector. The digital data sheet was based on the paper AA data sheet. Using Collector provided several benefits, including built-in backups, real time data collection, automatically georeferenced photos, and dropdown menus. After each day, field crews synced the data to ArcGIS online. This allowed the data to be stored online and on the local device itself. Since the data are stored on ArcGIS online, the project manager in Fort Collins could observe data as it was collected in the field. Finally, Collector allowed for easy data entry at the end of the field season. Species are chosen from a pre-generated species list, which reduces spelling errors, speeds up quality control, and improves quality assurance. Field crews used Apple iPad Pro tablets with Bad Elf brand Bluetooth GPS units.

Primary and alternate AA points were uploaded to ArcGIS online. These points were added to a map along with the digital data sheet, park boundary, and landowner layers. Each field map included locations of primary and alternate plots with topographical lines overlaid on satellite imagery to aid in navigation. To avoid biasing field determinations, no information on the map class or association of polygons was revealed to the crews..

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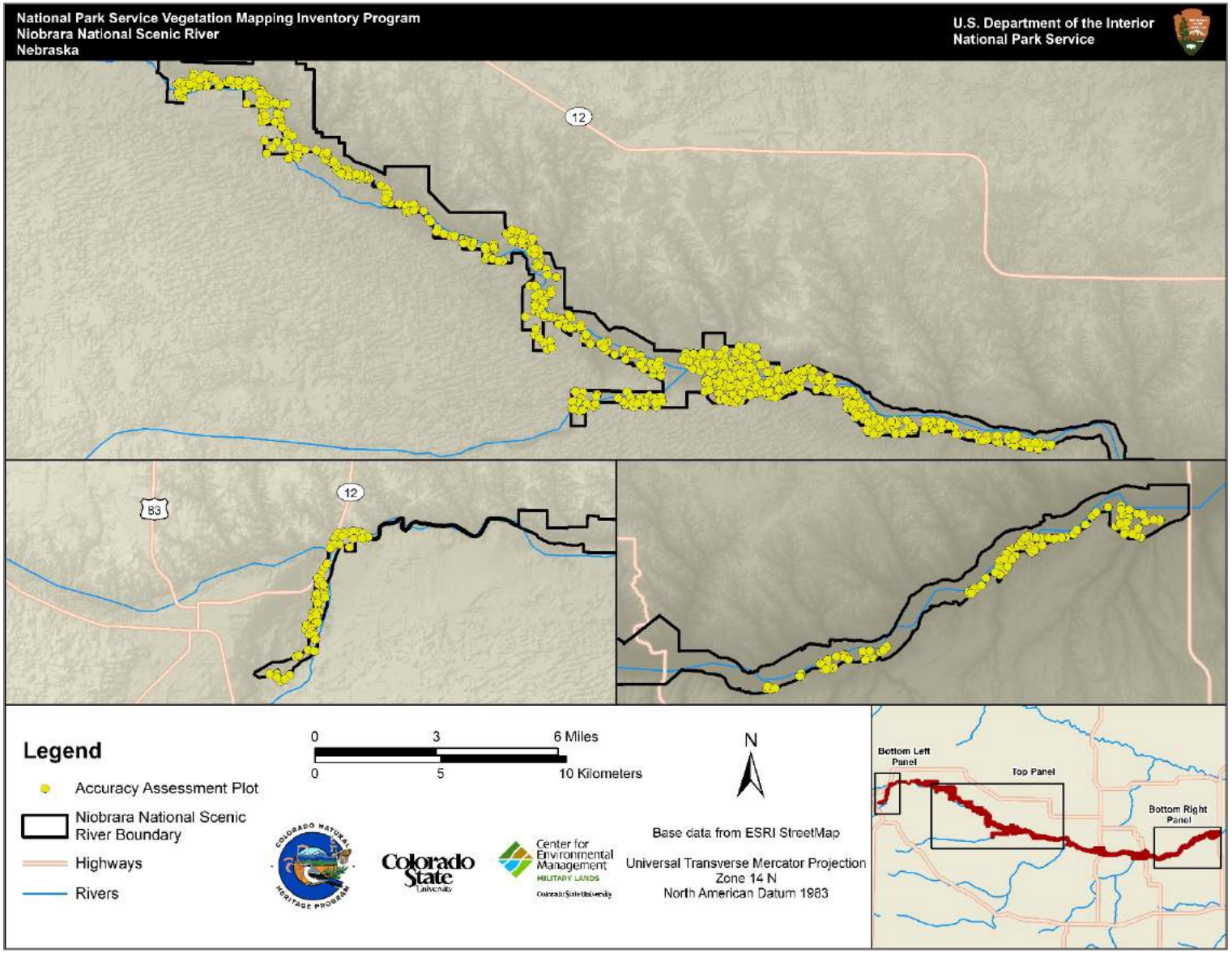

Figure 9. AA sample points visited during summer 2017 fieldwork.

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As with the vegetation classification plots, AA point locations were accessed using a combination of travel on roads, river travel by canoe, and foot travel, typically completed during day-trips. Once a crew successfully navigated to an AA plot, they evaluated the site relative to the AA criteria. The standard observational area of each plot was a 0.5 ha circle, which is equivalent to the MMU for each map class. If the plot was notably affected by some disturbance, such as an agricultural site or a road, the crew would attempt to move or reshape the plot. In the extremely rare case that it could not be moved or reshaped appropriately, the plot was rejected and an alternate location selected sequentially from the alternate plot list was substituted. If the plot appeared to encompass more than one distinct vegetation type (not considered an inclusion), the plot would be moved or reshaped. Moving and reshaping of plots followed modified guidance from Lea and Curtis (2010). When a plot was moved, the crew recorded the GPS coordinates of the new plot center on the field form. Plots that were inaccessible or deemed unsafe due to steep terrain were rejected and replaced with alternate plots.

Once an AA plot was determined to meet the selection criteria, the crew used the Field Key to Community Associations/Types (Appendix B) to assign a vegetation type. The vegetation types are either recognized USNVC types or are "park specials." The vegetation types are equivalent to or nested uniquely within a single map class. There may be many types within a single map class, but only one map class for each type. Thus, identifying the community to vegetation type will ultimately determine whether the correct map class has been applied. This method avoids the need to generate a separate map class key and provides the user with more information on map class composition. A primary or "best fit" assignment was recorded as well as a secondary or "next best" assignment.

In addition to assigning a vegetation type to each AA plot, the crew also recorded the crew member names, date, dominant species of each stratum, whether the plot was a good representation of the overall polygon, and whether the designated type was a good fit for the vegetation observed at the site (AA Field Form in Appendix F). The crew also recorded the UTM coordinates of the field plot center, which was especially crucial when plots were moved or reshaped, or the error in the GPS unit was high. They also noted any special conditions that could affect the classification of the plot (e.g., recent disturbance, potential species misidentification, etc.) and took a picture from plot center in each of the cardinal directions (north, east, south, and then west). These digital photos were archived according to plot number, and were referenced during data analysis in the event of a disagreement between the mapped class and the field-assigned class. A total of 2,951 AA photos were collected during the AA field work. A total of 3,575 photos were generated by the project and included in the geodatabase.

Due to the seasonal variability in water levels of the Niobrara River, some plots were inundated with water at the time of sampling. These sites were accessed via canoe or boat, or were observed from a vantage point on shore. The UTM coordinates were recorded at the point of observation. Although the vegetation at these sites is likely seasonally variable, depending on lake levels, the crew recorded the species that were visible at the time of sampling and were able to assign the plot a vegetation type, typically "Seasonally Flooded Herbaceous." Consequently, no plots were rejected because of flooding at the site

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4.2.3. Data Quality Control

The data underwent quality control (QC) procedures prior to and following data entry before any analyses were performed. The first QC step was review and verification of field form data. Data on the field forms were checked for completeness and to ensure that values were appropriate for the given parameter. Following entry of the data into the PLOTS database, routine QC checks of the data were completed to eliminate possible transcription errors. These checks included searching for null values, as well as checking for values out of range, nonsensical, or otherwise erroneous values. After making necessary corrections, the data were imported into ArcGIS as a layer file and a data QC check was completed to ensure that the geocoding was correct for all points.

4.2.4. Accuracy Assessment Data Analysis

To analyze the NIOB AA data, a table was created from the pertinent data fields in the PLOTS database and imported into ArcGIS. Pertinent data fields included Plot ID, Primary Association, Secondary Association, Primary Map Class, Secondary Map Class, Plot XY Coordinates, and Field XY Coordinates. The imported database was converted to a shapefile and spatially joined to the vegetation map layer. This spatial join produced a list of all sampled points, the map class of the Primary and Secondary Association identified by the field crew, and the map class of the vegetation map polygon where the point was sampled. The attribute table of the spatial join was exported from ArcGIS as a table and imported to MS Excel for further evaluation.

The data table imported to MS Excel was evaluated to identify plot records where the field map class (field call) did not agree with the map class of the vegetation map (map call). Records where the primary field call was correct were considered correct and removed from the analysis. Records for which the primary field call disagreed with the mapped class but the crew had made a secondary call were then evaluated. Records for which the secondary call was correct were considered correct. The remaining records were considered incorrect and retained for further evaluation to determine the source of the disagreement and potential need for reconciliation. The analysis of this dataset provided an initial (raw) accuracy measure.

The remaining records where neither the primary nor secondary field call agreed with the map call were individually evaluated by reviewing all available data for the sample point and the map polygon. The purpose of the review was to identify the source of the disagreement between the field call and the map call, and verify whether the error was attributable to the map call or some other factor. Verifying the source of error allows one to reconcile errors that in reality have very little to do with the accuracy of the map polygons, and provides a truer measure of the map accuracy. The analysis of this dataset provided a reconciled accuracy measure. The reconciled accuracy measure remains unbiased by correcting only errors that can objectively be attributed to an erroneous field call or a change in land use or land cover.

Three potential sources of disagreement were identified prior to verifying the sources. These included cases where the disagreement was due to an erroneous map call (MC), an erroneous field call (FC), or due to recent changes in the land use or land cover (RC) (i.e., changes occurring after the imagery date). Erroneous field calls were further classified as due to a species or association identification error (FC1), a cover or density estimate error (FC2), a minimum map unit (MMU)

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estimate error (FC3), or a simple recording error (FC4). Any disagreement that could not objectively be attributed to something other than a map call were classified as an erroneous map call (MC). All disagreements classified as MC were retained as errors. All disagreements classified as FC1-FC4 or RC were considered to be correct.

The review of all disagreements included reviewing the field data sheets, the sample point photos, the map polygons, and imagery of the area. Prior to starting the review, additional columns were added to the evaluation spreadsheet for "Error Classification," "Comments/Justification," and "Reconciled Field Call." Error Classification is one of six codes listed above (FC1-FC4, MC, RC), Comments/Justification provides a short description of what the specific issue was, and Reconciled Field Call is the post-reconciliation value assigned to the point (may remain the same or change).

Following the reconciliation, the data were arrayed to create an error matrix as well as a list of all map classes and their areas. Map class names were categorized by the physiognomy of the type to ensure that similar types were positioned near one another in the matrix. To do this we simply added a digit to the map class name to designate the physiognomy. The matrix and list were then copied and pasted into the NPS Contingency Table workbook (NPS 2018). For more information on the NPS Contingency Table Spreadsheet see Lea and Curtis (2010).

The MS Excel contingency table workbook calculated overall accuracy (with confidence intervals), individual class accuracies (with confidence intervals), Kappa coefficient (with confidence intervals), and measures of users' and producers' accuracy. The Kappa coefficient is a measure of overall accuracy that varies from 0 to 1, where 0.1 – 0.20 represents slight agreement, 0.21 – 0.40 represents fair agreement, 0.41 – 0.60 represents moderate agreement, 0.61 – 0.80 represents substantial agreement, and 0.81 – 0.99 represents near perfect agreement (Landis and Koch 1977).

Users' accuracy is based on the mapped classes (rows in the contingency table), and is defined as the probability that a location mapped as class x is in fact class x on the ground. Users' accuracy is more important to map users because they are most interested in knowing how well the map represents the types on the ground (Lea and Curtis 2010). The producers' accuracy provides the map producer with an indication of how accurately a class may be detected wherever it occurs within the mapped area (inference area) (Lea and Curtis 2010).

4.2.5. Map Class Aggregation

Map classes with low individual class accuracy were evaluated for aggregation into the class(es) with which they were confused. The class errors were evaluated to determine the specific classes to combine to improve the accuracy of the classes. Aggregating map classes decreases the thematic resolution of the aggregated classes. Therefore, the objective is to maximize the individual class accuracies while minimizing the loss of thematic resolution of map classes. This requires identifying the correct map classes to combine, and not combining more classes than is absolutely necessary to improve the accuracy to an acceptable level, consistent with park staff input.

The aggregating process was attempted using the Lea and Curtis (2010) protocol which states that the sum of the individual class accuracies is "simply" the accuracy of the lumped classes, and the sum of

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the confidence intervals of the individual classes is the confidence interval of the lumped classes. While Lea and Curtis (2010) instruct users to combine the row and column values for low accuracy classes and provides extra worksheets inside the workbook for this purpose, we found that aggregating the classes outside of the workbook and entering the aggregated data into a new worksheet was the most effective method.

4.3. Results

4.3.1. Accuracy Assessment Field Data Collection

The field crews collected data at 647 primary points and 108 alternate points, for a total of 755 AA points sampled. The total inference area within the 23,074 ac (9,338 ha) of NIOB is 20,875 ac (8,448 ha), or 90.5%. Open water and land use areas (agriculture, roads, urban, etc.) are not included in the inference area. The inference area in each map class and the count of sample points collected within each is shown in Table 15.

Table 15. Count of AA sample points and inference area for each map class.

Map Class Code	Map Class Inference Area (hectares)	Number of AA Sample Points
MC101	1,088	30
MC102	1,114	30
MC102a	276	32
MC102b	32	17
MC102c	28	12
MC102d	81	24
MC103	19	6
MC104	94	25
MC105	109	21
MC201	342	30
MC202	169	31
MC203	13	10
MC204	3	5
MC205	3	1
MC301	555	32
MC302	200	31
MC303	499	30
MC304	460	30

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Table 15 (continued). Count of AA sample points and inference area for each map class.

Map Class Code	Map Class Inference Area (hectares)	Number of AA Sample Points
MC305	17	1
MC306	344	31
MC307	420	30
MC308	61	19
MC309	226	30
MC310	168	31
MC311	566	32
MC313	280	30
MC314	86	30
MC314a	17	6
MC314b	106	30
MC315	866	30
MC316	3	5
MC317	96	31
MC401	85	17
MC402	22	5

4.3.2. Accuracy Assessment Data Analysis

Field crews collected data from a total of 755 AA sample points. Prior to any effort to reconcile data collection errors, 606 samples agreed with the map classification and 149 disagreed with the map classification. As a simple plot count proportion across all map classes, the overall accuracy before reconciliation was 80.3% (606/755). When the accuracy for each map class is weighted relative to the acreage it occupies within NIOB (i.e., as a proportion of the population), the initial overall accuracy was 83.0% with a Kappa accuracy of 79.6%. When each AA sample was evaluated for a variety of potential errors, a number of the disagreements were overturned, resulting in revised accuracies. It was determined that 32 plot records disagreed due to either an erroneous field call (FC1-4) or a change in the vegetation since the imagery date (RC), and 117 disagreed due to a true map classification error (MC). Those records identified as incorrect due to an erroneous field call or changes in vegetation were considered correct for the purpose of the AA.

The 117 plots ultimately identified as disagreeing with the mapped class during the QC process were attributed to map classification error. Table 16 summarizes the outcome of the error reconciliation. As a simple plot count proportion, the reconciled overall accuracy was 84.5%. The spatially-

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weighted overall accuracy was 87.8% with a Kappa statistic of 83.9%. The overall accuracy, Kappa statistic, and upper and lower 90% confidence intervals for the initial (raw) AA data and reconciled AA data are provided in Table 17.

Table 16. Accuracy assessment error reconciliation summary for NIOB based on simple plot count proportions (not spatially weighted).

Category	Reconciliation Type	Acronym Code	Count	Percent
Initial (raw) Accuracy	Map Class Agreement	–	606	80%
	Map Class Disagreement	–	149	20%
Concise (reconciled) Accuracy	Map Class Agreement	–	638	85%
	Map Class Disagreement	–	117	15%
Evaluation Criteria	Initial Agreement	Match	606	77%
Map Call Errors	Classification Error	MC1	117	–
	Spatial Error	MC2	0	–
	Total Map Call Errors	–	**117**	**15%**
Field Call Errors	Species/Type ID Error	FC1	3	12%
	Cover Estimation Error	FC2	21	81%
	MMU Estimation Error	FC3	2	8%
	Data Recording Error	FC4	0	0%
	Total Field Call Errors	–	**26**	**3%**
Vegetation Change Errors	Inundation	VC1	3	50%
	Mechanical Treatment	VC2	3	50%
	Chemical Treatment	VC3	–	0%
	Burned	VC4	–	0%
	Total Vegetation Change Errors	–	**6**	**1%**

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Table 17. Spatially-weighted initial and reconciled overall map accuracy.

Accuracy Type	Limit Type (lower & upper)	Initial (raw) Accuracy, Percent	Reconciled Accuracy, Percent
Overall Acruacy	Lower Limit, 90% Confidence Interval	80%	85%
	Upper Limit, 90% Confidence Interval	86%	90%
	Overall Accuracy (all)	**83%**	**88%**
Kappa	Lower Limit, 90% Confidence Interval, K	77%	82%
	Upper Limit, 90% Confidence Interval, K	82%	86%
	Kappa (all)	**80%**	**84%**

Many of the upland mixedgrass grassland community samples disagreed with the mapped class, which may have been the result of a minor drought in August 2017 (NOAA 2018). During 2017 field sampling, many of the tall C_4 grasses such as *Calamovilfa longifolia*, *Schizachyrium scoparium*, *Andropogon gerardii*, and *Andropogon hallii* were not abundant in any of the communities across NIOB. In contrast, surveys from 2015 and 2016 found much greater abundances of flowering culms during a similar time of year. The timing of the 2017 drought (August) may have impacted the growth of these species. Although resilient to drought, C_4 grasses may still become stressed during high temperatures and low precipitation (Knapp and Gilliam 1985). The accuracies for these communities were all poor; however, in subsequent years, these species may rebound to their previous abundances.

Individual class accuracies are considered a more valuable measure of the map accuracy than the overall accuracy. Individual class accuracies are evaluated as either the “users’ accuracy” or the “producers’ accuracy.” Users’ accuracy is based on the mapped classes (rows in the contingency table) and is defined as the probability that a location mapped as class x is in fact class x on the ground. Users’ accuracy is more important to map users because they are most interested in knowing how well the map represents the types on the ground (Lea and Curtis 2010).

Producers’ accuracy is based on the true vegetation class in the field (columns in the contingency table) and is defined as the probability that a location of vegetation class x in the field is correctly mapped as class x. Producers’ accuracy provides the map producer with an indication of how accurately a class may be detected wherever it occurs within the mapped area (inference area) (Lea and Curtis 2010). The users’ and producers’ accuracies for each map class in the reconciled dataset are presented in Table 18. Project data and the contingency table workbooks are included with the project products, and can be downloaded from NPS VMI site.

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Table 18. Users' and Producers' reconciled accuracies for each map class at NIOB.

Map Class Code	Users' Accuracy %	Lower Limit, 90% CI	Upper Limit, 90% CI	Producers' Accuracy %	Lower Limit, 90% CI	Upper Limit, 90% CI	Est. True MC Area (ha)
MC101	86.7%	74.8%	98.5%	84.2%	82.9%	85.6%	1,119.07
MC102	86.7%	74.8%	98.5%	100.0%	98.8%	100.0%	965.67
MC102a	71.9%	57.2%	86.5%	76.9%	76.4%	77.4%	257.75
MC102b	47.1%	24.2%	69.9%	15.7%	15.3%	16.2%	94.26
MC102c	58.3%	30.8%	85.9%	12.6%	12.0%	13.2%	128.54
MC102d	45.8%	27.0%	64.6%	81.1%	80.9%	81.3%	45.58
MC103	66.7%	26.7%	100.0%	100.0%	99.9%	100.0%	12.65
MC104	88.0%	75.3%	100.0%	100.0%	99.9%	100.0%	82.33
MC105	85.7%	70.8%	100.0%	94.9%	94.8%	95.1%	98.37
MC201	90.0%	79.3%	100.0%	87.3%	86.9%	87.7%	352.63
MC202	96.8%	89.9%	100.0%	90.8%	90.7%	91.0%	179.57
MC203	70.0%	41.2%	98.8%	83.6%	83.5%	83.6%	11.29
MC204	80.0%	40.6%	100.0%	15.8%	15.7%	15.8%	14.04
MC205	100.0%	50.0%	100.0%	100.0%	100.0%	100.0%	3.33
MC301	100.0%	98.4%	100.0%	99.8%	99.8%	99.8%	555.86
MC302	93.5%	84.7%	100.0%	90.0%	89.8%	90.2%	207.93
MC303	90.0%	79.3%	100.0%	96.7%	96.2%	97.2%	464.56
MC304	80.0%	66.3%	93.7%	82.5%	81.7%	83.2%	446.28
MC305	100.0%	50.0%	100.0%	75.9%	75.9%	75.9%	22.53
MC306	83.9%	71.4%	96.4%	95.7%	95.3%	96.1%	301.75

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Table 18 (continued). Users' and Producers' reconciled accuracies for each map class at NIOB.

Map Class Code	Users' Accuracy %	Lower Limit, 90% CI	Upper Limit, 90% CI	Producers' Accuracy %	Lower Limit, 90% CI	Upper Limit, 90% CI	Est. True MC Area (ha)
MC307	86.7%	74.8%	98.5%	98.5%	98.0%	99.0%	369.05
MC308	94.7%	83.7%	100.0%	83.6%	83.5%	83.7%	69.60
MC309	83.3%	70.5%	96.2%	72.6%	72.2%	73.0%	259.73
MC310	74.2%	59.7%	88.7%	91.6%	91.3%	91.9%	136.20
MC311	96.9%	90.3%	100.0%	95.7%	95.3%	96.0%	573.30
MC313	90.0%	79.3%	100.0%	69.2%	68.8%	69.6%	364.09
MC314	86.7%	74.8%	98.5%	100.0%	99.9%	100.0%	74.29
MC314a	83.3%	50.0%	100.0%	61.2%	61.1%	61.2%	23.10
MC314b	76.7%	62.3%	91.0%	89.7%	89.6%	89.9%	90.96
MC315	93.3%	84.2%	100.0%	90.1%	89.3%	90.8%	897.82
MC316	100.0%	90.0%	100.0%	100.0%	100.0%	100.0%	2.71
MC317	90.3%	80.0%	100.0%	69.0%	68.9%	69.2%	126.15
MC401	88.2%	72.4%	100.0%	100.0%	99.9%	100.0%	74.96
MC402	100.0%	90.0%	100.0%	100.0%	100.0%	100.0%	21.74

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4.3.3. Map Class Aggregation

Following review of the individual class accuracies, the classification team met with the interpretation team to discuss the results. In evaluating possible aggregation of preliminary map classes, the teams considered results of the contingency table illustrating the distribution of disagreements among types, nuances of the communities, and the locations and extents of types. As a result of the discussions, it was determined that nine map classes with low class accuracies (MC102 Upland Mixedgrass Grassland, MC102a *Schizachyrium scoparium* - *Bouteloua* (*curtipendula*, *gracilis*) Mixedgrass Grassland, MC102b *Andropogon gerardii* Tall Grass Prairie Grassland, MC102c *Hesperostipa comata* - *Pascopyrum smithii* Mixedgrass Grassland, MC102d *Andropogon hallii – Calamovilfa longifolia* Grassland, MC103 *Phalaris arundinacea* Western Marsh, MC104 Marsh Complex, MC203 *Cornus drummondii – Prunus* spp. Shrubland, MC204 *Symphoricarpos occidentalis* Shrubland) would be aggregated into 3 new map classes. Upland grasslands MC102, MC102a, MC102b, MC102c, and MC102d were combined into a single map class (Table 19). The marsh communities (MC103, MC104) were combined into a single map class, and the dogwood (MC203) and snowberry (MC204) shrublands were combined.

Table 19. Final aggregated and initial map classes subsumed within them.

Final Aggregated Map Class	Initial Map Classes Subsumed
MC102 Upland Mixedgrass Grassland	MC102 Upland Mixedgrass Grassland
	MC102a *Schizachyrium scoparium* - *Bouteloua* (*curtipendula*, *gracilis*) Mixedgrass Grassland
	MC102b *Andropogon gerardii* Tall Grass Prairie Grassland
	MC 102c *Hesperostipa comata* - *Pascopyrum smithii* Mixedgrass Grassland
	MC102d *Andropogon hallii* - *Calamovilfa longifolia* Grassland
MC103/104 Marsh Complex	MC103 *Phalaris arundiancea* Western Marsh
	MC104 Marsh Complex
MC203/204 *Prunus* spp. - *Symphoricarpos occidentalis* Shrubland Complex	MC203 *Cornus drummondii* - *Prunus* spp. Shrubland
	MC204 *Symphoricarpos occidentalis* Shrubland

Two map classes with low class accuracy (MC310 *Fraxinus pennsylvanica* Ruderal Forest and Woodland and MC314b *Tilia americana* – (*Quercus macrocarpa*) / *Ostrya virginiana* Forest) were retained. These map classes were retained because their accuracy was reasonably close to the 80% threshold (74.2% and 76.7%). The new aggregated classes and the original classes combined to create them are listed in Table 19. Table 18 shows the individual accuracies before the aggregation. Tables 20 and 21 report an estimated true area for each map class. This area is estimated based upon the producer's accuracy and differs slightly from the mapped acreage.

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Table 20. Users' and producers' accuracies for the final aggregated map classes.

Map Class Code	Users' Accuracy %	Lower Limit, 90% CI	Upper Limit, 90% CI	Producers' Accuracy %	Lower Limit, 90% CI	Upper Limit, 90% CI	Est. True MC Area (ha)
MC101	86.7%	74.8%	98.5%	84.2%	82.9%	85.6%	1,119.07
MC102	86.6%	21.5%	92.2%	88.8%	87.4%	90.2%	1,491.81
MC103/104	84.4%	81.3%	87.5%	100.0%	99.9%	100.0%	94.98
MC104	88.0%	75.3%	100.0%	100.0%	99.9%	100.0%	82.33
MC105	85.7%	70.8%	100.0%	94.9%	94.8%	95.1%	98.37
MC201	90.0%	79.3%	100.0%	87.3%	86.9%	87.7%	352.63
MC202	96.8%	89.9%	100.0%	90.8%	90.7%	91.0%	179.57
MC203/204	80.0%	78.3%	81.7%	51.3%	51.2%	51.4%	25.32
MC205	100.0%	50.0%	100.0%	100.0%	100.0%	100.0%	3.33
MC301	100.0%	98.4%	100.0%	99.8%	99.8%	99.8%	555.86
MC302	93.5%	84.7%	100.0%	90.0%	89.8%	90.2%	207.93
MC303	90.0%	79.3%	100.0%	96.7%	96.2%	97.2%	464.56
MC304	80.0%	66.3%	93.7%	82.5%	81.7%	83.2%	446.28
MC305	100.0%	50.0%	100.0%	75.9%	75.9%	75.9%	22.53
MC306	83.9%	71.4%	96.4%	95.7%	95.3%	96.1%	301.75
MC307	86.7%	74.8%	98.5%	98.5%	98.0%	99.0%	369.05
MC308	94.7%	83.7%	100.0%	83.6%	83.5%	83.7%	69.60
MC309	83.3%	70.5%	96.2%	72.6%	72.2%	73.0%	259.73
MC310	74.2%	59.7%	88.7%	91.6%	91.3%	91.9%	136.20
MC311	96.9%	90.3%	100.0%	95.7%	95.3%	96.0%	573.30

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Table 20 (continued). Users' and producers' accuracies for the final aggregated map classes.

Map Class Code	Users' Accuracy %	Lower Limit, 90% CI	Upper Limit, 90% CI	Producers' Accuracy %	Lower Limit, 90% CI	Upper Limit, 90% CI	Est. True MC Area (ha)
MC313	90.0%	79.3%	100.0%	69.2%	68.8%	69.6%	364.09
MC314	86.7%	74.8%	98.5%	100.0%	99.9%	100.0%	74.29
MC314a	83.3%	50.0%	100.0%	61.2%	61.1%	61.2%	23.10
MC314b	76.7%	62.3%	91.0%	89.7%	89.6%	89.9%	90.96
MC315	93.3%	84.2%	100.0%	90.1%	89.3%	90.8%	897.82
MC316	100.0%	90.0%	100.0%	100.0%	100.0%	100.0%	2.71
MC317	90.3%	80.0%	100.0%	69.0%	68.9%	69.2%	126.15
MC401	88.2%	72.4%	100.0%	100.0%	99.9%	100.0%	74.96
MC402	100.0%	90.0%	100.0%	100.0%	100.0%	100.0%	21.74

Table 21. Overall accuracy and Kappa accuracy for the final NIOB vegetation map.

Accuracy Type	Limit Type (lower & upper)	Percent
Overall Accuracy	Lower Limit, 90% Confidence Interval	84.5
	Upper Limit, 90% Confidence Interval	93.2
	Overall Accuracy (all)	**88.9**
Kappa	Lower Limit, 90% Confidence Interval, K	85.2
	Upper Limit, 90% Confidence Interval, K	89.3
	Kappa (all)	**87.3**

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The overall accuracy of the NIOB map is 87.8% with a Kappa statistic of 83.9% (the Kappa Coefficient provides an accuracy value that corrects for chance agreement). The accuracy of the final aggregated map is 88.9%. The users' and producers' accuracies for the final aggregated map classes are presented in Table 20 and Figure 10. The aggregated accuracy, the Kappa Statistic, and the upper and lower 90% confidence intervals for each are shown in Table 21.

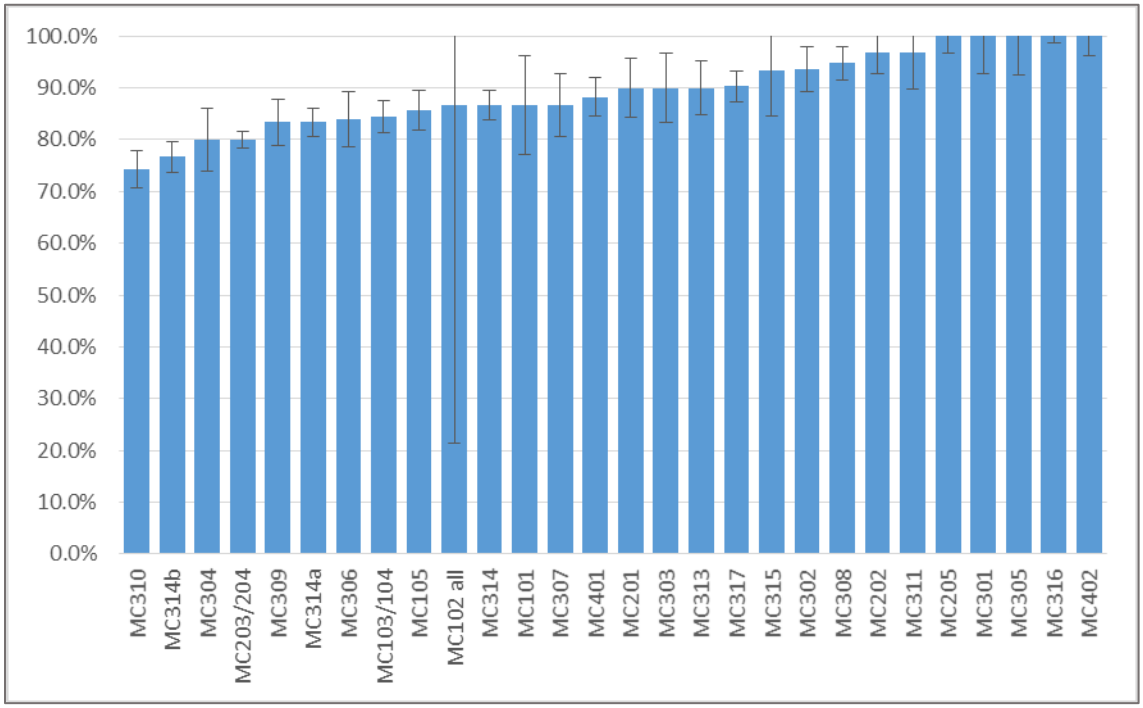

Figure 10. Users' accuracy and 90% confidence intervals for NIOB vegetated map classes.

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5. Conclusions

The vegetation inventory project at NIOB classified and mapped vegetation within the park boundary. The project was conducted over a four-year period from 2015 to 2019. The primary imagery used for the project was 30 cm 4-band imagery acquired in October 2015.

The vegetation inventory resulted in a report, a vegetation map with accuracy exceeding the requirements and several associated geospatial database products. The overall users' accuracy of the map is 87.8%, although several classes had individual users' accuracy below the 80% threshold. Where initial thematic accuracy was low for several map classes, map classes were aggregated into classes with which they were confused. The accuracy of this aggregated map is 88.9%, with only two classes remaining (MC310, MC314b) with accuracy below the 80% threshold when including 90% confidence intervals on the estimates. Examining the confidence intervals in Figure 10, there are five additional classes that include the 80% threshold.

The project also developed other products valuable for park resource management. They include the vegetation classification, field key to the associations, local association descriptions, and photo database. Together with the vegetation data layer, these products provide NIOB with an array of tools to assist in managing park resources and making informed resource management decisions.

Included in the associations described for NIOB are 24 vegetation types that were not sampled during the classification phase and were later described from field notes made by mapping staff. These additional types are described from their global range descriptions and not from local sampling. Additional field sampling would be required to characterize the local expression of these types at NIOB, if desired.

The final vegetation data layer contains the aggregated map classes and details of the constituent classes. Aggregating map classes allows the map to reach the accuracy thresholds for individual classes at the cost of thematic resolution. Because different management or research applications may place greater value on thematic resolution than per-class accuracy, the detail of the aggregated classes was retained in the geodatabase and can be displayed and manipulated as needed.

The NIOB vegetation classification and map will be helpful in managing myriad park resources. The geospatial database, map, and other products directly support managing and monitoring plant and animal habitats, examining the effects of land uses and environmental changes on vegetation over time, and evaluating the long-term effects of management activities on plant communities within NIOB.

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Appendix A: Mapped Plant Community Descriptions

List of Mapped Plant Communities

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List of Mapped Plant Communities (continued)

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List of Mapped Plant Communities (continued)

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Mapped Herbaceous Vegetation Types

CEGL005264 Bromus inermis – (Pascopyrum smithii) Ruderal Grassland

The table below shows the USNVC Hierarchy for CEGL005264 Bromus inermis – (*Pascopyrum smithi*i) Ruderal Grassland.

USNVC Hierarchy for CEGL005264 Bromus inermis – (Pascopyrum smithii) Ruderal Grassland

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.B Temperate & Boreal Grassland & Shrubland
Formation	2.B.2 Temperate Grassland & Shrubland
Division	2.B.2.Na Western North American Grassland & Shrubland
Macrogroup	2.B.2.Na Western North American Ruderal Grassland & Shrubland
Group	2.B.2.Na Western North American Interior Ruderal Grassland & Shrubland
Alliance	A3254 *Agropyron cristatum - Bromus inermis - Poa pratensis* Ruderal Grassland Alliance
Association	2.B.2.Na *Bromus inermis* - (*Pascopyrum smithii*) Ruderal Grassland (CEGL005264)

Field Plots: 0064

Map Class: NIOB MC101

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: 2442 ft

Aspect: 268˚

Slope: 10˚

Macro Topography: Hills

Geology: Ogallala Group

Soil Texture: Loamy Sand

Environment: One site was sampled within this type. These communities typically occur on hills with loamy sand. Ground cover is dominated by litter with cover of 70% and bare soil has cover of 10%. This occurred on a gentle slope of 10 degrees.

Local Vegetation Description

Structure: Herbaceous (100%)

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Vegetation Floristics: *Bromus inermis* completely dominates the plot with cover of ~90%. Other grasses present are *Panicum virgatum*, *Andropogon hallii*, and *Carex brevior*, but their cover values never exceed 10% total. This site has been completely invaded.

Dynamics: *Bromus inermis* is a strongly rhizomatous, cool-season grass that grows 0.5-1 (1.5) m tall (Cronquist et al. 1977). It is a highly competitive, sod-forming grass with a dense fibrous root and rhizome system. The extensive rhizome system allows it to rapidly spread and makes it able to tolerate heavy grazing by livestock (Hansen et al 1995). Although this grass grows best on moist alluvial sites, it does not tolerate prolonged flooding (Hansen et al. 1995). It also has good drought resistance, which allows it to persist in semi-arid regions (Cronquist et al. 1977). Flooding of infested riparian areas has been used to restore native riparian or wetland species in degraded (de-watered) sites (Hansen et al. 1995). *Bromus inermis* is also fire-adapted and will vigorously sprout after most burns (Hansen et al. 1995). However, this cool-season grass is not tolerant of hot, late-spring burns, which is during its active growing period (Hansen et al. 1995). This may be an effective control measure where native vegetation is dominated by warm-season grasses.

Conservation Status Rank

Global: GNA

State (Nebraska): N/A

Global Environmental Description

This smooth brome grassland type occurs widely throughout the northern Great Plains, on relatively mesic sites in the semi-arid interior western United States, and perhaps more widely in the midwestern U.S. and Canada. Stands can occur in a wide variety of human-disturbed habitats, including highway rights-of-way, jeep trails, etc. The type is also widely planted for revegetating disturbed land, pasture and hay fields, and has escaped into a variety of habitats, including prairie, riparian grasslands, and mesic mountain meadows. This community is found at all elevational ranges with best examples occurring on mesic alluvial terraces. *Bromus inermis* grows best on moist, well-drained, finer-textured loam and clay loams, not heavy clays or sand, and does not tolerate prolonged flooding, however, it does persist quite well on well-drained sandy loam derived from granitic parent material. It also occurs in foothills and plains at lower elevations on relatively mesic sites. It occurs on poorly drained sites to rapidly drained sites with fine-textured alluvial soils derived from shale formations found in Utah. This community persists because it is rhizomatous, and once seeded, with enough moisture, will persist, regardless of elevation, soil or landform.

Global Vegetation Description

This smooth brome grassland type occurs widely throughout the northern Great Plains, in disturbed montane meadows in the Rocky Mountains, on relatively mesic sites in the semi-arid interior western United States, and perhaps more widely in the midwestern U.S. and Canada. Stands can occur in a wide variety of human-disturbed habitats, including highway rights-of-way, jeep trails, etc. The type is also widely planted for revegetating disturbed land, pasture and hay fields, and has escaped into a variety of habitats, including prairie, riparian grasslands, and mesic mountain meadows. The

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dominant grass is *Bromus inermis*, a naturalized species from Eurasia that forms moderately dense to dense stands that often develop into monocultures. Other weedy species such as *Cirsium arvense* and *Poa pratensis* may occur as well, but native species are generally less than 10% cover. Native species may include mixed-grass prairie and montane meadow grasses, such as *Pascopyrum smithii*, *Deschampsia caespitosa*, and *Hesperostipa comata* (= *Stipa comata*), and sparse, scattered mesic shrubs such as Symphoricarpos spp., as well as many others. However, the native species are not conspicuous enough to identify the native plant association that could occupy the site, or the stand would be typed as such.

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of USNVC Hierarchy for CEGL005264 Bromus inermis – (*Pascopyrum smithi*i) Ruderal Grassland.

Bromus inermis – (*Pascopyrum smithii*) Ruderal Grassland (CNHP).

Short Citation

- Cronquist et al., 1977

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- Hansen et al., 1995

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NPSNIOB005 Ruderal Herbaceous Grassland

USNVC: Park Special NPSNIOB005

Field Plots: 0082, 0088, 0155, 0168, 0175, 0186, 0196

Map Class: NIOB MC101

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2226.71 ft (range 2005 ft to 2453 ft)

Aspect: Mean 52.86˚ (range Flat to 190˚)

Slope: Mean 3.57˚ (range Flat to 22˚)

Macro Topography: Alluvial Terrace, Bluff

Geology: Ogallala Group, White River Group

Soil Texture: Sand, Loamy Sand, Sandy Loam, Clay Loam

Environment: 7 sites were sampled within this type. All of these sites appear to have been different grassland communities that have been invaded by ruderal species. Most of sites fall within heavily grazed cow pastures on alluvial terraces and bluffs. Soil texture is variable and ranges from clay loam to sand. The majority of these plots occurred along old floodplains though they occasionally occur on a slope above the terrace. Ground cover is typically dominated by litter (~70% cover) followed by bare soil (~10% cover).

Local Vegetation Description

Structure: Canopy (0%-20%), Dwarf Shrub (0%-10%), Herbaceous (50%-90%)

Vegetation Floristics: These grasslands have been taken over by weedy species such as *Dichanthelium oligosanthes* and *Poa pratensis*. These species will usually have greater than 50% cover while other graminoids in this type will have less than 20% cover. *Schizachyrium scoparium* is a species that appeared in abundance in several of the plots, and it often dominated the plots closely followed by *Dichanthelium oligosanthes*. Forbs generally composed ~20% of the cover for the plot. Common forbs include *Ambrosia psilostachya* and *Verbena stricta*.

Dynamics: N/A

Conservation Status Rank

Global: N/A

State (Nebraska): N/A

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Global Environmental Description

N/A

Global Vegetation Description

N/A

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of USNVC: Park Special NPSNIOB005.

Ruderal Herbaceous Grassland (CNHP)

Short Citation

N/A

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NPSNIOB002 Weedy Forb Ruderal Herbaceous

USNVC: Park Special NPSNIOB002

Field Plots: 0059, 0069, 0096, 0117, 0079

Map Class: NIOB MC101

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: 2175.5 ft (range 1995 ft to 2444 ft)

Aspect: Mean 30˚ (range Flat to 150˚)

Slope: Mean 0.6˚ (range Flat to 3˚)

Macro Topography: Alluvial Flat, Gully, Plain

Geology: Ogallala Group, White River Group

Soil Texture: Sand, Loamy Sand, Sandy Loam

Environment: 5 sites were sampled within this type. This community mainly occurs along alluvial flats or plains. Soil texture ranges from sandy loam to sand. Ground cover is dominated by litter with cover ranging from 55% to 74%. Downed wood ranges from 5% to 25% cover. Bare soil and sand is usually present in small amounts between 5% and 20% cover. These sites usually occurred on the low level flat, but one site occurred in a gully on a very gentle slope (3 degrees).

Local Vegetation Description

Structure: Canopy (0%-10%), Short Shrub (0%-20%), Herbaceous (60%-100%)

Vegetation Floristics: These are heavily disturbed areas. A fire came through in 2012 and allowed noxious species to thrive. There are no trees; however, old burned oak and juniper can be in the plot. Common weedy forbs include *Cannabis sativa*, *Ambrosia psilostachya*, and *Helianthus anuus*. The cover ranges from 20% to 60%. Gaminoids tend to be slightly less abundant than forbs. The main graminoids are *Bromus japonicus*, *Dichanthelium oligosanthes*, *Bouteloua curtipendula*, and *Carex* spp.

Dynamics: N/A

Conservation Status Rank

Global: N/A

State (Nebraska): N/A

Global Environmental Description

N/A

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Global Vegetation Description

N/A

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of USNVC: Park Special NPSNIOB002.

Weedy Forb Ruderal Herbaceous (CNHP)

Short Citation

N/A

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CEGL003019 Bromus tectorum Ruderal Grassland

The table below shows the USNVC Hierarchy for CEGL003019 Bromus tectorum Ruderal Grassland.

USNVC Hierarchy for CEGL003019 Bromus tectorum Ruderal Grassland

Category	Description
Class	3 Desert & Semi-Desert
Subclass	3.B Cool Semi-Desert Scrub & Grassland
Formation	3.B.1 Cool Semi-Desert Scrub & Grassland
Division	3.B.1.Ne Western North American Cool Semi-Desert Scrub & Grassland
Macrogroup	3.B.1.Ne Western North American Cool Semi-Desert Ruderal Scrub & Grassland
Group	3.B.1.Ne Great Basin-Intermountain Ruderal Dry Shrubland & Grassland
Alliance	A1814 *Bromus tectorum - Taeniatherum caput-medusae* Ruderal Annual Grassland Alliance
Association	3.B.1.Ne *Bromus tectorum* Ruderal Grassland (CEGL003019)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC101

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2183.43 ft (range 2107 ft to 2322 ft)

Aspect: Mean 40.71˚ (range 0˚ to 280˚)

Slope: Mean 2.43˚ (range 0˚ to 12˚)

Macro Topography: Floodplain Upper Terrace, Hillslope

Geology: Ogallala Formation, White River Group

Soil Texture: Loamy Sand

Environment: These communities tend to occur in grazed pastures on upper floodplain terraces. Ground cover tends to be dominated by litter with values ranging from 50% and 80%. Bare soil often forms a large component of the ground cover with values ranging from 10% and 40%. Basal area typically composes between 15 and 20%.

Local Vegetation Description

Structure: Herbaceous (70%-90%)

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Vegetation Floristics: This community is similar to NPSNIOB005 but is differentiated by the dominance of *Bromus tectorum* and *Bromus japonicum* on flood disturbed grasslands. *Bromus tectorum* and *Bromus japonicum* tend to have cover values over 80%.

Dynamics: *Bromus tectorum* is an annual grass able to germinate in cool temperatures and complete its lifecycle in the spring before drying out mid-summer. Its fine structure makes it extremely flammable when dry, and it will increase the fire frequency of a site (FEIS 2001). Frequent fires favor *Bromus tectorum* because they eliminate competing perennial vegetation, but do not kill all the *Bromus tectorum* seeds, which survive in the unburned organic material (FEIS 2001). This altered ecological process has promoted the spread of *Bromus tectorum* and other exotic annual bromes at the expense of sagebrush shrublands in large parts of the western U.S. (Young and Evans 1973, 1978, Daubenmire 1975).

T. Naumann (pers. comm. 2005) reported successful restoration of cheatgrass-invaded systems by the use of prescribed fire, timed and controlled so as to destroy the seeds of *Bromus tectorum* while stimulating growth in remnant native warm-season grasses. She also reported that prescribed fire was least successful in areas of shallow soils, presumably because native grasses cannot develop sufficient root mass to compete with cheatgrass. Work by Redente and others (e.g., Redente et al. 1992) indicates that, under some circumstances, native grass and shrub species can regain competitive advantage over annuals such as *Bromus tectorum* if a source of carbon, such as sugar or sawdust, is added to the system. Amending the soil with carbon increases the activity of soil microbes and results in the reduction of plant-available nitrogen.

This type is most common where disturbances have eliminated or largely set back the native vegetation. Where the brome grasses are invading native vegetation, the types may still be tracked as native types, since the native species may still persist. A recent study (Karl et al. 1999) found that, despite strong seed and seedling production by the exotic brome grasses (*Bromus japonicus*, *Bromus tectorum*), the large amount of herbaceous biomass produced by the two vegetatively propagating native grasses *Bouteloua gracilis* and *Pascopyrum smithii* suggests that these native grasses may well maintain their ecological importance in the stands.

Evans et al. (2001) studied the invasion by cheatgrass of an undisturbed native grassland in Canyonlands National Park (Virginia Park). Their study showed that *Bromus* may cause a short-term decrease in nitrogen loss by decreasing substrate availability and denitrification enzyme activity, but in the long term, nitrogen loss is likely to be greater in invaded sites because of increased fire frequency and greater nitrogen volatilization during fire. A study by Englund (2004) at the same site showed decreasing levels of soil organic carbon as *Bromus tectorum*, with its shallow root systems, replaced perennial grasses with their more massive root systems.

In Nevada, Beatley (1976) found dense stands of the introduced winter annual grass *Bromus tectorum* growing in disturbed Artemisia shrublands. *Bromus rubens* is more common in lower elevation sites, and *Bromus tectorum* is most common in higher elevation sagebrush and pinyon-juniper communities.

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Conservation Status Rank

Global: GNA

State (Nebraska): N/A

Global Environmental Description

This herbaceous vegetation type is found throughout much of western North America from the western Great Plains to the Intermountain and southwestern U.S. Elevation ranges from sea level to 2200 m. Stands occur after disturbance of a natural shrub- or grass-dominated community, resulting in the replacement of the natural vegetation by non-native, annual grass species of *Bromus*, although invasion of undisturbed sites has also been reported (e.g., Evans et al. 2001). At Wind Cave National Park in South Dakota, weedy non-native graminoid vegetation occurs on recently disturbed areas, most commonly along roads. Small stands also occur in prairie dog towns (H. Marriott pers. comm. 1999). In the Great Basin, *Bromus tectorum* grasslands have invaded large areas of burned-over sagebrush steppe. *Bromus tectorum* increases the fire frequency of steppe communities, which eventually eliminates sagebrush (FEIS 2001).

Global Vegetation Description

This herbaceous vegetation type is found throughout much of western North America from the western Great Plains to the Intermountain West. It occurs most often after disturbance of a natural shrub- or grass-dominated community that results in the replacement of the natural vegetation by non-native, annual grass species of *Bromus*. *Bromus tectorum* typically dominates the community with over 80-90% of the total vegetation cover, making it difficult to determine what natural community was formerly present. This vegetation also includes grasslands dominated or codominated by other Eurasian introduced annual *Bromus* species such as *Bromus hordeaceus*, *Bromus madritensis*, *Bromus japonicus*, *Bromus rigidus*, or *Bromus rubens*. It is distinct from the annual *Bromus* communities found along the Pacific Coast typical of the Mediterranean or maritime climates.

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of USNVC Hierarchy for CEGL003019 Bromus tectorum Ruderal Grassland.

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Bromus tectorum Ruderal Grassland (CNHP)

Short Citation

- Evans et al. 2001
- FEIS 2001
- H. Marriotts pers. Comm 1999

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CEGL003081 Poa pratensis Ruderal Marsh

The table below shows the USNVC Hierarchy for CEGL003081 Poa pratensis Ruderal Marsh.

USNVC Hierarchy for CEGL003081 Poa pratensis Ruderal Marsh

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.C Shrub & Herb Wetland
Formation	2.C.4 Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland
Division	2.C.4.Nb Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland
Macrogroup	2.C.4.Nb Western North American Ruderal Marsh, Wet Meadow & Shrubland
Group	2.C.4.Nb Western North American Ruderal Marsh, Wet Meadow & Shrubland
Alliance	A3848 *Poa pratensis - Agrostis gigantea - Agrostis stolonifera* Ruderal Marsh Alliance
Association	2.C.4.Nb *Poa pratensis* Ruderal Marsh (CEGL003081)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC101

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2252 ft (range 2058 ft to 2451 ft)

Aspect: Mean 28.46˚ (range 0˚ to 338˚)

Slope: Mean 0.77˚ (range 0˚ to 5˚)

Macro Topography: Upland, Floodplain Upper Terrace

Geology: White River Group, Ogallala Formation

Soil Texture: Loamy Sand, Sandy Loam

Environment: These communities tend to occur on upland areas; however, this may occur on floodplains as well. These communities tend to occur in grazed pastures. Ground cover is dominated by litter with values ranging from 70% to 90%. Bare soil may be present especially where active grazing occurs with cover typically <10%. Basal area generally forms <20% of the ground cover.

Local Vegetation Description

Structure: Short Shrub (0%-15%), Dwarf Shrub (0%-15%), Herbaceous (60%-100%)

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Vegetation Floristics: This community is typically a monoculture of *Poa pratensis*. Common associates that may occur include *Bromus inermis*, *Bromus tectorum*, *Ambrosia psilostachya*, and *Verbena stricta*. Sites usually occurred on disturbed dry grasslands.

Dynamics: *Poa pratensis* is widespread in the western U.S. where, following disturbance, its extensive rhizome system allows it to spread and establish, outcompeting many native graminoids. It is tolerant of heavy grazing and increases at the expense of less tolerant native species (Hansen et al. 1995, Volland 1978). It is also adapted to burning and quickly resprouts after fire, except when burned during growing periods (Volland and Dell 1981).

Conservation Status Rank

Global: GNA

State (Nebraska): N/A

Global Environmental Description

This semi-natural grassland is widespread in the western U.S. and northern Great Plains where it has invaded natural prairies, meadows and riparian areas. Elevation ranges from 1100-3200 m (3600-10,500 feet). Sites are generally flat to moderately sloping and occur on all aspects. Stands typically occur on pastures found in the plains, montane meadows, stream benches and terraces. In the semi-arid regions it is restricted to relatively mesic sites. Soils are variable, but *Poa pratensis* grows best on moist, fertile sandy to clayey alluvium with high organic content (Hansen et al. 1995). It does not tolerate prolonged flooding, high water tables or poor drainage well. However, it can tolerate mildly alkaline and saline soils, and some drought (Hansen et al. 1995, Hall and Hansen 1997, Kovalchik 1987, Manning and Padgett 1995, Padgett et al. 1989).

Global Vegetation Description

This semi-natural grassland is widespread in the western U.S. and northern Great Plains where it has invaded natural meadows and riparian areas. Sites are generally flat to moderately sloping and occur on all aspects. Stands typically occur on pastures found in the plains, montane meadows, stream benches and terraces. In the semi-arid region it is restricted to relatively mesic sites. Soils are highly variable, but *Poa pratensis* grows best on moist, fertile sandy to clayey alluvium with high organic content. It does not tolerate prolonged flooding, high water tables or poor drainage well. However, it can tolerate mildly alkaline and saline soils, and some drought. The vegetation is characterized by a moderate to dense herbaceous canopy that is strongly dominated by the introduced perennial, sod-forming graminoid *Poa pratensis*. *Poa pratensis* has invaded many natural plant associations, but the diagnostic character in this association is that there is typically not enough of the native grassland left to classify it as a poor condition natural type. Associates are often those early-seral and weedy species that tolerate the historic heavy livestock grazing or other disturbance well, such as *Achillea millefolium*, *Cirsium arvense*, *Elymus repens*, *Equisetum* spp., *Fragaria virginiana*, *Hordeum* spp., *Juncus balticus*, *Linaria vulgaris*, *Potentilla gracilis*, *Taraxacum officinale*, and introduced forage species such as *Agrostis stolonifera*, *Bromus inermis*, and *Phleum pratense*. Remnant natives

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Pascopyrum smithii, *Deschampsia caespitosa*, and *Carex* spp. are often present in low cover. Occasional trees and shrubs may also be present.

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of USNVC Hierarchy for CEGL003081 Poa pratensis Ruderal Marsh.

Poa pratensis Ruderal Marsh (CNHP)

Short Citation

- Hall and Hansen 1997
- Hansen et al. 1995
- Kovalchik 1987
- Manning and Padgett 1995
- Padgett et al. 1989

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- Volland 1978
- Volland and Dell 1981

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NPSNIOB007 Juniperus virginiana Ruderal Shrub Invaded Grassland

USNVC: Park Special NPSNIOB007

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC101

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1949 ft (range 1807 ft to 2091 ft)

Aspect: Mean 5˚ (range 0˚ to 10˚)

Slope: Mean 2.5˚ (range 0˚ to 5˚)

Macro Topography: Floodplain Lower Terrace, Upland

Geology: White River Group, Pierre Shale

Soil Texture: Sand, Loamy Sand

Environment: These shrublands generally occur on disturbed floodplains and slopes. Ground cover is typically dominated by litter including small woodchips from previous *Juniperus virginiana* removal. Litter values are usually ~80% of the ground cover. Bare soil often makes us <5% of the ground cover. Basal area typically composes <20%.

Local Vegetation Description

Structure: Canopy (<5%), Short Shrub (10%-20%), Herbaceous (60%-80%)

Vegetation Floristics: Shrub or sub-shrub height *Juniperus virginiana* has invaded native or ruderal grasslands. Total *Juniperus virginiana* shrub cover is >35%.

