National Park Service
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Natural Resource Stewardship and Science

Vegetation Classification and Mapping

Missouri National Recreational River

Natural Resource Report NPS/MNRR/NRR—2019/2051

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View of the Missouri River within the Missouri National Recreational River (Joe Stevens, Colorado State University).

Vegetation Classification and Mapping

Missouri National Recreational River

Natural Resource Report NPS/MNRR/NRR—2019/2051

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Executive Summary

The vegetation inventory project at Missouri National Recreational River (MNRR) 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.

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. The initial planning and scoping meetings to support study plan development took place in December, 2009, in Yankton, South Dakota, and included representation by MNRR, NPS Northern Great Plains Network, Colorado State University (CSU), and other interested agencies and organizations.

A variety of existing imagery sources were utilized for the MNRR mapping project. The primary imagery used for the base map for the project was 2016 60 cm National Aerial Imagery Program (NAIP) imagery. Additional imagery supporting the interpretation phase included current and historic true-color Google Earth and Bing Maps imagery, as well as 2015 4-band 30 cm imagery from Cornerstone Mapping Inc., and imagery from Digital Globe, Inc. (2014 WorldView-2, Quickbird).

Prior to field work, the preliminary classification developed for the study plan identified 114 U.S. National Vegetation Classification (USNVC) associations; 34 were known to occur in the project area, while the other 80 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 collected at 162 subjective plot locations at MNRR over the summer of 2015 supported vegetation classification using hierarchical clustering and professional expertise. Additional types were identified in the course of additional field work and photointerpretation reconnaissance. The final vegetation classification includes 42 USNVC associations and 10 park special types. Types include 20 forest and woodland types, 8 shrubland types, 17 herbaceous types, and 7 sparse vegetation types.

The final mapping model, which cross walks vegetation types present with what can be consistently classified and mapped (i.e., interpreted), consists of 31 map classes within MNRR. Of these, six 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 25 non-land use map classes, 14 represent a single USNVC association or park special, two map classes represent two USNVC associations or park specials, five map classes represent three USNVC associations or park specials, two map classes represent four USNVC associations or park specials, one map class represents five USNVC associations or park specials, and one map class represents six USNVC associations or park specials.

Species dominating in forest and woodland types include eastern redcedar (*Juniperus virginiana*), green ash (*Fraxinus pennsylvanica*), bur oak (*Quercus macrocarpa*), roughleaf dogwood (*Cornus drummondii*), common hackberry (*Celtis occidentalis*), eastern cottonwood (*Populus deltoides*), Virginia creeper (*Parthenocissus quinquefolia*), and white snakeroot (*Ageratina altissima*). Dominant species of the shrubland types found in the park are roughleaf dogwood (*Cornus drummondii*), Russian olive (*Elaeagnus angustifolia*), and sandbar willow (*Salix interior*). Other less extensive shrubland types are dominated by either western snowberry (*Symphoricarpos occidentalis*) or smooth sumac (*Rhus glabra*). The most common species within herbaceous types tend toward ruderal, and include Kentucky bluegrass (*Poa pratensis*), smooth brome (*Bromus inermis*), and cuman ragweed (*Ambrosia psilostachya*). The most common species in wetland types include common reed (*Phragmites australis*) and reed canarygrass (*Phalaris arundinacea*).

The final MNRR vegetation map consists of 3,590 polygons totaling 69,011 ac (27,928 ha). Mean polygon size is 12.1 ac (4.90 ha). Of the total area, 37,789 ac (15,293 ha) or 55% represent natural or ruderal vegetation map classes. Agricultural vegetation such as cultivated crops and pasture account for approximately 6,238 ac (2,524 ha) or 9% of the total mapped area. Non-vegetated barren land was rare, only accounting for 45 ac (18 ha) or 0.1%. Developed areas such as open mowed fields, parking lots, buildings, and others account for approximately 1,562 ac (632 ha) or 2%. Open water is the most widespread land cover class, with an area of approximately 23,422 ac (9,479 ha) or 34% of the total mapped area. Within the total area occupied by vegetation map classes, forest and woodland types were the most extensive (17,007 ac (6,882 ha) or 46%), followed by herbaceous types (11,457 ac (4,636 ha) or 31%), sparse types (6,287 ac (2,544 ha) or 16%), and shrubland types (3,038 ac (1,229 ha) or 7%).

A total of 737 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 84.8%. When map class accuracies were weighted in proportion to the area they occupy within the park, the overall accuracy was 89.9%. Six map classes that still fell below the 80% thematic accuracy threshold were retained because their accuracies were close to 80% or they were represented by only a few polygons.

In addition to the vegetation polygon database and map, the project delivered several other products to support park resource management, including a vegetation classification, a field key to the associations, local association descriptions, a photographic database, a project geodatabase, ArcGIS .mxd files and the aerial imagery acquired for the project. These products provided the Park with an array of tools to assist in managing park resources and making informed resource management decisions. A geodatabase links the vegetation data layer to other feature classes such as vegetation classification and accuracy assessment 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 14N. Other products include ArcGIS .mxd files for each park district along with the aerial imagery acquired for the project. The final report also includes methods

and results, contingency tables showing AA results, field forms, a species list, and a guide to imagery interpretation.

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. The geospatial and other data and products 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 particularly would like to thank NPS staff at both the Missouri National Recreational River office and at the Vegetation Mapping Inventory Program for providing support for this project. We thank Mount Marty College for supporting crew housing during the initial and accuracy assessment surveys. We would also like to thank Dr. Mark Dixon at the University of South Dakota for sharing data and participating during the scoping phase, and the Yankton-Sioux Tribe for support and access. Helpful report reviews were provided by Isabel Ashton, Billy Schweiger, Lisa Yager and Milton Haar.

1. Introduction

1.1. NPS Vegetation Mapping Inventory Program

Since 1994, the National Park Service (NPS) Vegetation Mapping Inventory (VMI) Program has led an effort to classify, describe and map existing vegetation of national park units for the NPS Inventory and Monitoring (I&M) Division. The goals of this program are to provide baseline ecological 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 program aims to classify and map vegetation on over 270 national park units across the United States and territories.

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 the map accuracy before releasing the final comprehensive classification and map.

The NPS 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 2013) and include the following:

1. Review existing data and "best practices" to develop a brief proposal (1-5 pages).
2. Planning and scoping 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 project.
10. Validate thematic accuracy of map products.
11. Conduct formal accuracy assessment (AA).
12. Deliver final reports, GIS database and required products.

The study plan (steps 1-3) was prepared for the Missouri National Recreational River (MNRR) by Colorado State University (CSU Photo) in 2009 (Stevens et al. 2010). 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 unit (MMU)
- Vegetation Mapping Inventory Program 12-Step Guidance

The products derived from these efforts include:

- Spatial Data
    - Map classification data
    - Spatial database of vegetation communities
    - Field plot data from the classification and accuracy assessment phases from over 2,000 locations
    - Metadata for spatial databases
    - Map files to produce maps at various scales/size and levels of thematic detail
    - Quantitative accuracy assessment of spatial data
- Vegetation Information
    - Vegetation classification and community descriptions
    - Dichotomous field key of vegetation classes
    - Formal description for each vegetation class
    - Ground photos of vegetation classes
    - Field data in database format

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, as described in the NPS/BRD program documents (TNC and ESRI 1994, NPS 2013).

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:

- Is based upon current vegetation.
- Uses a systematic approach to classify along a continuum.
- Emphasizes natural and existing vegetation.
- Uses a combined physiognomic-floristic hierarchy.
- Identifies vegetation units based on both qualitative and quantitative data.
- Is appropriate for mapping at multiple scales.

The use of a standardized national vegetation classification and mapping protocol 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. These vegetation data and associated information support a wide variety of resource assessment, park management, and planning needs, and provide 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 (USNVC 2017) (Figure 1).

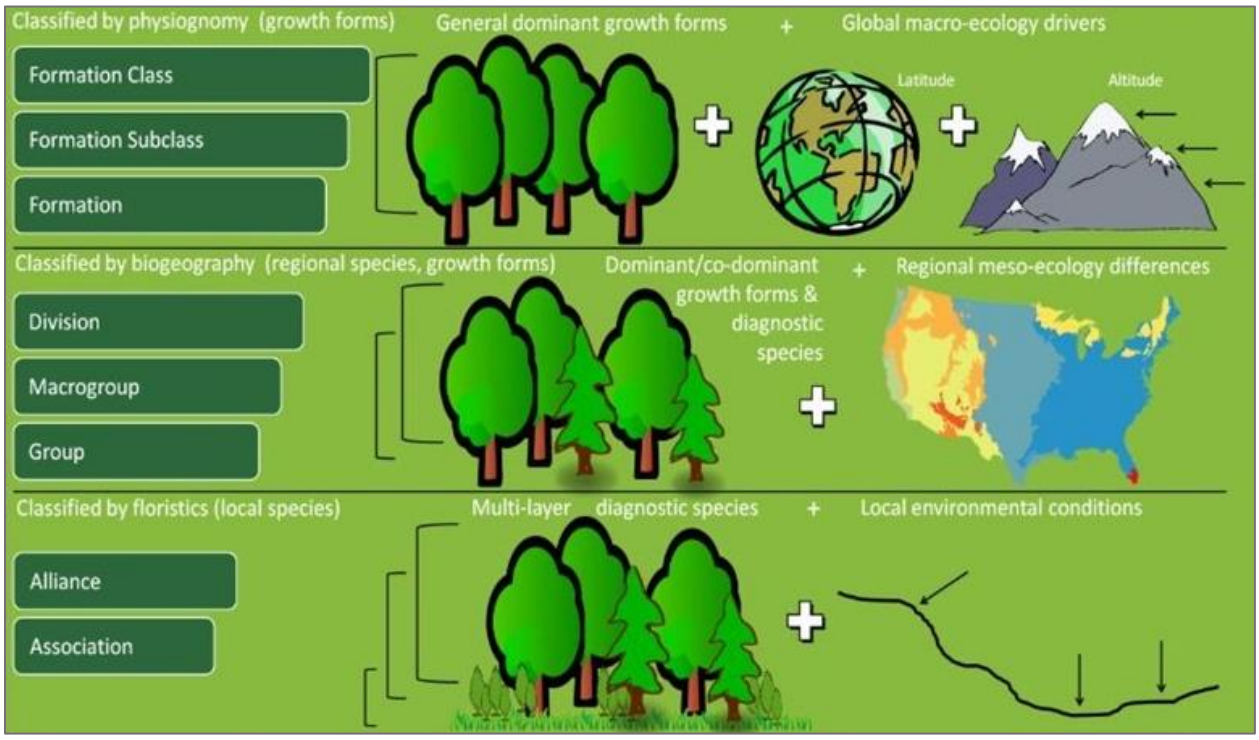

Figure 1. USNVC hierarchy and classification criteria (USNVC 2017).

Alliances and associations are based on both the dominance of species in the uppermost strata of a stand, as well as on diagnostic species (i.e., those consistently found in some types but not others).

Associations are the most specific classification unit and are hierarchically subsumed in 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. Table 1 provides criteria and examples of vegetation classification using the 2008 hierarchy for natural vegetation (USNVC 2017).

Associations 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 indicates 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.

For more information on the USNVC, see (Grossman, et al. 1998). For more information about the NPS Vegetation Mapping Inventory Program, see http://science.nature.nps.gov/im/inventory/veg/index.cfm. Additional information is available at the FGDC (Federal Geographic Data Committee) and National Vegetation Classification Standard websites, http://usnvc.org/ and http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation, as well as the NatureServe Explorer website: http://explorer.natureserve.org/classeco.htm.

Table 1. USNVC 2008 hierarchy criteria and example of classified types (USNVC 2017).

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 dominant growth forms.	Basic temperature (energy budget), moisture, and substrate/aquatic conditions.	Mesomorphic Tree Vegetation Class	Forest & Woodland
	Predominantly physiognomy	2 Formation Subclass	Combinations of general dominant and diagnostic growth forms.	Global macroclimatic factors driven primarily by latitude and continental position, or overriding substrate/aquatic conditions.	Temperate & Boreal Forest & Woodland Subclass	Temperate & Boreal Forest & Woodland
	Predominantly physiognomy	3 Formation	Combinations of dominant and diagnostic growth forms.	Global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.	Cool Temperate Forest & Woodland Formation	Cool Temperate Forest & Woodland
Middle Levels	Physiognomy, biogeography, and floristics	4 Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant species that reflect biogeographic differences.	Continental 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. *Iowiana* 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

Table 1 (continued). USNVC 2008 hierarchy criteria and example of classified types (USNVC 2017).

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

1.3. Missouri National Recreational River (MNRR) 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. Subsequently, the project was awarded to CSU in 2015. Expertise provided by CNHP, CEMML, and staff from MNRR, the Northern Great Plains Inventory and Monitoring Network (NGPN), and the NPS VMI ultimately contributed to the successful completion of the project.

CNHP was primarily responsible for collecting standardized field data, classifying data into vegetation types through analysis and expert opinion, managing plot data, performing the accuracy assessment, and report writing. CEMML was responsible for acquiring imagery of the park, 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 accuracy assessment, report writing, and database development. Staff from MNRR, 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

MNRR is located along the South Dakota and Nebraska border in northeastern Nebraska and southeastern South Dakota (Figure 2). MNRR was established by two acts of Congress amending the Wild and Scenic Rivers Act of 1968. The first act (1978) created the 59-Mile District (also referred to as the Gavins Point Segment) from Gavins Point Dam to Ponca State Park, Nebraska. The second act (1991) established the 39-Mile District (also referred to as the Fort Randall Segment) from Fort Randall Dam to Running Water, South Dakota, with the terminus located near the Niobrara River confluence. In addition, the 1991 act added a 20 mi (32 km) stretch of the lower Niobrara River, and an 8 mi (13 km) portion of lower Verdigre Creek into MNRR (Stark et al. 2011). Public Law 95-625, passed on 10 November, 1978, states:

> *MISSOURI RIVER, NEBRASKA, SOUTH DAKOTA. The segment from Gavins Point Dam, South Dakota, 95 km (59 mi) downstream to Ponca State Park, Nebraska, as generally depicted in the document entitled ―Review Report for Water Resources Development, South Dakota, Nebraska, North Dakota, Montana‖, prepared by the Division Engineer, Missouri River Division, Corps of Engineers, dated August 1977 (hereinafter in this paragraph referred to as the ―August 1977 Report). Such segment shall be administered as a recreational river by the Secretary. The Secretary shall enter into a written cooperative agreement with the Secretary of the Army (acting through the Chief of Engineers) for construction and maintenance of bank stabilization work and appropriate recreational development.*

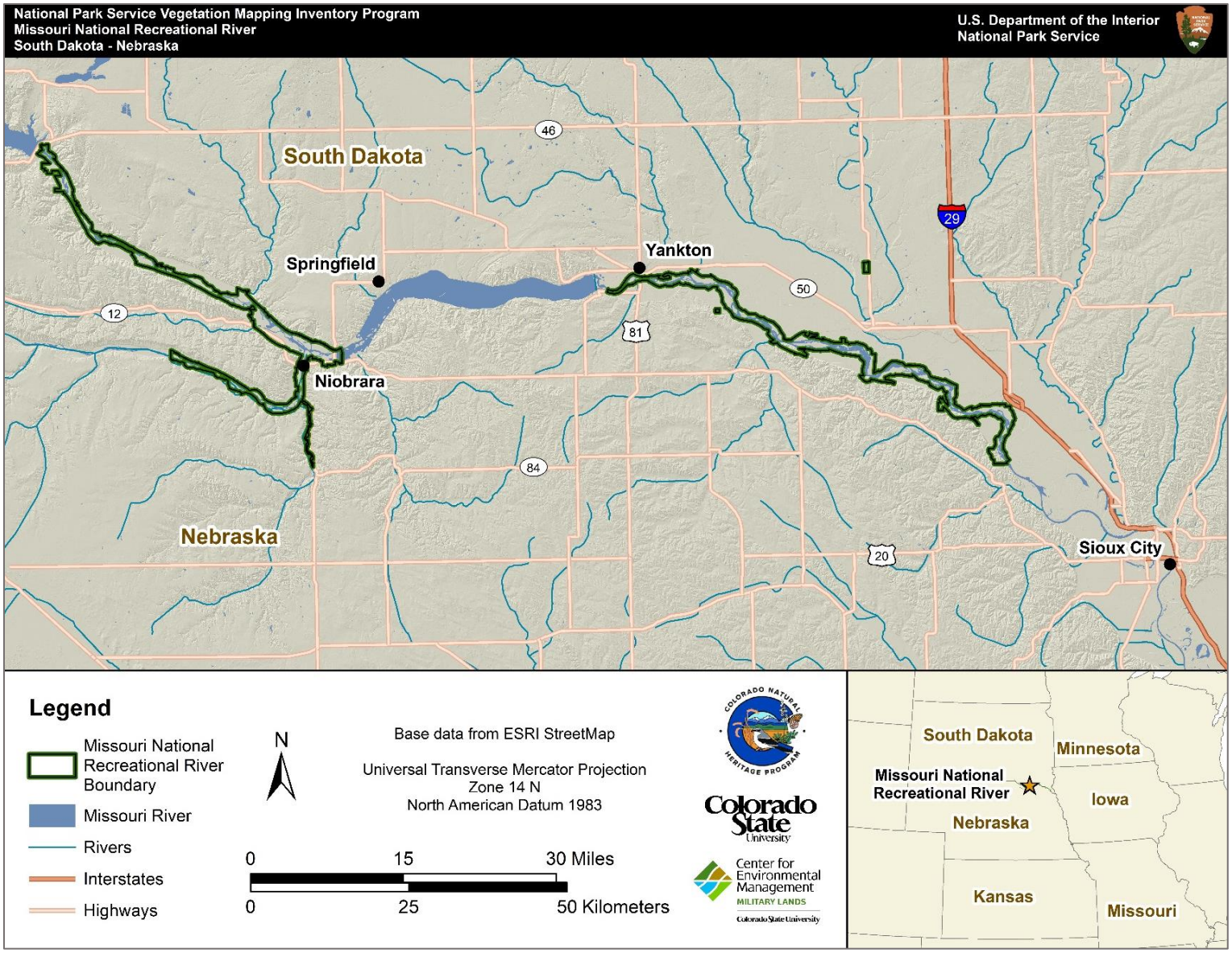

Figure 2. MNRR general location and administrative boundary.

Public Law 102-50, which established the 39-mile MNRR stretch in 1991, states:

> *(B) The 25-mile segment from the western boundary of Knox County to its confluence with the Missouri River, including that segment of the Verdigre Creek from the north municipal boundary of Verdigre, Nebraska, to its confluence with the Niobrara, to be administered by the Secretary of the Interior as a recreational river. MISSOURI RIVER, NEBRASKA AND SOUTH DAKOTA. The 39-mile segment from the headwaters of Lewis and Clark Lake to the Ft. Randall Dam, to be administered by the Secretary of the Interior as a recreational river.*

The 39-Mile District and the 59-Mile District are separated by Lewis and Clark Lake, which was created in 1957 with the completion of Gavins Point Dam (Figure 2). Gavins Point Dam and Fort Randall Dam are managed by the U.S. Army Corps of Engineers (USACE) as part of the Pick-Sloan Plan under the Flood Control Act of 1944 (Harvey and Harvey 2016). Refer to Harvey and Harvey (2016) for more details on the administrative history of MNRR.

The total administrative area of the park is 69,012 ac (27,928 ha). However, the NPS owns less than 1% of the land area (Stark et al. 2011). The NPS owns Bow Creek Recreational Area (299 ac, 121 ha), Mulberry Bend Overlook (30 ac, 12.1 ha), and Green Island (60 acres) and is in the process of completing the Goat Island Management Plan (~800 acres) following the Goat Island acquisition (842 ac, 340.75 ha). Spirit Mound Historic Prairie (321 ac, 129.8 ha) is owned and managed by the South Dakota Department of Game, Fish and Parks. The majority of land within the legislative boundary is privately owned. There are also numerous federal, state, tribal, and locally owned parcels within the administrative boundary, including Niobrara State Park, Ponca State Park, Bazille Creek Wildlife Management Area (WMA), Randal Creek Recreation Area, Clay County State Park, Elk Point WMA, Wiseman WMA, Frost WMA, Karl E. Mundt National Wildlife Refuge (NWR), and two properties owned by the US Army Corps of Engineers: North Alabama Bend and Audubon Bend (Stevens et al. 2010).

1.3.2. Physiographic Setting

MNRR is located on the edge of the last Pleistocene glaciation within three level III ecoregions including the Northwestern Glaciated Plains, Northern Glaciated Plains, and Western Corn Belt Plains (Bryce et al. 1998, Stark et al. 2011, USEPA 2013; Figure 3). USEPA (2013) describes the three ecoregions:

> *The Northwestern Glaciated Plains ecoregion is a transitional region between the generally more level, moister, more agricultural Northern Glaciated Plains (46) to the east and the generally more irregular, dryer, Northwestern Great Plains (43) to the west and southwest. The western and southwestern boundary roughly coincides with the limits of continental glaciation. Pocking this ecoregion is a moderately high concentration of semi-permanent and seasonal wetlands, locally referred to as Prairie Potholes.*

Figure 3. Level III Ecoregion boundaries for MNRR (USEPA 2013).

The Northern Glaciated Plains ecoregion is characterized by a flat to gently rolling landscape composed of glacial drift. The subhumid conditions foster a grassland transitional between tall and shortgrass prairie. High concentrations of temporary and seasonal wetlands create favorable conditions for waterfowl nesting and migration. Although the till soils are very fertile, agricultural success is subject to annual climatic fluctuations.

Once mostly covered with tallgrass prairie, over 80 percent of the Western Corn Belt Plains is now used for cropland agriculture and much of the remainder is in forage for livestock. A combination of nearly level to gently rolling glaciated till plains and hilly loess plains, an average annual precipitation of 26 to 37 inches, which occurs mainly in the growing season, and fertile, warm, moist soils make this one of the most productive areas of corn and soybeans in the world. Agricultural practices have contributed to environmental issues, including surface and groundwater contamination from fertilizer and pesticide applications as well as concentrated livestock production.

Approximately 45% of the area within the MNRR boundary is water, most of which is the Missouri River. The dominant vegetation type at MNRR is central plains riparian forest, but the unit also contains native and restored tall grass prairie, oak woodlands, pastures, plowed fields, and residential areas (Weeks et al. 2005, Stevens et al. 2010).The two districts have their own unique characteristics—the 39-Mile District is characterized by bluffs on both sides of the river, while the 59-Mile District is dominated by a wide floodplain to the north bordered by bluffs on the south side of the river.

The river was historically highly dynamic, forming a sinuous, braided channel. The meandering, dynamic nature of the river helped to create a variety of habitats by continuously eroding banks while also depositing fresh alluvium sand bars, which are important habitats for migrating birds and cottonwood regeneration (Faanes 1983, USFWS 2003, Dixon et al. 2015). Since the completion of the mainstem Missouri River dams, including Gavins Point and Fort Randall within the MNRR area, the river has become increasingly channelized and entrenched, effectively cutting the river off from its floodplain during flows that historically would have spread out across the lower bottoms (Weeks et al. 2005).

The floodplain of the Missouri River has historically supported a mixture of grasslands, deciduous forests, and wetlands (Weeks et al. 2005). The MNRR has been heavily influenced by conversion of floodplain area to agricultural land and cutting of forests for domestic and commercial uses (Stark et al. 2011). From 1881 to 1978, floodplain forests along the Missouri decreased by 56% due to clearing for agriculture (Johnson 1992, Weeks et al. 2005, Dixon et al. 2010). These practices have disrupted natural disturbance processes for almost all resident and migratory fauna as well as native flora that require scoring floods (Hesse et al. 1988). More recently, the accelerated conversion of hay and pasture grasslands to croplands (mainly corn and soybeans) was documented during 2006-2011 in the Western Corn Belt, which includes the Dakotas, Nebraska, Minnesota and Iowa. Long-term land cover trends indicate that such conversions are a persistent change in land use (Wright and Wimberly 2013).

1.3.3. Climate

The climate of the MNRR is fairly temperate, with a mean annual temperature of 47.5˚F (8.6˚C) (Fisichelli et al. 2014). Summers are usually hot and humid, while winters are cold and dry. The highest temperatures typically occur in July with an average high temperature of 72˚F (23.9˚C). The lowest temperatures usually occur in January with an average low temperature of 19.2˚F (-7.1˚C) (Cedar Ventures 2018). Due to the topographic influence of the river drainage, night time temperatures are often lower than surrounding plains (Davey et al. 2007).

Annual precipitation averages 24 in (62 cm) per year with a majority occurring during the spring and early summer (April – June), with the greatest amount typically occurring in June (Fisichelli et al. 2014, Cedar Ventures 2018). Precipitation can be highly variable in the spring and summer due to localized heavy storms (Davey et al. 2007). In the winter, there is usually <30 in (75 cm) of snow each year at MNRR. Severe droughts affect the Central Plains on approximately 20-year (bi-decadal) and 40-year (multi-decadal) cycles (Figure 4). 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 MNRR area (Wilhelmi and Wilhite 2002).

Both South Dakota and Nebraska were heavily impacted by severe drought conditions in 2013 and both states experienced a minor drought in 2017 (NOAA 2018).

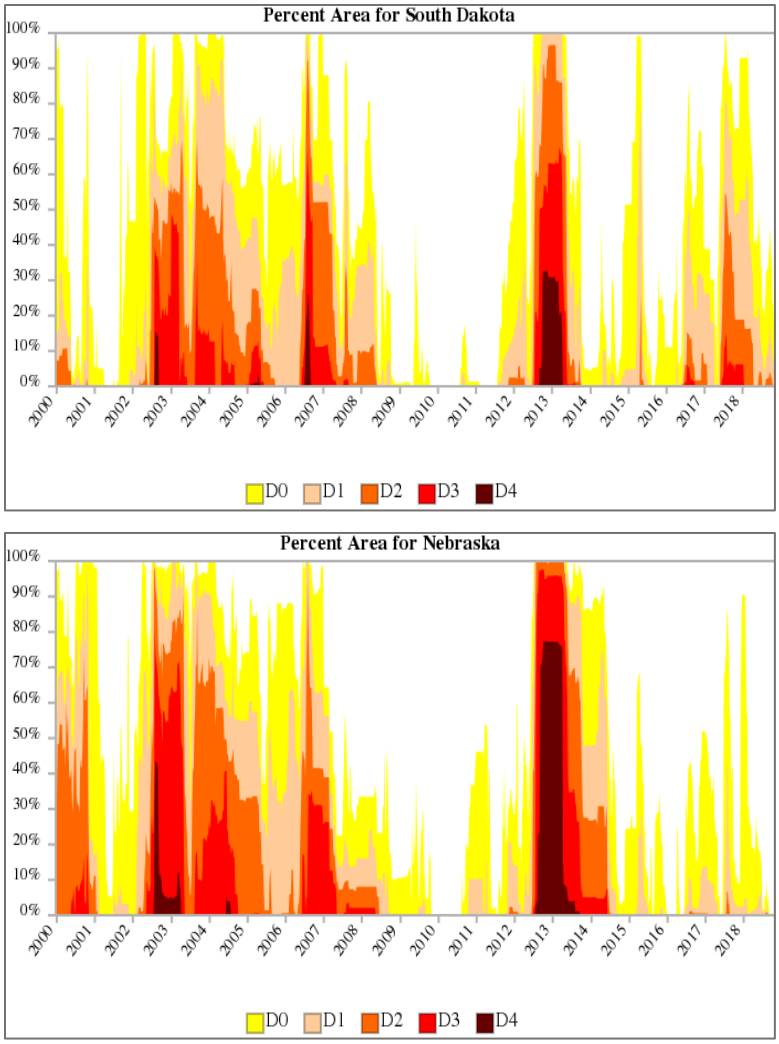

Figure 4. Drought record for Yankton, South Dakota area from 2000 – 2018 for South Dakota (top) and Nebraska (bottom) (NOAA 2018). Severity of Drought is ranked from least severe (D0) to most severe (D4).

1.3.4. Geology

The geology of the MNRR formed from recent glacial activity during the glacial and interglacial periods of the Pleistocene and from the Western Interior Seaway of the Cretaceous (Joeckel et al. 2017). The course of the Missouri River represents the southern terminus of the James Lobe of the Laurentide ice sheet during the Wisconsin glaciation period. Areas north of the river were glaciated and represent a large, relatively flat floodplain while areas to the south were non-glaciated and represent a glacial end moraine of steep, loess-covered bluffs with occasional outcrops of the underlying formation (Graham 2008, Joeckel et al. 2017). Underneath the Quaternary loess deposits, the river cuts through Cretaceous deposits. All of the geologic formations found within MNRR are sedimentary. The formations are, in ascending order, the Dakota formation, Graneros shale, Greenhorn limestone, Carlile shale, Niobrara formation, and Pierre shale (Joeckel et al. 2017).