Dynamics: N/A

Conservation Status Rank

Global: N/A

State (Nebraska): N/A

Global Environmental Description

N/A

Global Vegetation Description

N/A

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Example Photograph

The photograph below shows an example of USNVC Hierarchy for NPSNIOB007 Juniperus virginiana Ruderal Shrub Invaded Grassland.

Juniperus virginiana Ruderal Shrub Invaded Grassland (CNHP)

Short Citation

N/A

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A4042 Schizachyrium scoparium – Bouteloua curtipendula Central Plains Grassland Alliance

The table below shows the USNVC Hierarchy for A4042 Schizachyrium scoparium – Bouteloua curtipendula Central Plains Grassland Alliance.

USNVC Hierarchy for A4042 Schizachyrium scoparium – Bouteloua curtipendula Central Plains Grassland Alliance

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.B Temperate & Boreal Grassland & Shrubland
Formation	2.B.2 Temperate Grassland & Shrubland
Division	2.B.2.Nb Central North American Grassland & Shrubland
Macrogroup	2.B.2.Nb Great Plains Mixedgrass & Fescue Prairie
Group	2.B.2.Nb Central Great Plains Mixedgrass Prairie
Alliance	A4042 Schizachyrium scoparium - Bouteloua curtipendula Central Great Plains Grassland Alliance

Field Plots: 0056, 0063, 0139, 0145, 0198

Map Class: NIOB MC102a

Local Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 2309.6 ft (range 2213 ft to 2421 ft)

Aspect: Mean 106.5˚ (range 6˚ to 265˚)

Slope: Mean 8.75˚ (range 5˚ to 20˚)

Macro Topography: Bluff, Plain

Geology: Ogallala Group, White River Group

Soil Texture: Sand, Loamy Sand, Sandy Loam

Environment: Five sites were sampled within this type. These plots generally occur on bluffs between 5-20 degrees. These slopes are generally above the floodplain terrace. Litter is ranges from 55% and 75%. Bare soil ranges from 15% to 30%, and one site had small rocks covering 10% of the plot.

Local Vegetation Description

Structure: Dwarf Shrub (0%-30%), Herbaceous (60%-70%)

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Vegetation Floristics: Total herbaceous cover ranges from 60% to 70%. There tends to be a high diversity of graminoids; however, *Schizachyrium scoparium* is the dominant graminoid with cover values ~30%. *Bouteloua curtipendula, Panicum virgatum*, and *Hesperostipa comata* all occur in these sites and occasionally codominate with *Schizachyrium scoparium*. Forbs tend to have low cover (~20% cover) with *Ambrosia psilostachya* and *Helianthus pauciflorus* being common forbs.

Dynamics: N/A

Conservation Status Rank

Global: N/A

State (Nebraska): N/A

Global Environmental Description

Communities within this alliance are most commonly found on slopes but can occur on level ground. Soils and substrates vary considerably for this alliance. Loam and silt soils appear to be the most common; however, in the southwest of this alliance's range, some communities are predominantly on sandy soils (Weaver and Albertson 1956). Some communities are found on loess soils.

Global Vegetation Description

Across its range, this alliance is dominated by mid grasses. The vegetation cover can be moderately sparse to dense. Tall and short grasses contribute substantially to the vegetation cover in most communities. The proportions of these two lifeforms are typically negatively correlated with each other and vary with the specific community and site. The tall grasses are more prevalent on sandier soils and on moderate or gentle lower slopes. The short grasses tend to be more common on flat uplands or steep slopes with heavier soils (Weaver and Albertson 1956). Shrubs and small trees are usually absent or rare but can become common in the absence of fire, particularly in the eastern portion of this alliance's range.

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of A4042 Schizachyrium scoparium – Bouteloua curtipendula Central Plains Grassland Alliance.

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Schizachyrium scoparium – Bouteloua curtipendula Central Plains Grassland Alliance (CNHP)

Short Citation

- Weaver and Alberston 1956

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CEGL005221 Schizachyrium scoparium – Aristida basiramea – Sporobolus cryptandrus – Eragrostis trichodes Grassland

The table below shows the USNVC Hierarchy for CEGL005221 Schizachyrium scoparium – Aristida basiramea – Sporobolus cryptandrus – Eragrostis trichodes Grassland.

USNVC Hierarchy for CEGL005221 Schizachyrium scoparium – Aristida basiramea – Sporobolus cryptandrus – Eragrostis trichodes Grassland

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.B Temperate & Boreal Grassland & Shrubland
Formation	2.B.2 Temperate Grassland & Shrubland
Division	2.B.2.Nb Central North American Grassland & Shrubland
Macrogroup	2.B.2.Nb Central Lowlands Tallgrass Prairie
Group	2.B.2.Nb Central Tallgrass Prairie
Alliance	A4047 *Schizachyrium scoparium - Sorghastrum nutans - Bouteloua curtipendula* Central Sand & Gravel Grassland Alliance
Association	2.B.2.Nb *Schizachyrium scoparium - Aristida basiramea - Sporobolus cryptandrus - Eragrostis trichodes* Grassland (CEGL005221)

Field Plots: 0062, 0092, 0102

Map Class: NIOB MC102a

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2462.33 ft (range 2454 ft to 2472 ft)

Aspect: Mean 75˚ (range Flat to 300˚)

Slope: Mean 1.25˚ (range Flat to 5˚)

Macro Topography: Bluff, Plain

Geology: Ogallala Group, White River Group

Soil Texture: Loamy Sand, Sandy Loam

Environment: Three sites were sampled within this type. These communities typically occurred on uplain plains. Soil texture was usually sandy loam. Litter dominates the ground cover 65% cover. Basal area is usually the second most dominant ground cover with values ~30%.

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Local Vegetation Description

Structure: Dwarf Shrub (0%-10%), Herbaceous (80%-100%)

Vegetation Floristics: *Schizachyrium scoparium* is the dominant graminoid with cover values greater than 50%; *Poa pratensis* sometimes codominates with covers reaching 70% or 90%. Other graminoids in this type are *Hesperostipa comata*, *Panicum virgatum*, and *Bromus japonicus*. *Ambrosia psilostachya* is the dominant forb with cover values between 10% and 50%. Other forbs present include *Ratibida columnifera*, *Helianthus* spp., and *Verbena* spp.

Dynamics: This community is impacted by fire and drought. Grazing and conversion to agriculture can also impact this type.

Conservation Status Rank

Global: GNR

State (Nebraska): S2?

Global Environmental Description

This community occurs on upland terraces, rolling uplands, eroded slopes, and shallow draws associated with river valleys. Soils are very well-drained and vary from sandy loams to coarse sand and gravels formed in old alluvium or glacial till (Steinauer and Rolfsmeier 2010).

Global Vegetation Description

This sand and gravel prairie community is found in southeast Nebraska and northeast Kansas, in the east-central Great Plains of the United States. Stands occur on eroded slopes, rolling uplands, and in shallow draws associated with river valleys. Soils are very well-drained and vary from sandy loams to coarse sand and gravels formed in old alluvium or glacial till. Vegetation is dominated by a variety of midgrasses within a predominately tallgrass region. In southeastern Nebraska and northeast Kansas, dominants on sandy soils include *Schizachyrium scoparium*, *Eragrostis trichodes*, and *Sporobolus cryptandrus*. *Bouteloua gracilis*, *Bouteloua hirsuta*, and *Schizachyrium scoparium* dominate areas with gravelly soils. Common herbaceous species include species commonly found in mixedgrass prairies to the west. Other graminoids present include *Aristida basiramea*, *Digitaria cognata*, *Carex duriuscula*, *Carex praegracilis*, and *Cyperus schweinitzii*. Scattered tallgrasses such as *Andropogon gerardii*, *Sorghastrum nutans*, and *Panicum virgatum* may be present in areas proximate to tallgrass prairie stands. Fire and drought along with grazing and conversion agriculture impact this community.

Nebraska Natural Heritage Program Description

Southern Sand / Gravel Prairie: This is a moderately vegetated mixed-grass prairie community occurring in sandy and gravelly soils in a predominantly tall-grass prairie region of silty soils. Species diversity is variable based on soil texture. In areas with predominately gravelly soils, primary species include *Bouteloua curtipendula*, *Bouteloua gracilis* and *Schizachyrium scoparium*, while *Eragrostis trichodes* and *Sporobolus cryptandrus* are more common where soils are primarily sandy.

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Scattered tall-grasses such as *Andropogon gerardii*, *Sorghastrum nutans*, and *Panicum virgatum* may be present near the contact of these areas with tall-grass prairie. Herbaceous species are often conspicuous and include many species common in mixed-grass prairie farther west such as *Artemisia ludoviciana*, *Heterotheca villosa*, *Calylophus serrulatus*, *Hymenopappus tenuifolius*, *Opuntia humifusa*, and *Xanthisma spinulosum* var. *glaberrimum* in addition to many annual species typical of sandy prairies. *Froelichia gracilis*, and *Polygonum tenue* are annuals that are mostly restricted to gravelly sites. *Selaginella rupestris* is often a common in many gravelly sites along with numerous non-vascular cryptogams. *Yucca glauca* is often common on slopes. Species diversity is moderate to relatively high.

Example Photograph

The photograph below shows an example of CEGL005221 Schizachyrium scoparium – Aristida basiramea – Sporobolus cryptandrus – Eragrostis trichodes Grassland.

Schizachyrium scoparium – Aristida basiramea – Sporobolus cryptandrus – Eragrostis trichodes Grassland (CNHP)

Short Citation

- Steinauer and Rolfsmeier 2010

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CEGL002023 Andropogon gerardii – Panicum virgatum Sandhills Grassland

The table below shows the USNVC Hierarchy for CEGL002023 Andropogon gerardii – Panicum virgatum Sandhills Grassland.

USNVC Hierarchy for CEGL002023 Andropogon gerardii – Panicum virgatum Sandhills Grassland

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.B Temperate & Boreal Grassland & Shrubland
Formation	2.B.2 Temperate Grassland & Shrubland
Division	2.B.2.Nb Central North American Grassland & Shrubland
Macrogroup	2.B.2.Nb Great Plains Mixedgrass & Fescue Prairie
Group	2.B.2.Nb Northern Great Plains Mesic Mixedgrass Prairie
Alliance	A4028 *Andropogon gerardii - Sorghastrum nutans* Mixedgrass Western Plains Grassland Alliance
Association	2.B.2.Nb *Andropogon gerardii - Panicum virgatum* Sandhills Grassland (CEGL002023)

Field Plots: 0149, 0183

Map Class: NIOB MC102b

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2357 ft (range 2351 ft to 2363 ft)

Aspect: Mean 258˚ (range 160˚ to 356˚)

Slope: Mean 11˚ (range 5˚ to 17˚)

Macro Topography: Bluff, Hills

Geology: Ogallala Group, White River Group

Soil Texture: Sand

Environment: Two sites were sampled within this type. These types occurred on gentle slopes between 5 and 17 degrees. Soil texture was sand at both sites. Litter ranges from 45% to 65%, and sand ranged between 15% and 40%. Both sites had a moderate amount of basal area ~20%.

Local Vegetation Description

Structure: Dwarf Shrub (0%-20%), Herbaceous (70%-90%)

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Vegetation Floristics: *Andropogon gerardii* dominates the herbaceous layer with cover greater than 50%. Other graminoids include *Schizachyrium scoparium*, *Panicum virgatum*, *Bouteloua gracilis*, and *Andropogon hallii*. *Ambrosia psilostachya* dominates the forb layer with cover up to 40%.

Dynamics: N/A

Conservation Status Rank

Global: G3

State (Nebraska): S2

Global Environmental Description

This community occurs mostly in interdunal valleys and floodplains of streams and rivers, and on level ground where drainage is poor. Soils are poorly drained sandy loams and sands with considerable organic matter (but no peat accumulation) and are formed in eolian sand or alluvium. These sites are rarely, if ever, flooded but are constantly supplied by high groundwater levels (about 1 m below the surface) (Steinauer and Rolfsmeier 2000).

Global Vegetation Description

This community is dominated by a dense layer of mesophytic tall grasses 1-2 m tall, with *Andropogon gerardii* and *Sorghastrum nutans* most abundant in undisturbed sites. In moist swales and wetter areas along the margin of this community, *Calamagrostis canadensis* and *Spartina pectinata* may be abundant. Cool-season Eurasian (exotic) grasses such as *Phleum pratense* and invasive natives *Agrostis stolonifera* and *Poa pratensis* are commonly seeded in these sites and may dominate. Forbs are usually common, but are seldom mentioned in the literature. Conspicuous forbs species include *Euthamia gymnospermoides*, *Helianthus nuttallii*, *Rudbeckia hirta*, *Solidago canadensis*, and *Solidago gigantea*. Woody plants are uncommon, though scattered thickets of *Salix exigua* may be present. In the eastern portion of its range, this community often contains forbs typical of tall-grass prairie to the east, such as *Sisyrinchium campestre* and *Viola pedatifida*. Species diversity is relatively high in undisturbed sites, and often much lower in sites seeded to exotic cool-season grasses (Steinauer and Rolfsmeier 2000).

Nebraska Natural Heritage Program Description

Sandhills Mesic Tall – Grass Prairie: A dense to somewhat open layer of mesophytic grasses 1–2 m tall dominate this community, with *Andropogon gerardii* most abundant in the majority of sites, and with either *Panicum virgatum* or *Poa pratensis* common. In a few sites on the northeast periphery of the Sandhills, *Sorghastrum nutans* and *Sporobolus heterolepis* may also be abundant. In hayed meadows, cool-season aliens such as *Poa pratensis* may be abundant, with *Agrostis gigantea* and *Phleum pratense* common in lower places. Shrubs may be somewhat common (less so in hayed areas) and include *Amorpha canescens*, *Prunus pumila* var. *besseyi*, *Rosa arkansana* and *Salix humilis*. Among the more common herbaceous plants are *Achillea millefolium*, *Ambrosia psilostachya*, *Antennaria neglecta*, *Astragalus crassicarpus*, *Cirsium flodmanii*, *Helianthus*

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pauciflorus, *Rudbeckia hirta*, and *Siphium integrifolium*. Species diversity is rather high in undisturbed sites, and decreases as a result of early-season haying.

Example Photograph

The photograph below shows an example of CEGL002023 Andropogon gerardii – Panicum virgatum Sandhills Grassland.

Andropogon gerardii – Panicum virgatum Sandhills Grassland (CNHP)

Short Citation

- Steinauer and Rolfsmeier 2000

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CEGL002025 Andropogon gerardii – Sorghastrum nutans – Hesperostipa spartea Loess Hills Grassland

The table below shows the USNVC Hierarchy for CEGL002025 Andropogon gerardii – Sorghastrum nutans – Hesperostipa spartea Loess Hills Grassland.

USNVC Hierarchy for CEGL002025 Andropogon gerardii – Sorghastrum nutans – Hesperostipa spartea Loess Hills Grassland

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.B Temperate & Boreal Grassland & Shrubland
Formation	2.B.2 Temperate Grassland & Shrubland
Division	2.B.2.Nb Central North American Grassland & Shrubland
Macrogroup	2.B.2.Nb Central Lowlands Tallgrass Prairie
Group	2.B.2.Nb Central Tallgrass Prairie
Alliance	A4057 *Andropogon gerardii - Sorghastrum nutans - Coreopsis palmata* Central Grassland Alliance
Association	2.B.2.Nb *Andropogon gerardii - Sorghastrum nutans - Hesperostipa spartea* Loess Hills Grassland (CEGL002025)

Field Plots: 0067, 0114, 0184, 1004, 3035

Map Class: NIOB MC102b

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2101.2 ft (range 1837 ft to 2310 ft)

Aspect: Mean 235˚ (range Flat to 322˚)

Slope: Mean 9.5˚ (range Flat to 10˚)

Macro Topography: Alluvial Flat, Bluff, Hills

Geology: Ogallala Group, Pierre Shale, White River Group

Soil Texture: Sand, Sandy Loam, Loamy Sand

Environment: 5 sites were sampled within this type. Communities were typically found on alluvial flats or bluffs. Soil texture ranges from sandy loam to sand. Litter ranges from 34% to 70%, and sand or bare soil is usually present with cover values between 10% and 20%. These sites occurred on flat area or those with gentle slopes of ~10 degrees.

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Local Vegetation Description

Structure: Dwarf Shrub (0%-10%), Herbaceous (80%-90%)

Vegetation Floristics: *Sorghastrum nutans* is the dominant species present with cover values ranging from 40% to 90%; *Schizachyrium scoparium* usually the codominate graminoid with cover values between 20% and 60%. Other common graminoids include *Carex* spp., *Dichanthelium oligosanthes*, and *Bouteloua* spp. *Ambrosia psilostachya* is a common forb among these sites along with *Rudbeckia hirta*.

Dynamics: This community experiences moderate drought stress. It is maintained by fire with an average burn frequency of 1-3 years.

Conservation Status Rank

Global: G2

State (Nebraska): S1S2

Global Environmental Description

This community occurs on moderately steep mid- to upper slopes of hills and along ridges. It has been found on several aspects (Nelson 1985, Rosburg and Glenn-Lewin 1996). This dry-mesic community is associated with dry prairie on mesic slopes of steep loess hills. The soil is well-drained, acidic to neutral, and shallow to deep loess (40-100 cm) (Nelson 1985). The parent material is loess or glacial till and other deeply weathered substrates.

Global Vegetation Description

This big bluestem tallgrass prairie type is found in the west-central tallgrass prairie region of the United States, including the Loess Hills. Stands occur on moderately steep mid to upper slopes of loess hills and along ridges. It is most common on southern and western aspects. The soil is well-drained, acidic to neutral, and shallow to deep loess (40-100 cm). The parent material is a deep loess or glacial till and other deeply weathered substrates. This community is virtually lacking in shrubs and trees. Woody vegetation that is present, such as *Amorpha canescens*, is usually less than 0.5 m tall. The dominant vegetation is tallgrasses. Of the dominant species, *Andropogon gerardii*, *Sorghastrum nutans*, and *Hesperostipa spartea* (= *Stipa spartea*) typically exceed 1 m. *Schizachyrium scoparium*, also very common, is shorter. In Missouri some other species that are usually found in this community are *Echinacea pallida*, *Potentilla arguta*, *Silphium laciniatum*, and *Sporobolus compositus* var. *compositus*.

Nebraska Natural Heritage Program Description

Upland Tall-Grass Prairie: This community is dominated primarily by tall grasses 1–2 m tall, namely *Andropogon gerardii*, with *Sorghastrum nutans* conspicuous at some sites. On well-drained slopes and ridges the tall grasses may occur with conspicuous patches of *Schizachyrium scoparium*. On finer soils with higher clay content in the southeast, *Sporobolus heterolepis* is often common and even dominant in a few sites. Northward, and in sites with more silty or sandy soils *Hesperostipa*

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spartea may be common to locally abundant. On dry hill crests, particularly where mowed or grazed, short grasses including *Bouteloua gracilis* and *B. hirsuta* are occasionally present, but are always subordinate to the tall and mid grasses. Patches of *Pascopyrum smithii* and *Bouteloua gracilis* may also be locally common in some clay pans associated with tall-grass prairie. Lower slopes often contain patches of *Panicum virgatum* and *Sorghastrum nutans* (and often *Schizachyrium scoparium*), which may be locally common in uplands as well. Many prairies have been invaded and overtaken by the invasive perennial grasses *Bromus inermis* and *Poa pratensis*. Shrubs are scattered in the prairie, and are often associated with the moist draws, though *Prunus americana* may form thickets on the uplands. *Amorpha canescens* commonly occurs as scattered small shrubs with *Rosa arkansana*, and in some places, *Ceanothus herbaceus*. Other characteristic species include *Comandra umbellata*, *Erigeron strigosus*, *Helianthus pauciflorus*, *Linum sulcatum*, *Pediomelum argophyllum*, *Psoralidium floribundum*, *Solidago missouriensis*, and *Symphyotrichum ericoides*. *Equisetum laevigatum* is the only pteridophyte common in the prairie. Species diversity is moderate to relatively high.

Example Photograph

The photograph below shows an example of CEGL002025 Andropogon gerardii – Sorghastrum nutans – Hesperostipa spartea Loess Hills Grassland.

Andropogon gerardii – Sorghastrum nutans – Hesperostipa spartea Loess Hills Grassland (CNHP)

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Short Citation

- Nelson 1985
- Rosburg and Glenn-Lewin 1996

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CEGL001473 Calamovilfa longifolia – Hesperostipa comata Herbaceous Vegetation

The table below shows the USNVC Hierarchy for CEGL001473 Calamovilfa longifolia – Hesperostipa comata Herbaceous Vegetation.

USNVC Hierarchy for CEGL001473 Calamovilfa longifolia – Hesperostipa comata Herbaceous Vegetation

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.B Temperate & Boreal Grassland & Shrubland
Formation	2.B.2 Temperate Grassland & Shrubland
Division	2.B.2.Nb Central North American Grassland & Shrubland
Macrogroup	2.B.2.Nb Great Plains Sand Grassland & Shrubland
Group	2.B.2.Nb Great Plains Sand Grassland
Alliance	A1201 *Calamovilfa longifolia* Sand Prairie Alliance
Association	2.B.2.Nb *Calamovilfa longifolia - Hesperostipa comata* Grassland (CEGL001473)

Field Plots: 3026

Map Class: NIOB MC102c

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: 2455 ft

Aspect: Flat

Slope: Flat

Macro Topography: Bluff

Geology: Ogallala Group

Soil Texture: Loamy Sand

Environment: 1 site was sampled within this type. Soil texture was loamy sand. Bare soil is the dominant ground cover with a value of 50%. Litter composed the second major component of ground cover with a value of 40%. This plot occurred within a slight depression within a cow pasture.

Local Vegetation Description

Structure: Dwarf Shrub (10%), Herbaceous (60%)

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Vegetation Floristics: *Sporobolus cryptandrus* and *Bouteloua gracilis* codominate this plot with a combined cover value of ~60%. *Ambrosia psilostachya* is the dominant forb with a cover value of 20%.

Dynamics: Blowouts caused by drought and wind may occur in this type. The type probably represents a later successional stage. Earlier stages in the southern part of the association's range may be dominated by *Andropogon hallii* (e.g., *~Andropogon hallii - Calamovilfa longifolia* Grassland (CEGL001467)). Heavy grazing may increase the likelihood of blowouts.

Conservation Status Rank

Global: G3

State (Nebraska): S4

Global Environmental Description

Stands occur on stabilized sand dunes, as well as in interdunal valleys or draws, colluvial sands, and, less commonly, silty terraces of intermittent streams. Soils are medium to fine sands formed either from eolian or colluvial processes. For example, in Nebraska stands occur below sandstone outcrops and escarpments. More rarely, stands occur on floodplain terraces of intermittent streams, where soils are moderately deep, poorly drained, silty loams and loams (Heerwagen 1958, BLM 1979, Barnes et al. 1984, Steinauer and Rolfsmeier 2000).

Global Vegetation Description

This prairie sandreed grassland community type occurs in the central and northern Great Plains region of the United States and southwestern Canada. Stands occur on stabilized sand dunes, as well as in interdunal valleys, colluvial sands, and, less commonly, silty terraces of intermittent streams. Soils are medium to fine sands formed either from eolian or colluvial processes. The vegetation has an open canopy, dominated by mid to tall grasses. *Calamovilfa longifolia* and *Hesperostipa comata* (= *Stipa comata*) are the most conspicuous and dominant grasses. Other common grasses include *Bouteloua gracilis*, *Koeleria macrantha*, *Achnatherum hymenoides* (= *Oryzopsis hymenoides*), and *Sporobolus cryptandrus*. The type may grade into stands dominated by *Pascopyrum smithii* and *Nassella viridula* (= *Stipa viridula*) at the base of slopes. *Andropogon hallii* or *Hesperostipa spartea* (= *Stipa spartea*) may also be present. Sedges are rare but could include *Carex inops* ssp. *heliophila* or *Carex filifolia*. Forb diversity ranges from low to moderate, depending on the site. Dry valley sand prairies may be particularly forb-rich. Silty terraces of intermittent streams may contain *Artemisia frigida*, *Artemisia ludoviciana*, *Gutierrezia sarothrae*, *Psoralidium tenuiflorum*, and *Yucca glauca*. Shrubs are scattered and infrequent to absent, with *Rhus trilobata* the most common species. *Rosa woodsii*, *Elaeagnus commutata*, and *Artemisia cana* become more common in northern occurrences. These areas are highly susceptible to invasion by exotic brome grasses (*Bromus japonicus*, *Bromus squarrosus*, and *Bromus tectorum*) and may be quite weedy.

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Nebraska Natural Heritage Program Description

Sandhills Dry Valley Prairie: Total cover in this community is relatively high and is dominated by a mixture of tall warm-season grasses 1–2 m high (most commonly *Panicum virgatum*, with *Calamovilfa longifolia* common in places), mid grasses 0.5–1 m tall including *Sporobolus cryptandrus* and *Schizachyrium scoparium* (with cool-season *Hesperostipa comata* and *Pascopyrum smithii* sometimes present), and an underlayer <0.5 m tall dominated by the warm-season *Bouteloua gracilis* and the cool-season *Carex inops* (with the cool-season grasses *Dichanthelium oligosanthes* and *Koeleria macrantha* conspicuous). Herbaceous perennials are common, and include *Achillea millefolium*, *Ambrosia psilostachya*, *Salvia apiana*, *Ratibida columnifera*, *Sphaeralcea coccinea*, *Apocynum cannabinum*, *Cirsium flodmanii*, *Packera plattensis*, *Gaura coccinea*, *Physalis heterophylla* and many others. Shrubs are relatively short (<1 m tall) and scattered, with *Amorpha canescens*, *Rosa arkansana*, and *R. woodsii* among the more prevalent species. Disturbed sites are fairly susceptible to invasion by weedy native annuals including *Helianthus petiolaris*, *Croton texensis*, and *Peritoma serrulata*, in addition to alien species.

Example Photograph

The photograph below shows an example of CEGL001473 Calamovilfa longifolia – Hesperostipa comata Herbaceous Vegetation.

Calamovilfa longifolia – Hesperostipa comata Herbaceous Vegetation (CNHP)

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Short Citation

- Barnes et al. 1974
- BLM 1979
- Heerwagen 1958
- Steinauer and Rolfsmeier 2000

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A4033 Hesperostipa comata Northwestern Great Plains Grassland

The table below shows the Plot/Sample Data Environmental Summary for A4033 Hesperostipa comata Northwestern Great Plains Grassland.

USNVC Hierarchy for A4033 Hesperostipa comata Northwestern Great Plains Grassland

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.B Temperate & Boreal Grassland & Shrubland
Formation	2.B.2 Temperate Grassland & Shrubland
Division	2.B.2.Nb Central North American Grassland & Shrubland
Macrogroup	2.B.2.Nb Great Plains Sand Grassland & Shrubland
Group	2.B.2.Nb Great Plains Sand Grassland
Alliance	A4033 Hesperostipa comata Northwestern Great Plains Grassland Alliance

Field Plots: 0093, 0147, 0182, 0195

Map Class: NIOB MC102c

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2336.25 ft (range 1985 ft to 2640 ft)

Aspect: Mean 37.8˚ (range Flat to 189˚)

Slope: Mean 1.2˚ (range Flat to 6˚)

Macro Topography: Alluvial Flat, Alluvial Terrace, Bluff

Geology: Ogallala Group, White River Group

Soil Texture: Sand, Loamy Sand

Environment: 4 sites were sampled within this type. These plots usually occurred on floodplain terraces. Soils ranged from sand to loamy sand textures. Litter typically has high abundance with cover values around 75%, and bare soil is generally present as well with cover values of ~10%.

Local Vegetation Description

Structure: Dwarf Shrub (0%-20%), Herbaceous (70%-90%)

Vegetation Floristics: These herbaceous sites are dominated by graminoids. *Hesperostipa comata* is the characteristic species among these sites; its cover values generally greater than 50%. *Bouteloua*

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gracilis also tends to codominate within these sites. Other common graminoinds include *Poa pratensis* and *Dichanthelium oligosanthes*. Forbs tend to be fairly sparse and generally has less than 20% cover. The common forbs are *Ambrosia psilostachya* and *Croton texensis*.

Dynamics: N/A

Conservation Status Rank

Global: N/A

State (Nebraska): N/A

Global Environmental Description

Grasslands included in this alliance are common in the west-central and northwestern Great Plains. Elevations range from 600-2350 m. Climate is temperate, continental and semi-arid to subhumid. Mean annual precipitation ranges from 25-50 cm. The year-to-year variation is great, in both total annual precipitation and the proportion of precipitation occurring in the winter and spring versus summer. Stands typically occur on upland sites in rolling plains, breaks, foothills, and plateaus. Sites are flat to moderately steep slopes on any aspect. Soils are shallow to moderately deep, non-saline, often calcareous and alkaline, with sandy loam, loam, or sometimes clay loam texture. Parent materials often include limestone, sandstone, or shale with glacial deposits in the northern Great Plains. Adjacent stands in the plains are often grasslands dominated by *Pascopyrum smithii* in mesic bottomlands and *Bouteloua gracilis* in the xeric plains and *Festuca idahoensis* in the mountains, shrublands dominated by *Artemisia tridentata*, *Ribes* spp., or *Rhus trilobata*, and woodlands dominated by *Pinus edulis*, *Pinus flexilis*, *Pinus ponderosa*, or *Juniperus* spp.

Global Vegetation Description

This alliance is dominated by mid- and shortgrass species; woody species do not regularly achieve prominence. Total vegetation cover is typically moderate and leaf litter is present but not thick. Few of the species exceed 1 m, while many do not exceed 50 cm in height. Perennial and annual forbs are common but are not abundant in most stands.

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of A4033 Hesperostipa comata Northwestern Great Plains Grassland.

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Hesperostipa comata Northwestern Great Plains Grassland (CNHP)

Short Citation

N/A

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CEGL002034 Pascopyrum smithii – Hesperostipa comata Central Mixedgrass Grassland

The table below shows the USNVC Hierarchy for CEGL002034 Pascopyrum smithii – Hesperostipa comata Central Mixedgrass Grassland.

USNVC Hierarchy for CEGL002034 Pascopyrum smithii – Hesperostipa comata Central Mixedgrass Grassland

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.B Temperate & Boreal Grassland & Shrubland
Formation	2.B.2 Temperate Grassland & Shrubland
Division	2.B.2.Nb Central North American Grassland & Shrubland
Macrogroup	2.B.2.Nb Great Plains Mixedgrass & Fescue Prairie
Group	2.B.2.Nb Northern Great Plains Mesic Mixedgrass Prairie
Alliance	A4031 *Pascopyrum smithii - Nassella viridula* Northwestern Great Plains Grassland Alliance
Association	2.B.2.Nb *Pascopyrum smithii - Hesperostipa comata* Central Mixedgrass Grassland (CEGL002034)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC102c

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2319.33 ft (range 2144 ft to 2438 ft)

Aspect: Mean 107.67˚ (range Flat to 245˚)

Slope: Mean 13.33˚ (range Flat to 29˚)

Macro Topography: Hillslope, Upland

Geology: Ogallala Formation, White River Group

Soil Texture: Loamy Sand

Environment: These communities tend to occur on upland hills. Ground cover tends to be dominated by litter with cover values ranging from 70% to 85%. Bare soil may compose up to 20%. Basal area may compose up to 20% of the ground cover.

Local Vegetation Description

Structure: Herbaceous (60%-100%)

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Vegetation Floristics: Sites were dominated by cool-season graminoids such as *Pascopyrum smithii* and *Hesperostipa comata*. Common associates include *Bouteloua curtipendula*, *Bouteloua gracilis*, *Yucca glauca*, *Schizachyrium scoparium*, and *Andropogon gerardii*. Shrubs are fairly rare in the community with only the occasional *Artemisia frigida*, *Rosa arkansana*, or *Symphoricarpos occidentalis*.

Dynamics: N/A

Conservation Status Rank

Global: G4

State (Nebraska): S4

Global Environmental Description

This community occurs on many different topographic and soil types. It can be on upland slopes, ridgetops, plateaus, stream terraces, and rolling sandhills (Steinauer 1989, USFS 1992). The soils are fine- to medium-textured (clay to sandy loam) and moderately deep to deep. They are derived from a variety of materials across this community's range. These include eolian sand, sandstone, shale, siltstone, loess, or alluvium.

Global Vegetation Description

The dominant vegetation in this community is mid grasses. The vegetation may be moderately open to dense. The most abundant species are *Pascopyrum smithii* and *Hesperostipa comata* (= *Stipa comata*). Other graminoids that may be present to abundant are *Aristida purpurea*, *Aristida basiramea, Bouteloua gracilis*, *Koeleria macrantha*, *Calamovilfa longifolia* (on sandy soils), *Hesperostipa spartea* (= *Stipa spartea*), *Schizachyrium scoparium*, *Carex filifolia,* and *Carex duriuscula* (= *Carex eleocharis*). Common forbs include *Tragopogon dubius, Helianthus petiolaris*, *Amorpha canescens*, and *Artemisia campestris*. Shrubs are rare in this community. Scattered *Rosa arkansana*, *Artemisia frigida*, and occasionally *Symphoricarpos occidentalis* may be present.

Nebraska Natural Heritage Program Description

Wheatgrass Western Mixed-grass Prairie: This community is dominated by mid-height (0.5-1 m) coolseason graminoids, primarily *Pascopyrum smithii* and/or *Hesperostipa comata*, and short, warm-season *Bouteloua gracilis*. Shrubs are uncommon or absent, and overall species diversity is fairly low. Among the scattered herbaceous plants are *Gaura coccinea*, *Lithospermum incisum*, *Lygodesmia juncea*, *Lepidium densiflorum* and *Mirabilis linearis*. Often *Bromus tectorum, B. japonicus* may be common in areas that are heavily grazed, while *Poa pratensis* may be abundant in some areas.

Example Photograph

The photograph below shows an example of CEGL002034 Pascopyrum smithii – Hesperostipa comata Central Mixedgrass Grassland.

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Pascopyrum smithii – Hesperostipa comata Central Mixedgrass Grassland (CNHP)

Short Citation

- Steinauer 1989
- USFS 1992

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CEGL001467 Andropogon hallii – Calamovilfa longifolia Herbaceous Vegetation

The table below shows the USNVC Hierarchy for CEGL001467 Andropogon hallii – Calamovilfa longifolia Herbaceous Vegetation.

USNVC Hierarchy for CEGL001467 Andropogon hallii – Calamovilfa longifolia Herbaceous Vegetation

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.B Temperate & Boreal Grassland & Shrubland
Formation	2.B.2 Temperate Grassland & Shrubland
Division	2.B.2.Nb Central North American Grassland & Shrubland
Macrogroup	2.B.2.Nb Great Plains Sand Grassland & Shrubland
Group	2.B.2.Nb Great Plains Sand Grassland
Alliance	A1193 *Andropogon hallii* Sand Prairie Alliance
Association	2.B.2.Nb *Andropogon hallii - Calamovilfa longifolia* Grassland (CEGL001467)

Field Plots: 0014, 0016, 0061, 0089, 0110, 0115

Map Class: NIOB MC102d

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2317.5 ft (range 2230 ft to 2469 ft)

Aspect: Mean 156.17˚ (range 10˚ to 298˚)

Slope: Mean 10.5˚ (range 7˚ to 18˚)

Macro Topography: Bluff, Hills

Geology: Ogallala Group, White River Group

Soil Texture: Sand, Loamy Sand

Environment: 6 sites were sampled within this type. Soil texture is either sand or loamy sand. These sites usually occur along gentle slopes of hills with slopes ranging from 6 to 18 degrees. Litter is the usually the dominant ground cover ranging from 30% to 75%. Sand usually is a large component of ground cover with values ranging from 30% to 60%. Many of these sites occur in bison grazing areas.

Local Vegetation Description

Structure: Short Shrub (0%-10%), Dwarf Shrub (0%-50%), Herbaceous (70%-90%)

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Vegetation Floristics: These types are primarily herbaceous with cover ranging from 70% to 90%. *Andropogon hallii* and *Calamovilfa longifolia* usually codominate these sites with ~50% and 20% cover respectively; however, sites do not always contain both. Other common graminoids include *Dichanthelium oligosanthes*, *Bouteloua hirsuta*, *Bouteloua gracilis*, *Cyperus schweinitnzii*, and *Panicum virgatum*. Dwarf shrubs are often present with cover sometimes reaching 50%. *Rosa woodsii* is the most common shrub, but *Prunus americana* and *Prunus virginiana* may be present with moderate to dense cover on the dunes.

Dynamics: Blowouts may occur in this community type, leading to bare soils or subsoils. Blowouts may be related to severe droughts and windstorms, and may occur in conjunction with grazing pressures or fires that reduce the ability of the vegetation cover to stabilize the sand. *Andropogon hallii - Carex inops* ssp. *heliophila* Grassland (CEGL001466) may be an early-successional phase on blowouts, at least in the northern states (Burgess 1965). Blowouts may subsequently develop into this type where sands have been stabilized and vegetation cover and diversity are high.

Conservation Status Rank

Global: G4G5

State (Nebraska): S4S5

Global Environmental Description

This community is usually found on sandy deposits, such as dunes, with gentle to moderate slopes (Johnston 1987). The soil is sand, loamy sand, or sandy loam and often erodible. Hirsch (1985) reported that stands of this type in southwestern North Dakota were small, generally less than 0.05 ha.

Global Vegetation Description

This sand prairie community is found in the northern and central Great Plains of the United States and Canada. Stands are found on sandy deposits, usually on gentle to moderate slopes, ranging from stabilized rolling to choppy sand dunes. The soil is sand, loamy sand, or sandy loam, often erodible, and somewhat poorly developed. This community is dominated by moderately widely spaced mid to tall grasses. The most abundant species are *Andropogon hallii* and *Calamovilfa longifolia*. Other graminoids that may be found in this community include *Bouteloua gracilis*, *Bouteloua hirsuta*, *Carex duriuscula*, *Carex filifolia*, *Carex inops* ssp. *heliophila*, *Cyperus schweinitzii*, *Eragrostis trichodes*, *Hesperostipa comata* (= *Stipa comata*), *Koeleria macrantha*, *Muhlenbergia pungens*, *Redfieldia flexuosa*, and *Schizachyrium scoparium*. Forbs and shrubs are a minor component of the total vegetation. Characteristic forbs include *Chenopodium subglabrum*, *Chamaesyce serpyllifolia*, *Helianthus pauciflorus*, *Helianthus petiolaris*, *Lappula occidentalis* var. *occidentalis*, *Liatris punctata*, *Lithospermum incisum*, *Lygodesmia juncea*, *Monarda punctata*, *Oenothera rhombipetala*, *Penstemon haydenii* (in Nebraska), and *Psoralidium lanceolatum*. *Artemisia frigida* and *Yucca glauca* are the most common shrubs, especially on wind-blown dune crests and choppy slopes in Nebraska sandhills. In southeastern North Dakota, a subtype containing tallgrass species may be

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distinct; species include *Andropogon gerardii*, *Symphyotrichum ericoides* (= *Aster ericoides*), *Lithospermum canescens*, *Solidago nemoralis*, and *Sporobolus heterolepis*.

Nebraska Natural Heritage Program Description

Sandhills Dune Prairie: Vegetative cover in this community is relatively sparse in comparison with other grasslands, and is dominated by a mixture of tall grasses 1–2 m high, with an underlayer of mid grasses (0.5–1 m tall) and short grasses (<0.5 m tall). *Calamovilfa longifolia* is the most common tall grass, with *Bouteloua hirsuta* and *Carex inops* commonly forming a short graminoid underlayer. Other conspicuous grasses include *Andropogon hallii*, *Eragrostis trichodes*, and *Hesperostipa comata*. On steep slopes, *Schizachyrium scoparium* may become conspicuous, and may increase with grazing pressure. Wind-blown dune crests and slopes of choppy dunes are often dominated by *Muhlenbergia arenicola* and other species typical of blowouts, in addition to short shrubs such as *Yucca glauca* and *Prunus pumila* var. *besseyi*. Other shrubs which may be found scattered in this community include *Amorpha canescens*, *Rosa arkansana*, and *Toxicodendron rydbergii*. In a few places, *Prunus americana* and *Prunus virginiana* may form dense patches on dunes. Perennial herbs are plentiful, and among the more conspicuous are *Helianthus pauciflorus*, *Ipomoea heterophylla*, *Liatris glabrata*, *Lithospermum caroliniense*, *Opuntia fragilis*, *Penstemon angustifolius*, and others. Native annuals are also conspicuous, particularly in areas of active natural and man-made erosion, and include *Chenopodium berlandieri*, *C. pratericola*, *Cycloloma atriplicifolium*, *Erigeron bellidiastrum*, *Eriogonum annuum*, *Euphorbia geyeri*, *E. missurica* var. *petaloidea*, *Froelichia floridana*, *Ipomopsis longiflora*, and *Linum rigidum*. Alien species are infrequent in areas not modified by anthromorphic disturbance, and *Kali collina* and *K. tragus* are the most common. Species diversity is low to moderate, though quite high when compared with other inland dune ranges throughout the world. Blowouts are a noteworthy natural disturbance within this community, and consist of crater-like depressions ca. 50 m to several hectare large formed by wind erosion on dune crests. The soil in a blowout is loose and moving due to wind erosion and slippage. Active blowouts are often unvegetated or sparsely vegetated by rhizomatous "sand-binding" species. The initial plant invading the loose sand is *Redfieldia flexuosa*, though other species such as *Psoralidium lanceolatum*, *Muhlenbergia arenicola*, *Andropogon hallii*, and *Calamovilfa longifolia* may replace it in some locations. Annuals are conspicuously absent from active blowouts because of the inability of seedlings to withstand constant burial and uprooting in the moving sand. They appear as the blowouts begin to stabilize and eventually "heal over" and succeed to Sandhills Dune Prairie.

Example Photograph

The photograph below shows an example of CEGL001467 Andropogon hallii – Calamovilfa longifolia Herbaceous Vegetation.

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Andropogon hallii – Calamovilfa longifolia Herbaceous Vegetation (CNHP)

Short Citation

- Burgess 1965
- Hirsh 1985
- Johnston 1987

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A1193 Andropogon hallii Sand Prairie Alliance

The table below shows the USNVC Hierarchy for A1193 Andropogon hallii Sand Prairie Alliance.

USNVC Hierarchy for A1193 Andropogon hallii Sand Prairie Alliance

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.B Temperate & Boreal Grassland & Shrubland
Formation	2.B.2 Temperate Grassland & Shrubland
Division	2.B.2.Nb Central North American Grassland & Shrubland
Macrogroup	2.B.2.Nb Great Plains Sand Grassland & Shrubland
Group	2.B.2.Nb Great Plains Sand Grassland
Alliance	A1193 *Andropogon hallii* Sand Prairie Alliance

Field Plots: 0074, 0143, 0197, 3007

Map Class: NIOB MC102d

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2311.5 ft (range 2105 ft to 2503 ft)

Aspect: Mean 163˚ (range 89˚ to 288˚)

Slope: Mean 5.67˚ (range 5˚ to 7˚)

Macro Topography: Bluff, Hills, Plain

Geology: Ogallala Group, White River Group

Soil Texture: Loamy Sand, Sand

Environment: 4 sites were sampled within this type. These sites occurred above the floodplain terrace on more well drained and drier soils. These occurred on either loamy sand or sand. The plots occurred on gentle slopes with slopes of ~5 degrees. Ground cover is mainly composed of litter (45%-70% cover) and sand (10%-35% cover).

Local Vegetation Description

Structure: Herbaceous (60%-90%)

Vegetation Floristics: These herbaceous species are variable, but they all contain a high abundance of *Andropogon hallii* with cover ~60%. Other graminoids, such as *Schizachyrium scoparium*,

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Panicum virgatum, *Poa pratensis*, and *Eragrostis trichodes*, are common and may codominate with *Andropogon hallii*. Forbs tend to be abundant as well with cover ranging from 20% to 50%. *Ambrosia psilostachya*, *Artemesia ludoviciana*, and *Helianthus pauciflorus* tend to be common forbs within this type.

Dynamics: Wind is a dominant factor that shapes the landscape where this alliance occurs. Wind sometimes scours sand and vegetation from small areas and creates blowouts. These bare spots are initially colonized by species that are relatively uncommon in this alliance, such as *Redfieldia flexuosa*, *Muhlenbergia pungens*, *Yucca glauca*, and *Achnatherum hymenoides*. Eventually, these blowouts succeed to other communities (Savage 1937, Ramaley 1939a, Tolstead 1942, Harrison 1980). Tolstead (1942) cites Nebraska pioneer accounts that dunes were less vegetated than at present, and blowouts and stands were more common before cattle ranching. Fire frequency and extent are also thought to have declined since settlement because of fuel removal by livestock grazing and fire control (Burzlaff 1965, Wolfe 1973). Consequently, active dunes and large blowouts are less common now, as are the pioneer plant species *Redfieldia flexuosa*, *Andropogon hallii* and *Yucca glauca* (Harrison 1980).

These grasslands provide excellent summer forage and need careful management to prevent grazing out desirable species. Tolstead (1942) found that *Andropogon hallii* and *Eragrostis trichodes* are less common on pastures that receive year-round grazing. Generally, overgrazing this alliance decreases the cover of species of *Andropogon*, *Calamovilfa*, *Eragrostis*, and *Hesperostipa*, and increases the cover of *Bouteloua gracilis*, *Bouteloua hirsuta*, *Muhlenbergia pungens*, *Achnatherum hymenoides*, and *Sporobolus cryptandrus* (Savage 1937, Ramaley 1939a, Tolstead 1942, Harrison 1980). Overgrazing also kills out desirable shrubs, especially *Amorpha canescens* and *Prunus pumila* var. *besseyi* (Ryan et al. 1994). This grassland responds rapidly to management. Deferment of grazing in the late spring and summer favors warm-season grasses such *as Andropogon hallii*, *Bouteloua hirsuta*, *Bouteloua gracilis*, *Calamovilfa longifolia*, *Eragrostis trichodes*, *Koeleria macrantha*, and *Schizachyrium scoparium*.

Drought also causes declines in cover of all species, especially tall grasses, and can make the grassland more vulnerable to blowouts. Savage (1937) found large declines in tallgrass cover on sandy sites during drought in 1935. He ranked the cause of damage by decreasing effect: heat, drought, and, to a much lesser extent, grazing and then soil blowing. Ramaley (1939a) reports that in Colorado there is marginally enough precipitation to maintain this alliance. Drought causes retrogression to mixed sandhill, sand sage, or blow-out communities, which increases *Muhlenbergia pungens*, *Artemisia filifolia*, and *Achnatherum hymenoides*. Grazing during droughts increases the intensity of the damage (Ramaley 1939a).

Conservation Status Rank

Global: N/A

State (Nebraska): N/A

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Global Environmental Description

Stands of this alliance occur on sand deposits in the Great Plains. The climate is semi-arid and continental, with annual precipitation ranging from 46-61 cm. Elevations are generally between 1000 and 1600 m. Sites where this alliance is found are usually on gentle to steep slopes but sometimes on flat ground (Tolstead 1942, Steinauer 1989). The soils are sand, loamy sand, or sandy loam, and they can be poorly to moderately well-developed (Johnston 1987, Steinauer 1989). There is little runoff or evaporation because moisture quickly sinks into the coarse soil. Soil near the surface is consequently dry throughout much of the year, but moisture is present deeper in the soil profile. This favors deep-rooting species such as *Andropogon hallii* and *Calamovilfa longifolia* (Barnes and Harrison 1982). In the northern and western extent, adjacent grasslands dominated by *Pascopyrum smithii* or *Bouteloua* spp. occur on fine-textured soils. In western Texas, these grasslands form mosaics with *Quercus havardii* shrublands.

Global Vegetation Description

This alliance includes herbaceous vegetation with *Andropogon hallii*, occurring in the Great Plains from the United States-Canada border south to Texas. It is dominated by tall and midgrass species, with shortgrass species becoming important in the western portion of its range. *Andropogon hallii* is usually dominant or codominant. *Calamovilfa longifolia* is present to codominant in most stands south of the South Dakota-Nebraska border. *Bouteloua gracilis*, *Bouteloua hirsuta*, *Eragrostis trichodes*, *Hesperostipa comata* (= *Stipa comata*), *Koeleria macrantha*, *Pascopyrum smithii*, *Schizachyrium scoparium*, and *Sporobolus cryptandrus* are typical grasses in stands of this alliance. Upland sedges are also very common, especially *Carex filifolia*, *Carex inops* ssp. *heliophila*, and *Carex duriuscula* (= *Carex eleocharis*). Although graminoids are overwhelmingly dominant, several species of forbs can be found in many stands of this alliance. Some of the more common forbs are *Ambrosia psilostachya*, *Ipomoea leptophylla*, *Liatris punctata*, *Psoralidium* spp., and *Tradescantia occidentalis*. There may be widely scattered low shrubs, including *Rosa woodsii*, *Prunus pumila* var. *besseyi*, and *Yucca glauca*. In west Texas common associates on deep sands include *Panicum havardii*, *Sporobolus giganteus*, and *Calamovilfa gigantea*. Stands of this alliance occur on sand deposits, usually on gentle to steep slopes but sometimes on flat ground. The soils are sand, loamy sand, or sandy loam. They can be poorly to moderately well-developed. There is little runoff or evaporation because moisture quickly sinks into the coarse soil. Soil near the surface is consequently dry throughout much of the year, but moisture is present further down, favoring deep-rooting species such as *Andropogon hallii* and *Calamovilfa longifolia*. Wind sometimes scours sand and vegetation from small areas, creating blowouts. These bare spots are initially colonized by species that are uncommon in this alliance, such as *Muhlenbergia pungens* and *Redfieldia flexuosa*. Eventually, these blowouts succeed to one of the communities in this alliance. These grasslands occur on semi-stabilized quartz sand dunes in eastern Trans-Pecos Texas, where they form landscape mosaics with *Quercus havardii* shrublands, wetland dune swales, and sparsely vegetated dunes. In the southern plains, this alliance is a small-patch occurrence nested within the more common *Artemisia filifolia* shrublands. The rare plant *Penstemon haydenii*, an endemic to dune blowouts in the sandhills of Nebraska, may be endangered by the decline in habitat because of fire suppression and low to moderate stocking rates.

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Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of A1193 Andropogon hallii Sand Prairie Alliance.

Andropogon hallii Sand Prairie Alliance (CNHP)

Short Citation

- Barnes and Harrison 1982
- Johnson 1987
- Ramaley 1939a
- Savage 1937
- Steinaur 1989
- Tolstead 1942

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CEGL001474 Phalaris arundinacea Western Marsh

The table below shows the USNVC Hierarchy for CEGL001474 Phalaris arundinacea Western Marsh.

USNVC Hierarchy for CEGL001474 Phalaris arundinacea Western Marsh

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.C Shrub & Herb Wetland
Formation	2.C.4 Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland
Division	2.C.4.Nb Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland
Macrogroup	2.C.4.Nb Western North American Ruderal Marsh, Wet Meadow & Shrubland
Group	2.C.4.Nb Western North American Ruderal Marsh, Wet Meadow & Shrubland
Alliance	A3846 *Phalaris arundinacea* Western Ruderal Marsh Alliance
Association	2.C.4.Nb *Phalaris arundinacea* Western Marsh (CEGL001474)

Field Plots: 3034, 1055

Map Class: NIOB MC103

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2048.5 ft (range 1919 ft to 2178 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Flat, Alluvial Terrace

Geology: Pierre Shale

Soil Texture: Clay Loam, Peat

Environment: 2 sites were sampled within this type. These communities were typically found on alluvial flats. Soil texture was silty clay loam or a peat like material. Ground cover had litter ranging between 40% and 69%. Bare soil ranged from 10% to 30%. Moss ranged from 1% to 15%. These sites occurred on flat lowlevels.

Local Vegetation Description

Structure: Herbaceous (80%-90%)

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Vegetation Floristics: One site was dominated by *Phalaris arundinacea* (70%), but the other site only had 10% *Phalaris arundinacea*. These sites seem to have been invaded by *Lythrum salicaria* with 60% at one site and 30% at another. The diversity is low, and there are not many other plants.

Dynamics: *Phalaris arundinacea* produces abundant herbage and is planted for livestock forage. It is tolerant of moderate grazing by livestock, although heavy grazing will reduce density (Hansen et al. 1995). *Phalaris arundinacea* is a threat to riparian and wetland areas because it spreads rapidly from rhizomes, dominating sites, and is extremely difficult to remove once established (Hansen et al. 1995). Fire has been used with limited success to control the spread of *Phalaris arundinacea*, but the high water table where it grows makes it difficult to burn during the growing season (Hansen et al. 1995). Van Loh (2000) found stands growing on selenium-rich sites. It is not known if selenium is translocated into the plant tissue.

Conservation Status Rank

Global: G5

State (Nebraska): N/A

Global Environmental Description

This association is reported from throughout Washington, Colorado, Nebraska, Montana, Idaho, and northeastern Utah, but is likely more widespread in the western United States. It also occurs in Alberta, Canada. Elevations range from near sea level to 2307 m (7564 feet). Stands are found along riparian areas, pond and lake margins, wet meadows, and intermittent drainages. Sites are flat to rolling. The poorly drained soils are derived from alluvium and are commonly fine-textured but can also be coarser in texture. Subsoil is often mottled and gleyed (Crawford 2001). Sites are generally flooded from brief to extended periods, and soils remain saturated throughout the growing season.

Global Vegetation Description

This herbaceous association is reported from throughout Washington, Colorado, Nebraska, Montana, Idaho, and into northeastern Utah, but is likely more widespread in the western United States. It also occurs in Canada, in the southern two-thirds of British Columbia in areas with warm and relatively dry summers and in Alberta, from the Great Plains north into the Boreal Plains. Its distribution as a natural type is complicated because this native species is widely cultivated as a forage crop and has escaped and established in wetlands and riparian areas, displacing the local flora. Elevations range from near sea level to 2307 m. Stands are found along riparian areas, pond and lake margins, wet meadows, and intermittent drainages. The poorly drained alluvial soils are commonly fine-textured (occasionally coarse-textured) and may be flooded for brief to extended periods. The vegetation is characterized by a dense, tall herbaceous layer (often >80% canopy cover and 1.5-2 m tall) that is dominated by *Phalaris arundinacea*, which tends to occur in monocultures. Associated species may include *Equisetum arvense*, *Muhlenbergia asperifolia*, *Mentha arvensis*, *Schoenoplectus acutus* (= *Scirpus acutus*), and many other species in trace amounts where disturbed. Introduced species such as *Agrostis gigantea*, *Bromus inermis*, *Bromus tectorum*, *Cirsium arvense*, *Elymus repens*, *Euphorbia*

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esula, *Hordeum brachyantherum*, *Lepidium latifolium*, *Melilotus officinalis*, *Phleum pratense*, *Poa pratensis,* and *Sonchus oleraceus* are common in some disturbed stands.

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of CEGL001474 Phalaris arundinacea Western Marsh.

Phalaris arundinacea Western Marsh (CNHP)

Short Citation

- Crawford 2001
- Hansen et al. 1995
- Van Loh 2000

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CEGL002389 Typha spp. Great Plains Marsh

The table below shows the USNVC Hierarchy for CEGL002389 Typha spp. Great Plains Marsh.

USNVC Hierarchy for CEGL002389 Typha spp. Great Plains Marsh

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.C Shrub & Herb Wetland
Formation	2.C.4 Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland
Division	2.C.4.Nd Eastern North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland
Macrogroup	2.C.4.Nd Great Plains Marsh, Wet Meadow, Shrubland & Playa
Group	2.C.4.Nd Great Plains Freshwater Marsh
Alliance	A3487 *Typha angustifolia - Typha latifolia - Schoenoplectus* spp. Marsh Alliance
Association	2.C.4.Nd *Typha* spp. Great Plains Marsh (CEGL002389)

Field Plots: 0199, 1002

Map Class: NIOB MC104

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1903 ft (range 1644 ft to 2162 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Marsh

Geology: Pierre Shale

Soil Texture: Muck

Environment: 2 sites were sampled within this type. These communities were usually found within marshes. Soil texture is muck. Ground cover is variable among these two sites; one site was more on land while the other site had a lot water (50% cover). These occurred on low level marshes.