The 59-Mile District is a wide, meandering channel with sandbars, secondary channels, and some of the last remaining forested floodplain and floodplain wetland habitats on the Missouri River (Graham 2008). Unlike the 59-Mile District, the river in the 39-Mile District runs through a valley bordered by chalky bluffs of the Niobrara formation to the north and south of the river. Niobrara Chalk bluffs in the 39-Mile District have weathered to a distinctive orange color (Graham 2008). This can be seen near the confluence of the Niobrara and Missouri Rivers near Niobrara, Nebraska. For more information on the geology of the MNRR area, see Graham (2008).

1.3.5. Soils

The soils are composed of Quaternary alluvium and glacial loess. Most of the soils are silt or sand with some loam occurring in uplands. The river historically transported up to 318 million tons of sediment per year, which was deposited on the floodplain during flooding events (Galat et al. 1996). The annual deposition of this rich sediment contributed to the fertile soils of the valley.

1.3.6. Hydrology and Water Resources

The Missouri River is the longest river in the U.S., flowing through seven states, draining approximately one-sixth of the U.S., and encompassing a watershed of over 529,350 mi^2 (1,371,010 km^2) (Graham 2008, Wilson, et al. 2014). The Missouri River is fed by water from several tributaries and through groundwater sources. Major tributaries include the Yellowstone River, Niobrara River, Little Missouri River, and Knife River (Wilson, et al. 2014). There are six aquifers along the MNRR; three deep aquifers (Maha/Dakota, Codell, and Niobrara) and three shallow aquifers (High Plains, Quaternary Glacial Sediments, and Quaternary Alluvium) (Joeckel et al. 2017). The High Plains Aquifer supplies a significant amount of groundwater to MNRR as it discharges into Verdigre and Bazile Creeks in the 39-Mile District (Joeckel et al. 2017).

Surrounding and upstream land uses have impacted the regional hydrology. For example, runoff from agricultural lands has impacted water quality leading to water quality impairments in several MNRR tributaries (Wilson, et al. 2014). The main stem Missouri River dams have also impacted water resources at MNRR by reducing sediment transport and preventing overbank flooding from occurring below the dams. Prior to the completion of Fort Randall and Gavins Point Dams, the Missouri River carried approximately 318 million tons of sediment past Yankton, South Dakota per year (Galat et al. 1996). It is estimated that with the completion of the dams, sediment transport has decreased by 69 to 99 percent compared to pre-dam values (Galat el al. 1996). With dams and flow regulation, only about 4 million tons of sediment are now transported per year (Graham 2008).This change has reduced sandbar habitats along the Missouri River by 96% in the post-dam era (Dixon et al. 2012). The drastic reduction of sandbar habitat negatively impacted several endangered species, prompting federal and state land managers to implement the massive Missouri River Recovery Program (USFWS 2003, Lott et al. 2013). Additional loss of periodic overbank flooding from flow regulation also resulted in a decline in cottonwood regeneration (Dixon et al. 2012, Johnson et al. 2012). Cottonwood forests at MNRR are being replaced by later successional *Fraxinus pennsylvanica* forest, and invasive/weedy species such as *Juniperus virginiana* and *Elaeagnus angustifolia* are invading these stands (Dixon et al. 2010, Johnson et al. 2012).

Impact of the 2011 Missouri River Flood

Prior to 2011, MNRR had not experienced a significant overbank flooding event for the previous six decades, since the completion of the mainstem Missouri River dams (Dixon et al. 2015, Boever et al. 2018). In the summer of 2011, record post-dam runoff prompted sustained flow releases above flood stage for over three months at MNRR (Boever et al. 2018). This unprecedented, sustained flooding event had a significant impact on the nature of the post-dam river. Significant declines in woody vegetation across all age classes (e.g., sapling, pole, mature) were observed within the MNRR area (17.8% decline in the 39-Mile District, 13.4% decline in the 59-Mile District), while significant increases in cottonwood and Russian olive shrub density were also observed in the post-flood landscape (Boever et al. 2018). While uncertainty exists regarding the long-term impact of the 2011 flood, a single flood event is not expected to replace the historic disturbance regime or restore the river's floodplain communities from the previous six decades of flow regulation (Dixon et al. 2015, Boever et al. 2018).

1.3.7. Flora and Fauna

The vegetation of MNRR is quite diverse; 710 vascular species are documented within the park (NPSpecies 2015). The communities can generally be divided into floodplain communities driven by periodic flooding and saturated soils, and upland communities occurring on slopes and bluffs overlooking the river. Much of the floodplains historically have been successional cottonwood forests maintained through frequent flooding. However, with the completion of the dam and flow regulation, many of these forests are transitioning from *Populus deltoides* to *Fraxinus pennsylvanica* forests (Johnson et al. 2012). Flooding is required for *Populus deltoides* seedlings to germinate and to inhibit hardwood species such as *Fraxinus pennsylvanica*. Due to the rich soils of the Missouri River floodplain, many areas have been converted to agricultural uses (Wright and Wimberly 2013). The pastures generally support a mix of graminoids, usually dominated by brome species. The surrounding slopes and bluffs of the Missouri River are typically dominated by hardwood forests containing *Quercus macrocarpa*, *Fraxinus pennsylvanica*, *Celtis occidentalis*, and *Tilia americana*. These dense forests usually support a vigorous herbaceous layer of native forbs and graminoids such as *Ageratina altissima*, *Elymus canadensis*, and *Carex sprengelii*. Occasional grasslands on hills and bluffs above the floodplain support a mixed-grass prairie dominated by *Andropogon gerardii*, *Schizachyrium scoparium*, and *Bromus* spp. There is currently only one state-listed plant within the MNRR; *Panax quinquefolius* occurs in Bon Homme and Clay counties of South Dakota but was not encountered during field work. There are eight invasive plant species that may occur within the MNRR and are of concern (Table 2).

Unfortunately, many of these species have significantly spread over the past several decades and invaded numerous plant communities within the park. The most dominant nonnatives include *Phragmites australis* and *Cirsium arvense*. State parks and other agencies have attempted to control and remove these and other weedy species such as *Phalaris arundinacea* and *Juniperus virginiana*. A large effort was undertaken by Niobrara State Park and the USACE to remove *Juniperus virginiana* (Figure 5).

Table 2. Invasive species of greatest concern within MNRR (pers. comm. Isabell Ashton, 2015).

Scienitific Name	Common Name	Occurrence	Origin
Carduus nutans	Musk Thistle	Present in Park	Non-Native
Centaurea stoebe (syn. *maculosa*)	Spotted Knapweed	Not Present in Park	Non-Native
Elaeagnus angustifolia	Russian Olive	Present in Park	Non-Native
Euphorbia esula	Leafy Spurge	Present in Park	Non-Native
Lythrum salicaria	Purple Loosestrife	Present in Park	Non-Native
Cirsium arvense	Canada Thistle	Present in Park	Non-Native
Tamarix ramosissima	Saltcedar	Present in Park	Non-Native
Phragmites australis	Common Reed	Present in Park	Unknown

Figure 5. Example of recent *Juniperus virginiana* removal at Niobrara State Park. Removal occurred after classification and mapping was completed, but just prior to AA field sampling.

Wildlife within the MNRR is very diverse, with a total of 392 vertebrate species recorded within the boundary. There are 14 federally and state-listed sensitive species, including the federally endangered pallid sturgeon (*Scaphirhynchus albus*), interior least tern (*Sterna antillarum athalassos*), the federally threatened piping plover (*Charadrius melodus*), and the federally protected bald eagle (*Haliaeetus leucocephalus*). The 59-Mile District provides the best areas for pallid sturgeon and paddlefish spawning, while the Karl E. Mundt National Wildlife Refuge (NWR) in the 39-Mile District provides ideal habitat for bald eagles. MNRR provides important wintering, feeding, breeding, and staging grounds for migrating birds. The piping plover and least tern nest on the

sandbars within the park boundary. Karl E. Mundt NWR near Fort Randall Dam provides excellent habitat for wintering bald eagles.

Approximately 80 species of fish are documented within the park. Unfortunately, many native fish populations have declined due to the construction of the dams and changes in land use. The dams prevent migrations and alter the turbidity of the river. This has contributed to the decline and listing of the pallid sturgeon, which was listed as an endangered species in 1990 (NGPC 2013). Pallid sturgeon are adapted to living close to the bottom of large, silty rivers with a natural hydrograph. Their preferred habitat has a diversity of depths and velocities formed by braided channels, sandbars, sand flats, and gravel bars. Their decline has been precipitated by impounded rivers and flow regulation. Their preferred riverine habitat has been altered to more lentic, lake-like, habitat that altered the river's hydrograph, temperature, and turbidity.

Large mammals such as mountain lion (*Puma concolor*), elk (*Cervus canadensis*), bison (*Bison bison*), and grizzly bear (*Ursus arctos*) were common throughout the MNRR area prior to the arrival of Europeans, but most of these species are now considered extirpated from the area. The predominant large mammal currently at MNRR is the white-tailed deer (*Odocoileus virginianus*), although mule deer (*Odocoileus hemionus*) are also present along the western portion of the 39-Mile District. A variety of other mammal species including coyote (*Canis latrans*), fox species (*Vulpes* spp.), raccoon (*Procyon lotor*), and opossum (*Didelphis virginiana*), as well as a variety of rodents, bats, and voles are common in the MNRR area. There are nine state and/or federally listed species with the MNRR (Table 3).

Table 3. State and/or federally listed species within MNRR.

Scienitific Name	Common Name	Occurrence	Origin
Charadrius melodus	Piping plover	Threatened	Threatened
Sternula antillarum	Interior least tern	Endangered	Endangered
Grus americana	Whooping crane	Endangered	Endangered
Lontra canadensis	River otter	Threatened	Not Listed
Scaphirhyncus albus	Pallid sturgeon	Endangered	Endangered
Acipenser fulvescens	Lake sturgeon	Threatened	Not Listed
Macrhybopsis gelida	Sturgeon chub	Endangered	Not Listed
Leptodea leptodon	Scaleshell mussel	Endangered	Endangered
Nicrophorus americanus	American burying beetle	Endangered	Endangered

2. Vegetation Inventory and Classification

2.1. Methods

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

2.1.1. Legacy Data

Existing studies documenting the vegetation of the MNRR project area were reviewed and incorporated to inform the classification and image analysis portions of the project. Evaluation of legacy data indicated that, while there was some qualitative data available to inform the classification and mapping processes, there were little quantitative plot data available to supplant plot data needs. Legacy data were evaluated using the TNC and NPS (2009) evaluation framework shown in Table 4. Legacy data evaluation results are summarized in Table 5.

Table 4. Categories of utility for legacy data (TNC and NPS 2009).

Category	Description
I	Data are adequate for classification and mapping (i.e., the data are geo-referenced, 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 geo-referenced 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 geo-referenced, contains inadequate detail in the vegetation information, and/or may not represent existing vegetation at the sample location.
IV	Data set was assessed and found to be not useful at any level.
V	Data set was not available for assessment.

Table 5. Summary of MNRR legacy data evaluation from Stevens et al. (2010).

Legacy Data Category	Data Source Citation
II	Dixon et al. (2010)
II	Dixon (2014)
II	Dixon et al. (2015)
II	Dixon (2016)

Although these pre-existing data were well-developed, the data were assigned category II and not deemed adequate substitutes for vegetation plots for the classification phase. However, plot data from these studies helped inform preliminary classification and complement field crew data collected in 2015. Two of these studies (Dixon 2014, Dixon et al. 2015) measured changes after disturbance, while the aim of this project is to capture the current vegetation. Overall, these legacy data helped to complement vegetation classification, but could not be substituted for classification plots due to potential vegetation change and some less stringent floristic data collection.

2.1.2. Sample Design

Planning and Scoping

For the initial study plan scoping meetings, CSU staff traveled to Yankton, South Dakota, and met with MNRR staff, other interested agencies, and other subject matter experts. The meetings took place on December 7 and 8, 2009. Participants in the meeting and the affiliations of each are shown in Table 6 below.

Table 6. Participants and affiliations of the December 9, 2012 planning and scoping meeting.

Name	Affiliation
Joe Stevens	Ecologist, Colorado Natural heritage Program
David Jones	Ecologist, Center for Environmental Management on Military Lands
Mike Madell	Superintendent, Missouri National Recreational River
Gia Wagner	Chief of Resources, Missouri National Recreational River
Stephen Wilson	Data Manager, Northern Great Plains Network
John Macy	Resource Biologist, National Park Service
Anne Doherty-Stephan	Community Outreach Director, National Park Service
Dr. Mark Dixon	Professor, University of South Dakota, Dept. of Biology
Scott Wessel	Wildife Biologist, Nebraska State District 3
Rebekah Jessen	Coordinating Wildlife Bologist, Northern Prairies Land Trust
Gerry Steinauer	Botanist, Nebraska Natural Heritage Program

Group discussion topics at the scoping meeting 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, input from other stakeholders, and opportunities for in-kind support from the park. A field tour of MNRR took place on December 8, 2009 to support development of the study plan.

After project award in 2015, a teleconference was held among CSU, park staff, NGPN, and NPS VMI. Boundary issues for MNRR were discussed during the initial planning and scoping meetings.

The MNRR administrative boundary encompasses private lands, state lands such as Niobrara State Park and Ponca State Park, USACE lands, and Yankton Sioux tribal lands.

Sample Size

Based on the estimate of 66 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 200 plots was needed to support the classification. However, in practice, the number of vegetation types encountered tends to increase with increasing effort, and some type are oversampled, while others are undersampled. Therefore, an additional 100+ 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). An additional 50 plots were allocated subjectively in less-common geomorphic types reclassified from the soils data layer. 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 the USNVC alliance name, USNVC association global name, name assigned by Steinauer and Rolfsmeier (2003), wetland status, the probability of the type occurring on MNRR, and the NatureServe element code.

Sampling Strata

For the MNRR sampling design, a sample frame was developed using a combination of U. S. Geologic 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 Resources Conservation Service (NRCS) soil survey data. No vegetation maps previously existed for MNRR. 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 South Dakota and 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 for each state were clipped to the MNRR 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 22 unique vegetated ecological systems remained within MNRR (Table 7). 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 7. List of MNRR ecological systems and other mapped land use classes based on South Dakota and Nebraska GAP data.

Vegetation Class	Ecological System/Land Use	#Acres Classified on MNRR	% of Park
Forest & Woodland	Western Great Plains Wooded Draw and Ravine	0.4	<0.01%
	Ruderal Forest	0.9	<0.01%
	Northwestern Great Plains Shrubland	16.9	0.02%
	Eastern Great Plains Tallgrass Aspen Parkland	79.6	0.12%
	North-Central Interior Dry Oak Forest and Woodland	326.9	0.47%
	North-Central Interior Maple-Basswood Forest	725.7	1.05%
	Western Great Plains Dry Bur Oak Forest and Woodland	839.3	1.22%
	North-Central Interior Dry-Mesic Oak Forest and Woodland	2,149.4	3 .11 %
	Southeastern Great Plains Floodplain Forest	5,262.7	7.62%
Shrubland & Grassland	Western Great Plains Floodplain Systems	11,829.4	17.13%
	Western Great Plains Shortgrass Prairie	1.1	<0.01%
	North-Central Interior Oak Savanna	8.0	0.01%
	Great Plains Prairie Pothole	13.1	0.02%
	Western Great Plains Sand Prairie	312.0	0.45%
	Western Great Plains Tallgrass Prairie	355.6	0.52%
	Central Mixedgrass Prairie	378.5	0.55%
	Western Great Plains Depressional Wetland Systems	397.9	0.58%
	Central Tallgrass Prairie	888 .0	1.29%
	Eastern Great Plains Wet Meadow, Prairie and Marsh	2,192.1	3.17%
	Northwestern Great Plains Mixedgrass Prairie	2,802.4	4 .06%
Agricultural Vegetation	Pasture/Hay	562.2	0.80%
	Cultivated Cropland	5,993.3	8.68%
Developed & Other Human Use	Developed, High Intensity	4.7	0.01%
	Developed, Medium Intensity	21.6	0.03%
	Developed, Low Intensity	250.6	0.36%
	Developed, Open Space	1,005.0	1.46%
Other	Open Water (Fresh)	31,709.0	45.92%
	Disturbed, Non-specific	724.3	1.05%

Landform Data Layer

A modeled landform data layer was created from a 30 meter digital elevation model (DEM) from the USGS National Elevation Dataset (1999). An ArcInfo Macro Language (AML) script developed by the 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 2002). The ten resulting landform classes were: 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. At MNRR, class 10 was not present, and classes 1 and 4 that formed the Missouri River channel and other low-lying areas were merged into a single class, for a total of 8 classes used in the analysis. A 3 x 3 *Majority Filter Neighborhood* procedure and a *Clump and Eliminate* procedure were run in ERDAS Imagine software to generalize the landform data layer and eliminate small clusters of pixels.

Geomorphology Class Based on Soils Data

NRCS soil survey data from numerous counties in South Dakota and Nebraska were obtained and 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 the park. In addition to the plots allocated randomly and subjectively using the land cover and landform combined classes, 25 of the least common geomorphic classes having less than 100 acres within the park were identified, and approximately 50 plots were subjectively placed in polygons that appeared to support non-cultural vegetation, based on examination of imagery. 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 with steep terrain and cliffs were considered inaccessible or too hazardous for field work. A cost surface using a threshold of 40+ degrees or 89% slope was developed using a 10 m DEM data layer.

Building the Strata Data Layer

The eight-category landform data layer was intersected with the ecological system data layer containing 22 classes to create map classes characterized by vegetation and a dominant landform. Paved and unpaved park 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 a slope of 40 degrees or more were then removed, resulting in the final allocation. Approximately half of the allocated plots were distributed in each park district. Within the 39-Mile District, approximately 50% of stratified random plots were located on publicly accessible lands. Within the 59-Mile District, approximately 25% of stratified random plots were located on publicly accessible lands.

2.1.3. Vegetation Data Collection

Sampling of vegetation classification plots was conducted in the summer of 2015 by 2 two-person crews and a crew leader. The field sampling effort began on June 1st and continued through July 27th. Crews were housed over the field season in the dormitories at Mount Marty College in Yankton, South Dakota. Data were collected using paper data sheets and Oregon 650 Garmin GPS units in accordance with NPS Vegetation Mapping Inventory protocols. Field sampling locations were accessed from roads using four-wheel-drive vehicles and from the river using canoes.

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 the park. Trained crews used maps of the project area with the locations of target destinations as well as a list of the 114 potential vegetation types to be sampled, and were instructed to attempt to collect three plots in each type. MNRR is a large, diverse place with points in remote areas, so crews were hired for their ability to work in variable outdoor conditions, to work while hiking, and to make careful and effective choices regarding access routes to plots.

Crew members were provided with a field manual describing the field form and the plot sampling methodology, backcountry safety, plant species lists, and accepted plant species codes. 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 8). A sample classification plot field form is included in Appendix E.

Table 8. 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 #, Photo #'s, 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, % ground cover, and environmental comments
Vegetation Attributes	Leaf phenology, leaf type, physiognomic class, height class, cover class, and dominant species by strata, vegetation comments, species list for all species in the plot indicating stratum and cover class, and any additional species from outside the plot

Plots were located in front-country areas less than ~3 hours travel time from road or river-accessible points; no back-country areas were sampled but none exist in this park. To minimize travel, crews occasionally camped within state recreation areas to sample the easternmost reaches of MNRR. Camping was usually for several days at a time. The following provides an 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 technicians planned a strategy for sampling plots most efficiently, taking proximity of roads, trails, topography and vegetation into consideration. Crews planned routes to collect the most plots in the most different potential vegetation types while minimizing travel time.

Navigation to plots was by GPS units as well as maps and compasses via motor vehicle, boat, and foot travel. After arriving at a site, crews walked through the area to understand the vegetative characteristics of the plot, determine whether the plot was representative of the vegetation as a whole, and determine whether the plot met the minimum mapping unit size of 0.5 hectare.

If the plot was too heterogeneous or too close to an ecotone, crews moved the plot center (within the standards of project methodology) to a position having more homogeneous 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, sampled it using either a classification plot or an observation point. Observation points document the structure, dominant species, and environmental attributes of a dimensionless plot. They can be collected using the same forms and instructions as 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 evaluated 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 was established.

At each sampling location, plot layout and data collection followed the NPS VMI protocols. Crews recorded the GPS UTM location at the plot center. Using the plot center as a reference, the crew 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 used a 20x20 m square plot, but the plot shape was adapted to best fit the existing vegetation as needed (e.g., a 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 developed a comprehensive species list for the plot by recording the species name and canopy cover class for each stratum. Cover values were assessed using cover ranges from a twelve-category scale (Table 9). Crews selected the cover range that best represented the actual cover of the species in the stratum. The midpoint of the cover class is used for quantitative analysis.

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, surficial geology, and percent ground cover).

Table 9. Vegetation canopy cover classes used for plot sampling.

Cover Class	% Cover Range	Mid Point
T	<1%	0.50
P	1% - 5%	3.00
1	5% - 15%	10.00
2	15% - 25%	20.00
3	25% - 35%	30.00
4	35% - 45%	40.00
5	45% - 55%	50.00
6	55% - 65%	60.00
7	65% - 75%	70.00
8	75% - 85%	80.00
9	85% - 95%	90.00
10	>95%	97.50

All data collected for each plot was recorded on paper data forms. A GPS-enabled camera was used to take photos of the plot from each cardinal direction (north, east, south, and west – in that order). Crews took a representative photograph of the overall plot, where possible, to capture portions of the surrounding landscape.

Before breaking down the plot, crews assigned 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 MNRR'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 granted field crews access to their property. The denial of access to a majority of the MNRR acreage restricted vegetation field crews from reaching many of their randomly allocated vegetation plots points. Subsequently, crews were required to focus on public lands such as state parks, WMA, and property owned by the USACE. The general distribution of plots sampled on both park districts is shown in Figure 6. Areas with relatively poor access include much of the eastern half of the 59-Mile District and the middle third of the 39-Mile District. The impact of 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 since no samples or reconnaissance data were collected there.

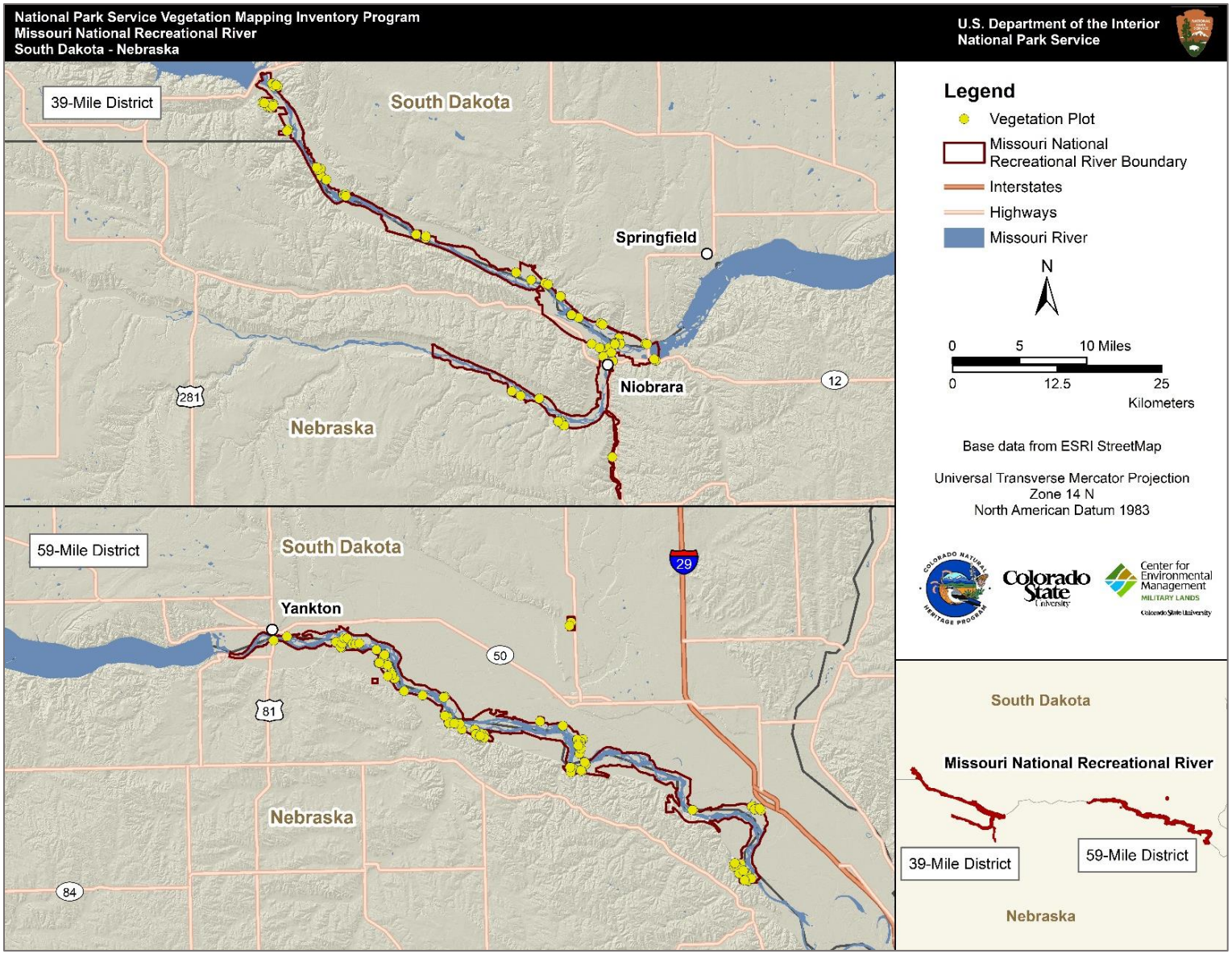

Figure 6. Vegetation sampling plots at MNRR.

2.1.4. Vegetation Classification

Data Management

Paper field data sheets were copied and scanned and duplicates were stored off-site for security. The forms were first reviewed for accuracy and completeness. Corrections were recorded in red with the reviewer's initials and the date. Data were transcribed into the PLOTS Version 4.0 database (CNHP 2015). Once all data were in PLOTS, the digital data were examined to eliminate any remaining data errors. This quality control process involved examining, sorting, and querying data to locate missing or erroneous information such as misspellings, duplicate entries, or typographic errors. All the plant names were entered into the database using the USDA PLANTS Database (USDA 2018) approved names and plant codes. Recorded species lists for each plot were compared to the assigned vegetation type to ensure congruity.

Each plot or observation point was labeled with the preliminary classification name the crews assigned in the field. The preliminary classification was a subjective classification based on the composition and structure of vegetation within the plot.

Photos collected at vegetation and observation plots were uploaded to the MNRR 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 professional judgment. The quantitative analysis was completed using the data from the total of 162 vegetation classification plots that passed quality control and were entered into the PLOTS 4.0 database (Figure 6). Prior to being analyzed, observation point data, which do not include detailed species and cover values, were removed from the classification dataset.

Species and cover data for the 162 vegetation classification plots were exported from the PLOTS 4.0 database in a list format. The mid-point of each cover class range was used as a discrete cover value for the analysis. For simplicity, since most species tend to dominate in a single stratum, for a given plot, the cover midpoint values for all strata were summed 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-by-species matrix containing canopy cover values for all strata combined. Text files were then imported into multivariate statistics software package PC-ORD version 6.0 (McCune and Medford 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) of the dominant species in the plots, with dominance determined by the uppermost strata. The divisions roughly stratified the data by physiognomic groups and simplified the analysis 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 and group average linkage method (McCune and Grace 2002). The output of the analysis suggested natural groupings of plots for comparison with the concepts of the USNVC associations in the preliminary classification. Decisions on how to refine the dendrograph were based on natural groupings first, and then manual analysis of the data behind the plots in those groupings. This analysis considered environmental characteristics of the plot and species composition, as well as the provisional community name given to the plot by the field crew. 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 Access and Microsoft 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 an existing USNVC type could not confidently be assigned. 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 the park.

Association Descriptions

Brief narratives that describe each classified type as it is expressed at MNRR 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 the characteristics broader. The range-wide global environment and vegetation descriptions were compiled for the MNRR project. The local descriptions for MNRR associations are provided in Appendix A.