Local Vegetation Description

Structure: Herbaceous (70%-90%)

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Vegetation Floristics: *Typha* sp. Dominate the plots; there is ~70% cover of *Typha* sp. Other species present include *Carex* spp., *Sparganium* sp., and *Sagittaria latifolia*. This site is at risk of encroachment from *Lythrum salicaria*.

Dynamics: N/A

Conservation Status Rank

Global: G5

State (Nebraska): S2

Global Environmental Description

This widespread community is found along streams, rivers, canals, and the banks of ponds and lakes. Elevations range from near sea level to 2000 m. Sites are nearly level. The soil is saturated or flooded for much of the year from freshwater sources such as springs or streams. The alluvial soils have variable textures ranging from sand to clay and usually with a high organic content.

Global Vegetation Description

This association is widespread across the western United States and western Great Plains occurring near streams, rivers, and ponds. The soil is flooded or saturated for at least part of the growing season. The alluvial soils have variable textures ranging from sand to clay and usually with a high organic content. The dominant species, Typha latifolia or *Typha angustifolia*, often forms dense, almost monotypic stands. Other species typical of wetlands may be found in lesser amounts in this community; among these are shallower water emergents such as *Carex* spp., *Eleocharis macrostachya*, *Eleocharis palustris*, *Glyceria* spp., *Juncus balticus*, *Juncus torreyi*, *Mentha arvensis*, *Schoenoplectus acutus*, and *Veronica* spp. In deeper water, *Lemna minor*, *Potamogeton* spp., *Sagittaria* spp., *Azolla filiculoides*, and other aquatics may be present in trace amounts.

Nebraska Natural Heritage Program Description

Cattail Shallow Marsh: The vegetation consists primarily of emergent hydrophytic macrophytes 1-2 m tall, sometimes with a sparse submersed aquatic layer in areas that remain flooded much of the season. Species composition is somewhat variable, but *Typha* spp. usually dominate, with *Bolboschoenus fluviatilis* often equally common or even dominant in the eastern half of the state. In relatively undisturbed sites, *Sparganium americanum* may be abundant, with other hydrophytes such as *Alisma triviale*, *Sagittaria* spp. and *Eleocharis* spp.. In shallower water along the outer margins, *Leersia oryzoides* and *Polygonum amphibium* may be abundant, often with assorted annuals and perennials including *Echinochloa* spp., *Leptochloa fusca*, *Persicaria bicorne, P. hydropiper*, and *P. lapathifolia*, *Symphyotrichum lanceolatum*, *Bidens cernua, B. frondosa*, *Boltonia asteroides*, *Potentilla norvegica* and *Rorippa* spp.. Degraded sites may become overrun by *Typha angustifolia* in wetter, and *Phalaris arundinacea* in drier portions. Lower areas within sites may contain inclusions of Playa Wetland communities.

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Example Photograph

The photograph below shows an example of CEGL002389 Typha spp. Great Plains Marsh.

Typha spp. Great Plains Marsh (CNHP)

Short Citation

N/A

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CEGL002030 Schoenoplectus acutus – Typha latifolia – (Schoenoplectus tabernaemontani) Sandhills Marsh

The table below shows the USNVC Hierarchy for CEGL002030 Schoenoplectus acutus – Typha latifolia – (Schoenoplectus tabernaemontani) Sandhills Marsh.

USNVC Hierarchy for CEGL002030 Schoenoplectus acutus – Typha latifolia – (Schoenoplectus tabernaemontani) Sandhills Marsh

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.C Shrub & Herb Wetland
Formation	2.C.4 Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland
Division	2.C.4.Nd Eastern North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland
Macrogroup	2.C.4.Nd Great Plains Marsh, Wet Meadow, Shrubland & Playa
Group	2.C.4.Nd Great Plains Freshwater Marsh
Alliance	A3487 *Typha angustifolia - Typha latifolia - Schoenoplectus* spp. Marsh Alliance
Association	2.C.4.Nd *Schoenoplectus acutus - Typha latifolia* - (*Schoenoplectus tabernaemontani*) Sandhills Marsh (CEGL002030)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC104

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2116.46 ft (range 1835 ft to 2543 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Floodplain Lower Terrace

Geology: White River Group, Ogallala Formation, Pierre Shale

Soil Texture: Sand, Sandy Loam, Clay Loam

Environment: These communities are often found along floodplain terraces. Ground cover is dominated by litter with cover ranging from 73% to 80%. Water is often present composing of ground cover <10%. Basal area usually composes ~20% of the ground cover.

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Local Vegetation Description

Structure: Herbaceous (70%-90%)

Vegetation Floristics: This community is dominated by *Schoenoplectus tabernaemontani* with lesser amounts of *Typha latifolia*. Some of these sites are being invaded by *Phragmites australis*. Shrubs surrounding these communities include *Amorpha fruticosa* and *Salix interior*. In shallower sites, other common species include *Carex lacustris*, *Polygonum amphibium*, and *Sparganium eurycarpum*.

Dynamics: N/A

Conservation Status Rank

Global: G4

State (Nebraska): S4

Global Environmental Description

This community occurs where the regionally high water table of the Sandhills intersects the land surface in interdunal valleys, and is commonly associated with lakes, though it may occur in smaller depressions as well. Soils are deep, very poorly drained, and contain much organic matter (peat or muck) and are formed in eolian sand or alluvium. Soils are flooded or waterlogged through much of the season. The water is usually slightly alkaline, and surface water levels fluctuate seasonally with groundwater levels (Steinauer and Rolfsmeier 2000).

Global Vegetation Description

The vegetational composition of this community varies in response to water depth and other factors. This community is dominated by tall, emergent, hydrophytic graminoids. In areas flooded most of the season *Schoenoplectus acutus* (= *Scirpus acutus*) is usually dominant, with *Typha latifolia* increasingly common in areas of deeper water. Scattered patches of *Phragmites australis* may be present, but are seldom common. *Sagittaria latifolia* frequently forms a sparse understory layer, but is often dense in openings in the overstory and in deeper water with *Typha latifolia* at the margin of the permanent water line. Other species found in openings include *Carex lacustris*, *Polygonum amphibium* var. *emersum* (= *Polygonum coccineum*), and *Sparganium eurycarpum*. In areas which experience a more frequent fluctuation in the water level, *Phragmites australis* dominates, and may spread extensively during extended periods of low water. Scattered *Carex lacustris*, *Polygonum amphibium* var. *emersum* (= *Polygonum coccineum*), and *Schoenoplectus acutus* are found with *Phragmites australis* in these sites. Species diversity is low (Steinauer and Rolfsmeier 2000). The vegetation may form two intergrading zones: a bulrush/cattail zone where areas are flooded most of the season and dominated by a mixture of species, and a reed zone where areas are seasonally flooded and dominated by *Phragmites australis*. *Phragmites* may spread extensively during periods when the water table is low. Understory vegetation is usually sparse in the denser stands, though scattered *Typha* and *Schoenoplectus* may be present along with other plants of the bulrush/cattail zone.

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Nebraska Natural Heritage Program Description

Sandhills Hardstem Bulrush Marsh: The vegetation consists primarily of emergent hydrophytic macrophytes to 2 m tall, usually with a submersed aquatic component in areas flooded most of the season. Species composition is highly variable in response to hydrologic regime and soils. This community is distinguishable by the predominance of *Schoenoplectus acutus*, making such areas conspicuous by their dark green color (though in some marshes in the western Sandhills, *Schoenoplectus tabernaemontani* may dominate). *Zizania palustris* may share dominance in deeper water in some sites, while broadleaf cattail, common arrowhead and bald spikerush may share dominance in slightly more shallow areas. Openings among the dominants are frequently occupied by arrowhead, with lesser amounts of bur-reed, water smartweed, and ripgut sedge, while submersed rooted and free-floating aquatics are usually also present in such openings, as well as among the dominants. Scattered patches of common-reed are also usually present, but often are not widespread unless the water levels decline over an extended period of time. At some sites, the emergent form of water smartweed may form conspicuous patches in shallow water or occasionally in small seasonally flooded basins. In places where this community occurs in shallow basins, these sites may be overtaken by the alien *Typha angustifolia*. Species diversity is low, though high quality examples may be relatively species rich.

Example Photograph

The photograph below shows an example of CEGL002030 Schoenoplectus acutus – Typha latifolia – (Schoenoplectus tabernaemontani) Sandhills Marsh.

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Schoenoplectus acutus – Typha latifolia – (*Schoenoplectus tabernaemontani*) Sandhills Marsh (CNHP)

Short Citation

- Steinauer and Rolfsmeier 2000

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CEGL001475 Phragmites australis Western Ruderal Wet Meadow

The table below shows the USNVC Hierarchy for CEGL001475 Phragmites australis Western Ruderal Wet Meadow.

USNVC Hierarchy for CEGL001475 Phragmites australis Western Ruderal Wet Meadow

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.C Shrub & Herb Wetland
Formation	2.C.4 Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland
Division	2.C.4.Nb Western North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland
Macrogroup	2.C.4.Nb Western North American Ruderal Marsh, Wet Meadow & Shrubland
Group	2.C.4.Nb Western North American Ruderal Marsh, Wet Meadow & Shrubland
Alliance	A3847 *Phragmites australis - Arundo donax - Alopecurus pratensis* Ruderal Marsh Alliance
Association	2.C.4.Nb *Phragmites australis* Western Ruderal Wet Meadow (CEGL001475)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC104

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1855 ft (range 1836 ft to 1865 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Floodplain Lower Terrace

Geology: Pierre Shale

Soil Texture: Clay Loam, Sand

Environment: These communities occur within low areas along floodplains and some areas next to the river. Ground cover is dominated by litter with values ranging from 35% to 82%. Water forms a major component of the canopy with cover ranging from 30% to 50%. Depending time of year, there may be more or less water.

Local Vegetation Description

Structure: Herbaceous (90%-100%)

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Vegetation Floristics: Community is entirely dominated by *Phragmites australis*. Stands are often dense and *Phragmites australis* can reach heights of >1.5m tall. Common associates include *Carex* spp., *Glycyrrhiza lepidota*, and *Typha latifolia*.

Dynamics: *Phragmites australis* generally requires seasonal flooding in the spring with water table fluctuating from 0.6 m above to 0.6 m below the surface (Johnston 1987). This rhizomatous species can out compete all but the most aggressive weedy species. With heavy disturbance, however, introduced species such as *Cirsium arvense* or *Lepidium latifolium* may invade this plant association (Hansen et al. 1995, Von Loh 2000).

Conservation Status Rank

Global: G4

State (Nebraska): S4

Global Environmental Description

This association is widespread in the western U.S. and Canada. Elevation ranges from 640-1980 m. Stands occur in temporarily to semipermanently flooded marshes, ditches, impoundments, pond and lake margins, swales, and wet meadows that often have been disturbed by human activity. Sites are usually saturated or flooded during the growing season, but the soil surface may dry out in late summer. Soils are often fine-textured silts and clays. In Colorado and Utah, this reed marsh often occurs in small wet patches in seeps and backwater areas of large floodplains in springs emerging from canyon walls, around the fringes of irrigation ponds, ditches, and along railroad embankments that have poor drainage.

Global Vegetation Description

The vegetation is often variable as *Phragmites australis* will often invade into existing natural or semi-natural communities present on the site. Once firmly established, this community is usually strongly dominated by *Phragmites australis* with few or no other vascular plants present. Stands have a dense, 1- to 3-m tall herbaceous layer dominated by the perennial graminoid *Phragmites australis* usually with at least 50% absolute cover. Associated graminoids include *Agrostis stolonifera*, *Carex* spp., (such as *Carex curatorum*), *Typha latifolia*, *Juncus balticus*, *Agrostis gigantea*, *Elymus canadensis*, *Equisetum* spp., *Hordeum jubatum*, *Muhlenbergia asperifolia*, *Schoenoplectus acutus* (= *Scirpus acutus*), and *Sporobolus contractus*. Forbs are diverse and provide low cover; those commonly present include *Ambrosia acanthicarpa*, *Conyza canadensis*, *Glycyrrhiza lepidota*, *Eurybia glauca* (= *Aster glaucodes*), *Iva acerosa* (= *Oxytenia acerosa*), *Iva axillaris*, *Mentha arvensis*, *Dichanthelium acuminatum* (= *Panicum acuminatum*), *Solidago canadensis*, *Solidago velutina*, and *Taraxacum officinale*. Introduced species such as *Lepidium latifolium* and *Cirsium arvense* may be present and compete well against *Phragmites australis* in disturbed sites. Some woody species may be present in very low amount; *Clematis ligusticifolia*, *Parthenocissus vitacea*, and *Rhus trilobata* may be present as well.

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Nebraska Natural Heritage Program Description

Reed Marsh: The vegetation consists primarily of *Phragmites australis* stands 2–3 m tall. Patches of reeds may spread extensively during periods when the water table is low. Understory vegetation is usually sparse in the dense stands of *Phragmites australis*, and consists of *Leersia oryzoides*, *Persicaria* spp., and *Bidens* spp.. *Schoenoplectus* spp. and *Sagittaria* spp. may also be present in wetter areas. In drier areas along the margin of the community, *Phalaris arundinacea* may be abundant. This community may be quite extensive in the upper ends of some Sandhills lakes and degraded fens. Species diversity is low.

Example Photograph

The photograph below shows an example of CEGL001475 Phragmites australis Western Ruderal Wet Meadow.

Phragmites australis Western Ruderal Wet Meadow (CNHP)

Short Citation

- Hansen et al. 1995
- Johnston 1987
- Von Loh 2000

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NPSNIOB008 Seasonally Flooded, Early Successional Herbaceous Sandbar Complex

USNVC: Park Special NPSNIOB008

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC105

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2035.83 ft (range 1828 ft to 2394 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Floodplain Lower Terrace

Geology: White River Group, Ogallala Formation, Pierre Shale

Soil Texture: Sand

Environment: These sandbar communities are found within the braided river. Ground cover is extremely variable depending on the time of the year. When vegetation is present, litter may reach cover values up to 80%. If new scoured, these sand bars may have bare soil cover up to 85%. Occasionally, these communities may become inundated and have water covering 100% of the ground cover.

Local Vegetation Description

Structure: Short Shrub (0%-<5%), Herbaceous (70%-100%)

Vegetation Floristics: This community is highly variable, but vegetation cover was always >20% (often >80%). Many of these sandbars appeared to be an intermediate stage following a sparse sandbar. If shrubs are present, common shrubs include *Amorpha fruticosa* and *Salix interior*. The majority of the vegetation cover is in the herbaceous stratum. Common species include *Carex* spp., *Juncus* spp., *Cyperus* spp., *Equisetum arvense*, *Bidens* spp., *Persicaria* spp., *Polygonum* spp., *Schoenoplectus* spp., *Xanthium strumarium*, and *Eleocharis* spp.

Dynamics: N/A

Conservation Status Rank

Global: N/A

State (Nebraska): N/A

Global Environmental Description

N/A

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Global Vegetation Description

N/A

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of NPSNIOB008 Seasonally Flooded, Early Successional Herbaceous Sandbar Complex.

Seasonally Flooded, Early Successional Herbaceous Sandbar Complex (CNHP)

Short Citation

N/A

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CEGL005272 Carex spp. – (Carex pellita, Carex vulpinoidea) Wet Meadow

The table below shows the USNVC Hierarchy for CEGL005272 Carex spp. – (Carex pellita, Carex vulpinoidea) Wet Meadow.

USNVC Hierarchy for CEGL005272 Carex spp. – (Carex pellita, Carex vulpinoidea) Wet Meadow

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.C Shrub & Herb Wetland
Formation	2.C.4 Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland
Division	2.C.4.Nd Eastern North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland
Macrogroup	2.C.4.Nd Eastern North American Marsh, Wet Meadow & Shrubland
Group	2.C.4.Nd Midwest Wet Prairie & Wet Meadow
Alliance	A4105 *Carex* spp. - *Calamagrostis canadensis* Midwest Wet Meadow Alliance
Association	2.C.4.Nd *Carex* spp. - (*Carex pellita*, *Carex vulpinoidea*) Wet Meadow (CEGL005272)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC105

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2105.4 ft (range 1850 ft to 2394 ft)

Aspect: Mean 17˚ (range Flat to 85˚)

Slope: Mean 2.4˚ (range Flat to 12˚)

Macro Topography: Floodplain Lower Terrace

Geology: White River Group, Ogallala Formation, Pierre Shale

Soil Texture: Sand

Environment: These communities generally occur along lower floodplain terraces. Ground cover is dominated by litter with values ranging from 25% to 86%. Basal area composes up to 20% of the ground cover, and occasionally flooding may scour this community with bare soil reaching up to 65% of the ground cover.

Local Vegetation Description

Structure: Short Shrub (0%-10%), Dwarf Shrub (0%-10%), Herbaceous (40%-80%)

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Vegetation Floristics: These types have mesic *Carex* spp. Present. Total cover ranges between 70% and 90%. The main species is *Carex pellita*. *Eleocharis* spp. are typically present as well.

Dynamics: N/A

Conservation Status Rank

Global: GNR

State (Nebraska): S1

Global Environmental Description

Stands occur on nearly level floodplains, often in bands surrounding channels, or in basins. Soils are poorly drained silty and clay loams formed in alluvium. Stands are flooded for much of the growing season, but may dry out in late summer. Hydrology varies from seasonally to almost semipermanently flooded (Steinauer and Rolfsmeier 2000).

Global Vegetation Description

The vegetation cover is quite dense, and may be patchy. The structure is dominated by graminoids 0.5-1.5 m tall. Typical species include *Carex cristatella*, *Carex molesta*, *Carex pellita* (= *Carex lanuginosa*), *Carex stipata*, *Carex tribuloides*, and *Carex vulpinoidea* (a dominant in southeast Nebraska meadows). Other frequent emergent graminoids include *Eleocharis* spp., *Juncus interior*, *Juncus torreyi*, *Scirpus atrovirens*, and *Scirpus pallidus*. *Leersia oryzoides* may be common where the stand borders a marsh. Forbs are common and may be conspicuous. Among the more common are *Apocynum cannabinum*, *Symphyotrichum lanceolatum* (= *Aster lanceolatus*), *Lycopus americanus*, *Lythrum alatum* and *Verbena hastata*. *Phalaris arundinacea* may invade this community to the point of excluding many of the native species (Steinauer and Rolfsmeier 2000).

Nebraska Natural Heritage Program Description

Eastern Sedge Wet Meadow: Vegetative cover is fairly dense and is often quite patchy. The dominants are graminoids 0.5-1.5 m tall, *Carex vulpinoidea* and other sedges, particularly *C. cristatella, C. molesta, C. pellita, C. stipata,* and *C. tribuloides*. In some sites in northeast Nebraska, *Scirpus pallidus* may be the dominant species. Other frequent graminoids include *Eleocharis* spp., *Juncus interior*, *J. torreyi*, and *Schoenoplectus* spp.. *Leersia oryzoides* may be common where this community borders a marsh. Perennial herbs are often common and conspicuous and include *Apocynum cannabinum*, *Lycopus americanus*, *Lythrum alatum*, *Solidago gigantea*, *Symphyotrichum lanceolatum*, and *Verbena hastata*. In many places, these species may appear to comprise the dominant vegetation. Overall species diversity is moderate.

Example Photograph

The photograph below shows an example of CEGL005272 Carex spp. – (Carex pellita, Carex vulpinoidea) Wet Meadow.

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Carex spp. – (*Carex pellita*, *Carex vulpinoidea*) Wet Meadow (CNHP)

Short Citation

- Steinauer and Rolfsmeier 2000

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Mapped Forest and Woodland Types

NPSNIOB009 Burnt Disturbed Forest and Woodland

USNVC: Park Special NPSNIOB009

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC301

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2268.21 ft (range 2090 ft to 2482 ft)

Aspect: Mean 123.73˚ (range Flat to 359˚)

Slope: Mean 13.55˚ (range Flat to 42˚)

Macro Topography: Hillslope, Floodplain Upper Terrace

Geology: White River Group, Ogallala Formation

Soil Texture: Sand, Sandy Loam, Loamy Sand

Environment: These communities typically occur on the hills and floodplain in the path of the 2012 fire. Litter dominates the ground cover with values ranging from 50%-80%. Wood is often present with values ranging from 5% to 20%. Bare soil forms a large component of ground cover with values ranging from 5% to 50%. Basal area usually composes between 10% and 18% of the ground cover.

Local Vegetation Description

Structure: Canopy (0%-30%), Tall Shrub (0%-30%), Short Shrub (0%-60%), Herbaceous (40%-70%)

Vegetation Floristics: Community represents large burnt areas from the 2012 and other fires. This is a variable community which may be dominated by weedy species or native species. Common ruderal species include *Bromus tectorum, Bromus japonicum, Bromus inermis, Poa pratensis, Cannabis sativa, Verbascum thapsus*, *Melilotus officinale,* and *Cirsium* spp. Common native species include *Schizachyrium scoparium, Andropogon hallii,* and *Calamovilfa longifolia*. Old burnt tree species that are being to resprout include *Quercus macrocarpa, Tilia americana, Celtis occidentalis, Fraxinus pennsylvanica,* and *Pinus ponderosa*. Overall post-fire pine recruitment appears to be low as *Pinus ponderosa* seedlings were only encountered in the Fairfield Creek burn scar, and it appears that the deciduous species in the area will begin to dominate this community.

Dynamics: N/A

Conservation Status Rank

Global: N/A

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State (Nebraska): N/A

Global Environmental Description

N/A

Global Vegetation Description

N/A

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of XXXX.

Burnt Disturbed Forest and Woodland (CNHP)

Short Citation

N/A

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CEGL000201 Pinus ponderosa / Schizachyrium scoparium Open Woodland

The table below shows the USNVC Hierarchy for CEGL000201 Pinus ponderosa / Schizachyrium scoparium Open Woodland.

USNVC Hierarchy for CEGL000201 Pinus ponderosa / Schizachyrium scoparium Open Woodland

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.2 Cool Temperate Forest & Woodland
Division	1.B.2.Nb Rocky Mountain Forest & Woodland
Macrogroup	1.B.2.Nb Central Rocky Mountain Dry Lower Montane-Foothill Forest
Group	1.B.2.Nb Black Hills-Northwestern Great Plains Ponderosa Pine Forest & Woodland
Alliance	A3466 *Pinus ponderosa* Northwest Great Plains Open Woodland Alliance
Association	1.B.2.Nb *Pinus ponderosa* / *Schizachyrium scoparium* Open Woodland (CEGL000201)

Field Plots: 0045, 0050, 0150, 0153, 0178, 0189

Map Class: NIOB MC302

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2266.44 ft (range 2090 ft to 2433 ft)

Aspect: Mean 176.44˚ (range Flat to 320˚)

Slope: Mean 26.89˚ (range Flat to 40˚)

Macro Topography: Alluvial Flat, Alluvial Terrace, Bluff, Canyon

Geology: Ogallala Group, Pierre Shale, White River Group

Soil Texture: Sand, Loamy Sand, Sandy Loam, Clay Loam

Environment: 9 sites were sampled within this type. Communities were typically found on bluffs above the floodplain. Soil texture ranges from sand to sandy clay loam with one site having clay loam. Ground cover is split between litter, wood, bare soil, moss, and basal area. Litter cover ranges from 20% to 74%. Wood cover ranges from 1% to 10%. Bare soil cover ranges from 1% to 55%. Moss cover ranges from 1% to 20%, and basal area ranges between 10% to 25%, with one plot having a cover value of 40%. This type generally occurs along north facing slope but occasionally occurs on south facing slopes. The slope is usually ~35 degrees.

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Local Vegetation Description

Structure: Emergent (0%-10%), Canopy (10%-50%), Subcanopy (0%-20%), Tall Shrub (0%-30%), Short Shrub (0%-10%), Dwarf Shrub (0%-40%), Herbaceous (20%-70%)

Vegetation Floristics: *Pinus ponderosa* forms an open canopy with cover ranging from 10% to 50%. *Juniperus virginiana* and *Quercus macrocarpa* also usually occur in the canopy of this type but not in abundance. The herbaceous layer has moderate cover (30%-70%) and is dominated by graminoids. Common species include *Schizachyrium scoparium* and *Bouteloua curtipendula*.

Dynamics: This type probably develops from *Schizachyrium scoparium* prairie as pines become established. Disturbances such as fire convert stands back to prairies (Marriott and Faber-Langendoen 2000). Fire was likely an important factor in the regulation of stand structure historically, particularly during drought years.

Conservation Status Rank

Global: G3G4

State (Nebraska): S3S4

Global Environmental Description

This community is usually found on south-facing slopes and in rocky breaks. The soils are derived from limestone and sandstone (Johnston 1987, McAdams et al. 1998). Slopes are usually moderately inclined. In the Great Plains, it usually occurs on south- and west-facing slopes of hills, rocky breaks, and watercourses. In the western portion of its range, this association occurs at mid-elevation, ranging from 1780 and 2430 m (5840-7970 feet), on sites with low to high solar exposure that increases with elevation. Stands occur on gentle slopes of mesatops and shoulders (5-10%) and occasionally on steep (40%) upper canyon slopes. Soils are primarily mapped as well-developed Mollisols derived from pumice slope alluvium, or occasionally as fine-textured Alfisols derived from mixed eolian, and rarely, Aridisols derived from colluvial basalts (Hibner 2009). At El Malpais National Monument in western New Mexico, it occurs on collapse features and on the tops of very gently rolling lava plateaus. The topography varies from fractured basalt and rocky mounds to flatter areas with some soil development. Substrates are derived from volcanic basalt, and ground surface is typically dominated by rock with litter well-represented. Elsewhere, the ground surface is typically characterized by scattered bunch grasses amid pumice gravel and litter.

Global Vegetation Description

This ponderosa pine / little bluestem association is a dry woodland found in the Great Plains of the United States extending west to the mountains of New Mexico, Colorado and Wyoming. In the Great Plains, it usually occurs on south- and west-facing slopes of hills, rocky breaks, and watercourses. In the western portion of its range, this association occurs at mid-elevation, ranging from 1780 and 2430 m (5840-7970 feet), on sites with low to high solar exposure that increases with elevation. Stands occur on gentle slopes of mesatops and shoulders (5-10%) and occasionally on steep (40%) upper canyon slopes. Soils are primarily mapped as well-developed Mollisols derived from pumice slope

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alluvium, or occasionally as fine-textured Alfisols derived from mixed eolian, and rarely, Aridisols derived from colluvial basalts. At El Malpais National Monument in western New Mexico, it occurs on collapse features and on the tops of very gently rolling lava plateaus. The topography varies from fractured basalt and rocky mounds to flatter areas with some soil development. Substrates are derived from volcanic basalt, and ground surface is typically dominated by rock with litter well-represented. Elsewhere, the ground surface is typically characterized by scattered bunchgrasses amid pumice gravel and litter. In the Great Plains, the overstory is dominated by *Pinus ponderosa*. *Juniperus scopulorum* may often be present, but typically only as scattered individuals. The shrub layer is composed of species such as *Juniperus scopulorum, Rhus trilobata,* and *Symphoricarpos* spp. *Schizachyrium scoparium* is the most abundant graminoid, often accompanied by *Andropogon gerardii, Bouteloua curtipendula, Bouteloua gracilis, Carex inops* ssp. *heliophila, Carex siccata* (= *Carex foenea*), *Hesperostipa comata* (= *Stipa comata*), *Pascopyrum smithii*, and *Poa pratensis*. Common forbs include *Achillea millefolium, Phlox hoodii,* and *Allium* spp. In New Mexico, this open woodland / savanna is dominated by *Pinus ponderosa* with canopies that range from 10-30% cover with other tree species (*Pinus edulis, Pseudotsuga menziesii, Quercus gambelii*) rare or incidental. *Pinus ponderosa* seedling and sapling reproduction is typically present. *Juniperus monosperma* and *Pinus edulis* saplings are also occasionally present in the subcanopy. Shrubs are usually poorly represented (occasionally *Robinia neomexicana* or *Ribes cereum* are well-represented). Stands are distinctively grassy (cover can reach 30%). Dominant graminoids include prairie species *Schizachyrium scoparium* along with *Muhlenbergia montana, Poa fendleriana,* and *Elymus elymoides*. *Bouteloua gracilis*, while often present, is clearly subdominant. Numerous forb species may be common to well-represented and are variable from stand to stand.

Nebraska Natural Heritage Program Description

Dry Ponderosa Pine Open Woodland and Savanna: This community has an open canopy of ponderosa pine with *Juniperus scopulorum* or *J. virginiana* sometimes present, but never abundant. A shrub layer may be scattered to extensive, consisting of *Rhus trilobata*, *Rosa arkansana*, *Rosa woodsii* and *Symphoricarpos occidentalis* on lower slopes. *Yucca glauca* is sometimes present. In well-preserved sites, herbaceous cover is mostly of short to mid grasses and sedges, with *Bouteloua gracilis*, *Carex filifolia*, and *Schizachyrium scoparium* often common in more open sites, and *Poa pratensis* and *Carex inops* abundant where tree cover is greater. Other scattered graminoids include *Andropogon gerardii* and *A. hallii*, *Calamovilfa longifolia*, *Elymus trachycaulus*, *Nassella viridula*, *Pascopyrum smithii*, and *Hesperostipa comata*. Herbaceous species include a mixture of mixed-grass prairie species such as *Symphyotrichum ericoides*, *Liatris punctata*, *Echinacea angustifolia*, and *Salvia apiana*, along with more shade tolerant plants including *Anemone patens*, *Antennaria* spp., and *Phlox hoodii*. Species diversity is low to moderate.

Example Photograph

The photograph below shows an example of CEGL000201 Pinus ponderosa / Schizachyrium scoparium Open Woodland.

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Pinus ponderosa / *Schizachyrium scoparium* Open Woodland (CNHP)

Short Citation

- Hibner 2009
- Johnston 1987
- Marriott and Faber-Langendoen 2000
- McAdams et al. 1998

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NPSNIOB012 Pinus ponderosa / Juniperus virginiana Woodland

USNVC: Park Special NPSNIOB012

Field Plots: 0003, 1054, 3033

Map Class: NIOB MC303

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2285 ft (range 2132 ft to 2402 ft)

Aspect: Mean 238.33˚ (range 75˚ to 320˚)

Slope: Mean 32.67˚ (range 20˚ to 40˚)

Macro Topography: Bluff

Geology: Ogallala Group, Pierre Shale

Soil Texture: Sandy Loam, Clay Loam

Environment: 3 sites were sampled within this type. These communities occurred north or south facing bluffs overlooking the Niobrara River with a slope between 20˚ and 40˚. The soil ranged from sandy loam to clay loam.

Local Vegetation Description

Structure: Canopy (30%-50%), Subcanopy (0%-20%), Short Shrub (0%-10%), Dwarf Shrub (0%-40%), Herbaceous (30%-70%)

Vegetation Floristics: *Pinus ponderosa* and *Juniperus virginiana* codominate the canopy with total cover ranging between 30% and 50%, but *Pinus ponderosa* tends to have greater cover than *Juniperus virginiana*. *Quercus macrocarpa* and *Ostrya virginiana* may occur in this type, but never reach codominance. Occasionally, there is a shrub layer of *Symphoricarpos occidentalis* and *Prunus virginiana*. Herbaceous cover is usually dominated by *Bouteloua curtipendula* and *Piptatheropsis micrantha* with total herbaceous cover ranging from 30% to 70%.

Dynamics: N/A

Conservation Status Rank

Global: N/A

State (Nebraska): N/A

Global Environmental Description

N/A

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Global Vegetation Description

N/A

Nebraska Natural Heritage Program Description

Pine – Juniper Scarp Woodland: Tree canopy is fairly open and 10-20 m tall, and consists mostly of scattered *Pinus ponderosa*. A 2-4 m tall subcanopy of *Juniperus scopulorum* or hybrids with *Juniperus virginiana* is present and may be sparse to fairly dense. In openings where juniper cover is not dense, a shrub layer of *Rhus trilobata* and *Prunus virginiana* is commonly present, with *Cercocarpus montanus* and *Ribes cereum* common at some sites in the Wildcat Hills. The herbaceous understory is usually very sparse to nearly absent as the density of the subcanopy increases. Common graminoids include *Piptatheropsis micrantha* and *Carex inops*, though some species of upland prairie may be present in openings. Species diversity is low.

Example Photograph

The photograph below shows an example of NPSNIOB012 Pinus ponderosa / Juniperus virginiana Woodland.

Pinus ponderosa / *Juniperus virginiana* Woodland (CNHP)

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Short Citation

N/A

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CEGL000873 Pinus ponderosa / Quercus macrocarpa Open Woodland

The table below shows the USNVC Hierarchy for CEGL000873 Pinus ponderosa / Quercus macrocarpa Open Woodland.

USNVC Hierarchy for CEGL000873 Pinus ponderosa / Quercus macrocarpa Open Woodland

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.2 Cool Temperate Forest & Woodland
Division	1.B.2.Nb Rocky Mountain Forest & Woodland
Macrogroup	1.B.2.Nb Central Rocky Mountain Dry Lower Montane-Foothill Forest
Group	1.B.2.Nb Black Hills-Northwestern Great Plains Ponderosa Pine Forest & Woodland
Alliance	A3466 *Pinus ponderosa* Northwest Great Plains Open Woodland Alliance
Association	1.B.2.Nb *Pinus ponderosa* / *Quercus macrocarpa* Open Woodland (CEGL000873)

Field Plots: 0002, 0051, 0077, 0085, 0142, 0180

Map Class: NIOB MC304

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2377.33 ft (range 2209 ft to 2658 ft)

Aspect: Mean 224.67˚ (range 6˚ to 354˚)

Slope: Mean 22.83˚ (range 10˚ to 35˚)

Macro Topography: Bluff, Canyon

Geology: Ogallala Group, White River Group

Soil Texture: Sandy Loam, Loamy Sand, Clay Loam

Environment: 6 sites were sampled within this type. Loamy sand is the dominant soil texture, but some sites occurred on sandy loam and silty clay loam. Litter always have the greatest abundance and ranges from 35% to 71%. Wood ranges from 5% to 20%, and bare soil ranges from 5% to 20%. Moss is usually present between 2% and 20%. These sites occur on moderate slopes between 10 degrees and 35 degrees.

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Local Vegetation Description

Structure: Emergent (0%-40%), Canopy (30%-80%), Subcanopy (20%-50%), Tall Shrub (0%-10%), Short Shrub (0%-40%), Dwarf Shrub (0%-30%), Herbaceous (10%-70%)

Vegetation Floristics: Pinus ponderosa is usually in the emergent or canopy layer. Its cover is usually ~30%, but it may as low as 10%. Other trees that codominate in the canopy layer are *Quercus macrocarpa, Juniperus virginiana,* and *Ostrya virginiana*; other trees tend to have cover ~30%. The herbaceous layer ranges from sparse to moderate cover ranging from 10% to 60%; graminoids dominate the herbaceous layer with main species being *Piptatheropsis micrantha* and *Elymus virginicus*.

Dynamics: This type includes a floristically variable set of stands in which oak cover also is variable, and it may be that this community represents seral stages to several ponderosa pine communities. Both fire and timber harvest can produce increased oak cover with removal of pines (Marriott and Faber-Langendoen 2000). Fire scars indicate that these areas have burned in the past. Fire likely aided the regeneration of *Quercus macrocarpa* and played a major role historically in the maintenance of this type. With regular fire, coverage of *Pinus ponderosa* may have been less than observed today. This type, without fire, will likely succeed to a Pinus ponderosa-dominated type, with little oak.

Conservation Status Rank

Global: G3

State (Nebraska): N/A

Global Environmental Description

This community is found on rolling hills and ridgetops on calcareous substrates (Hoffman and Alexander 1987, Johnston 1987). Hoffman and Alexander (1987) report that it may also occur on soils derived from igneous substrates. The soils are sandy loams to clayey loams with a pH of 5.3-6.0.

Global Vegetation Description

This ponderosa pine / bur oak community type occurs mainly in the Black Hills of the western United States. Stands occur predominantly on rolling hills and ridgetops on calcareous substrates. The soils are sandy loams to silty loams. *Pinus ponderosa* is the only species found in the canopy in most stands. *Quercus macrocarpa* forms a discontinuous subcanopy. Common shrubs are *Amelanchier alnifolia, Mahonia repens, Prunus virginiana, Symphoricarpos albus,* and *Spiraea betulifolia*. Typical herbaceous species are *Carex siccata* (= *Carex foenea*), *Apocynum androsaemifolium, Galium boreale, Maianthemum stellatum, Oryzopsis asperifolia, Lupinus argenteus,* and *Vicia americana*.

Nebraska Natural Heritage Program Description

N/A

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Example Photograph

The photograph below shows an example of CEGL000873 Pinus ponderosa / Quercus macrocarpa Open Woodland.

Pinus ponderosa / *Quercus macrocarpa* Open Woodland (CNHP)

Short Citation

- Hoffman and Alexander 1987
- Johnston 1987
- Marriott and Faber-Langendoen 2000

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NPSNIOB010 Populus deltoides Ruderal Forest

USNVC: Park Special NPSNIOB010

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC305

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2051 ft (range 2041 ft to 2061 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Floodplain Lower Terrace

Geology: Pierre Shale

Soil Texture: Loamy Sand

Environment: These communities typically occur on lower floodplain terraces. Litter dominates the ground cover with values reaching 60%. Much of this litter is small wood fragments from Juniper removal. Larger fragments are classified as wood and reach cover values up to 25%. Basal area usually composes ~10% of the ground cover.

Local Vegetation Description

Structure: Canopy (50%), Subcanopy (10%), Herbaceous (60%)

Vegetation Floristics: This community is heavily disturbed by flooding. Disturbance is indicated by large amounts of bare ground, debris, and invasive species. Sites where *Juniperus virginiana* has been mechanically removed or sites with >35% *Elaeagnus angustifolia* fall into this community.

Dynamics: N/A

Conservation Status Rank

Global: N/A

State (Nebraska): N/A

Global Environmental Description

N/A

Global Vegetation Description

N/A

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Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of NPSNIOB010 Populus deltoides Ruderal Forest.

Populus deltoides Ruderal Forest (CNHP)

Short Citation

N/A

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CEGL000658 Populus deltoides – Fraxinus pennsylvanica Floodplain Forest

The table below shows the USNVC Hierarchy for CEGL000658 Populus deltoides – Fraxinus pennsylvanica Floodplain Forest.

USNVC Hierarchy for CEGL000658 Populus deltoides – Fraxinus pennsylvanica Floodplain Forest

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.3 Temperate Flooded & Swamp Forest
Division	1.B.3.Na Eastern North American-Great Plains Flooded & Swamp Forest
Macrogroup	1.B.3.Na Great Plains Floodplain Forest
Group	1.B.3.Na Great Plains Cottonwood - Green Ash Floodplain Forest
Alliance	A3423 *Populus deltoides* Floodplain Forest Alliance
Association	1.B.3.Na *Populus deltoides - Fraxinus pennsylvanica* Floodplain Forest (CEGL000658)

Field Plots: 0087, 1009, 0146, 0038, 1007

Map Class: NIOB MC306

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1956.8 ft (range 1676 ft to 2395 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Flat, Alluvial Terrace, Floodplain

Geology: Pierre Shale, White River Group

Soil Texture: Loamy Sand, Sandy Loam, Clay Loam

Environment: 5 sites were sampled within this type. These communities typically occurred on alluvial flats. Soil texture ranged between loamy sand and sandy clay loam. These sites had a bit of downed wood; one site had wood dominate the ground cover with 50% cover, but the other only had wood with value of 20%. The litter ranged from 30% to 45%. All of these sites occurred on flat low levels.

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Local Vegetation Description

Structure: Emergent (0%-30%), Canopy (30%-70%), Subcanopy (0%-20%), Short Shrub (0%-20%), Dwarf Shrub (0%-20%), Herbaceous (40%-90%)

Vegetation Floristics: *Populus deltoides* occupies the canopy with cover values of ~30%. *Fraxinus pennsylvanica* and *Acer negundo* also occur in the canopy layer. *Quercus macrocarpa* can occur within this type as well. *Juniperus virginiana* is also present and may dominate the stand. The herbaceous layer ranges from 40% to 90% cover. Abundant plants include *Ambrosia psilostachya, Elymus virginicus, Galium aparine, Poa pratensis, Solidago gigantea,* and *Leersia oryzoides*.

Dynamics: N/A

Conservation Status Rank

Global: G2G3

State (Nebraska): N/A

Global Environmental Description

This community occurs along rivers and streams and around ponds and lakes. It often floods when it occurs on free-flowing rivers. However, some impounded rivers, including the Missouri River, no longer have a natural flooding regime. On these rivers, flooding may rarely occur. The soils are developed from alluvium. In southwest North Dakota, Girard et al. (1989) found this community on silty clay loam, clay loam, clay, and loam. The soils were alkaline. Johnson (1971) found sandy loams, loamy sands, and silty clays along the Missouri River.

Global Vegetation Description

This cottonwood - green ash riparian forest community occurs throughout the northern and central Great Plains of the United States and adjacent Canada. Stands occur along rivers and streams and around ponds and lakes. The alluvial soils are variable, with silty clay loam, clay loam, clay, and loam soils in the northern Plains and sandy soils in the central Plains. It is a riparian open to closed-canopy forest dominated by deciduous trees. *Populus deltoides* and *Fraxinus pennsylvanica* are the most abundant mature trees. *Acer negundo* and *Ulmus americana* may also be present in the tree layer. *Juniperus scopulorum* may occur in the western portion of this community's range, and *Juniperus virginiana* in the eastern part. This community is dynamic and in younger stands *Populus deltoides* is the dominant but as stands age *Fraxinus pennsylvanica* becomes more prominent. The shrub layer is often vigorous. Species such as *Rosa woodsii, Symphoricarpos occidentalis, Juniperus scopulorum, Juniperus communis, Prunus virginiana, Cornus drummondii,* and *Cornus sericea* ssp. *sericea* can be abundant. *Carex* spp., *Juncus* spp., *Leymus cinereus, Lysimachia ciliata, Thalictrum venulosum,* and *Elymus canadensis* are common in the northern Plains, and *Amphicarpaea bracteata, Carex blanda, Geum canadense, Parietaria pensylvanica* and others in the central Plains. Weedy species are almost ubiquitous, especially *Poa pratensis, Bromus inermis, Melilotus officinalis, Ambrosia* spp., and *Urtica* spp.

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Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of CEGL000658 Populus deltoides – Fraxinus pennsylvanica Floodplain Forest.

Populus deltoides – Fraxinus pennsylvanica Floodplain Forest (CNHP)

Short Citation

- Girard et al. 1989
- Johnson 1971

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CEGL002152 Populus deltoides / Juniperus scopulorum Floodplain Woodland

The table below shows the USNVC Hierarchy for CEGL002152 Populus deltoides / Juniperus scopulorum Floodplain Woodland.

USNVC Hierarchy for CEGL002152 Populus deltoides / Juniperus scopulorum Floodplain Woodland

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.3 Temperate Flooded & Swamp Forest
Division	1.B.3.Na Eastern North American-Great Plains Flooded & Swamp Forest
Macrogroup	1.B.3.Na Great Plains Floodplain Forest
Group	1.B.3.Na Great Plains Cottonwood - Green Ash Floodplain Forest
Alliance	A0636 *Populus deltoides* Floodplain Woodland Alliance
Association	1.B.3.Na *Populus deltoides* / *Juniperus scopulorum* Floodplain Woodland (CEGL002152)

Field Plots: 3027, 1051

Map Class: NIOB MC307

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2045.5 (range 1998 ft to 2093 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Flat, Alluvial Terrace

Geology: Pierre Shale

Soil Texture: Sand, Loamy Sand

Environment: 2 sites were sampled within this type. Communities generally occurred on floodplain terraces. Litter is the most abundant ground cover between 90% and 74%. Wood ranges between 5% and 15%. These types occur on low level flat.

Local Vegetation Description

Structure: Emergent (30%), Canopy (60%-80%), Herbaceous (10%-30%)

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Vegetation Floristics: *Populus deltoides* occur in the emergent stratum with cover ~30%. The canopy is mainly *Juniperus virginiana* with cover ~80%. A shrub layer is absent, but the herbaceous is not very abundant. The total herbaceous cover is less than 30% with common species being *Carex* sp. and *Poa pratensis*.

Dynamics: This type is found closest to the river on young, unstabilized floodplains, where it colonizes the freshly deposited alluvial substrates on the meanders of the streams and rivers. Proceeding away from the river, other later successional stages include, in the Little Missouri River drainage, *Populus deltoides - Fraxinus pennsylvanica* Floodplain Forest (CEGL000658) and *Fraxinus pennsylvanica - (Ulmus americana) / Symphoricarpos occidentalis* Floodplain Forest (CEGL002088). As the stream continues to move away from the more recent deposits, the stand may eventually succeed to the *Fraxinus pennsylvanica* type, a process that could take 100 years (Girard et al. 1989).

Conservation Status Rank

Global: G1G2

State (Nebraska): N/A

Global Environmental Description

This woodland community is found on soils with an upper profile of silt loam (0-60 cm) and a lower profile of sandy loam (61-90 cm). These soils developed from alluvial deposits. The pH is circumneutral and there is a high water holding capacity. This community occurs on broad, flat floodplains (Girard et al. 1989).

Global Vegetation Description

This cottonwood community is found in riparian areas of the northwestern Great Plains. Stands occur on broad, flat floodplain terraces of rivers and streams. Soils vary from silty loams to sandy alluvial deposits. The vegetation consists of an open-canopied tree layer. The dominant species is mature *Populus deltoides*. *Juniperus scopulorum, Juniperus virginiana*, or a hybrid, may contribute significant cover to both tree and sapling layer. *Fraxinus pennsylvanica* may be present as small trees, or, more commonly, as saplings. *Populus deltoides* reproduction is very limited. This community is a seral stage which, without significant disturbance, will eventually change into a *Fraxinus pennsylvanica*-dominated system. It may represent an invasive stage in *Populus deltoides - Fraxinus pennsylvanica* Forest (CEGL000658), where Juniperus invades in the absence of a natural flooding regime. The shrub layer of this community is composed chiefly of *Rosa woodsii, Symphoricarpos occidentalis*, and small *Juniperus scopulorum*. The herbaceous stratum typically contains *Elymus canadensis, Melilotus officinalis,* and *Thalictrum dasycarpum*.

Nebraska Natural Heritage Program Description

N/A

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Example Photograph

The photograph below shows an example of CEGL002152 Populus deltoides / Juniperus scopulorum Floodplain Woodland.

Populus deltoides / *Juniperus scopulorum* Floodplain Woodland (CNHP)

Short Citation

- Girard et al. 1989

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CEGL000947 Salix amygdaloides Riparian Woodland

The table below shows the USNVC Hierarchy for CEGL000947 Salix amygdaloides Riparian Woodland.

USNVC Hierarchy for CEGL000947 Salix amygdaloides Riparian Woodland

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.3 Temperate Flooded & Swamp Forest
Division	1.B.3.Nd Western North American Interior Flooded Forest
Macrogroup	1.B.3.Nd Interior Warm & Cool Desert Riparian Forest
Group	1.B.3.Nd Western Interior Riparian Forest & Woodland
Alliance	A3798 *Populus deltoides* ssp. *wislizeni - Populus deltoides* ssp. *monilifera - Salix amygdaloides* Riparian Woodland Alliance
Association	1.B.3.Nd *Salix amygdaloides* Riparian Woodland (CEGL000947)

Field Plots: 3030

Map Class: NIOB MC308

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: 2098 ft

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Flat

Geology: Pierre Shale

Soil Texture: Sand

Environment: 1 site was sampled within this type. Soil texture was sand. Litter is the dominant ground cover with 65% litter, and wood has ground cover of 10%. This site occurred on a low level flat.

Local Vegetation Description

Structure: Canopy (50%), Tall Shrub (40%), Herbaceous (80%)

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Vegetation Floristics: *Salix amygdaloides* is the only tree in the canopy. Its cover value is 50%. *Salix interior* is a tall shrub in this site with a cover value of 40%. The herbaceous stratum is vigorous, and the common species are *Solidago canadensis, Cirsium arvense,* and *Muhlenbergia racemosum*.

Dynamics: N/A

Conservation Status Rank

Global: G3

State (Nebraska): S1

Global Environmental Description

This riparian community occurs as stringers in a variety of locations such as backwater areas, old meander channels and wetland margins or as clumps along water courses (Thompson and Hansen 2002). Soils are usually Regosols or Chernozems, and the water table typically stays within 1 m of the soil surface during the growing season.

Global Vegetation Description

This peachleaf willow woodland type is found in the northern Rocky Mountains and into northern parts of the western Great Plains. Stands occur in riparian areas, located in backwater areas and overflow channels of large rivers, on narrow floodplains of small creeks, and on the edges of ponds and lakes. Often it occurs in small isolated clumps adjacent to streams and rivers. The water table is usually within 1 m (3 feet) of the soil surface during the growing season, and the vegetation is tolerant of flooding. *Salix amygdaloides* associations may occur on a range of soil types, except heavy clays. It is most common on silty to sandy soils. It is tolerant of flooding and weakly saline or alkaline soils. Soils may be saturated to within 1 m (3 feet) of the surface during much of the growing season. The vegetation is dominated by *Salix amygdaloides*.

Nebraska Natural Heritage Program Description

This community is dominated by a canopy of *Salix amygdaloides* 12-20 m tall with a subcanopy of *Salix bebbiana* 5 m tall and a tall shrub layer of *Cornus sericea* and *Ribes americanum* to 2 and 1.5 m, respectively. The understory is very disturbed and nearly consists of a near monoculture of *Phalaris arundinacea* with *Solidago gigantea*, *Parthenocissus vitacea* and *Typha latifolia*, bordering a degraded wetland bottom. Species diversity is fairly low.

Example Photograph

The photograph below shows an example of CEGL000947 Salix amygdaloides Riparian Woodland.

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Salix amygdaloides Riparian Woodland (CNHP)

Short Citation

- Thompson and Hansen 2002

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CEGL001454 Populus deltoides / Panicum virgatum – Schizachyrium scoparium Floodplain Woodland

The table below shows the USNVC Hierarchy for CEGL001454 Populus deltoides / Panicum virgatum – Schizachyrium scoparium Floodplain Woodland.

USNVC Hierarchy for CEGL001454 Populus deltoides / Panicum virgatum – Schizachyrium scoparium Floodplain Woodland

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.3 Temperate Flooded & Swamp Forest
Division	1.B.3.Na Eastern North American-Great Plains Flooded & Swamp Forest
Macrogroup	1.B.3.Na Great Plains Floodplain Forest
Group	1.B.3.Na Great Plains Cottonwood - Green Ash Floodplain Forest
Alliance	A0636 *Populus deltoides* Floodplain Woodland Alliance
Association	1.B.3.Na *Populus deltoides* / *Panicum virgatum* - *Schizachyrium scoparium* Floodplain Woodland (CEGL001454)

Field Plots: 1010

Map Class: NIOB MC308

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: 2043 ft

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Terrace

Geology: White River Group

Soil Texture: Loamy Sand

Environment: 1 site was sampled within this type. Loamy sand was the soil texture. Ground cover is mainly split between 35% litter and 30% bare soil. This site occurred on a flat floodplain.

Local Vegetation Description

Structure: Canopy (30%), Herbaceous (70%)

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Vegetation Floristics: *Populus deltoides* are the sole tree in the canopy with 30% cover. The herbaceous stratum is the only other stratum, and its total cover is ~70%. The dominant species include *Schizachyrium scoparium* and *Sorghastrum nutans*. The only dominant forb is *Ambrosia psilostachya* with 30% cover.

Dynamics: N/A

Conservation Status Rank

Global: G2

State (Nebraska): S2?

Global Environmental Description

This community occurs on low floodplain ridges and stream banks. It is found along strongly meandering rivers with moderate to low gradients. Soils are deep and somewhat poorly drained to moderately well-drained and range from fine, sandy loams to silty clay.

Global Vegetation Description

This community is found in the central and southern Great Plains of the United States. Stands occur in floodplains and along banks of permanent rivers or streams that flood periodically. Soils are deep, moderately poorly drained to somewhat well-drained, and vary from fine sandy loams to silty clay. A sparse to locally dense canopy of *Populus deltoides* dominates the open tree canopy, with *Salix amygdaloides* also present at many sites. The shrub layer is also poorly developed to nearly absent, with at most a sparse layer of *Shepherdia argentea* and *Symphoricarpos occidentalis*. The herbaceous understory is dominated by tall grasses 1-2 m tall, primarily *Panicum virgatum* and *Spartina pectinata*. Other graminoids frequently present include *Carex nebrascensis* and *Carex pellita*. In drier sites, the mid grasses *Bouteloua curtipendula, Pascopyrum smithii,* and *Schizachyrium scoparium* may be common. Forb species present in Wyoming stands include *Ambrosia psilostachya, Artemisia ludoviciana, Asclepias speciosa, Glycyrrhiza lepidota, Grindelia squarrosa, Liatris punctata,* and *Opuntia polyacantha*. Exotic species are usually uncommon in this community. Overall species diversity is low.

Nebraska Natural Heritage Program Description

Cottonwood Riparian Woodland: This community is dominated by a tall (20+ m), very open canopy of *Populus deltoides* with at most a few scattered short subcanopy trees. Shrubs are generally absent or confined to streambanks. Herbaceous understory is quite variable in response to moisture and management regime, but is generally dominated by mid-height to tall warm season grasses. Species diversity is relatively low.

Example Photograph

The photograph below shows an example of CEGL001454 Populus deltoides / Panicum virgatum – Schizachyrium scoparium Floodplain Woodland.

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Populus deltoides / *Panicum virgatum* – *Schizachyrium scoparium* Floodplain Woodland (CNHP)

Short Citation

N/A

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CEGL000659 Populus deltoides – (Salix amygdaloides) / Salix (exigua, interior) Floodplain Woodland

The table below shows the USNVC Hierarchy for CEGL000659 Populus deltoides – (Salix amygdaloides) / Salix (exigua, interior) Floodplain Woodland.

USNVC Hierarchy for CEGL000659 Populus deltoides – (Salix amygdaloides) / Salix (exigua, interior) Floodplain Woodland

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.3 Temperate Flooded & Swamp Forest
Division	1.B.3.Na Eastern North American-Great Plains Flooded & Swamp Forest
Macrogroup	1.B.3.Na Great Plains Floodplain Forest
Group	1.B.3.Na Great Plains Cottonwood - Green Ash Floodplain Forest
Alliance	A0636 *Populus deltoides* Floodplain Woodland Alliance
Association	1.B.3.Na *Populus deltoides* - (*Salix amygdaloides*) / *Salix* (*exigua*, *interior*) Floodplain Woodland (CEGL000659)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC308

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2164.75 ft (range 2099 ft to 2380 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Floodplain Upper Terrace

Geology: White River Group, Ogallala Formation

Soil Texture: Loamy Sand, Sand

Environment: These communities typically occur on lower terraces on floodplains. Ground cover is dominated by litter with cover ranging from 75%-85%. Bare soil and wood are often present; however, these rarely compose >5% of the ground cover. Basal area typically composes ~15% of the ground cover.

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Local Vegetation Description

Structure: Canopy (40%-70%), Tall Shrub (0%-50%), Short Shrub (10%-20%), Herbaceous (40%-60%)

Vegetation Floristics: Sites from this community are dominated by *Populus deltoides* and *Salix amygdaloides*. Other common canopy species include *Fraxinus pennsylvanica*, *Celtis occidentalis*, *Juniperus virginiana*, and *Acer negundo*. The understory is dominated by *Salix interior* and *Amorpha fruticosa*. Some sites have a high abundance of *Andropogon gerardii* and *Panicum virgatum*.

Dynamics: This type is subject to, and maintained by, periodic flooding. In one study, it has been suggested that 30 years post-flood, this type will likely transition into a grassland type, as the cottonwood and willow species do not regenerate (Bellah and Hulbert 1974). This type is often impacted by heavy grazing.

Flooding and scouring by sand and ice are common in most examples of this community. During floods, erosion and deposition of material may occur. Drought stress affects shallow-rooted plants when the water table drops. This community is a seral community and requires the creation of new sandbars, mudflats, and other barren stretches for its continued existence. Bellah and Hulbert (1974) found that this community existed for only about 20 years before succession altered the forest to another community. Johnson (1994) believed that alteration of the hydrology of the Platte River in Nebraska has reduced the frequency of flooding. Thus, early-successional communities such as this one were not being reestablished as quickly as they were being replaced by later seral communities.

Conservation Status Rank

Global: G3G4

State (Nebraska): S3

Global Environmental Description

This community is most commonly found as narrow bands adjacent to stream channels of streams and rivers, where it develops on newly deposited alluvium. The soils are predominantly sand (50% or more), although silt, clay, or loam may be present. Soils are poorly developed. The water table fluctuates with the level of the river or stream and flooding is common, especially in the spring. In Wyoming, height above the stream channel varies from 0.5-3 m (1.5-10 feet) (Jones and Walford 1995). This community often floods in late winter and spring.

Global Vegetation Description

This community has an open canopy 6-12 m tall and is typically dominated by *Populus deltoides* or with *Salix amygdaloides* as a codominant. *Fraxinus pennsylvanica* may be present, especially on the upland side of this community, and *Elaeagnus angustifolia* or *Juniperus* spp. may invade some sites. This woodland community has closely spaced shrubs and small trees. *Salix exigua*, a tall shrub, is usually more abundant along the streamside margins of this community and where the canopy of taller trees is most open, which may occur following a scouring (heavy flood) event. *Salix lutea* can also be conspicuous in some stands. In the more easterly parts of the range, *Salix interior* may

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replace *Salix exigua*. Other shorter shrubs that can be found are *Amorpha fruticosa*, *Symphoricarpos occidentalis*, and *Toxicodendron rydbergii*. Graminoids adapted to mesic sites dominate the understory of most sites, the most common species including *Carex emoryi*, *Carex pellita* (= *Carex lanuginosa*), *Elymus canadensis*, *Elymus virginicus*, *Hordeum jubatum*, *Muhlenbergia racemosa*, *Pascopyrum smithii*, *Poa pratensis*, and *Spartina pectinata*. Forbs that are frequently abundant in relatively undisturbed sites include *Equisetum arvense* and *Glycyrrhiza lepidota*. Flooding often creates open patches in the herbaceous layer that are available for colonization by nearby species. The floristic composition of these patches is greatly affected by the species that are near and can invade the disturbed areas. Because of the high permeability of the sandy floodplain soils, species typical of upland prairie may invade in addition to annual forbs typical of disturbed sites. Widely distributed species that are adapted to these sites include *Ambrosia psilostachya*, *Artemisia campestris* ssp. c*audata*, Artemisia ludoviciana, *Calamovilfa longifolia*, *Cenchrus longispinus*, *Chamaesyce serpyllifolia* (= *Euphorbia serpyllifolia*), *Euphorbia esula*, *Grindelia squarrosa*, *Helianthus petiolaris*, *Heterotheca villosa*, *Phyla lanceolata* (= *Lippia lanceolata*), *Opuntia macrorhiza*, *Poa pratensis*, and *Sporobolus cryptandrus*. These sites are prone to invasion by exotic grasses and forbs, the most widely established being *Agrostis stolonifera*, *Bromus tectorum*, *Cirsium arvense*, *Bassia scoparia* (= *Kochia scoparia*), *Melilotus* spp., *Taraxacum officinale*, and *Tragopogon dubius*.

Nebraska Natural Heritage Program Description

Cottonwood – Peachleaf Willow Riparian Woodland: This community is dominated by a fairly tall (6-17 m), open canopy of *Populus deltoides* and slightly shorter *Salix amygdaloides*. In broad stream valleys in the western half, the subcanopy is often poorly developed and contains scattered small trees of *Acer negundo* and *Fraxinus pennsylvanica*, with *Elaeagnus angustifolia* or *Juniperus scopulorum*, *J. virginiana* often invading to a large extent. In canyons or at the bases of steep banks, the subcanopy may be denser with scattered *Ulmus americana* and *Celtis occidentalis* in addition to *Fraxinus pennsylvanica* and *Acer negundo*. In the east, the subcanopy is may contain widely scattered small trees of *Acer negundo*, *Acer saccharinum*, *Celtis occidentalis*, *Fraxinus pennsylvanica*, or *Ulmus americana*, or be nearly absent. Patches of shrubs are generally present and conspicuous under the open canopy of this community. A shrub layer 2-4 m tall is usually present, with *Salix interior* most common in lower ground, while on higher terraces and adjacent banks, *Prunus americana*, *Prunus virginiana* and *Shepherdia argentea* may be conspicuous. Eastward, *Cornus drummondii* and *Amorpha fruticosa* comprise the bulk of the often somewhat sparser tall shrub layer. Patches of *Symphoricarpos occidentalis* form a short shrub stratum at many sites.

The herbaceous layer varies from sparse to dense depending on drainage and shade. In low ground it usually consists of hydrophytic and mesophytic graminoids < 1 m tall, which may sometimes include abundant *Equisetum arvense*, but usually includes sedges and grasses such as *Carex emoryi*, *Carex pellita*, *Muhlenbergia racemosa*, *Spartina pectinata*, and the introduced *Agrostis gigantea* or *Phalaris arundinacea*. Sites on higher terraces in the west tend to be dominated by grasses such as *Pascopyrum smithii* and *Nassella viridula* with scattered native plants such as *Glycyrrhiza lepidota*. Eastward *Nassella viridula* drops out and *Elymus canadensis* is more common.

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Flooding often creates open patches in the herbaceous layer, which are available for colonization by nearby species. Because of the high permeability of the sandy floodplain soil, species typical of upland prairie may be present in addition to annuals of upland sites. Among the more common ones are *Ambrosia artemisiifolia* and *A. psilostachya*, *Artemisia campestris* var. *caudata*, *Cenchrus longispinus*, *Euphorbia* spp., *Grindelia squarrosa*, *Helianthus petiolaris*, *Heterotheca villosa*, and *Sporobolus cryptandrus*. Species diversity is low to moderate.

Example Photograph

The photograph below shows an example of CEGL000659 Populus deltoides – (Salix amygdaloides) / Salix (exigua, interior) Floodplain Woodland.

Populus deltoides – (*Salix amygdaloides*) / *Salix* (*exigua*, *interior*) Floodplain Woodland (CNHP)

Short Citation

- Bellah and Hulbert 1974
- Johnson 1994
- Jones and Walford 1995

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CEGL000628 Acer negundo / Prunus virginiana Floodplain Forest

The table below shows the USNVC Hierarchy for CEGL000628 Acer negundo / Prunus virginiana Floodplain Forest.

USNVC Hierarchy for CEGL000628 Acer negundo / Prunus virginiana Floodplain Forest

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.3 Temperate Flooded & Swamp Forest
Division	1.B.3.Na Eastern North American-Great Plains Flooded & Swamp Forest
Macrogroup	1.B.3.Na Great Plains Floodplain Forest
Group	1.B.3.Na Great Plains Cottonwood - Green Ash Floodplain Forest
Alliance	A4131 *Fraxinus pennsylvanica - Ulmus americana - Populus deltoides* Floodplain Forest Alliance
Association	1.B.3.Na *Acer negundo* / *Prunus virginiana* Floodplain Forest (CEGL000628)

Field Plots: 0055, 0081, 0010, 0151

Map Class: NIOB MC309

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2300.75 ft (range 2183 ft to 2420 ft)

Aspect: Mean 48˚ (range Flat to 160˚)

Slope: Mean 10˚ (range Flat to 30˚)

Macro Topography: Alluvial Flat, Alluvial Terrace, Gully

Geology: Ogallala Group, White River Group

Soil Texture: Loamy Sand, Sandy Loam

Environment: 4 sites were sampled within this type. The soil texture is loamy sand. One site occurred on a gentle 10 degree slope near the river, while the other sites occurred on a flat floodplain. Litter ranges from 55%-70%; if present, wood cover is usually ~15%. Bare soil is minimal with cover between 5% and 25%. Basal area is generally around 15%.

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Local Vegetation Description

Structure: Canopy (30%-60%), Subcanopy (0%-20%), Tall Shrub (0%-30%), Short Shrub (0%-10%), Dwarf Shrub (0%-20%), Herbaceous (40%-70%), Vine (0%-50%)

Vegetation Floristics: Canopy is dominated by *Acer negundo* with cover ~20%, and *Fraxinus pennsylvanica* and *Juniperus virginiana* codominate the canopy with cover values ~20%. There is a shrub layer with usually ~10% cover typically containing *Prunus virginiana* and *Symphoricarpos occidentalis*. There is a lush herbaceous layer with more graminoids than forbs. Herbaceous cover ranges between 70% and 90%; common herbaceous species include *Carex* sp. and *Solidago gigantea*.

Dynamics: In Colorado, dense thickets of *Prunus virginiana* may occur. When left undisturbed, the shrub canopy can be very thick and nearly impenetrable. However, many stands in Colorado are in severely degraded states with very sparse shrub canopies (CNHP pers. comm. 1998).

Conservation Status Rank

Global: G3

State (Nebraska): N/A

Global Environmental Description

This uncommon riparian forest association has been documented on the banks, terraces and lower canyon slopes of small intermittent or perennial streams in western South Dakota and northwestern Colorado. It has been reported from throughout the western and northern Great Plains, including eastern Montana and Colorado, and is likely to occur in isolated stands in sheltered canyons throughout the Colorado Plateau. Stands occur on level to gently sloping sites between 1067 and 1800 m (3500-5900 feet) elevation. Aspect is not important, but in northwestern Colorado, stands are limited to narrow drainages that are oriented north-south. Soils are poorly developed and derived from alluvium or colluvium.

Global Vegetation Description

This box-elder riparian forest is found on floodplains at warm elevations in the western Great Plains of the United States, as well as in the Black Hills region and the Colorado Plateau. This is an early-successional community dominated by *Acer negundo*. Stands occur on level to gently sloping sites between 1067 and 1800 m (3500-5900 feet) elevation. Aspect is not important, but in northwestern Colorado, stands are limited to narrow drainages that are oriented north-south. Soils are poorly developed and derived from alluvium or colluvium. Tree cover may be somewhat sparse to high; stands typically have 10-25% cover but may have cover as high as 60% in narrow canyons. Other tree species may be present to codominant, including *Ulmus americana, Quercus macrocarpa, Fraxinus pennsylvanica,* and *Populus deltoides*. The shrub understory is well-developed and may be more than 2 m high; exact composition will vary by region. *Prunus virginiana, Rhus trilobata, Cornus sericea* (= *Cornus stolonifera*), *Symphoricarpos occidentalis, Ribes aureum, Artemisia tridentata* ssp. *tridentata, Mahonia repens,* and *Toxicodendron pubescens* are common, although at

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Wind Cave National Park *Prunus virginiana* may be absent. Total shrub cover (tall and short shrubs) is often greater than 50%. Herbaceous cover is variable but usually less than 50% and often is diverse. Species composition also varies, although graminoids tend to be dominant; common species include *Poa pratensis, Piptatherum micranthum, Poa fendleriana, Elymus lanceolatus, Bromus tectorum, Heterotheca villosa, Clematis ligusticifolia, Achillea millefolium, Monarda fistulosa,* and *Apocynum cannabinum*.

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of CEGL000628 Acer negundo / Prunus virginiana Floodplain Forest.

Acer negundo / *Prunus virginiana* Floodplain Forest (CNHP)

Short Citation

- CNHP pers. comm. 1998

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CEGL002014 Fraxinus pennsylvanica – Ulmus spp. – Celtis occidentalis Floodplain Forest

The table below shows the USNVC Hierarchy for CEGL002014 Fraxinus pennsylvanica – Ulmus spp. – Celtis occidentalis Floodplain Forest.

USNVC Hierarchy for CEGL002014 Fraxinus pennsylvanica – Ulmus spp. – Celtis occidentalis Floodplain Forest

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.3 Temperate Flooded & Swamp Forest
Division	1.B.3.Na Eastern North American-Great Plains Flooded & Swamp Forest
Macrogroup	1.B.3.Na Central Hardwood Floodplain Forest
Group	1.B.3.Na Silver Maple - Green Ash - Sycamore Floodplain Forest
Alliance	A3708 *Acer rubrum - Fraxinus pennsylvanica* Floodplain Forest Alliance
Association	1.B.3.Na *Fraxinus pennsylvanica - Ulmus* spp. - *Celtis occidentalis* Floodplain Forest (CEGL002014)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC309

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2118.57 ft (range 1843 ft to 2228 ft)

Aspect: Mean 49.14˚ (range Flat to 344˚)

Slope: Mean 1.43˚ (range Flat to 10˚)

Macro Topography: Hillslope, Floodplain Upper Terrace

Geology: White River Group, Ogallala Formation, Pierre Shale

Soil Texture: Loamy Sand

Environment: These areas form on floodplain terraces. Litter dominates the ground cover with values ranging from 70% and 80%. Wood is usually present with cover values <5%. Basal area composes approximately 15% of the ground cover.

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Local Vegetation Description

Structure: Canopy (20%-80%), Subcanopy (0%-20%), Short Shrub (0%-40%), Herbaceous (60%-80%)

Vegetation Floristics: This species rich community is found along upper floodplain terraces and in upland ravine bottoms. The canopy is dominated by *Fraxinus pennsylvanica* with codominants including *Celtis occidentalis, Juglans nigra, Tilia americana, Ulmus americana, Ulmus rubra,* and occasionally *Quercus macrocarpa*. Common shrubs include *Cornus drummondii, Symphoricarpos occidentalis,* and *Zanthoxylum americanum*. The herbaceous layer is typically composed of forbs such as *Galium aparine, Geum canadense,* and *Laportea canadensis*.

Dynamics: N/A

Conservation Status Rank

Global: G3G5

State (Nebraska): S3

Global Environmental Description

Stands occur along upper floodplain terraces of rivers and streams and in upland ravine bottoms. Soils are moderately well-drained to poorly drained.

Global Vegetation Description

The vegetation has an open to closed tree canopy that is dominated by *Fraxinus pennsylvanica, Celtis occidentalis,* and *Ulmus americana*. Other tree species that may be present include *Juglans nigra, Tilia americana, Acer saccharinum, Populus deltoides*. *Ulmus rubra* can be part of the subcanopy. The shrub layer in the western part of the range includes *Cornus drummondii, Ribes missouriense, Symphoricarpos occidentalis,* and *Zanthoxylum americanum,* as well as woody vines, such as *Parthenocissus vitacea, Smilax tamnoides* (= *Smilax hispida*), *Toxicodendron radicans,* and *Vitis riparia*. The herbaceous layer in the western part of the range includes *Elymus virginicus, Festuca subverticillata, Galium aparine, Geum canadense,* and *Laportea canadensis* (Steinauer and Rolfsmeier 2000).

Nebraska Natural Heritage Program Description

Eastern Riparian Forest: This community typically has a sparse to moderately open, tall canopy of *Populus deltoides* 10–30 m tall, though in some mature stands *Populus deltoides* may be nearly absent. The subcanopy is generally dense and 5-15 m tall (or taller in mature stands) and contains several species, most commonly *Fraxinus pennsylvanica* and *Ulmus americana*. Other trees which may be common include *Acer saccharinum*, *Acer negundo*, *Celtis occidentalis*, *Gleditsia tricanthos*, *Morus rubra* and *Ulmus rubra*. The introduced *Morus alba* is frequently present and sometimes common in places. *Juniperus virginiana* is common in some sites in central Nebraska. The shrub layer is frequently well-developed though not as extensive as in some floodplain woodland communities. *Cornus drummondii* is usually the common tall shrub, and a short shrub layer of

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Symphoricarpos orbiculatus and *Ribes missouriense* is frequently present. The herbaceous layer is usually lush with numerous woodland perennials including *Festuca subverticillata*, *Laportea canadensis*, *Sanicula* spp., and *Ageratina altissima*.

Example Photograph

The photograph below shows an example of CEGL002014 Fraxinus pennsylvanica – Ulmus spp. – Celtis occidentalis Floodplain Forest.

Fraxinus pennsylvanica – Ulmus spp. – Celtis occidentalis Floodplain Forest (CNHP)

Short Citation

- Steinauer and Rolfsmeier 2000

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CEGL005400 Fraxinus pennsylvanica – Ulmus americana – (Acer negundo, Tilia americana) Great Plains Floodplain Forest

The table below shows the USNVC Hierarchy for CEGL005400 Fraxinus pennsylvanica – Ulmus americana – (Acer negundo, Tilia americana) Great Plains Floodplain Forest.

USNVC Hierarchy for CEGL005400 Fraxinus pennsylvanica – Ulmus americana – (Acer negundo, Tilia americana) Great Plains Floodplain Forest

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.3 Temperate Flooded & Swamp Forest
Division	1.B.3.Na Eastern North American-Great Plains Flooded & Swamp Forest
Macrogroup	1.B.3.Na Great Plains Floodplain Forest
Group	1.B.3.Na Great Plains Cottonwood - Green Ash Floodplain Forest
Alliance	A4131 *Fraxinus pennsylvanica - Ulmus americana - Populus deltoides* Floodplain Forest Alliance
Association	1.B.3.Na *Fraxinus pennsylvanica - Ulmus americana -* (*Acer negundo*, *Tilia americana*) Great Plains Floodplain Forest (CEGL005400)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC309

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2063.75 ft (range 1855 ft to 2224 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Floodplain Lower Terrace

Geology: White River Group, Ogallala Formation, Pierre Shale

Soil Texture: Sandy Loam

Environment: The ground cover is dominated by litter with cover values ranging from 60% and 85%. Wood is often present with cover <5%. Bare soil is usually present with cover between 3% and 20%. Basal area composes approximately 18%.

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Local Vegetation Description

Structure: Emergent (0%-10%), Canopy (30%-60%), Subcanopy (0%-30%), Short Shrub (10%), Dwarf Shrub (20%-30%), Herbaceous (30%-80%)

Vegetation Floristics: This community occurs along terraces of river bottoms and floodplains with brief flooding. The canopy is dominated by *Fraxinus pennsylvanica* and *Ulmus americana*. Common associates include *Ulmus pumilla, Morus alba,* and *Acer negundo*. Shrubs can be variable and may include *Cornus* spp. and *Salix* spp.. Herbaceous ground cover tends to contain more forbs than graminoids such as *Laportea canadensis, Toxicodendron radicans*, and *Eupatorium perfoliatum*.

Dynamics: This community may succeed cottonwood-willow forests on floodplains in the absence of flooding. Flooding and wind throw disturbances alter the vegetation structure and composition.

Conservation Status Rank

Global: G3G4

State (Nebraska): N/A

Global Environmental Description

This community occurs primarily along higher terraces of river bottoms and floodplains and beside lakes and larger streams, where flooding is relatively brief. Soils are well-drained and moist. They are both organic and medium-textured to fine-textured mineral soils. Rarely, soils are clays and gravels (Eyre 1980).

Global Vegetation Description

The overstory is dominated by *Fraxinus pennsylvanica* and, at least prior to Dutch elm disease, *Ulmus americana*. Associates in parts of its range include *Acer negundo, Acer saccharinum, Acer rubrum, Celtis occidentalis* (rarely), and *Tilia americana*. The shrub/sapling layer, which is variable in structure and composition, may include *Cornus alternifolia, Carpinus caroliniana, Cornus sericea*, and *Salix* spp. The herbaceous ground cover contains *Asclepias incarnata, Carex* spp., *Elymus virginicus, Eupatorium maculatum, Eupatorium perfoliatum, Impatiens capensis, Laportea canadensis, Rudbeckia laciniata, Toxicodendron radicans*, and a variety of ferns, including *Matteuccia struthiopteris* (Eyre 1980).

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of CEGL005400 Fraxinus pennsylvanica – Ulmus americana – (Acer negundo, Tilia americana) Great Plains Floodplain Forest.

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Fraxinus pennsylvanica – Ulmus americana – (*Acer negundo*, *Tilia americana*) Great Plains Floodplain Forest (CNHP)

Short Citation

- Eyre 1980

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CEGL000643 Fraxinus pennsylvanica – Ulmus americana / Prunus virginiana Woodland

The table below shows the USNVC Hierarchy for CEGL000643 Fraxinus pennsylvanica – Ulmus americana / Prunus virginiana Woodland.

USNVC Hierarchy for CEGL000643 Fraxinus pennsylvanica – Ulmus americana / Prunus virginiana Woodland

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.2 Cool Temperate Forest & Woodland
Division	1.B.2.Ne North American Great Plains Forest & Woodland
Macrogroup	1.B.2.Ne Great Plains Forest & Woodland
Group	1.B.2.Ne Great Plains Mesic Forest & Woodland
Alliance	A3211 *Fraxinus pennsylvanica - Ulmus americana* Great Plains Forest Alliance
Association	1.B.2.Ne *Fraxinus pennsylvanica - Ulmus americana* / *Prunus virginiana* Woodland (CEGL000643)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC309

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2253.4 ft (range 2060 ft to 2413 ft)

Aspect: Mean 39.9˚ (range Flat to 348˚)

Slope: Mean 4.4˚ (range Flat to 27˚)

Macro Topography: Hillslope, Floodplain Lower Terrace

Geology: White River Group, Ogallala Formation, Pierre Shale

Soil Texture: Loamy Sand, Sandy Loam

Environment: These communities typically occurred on hillslopes; however, occasionally, some of these communities occurred on floodplains. Ground cover is dominated by litter with values ranging from 75% and 85%. Wood is often present with cover typically <5%. Basal area composes between 10% and 20% of the ground cover.

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Local Vegetation Description

Structure: Emergent (<5%), Canopy (30%-70%), Subcanopy (0%-40%), Tall Shrub (0%-30%), Short Shrub (0%-10%), Dwarf Shrub (30%), Herbaceous (30%-70%)

Vegetation Floristics: This community occurs along draws and deep ravines just downslope of *Quercus macrocarpa* communities. Canopy is dominated by *Fraxinus pennsylvanica* with *Ulmus americana* and *Acer negundo*. Canopy codominates include *Ulmus rubra, Celtis occidentalis, Tilia americana,* and *Juglans nigra*. In pristine stands, the understory is composed of two layers; the upper layer is a conspicuous shrub layer 2-3 m tall dominated by *Prunus virginiana, Ostrya virginiana,* or *Cornus drummondii*. The lower layer is dominated by graminoids such as *Elymus virginicus* and *Carex* spp.

Dynamics: In Theodore Roosevelt National Park, bison utilize this habitat for grazing, watering, and summertime shade (Hansen et al. 1984). Past heavy grazing by cattle is reflected in the dominance of some weedy species, such as *Melilotus officinalis* (= *Melilotus albus*) and *Poa pratensis* and even some of the dominance of *Symphoricarpos occidentalis* may be attributed to this past grazing history (Hansen et al. 1984).

Conservation Status Rank

Global: G2G3

State (Nebraska): S2

Global Environmental Description

Stands occur in upland ravines and broad valleys or on moderately steep slopes. They also occur along small permanent or ephemeral streams. In central North Dakota, this community is also found along the north slopes of end moraines or kames and along lakeshores. On these sites, soil and topography permit greater than normal moisture conditions. In south-central South Dakota stands occur on steep, north-facing escarpments and around boulder outcrops. In northwestern Nebraska they occur in deep mesic ravines or canyons. Soils are clay loams, sandy clay loam, silty clay, and sandy loam. Soil pH ranges from 6.0 to 8.1. Slopes range from 0 to 40%. In south-central South Dakota soils are dry to moist, and moderately drained (Godfread 1976, Williams 1979, Hansen and Hoffman 1988, Girard et al. 1989, Steinauer and Rolfsmeier 2000).

Global Vegetation Description

This community is an open- to closed-canopy woodland dominated by *Fraxinus pennsylvanica. Ulmus americana* or *Acer negundo* sometimes achieve codominance. The largest trees are 50-60 cm dbh, but most trees are 20-30 cm dbh. In sharply cut, V-shaped upland ravines, the largest trees are near the center or bottom of the ravine where there is greater soil moisture. The average tree age is 70 to 80 years. The tree subcanopy, when present, consists of the same species, with the infrequent addition of *Betula occidentalis, Crataegus succulenta, Ostrya virginiana,* and *Populus tremuloides* at some sites. In undisturbed stands, the understory is composed of two layers. The taller and more conspicuous layer is a shrub layer 2-3 m tall. This layer is dominated

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by *Prunus virginiana* with smaller amounts of *Symphoricarpos occidentalis*. In Nebraska, a variety of other shrubs occur. The most common are *Prunus americana, Prunus virginiana, Ribes aureum* var. *villosum, Rosa woodsii,* and *Symphoricarpos occidentalis*; less common shrubs *include Acer glabrum, Amorpha fruticosa, Cornus sericea, Crataegus succulenta, Rhus glabra, Ribes americanum, Ribes oxyacanthoides,* and *Rubus occidentalis*. *Toxicodendron rydbergii* frequently forms a short-shrub layer. *Vitis riparia* is the most common vine. Rangewide, the lower layer is dominated by grasses and sedges such as *Elymus virginicus* and *Carex sprengelii*. Common herbaceous species include *Aquilegia canadensis, Galium boreale, Galium aparine, Maianthemum stellatum,* and *Thalictrum dasycarpum*. In central South Dakota this community is a woodland with an open canopy of ash trees and an extremely dense shrubby understory. The average tree height is 6.7 m and the shrub understory is 1.6 m high. There are few herbaceous species. The continuation of the status of *Ulmus americana* as a prominent part of this community is uncertain due to the effects of Dutch elm disease (USACE 1979, Hansen et al. 1984, 1990, Hansen and Hoffman 1988, Girard et al. 1989, Steinauer and Rolfsmeier 2000).

Nebraska Natural Heritage Program Description

Green Ash – Elm – Hackberry Canyon Bottom Woodland: The dominant trees of this community include *Fraxinus pennsylvanica* and *Ulmus americana*, with *Acer negundo* present in more mesic sites. *Celtis occidentalis* is common locally, sometimes occurring as a dominant or sharing dominance with *Fraxinus pennsylvanica*. The subcanopy, when present, consists of the same species, though rarely *Betula occidentalis* or *Populus tremuloides* may be present in the Pine Ridge. Shrubs include *Prunus americana* and *Ribes oxyacanthoides* (in the Pine Ridge), in addition to *Prunus virginiana* and *Ribes aureum*, and less commonly *Cornus sericea*, *Rhus glabra*, and *Rubus occidentalis*. A short shrub layer of *Toxicodendron rydbergii* is often present, and in the *Juniperus communis* var. *depressa* and *Berberis repens* are present as well. *Vitis riparia* is the most common vine. The herbaceous layer is rich in species and is often dominated by woodland graminoids such as *Carex sprengellii* and *Elymus villosa* in undisturbed sites. *Poa pratensis* is a common invader that dominates most grazed sites. In the Pine Ridge, other herbaceous understory plants include an array of eastern deciduous forest species of the northeastern United States, including *Aquilegia canadensis*, *Galium boreale*, *Sanicula marilandica* and *Thalictrum dasycarpum*. Some species typical of the Rocky Mountains are may be present there as well, but are often not as common, including *Hackelia floribunda* and *Thalictrum venulosum*. Species diversity is low to moderate in most sites, though it may be relatively high in ungrazed sites in the Pine Ridge.

Example Photograph

The photograph below shows an example of CEGL000643 Fraxinus pennsylvanica – Ulmus americana / Prunus virginiana Woodland.

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Fraxinus pennsylvanica – Ulmus americana / *Prunus virginiana* Woodland (CNHP)

Short Citation

- Girard et al. 1989
- Godfread 1976
- Hansen et al. 1984
- Hansen et al. 1990
- Hansen and Hoffman 1988
- Steinauer and Rolfsmeier 2000
- Williams 1979
- USACE 1979

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CEGL005239 Fraxinus pennsylvanica – Ulmus americana – (Juglans nigra, Celtis occidentalis) Ruderal Forest

The table below shows the USNVC Hierarchy for CEGL005239 Fraxinus pennsylvanica – Ulmus americana – (Juglans nigra, Celtis occidentalis) Ruderal Forest.

USNVC Hierarchy for CEGL005239 Fraxinus pennsylvanica – Ulmus americana – (Juglans nigra, Celtis occidentalis) Ruderal Forest

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.2 Cool Temperate Forest & Woodland
Division	1.B.2.Na Eastern North American Forest & Woodland
Macrogroup	1.B.2.Na Eastern North American Ruderal Forest
Group	1.B.2.Na Eastern North American Native Ruderal Forest
Alliance	A3228 *Liriodendron tulipifera - Juglans nigra - Robinia pseudoacacia* Ruderal Forest Alliance
Association	1.B.2.Na *Fraxinus pennsylvanica - Ulmus americana* - (*Juglans nigra*, *Celtis occidentalis*) Ruderal Forest (CEGL005239)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC310

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2207.63 ft (range 2073 ft to 2455 ft)

Aspect: Mean 12.54˚ (range Flat to 190˚)

Slope: Mean 1.33˚ (range Flat to 17˚)

Macro Topography: Floodplain Upper Terrace

Geology: White River Group, Ogallala Formation, Pierre Shale

Soil Texture: Sand

Environment: These communities are usually found on upper terraces of floodplains. Ground cover is dominated by litter with cover values ranging from 70% to 90%. Wood is typically present with cover reaching up to 10%. Bare soil composes <5% of the ground cover. Basal area typically reaches up to 15% of the ground cover.

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Local Vegetation Description

Structure: Canopy (10%-50%), Subcanopy (0%-20%), Short Shrub (0%-30%), Herbaceous (10%-80%)

Vegetation Floristics: This community is a degraded *Fraxinus pennsylvanica* community occurring in mesic, sometimes bottomland, disturbed draws or in upland disturbed sites. Common canopy species include *Ulmus americana, Juglans nigra*, and *Celtis occidentalis*. Many sites have been invaded by *Juniperus virginiana* between 35% to 80% cover. Other canopy codominates include *Acer negundo* and *Elaeagnus angustifolia*.

Dynamics: N/A

Conservation Status Rank

Global: G2G3

State (Nebraska): N/A

Global Environmental Description

Stands occur in mesic, sometimes bottomland, disturbed draws or in upland, disturbed sites.

Global Vegetation Description

The vegetation is dominated by deciduous trees. Tree canopy cover varies from immature and open to mature, closed forest. Tree dominants include *Fraxinus pennsylvanica* and *Ulmus americana* (the latter often not reaching maturity because of Dutch Elm Disease). Typical associates include *Juglans nigra* and *Celtis occidentalis*.

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of CEGL005239 Fraxinus pennsylvanica – Ulmus americana – (Juglans nigra, Celtis occidentalis) Ruderal Forest.

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Fraxinus pennsylvanica – Ulmus americana – (*Juglans nigra*, *Celtis occidentalis*) Ruderal Forest (CNHP)

Short Citation

N/A

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CEGL002593 Juniperus virginiana Midwest Ruderal Forest

The table below shows the USNVC Hierarchy for CEGL002593 Juniperus virginiana Midwest Ruderal Forest.

USNVC Hierarchy for CEGL002593 Juniperus virginiana Midwest Ruderal Forest

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.2 Cool Temperate Forest & Woodland
Division	1.B.2.Na Eastern North American Forest & Woodland
Macrogroup	1.B.2.Na Eastern North American Ruderal Forest
Group	1.B.2.Na Eastern North American Native Ruderal Forest
Alliance	A3227 *Juniperus virginiana - Pinus virginiana - Pinus echinata* Ruderal Forest Alliance
Association	1.B.2.Na *Juniperus virginiana* Midwest Ruderal Forest (CEGL002593)

Field Plots: 0106

Map Class: NIOB MC311

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: 2211 ft

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Terrace

Geology: White River Group

Soil Texture: Sand

Environment: 1 sites was sampled within this type. Soil was sand. Found on an old floodplain terrace. Litter ranged was 50%, wood ranged was 5%, sand ranged was 40%, and moss was 5%.

Local Vegetation Description

Structure: Canopy (50%-100%), Tall Shrub (50%-100%), Herbaceous (40%)

Vegetation Floristics: This is not a diverse type. *Juniperus virginiana* dominates the type in the canopy layer with usually 80-90% cover. The herbaceous stratum ranges from <50% cover with

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Ageratina altissima, Carex spp., *Calamovilfa longifolia, Schizachyrium scoparium, Ambrosia psilostachya,* and *Urtica dioica* as the most abundant species.

Dynamics: N/A

Conservation Status Rank

Global: N/A

State (Nebraska): N/A

Global Environmental Description

Stands typically occur in old fields and other disturbed places.

Global Vegetation Description

This semi-natural redcedar forest type is expected to be found in locally disturbed areas in the central and upper midwestern United States. Stands typically occur in old fields and other disturbed places. The vegetation may vary in structure from open-canopy woodland (particularly as it invades herbaceous old fields) to dense, closed-canopy forest. *Juniperus virginiana* is the leading tree dominant. Other associates have not been well-described, but may include *Rhus typhina*.

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of CEGL002593 Juniperus virginiana Midwest Ruderal Forest.

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Juniperus virginiana Midwest Ruderal Forest (CNHP)

Short Citation

N/A

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CEGL005269 Elaeagnus angustifolia Ruderal Riparian Woodland

The table below shows the USNVC Hierarchy for CEGL005269 Elaeagnus angustifolia Ruderal Riparian Woodland.

USNVC Hierarchy for CEGL005269 Elaeagnus angustifolia Ruderal Riparian Woodland

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.3 Temperate Flooded & Swamp Forest
Division	1.B.3.Nd Western North American Interior Flooded Forest
Macrogroup	1.B.3.Nd Interior West Ruderal Flooded & Swamp Forest & Woodland
Group	1.B.3.Nd Interior West Ruderal Riparian Forest & Scrub
Alliance	A3566 *Elaeagnus angustifolia* Ruderal Riparian Scrub Alliance
Association	1.B.3.Nd *Elaeagnus angustifolia* Ruderal Riparian Woodland (CEGL005269)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC312

Local Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 2050 ft (range 2000 ft to 2100 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Floodplain Lower Terrace

Geology: White River Group, Ogallala Formation, Pierre Shale

Soil Texture: Sand

Environment: Ground cover may be quite. Litter usually dominates the ground cover. However, if recently flooded bare soil may become the dominate ground cover.

Local Vegetation Description

Structure: Canopy (10%-40%), Herbaceous (40%)

Vegetation Floristics: Surrounding these plots is an *Elaeagnus angustifolia* woodland. The herbaceous stratum is fairly sparse; total cover reaches at maximum 40%. *Calamovilfa longifolia* has

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the highest cover values between 10% and 20%. *Ambrosia psilostachya* is the most abundant forb with cover value of 30%.

Dynamics: *Elaeagnus angustifolia* has been planted widely across the western U.S. in windbreaks and as an ornamental. This tree species has bird-dispersed seeds and has invaded riparian woodlands extensively, replacing the native tree species, especially where flood control efforts limit regeneration of native trees such as *Populus deltoides* and *Populus fremontii*. *Elaeagnus angustifolia* is shade tolerant, so it is able to become established in the understory of *Populus* gallery forests and becomes the dominant when the mature cottonwood trees fall.

Conservation Status Rank

Global: GNA

State (Nebraska): N/A

Global Environmental Description

This woodland type is naturalized throughout the interior West and Great Plains, probably spreading as a result of *Elaeagnus angustifolia* being widely planted in hedgerows for windbreaks. It has spread to a variety of native habitats, particularly more mesic ones, such as riverbanks, stream terraces and shorelines. Stands also occur in upland basins and drainages. Stands may be small and linear, but many extend for great distances along streams. Adjacent vegetation includes other riparian shrublands and wetlands dominated by *Salix exigua* or *Scirpus* and/or *Schoenoplectus* spp. Upland vegetation is variable.

Global Vegetation Description

The vegetation is dominated by the tree *Elaeagnus angustifolia* with a variety of native and introduced species in the shrub and herbaceous layers. Canopy closure is open to moderately dense (25-50% cover). In the Colorado Plateau, *Tamarix ramosissima* may be present in the tree canopy with less cover than *Elaeagnus angustifolia*, or relict *Populus deltoides* or *Populus fremontii* trees may remain as canopy emergents. Shrubs in the understory include *Salix exigua, Rhus trilobata, Artemisia tridentata* ssp. *tridentata*, *Chrysothamnus linifolius*, and *Amorpha fruticosa*. The herbaceous understory is variable in composition and abundance depending on location. Some species known to occur include *Atriplex patula, Distichlis spicata, Eleocharis palustris, Euthamia occidentalis, Glycyrrhiza lepidota, Grindelia* sp., *Hordeum jubatum, Muhlenbergia asperifolia, Pascopyrum smithii, Spartina pectinata,* and *Sporobolus airoides*. Exotic herbaceous species may be common to abundant, including *Bassia scoparia, Bromus tectorum, Descurainia sophia, Lepidium latifolium,* and *Xanthium strumarium*.

Nebraska Natural Heritage Program Description

N/A

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Example Photograph

The photograph below shows an example of CEGL005269 Elaeagnus angustifolia Ruderal Riparian Woodland.

Elaeagnus angustifolia Ruderal Riparian Woodland (CNHP)

Short Citation

N/A

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NPSNIOB013 Quercus macrocarpa / Juniperus virginiana / Elymus virginicus Forest

USNVC: Park Special NPSNIOB013

Field Plots: 1013, 1053, 3031, 0169, 1052, 0060, 0066, 0084, 0090, 0118, 0140, 3002

Map Class: NIOB MC313

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2163.5 ft (range 1854 ft to 2477 ft)

Aspect: Mean 188.25˚ (range Flat to 336˚)

Slope: Mean 7.58˚ (range Flat to 37˚)

Macro Topography: Alluvial Flat, Alluvial Terrace, Forest, Gully, Hills, Slope, Toe Slope

Geology: Ogallala Group, Pierre Shale, White River Group

Soil Texture: Sand, Loamy Sand, Sandy Loam

Environment: 12 sites were sampled within this type. This is an upland community type and occurs on either river terraces or gentle slopes. When occuring on gentle slopes, the slope ranges from 5˚ to 14˚; although, one site occurred in a gully with a steep slope of 34˚. Soil texture is typically either loamy sand or sandy loam. Ground cover usually comprises of litter, wood, bare soil, and basal area. Litter ranges between 40-70%. Wood is <20%, and bare soil ranges between 5-30%. Sand is the main bare soil. Basal area ranges from 15-40%.

Local Vegetation Description

Structure: Canopy (20%-80%), Subcanopy (10%-40%), Tall Shrub (0%-10%), Short Shrub (0%-30%), Dwarf Shrub (0%-10%), Herbaceous (10%-90%)

Vegetation Floristics: These plots are dominated by a canopy of *Quercus macrocarpa*. Canopy cover ranges from dense (80% cover) to fairly sparse (20% cover). Other mesic trees that may occupy the canopy include *Ulmus americana, Ostrya virginiana, Fraxinus pennsylvanica, Celtis occidentalis, Tilia americana,* and *Juglans nigra*. *Juniperus virginiana* may invade this type, but cover is usually less than 35%. If present, the shrub layer tends to be sparse; the cover is typically less than 20%. Common shrubs include *Zanthoxylum americanum* and *Prunus virginiana*. Herbaceous stratum can be either vigorous (~70% cover) or sparse (~20% cover) but is generally dominanted by graminoids. *Elymus virginicus* and *Piptatheropsis micrantha* are common graminoids and tend to dominate the plots when present.

Dynamics: N/A

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Conservation Status Rank

Global: G4

State (Nebraska): S2S3

Global Environmental Description

N/A

Global Vegetation Description

N/A

Nebraska Natural Heritage Program Description

The canopy of this community consists of moderate cover of *Quercus macrocarpa*, though scattered trees of *Fraxinus pennsylvanica*, *Acer negundo*, and *Ulmus* spp. are frequently present. Openings among the oak are frequently filled by *Juniperus virginiana*, and shrubs may be common where cedars are not as dense, with *Symphoricarpos occidentalis*, *Prunus virginiana*, and *Cornus drummondii* the common species. Remnant patches of *Prunus americana* and *Rhus glabra* are sometimes present where the canopy is more open. The herbaceous understory is often sparse where the subcanopy or shrub layers are dense. However, in sites where the woody understory is occasionally removed by fire or grazing herbaceous woodland plants dominate, along with shade-tolerant plants of prairie and woodland edges such as *Heliopsis helianthoides*. Species diversity is low to moderate.

Example Photograph

The photograph below shows an example of NPSNIOB013 Quercus macrocarpa / Juniperus virginiana / Elymus virginicus Forest.

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Quercus macrocarpa / *Juniperus virginiana* / *Elymus virginicus* Forest (CNHP)

Short Citation

N/A

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CEGL000555 Quercus macrocarpa / Ostrya virginiana Forest

The table below shows the USNVC Hierarchy for CEGL000555 Quercus macrocarpa / Ostrya virginiana Forest.

USNVC Hierarchy for CEGL000555 Quercus macrocarpa / Ostrya virginiana Forest

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.2 Cool Temperate Forest & Woodland
Division	1.B.2.Ne North American Great Plains Forest & Woodland
Macrogroup	1.B.2.Ne Great Plains Forest & Woodland
Group	1.B.2.Ne Great Plains Bur Oak Forest & Woodland
Alliance	A0245 Quercus macrocarpa Forest Alliance
Association	1.B.2.Ne *Quercus macrocarpa* / *Ostrya virginiana* Forest (CEGL000555)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC313

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2268.3 ft (range 2148 ft to 2443 ft)

Aspect: Mean 70.1˚ (range 0˚ to 296˚)

Slope: Mean 13.8˚ (range 0˚ to 39˚)

Macro Topography: Hillslope, Floodplain Upper Terrace

Geology: White River Group, Ogallala Formation

Soil Texture: Loamy Sand, Sand

Environment: These communities that occur on low slopes beside the river. Occasionally small streams may occur within these forests. Ground cover is dominated by litter with cover ranging from 34% to 85%. Wood is often present with cover <10%. Juniper removal may have created later piles of dead wood within these communities. Bare soil is often present with cover <5%. Basal area composes approximately 10% to 15% of the ground cover.

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Local Vegetation Description

Structure: Canopy (40%-70%), Subcanopy (0%-40%), Short Shrub (0%-20%), Dwarf Shrub (0%-30%), Herbaceous (30%-70%)

Vegetation Floristics: This community is dominated by *Quercus macrocarpa* with widely spaced *Ostrya virginiana* as a co-dominant. Other canopy associates include *Celtis occidentalis*, *Fraxinus pennsylvanica*, *Pinus ponderosa*, *Prunus virginiana*, and *Juniperus virginiana*. There is a sparse understory often times with lots of bare ground.

Dynamics: The riparian edges of some stands may experience periodic flooding. The upland portions of some stands may also be exposed to periodic fire (which may encourage oak regeneration).

Conservation Status Rank

Global: G2G3

State (Nebraska): N/A

Global Environmental Description

This community has been reported on gentle to moderately steep (14-47%) northerly slopes (Hoffman and Alexander 1987, Johnston 1987). Most occurrences are on upland slopes, but some are along streams and gullies. The soils are sandy loams and loams with pH of 5.8-7.4 (Johnston 1987). It has been found in the limestone and crystalline core (granitic) portions of the Black Hills.

Global Vegetation Description

This community is dominated by closely spaced small trees of *Quercus macrocarpa*. In some areas across the range of this type, *Fraxinus pennsylvanica* may be present. *Ostrya virginiana* is present in the tree subcanopy. The shrub layer may contain *Prunus virginiana* var. *virginiana*, *Ribes* spp., and *Symphoricarpos occidentalis*. The herbaceous layer is moderately diverse. Species include *Carex siccata* (= *Carex foenea*), *Carex saximontana, Carex sprengelii, Elymus virginicus, Mahonia repens, Maianthemum stellatum, Phlox gracilis* ssp. *gracilis, Thalictrum* spp., and *Woodsia* spp. In four stands sampled by Hoffman and Alexander (1987), the shrubs covered an average of 16%, graminoids 17%, and forbs 17%. The basal area in these stands was 26.6 m2/ ha. Invasive grass *Poa pratensis* is often found in the understory. Riparian sites are more floristically diverse and have a greater amount of vegetation cover (Hoffman and Alexander 1987).

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of CEGL000555 Quercus macrocarpa / Ostrya virginiana Forest.

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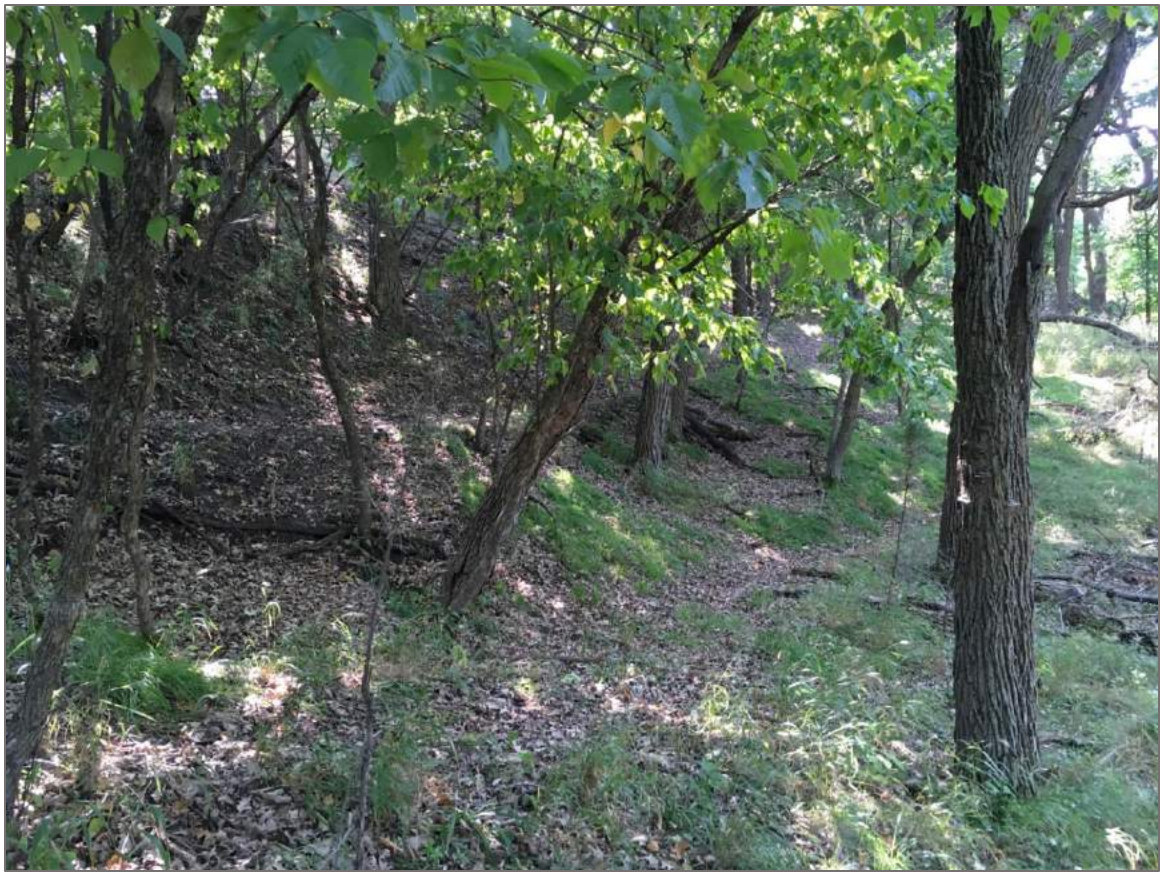

Quercus macrocarpa / *Ostrya virginiana* Forest (CNHP)

Short Citation

- Hoffman and Alexander 1987
- Johnston 1987

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CEGL002013 Betula papyrifera – (Tilia americana, Quercus macrocarpa) Canyon Forest

The table below shows the USNVC Hierarchy for CEGL002013 Betula papyrifera – (Tilia americana, Quercus macrocarpa) Canyon Forest.

USNVC Hierarchy for CEGL002013 Betula papyrifera – (Tilia americana, Quercus macrocarpa) Canyon Forest

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.2 Cool Temperate Forest & Woodland
Division	1.B.2.Ne North American Great Plains Forest & Woodland
Macrogroup	1.B.2.Ne Great Plains Forest & Woodland
Group	1.B.2.Ne Great Plains Mesic Forest & Woodland
Alliance	A3209 *Betula papyrifera - Populus tremuloides - Quercus macrocarpa* Forest Alliance
Association	1.B.2.Ne *Betula papyrifera* - (*Tilia americana*, *Quercus macrocarpa*) Canyon Forest (CEGL002013)

Field Plots: 0052, 0101, 1011, 0172, 3008, 0156, 3025

Map Class: NIOB MC314a

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2252.57 ft (range 1997 ft to 2402 ft)

Aspect: Mean 271.4˚ (range 0˚ to 352˚)

Slope: Mean 34.8˚ (range 18˚ to 45˚)

Macro Topography: Alluvial Terrace, Bluff, Cliff, Gully, Hills

Geology: Ogallala Group, White River Group

Soil Texture: Sand, Loamy Sand, Clay Loam

Environment: 7 sites were sampled within this type. Soil texture ranges from sandy clay loam to loamy sand. Litter ranges from 10% to 60%. Wood is usually present and ranges from 5% to 20%. Moss is usually present with cover values between 5% and 35%. Soil is sometimes saturated; one site had a stream running through it. All sites occurred along moderately steep slope ~43 degrees.

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Local Vegetation Description

Structure: Emergent (0%-10%), Canopy (20%-70%), Subcanopy (0%-70%), Tall Shrub (0%-20%), Dwarf Shrub (0%-30%), Herbaceous (0%-70%)

Vegetation Floristics: *Betula papyrifera* is a diagnostic species though not always dominant; cover values range between 10% and 50%. *Juniperus virginiana* is a codominant with similar cover values. Other trees that occupy the canopy stratum include *Acer negundo*, *Tilia americana, Ostrya virginiana,* and *Pinus ponderosa*. The herbaceous layer is not very abundant with cover values usually below 40%; graminoids typically have a greater abundance than forbs. Common species include *Eleocharis acicularis* and *Muhlenbergia racemosum*.

Dynamics: N/A

Conservation Status Rank

Global: G2?

State (Nebraska): S1

Global Environmental Description

This community occurs along steep springbranch canyons and adjacent river bluffs. Soils are deep, loamy, and poorly drained to well-drained. The parent material is eolian sand, alluvium, or Rosebud siltstone. Soils that occur near seeps may be highly saturated and have a dense layer of humus and leaf mold. Other than near seeps, the soils of this community are not saturated or flooded during the year (Steinauer and Rolfsmeier 2000).

Global Vegetation Description

This paper birch canyon forest is found in a restricted area along the Niobrara River in western Nebraska, United States. It occurs along steep springbranch canyons and on adjacent river bluffs. Soils are deep, loamy, and poorly drained to well-drained. The parent material is eolian sand, alluvium, or Rosebud siltstone. Soils that occur near seeps may be highly saturated and have a dense layer of humus and leaf mold. Other than near seeps, soils are not saturated or flooded during the year. This community is transitional between a forest and a woodland. The overstory is dominated by a mixture of deciduous and coniferous trees, such as *Betula papyrifera, Fraxinus pennsylvanica, Juniperus virginiana, Pinus ponderosa, Quercus macrocarpa,* and *Tilia americana*. The trees are moderately tall with a dense canopy. They tend to be more forest-like near the bases of canyons and river bluffs. On upper slopes, trees are shorter with a more open canopy and the physiognomy is more like a woodland. The shrub layer is relatively sparse except near the edges of stands and where the canopy is open. A short-shrub layer of *Toxicodendron rydbergii* is often abundant. The herbaceous layer is sparse to well-developed, and is usually dominated by graminoids, primarily *Carex eburnea, Carex sprengelii, Elymus virginicus, Elymus villosus, Festuca subverticillata,* and *Piptatherum micranthum* (= *Oryzopsis micrantha*). Along springs and seeps, a dense layer of moss and fungi is present. The species composition is a mixture of species from the western montane, eastern deciduous, and northern boreal forests.

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Nebraska Natural Heritage Program Description

Paper Birch Springbranch Canyon Forest: The dominant overstory trees in this community are *Betula papyrifera*, which occurs in areas where its roots are continuously in contact with the water table, and *Tilia americana*, which occurs on adjacent low slopes. *Ostrya virginiana* is the dominant understory tree, with *Fraxinus pennsylvanica* and *Juniperus virginiana* present, but less common. Shrubs are sparse, though a short shrub layer of *Toxicodendron rydbergii* may be abundant. The herbaceous understory is likewise often sparse, with the slopes dominated by woodland sedges and grasses typical of the surrounding forest communities. Mesophytic forbs are often common on the lower slopes, including *Laportea candensis* and *Heracleum montanum*. Two species diagnostic of this community are *Aralia nudicaulis* and *Moehringia lateriflora*, both of which may be abundant. In the canyon bottoms, mosses, liverworts, and herbaceous perennials typical of the spring seep/stream community are common. Species diversity is relatively high.

Example Photograph

The photograph below shows an example of CEGL002013 Betula papyrifera – (Tilia americana, Quercus macrocarpa) Canyon Forest.

Betula papyrifera – (*Tilia americana*, *Quercus macrocarpa*) Canyon Forest (CNHP)

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Short Citation

- Steinauer and Rolfsmeier 2000

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CEGL002012 Tilia americana – (Quercus macrocarpa) / Ostrya virginiana Forest

The table below shows the USNVC Hierarchy for CEGL002012 Tilia americana – (Quercus macrocarpa) / Ostrya virginiana Forest.

USNVC Hierarchy for CEGL002012 Tilia americana – (Quercus macrocarpa) / Ostrya virginiana Forest

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.2 Cool Temperate Forest & Woodland
Division	1.B.2.Na Eastern North American Forest & Woodland
Macrogroup	1.B.2.Na Central Midwest Mesic Forest
Group	1.B.2.Na North-Central Beech - Maple - Basswood Forest
Alliance	A0220 *Acer saccharum - Tilia americana - Quercus rubra* Forest Alliance
Association	1.B.2.Na *Tilia americana* - (*Quercus macrocarpa*) / *Ostrya virginiana* Forest (CEGL002012)

Field Plots: 0046, 0048, 0078, 0179, 1012, 3032

Map Class: NIOB MC314b

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2176.5 ft (range 2107 ft to 2248 ft)

Aspect: Mean 132.2˚ (range 20˚ to 329˚)

Slope: Mean 23.33˚ (range 8˚ to 39˚)

Macro Topography: Alluvial Terrace, Bluff

Geology: Pierre Shale, White River Group

Soil Texture: Loamy Sand, Sandy Loam

Environment: 6 sites were sampled within this type. Loamy sand is the dominant soil texture though sandy loam occurs in this type as well. Litter is usually the dominant ground cover ranging from 30% to 70%. Wood ground cover ranges from 6% to 30% with most plots having values ~10%. Typically these occur along moderate slopes ranging between 20 degrees and 39 degrees on either the mid or low slope.

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Local Vegetation Description

Structure: Canopy (50%-80%), Subcanopy (0%-30%), Tall Shrub (0%-20%), Short Shrub (0%-20%), Herbaceous (30%-80%)

Vegetation Floristics: *Tilia americana* is the dominant tree with cover ranging from 50% to 80%, and occasionally codominantes with *Quercus macrocarpa*. *Ostrya virginiana* and *Juniperus virginiana* commonly occur in the subcanopy with cover between 20% and 30%. The herbaceous layer is abundant with total cover between 50% and 80%. Graminoids usually occur in greater abundance than forbs, and common herbaceous plants include *Carex* spp., *Elymus canadensis,* and *Galium aparine*.