Field Key to the Associations

A field key to the associations classified at MNRR was compiled 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 *Acer negundo* a shrub or a tree?). In that way,

starting to key from either sub-key should reach the same conclusion. The MNRR key to the associations is included in Appendix B.

2.2. Results

2.2.1. Vegetation Data Collection

The preliminary classification produced in the spring of 2015 prior to field sampling included 114 USNVC vegetation types that local experts had reasonable certainty would occur within MNRR. Field crews provisionally assigned 33 USNVC types from the list of preliminary classifications, and 14 USNVC types that were not listed in the preliminary classification.

The preliminary classification was used to target 319 points. These points were split about evenly between the 59-Mile District (160 plots) and the 39-Mile District (159 plots). However, the majority of these sites were not accessible due to private landowners denying access. Over the course of the field sampling season, a total of 79 vegetation plots and 83 observation plots were sampled (Figure 6). Due to the amount of private land and state parks within the NPS unit, no permanent plots were established.

A total of 302 plant species were recorded at MNRR (Appendix C). Several species were very abundant at MNRR. Species occurring in over 45 plots during the vegetation classification phase included *Juniperus virginiana*, *Fraxinus pennsylvanica*, *Cornus drummondii*, *Celtis occidentalis*, *Populus deltoides*, *Parthenocissus quinquefolia*, and *Ageratina altissima*. Only one threatened plant—*Panax quinquefolius*—has been documented within MNRR; field crews did not encounter that species during surveys.

2.2.2. Vegetation Classification

The vegetation classification at MNRR consists of 52 associations, alliances or park specials. There are 20 forest and woodland types, 8 shrubland types, 17 herbaceous types, and 7 sparse types. Of these, 10 types are not currently in the USNVC and were classified as park specials. Most of the park specials were created to capture ruderal or disturbed vegetation types not included in the USNVC. Examples include NPSMNRR002 Ruderal Herbaceous Grassland (dominated by a mix of weedy graminoids, such as *Poa pratensis*, *Bromus inermis*, and *Agropyron cristatum*) and NPSMNRR009 *Populus deltoides* Ruderal Forest (characterized by recent eastern redcedar removal areas with large piles of dead eastern redcedar and wood chips composing the majority of the ground cover).

Of the 162 classification plots in the dataset, 78 were classified as forest or woodland types, 23 were classified as shrubland types, 53 were classified as herbaceous types, and 8 were classified as sparse types. The complete list of vegetation classification plots and their classified type is included in Appendix D. Vegetation community descriptions for all MNRR vegetation types are provided in Appendix A.

The field inventory did not sample a number of types that were in the preliminary classification and suspected to occur in the park. Field trips conducted by mapping staff after the inventory field work identified associations that were subsequently added to the 21 types documented during the inventory phase. Many of these types were fairly rare and only assigned to a few polygons. These

determinations from one or more locations per type within the park were based on field notes and are not supported by vegetation plot or observation point data. Some types had very limited geographic distribution within the park. The mapping team added 14 USNVC associations and 8 park specials. Six map classes were created exclusively from the mapping team associations.

Forest and woodland types represent a large portion of the types classified at MNRR (Table 10). The most dominant species encountered at MNRR include *Juniperus virginiana*, *Fraxinus pennsylvanica*, *Cornus drummondii*, *Celtis occidentalis*, *Populus deltoides*, *Parthenocissus quinquefolia*, and *Ageratina altissima*.

Table 10. Forest and Woodland vegetation types documented at MNRR.

ELCODE	Association Name
NPSMNRR009	*Populus deltoides* Ruderal Forest
CEGL000658	*Populus deltoides* - *Fraxinus pennsylvanica* Floodplain Forest
CEGL000660	*Populus deltoides* / *Symphoricarpos occidentalis* Floodplain Woodland
NPSMNRR001	*Populus deltoides* - *Fraxinus pennsylvanica* / *Rhamnus cathartica* Ruderal Floodplain Forest
NPSMNRR005	*Populus deltoides* / *Cornus drummondii* Open 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
CEGL000947	*Salix amygdaloides* Riparian Woodland
CEGL002014	*Fraxinus pennsylvanica* - *Ulmus americana* - (*Juglans nigra*, *Celtis occidentalis*) Ruderal Forest
CEGL002593	*Juniperus virginiana* Midwest Ruderal Forest
CEGL005269	*Elaeagnus angustifolia* Ruderal Riparian Woodland
CEGL002072	*Quercus macrocarpa* / *Cornus drummondii* / *Aralia nudicaulis* Forest
CEGL000555	*Quercus macrocarpa* / *Ostrya virginiana* Forest
CEGL002012	*Tilia americana* - (*Quercus macrocarpa*) / *Ostrya virginiana* Forest
NPSMNRR006	*Quercus macrocarpa* / *Juniperus virginiana* Forest
CEGL002053	*Quercus macrocarpa* / *Andropogon gerardii* - *Hesperostipa comata* Woodland

The most extensive shrubland type found in the park was riparian willow communities composed of *Salix interior*. Other, less extensive shrubland types were dominated by either *Cornus drummondii* or *Symphoricarpos occidentalis* (Table 11).

Table11. Shrubland vegetation types documented at MNRR.

ELCODE	Association Name
CEGL008562	*Salix interior* Wet Shrubland
CEGL005282	*Salix interior* / *Pascopyrum smithii* - *Equisetum hyemale* Wet Shrubland
NPSMNRR010	*Populus deltoides* Shrubland
CEGL005220	*Cornus drummondii* - *Amorpha fruticosa* - *Cornus sericea* Wet Shrubland
CEGL005219	*Cornus drummondii* - (*Rhus glabra*, *Prunus* spp.) Shrubland
CEGL005453	*Prunus virginiana* Great Plains Shrubland
CEGL001131	*Symphoricarpos occidentalis* Shrubland
NPSMNRR007	*Rhus glabra* Mixedgrass Shrubland

The most common species within herbaceous types tended toward ruderal and included *Poa pratensis*, *Bromus inermis*, and *Ambrosia psilostachya*. The most common species in wetland types included *Phragmites australis* and *Phalaris arundinacea* (Table 12). Seven sparse vegetation communities were separated into two groups: cliffs/rock outcrops and riverine sandbars (Table 13). The extent and composition of the sandbars are highly seasonal and subject to constant change with changes in river levels.

Table 12. Herbaceous vegetation types documented at MNRR.

ELCODE	Association Name
CEGL005264	*Bromus inermis* - (*Pascopyrum smithii*) Ruderal Grassland
CEGL003019	*Bromus tectorum* Ruderal Grassland
CEGL003081	*Poa pratensis* Ruderal Marsh
NPSMNRR003	Weedy Forb Ruderal Herbaceous Vegetation
NPSMNRR002	Ruderal Herbaceous Grassland
NPSMNRR004	*Juniperus virginiana* Ruderal Shrub Invaded Grassland
CEGL002036	*Schizachyrium scoparium* - *Bouteloua curtipendula* Loess Mixedgrass Grassland
CEGL002023	*Andropogon gerardii* - *Panicum virgatum* Sandhills Grassland
CEGL002205	*Andropogon gerardii* - *Schizachyrium scoparium* Northern Plains Grassland
CEGL002024	*Andropogon gerardii* - *Panicum virgatum* - *Helianthus grosseserratus* Wet Meadow
CEGL001467	*Andropogon hallii* - *Calamovilfa longifolia* Grassland
CEGL002034	*Pascopyrum smithii* - *Hesperostipa comata* Central Grassland
CEGL001474	*Phalaris arundinacea* Western Marsh

Table 12 (continued). Herbaceous vegetation types documented at MNRR.

ELCODE	Association Name
CEGL001475	*Phragmites australis* Western Ruderal Wet Meadow
CEGL002389	*Typha* spp. Great Plains Marsh
CEGL002026	*Schoenoplectus tabernaemontani* - *Typha* spp. - (*Sparganium* spp., *Juncus* spp.) Marsh
CEGL005272	*Carex* spp. - (*Carex pellita*, *Carex vulpinoidea*) Wet Meadow

Table 13. Sparse vegetation types documented at MNRR.

ELCODE	Association Name
CEGL002049	Riverine Sand Flats - Bars Sparse Vegetation
CEGL005223	Great Plains Riverine Gravel Flats Sparse Vegetation
NPSMNRR008	Bare Alluvial Depositional Bar
CEGL002294	Shale Barrens 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

A total of 643 vegetation plot photos were collected during the field sampling effort. A total of 2,710 AA point photos (4 photos per plot) were collected during the AA phase. The total number of photos generated by the project and included in the photo dataset is 3,353 photos. Vegetation plot photos were collected over the summer of 2015, while AA point photos were collected over the summer of 2017.

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.

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

Minimum Mapping Unit. A minimum mapping unit (i.e., polygon size) of 0.5 hectares was used by the image interpreter. Polygons below the minimum mapping unit were mapped as the predominant adjacent map class.

Thematic Accuracy: The desired minimum users' accuracy for 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. At MNRR, 2016 60 cm National Aerial Imagery Program (NAIP) imagery served as the primary base map for the project. This was the most recent imagery available, and was used to map shorelines and islands, the locations of which can vary considerably among imagery sources and over time. A variety of other existing imagery sources was utilized for the MNRR mapping project. Table 14 describes specifications for all imagery used for this project. New imagery was acquired from Cornerstone Mapping Inc. for the lower portions of the Niobrara River and the Niobrara Delta, as there was not suitable existing imagery available for that area at the start 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 169 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 lower Niobrara River and Verdigre Creek portions of the MNRR project area on October 13, 2015 and delivered to CSU in December 2015. Each image was delivered as an individual geo-referenced 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. Additional imagery supplementing the interpretation phase included current and historic true-color Google Earth and Bing Maps imagery.

Table 14. Specifications for imagery used for the MNRR vegetation mapping project. The 2016 NAIP imagery served as the primary basemap for the project.

Product	Data Source	Year	Bands	Resolution (cm)
2016 NAIP	USDA-FSA	2016	RGB	60
2015 Cornerstone	Cornerstone Mapping Inc.	2015	RGB, CIR	30
WorldView-2*	Digital Globe, USACE	2014	8 bands	50
2014 NAIP	USDA-FSA	2014	RGB, CIR	100
2011 Merrick*	Merrick & Company	2011	RGB	30
QuickBird*	Digital Globe, USACE	2009	RGB, CIR	60
QuickBird*	Digital Globe, USACE	2009	RGB, CIR	60

* Imagery provided by NPS

3.1.3. Legacy Data

The *Vegetation Inventory Study Plan for Missouri National Recreational River* (Stevens et al. 2010) identified a variety of legacy datasets and base spatial data to support vegetation classification and mapping at MNRR. Legacy data were evaluated using the TNC and NPS (2009) evaluation framework (see section 2.1.1). The data and reports associated with Dixon et al. (2010), Dixon (2014), Dixon et al. (2015) and Dixon (2016) for project sites in or near the park proved helpful in validating and complementing the vegetation classification produced during the vegetation inventory phase of the project. Data from field plots associated with these projects also informed the delineation of vegetation polygons in areas where lack of access/permission and other constraints (e.g., time) prohibited sampling.

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 of the project, 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 (Stevens et al. 2010) provided a starting point for the types that were likely present at the park, 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 the summer of 2015 was complete and the list of MNRR 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 both forest and woodland 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 accuracy assessment 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 Chapter 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, 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. Field reconnaissance served as the primary means to refine this initial physiognomic map. Field GPS tablets and paper maps were used 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 supported classifying and delineating polygons at a finer level of detail, until a balance between robustness of the map and our ability to achieve thematic accuracy requirements was achieved. Field reconnaissance for map development occurred throughout the summer and fall of 2016 and in the spring of 2017, prior to AA fieldwork commencing. Reconnaissance allowed mappers to become familiar with the area's local taxa and ecology, and begin to 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 the park, 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 data, 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 all map classes. Three-dimensional visualizations using Google Earth was used to better see vegetation structure and composition, especially in the steep terrain in and around the glacial end moraine of the Missouri Breaks. Different combinations of imagery bands were used to differentiate some types. Interpretation notes for MNRR map classes are summarized in Appendix I.

3.1.6. Validation of Map Thematic Accuracy

Whereas accuracy assessment is a considerable investment in time and effort, validation is a process of more limited sampling, the objective of which is to determine whether a final draft map is accurate enough to justify field-based thematic accuracy assessment 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 accuracy assessment. Map thematic validation is important to ensure that errors in the map, the association key, and the classification are corrected before the accuracy assessment phase of the project begins.

The NPS (2013) 12-Step Guidance document recommends independent third party validation of the map and key prior to the accuracy assessment. Map thematic validation is completed by image analysts and ecologists visiting the site together and briefly testing the map and key in the field. While some projects plan a quantitative, third-party validation, this was not done for the MNRR project. The imagery interpretation team conducted three validation trips to MNRR 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 confidence in 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 accuracy assessment phase.

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

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 (closer to 10% total plant cover), these types can be difficult to distinguish from grasslands and shrublands with low total cover. At the lower end of the scale (closer to 1% total plant cover), these types can be confused with and intergrade with non-vegetated surfaces. Sparse vegetation types at MNRR were primarily found on riverine sandbars, which are 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, given temporal variation in the community and the tendency for the sand substrate to over-saturate the image, obscuring the vegetation photo-signature (Figure 7). To account for this challenge, the Riverine Sparse Bar map class was broadened to include bare sand, defined as non-vegetated areas that had recently been reworked.

Changes in Vegetation

In some areas of the park, changes in vegetation occurred during the project due to changes in river flows, weed spraying, vegetation clearing in support of listed species conservation (Figure 8), mechanical removal of Russian olive and eastern redcedar trees, and land use conversion. Land use conversion from natural vegetation to agriculture occurred in a few areas (Figure 9), but the primary

impact to the project was removal of eastern redcedar. Active removal was occurring throughout the duration of the project, altering communities and changing map classes (Figure 10). Some of these changes were captured by the mapping team during the validation phase of the project, but others were likely not captured.

Figure 7. Example of a dynamic riverine sandbar at MNRR. 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, also from 2016 (NAIP Image). Note the over-saturation of the aerial image, which has obscured the vegetation photo-signature of both the sparse vegetation and the regenerating cottonwood stand (CSU Photo).

Figure 8. Example of vegetation clearing for threatened and endangered species management at MNRR. The brown sandbar has been treated aerially with herbicide to maintain an open, non-vegetated condition, which is the preferred nesting habitat for the piping plover (*Charadrius melodus*) and least tern (*Sternula antillarum*). Large-scale clearing activities occurred throughout the duration of the project. (CSU Photo)

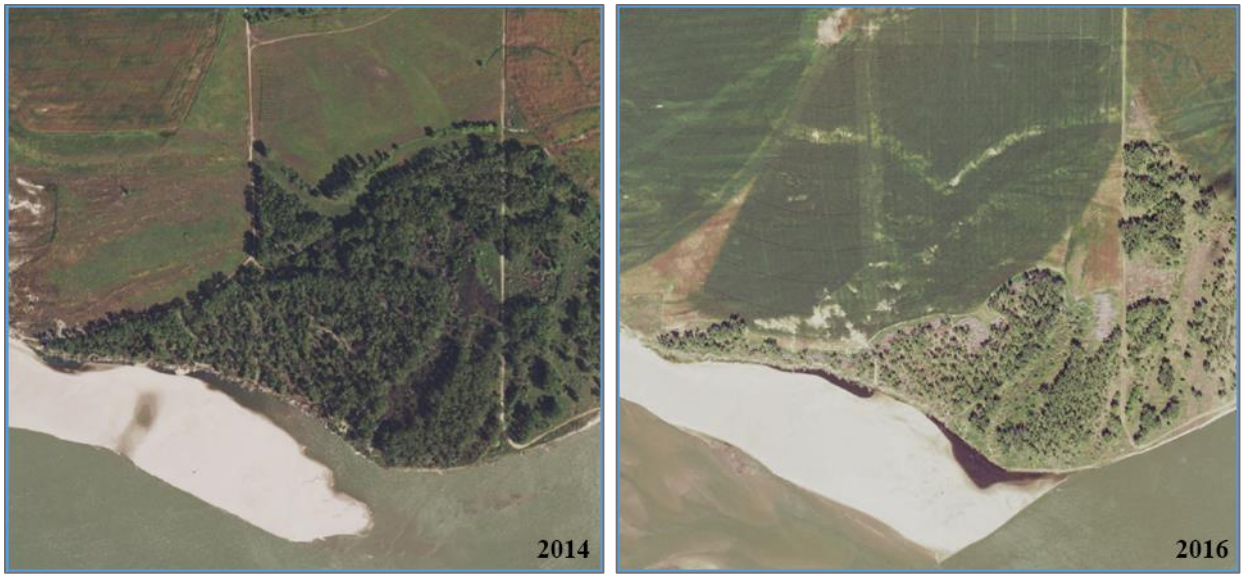

Figure 9. Example of land use conversion at MNRR from a natural riparian forest community (2014) to row-crop agriculture (2016). Some of these changes were captured by the mapping team during the validation phase of the project, but others were likely not captured (NAIP Imagery).

Figure 10. Example of pre (left) and post (right) eastern redcedar removal at MNRR. Mechanical removal altered communities and resulted in different map class designations. Some of these changes were captured by the mapping team during the validation phase of the project (CSU Photo).

Dynamic Marsh Environments

Marsh environments near the Niobrara River confluence proved exceptionally difficult to map due to seasonal and interannual changes in water levels. Numerous USNVC types (e.g., CEGL002389 *Typha* spp. Great Plains Marsh, and CEGL002026 *Schoenoplectus tabernaemontani* - *Typha* spp. - (*Sparganium* spp., *Juncus* spp.) Marsh) occurred together as a "patchwork" complex across the landscape (Figure 11). Difficulties were compounded by the presence/dominance of invasive or noxious species such as *Phragmites australis* and *Phalaris arundinacea*. Areas dominated by these invasive/noxious species transitioned to ruderal map classes (e.g., CEGL001474 *Phalaris*

arundinacea Western Marsh; CEGL001475 *Phragmites australis* Western Ruderal Wet Meadow), while areas invaded but not dominated were referred to as a degraded version of the natural type. Seasonal differences within the communities, changes in river flow, and general difficulties accessing each location resulted in relatively low map accuracies for individual USNVC types within this complex.

Figure 11. Example of the dynamic marsh community complex at MNRR. This photo shows 3-4 USNVC types occurring below the minimum mapping unit size in a wetland vegetation complex. (CSU Photo).

Private Land Access

Given that a majority of MNRR is privately owned, access depended on private landowners granting permission for vegetation sampling and mapping efforts. Most landowners declined our requests to access their land for the project. Additionally, several landowners that had allowed vegetation plot sampling to occur declined our request for access for mapping and accuracy assessment 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 (i.e., the highest possible level of floristic detail) 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 25 natural and ruderal vegetated map classes, along with four sub-map classes representing 52 USNVC associations or other unpublished communities defined by the project (i.e., park specials).

The final map classification consists of 31 map classes for MNRR. Of these 31 map classes, 25 represent 42 natural/ruderal associations types within the USNVC, 10 types described as unpublished park specials, 2 types represent cultural vegetation (i.e., agricultural vegetation), and 4 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 are shown below.

Herbaceous Vegetation

- MC101 Ruderal Herbaceous Grassland
    - CEGL005264: *Bromus inermis* - (*Pascopyrum smithii*) Ruderal Grassland
    - CEGL003019: *Bromus tectorum* Ruderal Grassland
    - CEGL003081: *Poa pratensis* Ruderal Marsh
    - NPSMNRR003: Weedy Forb Ruderal Herbaceous Vegetation
    - NPSMNRR002: Ruderal Herbaceous Grassland
    - NPSMNRR004: *Juniperus virginiana* Ruderal Shrub Invaded Grassland
- MC102 *Schizachyrium scoparium* - *Bouteloua* (*curtipendula*, *gracilis*) Mixedgrass Grassland
    - CEGL002036: *Schizachyrium scoparium* - *Bouteloua curtipendula* Loess Mixedgrass Grassland
- MC103 *Andropogon gerardii* Tall Grass Prairie Grassland
    - CEGL002023: *Andropogon gerardii* - *Panicum virgatum* Sandhills Grassland
    - CEGL002205: *Andropogon gerardii* - *Schizachyrium scoparium* Northern Plains Grassland
    - CEGL002024: *Andropogon gerardii* - *Panicum virgatum* - *Helianthus grosseserratus* Wet Meadow
    - CEGL001467: *Andropogon hallii* - *Calamovilfa longifolia* Grassland
- MC104 *Hesperostipa comata* - *Pascopyrum smithii* Mixedgrass Grassland
    - CEGL002034: *Pascopyrum smithii* - *Hesperostipa comata* Central Mixedgrass Grassland
- MC105 Marsh Complex
    - MC105a *Phalaris arundinacea* Western Marsh
        - CEGL001474: *Phalaris arundinacea* Western Marsh
    - MC105b *Phragmites australis* Western Ruderal Wet Meadow
        - CEGL001475: *Phragmites australis* Western Ruderal Wet Meadow
    - MC105c *Typha* spp., *Schoenoplectus* spp. Great Plains Marsh
        - CEGL002389: *Typha* spp. Great Plains Marsh
        - CEGL002026: *Schoenoplectus tabernaemontani* - *Typha* spp. - (*Sparganium* spp., *Juncus* spp.) Marsh
    - MC105d *Carex* spp., *Juncus* spp., *Eleocharis* spp. Wet Meadow
        - CEGL005272: *Carex* spp. - (*Carex pellita*, *Carex vulpinoidea*) Wet Meadow

Shrublands:

- MC201 *Salix interior* Wet Shrubland
    - CEGL008562: *Salix interior* Wet Shrubland
    - CEGL005282: *Salix interior* / *Pascopyrum smithii* - *Equisetum hyemale* Wet Shrubland
    - NPSMNRR010: *Populus deltoides* Successional Shrubland
- MC202 *Cornus drummondii* - *Amorpha fruticosa* - *Cornus sericea* Wet Shrubland
    - CEGL005220: *Cornus drummondii* - *Amorpha fruticosa* - *Cornus sericea* Wet Shrubland
- MC203 *Cornus drummondii* - *Prunus* spp. Upland Shrubland
    - CEGL005219: *Cornus drummondii* - (*Rhus glabra*, *Prunus* spp.) Shrubland
    - CEGL005453: *Prunus virginiana* Great Plains Shrubland
- MC204 *Symphoricarpos occidentalis* Shrubland
    - CEGL001131: *Symphoricarpos occidentalis* Shrubland
- MC205 *Rhus glabra* Mixedgrass Shrubland
    - NPSMNRR007: *Rhus glabra* Mixedgrass Shrubland

Woodlands and Forests:

- MC301 *Populus deltoides* Ruderal Forest and Woodland
    - NPSMNRR009: *Populus deltoides* Ruderal Forest
- MC302 *Populus deltoides* Floodplain Forest and Woodland
    - CEGL000658: *Populus deltoides* - *Fraxinus pennsylvanica* Floodplain Forest
    - CEGL000660: *Populus deltoides* / *Symphoricarpos occidentalis* Floodplain Woodland
    - NPSMNRR001: *Populus deltoides* - *Fraxinus pennsylvanica* / *Rhamnus cathartica* Ruderal Floodplain Forest
- MC303 *Populus deltoides* / *Cornus drummondii* Open Floodplain Forest
    - NPSMNRR005: *Populus deltoides* / *Cornus drummondii* Open Floodplain Forest
- MC304 *Populus deltoides* / *Juniperus virginiana* Floodplain Forest and Woodland
    - CEGL002152: *Populus deltoides* / *Juniperus scopulorum* Floodplain Forest
- MC305 *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
- MC306 *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
    - CEGL000643: *Fraxinus pennsylvanica* - *Ulmus americana* / *Prunus virginiana* Woodland
- MC307 *Fraxinus pennsylvanica* Ruderal Forest and Woodland
    - CEGL005239: *Fraxinus pennsylvanica* - *Ulmus americana* - (*Juglans nigra*, *Celtis occidentalis*) Ruderal Forest
- MC308 *Juniperus virginiana* Midwest Ruderal Woodland and Forest
    - CEGL002593: *Juniperus virginiana* Midwest Ruderal Forest
- MC309 *Elaeagnus angustifolia* Ruderal Riparian Woodland and Forest
    - CEGL005269: *Elaeagnus angustifolia* Ruderal Riparian Woodland
- MC310 *Quercus macrocarpa* Dry Mesic Upland Forest
    - CEGL002072: *Quercus macrocarpa* / *Cornus drummondii* / *Aralia nudicaulis* Forest
    - CEGL000555: *Quercus macrocarpa* / *Ostrya virginiana* Forest
- MC311 *Tilia americana* - (*Quercus macrocarpa*) / *Ostrya virginiana* Forest
    - CEGL002012: *Tilia americana* - (*Quercus macrocarpa*) / *Ostrya virginiana* Forest
- MC312 *Quercus macrocarpa* / *Juniperus virginiana* Ruderal Forest and Woodland
    - NPSMNRR006: *Quercus macrocarpa* / *Juniperus virginiana* Forest
- MC313 *Quercus macrocarpa* Woodland and Wooded Grassland
    - CEGL002053: *Quercus macrocarpa* / *Andropogon gerardii* - *Hesperostipa spartea* Woodland

Sparse Vegetation:

- MC401 Riverine Sparse Bar Vegetation
    - CEGL002049: Riverine Sand Flats-Bars Sparse Vegetation
    - CEGL005223: Great Plains Riverine Gravel Flats Sparse Vegetation
    - NPSMNRR008: Bare Alluvial Depositional Bar
- 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 Land/Hay Field
- LC003 Non-vegetated, (Barren Land, Cut Bank, Borrow Pit)
- LC004 Developed, Open Space
- LC005 Developed, (Low, Med, High) Intensity
- LC006 Water

Of the 25 vegetated map classes, 14 map classes represent a single association/park special, 2 map classes represent 2 associations, 5 map classes represent 3 associations/park specials, 2 map classes represents 4 associations, 1 map class represents 5 associations, and 1 map class represents 6 associations/park specials. 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 that occupy the largest acreage. Descriptions of map classes representing USNVC floristic types (i.e., associations) can be derived from the descriptions of associations and park specials presented in Appendix A.

3.2.2. Summary Statistics

The MNRR vegetation data layer consists of 3,590 polygons totaling 69,011 ac (27,928 ha; Table 15). Mean polygon size for vegetated types was 12.1 ac (4.9 ha). Of the total area, approximately 37,789 ac (15,293 ha) or 55% of the park represented natural or ruderal vegetation map classes.

Map classes representing barren areas and developed classes occupied approximately 1,562 ac (632 ha) or 2% of the park. Agricultural vegetation accounted for 6,238 ac (2,524 ha) or 9% of the park. Water was mapped on 23,422 ac (9,479 ha) accounting for 34% of the park area. Of the broad physiognomic groupings of map classes, woodland and forest types were the most extensive at 17,007 ac (6,882 ha or 25% of the park), followed by herbaceous vegetation at 11,457 ac (4,636 ha or 17% of the park), sparse vegetation at 6,287 ac (2,544 ha or 9% of the park), and shrublands at 3,038 ac (1,229 ha or 4% of the park) (Figure 12).

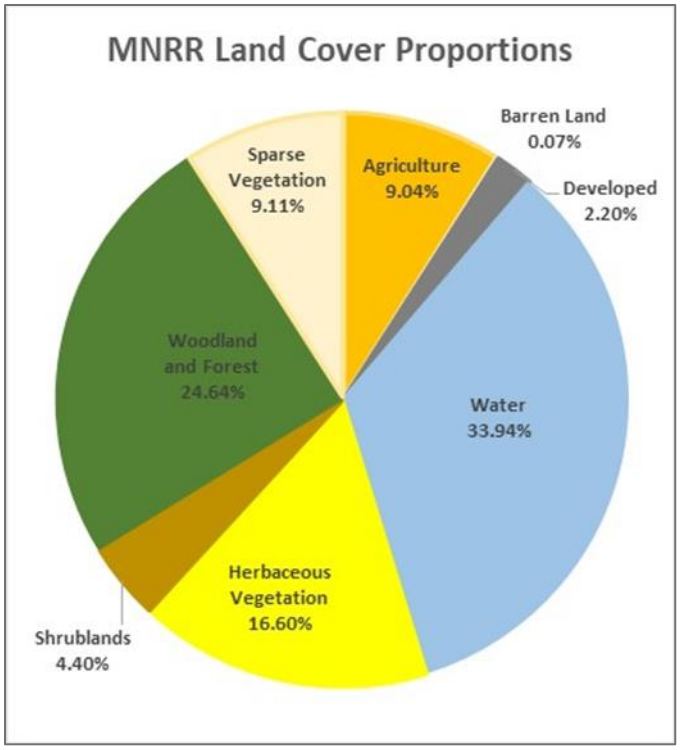

Figure 12. Percent of mapped area by vegetation physiognomy and land cover class.

3.2.3. Herbaceous Vegetation

Herbaceous vegetation map classes occupied 16.6% (11,457 ac; 4,636 ha) of the park area and accounted for 26% (1,042 polygons) of the mapped polygons. The Marsh Complex map class (MC105) represented the largest component of herbaceous vegetation at MNRR, occupying 6,977 acres (2,823 ha) or 10.1% of the MNRR area. This map class was mapped as a complex of five USNVC associations. Sub-map classes were delineated for this map class, where applicable: *Phalaris arundinacea* Western Marsh (MC105a), the *Phragmites australis* Western Ruderal Wet Meadow (MC105b), the *Typha* spp., *Schoenoplectus* spp. Great Plains Marsh (MC105c), and the *Carex* spp., *Juncus* spp., *Eleocharis* spp. Wet Meadow (MC105d). The second most abundant herbaceous vegetation type was the Ruderal Herbaceous Grassland map class (MC101). This type occupied 3,497 ac (1,415 ha) and represented 5% of the MNRR area. Other herbaceous vegetation types (i.e., MC103 *Andropogon gerardii* Tall Grass Prairie Grassland) played a minor role across the MNRR park area, occupying only 1.4% (944 ac; 382 ha) of the park. A complete summary of herbaceous vegetation map class statistics is included in Table 15.

Table 15. Statistics by map class for the Missouri National Recreational River vegetation map. The minimum mapping unit was 0.5 hectares.

Vegetation Type	Map Class	Number of Polygons	Minimum size (ha)	Maximum size (ha)	Mean size (ha)	Total area (ha)
Herbacious Vegetation	MC101 Ruderal Herbaceous Grassland	460	0.5	42.29	3.08	1,415.34
	MC102 *Schizachyrium scoparium - Bouteloua* (*curtipendula*, *gracilis*) Mixedgrass Grassland	9	0.58	2.55	1.31	11.77
	MC103 *Andropogon gerardii* Tall Grass Prairie Grassland	45	0.51	63.61	8.50	382.26
	MC104 *Hesperostipa comata - Pascopyrum smithii* Mixedgrass Grassland	5	0.55	0.96	0.74	3.71
	MC105 Marsh Complex	523	0.50	102.87	5.40	2,823.55
Shrubland	MC201 *Salix interior* Wet Shrubland	333	0.5	32.73	3.50	1,164.68
	MC202 *Cornus drummondii - Amorpha fruticosa - Cornus sericea* Wet Shrubland	17	0.59	15.37	3.07	52.14
	MC203 *Cornus drummondii - Prunus* spp. Upland Shrubland	6	0.74	4.37	1.54	9.24
	MC204 *Symphoricarpos occidentalis* Shrubland	2	1.24	1.27	1.25	2.51
	MC205 *Rhus glabra* Mixedgrass Shrubland	1	0.71	0.71	0.71	0.71
Woodland and Forest	MC301 *Populus deltoides* Ruderal Forest and Woodland	73	0.51	15.90	3.24	236.29
	MC302 *Populus deltoides* Floodplain Forest and Woodland	198	0.51	104.80	6.41	1,268.33
	MC303 *Populus deltoides* / *Cornus drummondii* Open Floodplain Forest	35	0.74	87.27	11.53	403.54
	MC304 *Populus deltoides* / *Juniperus virginiana* Floodplain Forest and Woodland	187	0.52	111.43	8.92	1,668.72
	MC305 *Populus deltoides - Salix amygdaloides* Floodplain Woodland and Forest	212	0.51	35.33	3.82	808.88

Table 15 (continued). Statistics by map class for the Missouri National Recreational River vegetation map. The minimum mapping unit was 0.5 hectares.

Vegetation Type	Map Class	Number of Polygons	Minimum size (ha)	Maximum size (ha)	Mean size (ha)	Total area (ha)
Woodland and Forest (continued)	MC306 *Fraxinus pennsylvanica* - *Ulmus* spp. - *Celtis occidentalis* Floodplain Forest and Woodland	107	0.51	23.39	3.06	326.88
	MC307 *Fraxinus pennsylvanica* Ruderal Forest and Woodland	146	0.51	31.02	2.88	420.81
	MC308 *Juniperus virginiana* Midwest Ruderal Woodland and Forest	145	0.50	31.60	3.10	449.20
	MC309 *Elaeagnus angustifolia* Ruderal Riparian Woodland and Forest	121	0.50	19.34	2.04	246.11
	MC310 *Quercus macrocarpa* Dry Mesic Upland Forest	81	0.51	39.63	7.29	590.24
	MC311 *Tilia americana* - (*Quercus macrocarpa*) / *Ostrya virginiana* Forest	14	0.79	43.66	13.40	187.67
	MC312 *Quercus macrocarpa* / *Juniperus virginiana* Ruderal Forest and Woodland	82	0.51	29.02	3.24	265.84
	MC313 *Quercus macrocarpa* Woodland and Wooded Grassland	8	0.54	2.99	1.26	10.06
Sparse Vegetation	MC401 Riverine Sparse Bar Vegetation	284	0.51	155.97	8.76	2,487.44
	MC402 Sparse Cliff Vegetation	24	0.51	8.40	2.37	56.82
Cultural Vegetation	LC001 Agricultural Vegetation, Cultivated Crops	167	0.51	136.99	9.73	1,625.65
	LC002 Agricultural Vegetation, Pasture Land/Hay Ground	111	0.51	113.35	8.10	898.72
Land Cover	LC003 Non-vegetated, (Barren Land, Borrow Pit, Cut Bank)	5	0.54	14.05	3.66	18.30
	LC004 Developed, Open Space	113	0.51	30.29	4.03	455.51

Table 15 (continued). Statistics by map class for the Missouri National Recreational River vegetation map. The minimum mapping unit was 0.5 hectares.

Vegetation Type	Map Class	Number of Polygons	Minimum size (ha)	Maximum size (ha)	Mean size (ha)	Total area (ha)
Land Cover (continued)	LC005 Developed, High Intensity	33	0.51	34.73	4.80	158.39
	LC006 Water	43	0.51	3,478.39	220.44	9,478.63
Totals	**–**	**3,590**	**–**	**–**	**–**	**27,927.95**

3.2.4. Shrublands

Five shrubland map classes at MNRR account for 4% (3,038 ac; 1,229 ha) of the park area (Table 15). The most common type, the *Salix interior* Wet Shrubland (MC201), accounts for 2,878 ac (1,165 ha) or 4.2% of the park area. The other four map classes (e.g., MC205 *Rhus glabra* Mixedgrass Shrubland; MC203 *Cornus drummondii* - *Prunus* spp. Upland Shrubland) occupy only 160 ac (65 ha), or 0.2% of the Park.

3.2.5. Woodland and Forest

There are 13 woodland and forest vegetation map classes at MNRR occupying 25% (17,007 ac; 6,882 ha) of the park area (Table 15). The most abundant type was the *Populus deltoides* / *Juniperus virginiana* Floodplain Forest and Woodland (MC304), which represented 4,123 ac (1,668 ha) or 5.98% of the Park. The next most common types included the *Populus deltoides* Floodplain Forest and Woodland (MC301), the *Populus deltoides* - *Salix amygdaloides* Floodplain Woodland and Forest (MC305), and the *Quercus macrocarpa* Dry Mesic Upland Forest (MC310), which occupied 4.5% (3,134 ac; 1,268 ha), 2.90% (1999 ac; 809 ha), and 2.1% (1,458.5 ac; 590 ha), respectively.

3.2.6. Sparse Vegetation

Sparse vegetation map classes comprise 9.1% (6,287 ac; 2,544 ha) of the MNRR park area. The Riverine Sparse Bar Vegetation (MC401) map class represents a majority of the coverage at 8.91% (6,147 ac; 2,487 ha) of the park area (Table 15).

3.2.7. Map Layer Development

Following the accuracy assessment 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 of 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 MC105 Marsh Complex)
- sub map class name (sub_map_class_name; for polygons in MC105 Marsh Complex)
- sub map class name translated (sub_map_class_translated; for polygons in MC105 Marsh Complex)
- polygon perimeter (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 accuracy assessment plots and associated sampling data from the PLOTS database, plot photos, and project boundary extent. Database tables document the USNVC hierarchy and allow 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.

4. Accuracy Assessment

4.1. Introduction

Accuracy Assessment (AA) 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 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 and an estimate of the users' and producers' accuracy for each map class. 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..

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 MNRR. 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.

When vegetation types with lower accuracy represent types of management interest, 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 MNRR 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. Methods

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 access permission within the MNRR administrative boundary.

- **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; however, these buffers may not always have been met due to limited allocation on accessible public lands.

Sample sizes for each evaluated map class were selected using guidance from Lea and Curtis (2010) (Table 16). 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 699 primary points and an additional 318 alternate points 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% or large marshy areas), 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 16. 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.

4.2.2. Field AA Data Collection

Field staff for AA data collection consisted of two 2-person crews and a crew leader that worked from June 12th through September 26th of 2017. All crew members had backgrounds in botany and ecology sampling techniques, but were previously unfamiliar with the vegetation present at MNRR. 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. Collector allows data to be captured digitally on a tablet. Data are recorded 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 for the project through drop-down 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, a digital data sheet was created in Collector. The digital data sheet was based on the paper AA data sheet. 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, project managers could remotely view and examine data immediately following its collection. During data collection, species were chosen from a pre-generated species list, which reduces spelling errors and speeds up quality control and 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 viewable on the field devices 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.

As with the vegetation classification plots, AA point locations were accessed using a combination of travel on roads, boat travel (supported by NPS), 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 attempted to move or reshape the plot. In the extremely rare case that the plot could not be moved or reshaped appropriately, it was rejected and replaced with an alternate plot selected sequentially from the alternate plot list. If the plot appeared to encompass more than one distinct vegetation type (not considered an inclusion), the plot was 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 and cliffs 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. A primary or "best fit" assignment was recorded as well as a secondary or "next best" assignment. The vegetation types were either recognized USNVC types or park specials if no USNVC type was suitable. The vegetation types were equivalent to, or nested uniquely within, a single map class. There could be many types within a single map class, but only one map class for each type. Thus, identifying the sample plot vegetation type ultimately determined whether the correct map class had 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.

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 and their respective cover classes, cover class of each stratum, ground cover, leaf phenology of dominant 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. The crew also recorded the UTM coordinates of the field plot center, which was especially crucial when plots were moved, 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) and took a picture from plot center in each of the cardinal directions (beginning with north, and followed by 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.

Due to the seasonal variability along the Missouri River, some plots were inundated with water at the time of sampling. These sites were accessed via canoe 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 water levels, the crew recorded the species that were visible at the time of sampling.

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, 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 MNRR AA data, a table was created from the pertinent data fields in the PLOTS database and imported into ArcGIS (Appendix H). The data fields imported included Plot ID, Primary Association, Secondary Association, Primary Map Class, Secondary Map Class, Plot XY Coordinates, and Field XY Coordinates. The imported data were 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 Microsoft (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 matched the map call were considered correct and removed from the analysis. Records where the primary field call disagreed with the mapped class but the crew made a secondary field call were then evaluated. Records for which the secondary call matched the map call 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 the 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 to verify whether the error was attributable to the map class or some other factor. Verifying the source of error allows one to reconcile errors that have very little to do with the accuracy of the map polygons, and provides a better measure of 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 ID error (FC1), a cover or density estimate error (FC2), a minimum map unit 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 RC1 were considered to be correct.

The review of all disagreements included review of 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 the six codes listed above (FC1-FC4, MC1, and RC1). 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 same or change).

An example of a disagreement that was corrected would be a point where the field crew identified the type as *Fraxinus pennsylvanica* ruderal forest, while the map called that point *Fraxinus pennsylvanica – Ulmus americana – Celtis occidentalis* floodplain forest. Review of the photos and species list identified greater abundances of *Ulmus americana* and *Celtis occidentalis*, indicating the

class was actually a non-ruderal community. This example would be considered a simple data recording error (FC4) and reconciled as correct.

Following the reconciliation, the data were arrayed in MS Excel to create an error matrix as well as a list of all map classes and associated 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 estimates the proportion of agreement due to chance and adjusts the overall accuracy value accordingly. The Kappa statistic 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 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. 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. 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 followed the Lea and Curtis (2010) protocol, which states that the sum of the individual class accuracies is the accuracy of the lumped classes, and the sum of the confidence intervals of the individual classes is the confidence of the lumped classes. While Lea and Curtis (2010) instructs 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 consistent and effective method.

4.3. Results

4.3.1. Accuracy Assessment Field Data Collection

The field crew collected data at 613 primary points and 124 alternate points, for a total of 737 AA points (Figure 13). The total inference area within the 69,011 ac (27,928 ha) of MNRR was 37,789 ac (15,293 ha), or 55%. Open water (river and lake areas) and land use areas (e.g., agriculture, roads, urban) were not included in the inference area. The inference area for each map class and the count of sample points collected within each is shown in Table 17.

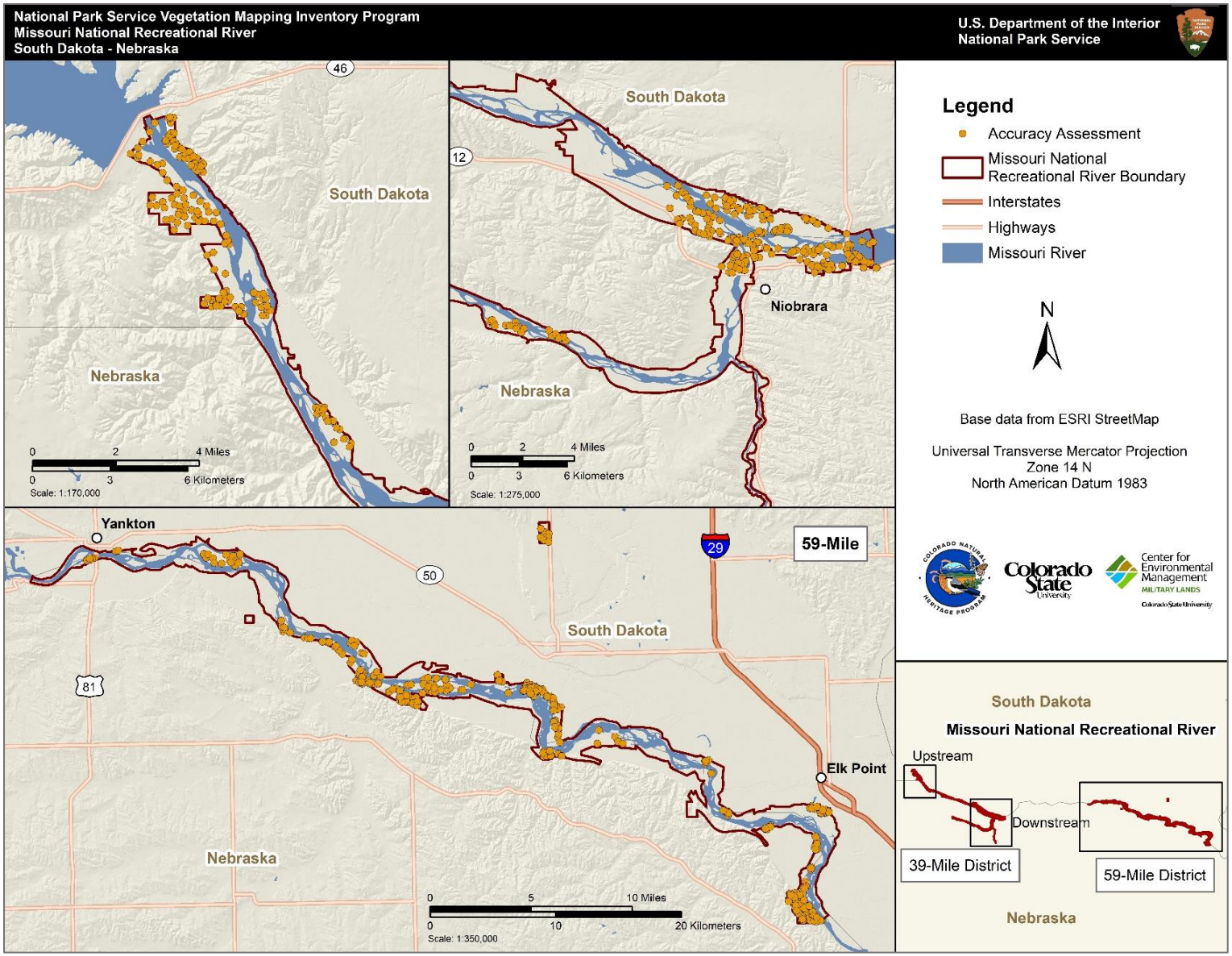

Figure 13. Accuracy assessment plot locations visited in the summer of 2017 at MNRR.

Table 17. Inference area and count of sample points in each map class at MNRR going into the accuracy assessment (AA) phase.

Map Class Code	Map Class Inference Area (hectares)	Number of AA Sample Points
MC101	1,414	31
MC102	12	7
MC103	382	32
MC104	4	3
MC105	1,728	32
MC105a	652	34
MC105b	78	31
MC105c	171	31
MC105d	192	29
MC201	1,164	32
MC202	52	32
MC203	9	6
MC204	3	2
MC205	1	1
MC301	237	32
MC302	1,270	32
MC303	404	32
MC304	1,671	30
MC305	808	33
MC306	326	35
MC307	421	32
MC308	448	31
MC309	244	30
MC310	591	33
MC311	187	31
MC312	266	32
MC313	10	3
MC401	2,489	31
MC402	57	17

4.3.2. Accuracy Assessment Data Analysis

Field crews collected data from a total of 737 AA sample points (Figure 13). Prior to any effort to reconcile data collection errors, 601 samples agreed with the map classification and 136 disagreed with the map classification. As a simple plot count proportion across all map classes, the overall accuracy before reconciliation was 81.5% (601/737). When the accuracy for each map class is weighted relative to the acreage it occupies within the park (i.e., as a proportion of the population), the initial overall accuracy was 76.4%. 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 25 plot records disagreed due to either an erroneous field call (FC1-4) or a change in the vegetation since the imagery date (RC), and 111 disagreed due to a true map classification error (MC). Those records identified as incorrect due to an erroneous field call or changes in vegetation since the imagery date were considered correct for the purpose of the AA.

The 111 plots ultimately identified as disagreeing with the mapped class during the QC process were attributed to map classification error. Table 18 summarizes the outcome of the error reconciliation. As a simple plot count proportion not spatially-weighted, the reconciled overall accuracy was 84.8%. The overall accuracy, accuracy with the Kappa coefficient applied, and upper and lower 90% confidence intervals for the initial (raw) AA data and reconciled AA data (as a spatially weighted population proportion) are provided in Table 19.

Table 18. Accuracy assessment error reconciliation summary for MNRR for simple count proportions (not spatially weighted).

Category	Reconciliation Type	Acronym Code	Count	Percent
Initial (raw) Accuracy	Map Class Agreement	–	601	82%
	Map Class Disagreement	–	136	18%
Concise (reconciled) Accuracy	Map Class Agreement	–	626	85%
	Map Class Disagreement	–	111	15%
Evaluation Criteria	Initial Agreement	Match	601	82%
Map Call Errors	Classification Error	MC1	111	–
	Spatial Error	MC2	0	–
	Total Map Call Errors	–	**111**	**15%**
Field Call Errors	Species/Type ID Error	FC1	2	10%
	Cover Estimation Error	FC2	19	90%
	MMU Estimation Error	FC3	0	0%
	Data Recording Error	FC4	0	0%
	Total Field Call Errors	**–**	**21**	**3%**

Table 18 (continued). Accuracy assessment error reconciliation summary for MNRR for simple count proportions (not spatially weighted).

Category	Reconciliation Type	Acronym Code	Count	Percent
Vegetation Change Errors	Inundation	VC1	3	75%
	Mechanical Treatment	VC2	1	25%
	Chemical Treatment	VC3	0	0%
	Burned	VC4	0	0%
	Total Vegetation Change Errors	–	**4**	**1%**

Table 19. Initial and reconciled overall map spatially weighted accuracy.

Accuracy Type	Limit Type (lower & upper)	Initial (raw) Accuracy, Percent	Reconciled Accuracy, Percent
Overall Acruacy	Lower Limit, 90% Confidence Interval	74%	88%
	Upper Limit, 90% Confidence Interval	79%	92%
	Overall Accuracy (all)	**76%**	**90%**
Kappa	Lower Limit, 90% Confidence Interval, K	74%	82%
	Upper Limit, 90% Confidence Interval, K	79%	86%
	Kappa (all)	**77%**	**84%**

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. Possible aggregation of preliminary map classes 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 five map classes with low class accuracies (MC 105 – Marsh Complex, MC 105a – *Phalaris arundinacea* Western Marsh, MC 105b – *Phragmites australis* Western Ruderal Wet Meadow, MC 105c – *Typha* spp., *Schoenoplectus* spp. Great Plains Marsh, and MC 105d – *Carex* spp., *Juncus* spp., *Eleocharis* spp. Wet Meadow) would be aggregated into a single new map class. Six map classes with low class accuracy (MC 104 – *Hesperostipa comata – Pascopyrum smithii* Mixedgrass Grassland, MC301 – *Populus deltoides* Ruderal Forest and Woodland, MC302 – *Populus deltoides* Floodplain Forest and Woodland, MC305 – *Populus deltoides – Salix amygdaloides* Floodplain Woodland and Forest, MC307 – *Fraxinus pennsylvanica* Ruderal Forest and Woodland, and MC313 – *Quercus macrocarpa* Woodland and Wooded Grassland) were retained. Several of the map classes (MC302, MC305, and MC307) were retained because their

accuracy was reasonably close to the 80% threshold (75.0%, 78.8%, and 78.1% respectively). Other map classes (MC104, MC313) were retained due to being small communities with only three AA points in which only one point was mapped incorrectly. Table 20 shows the individual accuracies before the aggregation. The new aggregated classes and the original classes combined to create them are listed in Table 21. Tables 20 and 21 report an estimated true area for each map class. This area is estimated based upon the producers' accuracy and differs slightly from the mapped acreage.

Table 20. Users' and producers' reconciled accuracies for each map class at MNRR. CI = confidence interval; MC = map class.

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	96.8%	89.9%	100.0%	94.2%	93.7%	94.6%	1453.57
MC102	100.0%	92.9%	100.0%	72.0%	72.0%	72.0%	16.32
MC103	81.3%	68.3%	94.2%	87.2%	86.9%	87.5%	356.31
MC104	66.7%	5.2%	100.0%	100.0%	100.0%	100.0%	2.46
MC105	100.0%	98.4%	100.0%	100.0%	100.0%	100.0%	1728.23
MC105a	73.5%	59.6%	87.4%	98.9%	98.3%	99.4%	484.89
MC105b	96.8%	89.9%	100.0%	32.7%	32.6%	32.7%	229.96
MC105c	93.5%	84.7%	100.0%	76.6%	76.5%	76.7%	208.87
MC105d	24.1%	9.3%	38.9%	89.4%	89.2%	89.6%	51.98
MC201	90.6%	80.6%	100.0%	91.9%	91.3%	92.6%	1147.33
MC202	93.8%	85.1%	100.0%	53.2%	53.2%	53.3%	91.93
MC203	100.0%	91.7%	100.0%	100.0%	100.0%	100.0%	9.26
MC204	100.0%	75.0%	100.0%	100.0%	100.0%	100.0%	2.51
MC205	100.0%	50.0%	100.0%	1.9%	1.9%	2.0%	36.56
MC301	43.8%	27.8%	59.7%	80.9%	80.6%	81.2%	128.25
MC302	75.0%	60.8%	89.2%	87.1%	86.0%	88.2%	1093.77
MC303	90.6%	80.6%	100.0%	62.0%	61.6%	62.3%	590.58
MC304	96.7%	89.6%	100.0%	92.8%	92.3%	93.4%	1739.69
MC305	78.8%	65.6%	82.0%	91.3%	90.7%	92.0%	697.07
MC306	82.9%	70.9%	94.8%	69.1%	68.8%	69.4%	390.45

Table 20 (continued). Users' and producers' reconciled accuracies for each map class at MNRR. CI = confidence interval; MC = map class.

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	78.1%	64.5%	91.7%	74.0%	73.6%	74.5%	443.94
MC308	96.8%	89.9%	100.0%	100.0%	99.9%	100.0%	433.89
MC309	100.0%	98.3%	100.0%	87.8%	87.8%	87.8%	278.12
MC310	93.9%	85.6%	100.0%	94.8%	94.6%	95.1%	585.43
MC311	90.3%	80.0%	100.0%	90.4%	90.3%	90.5%	187.09
MC312	84.4%	72.3%	96.5%	87.8%	87.6%	88.1%	255.58
MC313	66.7%	5.2%	100.0%	26.3%	26.2%	26.5%	25.27
MC401	100.0%	98.4%	100.0%	96.7%	96.6%	96.8%	2574.2
MC402	82.4%	64.2%	100.0%	100.0%	99.9%	100.0%	46.71

Table 21. Final aggregated map class and initial map classes subsumed within it.

Final Aggregated Map Class	Initial Map Classes Subsumed
MC105 Marsh Complex	MC105 Marsh Complex
	MC105a *Phalaris arundinacea* Western Marsh
	MC105b *Phragmites australis* Western Ruderal Wet Meadow
	MC105c *Typha* spp., *Schoenoplectus* spp. Great Plains Marsh
	MC105d *Carex* spp., *Juncus* spp., *Eleocharis* spp. Wet Meadow

The overall spatially weighted accuracy of the MNRR map is 89.9% with a Kappa statistic of .841. The accuracy of the "aggregated map" is 91.3%. The users' and producers' accuracies for the final aggregated map classes are presented in Figure 14 and Table 22. The final aggregated accuracy, the Kappa statistic, and the upper and lower 90% confidence intervals for each are shown in Table 23.

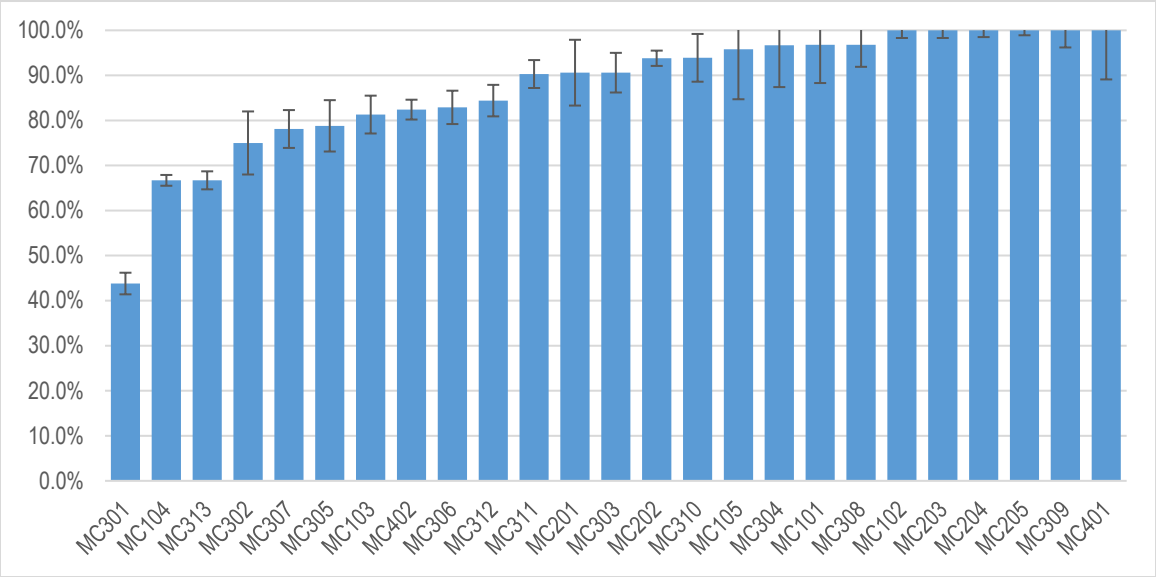

Figure 14. Users' accuracy and 90 percent confidence intervals for MNRR vegetation map classes.