Dynamics: N/A

Conservation Status Rank

Global: G3

State (Nebraska): S2S3

Global Environmental Description

This community occurs on the bluffs of streams and rivers and on the adjacent uplands. Soils are well-drained loams. They are moderately acidic and generally fertile because of the high nutrient content of *Tilia* leaves. The parent material is primarily loess. The soils are not flooded or saturated during the year (MNNHP 1993, Steinauer and Rolfsmeier 2000).

Global Vegetation Description

This basswood - bur oak forest type is found in the western tallgrass region of the midwestern United States. Stands occur on bluffs and adjacent level uplands near rivers and streams. The soils are generally fertile, well-drained loams. The parent material is primarily loess. The soils are not saturated or flooded at any time during the year. The overstory is dominated by *Quercus macrocarpa* and *Tilia americana*. Other species found in the tree layer include *Celtis occidentalis, Ostrya virginiana,* and *Ulmus americana*. The shrub and herbaceous strata are well-developed. Common species in the shrub layer include *Zanthoxylum americanum*. The herbaceous layer typically contains species such as *Caulophyllum thalictroides, Phlox divaricata, Podophyllum peltatum, Maianthemum stellatum,* and *Urtica dioica*. Shrubs are often most abundant near the tops of bluffs where the trees are not as closely spaced.

Nebraska Natural Heritage Program Description

Bur Oak – Basswood – Ironwood Forest: The overstory of this community is generally dominated by *Quercus macrocarpa*, with *Tilia americana* frequent to common in places. Other common canopy trees include *Fraxinus pennsylvanica* and *Celtis occidentalis*. *Ostrya virginiana* is common in the subcanopy, with scattered *Morus rubra* and *Ulmus thomasii* in more protected sites, and *Juniperus virginiana* often common on drier slopes. Shrubs and vines are scattered and uncommon, with *Prunus virginiana* and *Ribes missouriense* the most frequently encountered. The herbaceous layer

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varies from sparsely to moderately vegetated, with *Carex sprengellii* often abundant and with numerous other herbaceous plants variously common, including *Hydrophyllum virginianum*, *Galium aparine*, *Sanicula canadensis* and *Osmorhiza longistylis*. Species diversity is moderate to relatively high.

Example Photograph

The photograph below shows an example of CEGL002012 Tilia americana – (Quercus macrocarpa) / Ostrya virginiana Forest.

Tilia americana – (*Quercus macrocarpa*) / *Ostrya virginiana* Forest (CNHP)

Short Citation

- MNNHP 1993
- Steinauer and Rolfsmeier 2000

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NPSNIOB003 Quercus macrocarpa / Juniperus virginiana Ruderal Forest

USNVC: Park Special NPSNIOB003

Field Plots: 0013, 0065, 0104, 0105, 0131, 0148, 0187

Map Class: NIOB MC315

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2123.71 ft Range 1837 ft to 2436 ft

Aspect: Mean 155.29˚ Range Flat to 330˚

Slope: Mean 9.29˚ Range Flat to 40˚

Macro Topography: Alluvial Flat (1), Alluvial Terrace (2), Bluff (1), Dell (1), Gully (2)

Geology: Ogallala Group (1), Pierre Shale (2), White River Group (4)

Soil Texture: Sand (1), Loamy Sand (1), Sandy Loam (2), Clay Loam (2), Loam (1)

Environment: 7 sites were sampled within this type. This is an upland community type that occurs on river terraces or on gentle slopes. The gentle slopes range between 5˚-10˚ degrees with one plot occuring in a steep gully with a slope of 40˚. Litter is the dominant ground cover with values typically ranging from 50% to 70%. Wood is typically present and may cover up to 20% of the plot. Bare soil is sometimes present, but it does not cover more than 10% of the plot.

Local Vegetation Description

Structure: Canopy (20%-80%), Tall Shrub (0%-40%), Herbaceous (10%-50%)

Vegetation Floristics: *Quercus macrocarpa* comprises the majority of the canopy typically ranging from 50% to 80%, but some sites have values as low at 20% cover. *Juniperus virginiana* invades these sites either in the canopy or tall shrub stratum. When present, *Juniperus virginiana* usually has covers above 40%. Other trees that occur in the canopy are *Juglans nigra, Celtis occidentalis, Ostrya virginiana,* and *Fraxinus pennsylvanica*. The herbaceous layer can range from moderate cover (~50% cover) to sparse (~10% cover), but graminoids have a greater abundance than forbs. Common graminoids include *Elymus virginicus* and *Carex* spp.

Dynamics: N/A

Conservation Status Rank

Global: N/A

State (Nebraska): S3

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Global Environmental Description

N/A

Global Vegetation Description

N/A

Nebraska Natural Heritage Program Description

Dry Upland Bur Oak Woodland: The canopy of this community consists of moderate cover of *Quercus macrocarpa*, though scattered trees of *Fraxinus pennsylvanica*, *Acer negundo* and *Ulmus* spp. are frequently present. Openings among the oak are frequently filled by eastern redcedar, and shrubs may be common where cedars are not as dense, with *Symphoricarpos occidentalis*, *Prunus virginiana*, and *Cornus drummondii* the common species. Remnant patches of *Prunus americana* and *Rhus glabra* are sometimes present where the canopy is more open. The herbaceous understory is often sparse where the subcanopy or shrub layers are dense. However, in sites where the woody understory is occasionally removed by fire or grazing herbaceous woodland plants dominate, along with shade-tolerant plants of prairie and woodland edges such as *Heliopsis helianthoides*. Species diversity is low to moderate.

Example Photograph

The photograph below shows an example of NPSNIOB003 Quercus macrocarpa / Juniperus virginiana Ruderal Forest.

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Quercus macrocarpa / *Juniperus virginiana* Ruderal Forest (CNHP)

Short Citation

N/A

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NPSNIOB006 Quercus macrocarpa – Populus x smithii Relict Woodland

USNVC: Park Special NPSNIOB006

Field Plots: 0129, 0125, 0127, 0126, 0128

Map Class: NIOB MC316

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2354.8 ft (range 2287 ft to 2405 ft)

Aspect: Mean 79.6˚ (range Flat to 340˚)

Slope: Mean 24.8˚ (range Flat to 38˚)

Macro Topography: Alluvial Flat, Alluvial Terrace, Bluff, Hills

Geology: Ogallala Group

Soil Texture: Loamy Sand, Sandy Loam, Clay Loam

Environment: 5 sites were sampled within this type. Soil texture ranges from sandy clay loam to loamy sand. Ground cover is dominanted by litter ~60% cover. Wood is usually between 15% and 25%. All of these sites occurred along moderate slopes between 24 degrees and 38 degrees. The slopes generally are north facing with one site facing the northeast.

Local Vegetation Description

Structure: Canopy (30%-50%), Subcanopy (0%-10%), Dwarf Shrub (0%-10%), Herbaceous (70%-90%)

Vegetation Floristics: All of these plots contain Populus x *smithii*. This aspen is mostly likey a hybrid of quacking aspen (*Populus grandidentata*) and big tooth aspen (*Populus tremuloides*). These represent relict aspen stands from the Pleistocene. The canopy is mainly composed of *Populus* x *smithii* but they are in a clearing; other trees have been mechanically removed especially *Juniperus virginiana*. In the plots, there are large piles of *Juniperus virginiana*. Main trees encroaching on these clearings include *Quercus macrocarpa* and *Juniperus virginiana*. Since this area is very open, there is an abundant herbaceous stratum with cover ~70%. Every plot is mainly composed of *Elymus canadensis* and *Poa pratensis*.

Dynamics: N/A

Conservation Status Rank

Global: N/A

State (Nebraska): N/A

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Global Environmental Description

N/A

Global Vegetation Description

N/A

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of NPSNIOB006 Quercus macrocarpa – Populus x smithii Relict Woodland.

Quercus macrocarpa – Populus x *smithii* Relict Woodland (CNHP)

Short Citation

N/A

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CEGL002052 Quercus macrocarpa / Andropogon gerardii – Panicum virgatum Woodland

The table below shows the USNVC Hierarchy for CEGL002052 Quercus macrocarpa / Andropogon gerardii – Panicum virgatum Woodland.

USNVC Hierarchy for CEGL002052 Quercus macrocarpa / Andropogon gerardii – Panicum virgatum Woodland

Category	Description
Class	1 Forest & Woodland
Subclass	1.B Temperate & Boreal Forest & Woodland
Formation	1.B.2 Cool Temperate Forest & Woodland
Division	1.B.2.Ne North American Great Plains Forest & Woodland
Macrogroup	1.B.2.Ne Great Plains Forest & Woodland
Group	1.B.2.Ne Great Plains Bur Oak Forest & Woodland
Alliance	A0620 *Quercus macrocarpa* / *Corylus* spp. / Mixedgrass Woodland Alliance
Association	1.B.2.Ne *Quercus macrocarpa* / *Andropogon gerardii - Panicum virgatum* Woodland (CEGL002052)

Field Plots: 0170

Map Class: NIOB MC317

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: 2273 ft

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Flat

Geology: White River Group

Soil Texture: Loamy Sand

Environment: 1 site was sampled within this type. This occurred on loamy sand with 70% litter, 10% wood, 5% bare soil, and 15% basal area. This site was located along a thin oak forest surrounded by a ruderal grassland in a cow pasture.

Local Vegetation Description

Structure: Canopy (60%), Herbaceous (70%)

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Vegetation Floristics: *Quercus macrocarpa* forms a woodland canopy with cover <60%. Other common canopy associates include *Carya illinoinensis, Celtis occidentalis, Fraxinus pennsylvanica, Junglans nigra,* and *Ulmus* spp. There is not a distinct shrub layer. The herbaceous cover is 70% and contains species such as *Poa pratensis*, *Elymus virginicus*, *Andropogon gerardii,* and *Panicum virgatum*.

Dynamics: This community was historically dominated by tall, fire-resistant *Quercus macrocarpa* (Abrams 1986). In the absence of fire, there has been a marked shift to codominance by more fire-tolerant hardwoods (Abrams 1986).

Conservation Status Rank

Global: G1G2

State (Nebraska): S1

Global Environmental Description

This community occurs in river valleys, on nearly level to gently sloping soils. Soils are deep, fertile and relatively mesic. They usually have a significant silt component. Drought is common in this community but the sheltered position in the valleys and the presence of a watercourse somewhat ameliorate the effects (Lauver et al. 1999, Steinauer and Rolfsmeier 2000).

Global Vegetation Description

The overstory of this community is dominated by short to moderately tall fire-resistant, deciduous trees. In Nebraska, the typical overstory was historically dominated by *Quercus macrocarpa*. Currently, in the absence of fire, typical associates include *Carya illinoinensis, Celtis occidentalis, Fraxinus pennsylvanica, Juglans nigra, Juniperus virginiana, Quercus macrocarpa,* and *Ulmus* spp. There is often a short-shrub layer, but it is rarely extensive. *Symphoricarpos orbiculatus* and small trees make up this layer. The understory is composed of a mixture of woodland and grassland species, including *Andropogon gerardii, Panicum virgatum,* and *Spartina pectinata* (Lauver et al. 1999, Steinauer and Rolfsmeier 2000).

Nebraska Natural Heritage Program Description

Mesic Bur Oak Forest and Woodland: The canopy of sites is commonly dominated by *Celtis occidentalis* and *Quercus macrocarpa* in nearly equal proportion, or by a canopy of *Quercus macrocarpa* with a conspicuous tall subcanopy of *Celtis occidentalis*. Scattered large *Gleditsia triacanthos*, *Juglans nigra*, or *Populus deltoides* are sometimes also present. The subcanopy is variable and is either overwhelmingly dominated by tall *Celtis occidentalis* or more frequently a shorter layer of *Ulmus americana* and *Ulmus rubra*. *Carya cordiformis*, *Morus rubra* or *Tilia americana* may be present in richer sites. Other trees sometimes present include *Acer saccharinum* and *Aesculus glabra*. The shrub layer is often sparse or nearly absent, usually represented by scattered *Symphoricarpos orbiculata* and lesser amounts of *Ribes missouriense*. The herb layer is fairly dense and consists of forest graminoids such as sedges, *Festuca subverticillata*, and *Elymus virginicus* with annuals in disturbed openings, such as *Galium aparine*, *Hydrolea quadrivalvis* and

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Anthriscus sylvestris. *Erythronium albidum* and *Dicentra cucullaria* are sometimes present, but are never as common as in Dry-Mesic Bur Oak Forest and Woodland. *Parthenocissus quinquefolia* often covers the forest floor early in the season, but is overtaken by tall coarse perennials including *Laportea canadensis*, *Verbesina alternifolia*, *Persicaria virginiana* and *Urtica gracilis* as the season progresses. Species diversity is moderate to high.

Example Photoraph

The photograph below shows an example of CEGL002052 Quercus macrocarpa / Andropogon gerardii – Panicum virgatum Woodland.

Quercus macrocarpa / *Andropogon gerardii – Panicum virgatum* Woodland (CNHP)

Short Citation

- Abrams 1986
- Lauver et al. 1999
- Steinauer and Rolfsmeier 2000

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Mapped Shrubland Types

CEGL005282 Salix interior / Pascopyrum smithii – Equisetum hyemale Wet Shrubland

The table below shows the USNVC Hierarchy for CEGL005282 Salix interior / Pascopyrum smithii – Equisetum hyemale Wet Shrubland.

USNVC Hierarchy for CEGL005282 Salix interior / Pascopyrum smithii – Equisetum hyemale Wet Shrubland

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.C Shrub & Herb Wetland
Formation	2.C.4 Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland
Division	2.C.4.Nd Eastern North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland
Macrogroup	2.C.4.Nd Great Plains Marsh, Wet Meadow, Shrubland & Playa
Group	2.C.4.Nd Great Plains Riparian Wet Meadow & Shrubland
Alliance	A3589 *Salix interior* Wet Shrubland Alliance
Association	2.C.4.Nd *Salix interior* / *Pascopyrum smithii - Equisetum hyemale* Wet Shrubland (CEGL005282)

Field Plots: 0086, 0146, 0167, 0191, 0192, 1006, 1008, 1050, 0099, 0185

Map Class: NIOB MC201

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2031.5 ft (range 1659 ft to 2395 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Flat, Alluvial Terrace, Floodplain

Geology: Pierre Shale, White River Group

Soil Texture: Sand, Loamy Sand, Sandy Loam

Environment: 10 sites were sampled within this type. These all occurred along low floodplains next to the river. The ground cover values range between 35% and 80%; however, most values lie around 65%. Sand is occasionally present with cover values ranging from 10% to 20%. Basal area ranges from 15% to 45%.

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Local Vegetation Description

Structure: Canopy (0%-30%), Subcanopy (0%-20%), Tall Shrub (0%-90%), Short Shrub (0%-80%), Dwarf Shrub (0%-40%), Herbaceous (70%-90%)

Vegetation Floristics: *Salix interior* and *Amorpha fruticosa* codominate this type; their cover values are generally around 40% and 60%. One plot was very dense and had shrub cover greater than 90%. The herbaceous layer is dominated by graminoids with cover between 30% and 80%. These vary from plot to plot and some of the species include *Elymus canadensis, Poa pratensis,* and *Muhlenbergia racemosa*. Forbs are also prevalent within this type; cover values range from 10% to 60%. *Solidago gigantea* or *Solidago canadensis* dominate the forb layer.

Dynamics: These require high water tables, and flooding, but generally do not experience scouring floods, which allows for the graminoid understory to develop.

Conservation Status Rank

Global: G5

State (Nebraska): S4S5

Global Environmental Description

This association is found in riparian channels, immediate streambanks, backwater channels, irrigation ditches, and other low wet areas that are not subject to frequent flooding scour.

Global Vegetation Description

This association is found in the central and northern Great Plains along rivers and streams. Soils are poorly developed or absent. The substrate is typically alluvial sand or gravel, though finer sediments can occur in places. Shrubs dominate. Depending on time since the last major disturbance (usually flooding), the shrubs can be short to tall (0-4 m). *Salix interior* is the dominant shrub but other shrubs or saplings are common, including *Salix amygdaloides*, *Salix nigra* (in the East), *Salix lutea*, *Salix eriocephala*, *Populus deltoides*, and *Cornus sericea*. The understory is usually moderate to lush but can be sparse if subject to a recent major flood. The herbaceous layer is typically dominated by mid and tall graminoids such as *Carex* spp., *Pascopyrum smithii, Panicum virgatum, Spartina pectinata,* and *Schoenoplectus* spp. (in wetter areas). Other common herbaceous species include *Equisetum hyemale, Xanthium strumarium, Polygonum* spp., and *Ambrosia artemisiifolia.*

Nebraska Natural Heritage Program Description

Sandbar Willow Shrubland: The vegetation of this community is dominated by shrubs and sapling trees 2–4 m tall with *Salix interior* the dominant species, sometimes with lesser amounts of *Salix bebbiana* and *Cornus sericea*. *Amorpha fruticosa* is often present, and may be somewhat common on mesic (rather than wet) ground. The understory is highly variable due to the early successional nature of the community and may consist of bare sand, annuals, or perennial hydrophytes. In wetter sites, perennial hydrophytes such as *Carex emoryi*, *Lycopus americanus* and *Eleocharis* spp. may be common. On slightly higher ground, *Spartina pectinata*, *Equisetum hyemale*, *Symphyotrichum*

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lanceolatum, *Phyla* spp., and *Solidago* spp. are present. In some mature mesic sites, a distinct canopy may develop and a mixture of herbaceous woodland plants and hydrophytes may occur. On the driest sites, plants typical of disturbed floodplain terraces, such *Ambrosia artemisiifolia* and *Bromus* spp. may be scattered. On some frequently inundated sites, scattered hydrophytic annuals may occur. Species diversity is low to moderate.

Example Photograph

The photograph below shows an example of CEGL005282 Salix interior / Pascopyrum smithii – Equisetum hyemale Wet Shrubland.

Salix interior / *Pascopyrum smithii – Equisetum hyemale* Wet Shrubland (CNHP)

Short Citation

N/A

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NPSNIOB001 Amorpha fruticosa / Solidago gigantea Wet Shrubland

USNVC: Park Special NPSNIOB001

Field Plots: 0141, 0144, 0181, 3028

Map Class: NIOB MC201

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2217.5 ft (range 1996 ft to 2390 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Flat, Floodplain

Geology: Pierre Shale, White River Group

Soil Texture: Sand, Loamy Sand, Sandy Loam, Clay Loam

Environment: 4 sites were sampled within this type. Soil texture is variable and ranges from sandy loam and sand. Litter composed 75% of the ground cover. These all occurred on the floodplain.

Local Vegetation Description

Structure: Short Shrub (10%-70%), Dwarf Shrub (0%-50%), Herbaceous (60%-80%)

Vegetation Floristics: *Amorpha fruticosa* forms a moderately dense short shrub stratum with cover typically ~60%. The herbaceous layer is tall and reaches the same height as the *Amorpha fruticosa*, and its cover generally reaches ~60%. The diversity is extremely low at these sites.

Dynamics: N/A

Conservation Status Rank

Global: N/A

State (Nebraska): N/A

Global Environmental Description

N/A

Global Vegetation Description

N/A

Nebraska Natural Heritage Program Description

N/A

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Example Photograph

The photograph below shows an example of NPSNIOB001 Amorpha fruticosa / Solidago gigantea Wet Shrubland.

Amorpha fruticosa / *Solidago gigantea* Wet Shrubland (CNHP)

Short Citation

N/A

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CEGL008562 Salix interior Wet Shrubland

The table below shows the USNVC Hierarchy for CEGL008562 Salix interior Wet Shrubland.

USNVC Hierarchy for CEGL008562 Salix interior Wet Shrubland

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.C Shrub & Herb Wetland
Formation	2.C.4 Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland
Division	2.C.4.Nd Eastern North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland
Macrogroup	2.C.4.Nd Eastern North American Wet Shoreline Vegetation
Group	2.C.4.Nd Eastern North American Riverine Wetland Vegetation
Alliance	A3646 *Salix interior* Riverscour Shrubland Alliance
Association	2.C.4.Nd *Salix interior* Wet Shrubland (CEGL008562)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC201

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: 2134 ft

Aspect: Flat

Slope: Flat

Macro Topography: Floodplain Lower Terrace

Geology: White River Group, Ogallala Formation

Soil Texture: Loamy Sand

Environment: These communities typically occurred within the floodplain. Ground cover is dominated by litter with values reaching up to 80%. Basal area typically composes approximately 20% of the ground cover.

Local Vegetation Description

Structure: Short Shrub (40%), Herbaceous (80%)

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Vegetation Floristics: This type is an early successional stage of temporarily flooded vegetation next to a river. *Salix interior* dominates this community with the occasional *Amorpha fruticosa* and *Populus deltoides* seedlings. The herbaceous layer may include *Poa partensis, Solidago* spp., and *Verbena stricta*. There tends to be little diversity within this community and much of the ground cover is bare soil.

Dynamics: This type originates after flash floods that create new deposits or scour existing alluvial material. This community is a primary or early secondary community and requires floods to create new areas on which it can develop. Once established, this community may exist for only about 10-20 years before it is replaced by a later seral stage. But it is rare for this community to have such a long interval between flooding disturbance, as long as flooding occurs every 3-5 years, this community will persist.

Conservation Status Rank

Global: G4G5

State (Nebraska): S4S5

Global Environmental Description

This community is found on recently deposited or disturbed alluvial material. The parent material is alluvial sand, although silt, clay, or gravel may be present. Soil development is poor to absent.

Global Vegetation Description

This community is dominated by shrubs, generally between 2 and 4 m tall. The most abundant of these is *Salix interior*. Saplings of *Populus deltoides* or *Platanus occidentalis* are also frequently found in the shrub layer. This stratum can have moderate to high stem density in overall composition of the community. The species in the shrub layer do not form a closed canopy, this allows significant light to reach the ground layer. Patches are also frequently found where the shrub layer is absent. The herbaceous cover is sparse to moderate, but rarely exceeds 30%. Older stands and places with less competition from the shrubs may have greater herbaceous cover. The composition of the herbaceous layer can vary greatly; species that are often found in this community include *Polygonum lapathifolium, Eupatorium* spp., *Schoenoplectus americanus* (= *Scirpus americanus*), and *Xanthium strumarium*.

Nebraska Natural Heritage Program Description

Sandbar Willow Shrubland: The vegetation of this community is dominated by shrubs and sapling trees 2–4 m tall with *Salix interior* the dominant species, sometimes with lesser amounts of *Salix bebbiana* and *Cornus sericea*. *Amorpha fruticosa* is often present, and may be somewhat common on mesic (rather than wet) ground. The understory is highly variable due to the early successional nature of the community and may consist of bare sand, annuals, or perennial hydrophytes. In wetter sites, perennial hydrophytes such as *Carex emoryi*, *Lycopus americanus* and *Eleocharis* spp. may be common. On slightly higher ground, *Spartina pectinata*, *Equisetum hyemale*, *Symphyotrichum lanceolatum*, *Phyla* spp., and *Solidago* spp. are present. In some mature mesic sites, a distinct canopy

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may develop and a mixture of herbaceous woodland plants and hydrophytes may occur. On the driest sites, plants typical of disturbed floodplain terraces, such *Ambrosia artemisiifolia* and *Bromus* spp. may be scattered. On some frequently inundated sites, scattered hydrophytic annuals may occur. Species diversity is low to moderate.

Example Photograph

The photograph below shows an example of CEGL008562 Salix interior Wet Shrubland.

Salix interior Wet Shrubland (CNHP)

Short Citation

N/A

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NPSNIOB004 Rhus glabra Mixedgrass Shrubland

USNVC: Park Special NPSNIOB004

Field Plots: 0020, 0068, 0130, 0194, 3003, 3004, 0070

Map Class: NIOB MC202

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2067.57 ft (range 1864 ft to 2280 ft)

Aspect: Mean 171.86˚ (range 42˚ to 288˚)

Slope: Mean 10.83˚ (range 5˚ to 28˚)

Macro Topography: Bluff, Hills

Geology: Ogallala Group, Pierre Shale

Soil Texture: Sand, Loamy Sand, Sandy Loam, Silt Loam, Clay Loam

Environment: 7 sites were sampled within this type. Sites were usually dominated by litter with cover around 75%; however, litter cover in one site reached as low as 20%. Bare soil ranges from 2% to 15%. These sites usually occur on gentle slopes ranging ~5 degrees. Additionally, these all occurred in very disturbed cow pastures.

Local Vegetation Description

Structure: Tall Shrub (0%-20%), Short Shrub (20%-80%), Dwarf Shrub (0%-10%), Herbaceous (40%-90%)

Vegetation Floristics: *Rhus glabra* typically forms a moderate to dense cover in the stratum layer (30% to 80%). Graminoids typically have greater abundance than forbs, and *Poa pratensis* is the main grass among these sites; cover usually ranges from 60% to 80%. These sites seem to all be deteriorated types that have thrived after the 2012 fire and heavy disturbance from grazing.

Dynamics: N/A

Conservation Status Rank

Global: N/A

State (Nebraska): N/A

Global Environmental Description

N/A

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Global Vegetation Description

N/A

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of NPSNIOB004 Rhus glabra Mixedgrass Shrubland.

Rhus glabra Mixedgrass Shrubland (CNHP)

Short Citation

N/A

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CEGL005453 Prunus virginiana Great Plains Shrubland

The table below shows the USNVC Hierarchy for CEGL005453 Prunus virginiana Great Plains Shrubland.

USNVC Hierarchy for CEGL005453 Prunus virginiana Great Plains Shrubland

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.B Temperate & Boreal Grassland & Shrubland
Formation	2.B.2 Temperate Grassland & Shrubland
Division	2.B.2.Nb Central North American Grassland & Shrubland
Macrogroup	2.B.2.Nb Great Plains Mixedgrass & Fescue Prairie
Group	2.B.2.Nb Northern Great Plains Mesic Mixedgrass Prairie
Alliance	A4036 *Prunus virginiana - Symphoricarpos occidentalis - Amelanchier alnifolia* Great Plains Shrubland Alliance
Association	2.B.2.Nb *Prunus virginiana* Great Plains Shrubland (CEGL005453)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC203

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2246.13 ft (range 2120 ft to 2479 ft)

Aspect: Mean 166.25˚ (range 0˚ to 330˚)

Slope: Mean 5˚ (range 0˚ to 15˚)

Macro Topography: Hillslope

Geology: White River Group, Ogallala Formation

Soil Texture: Loamy Sand

Environment: These communities occur along gentle hills of lower floodplain terraces. Ground cover is dominated by litter with cover ranging from 79% to 85%. Wood is typically present with cover values <5%. Basal area composes approximately 20% of the ground cover.

Local Vegetation Description

Structure: Short Shrub (10%-70%), Dwarf Shrub (0%-40%), Herbaceous (70%-100%)

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Vegetation Floristics: This shrubland community occurs as small thickets, narrow bands, or irregular patches between large riparian areas and more upland communities. The shrub layer is dominated by *Prunus virginiana* and *Prunus americana* similar to CEGL005219; however, this community lacks *Cornus drummondii*. The herbaceous layer is dominated by graminoids and often by weedy species such as *Bromus inermis* and *Poa pratensis*. In less disturbed sites, herbaceous stratum may be dominated by a combination of *Hesperostipa comata*, *Schizachyrium scoparium*, *Andropogon gerardii*, and *Sorghastrum nutans*.

Dynamics: Some stands on slopes are the result of recent fire that killed the overlying canopy, converting *Pinus ponderosa* / *Prunus virginiana* Forest (CEGL000192) to this *Prunus virginiana* shrubland type. In Montana, *Prunus virginiana* communities may be grazing-induced successional stages of the *Fraxinus pennsylvanica / Prunus virginiana* community type (Hansen et al. 1995). Both *Prunus virginiana* and *Symphoricarpos occidentalis* are tolerant of fire and will usually sprout after fires and grow into even denser stands. Dense stands of *Prunus virginiana* may preclude use by livestock, while open stands may provide adequate grazing opportunities. However, if grazed for the entire season, the strongly rhizomatous *Rosa woodsii* and non-native grasses may become established (Hansen et al. 1988b, Manning and Padgett 1995).

Conservation Status Rank

Global: GNR

State (Nebraska): N/A

Global Environmental Description

This widespread small-patch shrubland often grows at the interface between larger riparian areas and the adjacent upland. It often occupies draws, ephemeral creeks in steep narrow-bottomed canyons, and shallow ravines.

Global Vegetation Description

Shrub cover ranges from 100% to more open stands of 30%. Shrub cover is generally greater in drainage bottoms and on lowermost slopes, and less on upper slopes. *Prunus virginiana* is usually the dominant shrub species, but *Prunus americana* and other shrubs may be solely present to codominant. Other shrubs include *Rhus trilobata*, *Salix exigua, Sambucus* spp., *Amorpha canescens, Ericameria nauseosa, Symphoricarpos occidentalis, Rosa woodsii,* and *Toxicodendron rydbergii*. In drainage bottoms, herbaceous cover is usually sparse, less than 10%. On slopes, the shrubs typically occur in some grassland type, and graminoid cover can be greater than 75%. Native herbaceous species are not well-described. Exotic species, such as *Bromus inermis, Cirsium arvense, Poa pratensis,* and *Bromus tectorum*, are common on disturbed sites.

Nebraska Natural Heritage Program Description

N/A

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Example Photograph

The photograph below shows an example of CEGL005453 Prunus virginiana Great Plains Shrubland.

Prunus virginiana Great Plains Shrubland (CNHP)

Short Citation

- Hansen et al. 1988b
- Hansen et al. 1995
- Manning and Padgett 1995

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CEGL005219 Cornus drummondii – (Rhus glabra, Prunus spp.) Shrubland

The table below shows the USNVC Hierarchy for CEGL005219 Cornus drummondii – (Rhus glabra, Prunus spp.) Shrubland.

USNVC Hierarchy for CEGL005219 Cornus drummondii – (Rhus glabra, Prunus spp.) Shrubland

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.B Temperate & Boreal Grassland & Shrubland
Formation	2.B.2 Temperate Grassland & Shrubland
Division	2.B.2.Nb Central North American Grassland & Shrubland
Macrogroup	2.B.2.Nb Central Lowlands Tallgrass Prairie
Group	2.B.2.Nb Central Tallgrass Prairie
Alliance	A4208 *Corylus americana - Malus ioensis - Ceanothus americanus* Central Shrubland Alliance
Association	2.B.2.Nb *Cornus drummondii* - (*Rhus glabra*, *Prunus* spp.) Shrubland (CEGL005219)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC203

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2150 ft (range 2100 ft to 2500 ft)

Aspect: Mean 103.33˚ (range 70˚ to 135˚)

Slope: Mean 7.67˚ (range 6˚ to 9˚)

Macro Topography: Hillslope

Geology: White River Group, Ogallala Formation, Pierre Shale

Soil Texture: Sandy Loam

Environment: This upland community typically occurs away from floodplain on hillslopes. Ground cover is dominated by litter with values ranging from 50% to 75%. A small amount of wood may be present with cover <5%.

Local Vegetation Description

Structure: Short Shrub (20%-30%), Dwarf Shrub (0%-10%), Herbaceous (20%-30%)

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Vegetation Floristics: This shrub community is dominated by *Cornus drummondii* and *Prunus americana/Prunus virginiana* shrubland. Other common shrubs include *Symphoricarpos occidentalis* and *Rhus glabra*. The herbaceous layer is typically dominated by graminoids. Common species are *Bromus inermis* and *Poa pratensis*. Less common graminoids include *Pascopyrum smithii, Hesperostipa comata, Schizachyrium scoparium, Andropogon gerardii,* and *Sorghastrum nutans*.

Dynamics: This type is probably both a natural and a semi-natural type. Many stands have originated through human disturbance, and it is probably best treated as a semi-natural type.

Conservation Status Rank

Global: GNR

State (Nebraska): N/A

Global Environmental Description

This community is found in the central Great Plains on level to moderate, well-drained slopes of uplands, usually along the borders of upland woods, but also in grassland ravines. Soils are silty loams formed in loess or glacial till.

Global Vegetation Description

The vegetation consists of bands or patches of shrubs 2-3 m tall. In the shrubland/oak woodland transition, woody tree species may also be present. *Rhus glabra* and *Cornus drummondii* are usually the dominant species, though in places *Corylus americana, Prunus americana, Prunus angustifolia, Symphoricarpos orbiculatus,* or *Rhus aromatica* may dominate. Where shrub cover is dense, vines such as *Celastrus scandens* and *Parthenocissus vitacea* may be present. Under the dense canopy, the herbaceous layer may be sparse, consisting of exotic species, such as *Poa pratensis* and *Nepeta cataria*. In open stands, the herbaceous layer is more dense and consists of species of tallgrass and mixedgrass prairie (Rosburg and Glenn-Lewin 1996, Hoagland 1998a, Steinauer and Rolfsmeier 2000). Rosburg and Glenn-Lewin (1996) describe both a shrub edge type, dominated by *Cornus drummondii* and *Symphoricarpos* sp., and a dogwood/elm woodland type, with *Ulmus rubra* and other woody tree species present. Those types are treated together here. Their shrub edge type contained a number of tallgrass species, including *Andropogon gerardii* and *Carex inops* ssp. *heliophila* (= *Carex heliophila*).

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of CEGL005219 Cornus drummondii – (Rhus glabra, Prunus spp.) Shrubland.

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Cornus drummondii – (*Rhus glabra*, *Prunus* spp.) Shrubland (CNHP)

Short Citation

- Hoagland 1998a
- Rosburg and Glenn-Lewin 1996
- Steinauer and Rolfsmeier 2000

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CEGL001131 Symphoricarpos occidentalis Shrubland

The table below shows the USNVC Hierarchy for CEGL001131 Symphoricarpos occidentalis Shrubland.

USNVC Hierarchy for CEGL001131 Symphoricarpos occidentalis Shrubland

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.B Temperate & Boreal Grassland & Shrubland
Formation	2.B.2 Temperate Grassland & Shrubland
Division	2.B.2.Nb Central North American Grassland & Shrubland
Macrogroup	2.B.2.Nb Great Plains Mixedgrass & Fescue Prairie
Group	2.B.2.Nb Northern Great Plains Mesic Mixedgrass Prairie
Alliance	A4036 *Prunus virginiana - Symphoricarpos occidentalis - Amelanchier alnifolia* Great Plains Shrubland Alliance
Association	2.B.2.Nb *Symphoricarpos occidentalis* Shrubland (CEGL001131)

Field Plots: 0071, 0076, 0123, 0124, 0190

Map Class: NIOB MC204

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2199.6 ft Range 2090 ft to 2419 ft

Aspect: Range Flat to 355˚

Slope: Range Flat to 8˚

Macro Topography: Alluvial Terrace, Bluff

Geology: Ogallala Group, White River Group

Soil Texture: Loamy Sand, Silt Loam

Environment: 5 sites were sampled within this type. Soil texture is usually loamy sand. Litter is the dominant ground cover and ranges from 60% to 84%. Bare soil is often present as well with cover to 20%. These sites occur on gentle slope to flat slopes (5-8 degrees) on terraces near the floodplain.

Local Vegetation Description

Structure: Canopy (0%-30%), Short Shrub (0%-70%), Dwarf Shrub (0%-30%), Herbaceous (40%-90%)

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Vegetation Floristics: *Symphoricarpos occidentalis* is the dominant species in the shrub stratum with cover ranging from 10% to 70%. *Poa pratensis* is typically the dominant graminoid in the herbaceous layer ranging from 10% to 50%. *Dichanthelium oligosanthes* also co-occurs with *Poa pratensis*. *Verbena stricta* is in the forb layer with cover between 10% and 20%.

Dynamics: Stands may occasionally be flooded (Jones and Walford 1995). *Symphoricarpos occidentalis* seems to thrive in disturbed areas (Hansen and Hoffman 1988), especially those subject to disturbance by fire and cattle grazing. These shrublands often have a significant component of exotic species, especially where grazing has been heavy. *Bromus inermis, Cirsium arvense,* and *Poa pratensis* are among the most abundant of these exotics. Overgrazing of prairies can lead to the expansion of degraded forms of this community.

Conservation Status Rank

Global: G4G5

State (Nebraska): S4

Global Environmental Description

This community is found on relatively deep soils in mesic swales, depressions, ravines and floodplains. Some examples of this community experience intermittent and brief flooding. In Glacier National Park, it occurs at 1022-1092 m (3350-3580 feet) elevation. The soils are fertile and well-drained to imperfectly drained silts and loams. The upper soil horizon is usually deep, although a thin layer of sand may be present if the site has been recently flooded (Jones and Walford 1995).

Global Vegetation Description

This western snowberry shrubland is found in the western tallgrass, northern Great Plains, and in the foothills of the northern Rocky Mountains of the United States and Canada. Stands occur in mesic depressions and swales, typically surrounded by upland grassland communities. The soils are silts and loams. This type has three distinct vegetation layers, a shrub layer (approximately 80 cm tall), a graminoid-dominated layer (approximately 30 cm tall), and a forb-dominated layer (<20 cm tall). *Symphoricarpos occidentalis* is the predominant species in the shrub layer and at times forms almost monospecific stands. *Rosa woodsii* commonly occurs interspersed with the *Symphoricarpos occidentalis*. Other shrubs, such as *Rhus trilobata* and *Prunus virginiana*, often occur as thickets on the fringe of this community. *Rhus trilobata* and *Prunus virginiana* can reach 2 m or more. The herbaceous layer is poorly represented where the shrubs are dense, although Poa pratensis occurs in many stands. Common forbs include *Artemisia ludoviciana, Solidago* spp., and *Achillea millefolium*. Vines, such as *Parthenocissus vitacea*, are often found climbing through the shrubs. This type is frequently observed in heavily grazed meadows and prairies.

Nebraska Natural Heritage Program Description

Buckbrush Shrubland: This community is usually densely vegetated by shrubs mostly under 1 m tall. Shrub cover is usually >50% and often may approach 100%. *Symphoricarpos occidentalis* is the most abundant species. *Prunus virginiana*, *Ribes aureum*, and *Rhus trilobata* are often scattered

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among the *Symphoricarpos occidentalis*, forming a sparse 1-2 m tall overstory. A short shrub understory of *Toxicodendron rydbergii* is often present and is sometimes the dominant ground cover. Woody and herbaceous vines are sometimes present, including *Clematis ligusticifolia* and *Parthenocissus vitacea*. The herbaceous layer is poorly developed in most sites and often consists of weedy aliens (*Bromus tectorum*, *Nepeta cataria*, *Poa pratensis*) and a few native annuals such as Pennsylvania pellitory. In more open sites, native grasses fill the spaces between shrubs, the most common species being *Bouteloua curtipendula*, *Calamovilfa longifolia*, *Pascopyrum smithii* and *Schizachyrium scoparium*. Species diversity is relatively low.

Example Photograph

The photograph below shows an example of CEGL001131 Symphoricarpos occidentalis Shrubland.

Symphoricarpos occidentalis Shrubland (CNHP)

Short Citation

- Hansen and Hoffman 1988
- Jones and Walford 1995

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CEGL002177 Artemisia filifolia / Calamovilfa longifolia Shrubland

The table below shows the USNVC Hierarchy for CEGL002177 Artemisia filifolia / Calamovilfa longifolia Shrubland.

USNVC Hierarchy for CEGL002177 Artemisia filifolia / Calamovilfa longifolia Shrubland

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.B Temperate & Boreal Grassland & Shrubland
Formation	2.B.2 Temperate Grassland & Shrubland
Division	2.B.2.Nb Central North American Grassland & Shrubland
Macrogroup	2.B.2.Nb Great Plains Sand Grassland & Shrubland
Group	2.B.2.Nb Great Plains Sand Shrubland
Alliance	A0816 *Artemisia filifolia* Great Plains Sand Prairie Scrub Alliance
Association	2.B.2.Nb *Artemisia filifolia* / *Calamovilfa longifolia* Shrubland (CEGL002177)

Field Plots: 0188

Map Class: NIOB MC205

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: 2089 ft

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Flat

Geology: Ogallala Group

Soil Texture: Sand

Environment: 1 site was sampled within this type. The plot occurred on sand. The ground cover mainly composed of sand (40%) and cryptogam (45%) with some small amount of litter (10%). This area seemed as though it was disturbed by cattle grazing in the area.

Local Vegetation Description

Structure: Dwarf Shrub (50%), Herbaceous (50%)

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Vegetation Floristics: The dwarf shrub layer is dominated by *Artemisia frigida* with a cover of 50%. The herbaceous layer is split fairly evenly between graminoids and forbs. Dominant graminoids include *Calamovilfa longifolia* (20%) and *Koeleria macrantha* (10%). Dominant forbs include *Heterotheca canescens* (20%) and *Chamaesyce missurica* (10%).

Dynamics: N/A

Conservation Status Rank

Global: G2G3

State (Nebraska): N/A

Global Environmental Description

Sand sagebrush shrublands are confined to the highest sand hills and ridges; this type forms a mosaic with yucca shrub grasslands (*Yucca glauca*) on some lower sand ridges and where sand hills/ridges adjoin butte tops (Von Loh et al. 1999).

Global Vegetation Description

Sand sagebrush communities within Badlands National Park have sparse to moderate cover, between 15-50%. Higher sandhills also have a large proportion of bare sand to vegetation between individual shrubs. The only shrub that becomes codominant with *Artemisia filifolia* is *Yucca glauca*, and it typically occurs on lower sand ridges and places where sandhills interface with nearly flat butte tops. Herbaceous cover is sparse to moderate, typically consisting of *Bouteloua gracilis, Calamovilfa longifolia, Sporobolus cryptandrus, Carex filifolia,* and *Andropogon hallii*. Some stands may contain *Schizachyrium scoparium* (Von Loh et al. 1999).

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of CEGL002177 Artemisia filifolia / Calamovilfa longifolia Shrubland.

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Artemisia filifolia / *Calamovilfa longifolia* Shrubland (CNHP)

Short Citation

- Von Loh et al. 1999

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Mapped Sparse Vegetation Types

CEGL002049 Riverine Sand Flats – Bars Sparse Vegetation

The table below shows the USNVC Hierarchy for CEGL002049 Riverine Sand Flats – Bars Sparse Vegetation.

USNVC Hierarchy for CEGL002049 Riverine Sand Flats – Bars Sparse Vegetation

Category	Description
Class	2 Shrub & Herb Vegetation
Subclass	2.C Shrub & Herb Wetland
Formation	2.C.4 Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland
Division	2.C.4.Nd Eastern North American Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland
Macrogroup	2.C.4.Nd Eastern North American Wet Shoreline Vegetation
Group	2.C.4.Nd Eastern North American Riverine Wetland Vegetation
Alliance	A3659 Eastern North American Sparsely Vegetated Rivershore Alliance
Association	2.C.4.Nd Riverine Sand Flats - Bars Sparse Vegetation (CEGL002049)

Field Plots: 1005, 3005, 3029, 3036

Map Class: NIOB MC401

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1942.75 ft Range 1647 ft to 2093 ft

Aspect: Flat

Slope: Flat

Macro Topography: Bar, Floodplain, Marsh

Geology: Pierre Shale, White River Group

Soil Texture: Sand

Environment: 4 sites were sampled within this type. Sand is the primary component of the ground cover typically covering up to ~60%. The soil texture is always sand though sometime with some organic material, and occur on bars along the river edge.

Local Vegetation Description

Structure: Herbaceous (10%-90%)

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Vegetation Floristics: Vegetation is usually sparse and only composed of an herbaceous stratum. Common species include *Cyperus* spp., *Eleocharis* sp., and *Bidens curnea*; individual cover values never reach more than 20%. Several plots were more established sand bars with greater cover values. These two plots have herbaceous cover greater than 70%.

Dynamics: This community can be very short-lived. For example, in Nebraska, it rarely persists for more than a single season before it is either destroyed by flooding or succeeds to other communities such as *Salix exigua* communities (Steinauer and Rolfsmeier 2000).

Conservation Status Rank

Global: G4G5

State (Nebraska): S5

Global Environmental Description

This community is a sparsely vegetated community that occurs along river shorelines, islands, pointbars, and flats. These sandbars form when receding floodwaters deposit sand and lesser amounts of clay, silt, gravel, and cobbles in the stream bed. Soils are often undeveloped due to the ephemeral nature of the stands. Drainage depends on depth above the water level (Nelson 1985, Steinauer and Rolfsmeier 2000).

Global Vegetation Description

This community ranges from the western Great Plains to the eastern parts of the midwestern United States and Canada. It is a sparsely vegetated community that occurs along river shorelines, islands, pointbars, and flats. These sandbars form when receding floodwaters deposit sand and lesser amounts of clay, silt, and cobbles in the stream bed. Soils are often undeveloped due to the ephemeral nature of the stands. Drainage depends on depth above the water level. Herbaceous species shared in Missouri and Nebraska include *Cyperus* spp. (*Cyperus erythrorhizos, Cyperus odoratus, Cyperus squarrosus*), *Eragrostis hypnoides, Eragrostis trichodes, Leptochloa fusca* ssp. *fascicularis* (= *Leptochloa fascicularis*), *Polygonum* spp. (including *Polygonum lapathifolium*), *Rorippa sinuata*, *Sporobolus cryptandrus*, and *Xanthium strumarium*.

Nebraska Natural Heritage Program Description

Sandbar/Mudflat: The vegetation is highly variable due to the ephemeral, successional nature of the community. Recently exposed sandbars are initially devoid of vegetation, but are soon colonized by opportunistic annual herbs and graminoids, usually under 0.5 m tall. Lower areas adjacent to the river channel are dominated by hydrophytic species, while higher areas of the sandbar are dominated by plants tolerant of the drier conditions present on the more rapidly drained soils. Species diversity is low to moderate.

Example Photograph

The photograph below shows an example of CEGL002049 Riverine Sand Flats – Bars Sparse Vegetation.

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Riverine Sand Flats – Bars Sparse Vegetation (CNHP)

Short Citation

- Nelson 1985
- Steinauer and Rolfsmeier 2000

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NPSNIOB011 Bare Alluvial Depositional Bar

USNVC: Park Special NPSNIOB011

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC401

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2095.5 ft (range 2094 ft to 2097 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Sandbar, Floodplain Lower Terrace

Geology: White River Group, Ogallala Formation, Pierre Shale

Soil Texture: Sand

Environment: This sparse community is almost entirely bare sand. Occasionally, these communities become inundated.

Local Vegetation Description

Structure: Herbaceous (0%-10%)

Vegetation Floristics: There is almost no vegetation present on these alluvial bars; if present, herbaceous vegetation is <1%. Alluvial bars in this type are constantly being reworked and recolonized. Substrate comprising this depositional bar can be sand, gravel, shale, or mud.

Dynamics: N/A

Conservation Status Rank

Global: N/A

State (Nebraska): N/A

Global Environmental Description

N/A

Global Vegetation Description

N/A

Nebraska Natural Heritage Program Description

N/A

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Example Photograph

The photograph below shows an example of NPSNIOB011 Bare Alluvial Depositional Bar.

Bare Alluvial Depositional Bar (CNHP)

Short Citation

N/A

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CEGL002294 Shale Barrens Slopes Sparse Vegetation

The table below shows the USNVC Hierarchy for CEGL002294 Shale Barrens Slopes Sparse Vegetation.

USNVC Hierarchy for CEGL002294 Shale Barrens Slopes Sparse Vegetation

Category	Description
Class	6 Open Rock Vegetation
Subclass	6.B Temperate & Boreal Open Rock Vegetation
Formation	6.B.1 Temperate & Boreal Cliff, Scree & Other Rock Vegetation
Division	6.B.1.Na Eastern North American Temperate & Boreal Cliff, Scree & Rock Vegetation
Macrogroup	6.B.1.Na Great Plains Cliff, Scree & Rock Vegetation
Group	6.B.1.Na Great Plains Cliff, Scree & Rock Vegetation
Alliance	A3982 Great Plains Acidic Rock Outcrop Alliance
Association	6.B.1.Na Shale Barren Slopes Sparse Vegetation (CEGL002294)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC402

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: 1926 ft

Aspect: Flat

Slope: Flat

Macro Topography: Cliff

Geology: Pierre Shale

Soil Texture: N/A

Environment: Ground cover is usually composed of small rocks (~30%) and bare soil (~70%).

Local Vegetation Description

Structure: Herbaceous (0%-10%)

Vegetation Floristics: This sparse vegetation type has total vegetation cover <10% and occurs on flat to moderate slopes of exposed Pierre, Carlile, and Granerous shale formations.

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Dynamics: Poor soils and natural erosion prevent the development of substantial vegetative cover.

Conservation Status Rank

Global: GNR

State (Nebraska): N/A

Global Environmental Description

Stands are reported on the Mowry Shale outcrops around the Black Hills and the Pierre Shale outcrops of central and western South Dakota. In the Black Hills, stands occur on sparsely vegetated exposures of the Cretaceous Mowry Formation, made up of siliceous shales, clays and bentonite. Slopes are flat to moderate and of variable aspect. Soils are poor, loose and easily eroded. The Mowry Formation occurs on the periphery of the Black Hills, at elevations ranging from 915 to 1300 m (3000-4250 feet) (Marriott and Faber-Langendoen 2000).

Global Vegetation Description

This is a sparse vegetation type with total vegetative cover usually less than 10%. No information is available as to species composition (Marriott and Faber-Langendoen 2000).

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of CEGL002294 Shale Barrens Slopes Sparse Vegetation.

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Shale Barrens Slopes Sparse Vegetation (CNHP)

Short Citation

- Marriott and Faber-Langendoen 2000

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CEGL002047 Siltstone – Sandstone Rock Outcrop Sparse Vegetation

The table below shows the USNVC Hierarchy for CEGL002047 Siltstone – Sandstone Rock Outcrop Sparse Vegetation.

USNVC Hierarchy for CEGL002047 Siltstone – Sandstone Rock Outcrop Sparse Vegetation

Category	Description
Class	6 Open Rock Vegetation
Subclass	6.B Temperate & Boreal Open Rock Vegetation
Formation	6.B.1 Temperate & Boreal Cliff, Scree & Other Rock Vegetation
Division	6.B.1.Na Eastern North American Temperate & Boreal Cliff, Scree & Rock Vegetation
Macrogroup	6.B.1.Na Great Plains Cliff, Scree & Rock Vegetation
Group	6.B.1.Na Great Plains Cliff, Scree & Rock Vegetation
Alliance	A3982 Great Plains Acidic Rock Outcrop Alliance
Association	6.B.1.Na Siltstone - Sandstone Rock Outcrop Sparse Vegetation (CEGL002047)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC402

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: 1957 ft

Aspect: 283˚

Slope: 53˚

Macro Topography: Cliff

Geology: White River Group, Ogallala Formation, Pierre Shale

Soil Texture: N/A

Environment: These communities generally occur on steep slopes and ground cover is dominated by exposed outcrops (80%). Litter usually forms a minor component of the ground cover (20%).

Local Vegetation Description

Structure: Herbaceous (0%-10%)

Vegetation Floristics: This sparsely vegetated community is found on flat to moderately steep slopes (<60%) on eroded sandstone and siltstone escarpments, ravines, and ridgecrests. Vegetation tends to

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be sparse with a mixture of short shrubs such as *Rhus trilobata* and forbs such as *Eriogonum pauciflorum*. When a shallow layer of soil is present, some grasses (*Bouteloua gracilis, Elymus* sp.) may develop.

Dynamics: N/A

Conservation Status Rank

Global: G4

State (Nebraska): S4

Global Environmental Description

Stands occur on nearly level to moderately steep slopes (less than 60% grade) on irregularly eroded sandstone and siltstone escarpments, ravines, and ridgecrests. Soils are poorly developed to absent, and consist of very shallow sandy loams or silty loams (Steinauer and Rolfsmeier 2000).

Global Vegetation Description

The vegetation is sparse, with a mixture of short shrubs (<1 m tall) and mid and short grasses and forbs. In Nebraska, the short shrubs include widely scattered individuals of *Rhus trilobata*, though *Ericameria parryi* var. *howardii* (= *Chrysothamnus parryi* ssp. *howardii*) or *Cercocarpus montanus* are common in some stands. Forbs are usually more abundant than grasses in sites where soil development is minimal. *Eriogonum pauciflorum* and *Phlox hoodii* are among the more abundant. Where a shallow layer of soil has developed, grasses include *Bouteloua gracilis* and *Elymus lanceolatus*. Other species present can include *Arenaria hookeri, Astragalus laxmannii* var. *robustior, Astragalus spatulatus, Bouteloua curtipendula, Cryptantha cana, Gutierrezia sarothrae, Mentzelia decapetala, Muhlenbergia cuspidata, Muhlenbergia pungens, Paronychia depressa, Psoralidium lanceolatum,* and *Tetraneuris acaulis* (Steinauer and Rolfsmeier 2000).

Nebraska Natural Heritage Program Description

Rock Outcrop: This community is sparsely to moderately vegetated by a mixture of short shrubs (<1 m tall), mid and short grasses, and forbs. The shrub component frequently consists of widely scattered individuals of *Rhus trilobata*, though *Ericameria parryi* var. *howardii* is common in the Wildcat Hills and *Cercocarpus montanus* is present in some sites. Herbaceous perennials are usually more abundant than grasses in sites with little or no soil development. *Arenaria hookeri*, and *Phlox hoodii* are among the most abundant. Where a shallow layer of soil has developed, grasses are usually more abundant, with *Bouteloua gracilis* and *Elymus lanceolatus* among the more common species. Inclusions of Western Mixed-grass Prairie may be present in this community where the soil is slightly deeper. Species diversity in this community varies from relatively low to relatively high.

Example Photograph

The photograph below shows an example of CEGL002047 Siltstone – Sandstone Rock Outcrop Sparse Vegetation.

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Siltstone – Sandstone Rock Outcrop Sparse Vegetation (CNHP)

Short Citation

- Steinauer and Rolfsmeier 2000

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CEGL002046 Limestone – Dolostone Great Plains Xeric Cliff Sparse Vegetation

The table below shows the USNVC Hierarchy for CEGL002046 Limestone – Dolostone Great Plains Xeric Cliff Sparse Vegetation.

USNVC Hierarchy for CEGL002046 Limestone – Dolostone Great Plains Xeric Cliff Sparse Vegetation

Category	Description
Class	6 Open Rock Vegetation
Subclass	6.B Temperate & Boreal Open Rock Vegetation
Formation	6.B.1 Temperate & Boreal Cliff, Scree & Other Rock Vegetation
Division	6.B.1.Na Eastern North American Temperate & Boreal Cliff, Scree & Rock Vegetation
Macrogroup	6.B.1.Na Great Plains Cliff, Scree & Rock Vegetation
Group	6.B.1.Na Great Plains Cliff, Scree & Rock Vegetation
Alliance	A3980 Great Plains Alkaline Cliff Alliance
Association	6.B.1.Na Limestone - Dolostone Great Plains Xeric Cliff Sparse Vegetation (CEGL002046)

Field Plots: Field Reconnaisance Observations

Map Class: NIOB MC402

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2100 ft (range 2000 ft to 2200 ft)

Aspect: Mean 124˚ (range 12˚ to 344˚)

Slope: Mean 62˚ (range 40˚ to 90˚)

Macro Topography: Cliff

Geology: White River Group, Ogallala Formation, Pierre Shale

Soil Texture: N/A

Environment: These communities form steep bluffs along the Niobrara River. Ground cover is dominated by small rock (limestone) with cover typicaly reaching 50%. At the base of the bluff there is generally litter with cover ~45%.

Local Vegetation Description

Structure: Herbaceous (0%-10%)

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Vegetation Floristics: These exposures of Niobrara Chalk form large steep cliffs along the Missouri River.

Dynamics: N/A

Conservation Status Rank

Global: GNR

State (Nebraska): S5

Global Environmental Description

There are exposures of Niobrara Chalk along the Missouri River at the South Dakota - Nebraska border. There are numerous exposures along Lewis & Clark Lake, most of them located in Nebraska (D. Ode pers. comm. 2000).

Global Vegetation Description

No information is available on the vegetation of these cliffs.

Nebraska Natural Heritage Program Description

Northern Chalk Bluff and Cliff: Vegetation in this community is sparse, and the steeper (cliff) sites are unvegetated, or may contain scattered plants of *Mentzelia decapetala* in addition to lichens. In northwestern Nebraska, this community occurs on eroded slopes, ridge tops, and gullies. The most common species present include *Rosa arkansana*, *Prunus pumila*, *Mentzelia decapetala*, *Physaria arenosa* var. *argillosa*, *Cryptantha celosioides*, *Gutierrezia sarothrae*, *Schizachyrium scoparium*, *Oryzopsis hymenoides*, and *Rhus trilobata*. *Stanleya pinnata* is common and conspicuous in this area, but rare to absent elsewhere in the state. Species diversity of cliffs is extremely low, and the diverisy of the northwestern Nebraska bluffs is low to moderate.

Example Photograph

The photograph below shows an example of CEGL002046 Limestone – Dolostone Great Plains Xeric Cliff Sparse Vegetation.

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Limestone – Dolostone Great Plains Xeric Cliff Sparse Vegetation (CNHP)

Short Citation

- D. Ode pers comm. 2000

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CEGL005257 Sandstone Great Plains Dry Cliff Sparse Vegetation

The table below shows the USNVC Hierarchy for CEGL005257 Sandstone Great Plains Dry Cliff Sparse Vegetation.

USNVC Hierarchy for CEGL005257 Sandstone Great Plains Dry Cliff Sparse Vegetation

Category	Description
Class	6 Open Rock Vegetation
Subclass	6.B Temperate & Boreal Open Rock Vegetation
Formation	6.B.1 Temperate & Boreal Cliff, Scree & Other Rock Vegetation
Division	6.B.1.Na Eastern North American Temperate & Boreal Cliff, Scree & Rock Vegetation
Macrogroup	6.B.1.Na Great Plains Cliff, Scree & Rock Vegetation
Group	6.B.1.Na Great Plains Cliff, Scree & Rock Vegetation
Alliance	A3981 Great Plains Acidic Cliff Alliance
Association	6.B.1.Na Sandstone Great Plains Dry Cliff Sparse Vegetation (CEGL005257)

Field Plots: 0025, 0044, 0080, 0083, 3001

Map Class: NIOB MC402

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 2326.8 ft Range 2163 ft to 2436 ft

Aspect: Mean 142˚ Range 0˚ to 330˚

Slope: Mean 54.4˚ Range 5˚ to 80˚

Macro Topography: Badlands, Bluff, Cliff

Geology: Ogallala Group, White River Group

Soil Texture: Sand, Silt

Environment: 5 sites were sampled within this type. The soil type was mainly gravel from the eroding cliff face. These sites generally occurred along fairly steep slopes with slopes of ~80 degrees. Bare soil dominates the ground cover with values between 70% and 90%.

Local Vegetation Description

Structure: Herbaceous (0%-20%)

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Vegetation Floristics: These are generally sparesly vegetated areas (cover values ~20%) with some scattered forbs such as *Solidago gigantea* and graminoids such as *Phalaris arundinacea* and *Elymus canadensis*.

Dynamics: N/A

Conservation Status Rank

Global: G4G5

State (Nebraska): S5

Global Environmental Description

Stands occur on steep (>60%) slopes of sandstone or siltstone bedrock. Cliffs may exceed 100 m. Soils are not developed (Steinauer and Rolfsmeier 2000).

Global Vegetation Description

This dry sandstone cliff community is found in the central-western Great Plains of the United States. Stands occur on steep (>60%) slopes of sandstone or siltstone bedrock. Cliffs may exceed 100 m. Soils are not developed. The vascular layer varies from sparse to absent, particularly on siltstone. The nonvascular layer is not well described. Plants include scattered forbs, such as *Mentzelia decapetala* and *Penstemon glaber*. Sites may be utilized by nesting raptors. Type is found at Scotts Bluff, Wildcat Hills, and along the Niobrara River.

Nebraska Natural Heritage Program Description

Western Sandstone Cliff: Vegetation in this community is extremely sparse, and many sites are unvegetated. Plants occurring in this community are usually scattered perennial herbs that often do not flower. Occasionally grasses and other herbaceous or woody species typically associated with outcrops may be present on narrow ledges. Species diversity is extremely low.

Example Photograph

The photograph below shows an example of CEGL005257 Sandstone Great Plains Dry Cliff Sparse Vegetation.

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Sandstone Great Plains Dry Cliff Sparse Vegetation (CNHP)

Short Citation

- Steinauer and Rolfsmeier 2000

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Appendix B: Field Key to Community Associations/Types

Appendix B Contents

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Introduction

The vegetation classification and key of Niobrara National Scenic River (NIOB) was developed as part of the Vegetation Classification and Mapping project at NIOB. The field key was developed during the classification phase of the project and was also a critical tool during the accuracy assessment phase. It was developed using compiled field data, which was analyzed to identify the vegetation types that occur within NIOB. The vegetation types were classified according to the National Vegetation Classification (NVC) hierarchy (USNVC 2018) and related state classifications (Rolfsmeier and Steinauer 2010).

This key assists users in identifying the major physiognomic units and the vegetation alliances within NIOB. The key also lists each alliance's respective vegetation associations sampled within NIOB. The alliances and associations are based on one or more dominant and/or diagnostic species occurring in the landscape and on environmental settings. The key is used to distinguish formal mapping units and to conduct the accuracy assessment of the vegetation maps for these parks. This key can also be used for other projects within the park to type vegetation communities. The key is based on classification of new data collected by the Colorado Natural Heritage Program vegetation mapping field crew in 2015 and additional surveys conducted by the Center for Environmental Management of Military Lands in 2016.

The key may not denote all vegetation types that occur within the park, or explain the full range of variation of vegetation types as it appears on the ground. Species interact in a continuum based on a complex set of habitat preferences, and can intermix in wide or narrow zones within the landscape. While this key attempts to reflect this complexity, unusual or site-specific assemblages of plants may exist in the landscape and may not be easily keyed.

Before using this key several terms and concepts need to be clearly defined. The following paragraphs define the conventions for how those terms and concepts are used in the key. Be sure to consider these usage conventions as you work through the keys. If you are having trouble reaching a satisfactory conclusion, your interpretation of a term or concept may be different and leading you down the wrong path.

Shrubs tend to be multi-stemmed plants less than 5 meters tall. Trees are generally single-stemmed and are greater than 5 meters tall. Some subcanopy trees such as *Juniperus virginiana* may straddle the line between tree and shrub; these plants can occupy both layers, and the decision between shrub and subcanopy should be based on other plants in the area. If there is a distinct subcanopy of trees, *Juniperus virginiana* may be considered a shrub.

If a tree species such as *Fraxinus pennsylvanica* is under 5 meters tall, the tree can be included in the appropriate shrub layer for its height as opposed to including the tree into the seedling stratum. The seedling stratum is usually reserved for small tree and shrub seedlings <0.5 meters tall.

Forest canopies typically have greater than 60% cover; woodland canopies have cover values between 60% and 25%. However, cover values are variable, so these ranges are not necessarily hard cutoffs. Forests may have cover ~55% if you happen to catch a gap in the canopy, and woodlands

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may have cover values of ~15% if the trees are exceptionally sparse. When deciding on whether or not an area is a forest or woodland, consider the surrounding area is representative of the vegetation community over the entire area.

Due to the nature of riverine systems, floodplains and sandbars may drastically change from year to year. Some herbaceous vegetation may be scoured away leaving only *Salix* spp. or young *Populus deltoides.* At other times, previously sparse vegetation may become heavily vegetated. In other areas, sandbars may appear or disappear from year to year. Keep that dynamic characteristic in mind as you interpret an area and compare that interpretation with the couplets of the key.

When determining community types, consider clues about the land use history of the plot you are in and the surrounding area. Former agricultural land may have been reseeded with *Koeleria macrantha* in what was originally a *Salix* dominated floodplain. Likewise, areas that were previously dominated by *Eleagnus angustifolia* may have been cleared, creating a heavy cover of herbaceous species mixed with a lot of downed woody debris.

Species abbreviations use the USDA PLANTS Database syntax in which each Latin binomial and trinomial is assigned a unique symbol. For a binomial, the symbol consists of the uppercase first two letters of the genus, plus the uppercase first two letters of the specific epithet. For example, the symbol for *Pascopyrum smithii* is PASM, and the symbol for *Fraxinus pennsylvanica* is FRPE. Different plants with the same 4-letter code are differentiated by adding a number as a tie-breaking suffix. For example the symbol for *Elymus elymoides* is not ELEL, but ELEL5. Likewise, *Quercus macrocarpa* is not QUMA, but QUMA2. The symbol for a trinomial consists of the first two letters of the genus, plus the first two letters of the specific epithet, plus the first letter of the sub-specific or varietal epithet. For example the symbol for *Elymus elymoides* ssp. *elymoides* is ELELE. As with 4-letter symbols, different plants with the same 5-letter symbol are differentiated by adding a number as a tie-breaking suffix.

USNVC community types have a 10-digit CEGL code (CEGL000658). Communities present at NIOB without an appropriate USNVC type are labeled as “park specials” and are recognized under a 10-digit code beginning with “NPSNIOB” followed by a sequential number (NPSNIOB001).

The syntax of the USNVC names use the symbols “/”, “-”, and “( )” to indicate the structure and composition of the community. The “/” symbol separating two species names indicates the species are in different strata. The “-” symbol separating two species names indicates the species separated by the dash are codominant within the same stratum. Species names within parentheses [e.g. “( )”] means that a species may or may not be present in the community.

Determining vegetation associations and map units requires an awareness of the scale at which they are defined. The scale and the MMU of the sample unit is 0.5 ha.

The floristic structure of these associations is broken down into 5 strata: Emergent, Canopy, Subcanopy, Shrub, and Herbaceous. (Figure B-1)

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Emergent: Emergent stratum is characterized by tall trees that are distinctly above a canopy. The most common tree to occur in this stratum is *Populus deltoides*. In order for there to be an emergent stratum, there must first be a canopy stratum.

Canopy: A canopy is the main layer of trees formed by mature crowns.

Subcanopy: The subcanopy is a distinct layer of trees occurring beneath the canopy. There must be a canopy in order for there to be a subcanopy. Common subcanopy trees in this key include *Ostrya virginiana* and *Cornus drummondii*.

Shrub: The shrub layer is often underneath the canopy/subcanopy, but it may occur without either. The shrub canopy is composed of shrubs between 0.5m and 5m in height. Common shrubs include *Juniperus virginiana, Rhamnus cathartica,* and *Prunus virginiana*.

Herbaceous: The herbaceous layer is composed of graminoids, forbs, ferns, and seedlings. At NIOB, graminoids and forbs are the most common plants in the herbaceous layer.

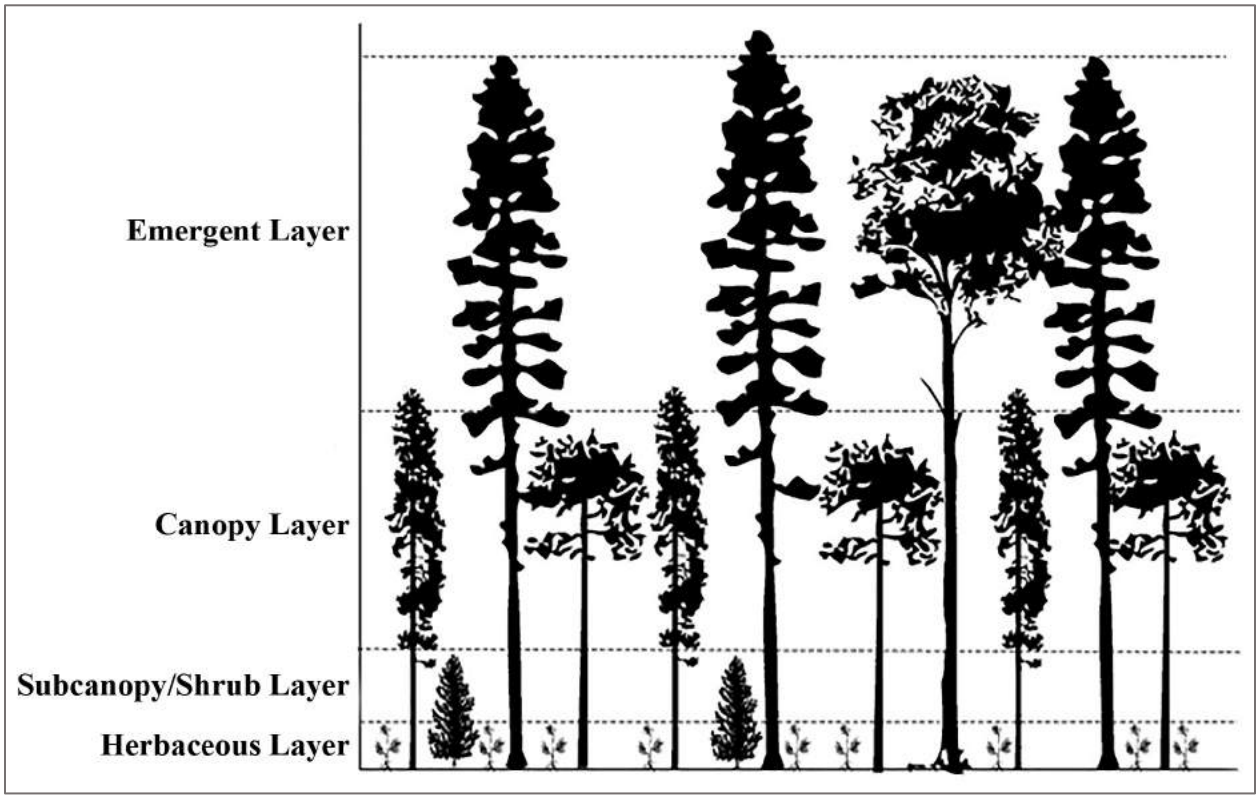

Figure B-1. The floristic structure of the associations used. Adapted from Warren and Lemmen 2014

The area of the map includes everything within the park's administrative boundary. That means there are map classes for all of the vegetated areas, the non-vegetated areas such as open water and sand bars, as well as areas of land-use such as agricultural fields, roads, and developed vegetation such as

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maintained lawns. Each of these types is described in the following key and defined in the map class descriptions document.

Land Use Classes

Adapted from the USGS 2011 and Anderson et al. 2001

The following land use classes are areas that are not included in the list of natural and semi-natural vegetation types. They are any area where the human use of the land dominates and dictates the vegetation present, if any. These areas tend to be heavily developed such agricultural croplands and pastures, and urban/commercial development such as roads, parking lots, houses, parks, etc. Additionally, open water is one of the land use classes.

Key to Land Use Classes

1a Area is vegetated with cover >20% ....(2a)

1b Area is un-vegetated or vegetation is <20% ....(5a)

2a Vegetation is primarily crops (corn, soybeans, wheat) or pasture vegetation of grasses or legumes (*Phleum pratense, Bromus inermis, Medicago sativa*) ....(3a)

2b Vegetation is developed turf grass for parks, golf courses, campgrounds, or other intensively managed areas..... .....(4a)

3a Areas used for the production of annual crops (e.g., corn, soybeans, wheat, etc.) that are currently or historically have been plowed. Includes all land being actively tilled or where evidence of tillage is discernable. If the area is not fallow, then greater than 20% of the total cover is composed of crop species..... .....**LC001 Cultivated Crops, Agricultural Vegetation**

1b Areas used for the production of grasses, legumes, or grass-legume mixtures planted for livestock grazing and/or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation. Dominant species typically include smooth brome, timothy, crested wheatgrass, but may also be Crop Reserve Program lands planted with a variety of mid to tallgrass species and left un-harvested..... .....**LC002 Pasture/Hay Ground, Agricultural Vegetation**

4a Areas with a mixture of some constructed materials, but mostly vegetation in the form of turf grass. Impervious surfaces typically account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, campgrounds, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes..... .....**LC004 Developed, Open Space**

4b All other developed areas. These areas typically include 20% to 100% impervious surfaces. These areas most commonly include urban/commercial development, roads, parking lots, etc.

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Areas such as the mowed margins of roadways are classified as developed, despite the presence of natural or semi-natural vegetation..... ..... **LC005 Developed, Low, Medium, and High Intensity**

5a Developed areas with typically 20% to 100% impervious surfaces. These areas most commonly include urban/commercial development, roads, parking lots, etc. Areas such as the mowed margins of roadways are classified as developed, despite the presence of natural or semi-natural vegetation..... ..... **LC005 Developed, Low, Medium, and High Intensity**

5b Not as above. Barren ground or open water ....(6a)

6a Areas of bare ground, strip mines, gravel pits, borrow pits, road cut banks and other areas that accumulate bare earthen material. Generally, vegetation accounts for <20% of total cover ..... **LC003 Non-vegetated/Barren Land, Borrow Pit, Cut Bank**

6b Areas of open water, generally with <25% cover of vegetation or exposed soil .... **LC006 Open Water**

Examples of land use classes: a) pasture; b) agricultural vegetation; c) developed open space; d) open water.

Key to Plant Associations

The following physiognomic classes separate the vegetation into groupings based on the growth habit and structure of the vegetation. The associations within each of these groupings are based on species and communities with similar diagnostic characteristics. However, because the definition and interpretation of those characteristics is highly variable, it is important to keep an open mind and remain flexible in how one interprets the terms and concepts used in the key. For example, if you are

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in an area that contains a patchy and variable cover of short shrubs set into a matrix of mixed grass, you may be inclined to call it a shrub association and work through the key from that perspective. Depending on the cover values, you may decide that it is a grassland with a low cover of shrubs and attempt to key the types through the grasslands section. Either approach may be correct. We have tried to build flexibility into the key that will allow one to reach the same conclusion regardless of the starting point. However, if you start to key an area from one key Division but are failing to reach what feels like a suitable conclusion, try starting from an alternative Division.

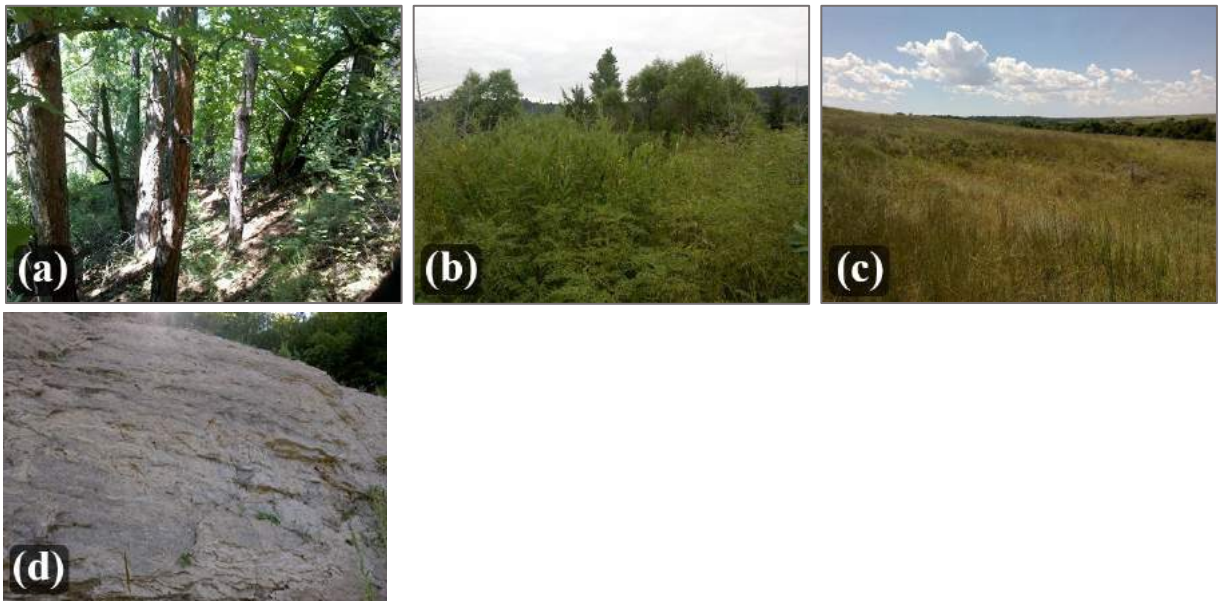
Physiognomic Classes

I. Deciduous and/or coniferous tree species, or a combination of the two, form an open to dense overstory canopy with cover generally >25% **Division A – Tree associations**

II. Shrubs form the dominant overstory stratum with cover typically >10%. If present, trees will generally have <10% cover. An herbaceous stratum is usually present and may have great abundance.....**Division B – Shrub associations**

Herbaceous plants dominate the site. Any woody species such as shrubs and trees typically have <10% cover. Total vegetation cover is typically >10%. **Division C – Herbaceous associations**

III. Total vegetation cover on the site is <10% and the surface of the substrate is easily visible. Typically, located in dynamic settings where disturbance occurs regularly (e.g. sandbars) or where substrates are not favorable for plant growth (e.g. solid rock) …**Division D – Sparse associations**



Example of a (a) tree association, (b) shrub association, (c) herbaceious association, and (d) sparse association (CNHP)

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Division A – Tree Associations

Tree associations include types considered forests as well as woodlands. Woodlands have an overstory tree canopy containing approximately 20-60% cover. For the most part, woodlands have an open canopy that allows a clear view of the sky throughout most of the area, although the crowns of trees in a woodland may occasionally touch or overlap.

Forests have an overstory tree canopy containing approximately 60-100% cover. The crowns of trees in a forest are almost always touching and often overlap; for the most part they form a closed canopy that precludes a clear view of the sky in most areas.

Examples of (a) forest and (b) woodland (CNHP)

While most forest and woodland types will have trees of different species occupying the different stratum, it is the uppermost stratum with at least 10% cover that is diagnostic of the community type. Likewise, different aged individuals of the same species may be present in each stratum in the community. However, it is always the dominant species of the uppermost stratum that is diagnostic of the overall community type, while dominant species in any sub strata are diagnostic of the specific association within the overall type.

Shrubs tend to be multi-stemmed plants less than 5 meters tall. Trees are generally single-stemmed and are greater than 5 meters tall. Some sub canopy trees such as *Juniperus virginiana* may straddle the line between tree and shrub; these plants can occupy both layers, and the decision between shrub and subcanopy should be based on height of the plant.

Some species such as *Fraxinus pennsylvanica, Quercus macrocarpa,* or *Ulmus americana* are always considered trees despite their height.

1a This community represents large burnt areas from the 2012 and other fires. The only trees in this community have been killed by fire. This is a variable community which may be dominated by weedy species or native species. Common ruderal species include *Bromus tectorum, Bromus japonicum, Bromus inermis, Poa pratensis, Cannabis sativa, Verbascum thapsus, Melilotus officinale,* and *Cirsium* spp. Common native species include *Schizachyrium*

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scoparium, Andropogon hallii, and *Calamovilfa longifolia*. Old burnt tree species that are beginning to re-sprout include *Quercus macrocarpa, Tilia americana, Celtis occidentalis, Fraxinus pennsylvanica,* and *Pinus ponderosa* .... **NPSNIOB009 Burnt Disturbed Forest [NIOB MC301]**

1b The majority >50% of the canopy is composed of trees not killed by fire ....(2a)

2a Site includes relict *Betula papyrifera* or *Populus* x *smithii*. Trees may be downed and dead. Location is a spring branch canyon or steep slopes adjacent to the Niobrara River Valley ..... (20a)

2b Site does not include any current or past evidence of *Betula papyrifera* or *Populus* x *smithii* .... (3a)

3a Evergreen trees such as *Pinus ponderosa* and *Juniperus virginiana* dominate the canopy. ..... (4a)

3b Deciduous trees such as *Quercus macrocarpa, Fraxinus pennsylvanica, Ulmus americana, Tilia americana, Populus deltoides,* etc. dominate the canopy..... .....(7a)

4a *Juniperus virginiana* dominates the type in the canopy layer with usually 80-90% cover. The herbaceous stratum has <50% cover with *Ageratina altissima, Carex* spp., *Calamovilfa longifolia, Schizachyrium scoparium, Ambrosia psilostachya,* and *Urtica dioica* as the most abundant species.....**CEGL002593 *Juniperus virginiana* Midwest Ruderal Forest [NIOB MC311]**

4b *Pinus ponderosa* dominates the canopy usually forming a woodland or forest. *Juniperus virginiana* and *Quercus macrocarpa* may co-dominate ....(5a)

5a *Pinus ponderosa* forms an open canopy with cover ranging from 10% to 50%. *Juniperus virginiana* and *Quercus macrocarpa* also usually occur in the canopy with <35% cover. The herbaceous layer has moderate cover (~30%-70%) and is dominated by graminoids. Common species typically include *Schizachyrium scoparium*, *Bouteloua curtipendula*, *Poa pratensis, Panicum virgatum,* and *Elymus virginicus*.....**CEGL000201 *Pinus ponderosa/Schizachyrium scoparium* Open Woodland [NIOB MC302]**

5b *Pinus ponderosa* forms an open to closed canopy with *Juniperus virginiana* and *Quercus macrocarpa* in the sub canopy with >35% cover..... .....(6a)

6a *Pinus ponderosa* and *Juniperus virginiana* co-dominate the canopy, but *Pinus ponderosa* tends to have greater cover than *Juniperus virginiana*. *Quercus macrocarpa* and *Ostrya virginiana* may occur in this type, but never reach codominance. Occasionally, there is a shrub layer of *Symphoricarpos occidentalis* and *Prunus virginiana*. Herbaceous cover is usually dominated by *Bouteloua curtipendula* and *Piptatheropsis micrantha* with total herbaceous cover ranging from 30% to 70% .....**NPSNIOB012 *Pinus ponderosa / Juniperus virginiana* Woodland [NIOB MC303]**

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6b *Pinus ponderosa* is usually in the emergent or canopy layer. Its cover is usually ~30%, but it may be as low as 10%. *Quercus macrocarpa* will occur in the canopy with cover >25%. Other trees may co-dominate with *Quercus macrocarpa* including *Juniperus virginiana, Ostrya virginiana,* or other broadleaf trees; these trees tend to have cover ~30%. The herbaceous layer ranges from sparse to moderate cover ranging from 10% to 60%; graminoids dominate the herbaceous layer with main species being *Panicum virgatum, Schizachyrium scoparium*, *Piptatheropsis micrantha* and *Elymus virginicus*..... .....
CEGL000873 *Pinus ponderosa / Quercus macrocarpa* Open Woodland [NIOB MC304]

7a *Populus deltoides* and/or *Salix amygdaloides* have >15% cover..... .....(8a)

7b Other trees dominate such as *Elaeagnus angustifolia*, *Juniperus virginiana*, *Quercus macrocarpa*, *Fraxinus pennsylvanica*, or *Tilia americana*..... .....(13a)

8a This community is heavily disturbed by flooding. Disturbance is indicated by large amounts of bare ground, woody debris, and invasive and annual species. Sites where *Juniperus virginiana* has been mechanically removed or sites with >35% *Elaeagnus angustifolia* fall into this community.....**NPSNIOB010**
***Populus deltoides* Ruderal Forest [NIOB MC305]**

8b Not as above. Sites do not look heavily disturbed by flooding or mechanical removal of *Juniperus virginiana* ....(9a)

9a *Populus deltoides* or *Salix* spp. dominate or co-dominate the canopy. The sub canopy or shrub layer, if present, include *Salix* spp..... .....(10a)

9b Not as above. *Populus deltoides* dominates the canopy without *Salix* spp. in the canopy, sub canopy, or shrub layer..... .....(11a)

10a *Salix amygdaloides* is generally the only tree in the canopy with cover reaching up to 50%. *Salix interior* is a tall shrub in this site with a cover value of ~40%. The herbaceous stratum is vigorous, and the common species are *Solidago canadensis, Cirsium arvense,* and *Muhlenbergia racemosum*.....**CEGL000947**
***Salix amygdaloides* Riparian Woodland [NIOB MC308]**

10b Sites from this community may be dominated by *Populus deltoides* and *Salix amygdaloides*. *Populus deltoides* tends to be younger and between ~6-12m tall. Other common canopy species may include *Fraxinus pennsylvanica, Celtis occidentalis, Juniperus virginiana,* and *Acer negundo*. The understory may be dominated by *Salix interior* and *Amorpha fruticosa*. Some sites may have a high abundance of graminoids such as *Andropogon gerardii* and *Panicum virgatum* **CEGL000659**
***Populus deltoides-(Salix amygdaloides)/Salix (exigua, interior)* Floodplain Woodland [NIOB MC308]**

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11a *Populus deltoides* is typically the sole tree in the canopy with ~30% cover. Shrubs tend to be rare. The herbaceous layer has a total cover of ~70%. The dominant species include *Schizachyrium scoparium* and *Sorghastrum nutans* ..... **CEGL001454 *Populus deltoides/Panicum virgatum-Schizachyrium scoparium* Floodplain Woodland [NIOB MC308]**

11b *Populus deltoides* forms an open canopy with common associates including *Juniperus virginiana* and *Fraxinus pennsylvanica* ....(12a)

12a *Populus deltoides* occupies the canopy with cover values of ~30%. *Fraxinus pennsylvanica* and *Acer negundo* also occur in the canopy layer. *Quercus macrocarpa* can occur within this type as well. *Juniperus virginiana* may also be present and may dominate the stand. The herbaceous layer ranges from 40% to 90% cover. Abundant plants include *Ambrosia psilostachya, Elymus virginicus, Galium aparine, Poa pratensis, Solidago gigantea,* and *Leersia oryzoides* ..... **CEGL000658 *Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest [NIOB MC306]**

12b *Populus deltoides* occurs with low cover of ~30% or less. The canopy is mainly *Juniperus virginiana* with cover of ~80%. A shrub layer is absent, and the herbaceous layer is not very abundant. The total herbaceous cover is less than 30% with common species being *Carex* spp. and *Poa pratensis* ..... **CEGL002152 *Populus deltoides/Juniperus scopulorum* Floodplain Woodland [NIOB MC307]**

13a Canopy is dominated by *Elaeagnus angustifolia* or *Juniperus virginiana* ....(14a)

13b Not as above. Canopy is dominated by other species such as *Quercus macrocarpa, Fraxinus pennsylvanica, Tilia americana, Ulmus americana, Celtis occidentalis, Acer negundo,* etc. ..... (15a)

14a *Elaeagnus angustifolia* forms an open to somewhat closed canopy as the dominant to sole tree species in this woodland type. The herbaceous stratum is fairly variable and consist of both native and invasive species. ..... **CEGL005269 *Elaeagnus angustifolia* Ruderal Riparian Woodland [NIOB MC312]**

14b *Juniperus virginiana* dominates the canopy layer and may form either a forest or woodland. The herbaceous stratum is extremely variable has <50% cover with *Ageratina altissima, Carex* spp., *Calamovilfa longifolia, Schizachyrium scoparium, Ambrosia psilostachya,* and *Urtica dioica* as the most abundant species. This is not a diverse type..... ..... **CEGL002593 *Juniperus virginiana* Midwest Ruderal Forest [NIOB MC311]**

15a Canopy is mainly dominated by *Quercus macrocarpa, Populus* x *smithii,* or *Tilia americana* .... (16a)

15b Not as above. Canopy is composed of other species such as *Fraxinus pennsylvanica, Ulmus* spp.*, Celtis occidentalis, Acer negundo,* etc……..…(22a)

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16a *Quercus macrocarpa* and associated trees form a woodland canopy with cover <60%. Other common canopy associates include *Celtis occidentalis, Fraxinus pennsylvanica, Juglans nigra,* and *Ulmus* spp. There is not a distinct shrub layer. The herbaceous cover is 70% and contains species such as *Poa pratensis, Elymus virginicus, Andropogon gerardii,* and *Panicum virgatum* **CEGL002052**
***Quercus macrocarpa/Andropogon gerardii-Panicum virgatum* Woodland [NIOB MC317]**

16b Not as above. *Quercus macrocarpa* and other associated canopy species such as *Tilia americana, Fraxinus pennsylvanica, Celtis occidentalis, Ostrya virginiana,* etc. dominate the canopy ....(17a)

17a *Quercus macrocarpa* dominates this type with widely spaced *Ostrya virginiana* as a codominant. Other canopy associates include *Celtis occidentalis*, *Fraxinus pennsylvanica*, *Pinus ponderosa*, *Prunus virginiana*, and *Juniperus virginiana*. There is a sparse understory often times with lots of bare ground.....**CEGL000555**
***Quercus macrocarpa/Ostrya virginiana* Forest [NIOB MC313]**

17b Not as above. *Quercus macrocarpa* co-dominates with other trees such as *Juniperus virginiana*, *Tilia americana, Populus* x *smithii*, *Betula papyrifera, Fraxinus pennsylvanica, Celtis occidentalis, Ulmus americana, etc.* ....(18a)

18a *Betula papyrifera, Tilia americana, Populus* x *smithii* occur in the canopy usually with *Quercus macrocarpa*..... .....(20a)

18b Not as above. *Quercus macrocarpa* co-dominates with *Juniperus virginiana, Fraxinus pennsylvanica, Celtis occidentalis, Ostrya virginiana,* etc. ....(19a)

19a The canopy is dominated by *Quercus macrocarpa*. Canopy cover ranges from dense (~80%) to sparse (20%). Other mesic trees that may occupy the canopy or subcanopy include *Ulmus americana, Ostrya virginiana, Fraxinus pennsylvanica, Celtis occidentalis, Tilia americana,* and *Juglans nigra*. *Juniperus virginiana* may invade this type, but cover is usually less than 35%. If present, the shrub layer tends to be sparse; the cover is typically less than 20%. Common shrubs include *Zanthoxylum americanum* and *Prunus virginiana*. Herbaceous stratum can be either vigorous (~70%) or sparse (~20%) but is generally dominated by graminoids. *Elymus virginicus* and *Piptatheropsis micrantha* are common graminoids and tend to dominate the plots when present.....**NPSNIOB013**
***Quercus macrocarpa/Juniperus virginiana/Elymus virginicus* Forest [NIOB MC313]**

19b *Quercus macrocarpa* comprises the majority of the canopy typically ranging from 50% to 80%, but some sites have values as low at 20% cover. *Juniperus virginiana* invades these sites either in the canopy or tall shrub stratum. When present, *Juniperus virginiana* usually has covers >40%. Other trees that occur in the canopy are *Juglans nigra, Celtis occidentalis, Ostrya virginiana,* and *Fraxinus pennsylvanica*. The herbaceous layer can range from moderate (~50%) to sparse (~10%), but graminoids have a greater abundance than forbs. Common graminoids include *Elymus virginicus* and *Carex* spp. ....

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NPSNIOB003 *Quercus macrocarpa/Juniperus virginiana* Ruderal Forest [NIOB MC315]

20a All of these plots contain *Populus* x *smithii* in a clearing surrounded by *Quercus macrocarpa*. The canopy is mainly composed of *Populus* x *smithii*; typically, other trees have been mechanically removed especially *Juniperus virginiana*. Plots may include large piles of *Juniperus virginiana* debris. Trees encroaching on these clearings include *Quercus macrocarpa* and *Juniperus virginiana*. Since this area is very open, there is an abundant herbaceous stratum with cover ~70%. This stratum is usually composed of *Elymus canadensis* and *Poa pratensis* ..... **NPSNIOB006 *Quercus macrocarpa-Populus* x *smithii* Relict Woodland [NIOB MC316]**

20b *Tilia americana* and/*or Betula papyrifera* present, usually with *Quercus macrocarpa* .....(21a)

21a *Betula papyrifera* is a diagnostic species though not always dominant; cover values range between 10% and 50%. Sites usually occur on steep slopes next to the Niobrara River or along spring branch canyons. Other trees that occupy the canopy stratum include *Quercus macrocarpa, Juniperus virginiana, Acer negundo*, *Tilia americana, Ostrya virginiana,* and *Pinus ponderosa*. The herbaceous layer is not very abundant with cover values usually below 40%; graminoids typically have a greater abundance than forbs. Common species include *Eleocharis acicularis* and *Muhlenbergia racemosum* ..... **CEGL002013 *Betula papyrifera-(Tilia americana, Quercus macrocarpa)* Canyon Forest [NIOB MC314a]**

21b *Tilia americana* is the dominant tree with cover ranging from 50% to 80%, and occasionally codominantes with *Quercus macrocarpa*. *Ostrya virginiana* and *Juniperus virginiana* commonly occur in the subcanopy with cover between 20% and 30%. The herbaceous layer is abundant with total cover between 50% and 80%. Graminoids usually occur in greater abundance than forbs, and common herbaceous plants include *Carex* spp., *Elymus canadensis,* and *Galium aparine* ..... **CEGL002012 *Tilia americana-(Quercus macrocarpa)/Ostrya virginiana* Forest [NIOB MC314b]**

22a *Fraxinus pennsylvanica* and/or *Ulmus* spp. dominate the canopy along with a variety of native species such as *Acer negundo, Celtis occidentalis, Tilia americana,* and/or *Juglans nigra* ..... (23a)

22b *Fraxinus pennsylvanica* and/or *Ulmus* spp. dominate the canopy, but weedy species such as *Juniperus virginiana, Ulmus pumilla,* and *Morus alba* may co-dominate or dominate the canopy or shrub layer respectively. Additionally, there is low species diversity; herbaceous layer may be dominated by invasive species such as *Bromus tectorum* and/or *Poa pratensis* .... (25a)

23a *Acer negundo* and *Fraxinus pennsylvanica* dominate the canopy. Generally, there is a sparse shrub layer (~10% cover) contain *Prunus virginiana* and *Symphoricarpos occidentalis*. Graminoids tend to dominate the herbaceous layer with a mix of *Panicum virgatum, Schizachyrium scoparium, Andropogon gerardii, Carex* spp., *Poa pratensis*, and

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Piptatheropsis micranthum **CEGL000628**
***Acer negundo/Prunus virginiana* Floodplain Forest [NIOB MC309]**

23b *Acer negundo* is less dominant than *Fraxinus pennsylvanica* or *Ulmus americana. Cornus drummondii* may occur in the sub canopy ....(24a)

24a Canopy is dominated by *Fraxinus pennsylvanica* with *Ulmus americana* and *Acer negundo*. Canopy co-dominates include *Ulmus rubra*, *Celtis occidentalis*, *Tilia americana,* and *Juglans nigra*. In pristine stands, the understory is composed of two layers; the upper layer is a conspicuous shrub layer 2-3 m tall dominated by *Prunus virginiana, Ostrya virginiana,* or *Cornus drummondii*. The lower layer is dominated by graminoids such as *Elymus virginicus* and *Carex* spp. This community occurs along draws and deep ravines just downslope of *Quercus macrocarpa* communities. **CEGL000643**
***Fraxinus pennsylvanica-Ulmus americana*/*Prunus virginiana* Woodland [NIOB MC309]**

24b *Fraxinus pennsylvanica* is the most abundant tree in the canopy with cover ~50%. *Cornus drummondii*, *Morus alba*, and *Juniperus virginiana* may occur in the canopy or sub canopy. *Juniperus virginiana* has <40% cover. Herbaceous stratum ranges from 50% to 70% and is dominated by graminoides such as *Elymus virginicus* and *Carex* spp. This community usually occurs on upper floodplain terraces and in upland ravine bottoms..... .....
CEGL002014 *Fraxinus pennsylvanica-Ulmus* spp.-*Celtis occidentalis* Floodplain Forest [NIOB MC309]

25a This community occurs along terraces of river bottoms and floodplains with brief flooding and tends to have low species diversity. The canopy is dominated by *Fraxinus pennsylvanica* and *Ulmus americana*. Common associates include *Ulmus pumilla, Morus alba,* and *Acer negundo*. Shrubs can be variable and may include *Cornus* spp. and *Salix* spp. Herbaceous ground cover may contain a mix of graminoids and forbs including *Elymus virginicus, Eupatorium perfoliatum, Laportea canadensis,* and *Carex* spp..... .....
CEGL005400 *Fraxinus pennsylvanica-Ulmus americana*-(*Acer negundo*, *Tilia americana*) Great Plains Floodplain Forest [NIOB MC309]

25b *Fraxinus americana* or *Ulmus americana* dominate the canopy stratum. *Celtis occidentalis*, *Juniperus virginiana*, and *Cornus drummondii* may occur in the sub canopy or tall shrub stratum. Typically this community occurs after recent disturbances; often there is evidence of cut stumps or large piles of downed wood. Weedy species such as *Juniperus virginiana*, *Rhamnus cathartica*, and *Ulmus pumilla* may be vigorous and usually have >40% cover. If there is an open canopy, a weedy understory including *Bromus tectorum, Bromus inermis, Poa pratensis,* and/or *Euphorbia esula* may become prevalent. **CEGL005239**
***Fraxinus pennsylvanica-Ulmus americana*-(*Juglans nigra*, *Celtis occidentalis*) Ruderal Forest [NIOB MC310]**

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Division B – Shrub Associations

Shrublands are areas with <10% cover of trees and shrub cover >10%. Shrublands can be dense thickets in valleys or a sparse shrubland occurring in a grassland. The minimum mapping unit for communities is ½ hectare; however due to the patchy nature of shrublands, several clusters of shrubs can equal a minimum mapping unit as long as each patch of shrubs are <30m from each other. Shrubs are typically multi-stemmed plants <5m in height. Species that are always considered shrubs are *Salix interior, Prunus virginiana,* and *Rhus glabra*. Some species may be considered a tree or shrub such as *Juniperus virginiana* or *Cornus drummondii*. Generally, height is used to determine whether or not these species are shrubs (<5m) or trees (>5m).

The shrub category is further subdivided into tall shrubs, short shrubs, and dwarf shrubs. Tall shrubs are defined as typically multi-stemmed woody plants generally greater than 2 m tall at maturity. Short shrubs are defined as multi-stemmed woody plants generally between 0.5 and 2 m tall at maturity. Dwarf shrubs are defined as multi-stemmed woody plants generally below 0.5 m tall at maturity.

Examples of (a) tall shrub 2-5 m tall; (b) short shrub 0.5-2 m tall; (c) dwarf shrub <0.5 m tall (CNHP)

Note that USDA plants database lists *Salix exigua* as not occurring in the area of NIOB. NatureServe associations we are using for riparian willow types are all based on *Salix interior*. In any case where you believe you have identified *S. exigua*, please use the provided *S. interior* and do not substitute an alternative *S. exigua* type.

1a Shrubland dominated by *Salix interior* (or *Salix exigua*) or *Amorpha fruticose* .....(2a)

1b Shrubland not as above. Shrub cover is dominated by *Cornus drummondii, Prunus virginiana, Juniperus virginiana, Rhus glabra, Artemisia* spp., *Prunus americana, Rosa woodsii,* or *Symphoricarpos occidentalis*.....(4a)

2a *Amorpha fruticosa* forms a moderately dense short shrub stratum with cover typically ~60% or greater. The herbaceous layer can be tall and is typically composed of *Solidago gigantea* with cover ~60%. Other common species include *Glycyrrhiza lepidota, Solidago canadensis,* and *Helianthus annuus*.....
.**NPSNIOB001 *Amorpha fruticosa/Solidago gigantea* Wet Shrubland [NIOB MC201]**

2b Shrub layer is dominated by *Salix interior (*or *Salix exigua)* .....(3a)

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3a *Salix interior* is typically the only plant species present; however, *Populus deltoides* saplings may be present as well. *Xanthium strumarium* may also occur with cover up to 30%. This type occurs on riverine sandbars with sand covering 70% to 90% of the ground. **CEGL008562 *Salix interior* Wet Shrubland [NIOB MC201]**

3b *Salix interior* is the dominant shrub with cover between 40% and 50%. Occasionally, *Amorpha fruticosa* co-dominates with *Salix interior*. Herbaceous layer is dense usually with cover between 80% and 90% cover. Common herbaceous species present may include *Equisetum hyemale*, *Solidago canadensis*, *Solidago missouriensis*, *Glycyrrhiza lepidota*, and *Ambrosia psilostachya*. This type primarily occurs on low floodplains generally right next to the river .....
. CEGL005282 *Salix interior/Pascopyrum smithii-Equisetum hyemale* Wet Shrubland [NIOB MC201]

4a Shrub layer is composed of *Elaeagnus angustifolia, Cornus drummondii* or *Juniperus virginiana* .....(5a)

4b Shrub layer composed of *Prunus virginiana, Prunus americana*, *Rhus glabra*, *Symphoricarpos occidentalis*, or other species .....(8a)

5a The open tree or tall shrub canopy is dominated by an open to dense cover of *Elaeagnus angustifolia.* The herbaceous stratum may be variable and consist of both native and invasive species. .....
.. **CEGL005269 *Elaeagnus angustifolia* Ruderal Riparian Woodland [NIOB MC312]**

5b Not as above. Canopy dominated partly or entirely of *Juniperus virginiana* or *Cornus drummondii* ..... …(6a)

6a *Cornus drummondii* and *Rhus glabra* usually dominate the shrub cover. However, other shrubs that may be co-dominant to dominant include *Corylus americana, Prunus americana, Prunus angustifolia, Symphoricarpos occidentalis,* or *Rhus aromatica.* Depending on the density of the shrub cover the herbaceous layer may be sparse to variably dense.....
CEGL005219 *Cornus drummondii-(Rhus glabra, Prunus* spp.*)* Shrubland [NIOB MC203]

6b Not as above. Canopy contains cover >30% of *Juniperus virginiana*… .....(7a)

7a Shrub or sub-shrub height, <2m tall, *Juniperus virginiana* has invaded native or ruderal grasslands. *Juniperus virginiana* shrub cover is >35%.....
NPSNIOB007 *Juniperus virginiana* Ruderal Shrub Invaded Grassland [NIOB MC101]

7b Tall shrub or small tree *Juniperus virginiana* occur as scattered individuals. These sites generally occur in grasslands dominated by either native or non-native graminoids .....
.. **CEGL002593 *Juniperus virginiana* Midwest Ruderal Woodland and Forest [NIOB MC311]**

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8a Shrub layer is dominated by shrubs such as *Symphoricarpos occidentalis* or *Artemisia* spp. .....(9a)

8b Shrub layer is dominated by *Prunus virginiana, Prunus americana, Rosa woodsii,* or *Rhus glabra* .....(10a)

9a *Symphoricarpos occidentalis* is the dominant species in the short shrub stratum with a cover value of >50% and often approaches 100%. Other common shrubs include *Prunus virginiana* and *Rhus trilobata.* There is a lush graminoid layer (70% cover) with *Sorghastrum nutans, Schizachyrium scoparium,* and *Panicum virgatum*. However, many areas are disturbed leading to weedy species such as *Bromus tectorum, Nepeta cataria,* and *Poa pratensis*..... ..... **CEGL001131 *Symphoricarpos occidentalis* Shrubland [NIOB MC204]**

9b The dwarf shrub layer is dominated by *Artemisia frigida* with a cover of ~50%. The herbaceous layer is split fairly evenly between graminoids and forbs. Dominant graminoids include *Calamovilfa longifolia* (20%) and *Koeleria macrantha* (10%). Dominant forbs include *Heterotheca canescens* (20%) and *Chamaesyce missurica* (10%) ....**CEGL002177 *Artemisia filifolia/Calamovilfa longifolia* Shrubland [NIOB MC205]**

10a *Prunus virginiana* and/or *Prunus americana* is the dominant shrub. Total shrub cover may be open with a low of about 30% to dense with cover approaching 100%. Other shrubs that may be present to nearly co-dominant include *Prunus americana*, *Rhus trilobata*, *Salix interior*, *Amorpha canescens*, *Rosa woodsii*, *Symphoricarpos occidentalis*, and *Toxicodendron rydbergii*..... .....**CEGL005453 *Prunus virginiana* Great Plains Shrubland [NIOB MC203]**

10b *Rhus glabra* typically forms a moderate to dense cover (30%-80%). Other shrubs that occur and may co-dominate include *Symphoricarpos occidentalis* and *Rosa woodsii*. Graminoids typically have greater abundance than forbs often with many warm season graminoids such as *Schizachyrium scoparium, Panicum virgatum, Andropogon* spp., etc. or invasives such as *Poa pratensis,* or *Bromus inermis.* This community may occur in areas with *Juniperus virginiana* clearing and potentially prescribed fire..... .....**NPSNIOB004 *Rhus glabra* Mixedgrass Shrubland [NIOB MC202]**

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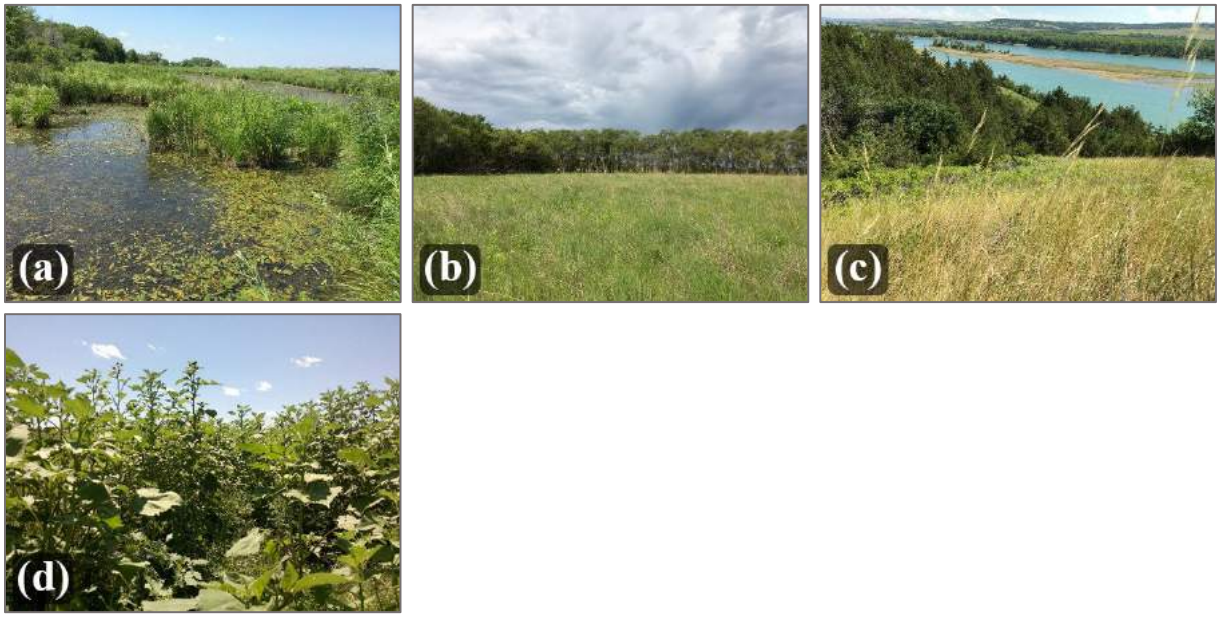
Division C – Herbaceous Associations

Herbaceous associations are dominated by forbs and grasses or grass-like species. They may contain shrubs, and occasional trees at low cover levels. Typically, shrub or tree species present in a grassland will be widely scattered and have low cover values of less than 10 - 15%.

Herbaceous communities within the area of the unit may be either riparian and wetland types, or upland types that occur away from areas of wet soils. Many of the herbaceous types exhibit a large amount of overlap in their species composition and can be difficult to classify in the field. This is particularly true of the wetland and riverine types that tend to form a mosaic of two to four species that range from complete monocultures to equally co-dominant across short distances the size of the MMU or smaller. Issues of scale and pattern become very important considerations in discerning the most appropriate type to select.



Examples of (a) wetland, (b) upland, (c) grassland, (d) forb-land.

1a Site is located in an upland area away from riparian or wetland settings and the herbaceous stratum is dominated by terrestrial plants. ....(2a)

1b Site is located in a wetland or riparian setting and the herbaceous stratum is dominated by mesic and wetland species such as *Phalaris arundinacea*, *Phragmites australis*, *Carex* spp. and *Typha* spp. ....(17a)

2a Herbaceous stratum is dominated by non-native or ruderal species. These may include *Poa pratensis*, *Bromus inermis*, *Bromus tectorum*, *Helianthus annuus*, *Euphorbia esula, Ambrosia psilostachya* or others..... .....(3a)

2b Herbaceous stratum is dominated by native species such as *Andropogon gerardii*, *Andropogon hallii*, *Calamovilfa longifolia*, *Panicum virgatum*, *Schizachyrium scoparium*, *Hesperostipa*

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comata, Sorghastrum nutans, or others..... .....(9a)

3a Sites is dominated by one or more of the following species *Melilotus officinalis*, *M. albus*, *Cirsium* spp., *Euphorbia esula*, *Verbascum thapsus*, *Medicago sativa*, *Conyza canadensis*, *Ambrosia* spp., *Arcticum minus*, *Cannabis sativa*, *Helianthus* spp., *Achillea millefolium*, *Rumex* sp., *Solidago* sp., etc. Sites usually had some component of ruderal grasses (*Poa pratensis*, *Bromus inermis*, *Bromus tectorum*, *Bromus japonicus*) but were always dominated by forbs. Bare ground was also common with up to 25% in most areas. *M. officinalis* monocultures often had bare ground estimates greater than 65%..... **.....**
NPSNIOB002 Weedy Forb Ruderal Herbaceous Vegetation [NIOB MC101]

3b Herbaceous stratum is dominated by non-native graminoides..... .....(4a)

4a Site is possibly located in what appears to be an old agricultural field. Common species include *Koeleria macrantha*, *Agropyron cristatum*, *Thinopyrum intermedium*, and *Elymus canadensis*. Other species that may be present, but do not dominate include *Bromus inermis*, *Bromus tectorum*, and/or *Poa pratensis*.....**NPSNIOB005 Ruderal Herbaceous Grassland [NIOB MC101]**

4b Site is dominated by one or two non-native graminoids such as *Bromus inermis*, *Bromus tectorum*, or *Poa pratensis* ....(5a)

5a The herbaceous layer is dominated by one or more Bromus species..... .....(6a)

5b The herbaceous layer is dominated or co-dominated by Poa pratensis and may include one to several species of native tallgrasses ....(7a)

6a *Bromus inermis* forms a moderately dense to dense cover that may create a monoculture. It is the dominant species with cover of about 60-90%. Other invasive species such as *Cirsium arvense*, *Verbascum thapsus*, *Nepeta cataria*, and *Poa pratensis* may occur as well. Native species present with low cover may include *Pascopyrum smithii*, *Deschampsia caespitosa*, and *Hesperostipa comata*. Forbs present may include *Ambrosia psilostachya* and *Verbena stricta*. These sites may also contain occasional sparse shrub cover of *Symphoricarpos* spp., and others. .....**CEGL005264 *Bromus inermis*-(*Pascopyrum smithii*) Ruderal Grassland [NIOB MC101]**

6b *Bromus tectorum* dominates the herbaceous layer with 80-90% of the total cover. Other invasive annual species of *Bromus* that may also be present to dominant include *Bromus hordeaceus*, *Bromus arvensis*, or *Bromus rubens*. Trace amounts of various native grasses may be present, but have insignificant cover relative to the *Bromus* spp. .....**CEGL003019 *Bromus tectorum* Ruderal Grassland [NIOB MC101]**

7a Site is relatively mesic due to occasional flooding, proximity to groundwater, or slope position. However, this type may occur in upland settings as well. Vegetation is dominated by a moderate to dense cover of *Poa pratensis* with additional cover of other ruderal species such

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as *Achillea millefolium*, *Cirsium arvense*, *Elymus repens*, *Equisetum* spp., *Fragaria virginiana*, *Hordeum* spp., *Juncus balticus*, *Linaria vulgaris*, *Potentilla gracilis*, *Taraxacum officinale*, and introduced forage species such as *Agrostis stolonifera*, *Bromus inermis*, and *Phleum pratense*. Remnants of the original natural community that may occasionally present with low cover are *Pascopyrum smithii*, *Deschampsia caespitosa*, and *Carex* spp. Occasional trees and shrubs may also be present. .....**CEGL003081 *Poa pratensis* Ruderal Marsh [NIOB MC101]**

7b Plot composition not as above..... .....(8a)

8a *Poa pratensis* and *Bromus inermis* are dominant to co-dominant and form a moderately dense to dense cover. Other ruderal species such as *Cirsium arvense*, *Verbascum thapsus*, *Nepeta cataria*, and *Poa pratensis* may occur as well. Native species present with low cover may include remnants of the original natural community such as *Pascopyrum smithii*, *Deschampsia caespitosa*, and *Hesperostipa comata*. Forbs present may include *Ambrosia psilostachya* and *Verbena stricta*. These sites may also contain occasional sparse shrub cover of *Symphoricarpos* spp., and others.....**CEGL005264 *Bromus inermis*-(*Pascopyrum smithii*) Ruderal Grassland [NIOB MC101]**

8b *Poa pratensis* is dominant to co-dominant with cover of about 50% or more. Native tall grasses, such as *Sorghastrum nutans* and *Andropogon gerardii* may be co-dominate to sub-dominant. Forbs may include *Medicago sativa* and *Ratibida pinnata*. The native and forb associates are usually not abundant and typically have cover of less than about 30%..... **CEGL002023 *Andropogon gerardii-Panicum virgatum* Sandhills Grassland [NIOB MC102b]**

9a *Hesperostipa comata, Sporobolus cryptandrus, Calamovilfa longifolia,* or *Bouteloua gracilis* forms a major component of the herbaceous layer (cover >30%) ....(10a)

9b Not as above. Site is dominated by *Andropogon* spp. or *Schizachyrium scoparium*.....(12a)

10a Herbaceous layer is usually composed of mid to tall grasses. Common species include a mix of *Calamovilfa longifolia, Hesperostipa comata, Sporobolus cryptandrus,* and *Bouteloua gracilis*.....**CEGL001473 *Calamovilfa longifolia-Hesperostipa comata* Grassland [NIOB MC102c]**

10b Not as above. *Calamovilfa longifolia* and *Sporobolus cryptandrus* are not a major component of the cover..... .....(11a)

11a Site is dominated by a mix of mid to shortgrass species. Vegetation cover is moderate but never dense. *Hesperostipa comata* is the characteristic species on these sites; with cover generally greater than 50%. *Bouteloua gracilis* tends to co-dominate. Other graminoids may include *Poa pratensis* and *Dichanthelium oligosanthes*. Forbs tend to have generally less than 20% cover. Common forbs present are *Ambrosia psilostachya* and *Croton texensis*.....