Table 22. 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	96.8%	88.3%	100.0%	84.2%	93.7%	94.6%	1,453.58
MC102	100.0%	98.3%	100.0%	72.0%	72.0%	72.0%	16.32
MC103	81.3%	77.1%	85.4%	87.2%	86.9%	87.5%	356.31
MC104	66.7%	65.5%	67.9%	100.0%	100.0%	100.0%	2.46
MC105	95.8%	84.7%	100.0%	100.0%	99.4%	100.0%	2,703.92
MC201	90.6%	83.3%	98.0%	91.9%	91.3%	92.6%	1147.33
MC202	93.8%	92.1%	95.4%	53.2%	53.2%	53.3%	91.93
MC203	100.0%	98.3%	100.0%	100.0%	100.0%	100.0%	9.26
MC204	100.0%	98.5%	100.0%	100.0%	100.0%	100.0%	2.51
MC205	100.0%	98.9%	100.0%	1.9%	1.9%	2.0%	36.56
MC301	43.8%	41.4%	46.1%	80.9%	80.6%	81.2%	128.25
MC302	75.0%	68.0%	82.0%	87.1%	86.0%	88.2%	1,093.77
MC303	90.6%	86.2%	95.1%	82.0%	61.6%	62.3%	590.58
MC304	96.7%	87.4%	100.0%	92.8%	92.3%	93.4%	1,739.69
MC305	78.8%	73.1%	84.5%	91.3%	90.7%	92.0%	697.07
MC306	82.9%	79.2%	86.5%	69.1%	68.8%	69.4%	390.45
MC307	78.1%	73.9%	82.3%	74.0%	73.6%	74.5%	443.94
MC308	96.8%	91.9%	100.0%	100.0%	99.9%	100.0%	433.89
MC309	100.0%	96.2%	100.0%	87.8%	87.8%	87.8%	278.12
MC310	93.9%	88.6%	99.3%	94.8%	94.6%	95.1%	585.43

Table 22 (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)
MC311	90.3%	87.2%	93.4%	90.4%	90.3%	90.5%	187.09
MC312	84.4%	80.9%	87.9%	87.8%	87.6%	88.1%	255.58
MC313	66.7%	64.7%	68.6%	26.3%	26.2%	26.5%	25.27
MC401	100.0%	89.1%	100.0%	96.7%	99.6%	96.8%	2,574.20
MC402	82.4%	80.2%	84.6%	100.0%	99.9%	100.0%	46.71

Table 23. Overall users' accuracy and Kappa accuracy for the final MNRR vegetation map.

Accuracy Type	Limit Type (lower & upper)	, Percent
Overall Accuracy	Lower Limit, 90% Confidence Interval	88.6%
	Upper Limit, 90% Confidence Interval	93.9%
	Overall Accuracy (all)	**91.3%**
Kappa	Lower Limit, 90% Confidence Interval, K	84.7%
	Upper Limit, 90% Confidence Interval, K	88.9%
	Kappa (all)	86.8%

5. Conclusions

The vegetation inventory project at MNRR classified and mapped vegetation in the park-managed area. The project was conducted over a four-year period from 2015 to 2019. The primary imagery used for the project was 2016 NAIP at a resolution of 60 cm. The vegetation classification plot work was completed in the summer of 2015, and the AA plot work was completed in the summer of 2017.

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 89.9%, although several classes had individual users' accuracy below the 80% threshold. Where initial thematic accuracy was low, map classes were aggregated into classes with which they were confused. The accuracy of this aggregated map is 91.3%; 6 map classes (MC 104 – *Hesperostipa comata* – *Pascopyrum smithii* Mixedgrass Grassland, MC301 – *Populus deltoides* Ruderal Forest and Woodland, MC302 – *Populus deltoides* Floodplain Forest and Woodland, MC305 – *Populus deltoides* – *Salix amygdaloides* Floodplain Woodland and Forest, MC307 – *Fraxinus pennsylvanica* Ruderal Forest and Woodland, and MC313 – *Quercus macrocarpa* Woodland and Wooded Grassland) had users' accuracies below the target of 80%. Examining the confidence intervals in Figure 14, there are two additional classes (MC103 and MC 306) 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 a photo database. Together with the vegetation data layer and database and custom map layouts, these products provide the park with an array of tools to assist in managing park resources and making informed resource management decisions.

Included in the associations described for the park are 21 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 MNRR, 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 a geodatabase and can be displayed and manipulated as needed.

The MNRR 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 the park.

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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 smithii*) 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: 390039, 390083, 390157, 590023, 590047, 590058, 590113, 590121, 590130, 591005

Map Class: MNRR MC101

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1151.4 ft (range 356 ft to 1352 ft)

Aspect: Mean 139.25˚ (range flat to 278˚)

Slope: Mean 8˚ (range 2˚ to 15˚)

Macro Topography: Alluvial Flat, Alluvial Terrace, Glaciated Uplands, Hills, Lowland, Plain

Geology: Alluvium, Carlile Shale, Eolian Deposits, Niobrara Formation, Pierre Shale, Till

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

Environment: 10 sites were sampled within this type. Soil texture is very variable and ranges from loam to loamy sand. Litter is usually greater than 60%, bare soil and sand are typically ~10%, and basal area makes up the rest of the cover. These sites generally occur on floodplain terraces, but some may occur on gentle slopes between 5 and 10 degrees.

Local Vegetation Description

Structure: Tall Shrub (0%-20%), Dwarf Shrub (0%-20%), Herbaceous (70%-100%)

Vegetation Floristics: *Bromus inermis* and *Poa pratensis* dominate these plots with covers of ~90%, but some sites had cover as low as 60%. Some of the forbs present are *Ambrosia psilostachya*, *Verbena stricta*, and *Cirsium arvense*. Native species if present include *Pascopyrum smithii*, *Deschampsia caespitosa*, and *Hesperostipa comata*. Occasionally sparse shrubs such as *Symphoricarpos* spp. are present as well.

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 *Bromus inermis* 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 *Bromus inermis* 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 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 CEGL005264 *Bromus inermis* – (*Pascopyrum smithii*) Ruderal Grassland.

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

Short Citation

- Cronquist et al. 1977
- Hansen et al. 1995

NPSMNRR002 Ruderal Herbaceous Grassland

USNVC: Park Special NPSMNRR002

Field Plots: 590001, 590057

Map Class: MNRR MC101

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1150.5 ft (range 1141 ft to 1160 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Flat

Geology: Carlile Shale

Soil Texture: Sandy Loam

Environment: 2 sites were sampled within this type. Sandy loam was the soil texture. Ground cover is dominated by bare soil or basal area (~50% each) and litter (20%-40%). These occurred along a flat floodplain.

Local Vegetation Description

Structure: Herbaceous (70%-90%)

Vegetation Floristics: Total herbaceous cover was at 90%. Graminoids are a mix with weedy species such as *Poa pratensis*, *Bromus inermis*, *Koeleria macrantha*, *Agropyron cristatum*, *Thinopyrum intermedium*, and *Elymus canadensis*.

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

Example Photograph

The photograph below shows an example of NPSMNRR002 Ruderal Herbaceous Grassland.

Ruderal Herbaceous Grassland (CNHP)

Short Citation

N/A

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: MNRR MC101

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1300 ft (range 1200 ft to 1600 ft)

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

Slope: Mean 2.43˚ (range 0˚ to 12˚)

Macro Topography: Upland, Hillslope, Floodplain Upper Terrace

Geology: Niobrara Formation, Carlile Shale, Pierre Shale

Soil Texture: Loamy Sand

Environment: Sandy loam was the soil texture. Ground cover is dominated by bare soil, basal area, and litter. These occurred along a flat floodplain.

Local Vegetation Description

Structure: Herbaceous (80%-100%)

Vegetation Floristics: This community is similar to NPSMNRR002 but is differentiated by the dominance of *Bromus tectorum* and/or *Bromus japonicus* on flood disturbed grasslands. *Bromus tectorum* and/or *Bromus japonicus* 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

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 CEGL003019 *Bromus tectorum* Ruderal Grassland.

Bromus tectorum Ruderal Grassland (CNHP)

Short Citation

- Beatley 1976
- Daubenmire 1975
- Englund 2004
- Evans et al. 2001
- FEIS 2001
- H. Marriott pers. comm. 1999
- Karl et al. 1999
- Naumann pers. comm. 2005
- Redente et al. 1992
- Young and Evans 1973
- Young and Evans 1978

CEGL003081 Poa pratensis Ruderal Marsh

The table below shows the 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: MNRR MC101

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1153.5 ft (range 1137 ft to 1170 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Upland, Floodplain Lower Terrace

Geology: Niobrara Formation, Carlile Shale, Pierre Shale

Soil Texture: Sandy loam

Environment: Area is dominated by litter and basal area. Ground cover is dominated by litter with values >70%. Basal area usually composes ~15%. Bare soil may be present with cover only ~1%.

Local Vegetation Description

Structure: Herbaceous (50%-80%)

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 region, 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. 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 *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 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
- Volland 1978
- Volland and Dell 1981

NPSMNRR003 Weedy Forb Ruderal Herbaceous Vegetation
USNVC: Park Special NPSMNRR003

Field Plots: Field Reconnaisance Observations

Map Class: MNRR MC101

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1142 ft (range 1070 ft to 1259 ft)

Aspect: Mean 78˚ (range Flat to 234˚)

Slope: Mean 5˚ (range Flat to 15˚)

Macro Topography: Various (Hillslope, Floodplain)

Geology: Dakota Group, Carlile Shale, Niobrara Chalk

Soil Texture: Sandy Loam

Environment: Ground cover is dominated by litter with values ranging from 67% to 88%. Basal area is the second most dominant cover with values ranging from 12% to 13%. Occasionally wood is present with cover <5%.

Local Vegetation Description

Structure: Herbaceous (30%-75%)

Vegetation Floristics: Sites were 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., *Articum minus, Cannabis sativa, Helianthus* spp., *Achillea millefolium*, 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%.

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

Example Photograph
The photograph below shows an example of NPSMNRR003 Weedy Forb Ruderal Herbaceous Vegetation.

Weedy Forb Ruderal Herbaceous Vegetation (CNHP)

Short Citation
N/A

NPSMNRR004 Juniperus virginiana Ruderal Shrub Invaded Grassland
USNVC: Park Special NPSMNRR004

Field Plots: Field Reconnaisance Observations

Map Class: MNRR MC101

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1226 ft (range 1125 ft to 1338 ft)

Aspect: Mean 73˚ (range Flat to 172˚)

Slope: Mean 11.75˚ (range Flat to 25˚)

Macro Topography: Floodplain Upper Terrace, Hillslope

Geology: Niobrara Formation, Pierre Shale, Carlile Shale

Soil Texture: Loam to Sandy Loam

Environment: Ground cover is dominated by litter with cover ranging from 10% to 86%. Basal area is the second most dominant ground cover with values ranging from 8% to 16%. Bare soil usually ranges from 1% to 5%.

Local Vegetation Description

Structure: Tall Shrub (10%-45%), Short Shrub (0%-10%), Herbaceous (50%-80%)

Vegetation Floristics: Shrub or sub-shrub height *Juniperus virginiana* has invaded native or ruderal grasslands. Total *Juniperus virginiana* shrub cover is >30%.

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

Example Photograph

The photograph below shows an example of NPSMNRR004 *Juniperus virginiana* Ruderal Shrub Invaded Grassland.

Juniperus virginiana Ruderal Shrub Invaded Grassland (CNHP)

Short Citation

N/A

CEGL002036 Schizachyrium scoparium – Bouteloua curtipendula Loess Mixedgrass Grassland

The table below shows the USNVC Hierarchy for CEGL002036 *Schizachyrium scoparium – Bouteloua curtipendula* Loess Mixedgrass Grassland.

USNVC hierarchy for CEGL002036 *Schizachyrium scoparium – Bouteloua curtipendula* Loess 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 Central Great Plains Mixedgrass Prairie
Alliance	A4042 *Schizachyrium scoparium - Bouteloua curtipendula* Central Great Plains Grassland Alliance
Association	2.B.2.Nb *Schizachyrium scoparium - Bouteloua curtipendula* Loess Mixedgrass Grassland (CEGL002036)

Field Plots: 390050, 390101, 390102, 591011

Map Class: MNRR MC102

Local Environmental Description

Plot/Sample Data Environmental Summary:

Elevation: Mean 1416.75 ft (range 1335 ft to 1609 ft)

Aspect: Mean 203.5˚ (range 155˚ to 230˚)

Slope: Mean 24.75˚ (range 19˚ to 40˚)

Macro Topography: Bluff, Ravine

Geology: Carlile Shale, Pierre Shale, Till

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

Environment: 4 sites were sampled within this type. All of these sites were found moderate south facing slopes (~20˚). Soil texture is variable and was different for each site. The soil ranged from loamy sand to sandy clay loam. Litter dominates the ground cover with values ranging from 60 to 65%. Bare soil ranges from 5% to 15%, and basal area ranges from 13% to 25%.

Local Vegetation Description

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

Vegetation Floristics: This herbaceous type is dominated by a large diversity of graminoids with a vigorous herbaceous stratum (~80% cover). Either *Schizachyrium scoparium* or *Andropogon gerardii* have the greatest cover values (~70%). All plots contain *Bouteloua curtipendula*, and other common graminoids include *Nassella viridula*, *Hesperostipa spartea*, and *Dichanthelium oligosanthes*. Forbs tend to not be as abundant or diverse as the graminoids, and the most abundant forbs are *Ambrosia psilostachya* and *Verbena stricta*.

Dynamics: N/A

Conservation Status Rank

Global: G3?

State (Nebraska): S3

Global Environmental Description

This community can occur on level to steep uplands in level, rolling and dissected loess plains. It is most commonly found on steep, rocky, south-facing slopes with inclinations ranging from 20-30°. The soils are formed from loess and are usually deep (>100 cm) clay, loam, or silt loam textures that are moderately to rapidly well-drained (Lauver et al. 1999, Steinauer and Rolfsmeier 2000). Sand may occur near or above streams. In and around Pierre, South Dakota, the Hill subtype occurs on highly calcareous clay (D. Ode pers. comm. 1996).

Global Vegetation Description

This *Schizachyrium scoparium* mixedgrass prairie community is found on loess deposits in the central and northern Great Plains of the United States. Stands occurs on level to steep uplands on soils that are usually deep loam or silt loam. Sand may occur near or above streams. This community is dominated by short and mid grasses, with tall grasses scattered on the lower slopes. Canopy cover is moderate to dense. Dominant species are *Schizachyrium scoparium* and *Bouteloua curtipendula*. *Schizachyrium scoparium* is especially dominant on steeper slopes while *Bouteloua curtipendula* may be more common on gentle slopes. On the level uplands and upper slopes *Bouteloua gracilis* may become more abundant whereas on the lower slopes *Andropogon gerardii*, *Panicum virgatum*, and *Pascopyrum smithii* may be more abundant. Other grasses that may be found include *Aristida purpurea*, *Koeleria macrantha*, *Hesperostipa comata* (= *Stipa comata*), *Sporobolus compositus* (= *Sporobolus asper*), *Muhlenbergia cuspidata*, and *Buchloe dactyloides*. *Buchloe dactyloides* is more common on level sites farther west. Common forbs include *Amorpha canescens*, *Artemisia dracunculus*, *Asclepias pumila*, *Symphyotrichum oblongifolium* (= *Aster oblongifolius*), *Symphyotrichum ericoides* (= *Aster ericoides*), *Solidago missouriensis*, *Liatris punctata*, *Lygodesmia juncea*, *Sphaeralcea coccinea*, *Echinacea angustifolia*, and *Ratibida columnifera*.

Nebraska Natural Heritage Program Description

Loess Mixed-Grass Prairie: This community is dominated by a mixture of tall (1–2 m) and mid (0.5–1 m) grasses, often with an understory of short (<0.5 m) grasses. On nearly level ridgetops and toe slopes, blue grama tends to dominate the short-grass layer, often occurring with western wheatgrass and lesser amounts of sideoats grama, little bluestem and big bluestem. In some sites, particularly where heavy grazing has recently occurred, the short grasses *Bouteloua gracilis* and *Buchloe dactyloides* may dominate, along with alien grasses such as *Bromus japonicus*. On slopes (particularly steep slopes), the mid-grasses *Schizachyrium scoparium* and *Bouteloua curtipendula* may dominate or may share dominance with *Andropogon gerardii*. On lower slopes and the bottoms of draws, tall and mid-grasses dominate, including *Andropogon gerardii*, *Bouteloua curtipendula*, and *Pascopyrum smithii*. *Panicum virgatum* is abundant in bottoms of draws at one site, though in most places the bottoms are heavily grazed and invaded by *Pascopyrum smithii*, *Buchloe dactyloides* (in areas), and weedy species. *Poa pratensis* is the most abundant invasive in this community, with *Bromus inermis* abundant at some sites. Both species often dominate disturbed sites. *Juniperus virginiana* is often invasive on steep north and east-facing slopes, and other shrubs may also form patches among them, including *Prunus virginiana*, *Rhus glabra*, and *Symphoricarpos occidentalis*. *Amorpha canescens* is the most common short shrub on slopes not infested with *Juniperus virginiana*, and in places *Artemisia filifolia*, *Rhus aromatica* var. *trilobata*, and *Toxicodendron rydbergii* are locally common. *Yucca glauca* is often common in uplands especially where soils are better-drained or slightly sandy. Common herbaceous plants include *Ambrosia psilostachya*, *Artemisia frigida*, *Calylophus serrulatus*, *Erigeron strigosus*, *Gaura coccinea*, *Gutierrezia sarothrae*, *Psoralidium tenuiflorum*, *Pediomelum argophyllum*, *Ratibida columnifera*, *Solidago missouriensis*, *Sphaeralcea coccinea*, and *Symphyotrichum ericoides*. Ungrazed sites, particularly eastward, may be dominated by *Andropogon gerardii* to the extent they are difficult to distinguish from tall-grass prairie communities. Species diversity is moderate to relatively high in well-preserved sites.

Example Photograph

The photograph below shows an example of CEGL002036 *Schizachyrium scoparium – Bouteloua curtipendula* Loess Mixedgrass Grassland.

Schizachyrium scoparium – Bouteloua curtipendula Loess Mixedgrass Grassland (CNHP)

Short Citation

- D. Ode pers. comm. 1996
- Lauver et al. 1999
- Steinauer and Rolfsmeier 2000

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: 390133, 592017

Map Class: MNRR MC103

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1269.5 ft (range 1175 ft to 1364 ft)

Aspect: Mean 105˚ (range Flat to 210˚)

Slope: Mean 6˚ (range Flat to 12˚)

Macro Topography: Hills, Island

Geology: Carlile Shale, Niobrara Formation

Soil Texture: Clay Loam

Environment: 2 sites were sampled within this type. Both sites had silty clay loam. Litter had 80% cover and ~20% basal area. One occurs on a river island, and the other occurs on a gentle midslope.

Local Vegetation Description

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

Vegetation Floristics: In undisturbed sites, tall mesophytic grasses such as *Andropogon gerardii, Sorghastrum nutans,* and *Panicum virgatum.* However, many of these sites have been disturbed and *Poa pratensis* is the dominant graminoid with cover ~50% with *Sorghastrum nutans* and *Andropogon gerardii* as codominates. Forbs are usually not abundant one site has a cover value of 30% of *Medicago sativa*.

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 big bluestem sandhills prairie community type occurs in the central Great Plains of the United States. Stands typically occur in interdunal valleys and floodplains of streams and rivers, and on level ground where drainage systems are poorly developed. Soils are somewhat poorly drained sandy loam or sands with organic matter (but no peat accumulation) and are formed in eolian sand or alluvium. Vegetation cover is dense and is primarily composed of tall mesophytic grasses, mostly *Andropogon gerardii* and *Sorghastrum nutans* in undisturbed sites, with *Agrostis stolonifera, Phleum pratense,* and *Poa pratensis* often replacing them in disturbed sites. Other common grasses include *Calamagrostis canadensis, Calamagrostis stricta, Elymus trachycaulus,* and *Panicum virgatum*. Typical forbs include *Helianthus nuttallii, Lotus unifoliolatus,* and *Rudbeckia hirta*. Thickets of shrubs, such as *Salix exigua,* are occasional.

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 big bluestem 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 pauciflorus*, *Rudbeckia hirta*, and *Siphium integrifolium*. Species diverisity 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

CEGL002024 Andropogon gerardii – Panicum virgatum – Helianthus grosserratus Wet Meadow

The table below shows the USNVC Hierarchy for CEGL002024 *Andropogon gerardii – Panicum virgatum – Helianthus grosserratus* Wet Meadow.

USNVC hierarchy for CEGL002024 *Andropogon gerardii – Panicum virgatum – Helianthus grosserratus* 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	A4056 *Andropogon gerardii - Panicum virgatum* Wet Prairie Alliance
Association	2.C.4.Nd *Andropogon gerardii - Panicum virgatum - Helianthus grosseserratus* Wet Meadow (CEGL002024)

Field Plots: 390007, 590003

Map Class: MNRR MC103

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1190 ft (range 1135 ft to 1245 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Flat

Geology: Carlile Shale, Pierre Shale

Soil Texture: Loamy Sand, Clay Loam

Environment: 2 sites were sampled within this type. The soil textures ranged from clay loam to loamy sand. Litter and basal area were the most dominant ground cover of ~50% and ~40% respectively. These sites occurred along a low level flat.

Local Vegetation Description

Structure: Herbaceous (90%)

Vegetation Floristics: This is an herbaceous type lacking any shrub or canopy layer. Graminoids dominate with *Andropogon gerardii* having the greatest cover with values between 50% and 90%. *Carex molesta* is another dominant species with cover values of 40%. Dominant forbs include *Ambrosia psilostachya* and *Chamaecrista fasciculata*. Both of these plots seems to have been revegetated agriculture.

Dynamics: Fire plays a role in the maintenance of this wet-mesic prairie, with an average fire frequency of every two to five years. Woody species can become more abundant in the absence of fire (Nelson 1985).

Conservation Status Rank

Global: G2G3

State (Nebraska): S1

Global Environmental Description

This community occurs in narrow draws of headwaters of small streams, depressions of terraces (sometimes uplands), and on floodplains of larger streams and rivers. The soil is somewhat poorly drained and deep (100 cm or more). The parent material is typically alluvium. In headwater draws loess, glacial till, or deeply weathered rock are likely to be the parent material. Surface water is often present after heavy rains and in the winter and spring. Some stands occur on sandy outwash plains, lakeplains, and shallow swales. The soils are sands, loamy sands, and sandy loams. They are imperfectly or somewhat imperfectly drained. The soils often have a slowly permeable layer within the profile, a high water table, additions of moisture through seepage, or a combination of several of these conditions. They have deep, acidic, dark A horizons which are high in organic matter. There is faint evidence of gleying immediately beneath the A horizon (White and Madany 1978, Nelson 1985, MNNHP 1993, Lauver et al. 1999, Steinauer and Rolfsmeier 2000).

Global Vegetation Description

This wet-mesic tallgrass prairie community is found widely throughout the central midwestern United States. Stands typically occur in narrow draws of headwaters of small streams, depressions of terraces (sometimes uplands), and on floodplains of larger streams and rivers. The loamy soils are somewhat poorly drained and deep (100 cm or more). Standing surface water may be present for short periods in the winter and spring or after heavy rains. Fire was common in this community. There is a single layer of dominant graminoids intermixed with abundant forbs. *Andropogon gerardii* and *Spartina pectinata* can exceed 2 m in height in this wet-mesic community. *Panicum virgatum* is usually somewhat shorter but still greater than 1 m tall. Other typical plants found in this community in Missouri are *Juncus interior, Tripsacum dactyloides, Helianthus grosseserratus, Potentilla simplex, Eryngium yuccifolium*, and *Carex bicknellii*. *Calamagrostis canadensis* is more common northward. Species diversity does not tend to be as high as in more mesic grassland communities. Woody species can become more abundant in the absence of fire.

Nebraska Natural Heritage Program Description

Lowland Tall-Grass Prairie: The vegetation of this community is dense and consists primarily of tall grasses 1-2 m or more tall. *Andropogon gerardii* is usually dominant or co-dominant with *Spartina pectinata* and sometimes *Sorghastrum nutans*. *Elymus canadensis*, *Carex pellita*, and *Tripsacum dactyloides* are locally common. In slightly wetter places, such as in swales, *Spartina pectinata* may dominate. Patches of shrubs may be present, including *Cornus drummondii*, *Prunus americana*, and *Symphoricarpos occidentalis*. Conspicuous herbaceous associates include fall-flowering composites such as *Helianthus grosseratus*, *Solidago* spp., and *Symphyotrichum lanceolatum*. Other common herbs are *Silphium intergrifolium*, *Anemone canadensis*, *Asclepias sullivantii*, *Packera plattensis*, *Thalictrum dasycarpum*, *Tradescantia bracteata* and *T. ohiensis*, and *Vernonia fasciculata*. Species diversity is relatively high.

Example Photograph

The photograph below shows an example of CEGL002024 *Andropogon gerardii – Panicum virgatum – Helianthus grosserratus* Wet Meadow.

Andropogon gerardii – Panicum virgatum – Helianthus grosserratus Wet Meadow (CNHP)

Short Citation

- Lauver et al. 1999

- MNNHP 1993
- Nelson 1985
- Steinauer and Rolfsmeier 2000
- White and Madany 1978

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: 590006, 590100, 591010

Map Class: MNRR MC103

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1206.33 ft (range 1172 ft to 1246 ft)

Aspect: Mean 86.33˚ (range Flat to 259˚)

Slope: Mean 1.33˚ (range Flat to 4˚)

Macro Topography: Alluvial Flat, Glaciated Uplands

Geology: Alluvium, Dakota Group, Eolian Deposits

Soil Texture: Sandy Loam, Sandy Clay, Clay Loam

Environment: 3 sites were sampled within this type. Soil texture ranged from sandy clay to sandy clay loam. Usually ground cover is broken down between litter (~25%), bare soil (~45%), and basal area (~30%). Two of these both occurred on relative flat uplands in South Dakota. One of these sites

was fairly different in that it was located in Ponca State Park. Litter reached up to 50% cover and bare soil was only 25% cover.

Local Vegetation Description

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

Vegetation Floristics: Total cover reached ~80%. *Sorghastrum nutans* or *Andropogon gerardii* is usually dominant species with cover of ~40%. Other graminoids present inlcude *Schizachyrium scoparium, Elymus virginicus* and *Panicum virgatum*. Forbs are not as abundant. Common forbs include *Melilotus officinale* and *Silphium perfoliatum*.

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 *Andropogon gerardii* 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 cryptandrus* is often common and

even dominant in a few sites. Northward, and in sites with more silty or sandy soils porcupine grass may be common to locally abundant. On dry hill crests, particularly where mowed or grazed, short grasses including *Bouteloua gracilis* and *Bouteloua 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)

Short Citation

- Nelson 1985
- Rosburg and Glenn-Lewin 1996

CEGL002205 Andropogon gerardii – Schizachyrium scoparium Northern Plains Grassland

The table below shows the USNVC Hierarchy for CEGL002205 *Andropogon gerardii – Schizachyrium scoparium* Northern Plains Grassland.

USNVC hierarchy for CEGL002205 *Andropogon gerardii – Schizachyrium scoparium* Northern 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 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 - Schizachyrium scoparium* Northern Plains Grassland (CEGL002205)

Field Plots: 390024, 390038, 390075, 392002, 590069, 590124, 590128, 590129, 592021

Map Class: MNRR MC103

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1288 ft (range 1146 ft to 1394 ft)

Aspect: Mean 205˚ (range Flat to 340˚)

Slope: Mean 14.75˚ (range Flat to 25˚)

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

Geology: Carlile Shale, Pierre Shale, Niobrara Formation, Ogallala Group

Soil Texture: Loamy Sand, Loam, Clay Loam

Environment: 9 sites were sampled within this type. The soil was generally fine textured and ranged from silty clay loam to sandy clay loam. Ground cover was typically dominated by litter (~70% cover). Several sites had litter values as low at 50% cover. When present, bare soil may have cover values up to 20%, basal area makes up the rest of the ground cover. Half of these plots occurred

along slopes ranging from 5 degrees to 25 degrees. No common aspect was apparent. The other sites occurred along low level terraces along the river.