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A4033 *Hesperostipa comata* Northwestern Great Plains Grassland Alliance [NIOB MC102c]

11b Sites are dominated by cool-season graminoids such as *Pascopyrum smithii* and *Hesperostipa comata*. Common associates include *Bouteloua curtipendula*, *Bouteloua gracilis*, *Schizachyrium scoparium*, and *Andropogon gerardii*. Shrubs are fairly rare in the community with only the occasional *Artemisia frigida*, *Rosa arkansana*, *Yucca glauca*, or *Symphoricarpos occidentalis* .....**CEGL002034 *Pascopyrum smithii-Hesperostipa comata* Central Mixedgrass Grassland [NIOB MC102c]**

12a Herbaceous layer is dominated by *Andropogon* spp. or *Sorghastrum nutans* .. .. (13a)

12b Not as above. Herbaceous layer is dominated by *Schizachyrium scoparium* without *Andropogon* spp. ....(16a)

13a Sites is dominated by *Andropogon hallii* ....(14a)

13b Sites is dominated by *Andropogon gerardii* or *Sorghastrum nutans*..... .....(15a)

14a Sites is primarily herbaceous with cover ranging from 70% to 90%. *Andropogon hallii* and *Calamovilfa longifolia* may co-dominate the sites; however, sites do not always contain both. Other common graminoids include *Dichanthelium oligosanthes*, *Bouteloua hirsuta*, *Bouteloua gracilis*, *Cyperus schweinitzii*, and *Panicum virgatum*. Dwarf shrubs are often present with cover sometimes reaching 50%. *Rosa woodsii* is the most common shrub, but *Prunus americana* and *Prunus virginiana* may be present with moderate to dense cover on the dunes **CEGL001467 *Andropogon hallii-Calamovilfa longifolia* Herbaceous Vegetation [NIOB MC102d]**

14b Sites have a high cover of *Andropogon hallii* around 60%. Other graminoids, such as *Schizachyrium scoparium, Panicum virgatum, Poa pratensis,* and *Eragrostis trichodes*, are common and may co-dominate with *Andropogon hallii*. Forbs tend to be abundant as well with cover ranging from 20% to 50%. *Ambrosia psilostachya, Artemisia ludoviciana,* and *Helianthus pauciflorus* tend to be common forbs within this type ....**A1193 *Andropogon hallii* Sand Prairie Alliance [NIOB MC102d]**

15a *Andropogon gerardii* dominates the herbaceous layer with cover greater than 50%. Other graminoids may include *Schizachyrium scoparium, Panicum virgatum, Bouteloua gracilis,* and *Andropogon hallii*. *Ambrosia psilostachya* dominates the forb layer with cover up to 40%. This type occurs mostly in interdunal valleys and floodplains of streams and rivers..... **CEGL002023 *Andropogon gerardii-Panicum virgatum* Sandhills Grassland [NIOB MC102b]**

15b *Sorghastrum nutans* is the dominant species with cover values ranging from 40% to 90%; *Schizachyrium scoparium* or *Andropogon gerardii* frequently co-dominates with cover values between 30% and 60%. Other common graminoids present may include *Carex* spp.,

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Dichanthelium oligosanthes, and *Bouteloua* spp. *Ambrosia psilostachya* is a common forb among these sites along with *Rudbeckia hirta*..... ..... **CEGL002025 *Andropogon gerardii-Sorghastrum nutans-Hesperostipa spartea* Loess [NIOB MC102b]**

16a *Schizachyrium scoparium* dominates with other common species such as *Bouteloua curtipendula, Panicum virgatum,* and *Hesperostipa comata.* Forb cover tends to be low (~20% cover); common species include *Ambrosia psilostachya* and *Helianthus pauciflorus.* The herbaceous stratum is usually moderately dense with cover between 60%-70%. ..... **A4042 *Schizachyrium scoparium-Bouteloua curtipendula* Central Plains Grassland Alliance [NIOB MC102a]**

16b *Schizachyrium scoparium* dominates the grassland with cover >50%. Poa pratensis occasionally co-dominates with cover between 70%-90%. Other common graminoids include *Hesperostipa comata, Panicum virgatum,* and *Bromus japonicus. Ambrosia psilostachya* is the dominant forb with cove values between 10%-50%. Common forbs include *Ratibida columnifera, Helianthus* spp., and *Verbena* spp..... **CEGL005221 *Schizachyrium scoparium-Aristida basiramea-Sporobolus cryptandrus-Eragrostis trichodes* Grassland [NIOB MC102a]**

17a Area is either a vegetated sandbar in the river or inundated or regularly flooded usually with standing water >4” ....(18a)

17b Area is saturated but not regularly flooded, such as a wet meadow ....(23a)

18a Site retains standing water usually >4” or is regularly flooded. Water will usually fill in footprints. Typical species include *Phalaris arundinacea, Phragmites australis, Schoenoplectus tabernaemontani,* and *Typha* spp. ....(19a)

18b Site occurs on a vegetated sand bar..... .....(22a)

19a Herbaceous stratum is dominated by *Phalaris arundinacea* and/or *Phragmites australis*.. ..... (20a)

19b Herbaceous stratum is dominated by *Schoenoplectus tabernaemontani* or *Typha* spp. .....(21a)

20a *Phalaris arundinacea* is the dominant plant with cover ranging from 40% to 100%. *Phragmites australis* may be present with cover up to 20%..... **CEGL001474 Phalaris arundinacea Western Marsh [NIOB MC103]**

20b *Phragmites australis* co-dominates with *Phalaris arundinacea* with roughly equal cover of ~90%. Other plants that may be present are *Xanthium strumarium*, *Euphorbia esula*, and *Cirsium canadensis* ..... **CEGL001475 Phragmites australis Western Ruderal Wet Meadow [NIOB MC104]**

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21a The site is dominated by *Schoenoplectus tabernaemontani* with lesser amounts of *Typha latifolia*. *Phragmites australis* may invade this type. Shrubs surrounding these communities include *Amorpha fruticosa* and *Salix interior*. In shallower sites, other common species include *Carex lacustris, Polygonum amphibium,* and *Sparganium eurycarpum*..... **CEGL002030 *Schoenoplectus acutus-Typha latifolia-(Schoenoplectus tabernaemontani)* Sandhills Marsh [NIOB MC104]**

21b *Typha* spp. dominates this type. *Schoenoplectus tabernaemontani* often co-dominates this type. Additionally, *Phalaris arundinacea* may invade this type. Common associates include *Eleocharis* spp. and *Sagittaria latifolia*.....**CEGL002389 *Typha* spp. Great Plains Marsh [NIOB MC104]**

22a Site is a sandbar recently reworked by river flows. Community composition may be highly variable, with vegetation cover of 20%-80%. The majority of the vegetation cover is herbaceous. Common species include *Carex* spp., *Juncus* spp., *Cyperus* spp., *Equisetum arvense, Lythrum salicaria, Bidens* spp., *Persicaria* spp., *Polygonum* spp., *Schoenoplectus* spp., *Xanthium strumarium,* and *Eleocharis* spp. If shrubs are present, they may include *Amorpha fruticosa, Salix interior,* or *Populus deltoides*.....**NPSNIOB008 Seasonally Flooded, Early Successional Herbaceous Sandbar Complex [NIOB MC105]**

22b On large point bars where reworking of the sandbar does occur regularly. *Cyperus* spp. thrives and dominates the vegetation. Herbaceous cover is generally <25%, but may occur at higher covers. Dominate species may include *Cyperus erythrorhizos, Cyperus odoratus,* and *Leersia oryzoides* .....**CEGL002049 Riverine Sand Flats-Bars Sparse Vegetation [NIOB MC401]**

23a Vegetation is dominated by a moderate to dense cover of *Poa pratensis* with additional cover of other ruderal species such as *Achillea millefolium*, *Cirsium arvense*, *Elymus repens*, *Equisetum* spp., *Fragaria virginiana*, *Hordeum* spp., *Juncus balticus*, *Linaria vulgaris*, *Potentilla gracilis*, *Taraxacum officinale*, and introduced forage species such as *Agrostis stolonifera*, *Bromus inermis*, and *Phleum pratense*. Other species present with low cover may include the remnants of the original natural community such as *Pascopyrum smithii*, *Deschampsia caespitosa*, and *Carex* spp. Occasional trees and shrubs may also be present. .....**CEGL003081 *Poa pratensis* Ruderal Marsh [NIOB MC101]**

23b Vegetation is dominated by *Phalaris*, *Phragmites,* or *Carex* spp. ....(24a)

24a Vegetation is dominated by *Carex* spp. Total cover ranges between 70% and 90%. Common species are *Carex pellita*, *C. vulpinoidea, C. molesta, C. stipata,* and *C. tribuloides*, but *Eleocharis* spp. along with *Juncus interior, J. torreyi,* and *Solidago* spp. are typically present as well.....**CEGL005272 *Carex* spp.-(*Carex pellita, Carex vulpinoidea*) Wet Meadow [NIOB MC105]**

24b Vegetation is dominated by *Phalaris arundinacea* or *Phragmites australis* ... .(25a)

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25a *Phalaris arundinacea* is the dominant plant with cover ranging from 40% to 100%. It may take over the entire area, but occasionally *Phragmites australis* occurs within the type with low cover..... **CEGL001474 *Phalaris arundinacea* Western Marsh [NIOB MC103]**

25b *Phragmites australis* forms monospecific dense stands, or *Phragmites australis* co-dominates with *Phalaris arundinacea* with roughly equal covers of ~90%. Other species that may be present are *Xanthium strumarium, Euphorbia esula,* and *Cirsium canadensis* ..... **CEGL001475 *Phragmites australis* Western Ruderal Wet Meadow [NIOB MC104]**

Division D – Sparse Associations

Sparse associations generally have <10% vegetated cover and tend to occur on rock outcrops or sandbars.

Examples of (a) outcrops and (b) sandbars (CNHP)

1a Area is next to or on a rock outcrop .....(2a)

1b Area is a sand bar next to or in the river.....(5a)

2a Rock outcrop is siltstone or sandstone; individual sediment grains within the rock are visible using a standard hand lens (10x) .....(3a)

2b Rock outcrop is limestone, dolostone, or shale; individual sediment grains are not visible within the rock using a standard hand lens (10x).....(4a)

3a Substrate is gravel from siltstone rock outcrops. These sites occur on steep cliffs near the river with slopes generally <45˚. Vegetation is sparse to absent. *Salsola collina, Solanum rostratum, Euphorbia marginata,* and *Astragalus racemosus* may be present with only a few individuals .....
CEGL002047 Siltstone-Sandstone Rock Outcrop Sparse Vegetation [NIOB MC402]

3b Community is largely confined to sandstone or siltstone cliffs with slopes >60%. Vegetation is sparse with occasional *Mentzelia decapetala* and *Penstemon glaber*. ....**CEGL005257 Sandstone Great Plains Dry Cliff Sparse Vegetation [NIOB MC402]**

4a Community occurs on eroded slopes of Niobrara Chalk. Vegetation is sparse and steeper cliffs are un-vegetated occasionally with a few individuals of *Mentzelia decapetala*. .....
CEGL002046 Limestone-Dolostone Great Plains Xeric Cliff Sparse Vegetation [NIOB MC402]

4b This sparse vegetation type has total vegetation cover <10% and occurs on flat to moderate slopes of exposed Pierre, Carlile, and Granerous shale formations .....
.....**CEGL002294 Shale Barren Slopes Sparse Vegetation [NIOB MC402]**

5a Vegetation typically includes low herbaceous cover (~10%) with species such as *Cyperus erythrorhizos, Cyperus odoratus,* and *Leersia oryzoides,* but may also have vigorous

herbaceous patches. On large stable point bars, herbaceous cover sometimes reaches 90% over small areas with the main species of *Cyperus erythrorhizos*, *Cyperus odoratus*, and *Leersia oryzoides*.....**CEGL002049 Riverine Sand Flats-Bars Sparse Vegetation [NIOB MC401]**

5b There is almost no vegetation present on these alluvial bars; if present, herbaceous vegetation is <1%. Alluvial bars in this type are constantly being reworked and recolonized. Substrate comprising this depositional bar can be sand, gravel, shale, or mud. **NPSNIOB011 Bare Alluvial Depositional Bar [NIOB MC401]**

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Appendix C: List of Plant Species Documented During Plot Sampling at NIOB

Plant Taxon Name	USDA Plants Taxon Code
Achillea millefolium	ACMI2
Acer negundo	ACNE2
Ageratina altissima	AGALA
Agropyron cristatum	AGCR
Agrostis hyemalis	AGHY
Agrostis stolonifera	AGST2
Agalinis tenuifolia	AGTE3
Alopecurus arundinaceus	ALAR
Ambrosia artemisiifolia	AMAR2
Amphicarpaea bracteata	AMBR2
Amorpha canescens	AMCA6
Amorpha fruticosa	AMFR
Ambrosia psilostachya	AMPS
Ammannia robusta	AMRO3
Anemone canadensis	ANCA8
Anemone cylindrica	ANCY
Andropogon sp.	ANDRO
Andropogon gerardii	ANGE
Andropogon hallii	ANHA
Antennaria parviflora	ANPA4
Apocynum cannabinum	APCA
Apocynum sp.	APOCY
Aquilegia canadensis	AQCA
Aristida basiramea	ARBA2
Artemisia campestris	ARCA12
Artemisia dracunculus	ARDR4
Artemisia frigida	ARFR4
Artemisia ludoviciana	ARLU
Aralia nudicaulis	ARNU2
Argemone polyanthemos	ARPO2

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Plant Taxon Name	USDA Plants Taxon Code
Asclepias sp.	ASCLE
Asclepias syriaca	ASSY
Aster sp.	ASTER
Asclepias verticillata	ASVE
Betula papyrifera	BEPA
Bidens cernua	BICE
Bidens sp.	BIDEN
Botrychium campestre	BOCA5
Bouteloua curtipendula	BOCU
Boehmeria cylindrica	BOCY
Bolboschoenus fluviatilis	BOFL3
Bouteloua gracilis	BOGR2
Bouteloua hirsuta	BOHI2
Bouteloua sp.	BOUTE
Bromus arvensis	BRAR5
Brickellia eupatorioides	BREU
Bromus inermis	BRIN2
Bromus sp.	BROMU
Bromus tectorum	BRTE
Carex blanda	CABL
Carex brevior	CABR10
Cactus	CACTU
Carex granularis	CAGR3
Carex hystericina	CAHY4
Calamovilfa longifolia	CALO
Carex molesta	CAMO11
Carex praegracilis	CAPR5
Carex sp.	CAREX
Campanula rotundifolia	CARO2
Cannabis sativa	CASA3
Carex sprengelii	CASP7
Carex tetanica	CATE6
Cenchrus longispinus	CELO3

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Plant Taxon Name	USDA Plants Taxon Code
Celtis occidentalis	CEOC
Celastrus scandens	CESC
Chenopodium sp.	CHENO
Chamaecrista fasciculata	CHFAF
Chamaesyce missurica	CHMI8
Chamaesyce serpens	CHSE4
Chenopodium simplex	CHSI2
Chorispora tenella	CHTE2
Cirsium altissimum	CIAL2
Cirsium arvense	CIAR4
Circaea lutetiana	CILU
Cirsium sp.	CIRSI
Cirsium undulatum	CIUN
Cirsium vulgare	CIVU
Convolvulus arvensis	COAR4
Conyza canadensis	COCA5
Commelina communis	COCO3
Commelina erecta	COER
Coreopsis grandiflora	COGR5
Cornus sericea	COSE16
Croton texensis	CRTE4
Cyperus acuminatus	CYAC2
Cycloloma atriplicifolium	CYAT
Cyperus bipartitus	CYBI6
Cyperus odoratus	CYOD
Cyperus sp.	CYPER
Cyperus schweinitzii	CYSC3
Cyperus strigosus	CYST
Dalea candida	DACA7
Dalea enneandra	DAEN
Dalea purpurea	DAPU5
Dalea villosa	DAVI
Desmodium glutinosum	DEGL5

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Plant Taxon Name	USDA Plants Taxon Code
Desmanthus illinoensis	DEIL
Dichanthelium acuminatum	DIAC2
Dichanthelium sp.	DICHA
Dichanthelium oligosanthes	DIOL
Dichanthelium wilcoxianum	DIWI5
Echinacea angustifolia	ECAN2
Echinochloa muricata	ECMU2
Eleocharis acicularis	ELAC
Elymus canadensis	ELCA4
Eleocharis elliptica	ELEL4
Eleocharis sp.	ELEOC
Eleocharis parvula	ELPA5
Elymus trachycaulus	ELTR7
Elymus virginicus	ELVI3
Elymus sp.	ELYMU
Equisetum arvense	EQAR
Equisetum hyemale	EQHY
Eragrostis sp.	ERAGR
Eriogonum annuum	ERAN4
Erigeron bellidiastrum	ERBE2
Erigeron sp.	ERIGE
Erigeron philadelphicus	ERPH
Eragrostis spectabilis	ERSP
Eragrostis trichodes	ERTR3
Euphorbia cyathophora	EUCY
Euphorbia esula	EUES
Euphorbia hexagona	EUHE5
Eutrochium maculatum	EUMA9
Eupatorium perfoliatum	EUPE3
Ferns	FERNS
Froelichia floridana	FRFL
Froelichia gracilis	FRGR3
Fraxinus pennsylvanica	FRPE

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Plant Taxon Name	USDA Plants Taxon Code
Galium aparine	GAAP2
Galium circaezans	GACI2
Galium sp.	GALIU
Galium triflorum	GATR3
Geum canadense	GECA7
Glyceria grandis	GLGR
Glechoma hederacea	GLHE2
Glycyrrhiza lepidota	GLLE3
Glyceria striata	GLST
Gleditsia triacanthos	GLTR
Glyceria sp.	GLYCE
Gutierrezia sarothrae	GUSA2
Hackelia virginiana	HAVI2
Helianthus annuus	HEAN3
Heterotheca canescens	HECA8
Hesperostipa comata	HECO26
Helianthus grosseserratus	HEGR4
Heliopsis helianthoides	HEHE5
Helianthus sp.	HELIA
Helianthus nuttallii	HENU
Helianthus pauciflorus	HEPA19
Hesperostipa spartea	HESP11
Heterotheca stenophylla	HEST3
Hordeum pusillum	HOPU
Impatiens capensis	IMCA
Ipomopsis longiflora	IPLO2
Ipomea sp.	IPOME
Juncus arcticus	JUARL
Juncus dudleyi	JUDU2
Juncus sp.	JUNCU
Juglans nigra	JUNI
Juncus nodosus	JUNO2
Juncus torreyi	JUTO

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Plant Taxon Name	USDA Plants Taxon Code
Juniperus virginiana	JUVI
Koeleria macrantha	KOMA
Lactuca canadensis	LACA
Laportea canadensis	LACA3
Lactuca sp.	LACTU
Lactuca serriola	LASE
Leonurus cardiaca	LECA2
Lemna sp.	LEMNA
Leersia oryzoides	LEOR
Lithospermum caroliniense	LICA13
Liatris punctata	LIPU
Linum rigidum	LIRI
Liatris squarrosa	LISQ
Lobelia siphilitica	LOSI
Lygodesmia juncea	LYJU
Lythrum salicaria	LYSA2
Machaeranthera pinnatifida	MAPI
Maianthemum stellatum	MAST4
Mentha arvensis	MEAR4
Melilotus sp.	MELIL
Medicago lupulina	MELU
Mentzelia nuda	MENU
Melilotus officinalis	MEOF
Medicago sativa	MESA
Mirabilis linearis	MILI3
Mimosa nuttallii	MINU6
Morus alba	MOAL
Monarda fistulosa	MOFI
Muhlenbergia asperifolia	MUAS
Muhlenbergia cuspidata	MUCU3
Muhlenbergia filiformis	MUFI2
Muhlenbergia sp.	MUHLE
Muhlenbergia pungens	MUPU2

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Plant Taxon Name	USDA Plants Taxon Code
Muhlenbergia racemosa	MURA
Nassella viridula	NAVI4
Nepeta cataria	NECA2
Oenothera rhombipetala	OERH
Oligoneuron rigidum	OLRIR
Onopordum acanthium	ONAC
Onosmodium bejariense	ONBEB
Opuntia fragilis	OPFR
Opuntia humifusa	OPHU
Osmorhiza claytonii	OSCL
Ostrya virginiana	OSVI
Oxalis stricta	OXST
Panicum capillare	PACA6
Panicum sp.	PANIC
Parietaria pensylvanica	PAPE5
Parthenocissus quinquefolia	PAQU2
Paspalum setaceum	PASE5
Pascopyrum smithii	PASM
Paspalum sp.	PASPA
Panicum virgatum	PAVI2
Pediomelum argophyllum	PEAR6
Pediomelum cuspidatum	PECU3
Penstemon grandiflorus	PEGR7
Penstemon sp.	PENST
Phalaris arundinacea	PHAR3
Phragmites australis	PHAU7
Physalis heterophylla	PHHE5
Physalis hispida	PHHI8
Phryma leptostachya	PHLE5
Physalis longifolia	PHLO4
Phleum pratense	PHPR3
Physalis sp.	PHYSA
Piptatheropsis micrantha	PIMI

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Plant Taxon Name	USDA Plants Taxon Code
Pinus ponderosa	PIPO
Pilea pumila	PIPU2
Plantago major	PLMA2
Plantago patagonica	PLPA2
Populus deltoides	PODE3
Polygonum hydropiperoides	POHY2
Polygonum sp.	POLYG
Polygonum persicaria	POPE3
Poa pratensis	POPR
Polygonum punctatum	POPU5
Populus x smithii	POSM2
Populus tremuloides	POTR5
Prunus americana	PRAM
Prunus pumila	PRPU3
Prunus sp.	PRUNU
Prunus virginiana	PRVI
Prunella vulgaris	PRVU
Pycnanthemum virginianum	PYVI
Quercus macrocarpa	QUMA2
Ratibida columnifera	RACO3
Redfieldia flexuosa	REFL
Rhus aromatica	RHAR4
Rhus glabra	RHGL
Rhus trilobata	RHTR
Ribes americanum	RIAM2
Ribes aureum	RIAU
Ribes missouriense	RIMI
Rosa arkansana	ROAR3
Rosa woodsii	ROWO
Rudbeckia hirta	RUHI2
Rudbeckia laciniata	RULA3
Rubus occidentalis	RUOC
Salix amygdaloides	SAAM2

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Plant Taxon Name	USDA Plants Taxon Code
Sanicula candensis	SACA15
Salix eriocephala	SAER
Salix exigua	SAEX
Salix interior	SAIN3
Sagittaria latifolia	SALA2
Salix sp.	SALIX
Salix lutea	SALU2
Salsola tragus	SATR12
Schoenoplectus acutus	SCACA
Scrophularia lanceolata	SCLA
Scutellaria parvula	SCPA7
Scirpus pallidus	SCPA8
Schoenoplectus pungens	SCPU10
Schizachyrium scoparium	SCSC
Schoenoplectus tabernaemontani	SCTA2
Setaria pumila	SEPUP2
Setaria viridis	SEVI4
Shepherdia argentea	SHAR
Sisymbrium altissimum	SIAL2
Smilax lasioneura	SMLA3
Solanum carolinense	SOCA3
Solidago canadensis	SOCA6
Solidago gigantea	SOGI
Solanum sp.	SOLAN
Solidago sp.	SOLID
Solidago missouriensis	SOMI2
Solidago mollis	SOMO
Solidago nemoralis	SONE
Solanum nigrum	SONI
Sorghastrum nutans	SONU2
Solanum rostratum	SORO
Solidago speciosa	SOSP2
Sparganium sp.	SPARG

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Plant Taxon Name	USDA Plants Taxon Code
Sporobolus cryptandrus	SPCR
Sparganium eurycarpum	SPEU
Sporobolus sp.	SPORO
Spartina pectinata	SPPE
Strophostyles helvola	STHE9
Strophostyles leiosperma	STLE6
Symphyotrichum ericoides	SYERE
Symphyotrichum laeve	SYLAL3
Symphiotrichum novae-angliae	SYNO2
Symphoricarpos occidentalis	SYOC
Taraxacum officinale	TAOF
Teucrium canadense	TECA3
Thalictrum dasycarpum	THDA
Tilia americana	TIAM
Toxicodendron radicans	TORA2
Toxicodendron rydbergii	TORY
Tragopogon dubius	TRDU
Tridens flavus	TRFL2
Trifolium sp.	TRIFO
Tradescantia occidentalis	TROC
Trifolium pratense	TRPR2
Typha angustifolia	TYAN
Typha latifolia	TYLA
Ulmus americana	ULAM
Ulmus pumila	ULPU
Ulmus rubra	ULRU
Ulmus thomasii	ULTH
Urtica dioica	URDI
Veronica americana	VEAM2
Verbena hastata	VEHA2
Verbena sp.	VERBE
Verbena stricta	VEST
Verbascum thapsus	VETH

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Plant Taxon Name	USDA Plants Taxon Code
Verbena urticifolia	VEUR
Viola sp.	VIOLA
Vitis riparia	VIRI
Xanthium strumarium	XAST
Yucca glauca	YUGL
Zanthoxylum americanum	ZAAM

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Appendix D: List of Plots and Classified Vegetation Associations

Plot code	Classified code	Scientific name
0002	CEGL000873	*Pinus ponderosa*/*Quercus macrocarpa* Open Woodland
0003	NPSNIOB012	*Pinus ponderosa*/*Juniperus virginiana* Open Woodland
0010	CEGL000628	*Acer negundo*/*Prunus virginiana* Floodplain Forest
0013	NPSNIOB003	*Quercus macrocarpa*/*Juniperus virginiana* Ruderal Forest
0014	CEGL001467	*Andropogon hallii-Calamovilfa longifolia* Grassland
0016	CEGL001467	*Andropogon hallii-Calamovilfa longifolia* Grassland
0020	NPSNIOB004	*Rhus glabra* Mixedgrass Shrubland
0025	CEGL005257	Sandstone Great Plains Dry Cliff Sparse Vegetation
0038	CEGL000658	*Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest
0044	CEGL005257	Sandstone Great Plains Dry Cliff Sparse Vegetation
0045	CEGL000201	*Pinus ponderosa*/*Schizachyrium scoparium* Open Woodland
0046	CEGL002012	*Tilia americana*-(*Quercus macrocarpa*)/*Ostrya virginiana* Forest
0048	CEGL002012	*Tilia americana*-(*Quercus macrocarpa*)/*Ostrya virginiana* Forest
0050	CEGL000201	*Pinus ponderosa*/*Schizachyrium scoparium* Open Woodland
0051	CEGL000873	*Pinus ponderosa*/*Quercus macrocarpa* Open Woodland
0052	CEGL002013	*Betula papyrifera*-(*Tilia americana, Quercus macrocarpa*) Canyon Forest
0055	CEGL000628	*Acer negundo*/*Prunus virginiana* Floodplain Forest
0056	A4042	*Schizachyrium scoparium-Bouteloua curtipendula* Centeral Great Plains Grassland Alliance
0059	NPSNIOB002	Weedy Forb Ruderal Herbaceous
0060	NPSNIOB013	*Quercus macrocarpa*/*Juniperus virginiana*/*Elymus virginicus* Woodland
0061	CEGL001467	*Andropogon hallii-Calamovilfa longifolia* Grassland
0062	CEGL005221	*Schizachyrium scoparium-Aristida basiramea-Sporobolus cryptandrus-Eragrostis trichodes*
0063	A4042	*Schizachyrium scoparium-Bouteloua curtipendula* Centeral Great Plains Grassland Alliance
0064	CEGL005264	*Bromus inermis*-(*Pascopyrum smithii*) Ruderal Grassland
0065	NPSNIOB003	*Quercus macrocarpa*/*Juniperus virginiana* Ruderal Forest

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Plot code	Classified code	Scientific name
0066	NPSNIOB013	*Quercus macrocarpa*/*Juniperus virginiana*/*Elymus virginicus* Woodland
0067	CEGL002025	*Andropogon gerardii-Sorghastrum nutans-Hesperostipa spartea* Loess Hills Grassland
0068	NPSNIOB004	*Rhus glabra* Mixedgrass Shrubland
0069	NPSNIOB002	Weedy Forb Ruderal Herbaceous
0070	NPSNIOB004	*Rhus glabra* Mixedgrass Shrubland
0071	CEGL001131	*Symphoricarpos occidentalis* Shrubland
0074	A1193	*Andropogon hallii Sand Prairie* Alliance
0076	CEGL001131	*Symphoricarpos occidentalis* Shrubland
0077	CEGL000873	*Pinus ponderosa*/*Quercus macrocarpa* Open Woodland
0078	CEGL002012	*Tilia americana*-(*Quercus macrocarpa*)/*Ostrya virginiana* Forest
0079	NPSNIOB002	Weedy Forb Ruderal Herbaceous
0080	CEGL005257	Sandstone Great Plains Dry Cliff Sparse Vegetation
0081	CEGL000628	*Acer negundo*/*Prunus virginiana* Floodplain Forest
0082	NPSNIOB005	Ruderal Grassland
0083	CEGL005257	Sandstone Great Plains Dry Cliff Sparse Vegetation
0084	NPSNIOB013	*Quercus macrocarpa*/*Juniperus virginiana*/*Elymus virginicus* Woodland
0085	CEGL000873	*Pinus ponderosa*/*Quercus macrocarpa* Open Woodland
0086	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
0087	CEGL000658	*Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest
0088	NPSNIOB005	Ruderal Grassland
0089	CEGL001467	*Andropogon hallii-Calamovilfa longifolia* Grassland
0090	NPSNIOB013	*Quercus macrocarpa*/*Juniperus virginiana*/*Elymus virginicus* Woodland
0091	CEGL000201	*Pinus ponderosa*/*Schizachyrium scoparium* Open Woodland
0092	CEGL005221	*Schizachyrium scoparium-Aristida basiramea-Sporobolus cryptandrus-Eragrostis trichodes*
0093	A4033	*Hesperostipa comata Northwestern* Great Plains Grassland Alliance
0096	NPSNIOB002	Weedy Forb Ruderal Herbaceous
0099	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
0100	CEGL000658	*Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest

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Plot code	Classified code	Scientific name
0101	CEGL002013	*Betula papyrifera*-(*Tilia americana, Quercus macrocarpa*) Canyon Forest
0102	CEGL005221	*Schizachyrium scoparium-Aristida basiramea-Sporobolus cryptandrus-Eragrostis trichodes*
0103	no fit determined	–
0104	NPSNIOB003	*Quercus macrocarpa*/*Juniperus virginiana* Ruderal Forest
0105	NPSNIOB003	*Quercus macrocarpa*/*Juniperus virginiana* Ruderal Forest
0106	CEGL002593	*Juniperus virginiana Midwest* Ruderal Forest
0110	CEGL001467	*Andropogon hallii-Calamovilfa longifolia* Grassland
0111	no fit determined	–
0114	CEGL002025	*Andropogon gerardii-Sorghastrum nutans-Hesperostipa spartea* Loess Hills Grassland
0115	CEGL001467	*Andropogon hallii-Calamovilfa longifolia* Grassland
0117	NPSNIOB002	Weedy Forb Ruderal Herbaceous
0118	NPSNIOB013	*Quercus macrocarpa*/*Juniperus virginiana*/*Elymus virginicus* Woodland
0123	CEGL001131	*Symphoricarpos occidentalis* Shrubland
0124	CEGL001131	*Symphoricarpos occidentalis* Shrubland
0125	NPSNIOB006	*Quercus macrocarpa-Populus* x *smithii* Relict Forest
0126	NPSNIOB006	*Quercus macrocarpa-Populus* x *smithii* Relict Forest
0127	NPSNIOB006	*Quercus macrocarpa-Populus* x *smithii* Relict Forest
0128	NPSNIOB006	*Quercus macrocarpa-Populus* x *smithii* Relict Forest
0129	NPSNIOB006	*Quercus macrocarpa-Populus* x *smithii* Relict Forest
0130	NPSNIOB004	*Rhus glabra* Mixedgrass Shrubland
0131	NPSNIOB003	*Quercus macrocarpa*/*Juniperus virginiana* Ruderal Forest
0139	A4042	*Schizachyrium scoparium-Bouteloua curtipendula* Centeral Great Plains Grassland Alliance
0140	NPSNIOB013	*Quercus macrocarpa*/*Juniperus virginiana*/*Elymus virginicus* Woodland
0141	NPSNIOB001	*Amorpha fruticosa*/*Solidago* spp. Shrubland
0142	CEGL000873	*Pinus ponderosa*/*Quercus macrocarpa* Open Woodland
0143	A1193	*Andropogon hallii Sand Prairie* Alliance
0144	NPSNIOB001	*Amorpha fruticosa*/*Solidago* spp. Shrubland

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Plot code	Classified code	Scientific name
0145	A4042	*Schizachyrium scoparium-Bouteloua curtipendula* Centeral Great Plains Grassland Alliance
0146	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
0147	A4033	*Hesperostipa comata Northwestern* Great Plains Grassland Alliance
0148	NPSNIOB003	*Quercus macrocarpa*/*Juniperus virginiana* Ruderal Forest
0149	CEGL002023	*Andropogon gerardii-Panicum virgatum* Sandhills Grassland
0150	CEGL000201	*Pinus ponderosa*/*Schizachyrium scoparium* Open Woodland
0151	CEGL000628	*Acer negundo*/*Prunus virginiana* Floodplain Forest
0153	CEGL000201	*Pinus ponderosa*/*Schizachyrium scoparium* Open Woodland
0155	NPSNIOB005	Ruderal Grassland
0156	CEGL002013	*Betula papyrifera*-(*Tilia americana, Quercus macrocarpa*) Canyon Forest
0167	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
0168	NPSNIOB005	Ruderal Grassland
0169	NPSNIOB013	*Quercus macrocarpa*/*Juniperus virginiana*/*Elymus virginicus* Woodland
0170	CEGL002052	*Quercus macrocarpa*/*Andropogon gerardii-Panicum virgatum* Woodland
0172	CEGL002013	*Betula papyrifera*-(*Tilia americana, Quercus macrocarpa*) Canyon Forest
0175	NPSNIOB005	Ruderal Grassland
0178	CEGL000201	*Pinus ponderosa*/*Schizachyrium scoparium* Open Woodland
0179	CEGL002012	*Tilia americana*-(*Quercus macrocarpa*)/*Ostrya virginiana* Forest
0180	CEGL000873	*Pinus ponderosa*/*Quercus macrocarpa* Open Woodland
0181	NPSNIOB001	*Amorpha fruticosa*/*Solidago* spp. Shrubland
0182	A4033	*Hesperostipa comata Northwestern* Great Plains Grassland Alliance
0183	CEGL002023	*Andropogon gerardii-Panicum virgatum* Sandhills Grassland
0184	CEGL002025	*Andropogon gerardii-Sorghastrum nutans-Hesperostipa spartea* Loess Hills Grassland
0185	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
0186	NPSNIOB005	Ruderal Grassland
0187	NPSNIOB003	*Quercus macrocarpa*/*Juniperus virginiana* Ruderal Forest
0188	CEGL002177	*Artemisia filifolia*/*Calamovilfa longifolia* Shrubland
0189	CEGL000201	*Pinus ponderosa*/*Schizachyrium scoparium* Open Woodland

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Plot code	Classified code	Scientific name
0190	CEGL001131	*Symphoricarpos occidentalis* Shrubland
0191	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
0192	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
0194	NPSNIOB004	*Rhus glabra* Mixedgrass Shrubland
0195	A4033	*Hesperostipa comata Northwestern* Great Plains Grassland Alliance
0196	NPSNIOB005	Ruderal Grassland
0197	A1193	*Andropogon hallii Sand Prairie* Alliance
0198	A4042	*Schizachyrium scoparium-Bouteloua curtipendula* Centeral Great Plains Grassland Alliance
0199	CEGL002389	*Typha* spp. Great Plains Marsh
1001	no fit determined	–
1002	CEGL002389	*Typha* spp. Great Plains Marsh
1003	no fit determined	–
1004	CEGL002025	*Andropogon gerardii-Sorghastrum nutans-Hesperostipa spartea* Loess Hills Grassland
1005	no fit determined	–
1006	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
1007	CEGL000658	*Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest
1008	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
1009	CEGL000658	*Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest
1010	CEGL001454	*Populus deltoides*/*Panicum virgatum-Schizachyrium scoparium* Floodplain Woodland
1011	CEGL002013	*Betula papyrifera*-(*Tilia americana, Quercus macrocarpa*) Canyon Forest
1012	CEGL002012	*Tilia americana*-(*Quercus macrocarpa*)/*Ostrya virginiana* Forest
1013	NPSNIOB013	*Quercus macrocarpa*/*Juniperus virginiana*/*Elymus virginicus* Woodland
1050	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
1051	CEGL002152	*Populus deltoides*/*Juniperus scopulorum* Floodplain Woodland
1052	NPSNIOB013	*Quercus macrocarpa*/*Juniperus virginiana*/*Elymus virginicus* Woodland
1053	NPSNIOB013	*Quercus macrocarpa*/*Juniperus virginiana*/*Elymus virginicus* Woodland
1054	NPSNIOB012	*Pinus ponderosa*/*Juniperus virginiana* Open Woodland
1055	CEGL001474	*Phalaris arundinacea* Western Marsh

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Plot code	Classified code	Scientific name
3001	CEGL005257	Sandstone Great Plains Dry Cliff Sparse Vegetation
3002	NPSNIOB013	*Quercus macrocarpa*/*Juniperus virginiana*/*Elymus virginicus* Woodland
3003	NPSNIOB004	*Rhus glabra* Mixedgrass Shrubland
3004	NPSNIOB004	*Rhus glabra* Mixedgrass Shrubland
3005	no fit determined	–
3006	no fit determined	–
3007	A1193	*Andropogon hallii Sand Prairie* Alliance
3008	CEGL002013	*Betula papyrifera*-(*Tilia americana, Quercus macrocarpa*) Canyon Forest
3025	CEGL002013	*Betula papyrifera*-(*Tilia americana, Quercus macrocarpa*) Canyon Forest
3026	CEGL001473	*Calamovilfa longifolia-Hesperostipa comata* Grassland
3027	CEGL002152	*Populus deltoides*/*Juniperus scopulorum* Floodplain Woodland
3028	NPSNIOB001	*Amorpha fruticosa*/*Solidago* spp. Shrubland
3029	CEGL002049	*Riverine Sand Flats-Bars* Sparse Vegetation
3030	CEGL000947	*Salix amygdaloides Riparian* Woodland
3031	NPSNIOB013	*Quercus macrocarpa*/*Juniperus virginiana*/*Elymus virginicus* Woodland
3032	CEGL002012	*Tilia americana*-(*Quercus macrocarpa*)/*Ostrya virginiana* Forest
3033	NPSNIOB012	*Pinus ponderosa*/*Juniperus virginiana* Open Woodland
3034	CEGL001474	*Phalaris arundinacea* Western Marsh
3035	CEGL002025	*Andropogon gerardii-Sorghastrum nutans-Hesperostipa spartea* Loess Hills Grassland
3036	CEGL002049	*Riverine Sand Flats-Bars* Sparse Vegetation

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Appendix E: Vegetation Classification Plot Field Form

NPS VEGETATION MAPPING PROGRAM: **NIOBRARA NATIONAL SCENIC RIVER VEGETATION SURVEY FORM**

PLOT LOCATION AND DESCRIPTION

Plot Code: NIOB.VMP._____ ☐ Observation Plot Survey Date: ____/____/ 2015 Surveyors: _____

Provisional Community Name: _____

GPS Name: _____ Elevation: _____ ft GPS Error _____m

UTM Zone: 14 T_____ UTM X: _____ ___ ___ ___ ___ (m E) UTM Y: ___ ___ ___ ___ ___ ___ ___ (m N)

Photo #: Plot ID _____ N_____ E_____ S_____ W_____

Directions to Plot:

Plot shape: _____ Plot length(m):_____ Plot width(m):_____ Radius(m):_____ Relative Stand Size: _____

Plot representativeness (discuss decisions for placement and/or reasons for non-representativeness)

ENVIRONMENTAL INFORMATION

Slope _____° Aspect_____°

Topographic Position (see cheat sheet)_____ Landform (see cheat sheet)_____

Surficial Geology (see cheat sheet)_____Primary_____Secondary_____

Cowardin System:	Soil Texture:	% Ground Cover:
___ Upland	___ sand	___ Litter / duff
___ Palustrine	___ loamy sand	___ Wood (> 1 cm)
___ Riverine	___ sandy loam	___ Bare soil
___ Lacustrine	___ silt loam	___ Sand (0.1-2 mm)
	___ sandy clay loam	___ Small rocks (0.2-10 cm)
Hydrology:	___ clay loam	___ Large rocks (> 10 cm)
___Permanently Flooded	___ silty clay loam	___ Bedrock
___Seasonally Flooded	___ silt	___ Water
___Semi-permanently Flooded	___ sandy clay	___ Moss
___Temporarily Flooded	___ clay	___ Lichen
___Intermittently Flooded	___ silty clay	___ Cryptogam
___Saturated	___ peat	___ Basal area
___Unknown	___ muck	___ Other: _____
	___ loam	Total= _____% (*must be 100%*)

Environmental & Disturbance Comments:	Landscape Comments:	Hydrology Evidence:	General Comments:

First page of the plot field form used at NIOB

NIOB VEGETATION SAMPLING **PLOT CODE NIOB.VMP_____**

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	Height Class Scale	Cover Class Scale
Trees and Shrubs __Evergreen __Cold-deciduous __Mixed evergreen-cold-deciduous Herbs ___Annual ___Perennial	___Broad-leaved ___Needle-leaved ___Microphyllous ___Graminoid ___Forb ___Pteridophyte	___Forest ___Woodland ___Shrubland ___Dwarf Shrubland ___Herbaceous ___Nonvascular ___Sparsely Vegetated	01 <0.5 m 02 0.5-1m 03 1-2 m 04 2-5 m 05 5-10 m 06 10-15 m 07 15-20 m 08 20-35 m 09 35 – 50 m 10 >50 m	T 0-1% P >1-5% 1 >5-15% +/- 2 >15-25% 3 >25-35% 4 >35-45% 5 >45-55% 6 >55-65% 7 >65-75% 8 >75-85% 9 >85-95% 10 > 95%

	Height Class	Cover Class	Dominant Species (Mark Diagnostic Species with *)
T1 Emergent	_____	_____	_____
T2 Canopy	_____	_____	_____
T3 Sub-canopy	_____	_____	_____
S1 Tall shrub	_____	_____	_____
S2 Short Shrub	_____	_____	_____
S3 Dwarf-shrub	_____	_____	_____
Ht Herbaceous	_____	_____	_____
H1 Gram.	_____	_____	_____
H2 Forbs	_____	_____	_____
H3 Ferns	_____	_____	_____
H4 Seedlings	_____	_____	_____
N Non-vascular	_____	_____	_____
V Vine/liana	_____	_____	_____

Vegetation Comments:

Landowner:_____Phone Number (if known):_____

☐ Public ☐ Private ☐ Conservation Partnership

Comments (i.e., access issues, landowner difficulty, positive landowner experience):

Second page of the plot field form used at NIOB

SPECIES LIST   PlotCode NIOB.VMP.

Stratum Codes	S1 Tall Shrub	H1 Graminoids	N Non-vascular
T1 Emergent	S2 Short Shrub	H2 Forbs	V Vine/liana
T2 Canopy	S3 Dwarf-shrub	H3 Ferns	E Epiphyte
T3 Sub-canopy		H4 Seedlings	

Cover Class Scale			
T	0-1%	5	>45-55%
P	>1-5%	6	>55-65%
1	>5-15% +/-	7	>65-75%
2	>15-25%	8	>75-85%
3	>25-35%	9	>85-95%
4	>35-45%	10	> 95%

Stratum	Species Name	CoverClass	Stratum	Species Name	CoverClass
				Species outside plot:	

Third page of the plot field form used at NIOB

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Appendix F: Accuracy Assessment Field Form

NIOB ACCURACY ASSESSMENT POINT FORM
(Data were collected using a digital field form in Collector for ArcGIS; digital field form was based off this form)

AA Point Code: NIOB-_____ Survey Date:____/____/2017 Survey Time:_____ No Access _____

Surveyor initials: _____

1° Choice Association Name:
_____

2° Choice Association Name:

_____

UTM X: ___ ___ ___ ___ ___ ___ **m E** **UTM Y:** ___ ___ ___ ___ ___ ___ ___ **m N** **GPS Accuracy:** ___ ___ ___ **m**

Elevation (m):_____ **Slope (deg.):_____** **Aspect (deg.):_____**

Camera Assigned name:_____ **Photo#_____**

Representativeness of point within polygon: Good Fair Poor Unk

Notes or Comments (other types nearby, complications at site, uncertainty with type, etc.):

Note: Items in **bold** font are required

First page of the accuracy assessment point form used at NIOB

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NIOB ACCURACY ASSESSMENT VEGETATION FORM

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class
Trees and Shrubs ___Evergreen ___Cold-deciduous ___Mixed evergreen - cold-deciduous Herbs __Annual ___Perennial	___Broad-leaf ___Needle-leaf ___Mixed broad-leaf/Needle leaf ___Micro-phyllous ___Graminoid ___Forb ___Pteridophyte	___Forest ___Woodland ___Shrubland ___Dwarf Shrubland ___Shrub herbaceous ___Herbaceous ___Nonvascular ___Sparsely Vegetated

Strata	Height Class	Cover Class	Dominant species (mark *Diagnostic* species with a *)	Cover Class
T2 Canopy	_____	_____		
T3 Sub-canopy	_____	_____		
S1 Tall shrub	_____	_____		
S2 Short Shrub	_____	_____		
S3 Dwarf-shrub	_____	_____		
H Herbaceous	_____	_____		
N Non-vascular	_____	_____		

Comments: *** All Canopy Cover Estimates Are Absolute!***

Height Scale		Cover Scale	
		T	0-1%
		P	>1-5%
01	<0.5 m	1	>5-15%
02	0.5-1m	2	>15-25%
03	1-2 m	3	>25-35%
04	2-5 m	4	>35-45%
05	5-10 m	5	>45-55%
06	10-15 m	6	>55-65%
07	15-20 m	7	>65-75%
08	20-35 m	8	>75-85%
09	35-50 m	9	>85-95%
10	>50 m	10	> 95%

Second page of the accuracy assessment point form used at NIOB

Appendix G: Preliminary Vegetation Classification

From Stevens et al. (2010)

Formation Subclass	NVC Alliance Name	Alliance Code	NVC Association Global Name	Steinauer and Rolfsmeier (2003) Name	Wetland Type? (w)	Occurrence at NIOB (k=known, p=potential)	NatureServe Element Code
Evergreen Forest	*Pinus ponderosa* Forest Alliance	A.124	*Pinus ponderosa* / *Prunus virginiana* Forest	Ponderosa Pine Forest	–	p	CEGL000192
Deciduous Forest	*Acer saccharum* - *Tilia americana* - (*Quercus rubra*) Forest Alliance	A.220	*Tilia americana* - (*Quercus macrocarpa*) / *Ostrya virginiana* Forest	Basswood - Ironwood Springbranch Canyon Forest	–	k	CEGL002012
	Betula papyrifera Forest Alliance	A.267	*Betula papyrifera* / *Corylus cornuta* Forest	–	–	p	CEGL002079
	Betula papyrifera Forest Alliance	A.267	*Betula papyrifera* - (*Tilia americana, Quercus macrocarpa*) Canyon Forest	Paper Birch Springbranch Canyon Forest	–	k	CEGL002013
	Betula papyrifera Forest Alliance	A.267	*Fraxinus pennsylvanica* - *Ulmus americana* / *Symphoricarpos occidentalis* Forest	–	–	p	CEGL002082
	Populus tremuloides Forest Alliance	A.274	–	–	–	k	–
	Populus deltoides Temporarily Flooded Forest Alliance	A.290	*Populus deltoides* - *Fraxinus pennsylvanica* Forest	–	w	p	CEGL000658
	Quercus macrocarpa Forest Alliance	A.245	*Quercus macrocarpa* / (*Amelanchier alnifolia, Cornus drummondii*) / *Aralia nudicaulis* Forest	Upland Bur Oak Forest		k	CEGL002072

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Appendix G (continued). Preliminary Vegetation Classification. From Stevens et al. (2010).

Formation Subclass	NVC Alliance Name	Alliance Code	NVC Association Global Name	Steinauer and Rolfsmeier (2003) Name	Wetland Type? (w)	Occurrence at NIOB (k=known, p=potential)	NatureServe Element Code
Evergreen Woodland	*Juniperus scopulorum* Woodland Alliance	A.506	–	–		p	–
	Juniperus scopulorum Woodland Alliance	A.506	*Juniperus scopulorum* / *Piptatherum micranthum* Woodland	–		p	CEGL000747
	Pinus ponderosa Woodland Alliance	A.530	*Pinus ponderosa* / *Juniperus scopulorum* Woodland	–		p	CEGL000861
	Pinus ponderosa Woodland Alliance	A.530	*Pinus ponderosa* / *Schizachyrium scoparium* Woodland	–		k	CEGL000201
Deciduous Woodland	*Populus deltoides* Temporarily Flooded Woodland Alliance	A.636	*Populus deltoides* - (*Salix amygdaloides*) / *Salix* (*exigua, interior*) Woodland	Cottonwood-Peachleaf Willow Riparian Woodland	w	k	CEGL000659
	Populus deltoides Temporarily Flooded Woodland Alliance	A.636	*Populus deltoides* / *Panicum virgatum* - *Schizachyrium scoparium* Woodland	Cottonwood Riparian Woodland	w	p	CEGL001454
	Fraxinus pennsylvanica - (*Ulmus americana*) Woodland Alliance	A.629	*Fraxinus pennsylvanica* - *Ulmus americana* / *Prunus virginiana* Woodland	Green ash - Elm - Hackberry Canyon Bottom Woodland		k	CEGL000643
	Fraxinus pennsylvanica - (*Ulmus americana*) Woodland Alliance	A.629	na	Green ash - Eastern Red cedar Scarp Woodland		k	na
	Quercus macrocarpa Woodland Alliance	A.620	*Quercus macrocarpa* / *Andropogon gerardii* - *Hesperostipa spartea* Woodland	Dry-Mesic Bur Oak Forest and Woodland		p	CEGL002053

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Appendix G (continued). Preliminary Vegetation Classification. From Stevens et al. (2010).

Formation Subclass	NVC Alliance Name	Alliance Code	NVC Association Global Name	Steinauer and Rolfsmeier (2003) Name	Wetland Type? (w)	Occurrence at NIOB (k=known, p=potential)	NatureServe Element Code
Deciduous Woodland (continued)	*Quercus macrocarpa* Woodland Alliance	A.620	*Quercus macrocarpa* / *Carex inops* ssp.. *heliophila* Woodland	–		p	CEGL000554
	Quercus macrocarpa Woodland Alliance	A.620	na	Dry Upland Bur Oak Woodland		k	na
	Salix amygdaloides Temporarily Flooded Woodland Alliance	A.645	*Salix amygdaloides* Woodland	–	w	p	CEGL000947
Evergreen Shrubland	*Artemisia filifolia* Shrubland Alliance	A.816	*Artemisia filifolia* / *Andropogon hallii* Shrubland	–		p	CEGL001459
Deciduous Shrubland	*Cornus sericea* Temporarily Flooded Shrubland Alliance	A.968	*Cornus drummondii* - *Amorpha fruticosa* - *Cornus sericea* Shrubland	Riparian Dogwood-False Indigobush Shrubland	w	p	CEGL005220
	Prunus virginiana Shrubland Alliance	A.919	*Prunus virginiana* - (*Prunus americana*) Shrubland	Chokecherry - Plum Shrub Thicket		k	CEGL001108
	Salix (*exigua, interior*) Temporarily Flooded Shrubland Alliance	A.947	*Salix exigua* / *Mesic Graminoids* Shrubland	Sandbar Willow Shrubland and Perennial Sandbar	w	k	CEGL001203
	Salix (*exigua, interior*) Temporarily Flooded Shrubland Alliance	A.947	*Salix exigua* Temporarily Flooded Shrubland	Sandbar Willow Shrubland	w	k	CEGL001197
	Shepherdia argentea Temporarily Flooded Shrubland Alliance	A.960	*Shepherdia argentea* Shrubland	Buffaloberry Shrubland	w	k	CEGL001128

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Appendix G (continued). Preliminary Vegetation Classification. From Stevens et al. (2010).

Formation Subclass	NVC Alliance Name	Alliance Code	NVC Association Global Name	Steinauer and Rolfsmeier (2003) Name	Wetland Type? (w)	Occurrence at NIOB (k=known, p=potential)	NatureServe Element Code
Deciduous Shrubland (continued)	*Symphoricarpos occidentalis* Temporarily Flooded Shrubland Alliance	A.961	*Symphoricarpos occidentalis* Shrubland	Buckbrush Shrubland	w	k	CEGL001131
Perennial Graminoid Vegetation	*Andropogon gerardii* - (*Calamagrostis canadensis, Panicum virgatum*) Herbaceous Alliance	A.1191	*Andropogon gerardii - Panicum virgatum - Helianthus grosseserratus* Herbaceous Vegetation	Lowland Tallgrass Prairie	–	p	CEGL002024
	Andropogon gerardii - (*Calamagrostis canadensis, Panicum virgatum*) Herbaceous Alliance	A.1191	*Andropogon gerardii - Panicum virgatum* Sandhills Herbaceous Vegetation	–	–	p	CEGL002023
	Andropogon gerardii - (*Sorghastrum nutans*) Herbaceous Alliance	A.1192	*Andropogon gerardii - Panicum virgatum - Schizachyrium scoparium* - (*Tradescantia tharpii*) Herbaceous Vegetation	–	–	p	CEGL005231
	Andropogon gerardii - (*Sorghastrum nutans*) Herbaceous Alliance	A.1192	*Andropogon gerardii - Sporobolus heterolepis - Schizachyrium scoparium - Pascopyrum smithii* Herbaceous Vegetation	–	–	p	CEGL002203
	Andropogon hallii Herbaceous Alliance	A.1193	*Andropogon hallii - Calamovilfa longifolia* Herbaceous Vegetation	Sandhills Dune Prairie	–	k	CEGL001467
	Bouteloua gracilis Herbaceous Alliance	A.1282		–	–	p	–

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Appendix G (continued). Preliminary Vegetation Classification. From Stevens et al. (2010).

Formation Subclass	NVC Alliance Name	Alliance Code	NVC Association Global Name	Steinauer and Rolfsmeier (2003) Name	Wetland Type? (w)	Occurrence at NIOB (k=known, p=potential)	NatureServe Element Code
Perennial Graminoid Vegetation (continued)	*Calamovilfa longifolia* Herbaceous Alliance	A.1201	*Calamovilfa longifolia - Hesperostipa comata* Herbaceous Vegetation	Eastern Sand Prairie and Sandhills Dry Valley Prairie	–	k	CEGL001473
	Carex nebrascensis Seasonally Flooded Herbaceous Alliance	A.1417	*Carex nebrascensis* Herbaceous Vegetation	–	w	p	CEGL001813
	Carex nebrascensis Seasonally Flooded Herbaceous Alliance	A.1417	*Carex interior - Eleocharis elliptica - Thelypteris palustris* Herbaceous Vegetation	–	w	p	CEGL002390
	Carex spp. - *Typha* spp. Saturated Herbaceous Alliance	A.1465	*Typha latifolia - Equisetum hyemale - Carex* (*hystericina, pellita*) Seep Herbaceous Vegetation	Freshwater Seep	w	k	CEGL002033
	Hesperostipa comata - Bouteloua gracilis Herbaceous Alliance	A.1234	*Hesperostipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation	Threadleaf Sedge Western Mixedgrass Prairie	–	k	CEGL002037
	Hordeum jubatum Temporarily Flooded Herbaceous Alliance	A.1358	*Hordeum jubatum* Herbaceous Vegetation	–	w	p	CEGL001798
	Juncus balticus Seasonally Flooded Herbaceous Alliance	A.1374	*Juncus balticus* Herbaceous Vegetation	–	w	p	CEGL001838
	Pascopyrum smithii Herbaceous Alliance	A.1232	*Pascopyrum smithii - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation	–	–	p	CEGL001579
	Pascopyrum smithii Herbaceous Alliance	A.1232	*Pascopyrum smithii* - (*Elymus trachycaulus*) Clay Pan Herbaceous Vegetation	–	–	p	CEGL002239

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Appendix G (continued). Preliminary Vegetation Classification. From Stevens et al. (2010).

Formation Subclass	NVC Alliance Name	Alliance Code	NVC Association Global Name	Steinauer and Rolfsmeier (2003) Name	Wetland Type? (w)	Occurrence at NIOB (k=known, p=potential)	NatureServe Element Code
Perennial Graminoid Vegetation (continued)	*Pascopyrum smithii* Herbaceous Alliance	A.1232	*Pascopyrum smithii* - *Hesperostipa comata* Central Mixedgrass Herbaceous Vegetation	–	–	p	CEGL002034
	Pascopyrum smithii Intermittently Flooded Herbaceous Alliance	A.1328	*Pascopyrum smithii* - *Buchloe dactyloides* - (*Phyla cuneifolia, Oenothera canescens*) Herbaceous Vegetation	–	w	p	CEGL002038
	Pascopyrum smithii Temporarily Flooded Herbaceous Alliance	A.1354	*Panicum virgatum* - (*Pascopyrum smithii*) Herbaceous Vegetation	–	w	p	CEGL001484
	Quercus macrocarpa Wooded Medium-Tall Herbaceous Alliance	A.1505	*Quercus macrocarpa* / Mixedgrass Sand Wooded Herbaceous Vegetation	–	–	p	CEGL002162
	Quercus macrocarpa Wooded Medium-Tall Herbaceous Alliance	A.1505	*Quercus macrocarpa* / Mixedgrass Shale Wooded Herbaceous Vegetation	–	–	p	CEGL002164
	Schizachyrium scoparium - *Bouteloua curtipendula* Herbaceous Alliance	A.1225	*Schizachyrium scoparium* - *Bouteloua curtipendula* - *Bouteloua hirsuta* - (*Yucca glauca*) Herbaceous Vegetation	Northern Loess/Shale Bluff Prairie	–	p	CEGL002035
	Schizachyrium scoparium - *Bouteloua curtipendula* Herbaceous Alliance	A.1225	*Schizachyrium scoparium* - *Bouteloua curtipendula* - *Hesperostipa spartea* - (*Pascopyrum smithii*) Herbaceous Vegetation	–	–	p	CEGL002377

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Appendix G (continued). Preliminary Vegetation Classification. From Stevens et al. (2010).

Formation Subclass	NVC Alliance Name	Alliance Code	NVC Association Global Name	Steinauer and Rolfsmeier (2003) Name	Wetland Type? (w)	Occurrence at NIOB (k=known, p=potential)	NatureServe Element Code
Perennial Graminoid Vegetation (continued)	*Schizachyrium scoparium* - *Bouteloua curtipendula* Herbaceous Alliance	A.1225	*Schizachyrium scoparium* - *Bouteloua curtipendula* Loess Mixedgrass Herbaceous Vegetation	–	–	p	CEGL002036
	Schizachyrium scoparium - *Bouteloua curtipendula* Herbaceous Alliance	A.1225	*Schizachyrium scoparium* - *Bouteloua* (*curtipendula, gracilis*) - *Carex filifolia* Herbaceous Vegetation	–	–	p	CEGL001681
	Schizachyrium scoparium - (*Sporobolus cryptandrus*) Herbaceous Alliance	A.1224	*Schizachyrium scoparium* - *Aristida basiramea* - *Sporobolus cryptandrus* - *Eragrostis trichodes* Herbaceous Vegetation	–	–	p	CEGL005221
	Spartina pectinata Temporarily Flooded Herbaceous Alliance	A.1347	*Calamagrostis canadensis* - *Juncus* spp. - *Carex* spp. Sandhills Herbaceous Vegetation	–	w	p	CEGL002028
	Spartina pectinata Temporarily Flooded Herbaceous Alliance	A.1347	*Spartina pectinata* - *Calamagrostis stricta* - *Carex* spp. Herbaceous Vegetation	Northern Cordgrass Wet Prairie	w	k	CEGL002027
	Spartina pectinata Temporarily Flooded Herbaceous Alliance	A.1347	*Spartina pectinata* - *Carex* spp. Herbaceous Vegetation	–	w	p	CEGL001477
	Sporobolus airoides Herbaceous Alliance	A.1267	*Sporobolus airoides* Northern Plains Herbaceous Vegetation	–		p	CEGL002274
	Typha (*angustifolia, latifolia*) - (*Schoenoplectus* spp.) Semipermanently Flooded Herbaceous Alliance	A.1436	–	–	w	p	–

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Appendix G (continued). Preliminary Vegetation Classification. From Stevens et al. (2010).

Formation Subclass	NVC Alliance Name	Alliance Code	NVC Association Global Name	Steinauer and Rolfsmeier (2003) Name	Wetland Type? (w)	Occurrence at NIOB (k=known, p=potential)	NatureServe Element Code
Perennial Graminoid Vegetation (continued)	*Typha* (*angustifolia, latifolia*) - (*Schoenoplectus* spp.) Semipermanently Flooded Herbaceous Alliance	A.1436	*Schoenoplectus acutus* - *Typha latifolia* - (*Schoenoplectus tabernaemontani*) Sandhills Herbaceous Vegetation	–	w	p	CEGL002030
	Typha (*angustifolia, latifolia*) - (*Schoenoplectus* spp.) Semipermanently Flooded Herbaceous Alliance	A.1436	*Typha* (*latifolia, angustifolia*) Western Herbaceous Vegetation	Cattail Shallow Marsh	w	k	CEGL002010
	Typha (*angustifolia, latifolia*) - (*Schoenoplectus* spp.) Semipermanently Flooded Herbaceous Alliance	A.1436	*Typha* spp. - *Schoenoplectus* spp. - Mixed herbs Great Plains Herbaceous Vegetation	Eastern Bulrush Deep Marsh	w	p	CEGL002228
	Typha (*angustifolia, latifolia*) - (*Schoenoplectus* spp.) Semipermanently Flooded Herbaceous Alliance	A.1436	*Typha* spp. Great Plains Herbaceous Vegetation	Eastern Bulrush Deep Marsh	w	p	CEGL002389
	Typha spp. – (*Schoenoplectus* spp., *Juncus* spp.) Seasonally Flooded Herbaceous Alliance	A.1394	*Schoenoplectus tabernaemontani* - *Typha* spp. - (*Sparganium* spp., *Juncus* spp.) Herbaceous Vegetation	Cattail Shallow Marsh	w	k	CEGL002026
	Yucca glauca Shrub Herbaceous Alliance	A.1540	*Yucca glauca* / *Calamovilfa longifolia* Shrub Herbaceous Vegetation	–	–	k	CEGL002675
Hydromorphic-Rooted Vegetation	*Lemna* spp. Permanently Flooded Herbaceous Alliance	A.1747	–	–	w	p	–

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Appendix G (continued). Preliminary Vegetation Classification. From Stevens et al. (2010).

Formation Subclass	NVC Alliance Name	Alliance Code	NVC Association Global Name	Steinauer and Rolfsmeier (2003) Name	Wetland Type? (w)	Occurrence at NIOB (k=known, p=potential)	NatureServe Element Code
Hydromorphic-Rooted Vegetation (continued)	*Potamogeton* spp. - *Ceratophyllum* spp. - *Elodea* spp. Permanently Flooded Herbaceous Alliance	A.1754	*Potamogeton* spp. - *Ceratophyllum demersum* Great Plains Herbaceous Vegetation	Northern Pondweed Aquatice Wetland	w	k	CEGL002044
Consolidated Rock + Sparse Vegetation	Open Cliff Sparsely Vegetated Alliance	A.1836	Limesone - Dolostone Great Plains Xeric Cliff Sparse Vegetation	Northern Chalk Bluff and Cliff	–	p	CEGL002046
	Open Cliff Sparsely Vegetated Alliance	A.1836	Sandstone Dry Cliff Sparse Vegetation	Western Sandstone Cliff	–	k	CEGL002045
	Open Cliff Sparsely Vegetated Alliance	A.1836	Shale Barren Slopes Sparse Vegetation	–	–	p	CEGL002294
	Open Cliff Sparsely Vegetated Alliance	A.1836	Siltstone - Sandstone Rock Outcrop Sparse Vegetation	–	–	p	CEGL002047
Boulder, Gravel, Cobble, or Talus Sparse Vegetation	Cobble/Gravel Shore Sparsely Vegetated Alliance	A.1850	Riverine Gravel Flats Great Plains Sparse Vegetation	Great Plains Gravel/Cobble Prairie	–	k	CEGL005223
Unconsolidated Material Sparse Vegetation	Sand Flats Temporarily Flooded Sparsely Vegetated Alliance	A.1864	Riverine Sand Flats - Bars Sparse Vegetation	–	w	k	CEGL002049
Semi Natural Vegetation	*Phragmites australis* Semipermanently Flooded Herbaceous Alliance	A.1431	*Phragmites australis* Western North America Temperate Semi-natural Herbaceous Vegetation	–	w	k	CEGL001475
	Juniperus virginiana Semi-natural Forest Alliance	A.137	–	–	–	k	–
	Juniperus virginiana Semi-natural Woodland Alliance		–	–	–	k	–

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Appendix G (continued). Preliminary Vegetation Classification. From Stevens et al. (2010).

Formation Subclass	NVC Alliance Name	Alliance Code	NVC Association Global Name	Steinauer and Rolfsmeier (2003) Name	Wetland Type? (w)	Occurrence at NIOB (k=known, p=potential)	NatureServe Element Code
Semi Natural Vegetation (continued)	*Elaeagnus angustifolia Semi-natural* Woodland Alliance	A.3566	–	–	–	k	–
	Poa pratensis Semi-natural Herbaceous Alliance	A.3562	*Poa pratensis* Herbaceous Vegetation	–	–	k	–
	Bromus tectorum Semi-natural Herbaceous Alliance			–	–	p	–
	(*Cirsium arvense, Euphorbia esula, Melilotus* spp.) - Mixed *Forbs* Herbaceous Alliance	A.3564	*Euphorbia esula* Herbaceous *vegetation*	–	–	k	CEGL005268
	Lythrum salicaria Herbaceous Alliance	A.3030	–	–	–	k	–
	Rhamnus cathartica Semi-natural Shrubland Alliance		–	–	–	k	–
	Phalaris arundinacea Seasonally Flooded Herbaceous Alliance	A.1381	–	–	–	k	–
	Bromus inermis Semi-natural Herbaceous Alliance	A.3561	–	–	–	k	–

Appendix H: Accuracy Assessment Contingency Tables

1) Table H-1 shows the initial contingency table using raw accuracy assessment plot data.
2) Table H-2 shows the revised contingency tables using reconciled accuracy assessment data.
3) Table H-3 shows the accuracy contingency table using final aggregated map classes.

Table H1. Initial/raw-accuracy assessment contingency table. Row values are mapped classes and column values are classes assigned in the field.

Map Class Codes	MC101	MC102	MC103	MC104	MC105	MC105a	MC105b	MC105c	MC105d	MC201	MC202	MC203	MC204	MC205	MC301	MC302	MC303	MC304	MC305	MC306	MC307	MC308	MC309	MC310	MC311	MC312	MC313	MC401	MC402	ROW TOTAL (n_{i+})
MC101	29	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**31**
MC102	–	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**7**
MC103	3	–	26	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**32**
MC104	–	1	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**3**
MC105	1	–	–	–	–	6	12	11	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	**32**
MC105a	1	–	–	–	–	25	6	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	**34**
MC105b	–	–	–	–	–	–	30	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**31**
MC105c	–	–	–	–	–	1	–	29	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**31**
MC105d	2	–	–	–	–	–	6	9	3	8	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**29**
MC201	–	–	–	–	–	–	–	–	–	29	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	–	**32**
MC202	–	–	–	–	–	–	–	–	–	1	29	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**32**
MC203	–	–	–	–	–	–	–	–	–	–	–	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**6**
MC204	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**2**
MC205	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
MC301	3	–	–	–	–	–	–	–	–	2	–	–	–	–	9	8	–	3	3	1	1	–	2	–	–	–	–	–	–	**32**
MC302	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24	5	1	–	1	1	–	–	–	–	–	–	–	–	**32**
MC303	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	29	2	–	1	–	–	–	–	–	–	–	–	–	**32**
MC304	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	28	–	–	–	–	–	–	–	–	–	–	–	**30**
MC305	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	1	1	26	–	1	–	–	–	–	–	–	2	–	**33**
MC306	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	27	2	–	–	2	–	–	3	–	–	**35**
MC307	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	1	1	4	22	–	–	–	–	2	–	–	–	**32**
MC308	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	29	–	–	–	–	–	–	–	**31**
MC309	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–	–	**30**
MC310	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	31	1	1	–	–	–	**33**
MC311	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–	26		–	–	–	**31**
MC312	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	1	–	27	–	–	–	**32**
MC313	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	2	–	–	**3**
MC401	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	**31**
MC402	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–		14	**17**
COLUMN TOTAL (n_{+j})	**42**	**9**	**27**	**3**	**0**	**32**	**55**	**50**	**4**	**43**	**31**	**7**	**2**	**4**	**11**	**35**	**36**	**36**	**32**	**40**	**31**	**29**	**33**	**35**	**27**	**30**	**5**	**34**	**14**	**737**

Table H2. Revised accuracy assessment contingency table. Row values are mapped classes and column values are classes assigned in the field.

Map Class Codes	MC101	MC102	MC103	MC104	MC105	MC105a	MC105b	MC105c	MC105d	MC201	MC202	MC203	MC204	MC205	MC301	MC302	MC303	MC304	MC305	MC306	MC307	MC308	MC309	MC310	MC311	MC312	MC313	MC401	MC402	ROW TOTAL (n_{i+})
MC101	30	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**31**
MC102	–	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**7**
MC103	3	–	26	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**32**
MC104	–	1	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**3**
MC105	–	–	–	–	32	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**32**
MC105a	1	–	–	–	–	25	6	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	**34**
MC105b	–	–	–	–	–	–	30	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**31**
MC105c	–	–	–	–	–	1	–	29	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**31**
MC105d	2	–	–	–	–	–	6	7	7	6	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**29**
MC201	–	–	–	–	–	–	–	–	–	29	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	–	**32**
MC202	–	–	–	–	–	–	–	–	–	1	30	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**32**
MC203	–	–	–	–	–	–	–	–	–	–	–	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**6**
MC204	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**2**
MC205	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
MC301	–	–	–	–	–	–	–	–	–	1	–	–	–	–	14	8	–	3	2	1	1	–	2	–	–	–	–	–	–	**32**
MC302	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24	5	1	–	1	1	–	–	–	–	–	–	–	–	**32**
MC303	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	29	2	–	1	–	–	–	–	–	–	–	–	–	**32**
MC304	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	29	–	–	–	–	–	–	–	–	–	–	–	**30**
MC305	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	1	1	26	–	1	–	–	–	–	–	–	2	–	**33**
MC306	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	29	1	–	–	2	–	–	2	–	–	**35**
MC307	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	1	–	3	25	–	–	–	–	1	–	–	–	**32**
MC308	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	30	–	–	–	–	–	–	–	**31**
MC309	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–	–	**30**
MC310	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	31	1	1	–	–	–	**33**
MC311	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–	28	–	–	–	–	**31**
MC312	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	1	–	27	–	–	–	**32**
MC313	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	2	–	–	**3**
MC401	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	31	–	**31**
MC402	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	14	**17**
COLUMN TOTAL (n_{+j})	**38**	**9**	**27**	**2**	**32**	**26**	**42**	**37**	**8**	**39**	**32**	**6**	**2**	**4**	**15**	**35**	**36**	**37**	**30**	**39**	**33**	**30**	**33**	**35**	**29**	**29**	**4**	**34**	**14**	**737**

Table H3. Final accuracy assessment contingency table. Row values are mapped classes and column values are classes assigned in the field.

Map Class Codes	MC101	MC102	MC103	MC104	MC105	MC201	MC202	MC203	MC204	MC205	MC301	MC302	MC303	MC304	MC305	MC306	MC307	MC308	MC309	MC310	MC311	MC312	MC313	MC401	MC402	ROW TOTAL (n_{i+})
MC101	30	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**31**
MC102	–	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**7**
MC103	3	–	26	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**32**
MC104	–	1	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**3**
MC105	3	–	–	–	145	7	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	**157**
MC201	–	–	–	–	–	29	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	–	**32**
MC202	–	–	–	–	–	1	30	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**32**
MC203	–	–	–	–	–	–	–	6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**6**
MC204	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**2**
MC205	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
MC301	–	–	–	–	–	1	–	–	–	–	14	8	–	3	2	1	1	–	2	–	–	–	–	–	–	**32**
MC302	–	–	–	–	–	–	–	–	–	–	–	24	5	1	–	1	1	–	–	–	–	–	–	–	–	**32**
MC303	–	–	–	–	–	–	–	–	–	–	–	–	29	2	–	1	–	–	–	–	–	–	–	–	–	**32**
MC304	–	–	–	–	–	–	–	–	–	–	–	1	–	29	–	–	–	–	–	–	–	–	–	–	–	**30**
MC305	–	–	–	–	–	1	–	–	–	–	1	–	1	1	26	–	1	–	–	–	–	–	–	2	–	**33**
MC306	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	29	1	–	–	2	–	–	2	–	–	**35**
MC307	–	–	–	–	–	–	–	–	–	–	–	2	–	1	–	3	25	–	–	–	–	1	–	–	–	**32**
MC308	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	30	–	–	–	–	–	–	–	**31**
MC309	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–	–	**30**
MC310	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	31	1	1	–	–	–	**33**
MC311	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–	28	–	–	–	–	**31**
MC312	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	1	–	27	–	–	–	**32**
MC313	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	2	–	–	**3**
MC401	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	31	–	**31**
MC402	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	14	**17**
COLUMN TOTAL (n_{+j})	**38**	**9**	**27**	**2**	**145**	**39**	**32**	**6**	**2**	**4**	**15**	**35**	**36**	**37**	**30**	**39**	**33**	**30**	**33**	**35**	**29**	**29**	**4**	**34**	**14**	**737**

Appendix I: Photo Signature Interpretation Guide for Niobara National Scenic River

Agricultural Vegetation, Cultivated Crops

Map Class Code: LC001

Color: brown, tan, red, or green

Texture: smooth with linear features (rows)

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: –

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

Photo signature example of the LC001 Agricultural Vegetation, Cultivated Crops map class.

`

Agricultural Vegetation, Pasture Land/Hay Field

Map Class Code: LC002

Color: reds, pinks tan, brown, or greens

Texture: very smooth with linear features (windrow lines)

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: Hay bales are often present in the imagery.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

Photo signature example of the LC002 Agricultural Vegetation, Pasture Land/Hay Field map class.

`

Non-vegetated, (Barren Land, Cut Bank, Borrow Pit)

Map Class Code: LC003

Color: White, tan, brown, and sandy in color

Texture: moderate

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes:–

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

Photo signature example of the LC003 Non-vegetated, (Barren Land, Cut Bank, Borrow Pit) map class.

`

Developed, Open Space

Map Class Code: LC004

Color: variable

Texture: variable

Crown Size: n/a

Crown Shape: n/a

Density: low to moderate

Notes: Lawns and maintained areas

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

Photo signature example of the LC004 Developed, Open Space map class.

`

Developed, (Low, Medium, High) Intensity

Map Class Code: LC005

Color: variable

Texture: smooth, buildings, roads

Crown Size: n/a

Crown Shape: n/a

Density: low to moderate

Notes: Roads and parking lot areas

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

Photo signature example of the LC005 Developed, (Low, Medium, High) Intensity map class.

`

Water

Map Class Code: LC006

Color: blue, tan

Texture: smooth, occasionally rough if chop on the water

Crown Size: n/a

Crown Shape: n/a

Density: moderate

Notes: Submerged sandbars are often evident within the images

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

Photo signature example of the LC006 Water map class.

`

Ruderal Herbaceous Grassland

Map Class Code: MC101

Color: reds, pinks, grey, tan, brown

Texture: smooth to coarse

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: Variety of textures and colors within ruderal grasslands. Typically greener (red in NIR) due to the abundance of smooth brome.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

Photo signature example of the MC101 Ruderal Herbaceous Grassland map class.

`

Upland Mixedgrass Grassland Complex

Map Class Code: MC102

Color: Tan, white, red, green, and brown, occasional orange tint

Texture: smooth

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: Patchiness within the upland grassland complex. Light tan/white dune tops represent a different community than the gray interdental areas. Overall dryer sites with less green vegetation.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

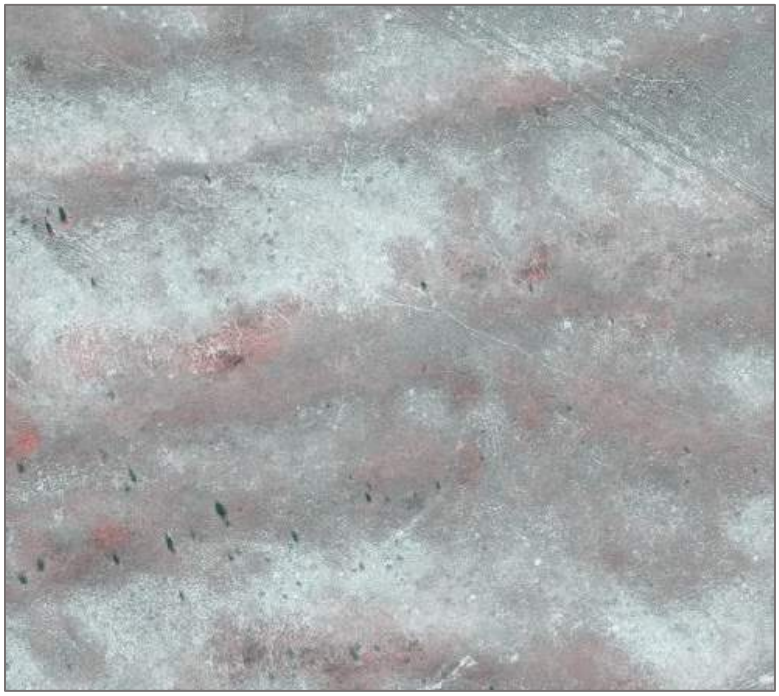

Photo signature example of the MC102 Upland Mixedgrass Grassland Complex map class.

`

Schizachyrium scoparium - Bouteloua (curtipendula, gracilis) Mixedgrass Grassland

Map Class Code: MC102a

Color: green and brown, occasional orange tint

Texture: smooth

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: Orangish tint signature is mature little bluestem.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

Photo signature example of the MC102a *Schizachyrium scoparium - Bouteloua* (*curtipendula, gracilis*) Mixedgrass Grassland map class.

`

Andropogon gerardii Tall Grass Prairie Grassland

Map Class Code: MC102b

Color: Tan, gray, red, brown

Texture: smooth

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: –

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

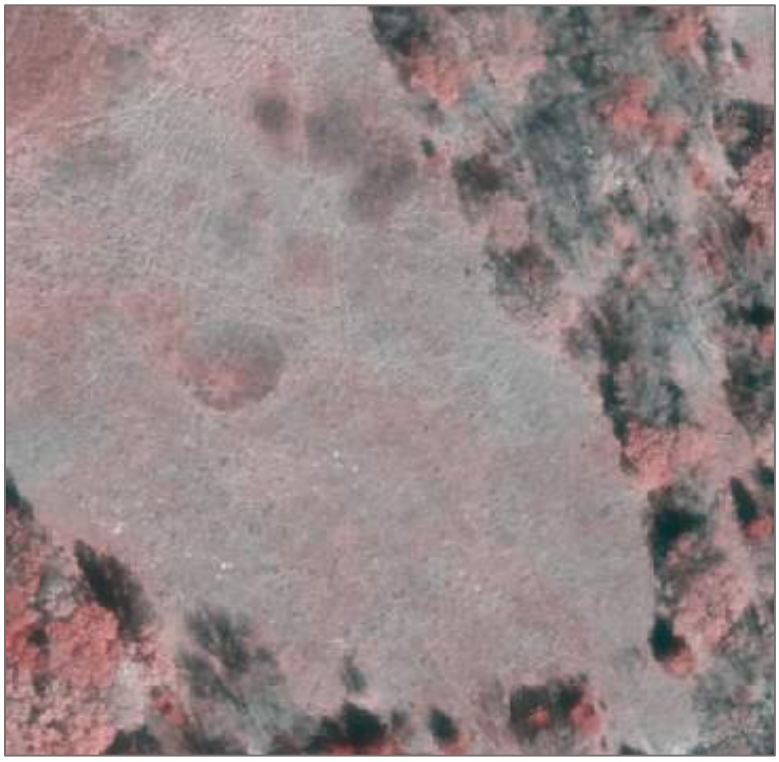

Photo signature example of the MC102b *Andropogon gerardii* Tall Grass Prairie Grassland map class.

`

Hesperostipa comata - Pascopyrum smithii Mixedgrass Grassland

Map Class Code: MC102c

Color: Tan, gray, darker gray, brown

Texture: smooth

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: Gray and tan colors dominant this predominantly cool season grass dominated system.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

Photo signature example of the MC102c *Hesperostipa comata - Pascopyrum smithii* Mixedgrass Grassland map class.

`

Andropogon hallii - Calamovilfa longifolia Grassland

Map Class Code: MC102d

Color: Tan, white, gray, brown

Texture: moderate

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: Occurs on the crest of relict dunes, thin community with abundant bare ground/sand. White/tan in image is underlying sand substrate showing through. Sand is not evident in interdunal areas.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

Photo signature example of the MC102d *Andropogon hallii - Calamovilfa longifolia* Grassland map class.

`

Marsh Complex

Map Class Code: MC103

Color: Tan, gray, pink, red, blue **Texture:** moderate to coarse

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: Varied texture and color within this complex of NVCS types. Standing water is often present within the images.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

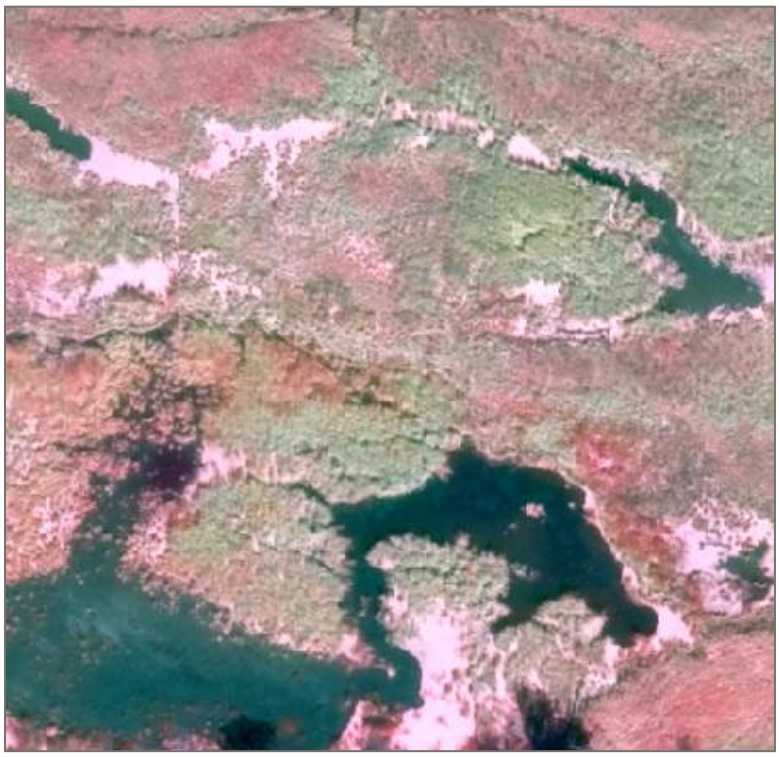

Photo signature example of the MC103 Marsh Complex map class.

`

Carex spp., *Juncus* spp., *Eleocharis* spp. Wet Meadow

Map Class Code: MC104

Color: red, pink, tan, brown

Texture: smooth

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: Low growing, smooth signature that is typically adjacent to the river.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

Photo signature example of the MC104 *Carex* spp., *Juncus* spp., *Eleocharis* spp. Wet Meadow map class.

`

Salix interior - Amorpha fruticosa Wet Shrubland

Map Class Code: MC201

Color: green, dark green, light green, tan

Texture: moderate to coarse

Crown Size: small

Crown Shape: flat, matted

Density: high

Notes: –

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery

Photo signature example of the MC201 *Salix interior - Amorpha fruticosa* Wet Shrubland map class.

`

Rhus glabra Mixedgrass Shrubland

Map Class Code: MC202

Color: red, green, dark green

Texture: low

Crown Size: small to moderate

Crown Shape: flat, matted

Density: moderate to high

Notes: Images acquired during fall senescence period captured the red tone color phase of the smooth sumac shrubland.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery

Photo signature example of the MC202 *Rhus glabra* Mixedgrass Shrubland map class.

`

Cornus drummondii - Prunus spp. – *Symphoricarpos occidentalis* Shrubland

Map Class Code: MC203

Color: green and brown

Texture: variable

Crown Size: small to medium

Crown Shape: circular

Density: moderate

Notes: Varied texture, typically non-riparian occurring on non-floodplain benches.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery

Photo signature example of the MC203 *Cornus drummondii - Prunus* spp. – *Symphoricarpos occidentalis* Shrubland map class.

`

Artemisia filifolia / *Calamovilfa longifolia* Shrubland

Map Class Code: MC204

Color: brown, tan, green

Texture: smooth to moderate

Crown Size: small

Crown Shape: flat, matted

Density: low

Notes: –

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery

Photo signature example of the MC204 *Artemisia filifolia* / *Calamovilfa longifolia* Shrubland map class.

`

Burnt Disturbed Forest

Map Class Code: MC301

Color: black, brown, gray, white

Texture: moderate to coarse

Crown Size: small to medium

Crown Shape: triangular

Density: moderate

Notes: Standing dead pine and redcedar appear as dark lines. White and gray represent dead canopies.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery

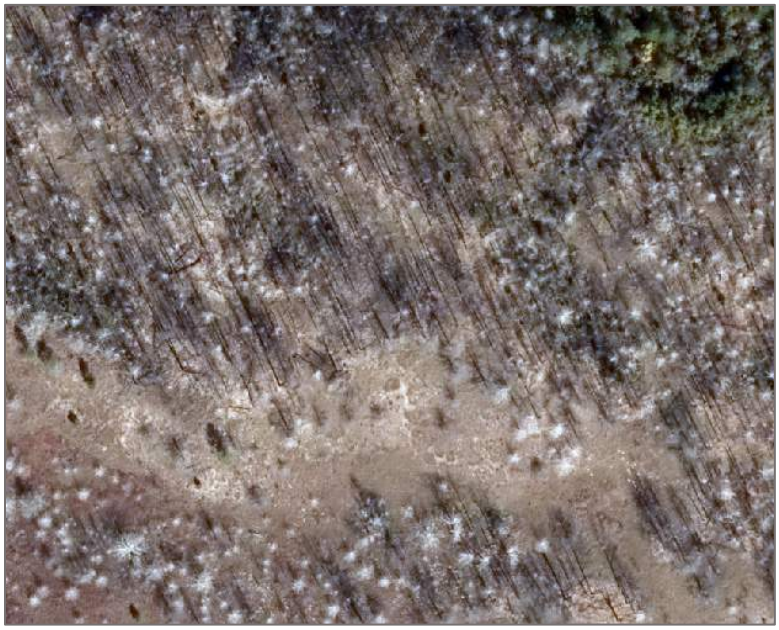

Photo signature example of the MC301 Burnt Disturbed Forest map class.

`

Pinus ponderosa Mixedgrass Open Woodland

Map Class Code: MC302

Color: dark green, red

Texture: coarse

Crown Size: moderate to large

Crown Shape: triangular

Density: moderate

Notes: Shadows often aid in differentiating pine from redcedar.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery

Photo signature example of the MC302 *Pinus ponderosa* Mixedgrass Open Woodland map class.

`

Pinus ponderosa / *Juniperus virginiana* Woodland and Forest

Map Class Code: MC303

Color: red, pink

Texture: moderately coarse

Crown Size: small to medium

Crown Shape: irregular

Density: moderate to high

Notes: Pines appear pink while redcedar are often dark red. Shadows often help differentiate pine from redcedar.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

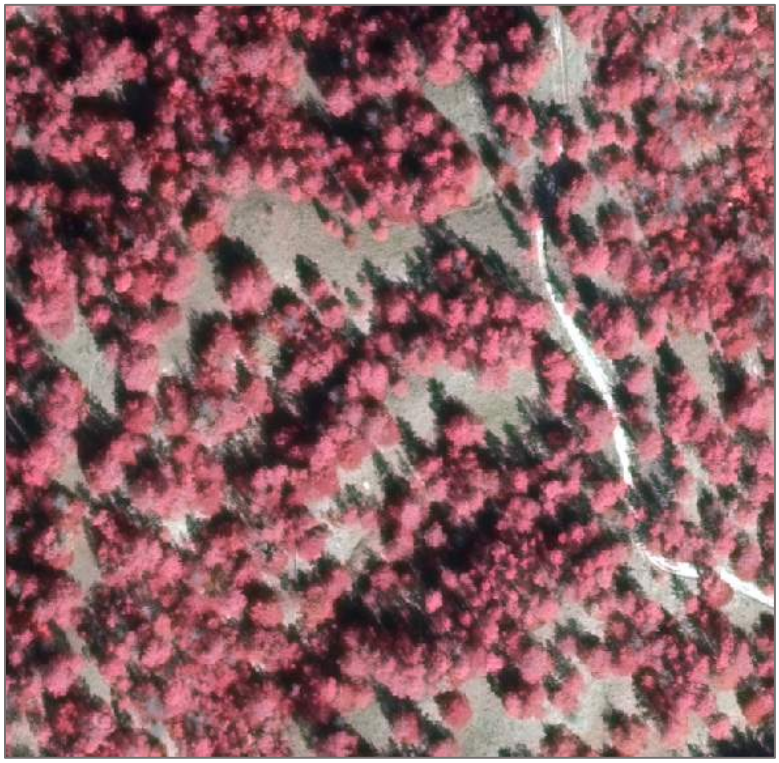

Photo signature example of the MC303 *Pinus ponderosa* / *Juniperus virginiana* Woodland and Forest map class.

`

Pinus ponderosa / *Quercus macrocarpa* Open Woodland and Forest

Map Class Code: MC304

Color: red, pink, gray, white,

Texture: moderate to coarse

Crown Size: moderate to large

Crown Shape: irregular

Density: high

Notes: Varied canopy with pines appearing pink to red and bur oak appearing white, pink, and gray with large, round canopies.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

Photo signature example of the MC304 *Pinus ponderosa* / *Quercus macrocarpa* Open Woodland and Forest map class.

`

Populus deltoides Ruderal Forest and Woodland

Map Class Code: MC305

Color: green, gray

Texture: moderately coarse

Crown Size: moderate

Crown Shape: round

Density: moderate

Notes: Varied canopy with cottonwoods having large, rounded crowns (darker greyish-green). Slash piles from clearing activities are often present.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery

Photo signature example of the MC305 *Populus deltoides* Ruderal Forest and Woodland map class.

`

Populus deltoides - Fraxinus pennsylvanica Floodplain Forest and Woodland

Map Class Code: MC306

Color: dark green

Texture: moderately coarse

Crown Size: small

Crown Shape: round

Density: moderate to high

Notes: Varied canopy with cottonwoods having large, rounded crowns (darker greyish-green) and green ash having lighter green canopies.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery

Photo signature example of the MC306 *Populus deltoides - Fraxinus pennsylvanica* Floodplain Forest and Woodland map class.

`

Populus deltoides / *Juniperus virginiana* Floodplain Forest and Woodland

Map Class Code: MC307

Color: green, dark green

Texture: moderately very coarse

Crown Size: small

Crown Shape: irregular

Density: moderate

Notes: Were available, wintertime, leaf-off imagery was used to see the evergreen redcedar shrubs under the cottonwood canopy.

Imagery Used: Leaf-off Google Earth Imagery, 2016 NAIPS, 2015 Cornerstone Imagery

Photo signature example of the MC307 *Populus deltoides* / *Juniperus virginiana* Floodplain Forest and Woodland map class.

`

Populus deltoides - Salix amygdaloides Floodplain Woodland and Forest

Map Class Code: MC308

Color: dark green, light green,

Texture: small to moderately coarse

Crown Size: small to moderate

Crown Shape: round, triangular

Density: high

Notes: Typically an open canopy woodland dominated by young to mid-aged cottonwoods and peachleaf willows. Understory grass community is typically observable in the imagery.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery

Photo signature example of the MC308 *Populus deltoides - Salix amygdaloides* Floodplain Woodland and Forest map class.

`

Fraxinus pennsylvanica - *Ulmus* spp. - *Celtis occidentalis* Floodplain Forest and Woodland

Map Class Code: MC309

Color: dark green

Texture: moderately coarse

Crown Size: small

Crown Shape: triangular, round

Density: high

Notes: Varied canopy without the large, round cottonwood crowns. Mixture of greens and yellows dominate the diverse forest canopy

Imagery Used: Leaf-off Google Earth Imagery, 2016 NAIPS, 2015 Cornerstone Imagery

Photo signature example of the MC309 *Fraxinus pennsylvanica* - *Ulmus* spp. - *Celtis occidentalis* Floodplain Forest and Woodland map class.

`

Fraxinus pennsylvanica Ruderal Forest and Woodland

Map Class Code: MC310

Color: dark green, light green

Texture: moderately coarse

Crown Size: moderate to large

Crown Shape: round

Density: low to high

Notes: Variable colors. Where available, wintertime, leaf-off imagery was used to see the evergreen redcedar shrubs and trees in the understory of the green ash forest.

Imagery Used: Leaf-off Google Earth Imagery, 2016 NAIPS, 2015 Cornerstone Imagery

Photo signature example of the MC310 *Fraxinus pennsylvanica* Ruderal Forest and Woodland map class.

`

MC311 *Juniperus virginiana* Midwest Ruderal Forest and Woodland

Map Class Code:

Color: dark red

Texture: moderately coarse

Crown Size: small

Crown Shape: irregular to triangular

Density: low to high

Notes: Redcedar were often dark red in NIR imagery. Shadows often helped distinguish redcedar from pine.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

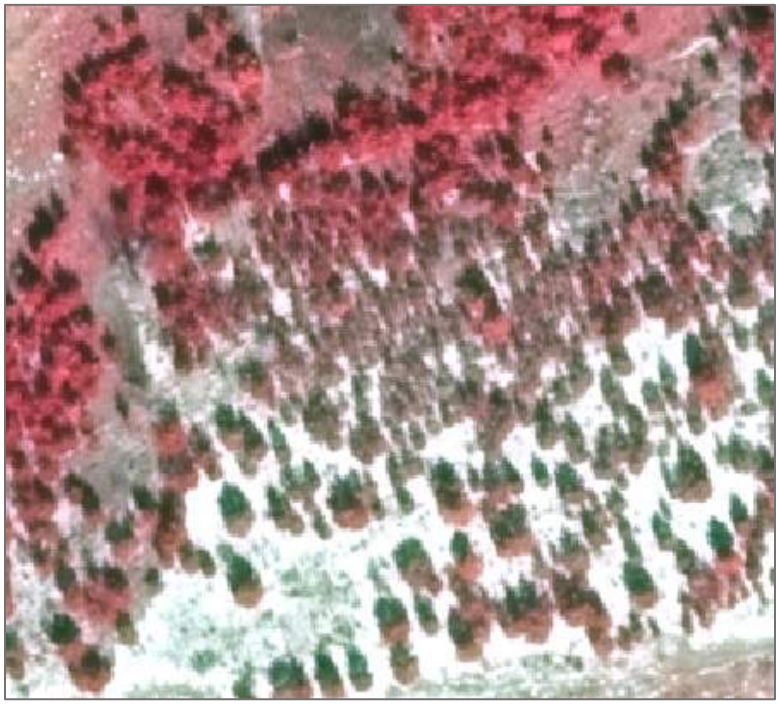

Photo signature example of the MC311 *Juniperus virginiana* Midwest Ruderal Forest and Woodland map class.

`

Quercus macrocarpa Dry Upland Forest

Map Class Code: MC313

Color: pinks, reds, grays

Texture: moderately coarse

Crown Size: moderate to large

Crown Shape: round

Density: high

Notes: 2015 Cornerstone imagery was used. Bur oak communities appeared pink to tan with large crowns.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

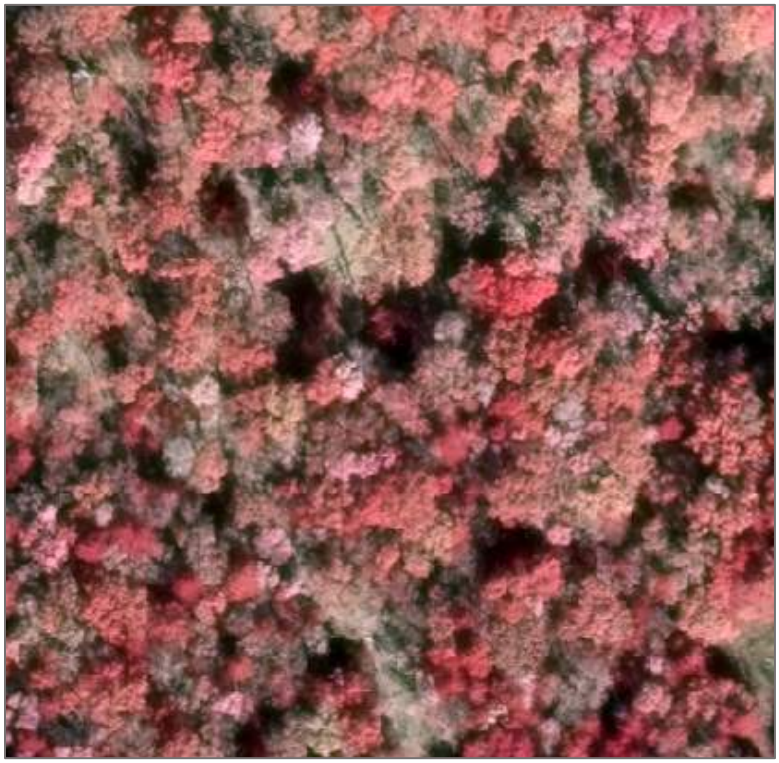

Photo signature example of the MC313 *Quercus macrocarpa* Dry Upland Forest map class.

`

Tilia americana - (*Betula papyrifera*) Springbranch Canyon Forest Complex

Map Class Code: MC314

Color: reds, white, green, dark green, brown, copper

Texture: moderately coarse

Crown Size: moderate to large

Crown Shape: round

Density: high

Notes: Within imagery acquired during the fall, Basswood stands appeared brown to copper in color.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

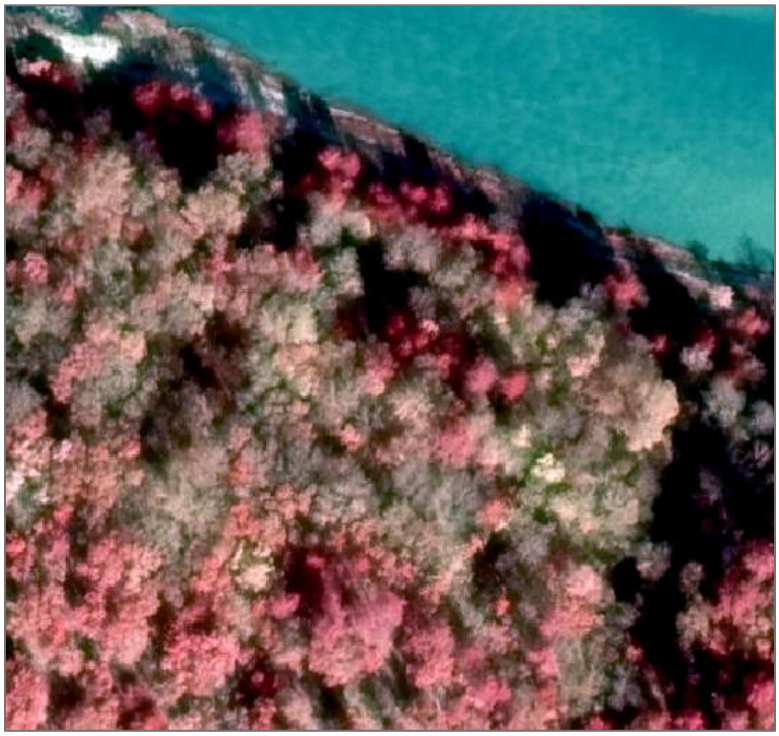

Photo signature example of the MC314 *Tilia americana* - (*Betula papyrifera*) Springbranch Canyon Forest Complex map class.

`

Betula papyrifera - (*Tilia americana*, *Quercus macrocarpa*) Canyon Forest

Map Class Code: MC314a

Color: green, dark green, brown, copper

Texture: moderately coarse

Crown Size: moderate to large

Crown Shape: round

Density: high

Notes: Within imagery acquired during the fall, Basswood stands appeared brown to copper in color. Birch appeared as white skeletons as the leaves had already fallen off in a majority of the imagery.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

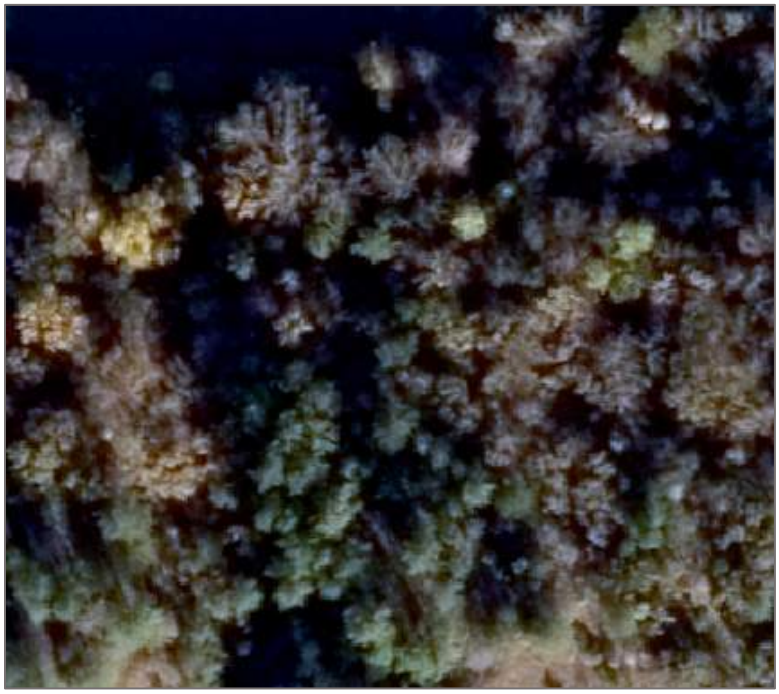

Photo signature example of the MC314a *Betula papyrifera* - (*Tilia americana*, *Quercus macrocarpa*) Canyon Forest map class.

`

Tilia americana - (*Quercus macrocarpa*) / *Ostrya virginiana* Forest

Map Class Code: MC314b

Color: green, dark green, brown, copper

Texture: moderately coarse

Crown Size: moderate to large

Crown Shape: round

Density: high

Notes: Within imagery acquired during the fall, Basswood stands appeared brown to copper in color.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

Photo signature example of the MC314b *Tilia americana* - (*Quercus macrocarpa*) / *Ostrya virginiana* Forest map class.

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MC315 *Quercus macrocarpa* / *Juniperus virginiana* Ruderal Forest and Woodland

Map Class Code:

Color: pink, red, gray, dark red

Texture: moderately coarse

Crown Size: moderate to large

Crown Shape: round

Density: high

Notes: 2015 Cornerstone imagery was used. Bur oak communities appeared pink to tan while the redcedar understory appeared dark red.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

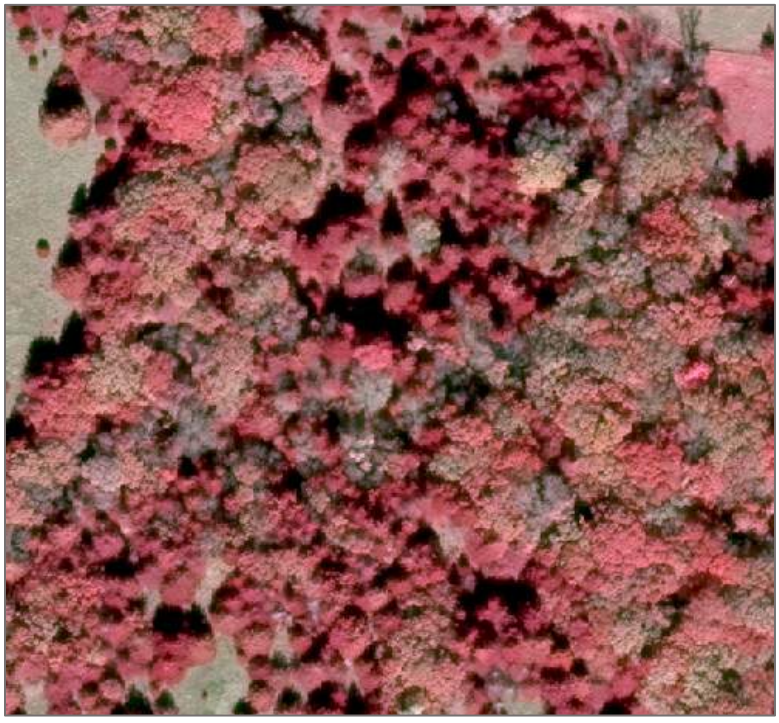

Photo signature example of the MC315 *Quercus macrocarpa* / *Juniperus virginiana* Ruderal Forest and Woodland map class.

`

Quercus macrocarpa - Populus x *smithii* (*Populus grandidentata* x *tremuloides*) Relict Woodland

Map Class Code: MC316

Color: gray, white, dark brown

Texture: moderate

Crown Size: moderate

Crown Shape: round, triangular

Density: low to moderate

Notes: –

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

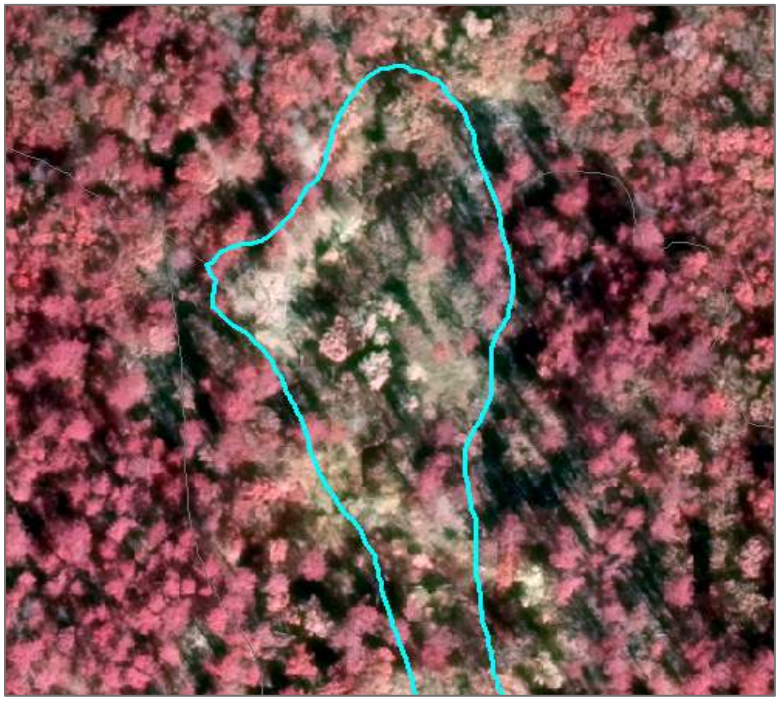

Photo signature example of the MC316 *Quercus macrocarpa - Populus* x *smithii* (*Populus grandidentata* x *tremuloides*) Relict Woodland map class.

`

Quercus macrocarpa Woodland and Wooded Grassland

Map Class Code: MC317

Color: red, pinks, whites

Texture: moderate

Crown Size: moderate

Crown Shape: round

Density: low to moderate

Notes: –

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

Photo signature example of the MC317 *Quercus macrocarpa* Woodland and Wooded Grassland map class.

`

Riverine Sparse Bar Vegetation

Map Class Code: MC401

Color: tan, brown

Texture: smooth

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: –

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIP Imagery, Google Earth Imagery

Photo signature example of the MC401 Riverine Sparse Bar Vegetation map class.

`

Sparse Cliff Vegetation

Map Class Code: MC402

Color: brown, tan

Texture: moderately to highly coarse

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: 3D visualization with Google Earth were used to observe sparse cliffs

Imagery Used: 3D visualizations with Google Earth, 2016 NAIP Imagery, 2015 Cornerstone Imagery

Photo signature example of the MC402 Sparse Cliff Vegetation map class.

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