Local Vegetation Description

Structure: Tall Shrub (0%-30%), Short Shrub (0%-10%), Dwarf Shrub (0%-30%), Herbaceous (70%-90%)

Vegetation Floristics: *Andropogon gerardii* comprises a large proportion of cover in the herbaceous cover (~40%). *Panicum virgatum* or *Schizachyrium scoparium* will codominate in this type with cover reaching 60%. *Bromus inermis* may invade this type and codominate with *Andropogon gerardii*. Other common graminoids include *Poa pratensis, Dichanthelium oligosanthes*, and *Bouteloua curtipendula*. Forbs typically occur in low abundance, but *Ambrosia psilostachya* can have cover up to 50%. Other common forbs include *Medicago sativa* and *Melilotus officinale*.

Dynamics: N/A

Conservation Status Rank

Global: G4

State (Nebraska): N/A

Global Environmental Description

This community is found in unglaciated areas on lower slopes and bottomlands of narrow gullies and draws. It requires more moisture than is generally provided by direct precipitation. The extra water comes from runoff from upslope areas and meltwater from snow which often accumulates in drifts on this community. The soil is loam to sandy loam and moderately deep to deep (Hanson and Whitman 1938).

Global Vegetation Description

This bluestem tallgrass prairie type is found in the unglaciated regions of the northwestern Great Plains of the United States. Stands occur on lower slopes and bottomlands of narrow gullies and draws. It requires more moisture than is generally provided by direct precipitation. The extra water comes from runoff from upslope areas and meltwater from snow which often accumulates in drifts on this community. The soil is loam to sandy loam and moderately deep to deep. The vegetation is dominated by moderately dense to dense tall and mid grasses. Most of the species are 0.7-1.5 m tall. Common grasses are *Andropogon gerardii, Bouteloua curtipendula, Schizachyrium scoparium, Sporobolus heterolepis*, and *Hesperostipa spartea (= Stipa spartea)*. Other grasses that may occur include *Elymus trachycaulus, Carex pensylvanica*, and *Panicum virgatum*. Forbs such as *Artemisia ludoviciana, Echinacea angustifolia, Helianthus pauciflorus ssp. pauciflorus, Helictotrichon hookeri, Juncus balticus, Liatris scariosa*, and *Lilium philadelphicum* are common. Shrubs, especially *Symphoricarpos occidentalis*, are often present but never abundant.

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an example of CEGL002205 *Andropogon gerardii – Schizachyrium scoparium* Northern Plains Grassland.

Andropogon gerardii – Schizachyrium scoparium Northern Plains Grassland (CNHP)

Short Citation

- Hanson and Whitman 1938

CEGL001467 Andropogon hallii – Calamovilfa longifolia Grassland

The table below shows the USNVC Hierarchy for CEGL001467 *Andropogon hallii – Calamovilfa longifolia* Grassland.

USNVC hierarchy for CEGL001467 *Andropogon hallii – Calamovilfa longifolia* 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	A1193 *Andropogon hallii* Sand Prairie Alliance
Association	2.B.2.Nb *Andropogon hallii - Calamovilfa longifolia* Grassland (CEGL001467)

Field Plots: Field Reconnaisance Observations

Map Class: MNRR MC103

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1300 ft (range 1200 ft to 1600 ft)

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

Slope: Mean 10.5˚ (range 7˚ to 18˚)

Macro Topography: Upland

Geology: Pierre Shale

Soil Texture: Sand

Environment: 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%.

Local Vegetation Description

Structure: Herbaceous (60%-100%)

Vegetation Floristics: This community was only found along dry ridgetops in the upper 39-mile district of MNRR. *Andropogon hallii* and *Calamovlifa longifolia* are the dominant graminoids with total herbaceous cover >70%. *Bouteloua gracilis, Bouteloua hirsuta, Koeleria macrantha,* and *Schizachyrium scoparium* are common associates. 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 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 hectares 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 *Calimovilfa 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* Grassland.

Andropogon hallii – Calamovilfa longifolia Grassland (CNHP)

<u>Short Citation</u>

- Burgess 1965
- Hirsch 1985
- Johnston 1987

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: MNRR MC104

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1492 ft (range 1454 ft to 1530 ft)

Aspect: Mean 129˚ (range 98˚ to 160˚)

Slope: Mean 11.5 ˚ (range 11˚ to 12˚)

Macro Topography: Hillslope

Geology: Pierre Shale

Soil Texture: Sandy Loam

Environment: This community typically occurs on upland slopes, ridgetops, plateaus, upper terraces, and sandhills with fine to medium texture soils such as clay to sandy loam. However, the soil type can be variable.

Local Vegetation Description

Structure: Herbaceous (70%-90%)

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

This mixedgrass prairie community type is found throughout the north-central Great Plains of the United States, and possibly Canada. Stands occur on many different topographic and soil types. They can be on upland slopes, ridgetops, plateaus, stream terraces, and rolling sandhills. The soils are fine- to medium-textured (clay to sandy loam) and moderately deep to deep. They are derived from a variety of parent material across this community's range. These materials include eolian sand, sandstone, shale, siltstone, loess, or alluvium. 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*, *Calamovilfa longifolia* (on sandy soils), *Carex duriuscula* (= *Carex eleocharis*), *Carex filifolia*, *Koeleria macrantha*, *Schizachyrium scoparium*, and *Hesperostipa spartea* (= *Stipa spartea*). Common forbs include *Amorpha canescens*, *Artemisia campestris*, *Helianthus petiolaris*, and *Tragopogon dubius*. Shrubs are rare in this community. Scattered *Artemisia frigida*, *Rosa arkansana*, and occasional *Symphoricarpos occidentalis* may be present.

Nebraska Natural Heritage Program Description

This community is dominated by mid-eight (0.5-1 m) cool-season 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.

Pascopyrum smithii – Hesperostipa comata Central Mixedgrass Grassland (CNHP)

Short Citation

- Steinauer 1989
- USFS 1992

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: 390037, 390092, 591022

Map Class: MNRR MC105a

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1243.33 ft (range 1210 ft to 1273 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Floodplain, Marsh

Geology: Alluvium, Carlile Shale, Niobrara Formation

Soil Texture: Sand, Muck

Environment: 3 sites were sampled within this type. Ground cover is variable. Litter ranges from 10% to 65% and bare soil ranges from 0% to 40%. These are all wet areas some with standing water and others seasonally flooded. These all occurs on the floodplain.

Local Vegetation Description

Structure: Herbaceous (40%-100%)

Vegetation Floristics: *Phalaris arundinacea* is the dominant plant with cover ranging from 40% to 100%. It has clearly taken over the stand, but one stand had some *Phragmites australis* (20%). Other species do not have much cover and include *Carex* spp., *Ambrosia psilostachya*, *Verbena hastata*, *Scirpus pallidus*, and *Schoenoplectus pungens*.

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 herbaceous association is reported throughout Washington, Colorado, Nebraska, Montana, Idaho, and into northeastern Utah, and 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. Elevations range from near sea level to 2307 m (7564 feet). 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. 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

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 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

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: 390074, 390134, 390136, 390137, 391014

Map Class: MNRR MC105b

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1387.8 ft (range 1214 ft to 1505 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Terrace, Floodplain, Island

Geology: Alluvium, Niobrara Formation

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

Environment: 5 sites were sampled within this type. Typically, these stands have coarser soil textures (sandy loam, loamy sand, sand); however, one site contained silty clay. Litter is the most prevalent ground cover with values of ~65%. Bare soil ranges between 5% and 10%. These all occurred on either floodplains or river islands.

Local Vegetation Description

Structure: Canopy (0%-10%), Tall Shrub (0%-40%), Short Shrub (0%-20%), Herbaceous (90%-100%)

Vegetation Floristics: *Phragmites australis* codominates with *Phalaris arundinacea* with roughly equal covers of ~90%. Other plants that may be present are *Xanthium strumarium*, *Euphorbia esula*, and *Cirsium canadensis*.

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 semi permanently 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

This reed marsh type is found across the west-temperate regions of the United States and Canada. Stands occur in semi permanently flooded marshes, ditches, impoundments, etc. that have often been disturbed by human activity. 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. In Colorado, this reed marsh often occurs in small wet patches in seeps and backwater areas of large floodplains, around the fringes of irrigation ponds, ditches, and along railroad embankments that have poor drainage. Stands have a dense, 1- to 1.5-m tall herbaceous layer dominated by the perennial graminoid *Phragmites australis*. Minor cover of associates such as *Agrostis stolonifera, Carex* spp., *Conyza canadensis, Glycyrrhiza lepidota, Iva axillaris, Mentha arvensis, Schoenoplectus acutus (= Scirpus acutus)*, and *Typha latifolia* may be present.

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 reed, and consists of *Leersia oryzoides*, *Persicaria* spp., and *Bidens* spp.. Scattered *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

- Johnston 1987

CEGL002026 Schoenoplectus tabernaemontani – Typha spp. – (Sparganium spp., Juncus spp.) Marsh

The table below shows the USNVC Hierarchy for CEGL002026 *Schoenoplectus tabernaemontani – Typha* spp. – (*Sparganium* spp., *Juncus* spp.) Marsh.

USNVC hierarchy for CEGL002026 *Schoenoplectus tabernaemontani – Typha* spp. – (*Sparganium* spp., *Juncus* spp.) 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 Eastern North American Marsh, Wet Meadow & Shrubland
Group	2.C.4.Nd Eastern North American Freshwater Marsh
Alliance	A3666 *Schoenoplectus tabernaemontani - Schoenoplectus fluviatilis - Typha* spp. Shallow Marsh Alliance
Association	2.C.4.Nd *Schoenoplectus tabernaemontani - Typha* spp. - (*Sparganium* spp., *Juncus* spp.) Marsh (CEGL002026)

Field Plots: 392014, 392015

Map Class: MNRR MC105c

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1256.5 ft (range 1247 ft to 1266 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Marsh

Geology: Niobrara Formation

Soil Texture: Muck

Environment: 2 sites were sampled within this type. Soil texture is muck. Water is the dominant ground cover ranging from 50% to 80% cover. These both occurred in marshes.

Local Vegetation Description

Structure: Herbaceous (90%-100%)

Vegetation Floristics: Where the water is deeper, *Schoenoplectus tabernaemontani* may be the only species present. It has generally has cover between 90% and 100%. In shallower waters, a variety of other hydrophytic plants are present such as *Sparganium* spp., *Eleocharis palustris*, *Juncus* spp., etc.

Dynamics: N/A

Conservation Status Rank

Global: G5

State (Nebraska): S2

Global Environmental Description

This community ranges broadly over the midwestern United States. It is found in basin-like depressions, backwater areas of floodplains and shallow margins of lakes or ponds. Soils are shallow to deep, very poorly drained, consisting of peats, mucks, or mineral materials, often found in alluvium (Lauver et al. 1999).

Global Vegetation Description

Vegetation varies from zones dominated by tall emergents 1-2 m tall to those with hydrophytic annual and perennial forbs <1 m tall. In the tall emergent zone, *Schoenoplectus tabernaemontani* (= *Scirpus tabernaemontani*), *Schoenoplectus fluviatilis* (= *Scirpus fluviatilis*), *Schoenoplectus acutus* (= *Scirpus acutus*), *Typha angustifolia*, and *Typha latifolia* may dominate, mixed with a variety of other herbaceous species, such as *Leersia oryzoides*, *Eleocharis palustris*, *Juncus* spp., and *Sparganium* spp. The hydrophytic annual and perennial forb zone is dominated by *Alisma subcordatum*, *Alisma triviale*, *Pontederia cordata*, *Sagittaria latifolia*, and *Sparganium eurycarpum*, along with *Bacopa rotundifolia* and *Heteranthera limosa*. Other species that may dominate locally include *Polygonum pensylvanicum* (= *Polygonum bicorne*), *Polygonum amphibium* var. *emersum* (= *Polygonum coccineum*), and *Polygonum lapathifolium*. Occasional floating-leaved aquatics are sometimes present, including *Azolla caroliniana*, *Lemna* spp., *Spirodela polyrrhiza*, and *Utricularia macrorhiza* (Eggers and Reed 1987; Steinauer and Rolfsmeier 2000).

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, large-fruit bur-reed 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 arundiacea* in drier portions. Lower areas within sites may contain inclusions of Playa Wetland communities.

Example Photograph

The photograph below shows an example of CEGL002026 *Schoenoplectus tabernaemontani – Typha* spp. – (*Sparganium* spp., *Juncus* spp.) Marsh.

Schoenoplectus tabernaemontani – Typha spp. – (*Sparganium* spp., *Juncus* spp.) Marsh (CNHP)

Short Citation

- Eggers and Reed 1987
- Lauver et al. 1999
- Steinauer and Rolfsmeier 2000

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: 390135, 391002, 391012, 392004, 392018

Map Class: MNRR MC105c

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1331 ft (range 1211 ft to 1502 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Floodplain, Island, Marsh

Geology: Alluvium, Pierre Shale, Niobrara Formation

Soil Texture: Loamy Sand, Clay Loam, Muck

Environment: 5 sites were sampled within this type. Soil texture ranges from muck to loamy sand. Ground cover is usually dominated by litter though it is variable and ranges between 15% to 75%. One site has 70% water.

Local Vegetation Description

Structure: Herbaceous (60%-90%)

Vegetation Floristics: *Typha* dominates this type. *Schoenoplectus tabernaemontani* often codominates this type. *Phalaris arundinacea* will invade this type.

Dynamics: N/A

Conservation Status Rank

Global: G4G5

State (Nebraska): S3

Global Environmental Description

Stands occur in shallow (<0.5 m) or deep depressions, ponds, and seepy drainages. Stands may originate from human-related disturbance, including heavy grazing of wetlands or creation of wetlands for watering cattle (stock ponds).

Global Vegetation Description

This cattail community type is found throughout the Northern Great Plains of the United States and Canada. Stands occur in shallow (<0.5 m) or deep depressions, stock ponds, and seepy drainages. The vegetation is dominated by relatively pure stands of *Typha* spp., either *Typha latifolia* or *Typha angustifolia* or both. Many associates can occur, including *Eleocharis* spp. and *Sagittaria latifolia*. This type may simply be a less diverse variation of ~*Typha* spp. - *Schoenoplectus* spp. - Mixed Herbs Great Plains Marsh (CEGL002228) that arises in disturbed wetland areas.

Nebraska Natural Heritage Program Description

Eastern Bulrush Deep Marsh: This community is dominated by emergent hydrophytic macrophytes that grow to 2 meters tall. *Schoenoplecuts tabernaemontani* is usually dominant in high quality sites, often with smaller patches of *Schoenoplectus acutus*. Zonation is often quite conspicuous, and the dominants may form dense patches or bands in response to water depth, duration of flooding, siltation and other factors. *Typha latifolia* is often abundant with common arrowhead and large-fruit bur-reed in slightly shallower water, though dominance of cattails may also be a sign of degradation due to siltation. In relatively shallow water, *Carex* spp., *Eleocharis* spp., *Phragmites australis* and *Schoenoplectus pungens* may be abundant. Submerged plants and duckweeds may often be found among the emergents in deeper water. Trees and shrubs are sometimes present in scattered patches within or at the periphery of this community, most *Salix amygdaloides, S. eriocephala, S. interior, Fraxinus pennsylvanica*, and *Amorpha fruticosa*, and a few sites may grade into floodplain woodland. Additional plants that may be scattered in shallow water include *Alisma triviale, Asclepias incarnata, Cicuta maculata, Persicaria coccinea*, and *Spartina pectinata* may be present. Species diversity is low to moderate.

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

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: 390073, 391003, 392005, 590139

Map Class: MNRR MC105d

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1244.75 ft (range 1223 ft to 1280 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Floodplain, Marsh, Wet Meadow

Geology: Alluvium, Pierre Shale, Niobrara Formation

Soil Texture: Loamy Sand, Silty Clay, Muck

Environment: 4 sites were sampled within this type. The soil texture ranges from muck to loamy sandy. Ground cover is pretty variable. Litter ranges from 20% to 69%, bare soil ranges from 5% to 40%, basal area ranges from 17% to 50%. They all occur on flat levels. The soil is always saturated with water.

Local Vegetation Description

Structure: Tall Shrub (0%-10%), Herbaceous (70%-90%)

Vegetation Floristics: These types have mesic *Carex* spp. present. Total cover ranges between 70% and 90%. The main species are *Carex pellita, Carex vulpinoidea, Carex molesta, Carex stipata,* and *Carex tribuloides*, but *Eleocharis* spp. along with *Juncus interior* and *Juncus torreyi* 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 semi permanently flooded (Steinauer and Rolfsmeier 2000).

Global Vegetation Description

This sedge wet meadow type is found in the central midwestern United States. 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. 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* and *Scirpus atrovirens*. *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.

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, namely *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.

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

Short Citation

- Steinauer and Rolfsmeier 2000

Mapped Forest and Woodland Types

NPSMNRR001 Populus deltoides – Fraxinus pennsylvanica / Rhamnus cathartica Ruderal Forest

USNVC: Park Special NPSMNRR001

Field Plots: 590028, 590064, 590112

Map Class: MNRR MC301

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 769.33 (range 1147 ft to 1161 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Terrace, Floodplain

Geology: Alluvium, Carlile Shale

Soil Texture: Sandy Loam, Clay Loam, Clay

Environment: 3 sites were sampled within this type. They all occurred along flat floodplain terraces with soils ranging from sandy loam to clay. There was between 20% and 30% downed wood in these sites, and litter covered unvegetated areas ranging from 35% to 60%.

Local Vegetation Description

Structure: Emergent (0%-60%), Canopy (30%-70%), Subcanopy (0%-10%), Tall Shrub (30%-90%), Short Shrub (0%-50%), Dwarf Shrub (0%-30%), Herbaceous (20%-70%)

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. The canopy contained an emergent stratum of *Populus deltoides* usually with covers of ~ 50% but cover may be as sparse as 10%. The canopy contains *Fraxinus pennsylvanica* with cover values between 20% and 50%; however, *Rhamnus cathartica* dominates the tall shrub stratum and occasionally the canopy stratum. *Rhamnus cathartica*'s cover is between 60% and 70%. *Morus alba* and *Cornus drummondii* may also be present in this type though their cover values do not exceed 20%. The Herbaceous layer is sparse with total cover values of ~20%. Typical herbaceous plants in this type include *Galium aparine*, *Maianthemum stellatum*, and *Viola* spp. Instead of forbs, the ground is covered by a dwarf shrub layer of *Parthenocissus quinquefolia* (60%).

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

Example Photograph
The photograph below shows an **example of** NPSMNRR001 *Populus deltoides – Fraxinus pennsylvanica* / *Rhamnus cathartica* Ruderal Forest.

Populus deltoides – Fraxinus pennsylvanica / *Rhamnus cathartica* Ruderal Forest (CNHP)

Short Citation

N/A

NPSMNRR009 Populus deltoides Ruderal Forest
USNVC: Park Special NPSMNRR009

Field Plots: Field Reconnaisance Observations

Map Class: MNRR MC301

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1208.47 ft (range 1106 ft to 1281 ft)

Aspect: Mean 11.53˚ (range Flat to 173˚)

Slope: Mean 0.33˚ (range Flat to 5˚)

Macro Topography: Floodplain Lower Terrace, River Island

Geology: Alluvium, Carlile Shale

Soil Texture: Loamy Sand

Environment: Soil usually ranges from loamy sand to sandy loam. Ground cover is dominated by litter with values ranging from (30% to 75%). Bare soil is the second most dominant ground cover with values ranging form 10% to 50%. Finally, basal area usually composes between 6% and 11%.

Local Vegetation Description

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

Vegetation Floristics: *Populus deltoides* forms an open overstory canopy on dynamic sites within or adjacent to the river channel where periodic flooding causes repeated disturbance. Sites typically include a high percentage of bare ground and large woody debris (>2cm diameter). Non-native invasive species may be present to prevalent.

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

Example Photograph
The photograph below shows an **example of** NPSMNRR009 *Populus deltoides* Ruderal Forest.

Populus deltoides Ruderal Forest (CNHP)

Short Citation

N/A

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: 390012, 390067, 390098, 390115, 390116, 392020, 590039, 590043, 592022

Map Class: MNRR MC302

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1232 ft (range 1139 ft to 1429 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Terrace, Alluvial Flat, Floodplain

Geology: Alluvium, Carlile Shale, Pierre Shale

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

Environment: 9 sites were sampled within this type. All sites were located on a flat floodplain. The dominant soil type was loamy sand, but one site had silt loam and another had sand. Downed wood makes up ~15% of the ground cover with litter having the highest ground cover of ~65%.

Local Vegetation Description

Structure: Emergent (0%-50%), Canopy (20%-70%), Subcanopy (0%-60%), Tall Shrub (0%-50%), Dwarf Shrub (0%-20%), Herbaceous (10%-70%)

Vegetation Floristics: *Populus deltoides* occupies the tallest stratum as either an emergent or canopy, and the cover for *P. deltoides* ranges between 20% and 50%. Canopy stratum can be quite variable in this type with sites recording *Ulmus americana*, *Morus rubra*, *Fraxinus pennsylvanica*, *Acer negundo*, *Cornus drummondii*, and *Tilia americana.* The most common trees to occupy the canopy though is *F. pennsylvanica*, and the cover for the canopy usually ranges between 50% and 70% though there were some plot with sparse (20%) or absent canopies. A tall shrub stratum is usually absent; though if there is one, it will have *Cornus drummondii* and covers between 10% and 20%. Dwarf shrubs such as *Toxicodendron radicans*, *Vitis riparia*, and *Parthenocissus quinquefolia* may occur in low abundances throughout the area. The herbaceous layer is usually sparse with cover around 20%, but in more open areas cover may reach 70%. The most common forbs include *Ageratina altissima* and *Nepeta cataria*; *Elymus virigincus* is the most common graminoid associated with this type.

Dynamics: The species dominating this community are pioneers of bare soil. The community is sometimes considered a "postclimax" type that exists in otherwise arid areas because of groundwater along streams and rivers. It is often subject to flooding, deterioration during periodic droughts, and destruction by herbicides, after which it reappears following natural seeding. In the southern portion of its range, cottonwood-willow forests on river bottomlands often contain an understory of *Juniperus virginiana* that has developed as a result of seed dissemination by birds from individuals in windbreak plantings on adjacent uplands. This conifer component may be gradually altering the type.

Girard (1985) stated that the condition of these woodland communities appears to be declining and suggests that improper grazing or overgrazing by livestock is a significant factor. Flooding is necessary to reproduce the conditions on which this community can establish. Without periodic floods to create bare alluvium, this community cannot become established in new areas to take the place of those that are succeeding to later seral stages.

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 community is a riparian forest with an open to closed canopy dominated by deciduous trees. Girard et al. (1989) sampled two stands in southwestern North Dakota that had an average of 293 trees/ha. Hansen et al. (1984) sampled four stands that had an average basal area of 41 m2/ha and

427 trees/ha. They found that the average cover by strata was shrubs 76.8%, graminoids 64.2%, and forbs 43.5%. *Populus deltoides* and *Fraxinus pennsylvanica* are the most abundant mature trees. *Acer negundo*, *Salix amygdaloides*, and *Juniperus scopulorum* may also be present in the tree layer. This community is seral, and in younger stands *Populus deltoides* is the dominant, but as stands age *Fraxinus pennsylvanica* becomes more prominent until the stand becomes a different community. The closed canopy leads to poor reproduction by *Populus deltoides* in stands of all ages. The shrub layer is often vigorous. Species such as *Rosa woodsii*, *Symphoricarpos occidentalis*, *Juniperus scopulorum*, *Juniperus communis*, and *Cornus sericea* ssp. *sericea* can be abundant. The composition of the herbaceous layer is variable. Along the Missouri River, Keammerer (1972) found *Poa pratensis* to be the most prevalent species, with *Amphicarpa bracteata*, *Bromus inermis*, and *Elymus virginicus* common. *Carex* spp., *Juncus* spp., *Leymus cinereus*, *Lysimachia ciliata*, *Thalictrum venulosum*, and *Elymus canadensis* are common. Weedy species are almost ubiquitous; among them are *Poa* spp., *Bromus inermis*, *Melilotus officinalis*, *Ambrosia* spp., and *Urtica* spp. Further comparisons are needed between stands in Nebraska, which may contain a different set of species, from those further north. See Steinauer and Rolfsmeier (1997) for a description of the Nebraska stands.

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 1985
- Girard et al. 1989
- Hansen et al. 1984
- Johnson 1971
- Keammerer 1972
- Steinauer and Rolfsmeier 1997

CEGL000660 Populus deltoides / Symphoricarpos occidentalis Floodplain Woodland

The table below shows the USNVC Hierarchy for CEGL000660 *Populus deltoides* / *Symphoricarpos occidentalis* Floodplain Woodland.

USNVC hierarchy for CEGL000660 *Populus deltoides* / *Symphoricarpos occidentalis* 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* / *Symphoricarpos occidentalis* Floodplain Woodland (CEGL000660)

Field Plots: Field Reconnaisance Observations

Map Class: MNRR MC302

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1205.5 ft (range 1103 ft to 1246)

Aspect: Flat

Slope: Flat

Macro Topography: River Island, Floodplain Lower Terrace

Geology: Alluvium

Soil Texture: Sandy Loam

Environment: Soil usually ranges from sandy loam to loam. Ground cover is dominated by litter with values ranging from 81% to 85%. Basal area ranged from 12% to 15%. Wood is typically present with cover <5%.

Local Vegetation Description

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

Vegetation Floristics: The canopy is dominated by *Populus deltoides*; common associates include *Acer negundo* and *Fraxinus pennsylvanica*. This type is defined by a distinct dwarf shrub layer of *Symphoricarpos occidentalis*. Other shrubs may include *Juniperus virginiana* and *Rosa* spp. The herbaceous layer tends to be dominated by *Pascopyrum smithii*, *Melilotus officinalis*, and *Taraxacum officinale*.

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 may include *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: G2G3

State (Nebraska): N/A

Global Environmental Description

This community is found on medium to coarse-textured alluvial soils on the floodplains of major rivers. The floodplains are both seasonally inundated and subirrigated (Thilenius et al. 1995). The meandering erosional and depositional pattern of rivers maintains and influences this community along rivers (Hansen et al. 1990). It is rarely found at higher elevations in the mountains of eastern Wyoming and western South Dakota (Johnston 1987).

Global Vegetation Description

This riparian woodland community is found in the northwestern Great Plains of the United States on medium to coarse-textured alluvial soils on the floodplains of major rivers. The floodplains are both seasonally inundated and subirrigated. It is found more rarely at higher elevations in the mountains of eastern Wyoming and western South Dakota. This community is dominated by a single deciduous tree species, *Populus deltoides*. In some stands other species, such as *Acer negundo* and *Fraxinus pennsylvanica*, may contribute to the canopy. The tallest trees exceed 15 m. The shrub layer is typically 0.5-1 m tall. It is dominated by *Symphoricarpos occidentalis* and commonly includes *Juniperus scopulorum* and *Rosa* spp. In Wyoming, *Ericameria nauseosa* (= *Chrysothamnus nauseosus*) is present and increases with heavy grazing. The herbaceous layer usually includes *Pascopyrum smithii*. Weedy species such as *Melilotus officinalis*, *Taraxacum officinale*, and *Poa secunda* are very common, especially in the presence of grazing. *Maianthemum stellatum* is abundant only where grazing is absent.

Nebraska Natural Heritage Program Description

N/A

Example Photograph

The photograph below shows an **example of** CEGL000660 *Populus deltoides* / *Symphoricarpos occidentalis* Floodplain Woodland.

Populus deltoides / *Symphoricarpos occidentalis* Floodplain Woodland (CNHP)

Short Citation

- Girard et al. 1989
- Hansen et al. 1990
- Johnston 1987
- Thilenius et al. 1995

NPSMNRR005 Populus deltoides / Cornus drummondii Open Floodplain Forest

USNVC: Park Special NPSMNRR005

Field Plots: Field Reconnaisance Observations

Map Class: MNRR MC303

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1164.19 ft (range 1053 ft to 1484 ft)

Aspect: Mean 13.97˚ (range 0˚ to 210˚)

Slope: Mean 0.56˚ (range 0˚ to 8˚)

Macro Topography: River Island, Floodplain Lower Terrace

Geology: Alluvium, Carlile Shale, Dakota Group

Soil Texture: Sandy Loam

Environment: This community occurs along floodplains next to the river. Ground cover is dominated by litter with values raning from 75% to 90%. Basal area often has cover ranging from 9% to 15%. Wood is often present with cover values <5%.

Local Vegetation Description

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

Vegetation Floristics: The communities were dominated by an overstory of widely spaced *Populus deltoides* with occasional to rare subcanopy trees including *Morus alba*, *Fraxinus pennsylvanica*, *Celtis occidentalis*, and *Juniperus virginiana*. A dense layer of roughleaf dogwood (*Cornus drummondii*, 2–4 m tall) was a consistent feature of these sites along with the occasional *Amorpha fruticosa*, *Prunus virginiana/Prunus americana*, and shrub height *Juniperus virginiana*. Vines were usually present and included *Parthenocissus quinquefolia* and *Toxicodendron radicans*. Some areas had extensive vine growth overtopping a majority of the shrubs forming an impenetrable vine wall. The understory was composed of litter and bare ground with a sparse herbaceous layer. A majority of the sites we visited resembled the scouring rush (*Equisetum hyemale*) phase described in the NENHP type although the graminoid phase was also encountered. All sites were located along the lower portions of the 59-mile district.

Dynamics: N/A

Conservation Status Rank

Global: N/A

State (Nebraska): S2?

Global Environmental Description
N/A

Global Vegetation Description
N/A

Nebraska Natural Heritage Program Description
Eastern Cottonwood – Dogwood Riparian Woodland: This community is dominated by a tall (20-30 m) overstory of *Populus deltoides*. Occasionally subcanopy trees may be conspicuous along the margin of this community, especially the introduced *Morus alba*. A dense layer of *Cornus drummondii* (2–4 m tall) is a consistent feature of this community, and is usually the only significant shrub present, though in some sites *Zanthoxylum americanum* may also be scattered or a sparse short shrub layer of *Symphoricarpos orbiculatus* is present. Vines are sometimes conspicuous, with *Parthenocissus quinquefolia* and *Toxicodendron radicans* most common.

Example Photograph
The photograph below shows an **example of** NPSMNRR005 *Populus deltoides* / *Cornus drummondii* Open Floodplain Forest.

Populus deltoides / *Cornus drummondii* Open Floodplain Forest (CNHP)

Short Citation

N/A

CEGL002152 Populus deltoides / Juniperus scopulorum Floodplain Forest

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

USNVC hierarchy for CEGL002152 *Populus deltoides* / *Juniperus scopulorum* 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	A0636 *Populus deltoides* Floodplain Woodland Alliance
Association	1.B.3.Na *Populus deltoides* / *Juniperus scopulorum* Floodplain Woodland (CEGL002152)

Field Plots: 390006, 390085, 590020, 590062, 590071, 590120, 590123, 590125, 590138

Map Class: MNRR MC304

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1171.22 ft (range 1119 ft to 1228 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Flat, Alluvial Terrace, Lowland

Geology: Alluvium, Carlile Shale

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

Environment: 9 sites were sampled within this type. All of these sites occurred along the floodplain or floodplain terrace of the Missouri River. The soil textures recorded were usually silt loam and loamy sand; other soil textures included sand and clay loam. These sites contained ~15% downed wood, and leaf litter ranged from 40% to 65%; between 5% and 10% bare soil was also occasionally present at these sites.

Local Vegetation Description

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

Vegetation Floristics: *Populus deltoides* occurs in the emergent layer for these sites with cover ranging from 10% to 60%. The canopy is comprised of *Juniperus virginiana* generally cover is greater than 50%. *Ulmus americana* occasionally occurs in the canopy stratum. A tall shrub stratum with cover of between 10% and 30% is typically present containing *Cornus drummondii*, *Zanthoxylum americana*, and *Rhamnus cathartica*. Usually sites contain a sparse herbaceous layer with cover <10%, but other plots contained an herbaceous layer with moderate cover with cover up to 50%. Both sites have a sparse herbaceous stratum only totalling to 10% cover. Some common forbs within the herbaceous layer include *Ageratina altissima* and *Nepeta cataria*.

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: G1

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

Example Photograph
The photograph below shows an example of CEGL002152 *Populus deltoides* / *Juniperus scopulorum* Floodplain Forest.

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

Short Citation

- Girard et al. 1989

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: 390138, 390139, 591004

Map Class: MNRR MC305

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1232 ft (range 1216 ft to 1248 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Terrace, Floodplain

Geology: Alluvium, Niobrara Formation

Soil Texture: Sand, Loamy Sand

Environment: 3 sites were sampled within this type. All plots were found on floodplains near the river. Soil texture is sand or loamy sand. Sand/bare soil ranges from 19% to 34%, and litter ranges between 20% to 45%.

Local Vegetation Description

Structure: Canopy (0-30%), Tall Shrub (40%-90%), Short Shrub (0%-60%), Herbaceous (30%-80%)

Vegetation Floristics: These communities had a sparse canopy of *Populus deltoides* and/or *Salix amygdaloides* with cover up to 30%. There is a vigorous shrub layer of *Salix interior* and *Salix eriocephala* with cover values of 90%. The herbaceous layer is variable between 30% to 80% cover with plants such as *Phalaris arundinacea* and *Melilotus officinale*.

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 *Populus deltoides* and *Salix* spp. 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 cottonwood - willow woodland is found widely in the central Great Plains of the United States. Stands occur on recently deposited alluvial material along rivers and streams. The soils are derived from alluvial sand, silt, and clay and are poorly developed. The water table fluctuates with the level of the adjacent river or stream. *Populus deltoides* is the dominant species in this community, although *Salix exigua* and/or *Salix interior* is generally more dominant in the initial stage following a major flood event. *Salix amygdaloides* is rare to codominant. The shrub/sapling layer is conspicuous, especially near the streambank, and consists mainly of *Salix exigua*, *Populus deltoides*, and *Salix*

amygdaloides, or occasionally *Salix lutea*. In the more easterly parts of the range, *Salix interior* may replace *Salix exigua*. On the older margins of this community *Fraxinus pennsylvanica* is often found as a sapling or small canopy tree. The herbaceous stratum is variable. Graminoids typical of undisturbed sites include *Carex emoryi*, *Carex pellita* (= *Carex lanuginosa*), *Pascopyrum smithii*, and *Spartina pectinata*. *Equisetum arvense* and *Glycyrrhiza lepidota* are common forbs in these sites. Widely distributed species that are adapted to these sites include *Ambrosia psilostachya, Artemisia campestris* ssp. *caudata, 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 field horsetail, 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 *Nassela viridula* drops out and *Elymus canadensis* is more common.

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*) (CNHP)

Short Citation

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

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: 390154, 391016, 591007

Map Class: MNRR MC305

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1327.67 ft (range 1236 ft to 1450 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Floodplain, Island, Alluvial Flat

Geology: Alluvium, Carlile Shale, Niobrara Formation

Soil Texture: Sand, Loamy Sand

Environment: 3 sites were sampled within this type. This type occurs along loamy sand or sand. Litter is variable ranging from 25% to 65%. One site occurred on very sandy soils with ground cover of 40%. These occurred along flat floodplains.

Local Vegetation Description

Structure: Canopy (40%-60%), Tall Shrub (0-10%), Herbaceous (80%-90%)

Vegetation Floristics: This is a low diversty type. *Salix amygdaloides* is the only tree in the canopy with cover between 40% and 60%. The herbaceous layer is dense but mainly *Phalaris arundinacea.*

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

In the Black Hills, Peachleaf Willow Woodland has been documented from a single site, along Iron Creek near its confluence with Spearfish Creek. In this stand, *Salix amygdaloides* (peachleaf willow) forms a tall-shrub stratum with *Salix bebbiana* (Bebb willow) and *Cornus serice*a (red-osier dogwood). Stands occur as intermittent patches in a narrow zone along the creek. The overall size is less than 0.5 acre, and peachleaf willow forms a shrubland rather than a woodland. The very limited extent of the type and its atypical structure suggest that Peachleaf Willow Woodland may not be a valid type for the area (Marriott and Faber-Langendoen 2000). Thompson and Hansen (2002) documented five stands in southern Alberta and, although listing them as shrub types, describe the vegetation as consisting of "a tree layer dominated by the short-statured *Salix amygdaloides*." Four stands have been documented from eastern Colorado (Carsey et al. 2003a).

Nebraska Natural Heritage Program Description

Peachleaf Willow Woodland: 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 scattered *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.

Salix amygdaloides Riparian Woodland (CNHP)

Short Citation

- Carsey et al. 2003a
- Marriott and Faber-Langendoen 2000
- Thompson and Hansen 2002

CEGL001454 Populus deltoides / Panicum virgatum – Schizachyrium scoparium Woodland

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

USNVC hierarchy for CEGL001454 *Populus deltoides* / *Panicum virgatum – Schizachyrium scoparium* 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 Plot: 592006

Map Class: MNRR MC305

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: 1153 ft

Aspect: Flat

Slope: Flat

Macro Topography: Island

Geology: Carlile Shale

Soil Texture: Clay Loam

Environment: 1 site was sampled within this type. It was found on a river island on sandy clay loam. Litter was the prominent ground cover of 85%.

Local Vegetation Description

Structure: Canopy (30%), Herbaceous (90%)

Vegetation Floristics: There is a sparse canopy of *Populus deltoides* of ~30%; *Salix amygdaloides* may be present in the canopy as well. If present, the shrub layer is occupied by *Shepherdia argentea* and *Symphoricarpos occidentalis. Panicum virgatum* is the dominant herbaceous with cover of 90%. Other common graminoids include *Carex nebrascensis, Carex pellita, Schizachyrium scoparium, Bouteloua curtipendula,* and *Pascopyrum smithii*.

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* Woodland.

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

Short Citation

N/A

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: 390001, 390010, 390106, 590012, 590014, 590016, 590025, 591006, 591021, 592019

Map Class: MNRR MC306

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1219.78 ft (range 1000 ft to 1523 ft)

Aspect: Mean 160.67˚ (range Flat to 270˚)

Slope: Mean 9.33˚ (range Flat to 39˚)

Macro Topography: Alluvial Flat, Alluvial Terrace, Bluff

Geology: Alluvium, Carlile Shale, Pierre Shale

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

Environment: 10 sites were sampled within this type. Most sites occurred on floodplain terraces; however, a few plots were along moderate slopes ranging from 20˚ to 39˚. The soil textures are all loam ranging from loamy sand to silty clay loam. Litter comprises about 50% of the ground cover; however, one site contained 45% bare soil. Wood is usually present with cover ranging from 5% to 20%.

Local Vegetation Description

Structure: Canopy (40%-80%), Subcanopy (0%-70%), Tall Shrub (0%-20%), Short Shrub (0%-10%), Herbaceous (50%-90%)

Vegetation Floristics: The canopy contains *Fraxinus pennsylvanica*; *F. pennsylvanica* dominates or codominates usually with cover values of ~50% though may range as low as 10%. *Cornus drummondii*, *Morus alba*, and *Juniperus virginiana* also occur in the canopy or subcanopy stratum. The herbaceous stratum ranges from 50% to 90% and is dominated graminoids such as *Elymus virginicus* and *Carex* spp. usually *Carex molesta* and *Carex blanda*. *Ageratina altissima* seems to be a common forb present in many of these plots. Several of the sites near agricultural fields have been invaded by *Bromus inermis* which dominates the herbaceous stratum with cover values up to 90%. These sites differ from CEGL5239 by the amount of *Juniperus virginiana* present; plots within CEGL005239 typically have >40% *Juniperus virginiana*.

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

This community is found in the central United States along upper floodplain terraces of rivers and streams and in upland ravine bottoms. Soils are moderately well-drained to poorly drained. Tree canopies are 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 its range includes *Elymus virginicus, Festuca subverticillata, Galium aparine, Geum canadense*, and *Laportea canadensis*.

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 *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*. Species diversity varies from low to moderately high.

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

N/A

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: MNRR MC306

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1200.31 ft (range 1040 ft to 1413 ft)

Aspect: Mean 2.33˚ (range 0˚ to 324˚)

Slope: Mean 1.17˚ (range 0˚ to 17˚)

Macro Topography: Hillslope, Floodplain Upper Terrace

Geology: Alluvium, Carlile Shale, Dakota Formation

Soil Texture: Loam

Environment: These communities occur along the upper terrace of the floodplain. Ground cover is dominated by litter with cover values ranging from 75% to 90%. Basal area forms a large part of the ground cover with values ranging from 8% to 15%. Wood is often present with values <10%.

Local Vegetation Description

Structure: Canopy (50%-80%), Subcanopy (10%-30%), Tall Shrub (0%-20%), Short Shrub (0%-20%), Herbaceous (20%-60%)

Vegetation Floristics: This community lacks diversity and 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 may contain a mix of graminoids and forbs including *Elymus virginicus, Eupatorium perfoliatum, Laportea canadensis,* and *Carex* spp.

Dynamics: This community may succeed cottonwood-willow forests on floodplains in the absence of flooding. Flooding and windthrow 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

This ash - elm floodplain forest is found in the northern Great Plains states and adjacent prairie provinces of west-central Canada. Stands occur 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. 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, Osmunda claytoniana,* and *Osmunda cinnamomea*. Diagnostic features include the dominance of *Fraxinus pennsylvanica* and *Ulmus americana*, lack of more eastern herbs (e.g., *Osmunda claytoniana* and *Osmunda cinnamomea*) and tree species (e.g., *Fraxinus nigra, Juglans cinerea, Juglans nigra, Quercus bicolor*), the infrequent and short flooding, and the presence of both upland and floodplain associates.

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.

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

Short Citation

- Eyre 1980

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: MNRR MC306

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1187.1 ft (range 1072 ft to 1360 ft)

Aspect: Mean 81.7˚ (range 0˚ to 346˚)

Slope: Mean 22.5˚ (range 0˚ to 50˚)

Macro Topography: Hillslope, Floodplain Upper Terrace

Geology: Dakota Group, Greenhorn Limestone, Carlile Shale

Soil Texture: Silty loam, Sandy loam

Environment: These communities typically occurred on East slopes. Litter dominates the ground cover with values ranging from 76% to 87%. Basal area of the vegetation generally comprises 8%-19% of the ground cover. Wood is typically present with values <10%.

Local Vegetation Description

Structure: Canopy (40%-70%), Subcanopy (0%-30%), Tall Shrub (40%-70%), Herbaceous (20%-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 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 Pine Ridge *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 sprengelii* and *Elymus villosus* 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.

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

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: 390016, 390017, 390028, 391018, 590005, 590029, 590041, 590060

Map Class: MNRR MC307

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1321.88ft (range 1126 ft to 1559 ft)

Aspect: Mean 150.8˚ (range Flat to 235˚)

Slope: Mean 12.2˚ (range Flat to 44˚)

Macro Topography: Alluvial Terrace, Bluff, Interfluve, Ravine, Slope

Geology: Alluvium, Pierre Shale, Niobrara Formation

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

Environment: 8 sites were sampled within this type. Soil texture is loamy usually ranging between sandy clay loam and sandy loam. Ground cover is variable and usually dominated by litter (~50%) though some sites have a large amount of bare soil present ranging between 45% to 75%.

Local Vegetation Description

Structure: Emergent (0%-40%), Canopy (40%-80%), Subcanopy (0%-70%), Tall Shrub (0%-60%), Short Shrub (0%-40%), Herbaceous (0%-100%), Vine (0%-20%)

Vegetation Floristics: These plots are degraded forms of CEGL002014 where other species have invaded. Canopy is usually dominated by *Fraxinus americana* or *Ulmus americana* with usually <50% cover. Other trees that co-occur are *Celtis occidentalis*, *Juniperus virginiana*, and *Cornus drummondii*. The weedy species typically present include *Juniperus virginiana*, *Rhamnus cathartica*, and *Ulmus pumilla*. The herbaceous layer can be vigorous (>70%) or very sparse (<20%). Herbaceous species are variable, but *Bromus inermis* and *Carex* spp. tend to thrive in the understory.

Dynamics: N/A

Conservation Status Rank

Global: GNA

State (Nebraska): N/A

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

Global Vegetation Description
This semi-natural ash - elm community is found in the central midwestern United States. Stands occur in mesic, sometimes bottomland, disturbed draws or in upland, disturbed sites. 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.

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

Short Citation

N/A

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: 390123, 390146, 590018, 590152

Map Class: MNRR MC308

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1230.5 ft (range 1165 ft to 1313 ft)

Aspect: Mean 47˚ (range Flat to 188˚)

Slope: Mean 4.25˚ (range Flat to 17˚)

Macro Topography: Alluvial Flat, Alluvial Terrace, Hills

Geology: Alluvium, Carlile Shale, Niobrara Formation

Soil Texture: Loamy Sand, Clay Loam

Environment: 4 sites were sampled within this type. The soil textures range from loamy sand to silty clay loam.

Local Vegetation Description

Structure: Canopy (70%-90%), Tall Shrub (0%-30%), Herbaceous (30%-70%), Vine (0%-20%)

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 30% to 50% cover with *Ageratina altissima, Carex* spp., and *Urtica dioica* as the most abundant species.

Dynamics: N/A

Conservation Status Rank

Global: GNA

State (Nebraska): N/A

Global Environmental Description
Stands typically occur in old fields and other disturbed places.

Global Vegetation Description
This semi-natural *Juniperus virginiana* 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.

Juniperus virginiana Midwest Ruderal Forest (CNHP)

Short Citation

N/A

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: 592007, 592008

Map Class: MNRR MC309

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1152.5 (range 1146 ft to 1159 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Island

Geology: Carlile Shale

Soil Texture: Sand

Environment: 2 sites were sampled within this type. Both of these occurred on sand soil texture. Sand is the dominant ground cover ranging from 70% to 87%.

Local Vegetation Description

Structure: Tall Shrub (0%-10%), Herbaceous (40%-60%)

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

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

This widespread Russian-olive woodland type is found in the northern Great Plains, Colorado Plateau, and probably throughout much of the western United States and adjacent Canada. It is a naturalized species that has been widely planted in hedgerows for windbreaks. It has since spread to a variety of native habitats, particularly more mesic ones, such as near streams and rivers, although small upland stands are also known. The vegetation is dominated by *Elaeagnus angustifolia*, sometimes accompanied by *Tamarix* spp. Remnant *Populus fremontii* trees may remain as canopy emergents. Stands may be small and linear. The vegetation is dominated by the tree *Elaeagnus angustifolia* with a variety of native and introduced species in the shrub and herbaceous layers. Associated species have not been characterized. Canopy closure is between 40 and 50%. Shrub cover is provided by *Salix exigua* and *Amorpha fruticosa*. *Pascopyrum smithii, Sporobolus airoides, Distichlis spicata*, and *Hordeum jubatum* comprise the herbaceous layer in some stands; in others the understory is dominated by introduced species, such as *Lepidium latifolium, Descurainia sophia*, and *Bassia scoparia* (= *Kochia scoparia*).

Nebraska Natural Heritage Program Description

N/A

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

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: 590007, 590032, 590099

Map Class: MNRR MC310

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1278.67 ft (range 1219 ft to 1325 ft)

Aspect: Mean 228.67˚ (range 147˚ to 349˚)

Slope: Mean 23˚ (range 10˚ to 30˚)

Macro Topography: Ravine, Slope

Geology: Carlile Shale, Niobrara Formation

Soil Texture: Loamy Sand, Sandy Loam, Clay Loam

Environment: 3 sites were sampled within this type. The soil texture ranged from loamy sand to clay loam. Litter ranges from 30% to 70% cover, wood ranges from 8% to 14%, and bare soil ranges from 1% to 40%.

Local Vegetation Description

Structure: Canopy (50%-80%), Subcanopy (0%-60%), Tall Shrub (0%-10%), Short Shrub (0%-10%), Herbaceous (40%-70%)

Vegetation Floristics: The canopy has *Quercus macrocarpa* (50% to 80% cover) with a subcanopy of *Ostrya virginiana* or *Celtis occidentalis* (20% to 40% cover). The shrub layer is typically sparse to absent and includes *Prunus virginiana* and *Juniperus virginiana.* Additionally, *Ribes missouriensis* and *Rubus occidentalis* typically occur in the dwarf shrub layer with low abundances. The herbaceous layer is dominated by *Carex* spp.

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 bur oak community type is found in the Black Hills of the western United States. Stands occur at elevations of 1067-1400 m (3500-4600 feet) on gentle to moderately steep (14-47%) northerly slopes. Most occurrences are on upland slopes but some are along streams and gullies. The occurrences of this type along streams are often more floristically diverse than upland examples. The soils are sandy loams and loams with pH of 5.8-7.4. This community is dominated by closely spaced small trees of *Quercus macrocarpa*. In some areas across the range of this type *Fraxinus pennsylvanica* and *Prunus virginiana* 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.

Nebraska Natural Heritage Program Description

N/A

Example Photograph

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

Quercus macrocarpa / *Ostrya virginiana* Forest (CNHP)

Short Citation

- Hoffman and Alexander 1987
- Johnston 1987

CEGL002072 Quercus macrocarpa / Cornus drummondii / Aralia nudicaulis Forest

The table below shows the USNVC Hierarchy for CEGL002072 *Quercus macrocarpa* / *Cornus drummondii* / *Aralia nudicaulis* Forest.

USNVC hierarchy for CEGL002072 *Quercus macrocarpa* / *Cornus drummondii* / *Aralia nudicaulis* 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* / *Cornus drummondii* / *Aralia nudicaulis* Forest (CEGL002072)

Field Plots: 390045, 590027, 590037, 590048, 590059, 590081, 590091, 590105, 590107, 590148, 590103, 590153

Map Class: MNRR MC310

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1284.08 ft (range 1128 ft to 1407 ft)

Aspect: Mean 233.92˚ (range 20˚ to 359˚)

Slope: Mean 13.67˚ (range 6˚ to 30˚)

Macro Topography: Alluvial Terrace, Bluff, Dell, Hills, Hollow, Ravine

Geology: Carlile Shale, Pierre Shale, Niobrara Formation

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

Environment: 12 sites were sampled within this type. The most common soil textures are sandy loam and silt loam, but soil texture ranges from silt to sandy loam. Ground cover is variable among these plots. In half of the sites litter dominates with cover of ~60%, and litter is sparse with cover of ~20% in the other half. Wood can range from 5% to 25%, and bare soil can be abundant or sparse depending on the litter. In sparse litter plots, bare soil can reach cover values up to 50%, while it generally remains at ~10% in litter abundant sites. This site occurred along gentle to moderate slopes ranging from 6˚ to 30˚.

Local Vegetation Description

Structure: Emergent (0%-10%), Canopy (60%-80%), Subcanopy (0%-30%), Tall Shrub (0%-40%), Short Shrub (0%-10%), Dwarf Shrub (0%-40%), Herbaceous (20%-90%)

Vegetation Floristics: *Quercus macrocarpa* usually dominates or codominates stands. *Q. macrocarpa* typically has cover values of 60%, but some sites reported cover values of 20%. Other common trees in the canopy include *Fraxinus pennsylvanica, Celtis occidentalis, Ostrya virginiana, Gymnocladus dioecious*, and these trees usually have individual cover values of ~20%. A dwarf shurb layer is typically absent though occasionally has ~40% cover of *Parthenocissus quinquefolia*. The herbaceous layer is quite variable between plots ranging between 20% and 90% cover. The herbaceous stratum is dominated by graminoids and usually *Carex molesta,* but some sites had an abundance of forbs such as *Ageratina altissima* or *Laportea canadensis.*

Dynamics: Many stands of this community type have apparently originated post-settlement (after 1850). In the Loess Hills and central region of Iowa there were few reports of *Quercus macrocarpa* stands, except as scattered *Quercus macrocarpa* in tallgrass prairie. Since then, many of these spots have succeeded to *Quercus macrocarpa* woodland and forest (Rosburg and Glenn-Lewin 1996; Johnson-Groh et al. 1987). These reports can be duplicated throughout the range of this type. Currently there is very little regeneration of *Quercus macrocarpa* in these stands (Steinauer and Rolfsmeier 1997).

Conservation Status Rank

Global: G4

State (Nebraska): S2S3

Global Environmental Description

This community is found in the central and northern tallgrass prairie region of the midwestern United States. It typically occurs on gentle to steep slopes of draws and bluffs, where, historically, firebreaks occurred. Soils in the northern part of the range include well-drained sandy loams to loams formed in glacial till, and in the southern part include silty to sand loams formed primarily in loess and glacial till (Rosburg and Glenn-Lewin 1996, Steinauer and Rolfsmeier 2000).

Global Vegetation Description

The tree layer is a closed canopy dominated by *Quercus macrocarpa* with a mixture of shade-tolerant trees, such as *Celtis occidentalis, Fraxinus pennsylvanica, Ulmus americana*, and *Ulmus rubra*, and further north *Populus tremuloides*. Occasionally *Tilia americana* or *Quercus rubra* are present. The shrub layer is often prominent, dominated by *Amelanchier alnifolia* in the north and *Cornus drummondii* in the south. Other species shared across the range include *Prunus virginiana, Ribes missouriense, Rubus occidentalis, Symphoricarpos occidentalis, Symphoricarpos orbiculatus,* and *Zanthoxylum americanum*. Vines include *Celastrus scandens, Parthenocissus quinquefolia,* and *Toxicodendron radicans*. The herbaceous layer can be quite sparse. Common species include *Aralia nudicaulis, Carex assiniboinensis, Carex blanda, Elymus villosus, Galium boreale,*

Geum canadense, *Maianthemum stellatum*, *Osmorhiza longistylis*, *Poa pratensis*, *Polygonatum biflorum*, and *Viola sororia*.

Nebraska Natural Heritage Program Description

Dry-Mesic Bur Oak Forest and Woodland: These sites are primarily dominated by *Quercus macrocarpa*, though in some sites *Fraxinus pennsylvanica* may also be conspicuous on upper slopes, while *Celtis occidentalis*, *Juglans nigra* or *Tilia americana* may be common on lower slopes. *Ulmus rubra* and *Celtis occidentalis* are the most common subcanopy trees, with lesser amounts of *Fraxinus pennsylvanica* and *Ulmus americana*. In the extreme southeast, *Carya cordiformis*, *Cercis canadensis*, or *Morus rubra* may be locally common in the subcanopy. Degraded sites may be invaded by *Juniperus virginiana*, the introduced *Ulmus pumila*, or *Morus alba*. *Juniperus virginiana* is especially prominent in the lower Niobrara and upper Missouri drainages, where it may outcompete nearly all other understory species. The shrub layer varies from somewhat dense to sparse or nearly absent. The tall shrub layer is sparse to moderate and usually contains *Cornus drummondii* in the south or *Prunus virginiana* in the north. *Zanthoxylum americanum* is locally common throughout. Short shrubs are often more prominent, especially *Ribes missouriensis* and *Symphoricarpos orbiculatus*, with scattered *Symphoricarpos occidentalis* in some sites northward. The herbaceous layer is usually fairly sparse on upper slopes and quite dense below. Among the common species are several shade tolerant graminoids such as *Carex blanda*, *Carex grisea*, *Festuca subverticillata*, and *Elymus villosa*. *Parthenocissus quinquefolia* commonly dominates the forest floor of most sites, with *Sanicula odorata* or *Osmorhiza longistylis* often equally abundant on lower slopes. *Carex sprengellii* may overwhelmingly dominate the forest floor in the far north. Other frequent herbs include *Ageratina altissima*, *Galium aparine*, *Viola pubescens*, *Desmodium* spp., *Arisaema triphyllum*, and *Cryptotaenia canadensis*. *Erythronium albidum* and *Dicentra cucullaria* often blanket the forest floor of some higher quality sites in early spring. Species diversity is moderate to relatively high.

Example Photograph

The photograph below shows an example of CEGL002072 *Quercus macrocarpa* / *Cornus drummondii* / *Aralia nudicaulis* Forest.

Quercus macrocarpa / *Cornus drummondii* / *Aralia nudicaulis* Forest (CNHP)

Short Citation

- Johnson-Groh et al. 1987
- Rosburg and Glenn-Lewin 1996
- Steinauer and Rolfsmeier 1997
- Steinauer and Rolfsmeier 2000

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: 590093, 590143, 590149, 590150, 590151, 590154, 590159

Map Class: MNRR MC311

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1223 ft (range 1136 ft to 1308 ft)

Aspect: Mean 96˚ (range 14˚ to 350˚)

Slope: Mean 23.33˚ (range 18˚ to 34˚)

Macro Topography: Alluvial Terrace, Dell, Glen, Hills, Ravine

Geology: Carlile Shale

Soil Texture: Sandy Loam, Silt, Silt Loam, Clay Loam

Environment: 7 sites were sampled within this type. Soil textures ranged from silt to sandy loam. Litter is usually low with ground cover between 15% and 20%, but one site had 60% litter. Bare soil is high with cover values between 40%-60%. Downed wood is variable though usually at ~15%. This stands occurred on north or north east facing moderate slopes between 18 and 34 degrees.

Local Vegetation Description

Structure: Emergent (0%-30%), Canopy (50%-80%), Subcanopy (0%-30%), Tall Shrub (0%-40%), Short Shrub (0%-20%), Dwarf Shrub (0%-10%), Herbaceous (0%-90%)

Vegetation Floristics: *Tilia americana* typically dominates these sites with occasional codominance of *Quercus macrocarpa*. Other trees found in the canopy include *Celtis occidentalis*, *Ostrya virginiana*, and *Juglans nigra*. The canopy is always dense with at least 60% cover. Herbaceous stratum is very variable ranging from absent to 90% cover. Forbs dominate the herbaceous stratum with the dominate plants being *Viola canadense*, *Ageratina altissima*, and *Laportea canadensis*. All of the plots were found in Ponca State Park.

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 varies from sparsely to moderately vegetated, with *Carex sprengelii* 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

NPSMNRR006 Quercus macrocarpa / Juniperus virginiana Forest
USNVC: Park Special NPSMNRR006

Field Plots: Field Reconnaisance Observations

Map Class: MNRR MC312

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1215.07 ft (range 0 ft to 1462 ft)

Aspect: Mean 126.97˚ (range 0˚ to 310˚)

Slope: Mean 17.79˚ (range 0˚ to 39˚)

Macro Topography: Hillslope

Geology: Niobrara Formation, Carlile Shale, Pierre Shale

Soil Texture: Sand to Sandy Loam

Environment: These communities occurred on upper slopes of bluffs overlooking the river. Ground cover is dominated by litter with cover ranging from 60% to 90%. Large rocks may be present with values <5%. Bare soil is often present with cover <15%. Basal area composes <10% of the ground cover.

Local Vegetation Description

Structure: Canopy (40%-80%), Subcanopy (0%-60%), Short Shrub (0%-10%), Dwarf Shrub (20%), Herbaceous (5%-10%)

Vegetation Floristics: This is an open to closed forest dominated by *Quercus macrocarpa* and *Juniperus virginiana*. *Juniperus virginiana* has cover between 35% and 80%.

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

Example Photograph
The photograph below shows an example of NPSMNRR006 *Quercus macrocarpa* / *Juniperus virginiana* Forest.

Quercus macrocarpa / *Juniperus virginiana* Forest (CNHP)

Short Citation

N/A

CEGL002053 Quercus macrocarpa / Andropogon gerardii – Hesperostipa spartea Woodland

The table below shows the USNVC Hierarchy for CEGL002053 *Quercus macrocarpa* / *Andropogon gerardii – Hesperostipa spartea* Woodland.

USNVC hierarchy for CEGL002053 *Quercus macrocarpa* / *Andropogon gerardii – Hesperostipa spartea* 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.1 Great Plains Forest & Woodland
Group	1.B.2.Ne.1.a Great Plains Bur Oak Forest & Woodland
Alliance	A0620 Great Plains Bur Oak Woodland
Association	1.B.2.Ne *Quercus macrocarpa* / *Andropogon gerardii – Hesperostipa spartea* Woodland (CEGL002053)

Field Plots: Field Reconnaisance Observations

Map Class: MNRR MC313

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1153.67 ft (range 1057 ft to 1240 ft)

Aspect: Mean 217.67˚ (range 0˚ to 330˚)

Slope: Mean 8.67˚ (range 8˚ to 10˚)

Macro Topography: Hillslope

Geology: Carlile Shale, Niobrara Formation

Soil Texture: Sandy Loam

Environment: These communities typically occur on gentle slopes. Litter dominates the ground cover with values between 50% and 70%. Bare ground may be present when the community is located in the grazed pastures. Cover values of bare ground may reach up to 10%.

Local Vegetation Description

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

Vegetation Floristics: This community is an open woodland occurring on gentle to steep slopes. The canopy is dominated by *Quercus macrocarpa* with cover <65%. This type lacks codominant trees and shrubs. Herbaceous stratum is vigorous and dominated by a variety of graminoids including *Bromus inermis*, *Poa pratensis*, *Hesperostipa comata*, *Pascopyrum smithii*, *Schizachyrium scoparium*, *Andropogon gerardii*, and *Panicum virgatum*.

Dynamics: This community depends on fire to maintain a prairie understory and open canopy structure (Nelson 1985). Fires prevented the woody vegetation from forming a closed canopy and restricted it to lower slope mesic ravines.

Conservation Status Rank

Global: G2G3

State (Nebraska): S2S3

Global Environmental Description

This community occurs near floodplains and on gently sloping to steep upland mesic sites especially within 30 km of the Missouri River but possibly along other rivers. In Nebraska it may have been most abundant in the southeast because conditions are most suitable for tree growth there. The soils on which this community occurs are silt or loam, shallow to deep, with a pH range from 5.6-7.3. The soils of this community are moderately well-drained to well-drained. The parent material is loess or glacial till (Nelson 1985; Lauver et al. 1999; Steinauer and Rolfsmeier 2000).

Global Vegetation Description

The overstory of this community is open and dominated by *Quercus macrocarpa*. *Quercus muehlenbergii* can be a common associate. Shrubs are absent to common and include *Cornus drummondii*, *Ceanothus herbaceus* (= *Ceanothus ovatus*), *Corylus americana*, *Prunus americana*, *Rhus glabra*, *Ribes missouriense*, *Symphoricarpos occidentalis*, and *Zanthoxylum americanum*. The herbaceous stratum can be similar to dry prairie. It includes the grasses *Andropogon gerardii*, *Schizachyrium scoparium*, *Sorghastrum nutans*, *Sporobolus heterolepis*, and *Hesperostipa spartea* (= *Stipa spartea*), as well as *Maianthemum stellatum*, *Monarda fistulosa*, and *Solidago canadensis*. In the past, periodic fires kept the canopy from closing. Where fire regimes have been disrupted, this community often begins to succeed to other, more closed oak types (Nelson 1985; Lauver et al. 1999; Steinauer and Rolfsmeier 2000). See Steinauer and Rolfsmeier (2000) for variability within this community.

Nebraska Natural Heritage Program Description

Dry – Mesic Bur Oak Forest and Woodland: These sites are primarily dominated by *Quercus macrocarpa*, though in some sites *Fraxinus pennsylvanica* may also be conspicuous on upper slopes, while *Celtis occidentalis*, *Juglans nigra* or *Tilia americana* may be common on lower slopes. *Ulmus rubra* and *Celtis occidentalis* are the most common subcanopy trees, with lesser amounts of *Fraxinus pennsylvanica* and *Ulmus americana*. In the extreme southeast, *Carya cordiformis*, *Cercis canadensis*, or *Morus rubra* may be locally common in the subcanopy. Degraded sites may be invaded by *Juniperus virginiana*, the introduced *Ulmus pumila*, or *Morus alba*. *Juniperus virginiana*

is especially prominent in the lower Niobrara and upper Missouri drainages, where it may outcompete nearly all other understory species. The shrub layer varies from somewhat dense to sparse or nearly absent. The tall shrub layer is sparse to moderate and usually contains *Cornus drummondii* in the south or *Prunus virginiana* in the north. *Zanthoxylum americanum* is locally common throughout. Short shrubs are often more prominent, especially *Ribes missouriense* and *Symphoricarpos orbiculatus*, with scattered *Symphoricarpos occidentalis* in some sites northward. The herbaceous layer is usually fairly sparse on upper slopes and quite dense below. Among the common species are several shade tolerant graminoids such as *Carex blanda*, *Carex grisea*, *Festuca subverticillata*, and *Elymus villosa*. *Parthenocissus quinquefolia* commonly dominates the forest floor of most sites, with *Sanicula odorata* or *Osmorhiza longistylis* often equally abundant on lower slopes. *Carex sprengellii* may overwhelmingly dominate the forest floor in the far north. Other frequent herbs include *Ageratina altissima*, *Galium aparine*, *Viola pubescens*, *Desmodium* spp., *Arisaema triphyllum*, and *Cryptotaenia canadensis*. *Erythronium albidum* and *Dicentra cucullaria* often blanket the forest floor of some higher quality sites in early spring. Species diversity is moderate to relatively high.

Example Photograph

The photograph below shows an example of CEGL002053 *Quercus macrocarpa* / *Andropogon gerardii – Hesperostipa spartea* Woodland.

Quercus macrocarpa / *Andropogon gerardii – Hesperostipa spartea* Woodland (CNHP)

Short Citation

- Lauver et al. 1999
- Nelson 1985
- Steinauer and Rolfsmeier 2000

Mappd 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: 390004, 390113, 390114, 390117, 392012, 590067, 590126

Map Class: MNRR MC201

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1243.57 ft (range 1100 ft to 1410 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Flat, Floodplain, Marsh

Geology: Alluvium, Pierre Shale

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

Environment: 7 sites were sampled within this type. Soil texture was variable and included sand, sandy loam, sandy clay loam, silty clay loam, and muck. Litter is usually the most abundant ground cover at ~75%. At one site there was 35% downed wood. These all occurred on flat floodplains.

Local Vegetation Description

Structure: Tall Shrub (0%-40%), Short Shrub (0%-50%), Herbaceous (70%-90%)

Vegetation Floristics: *Salix interior* is the dominant shrub with cover between 40% and 50%. The herbaceous layer is vigorous between 80% and 90% cover. Common plants include *Equisetum hyemale*, *Solidago canadensis*, *Solidago missouriensis*, *Glycyrrhiza lepidota*, and *Ambrosia psilostachya*.

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: GNR

State (Nebraska): N/A

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

N/A

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

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: 390130, 391015

Map Class: MNRR MC201

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1346 ft (range 1237 ft to 1455 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Floodplain

Geology: Alluvium, Niobrara Formation

Soil Texture: Sand

Environment: 2 sites were sampled within this type. These were seasonally flooded with sand as the soil texture. Sand also dominated the ground cover ranging between 70% and 90% cover.

Local Vegetation Description

Structure: Short Shrub (20%-50%), Herbaceous (0%-30%)

Vegetation Floristics: *Salix interior* is the main plant in these types with cover between 20% and 50%. Sites may have an herbaceous layer with up to 30% cover. Common species include *Xanthium*

strumarium, Polygonum lapathifolium, and *Eupatorium* spp. Occasionally, small seedlings of *Populus deltoides* or *Platanus occidentalis* may be present.

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: G5

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 willow shrubland community is found scattered along rivers and streams at lower elevations in parts of the Great Plains and midwestern United States, the Mississippi River Alluvial Plain, and the Appalachians. This type represents an early-successional stage of temporarily flooded riparian vegetation that occurs most commonly on alluvial sands. The substrate may also contain silts, clays, and/or gravels. The canopy is dominated by *Salix interior,* which can form dense stands up to 4 m tall. There are often areas where the shrub layer is absent. Seedlings and small saplings of *Populus deltoides* or *Platanus occidentalis* may be present. The herbaceous cover is sparse to moderate, but rarely exceeds 30%. Species present include *Polygonum lapathifolium*, *Eupatorium* spp., *Schoenoplectus americanus* (= *Scirpus americanus*), and *Xanthium strumarium*. The composition of this community, especially the herbaceous layer, varies from year to year with succession or renewed disturbance.

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 may develop and a mixture of herbaceous woodland plants and hydrophytes may occur. On the driest sites, plants typical of disturbed floodplain terraces, such *Artemisia psilostachya* 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

CEGL005220 Cornus drummondii – Amorpha fruticosa – Cornus sericea Wet Shrubland

The table below shows the USNVC Hierarchy for CEGL005220 *Cornus drummondii – Amorpha fruticosa – Cornus sericea* Wet Shrubland.

USNVC hierarchy for CEGL005220 *Cornus drummondii – Amorpha fruticosa – Cornus sericea* 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	A3588 *Cornus drummondii - Amorpha fruticosa* Wet Shrubland Alliance
Association	2.C.4.Nd *Cornus drummondii - Amorpha fruticosa - Cornus sericea* Wet Shrubland (CEGL005220)

Field Plots: 590061, 590073, 590140

Map Class: MNRR MC202

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1124 ft (range 915 ft to 1331 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Alluvial Flat

Geology: Alluvium, Carlile Shale

Soil Texture: Sandy Loam, Clay Loam

Environment: 3 sites were sampled within this type. The majority soil texture is sandy loam, but one site contained silty clay loam. Litter is typically the most abundant ground cover ranging from 39% to 60%. Bare soil usually ranges from 10% to 25%, but one site had bare soil as high at 60%. All of these sites occurred along a flat floodplain.

Local Vegetation Description

Structure: Tall Shrub (0%-80%), Short Shrub (0%-40%), Herbaceous (70%-80%), Vine (0%-10%)

Vegetation Floristics: *Cornus drummondii* and *Amorpha fruticosa* are the dominant shrubs. Typical cover for these are ~40%, and often it is only one or another of these shrubs; only one plot contained both. Furthermore, one plot contained 80% cover of *Cornus drummondii*. The herbaceous stratum is often lush with total cover of at least 70% among all three plots. Forbs tend to dominate over grasses. The forbs seem to be quite diverse though they all seem to have been disturbed because the most abundant plants are *Ambrosia psilostachya, Cannabis sativa*, and *Euphorbia esula*.

Dynamics: N/A

Conservation Status Rank

Global: G4?

State (Nebraska): S4?

Global Environmental Description

This community type is currently known from eastern Nebraska where it is found along high banks, raised islands, and terraces above the stream channel, which experience periodic flooding in late winter or spring. Soils are moderately well-drained and formed in alluvium (Steinauer and Rolfsmeier 2000).

Global Vegetation Description

This dogwood shrubland community is found along rivers and streams in the central Great Plains of the United States. It is found along high banks, raised islands, and terraces above the stream channel, which experience periodic flooding in late winter or spring. Soils are moderately well-drained and formed in alluvium. Vegetation consists of patches of moderate to locally dense of cold-deciduous shrubs 2-3 m tall. *Amorpha fruticosa* and *Cornus drummondii* dominate the stands, with scattered patches of *Cornus sericea, Salix exigua* and *Populus deltoides* saplings. Herbaceous understory varies in response to flooding. Sedges, such as *Carex cristatella, Carex emoryi*, and *Carex pellita*, are found with mesophytic grasses, such as *Panicum virgatum* and *Andropogon gerardii*. In more xeric habitats, weedy annual forbs, such as *Ambrosia artemisiifolia*, may be abundant, whereas wetter sites are dominated by forbs typical of marshes, e.g. *Impatiens capensis, Mentha arvensis*.

Nebraska Natural Heritage Program Description

Riparian Dogwood – False Indigobush Shrubland: This community consists of patches with moderate to locally dense cover of broadleaf shrubs 2–3 m tall dominated by *Amorpha fruticosa* and *Cornus drummondii* or *Cornus sericea*. Occasional patches of *Salix interior* and *Populus deltoides* saplings may also be present. Herbaceous understory varies in response to depth to water and flooding, and may include sedges such as *Carex cristatella, C. emoryi*, and *C. pellita*, and mesophytic grasses such as *Panicum virgatum* and *Spartina pectinata*. In more xeric sites, weedy annual herbs such as *Ambrosia psilostachya* may be abundant, whereas wetter sites are dominated by

forbs typical of marshes, such as *Impatiens capensis* and *Mentha canadensis*. A short shrub layer of *Toxicodendron rydbergii* is present at some sites. Species diversity is low to moderate.

Example Photograph

The photograph below shows an example of CEGL005220 *Cornus drummondii – Amorpha fruticosa – Cornus sericea* Wet Shrubland.

Cornus drummondii – Amorpha fruticosa – Cornus sericea Wet Shrubland (CNHP)

Short Citation

- Steinauer and Rolfsmeier 2000

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: MNRR MC203

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1425.33 ft (range 1418 ft to 1438 ft)

Aspect: Mean 103.33˚ (range 70˚ to 135˚)

Slope: Mean 7.67˚ (range 6˚ to 9˚)

Macro Topography: Hillslope

Geology: Pierre Shale

Soil Texture: Sandy Loam

Environment: This upland community typically occurs away from floodplains. 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%)

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.

Cornus drummondii – (*Rhus glabra*, *Prunus* spp.) Shrubland (CNHP)

Short Citation

- Hoagland 1998a
- Rosburg and Glenn-Lewin 1996
- Steinauer and Rolfsmeier 2000

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: MNRR MC203

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1482.67 ft (range 1456 ft to 1505 ft)

Aspect: Mean 86˚ (range 0˚ to 218˚)

Slope: Mean 9.33˚ (range 0˚ to 15˚)

Macro Topography: Hillslope, Upland

Geology: Pierre Shale, Niobrara Formation

Soil Texture: Sandy Loam

Environment: These communities generally occur on rolling hills. The ground cover is typically dominated by litter with values ranging from 79% to 85%. Wood is generally present with cover values <5%. Basal area tends to form 15% to 20% of the ground cover.

Local Vegetation Description

Structure: Canopy (0%-10%), Short Shrub (10%-30%), Herbaceous (70%)

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

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. 1995
- Hansen et al. 1988b
- Manning and Padgett 1995

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 Plot: 590131

Map Class: MNRR MC204

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: 1323 ft

Aspect: 215˚

Slope: 12˚

Macro Topography: Hills

Geology: Niobrara Formation

Soil Texture: Clay Loam

Environment: 1 site was sampled within this type. Soil texture with clay loam. Ground cover has litter of 50%, bare soil 20%, and basal area 30%. This occurred on a slight southwest slope (12˚).

Local Vegetation Description

Structure: Short Shrub (60%), Herbaceous (70%)

Vegetation Floristics: *Symphoricarpos occidentalis* is the dominant species in the short shrub stratum with a cover value >50%. There is a lush graminoid layer (70% cover) with *Sorghastrum nutans, Schizachyrium scoparium,* and *Panicum virgatum*. There are fewer forbs (10% cover) with *Lygodesmia juncea* and *Rosa woodsii*. In disturbed sites, weedy species can invade such as *Bromus tectorum, Nepeta cataria,* and *Poa pratensis.*

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

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

NPSMNRR007 Rhus glabra Mixedgrass Shrubland
USNVC: Park Special NPSMNRR007

Field Plots: Field Reconnaisance Observations

Map Class: MNRR MC205

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1383.75 ft (range 1350 ft to 1410 ft)

Aspect: Mean 202.5˚ (range 180˚ to 250˚)

Slope: Mean 10.25˚ (range 7˚ to 12˚)

Macro Topography: Hillslope, Upland

Geology: Niobrara Formation, Pierre Shale, Carlile Shale

Soil Texture: Sandy Loam

Environment: These sites occur on upland hills. Ground cover is dominated by litter with values ranging from 75% and 85%. Bare soil may be present with cover up to 5%. Wood may be present with cover <5%. Basal area covers up to 15% of the ground cover.

Local Vegetation Description

Structure: Short Shrub (50%-60%), Dwarf Shrub (0%-60%), Herbaceous (40%-80%)

Vegetation Floristics: *Rhus glabra* typically forms a moderate to dense cover in the shrub layer (30% to 80%). Graminoids typically have greater abundance than forbs, and *Poa pratensis* and *Bromus inermis* are the main grasses among these sites; cover usually ranges from 60% to 80%. This community often occurred in areas with *Juniperus virginiana* clearing and potentially prescribed fire.

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

Example Photograph

The photograph below shows an example of NPSMNRR007 *Rhus glabra* Mixedgrass Shrubland.

Rhus glabra Mixedgrass Shrubland (CNHP)

Short Citation

N/A

NPSMNRR010 Populus deltoides Successional Shrubland
USNVC: Park Special NPSMNRR010

Field Plots: Field Reconnaisance Observations

Map Class: MNRR MC201

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1183 ft (range 1077 ft to 1277 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Sandbar, Floodplain Lower Terrace

Geology: Alluvium, Carlile Shale

Soil Texture: Sand, Loamy Sand

Environment: These communities generally occur on recently flooded areas such as scoured sandbars or floodplains. Ground cover may either be dominated by litter or bare soil depending on time of year and recent flooding. Basal area typically may reach up to 15% of the ground cover.

Local Vegetation Description

Structure: Tall Shrub (10%-50%), Short Shrub (0%-40%), Herbaceous (30%-70%)

Vegetation Floristics: This successional shrubland is dominated by young *Populus deltoides* usually <5m tall. Short or dwarf shrubs of *Fraxinus pennsylvanica* may be present as well. If there is an herbaceous layer, there tends to be dominated by weedy species such as *Conyza canadensis*, *Solidago* spp., *Ambrosia psilostachya*, *Poa pratensis*, *Bromus tectorum*, etc.

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

Example Photograph
The photograph below shows an example of NPSMNRR010 *Populus deltoides* Successional Shrubland.

Populus deltoides Successional Shrubland (CNHP)

Short Citation

N/A

Mapped Sparse 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: 391013

Map Class: MNRR MC401

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: 1472 ft

Aspect: Flat

Slope: Flat

Macro Topography: Floodplain

Geology: Alluvium

Soil Texture: Sand

Environment: 1 site was sampled within this type. Soil texture is Sand. Ground cover have a litter value of 25%, water 50%, and 20% basal area. This occurred along a flat floodplain.

Local Vegetation Description

Structure: Herbaceous (90%)

Vegetation Floristics: This sparse vegetation typically includes some herbaceous cover (~10%) with species such as *Cyperus erythrorhizos*, *Cyperus odoratus*, and *Leersia oryzoides*, but this type may also have a vigorous herbaceous layer. On large stable point bars such as those near the confluence of the Niobrara and Missouri Rivers, herbaceous cover sometimes reaches 90% with the main species of *Cyperus erythrorhizos*, *Cyperus odoratus*, and *Leersia oryzoides*.

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.

Riverine Sand Flats – Bars Sparse Vegetation (CEMML)

Short Citation

- Nelson 1985
- Steinauer and Rolfsmeier 2000

CEGL005223 Great Plains Riverine Gravel Flats Sparse Vegetation

The table below shows the USNVC Hierarchy for CEGL005223 Great Plains Riverine Gravel Flats Sparse Vegetation.

USNVC hierarchy for CEGL005223 Great Plains Riverine Gravel Flats 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 Great Plains Marsh, Wet Meadow, Shrubland & Playa
Group	2.C.4.Nd Great Plains Riverscour Vegetation
Alliance	A3591 *Sporobolus cryptandrus - Artemisia campestris* Wet Meadow Alliance
Association	2.C.4.Nd Great Plains Riverine Gravel Flats Sparse Vegetation (CEGL005223)

Field Plots: Field Reconnaisance Observations

Map Class: MNRR MC401

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1223.5 ft (range 1216 ft to 1231 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Sandbar

Geology: Alluvium

Soil Texture: Sand

Environment: This spase community is dominated by small gravel with cover reaching ~60%. Drift wood is often scattered about with cover up to 10%.

Local Vegetation Description

Structure: Herbaceous (0%-10%)

Vegetation Floristics: Areas of gravel deposited on sand bars downstream of the James River confluence. Species tend to be sparse but may be comprised of *Cyperus erythrorhizos*, *Cyperus odoratus*, and *Leersia oryzoides*. Other common forbs that may occur include *Ambrosia artemisiifolia*, *Chamaesyce serpyllifolia*, *Froelichia gracilis*, and *Opuntia macrorhiza*.

Dynamics: Reduced river flows and decreased frequency of flooding may cause many of these sites to succeed to woodland (Steinauer and Rolfsmeier 2000).

Conservation Status Rank

Global: GNR

State (Nebraska): S2?

Global Environmental Description

This community is found along major rivers where gravel has been deposited on the first terraces of rivers. The substrate consists of a mixture of gravel and some sand, and soils are poorly developed or absent. Sites can occasionally be flooded in spring (Steinauer and Rolfsmeier 2000).

Global Vegetation Description

Vegetation is sparse and often consists of nearly equal cover of annual grasses and annual or biennial forbs under 1 m tall. *Sporobolus cryptandrus* and *Artemisia campestris* ssp. *caudata* are conspicuous. In some sites, *Populus deltoides* may be scattered to woodland-like in structure. Shrubs are also scattered and uncommon, with *Amorpha fruticosa* the most frequent. Other herbaceous species that can occur include *Ambrosia artemisiifolia*, *Chamaesyce glyptosperma*, *Chamaesyce serpyllifolia*, *Froelichia gracilis*, *Helianthus petiolaris*, *Opuntia macrorhiza*, *Pectis angustifolia*, and *Triplasis purpurea* (Steinauer and Rolfsmeier 2000).

Nebraska Natural Heritage Program Description

Riverine Gravel Flats: The vegetation of this community is relatively sparse and often consists of nearly equal cover of tufted annual and perennial grasses and annual or biennial herbs under 1 m tall. *Sporobolus cryptandrus* is usually the most common grass, though *Bouteloua gracilis* is sometimes frequent. In canyon bottoms, patches of taller grasses typical of adjacent slopes, such as *Calamovilfa longifolia* and *Andropogon hallii*, may be conspicuous. Annual and perennial herbs are common and conspicuous, the most frequent being *Mentzelia nuda*, *Chrysopsis* spp., *Ambrosia artemisiifolia*, *Pectis angustifolia*, and *Artemisia ludoviciana*. Common invasive exotics include *Kali collina* and *Bromus* spp.. In some sites along the Platte River, *Populus deltoides* may be scattered, and in some places may be sufficiently dense to classify the community as open woodland. Shrubs are scattered and uncommon, with *Amorpha fruticosa* the most frequently encountered in riverine sites. Species diversity is low to moderate.

Example Photograph

The photograph below shows an example of CEGL005223 Great Plains Riverine Gravel Flats Sparse Vegetation.

Great Plains Riverine Gravel Flats Sparse Vegetation (CNHP)

Short Citation

- Steinauer and Rolfsmeier 2000

NPSMNRR008 Bare Alluvial Depositional Bar
USNVC: Park Special NPSMNRR008

Field Plots: Field Reconnaisance Observations

Map Class: MNRR MC401

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1171.6 ft (range 1084 ft to 1264 ft)

Aspect: Flat

Slope: Flat

Macro Topography: Sandbar, Floodplain Lower Terrace

Geology: Alluvium, Carlile Shale, Graneros Shale

Soil Texture: Sand, Loamy 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

Example Photograph

The photograph below shows an example of NPSMNRR008 Bare Alluvial Depositional Bar.

Bare Alluvial Depositional Bar (CNHP)

Short Citation

N/A

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: 390096, 591008

Map Class: MNRR MC402

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1300 ft (range 1179 ft to 1421 ft)

Aspect: Mean 274˚ (range 220˚ to 328˚)

Slope: Mean 42.5˚ (range 40˚ to 45˚)

Macro Topography: Bluff, Cliff

Geology: Carlile Shale, Pierre Shale

Soil Texture: Sand

Environment: 2 sites were sampled within this type. The substrate was gravel from siltstone rock outcrops. These sites occurred on steep cliffs near the river with slopes generally <45˚.

Local Vegetation Description

Structure: Herbaceous (0%-5%)

Vegetation Floristics: Vegetation is sparse to absent. *Salsola collina*, *Solanum rostratum*, *Euphorbia marginata*, and *Astragalus racemosus* were present at one site, but only a few individuals.

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

This siltstone - sandstone rock outcrop sparsely vegetated community is found in the central Great Plains. Stands occur on nearly level to moderately steep slopes 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. 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*.

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.

Siltstone-Sandstone Rock Outcrop Sparse Vegetation (CNHP)

Short Citation

- Steinauer and Rolfsmeier 2000

CEGL002294 Shale Barren Slopes Sparse Vegetation

The table below shows the USNVC Hierarchy for CEGL002294 Shale Barren Slopes Sparse Vegetation.

USNVC hierarchy for CEGL002294 Shale Barren 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: MNRR MC402

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1295 ft (range 1250 ft to 1335 ft)

Aspect: Mean 223.5˚ (range 200˚ to 247˚)

Slope: Mean 53˚ (range 23˚ to 75˚)

Macro Topography: Cliff, Hillslope

Geology: Pierre Shale, Carlile Shale

Soil Texture: N/A

Environment: This slope sparse community often forms tall cliffs along the main Missouri River. Ground cover is dominated by loose small rocks (shale) ~50% or bare soil ~50%.

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.

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 Barren Slopes Sparse Vegetation.

Shale Barren Slopes Sparse Vegetation (CNHP)

Short Citation

- Marriott and Faber-Langendoen 2000

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: MNRR MC402

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1218 ft (range 1190 ft to 1253 ft)

Aspect: Mean 124˚ (range 12˚ to 344˚)

Slope: Mean 62˚ (range 40˚ to 90˚)

Macro Topography: Cliff

Geology: Niobrara Formation

Soil Texture: N/A

Environment: These communities form steep bluffs along the Missouri 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%)

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*, *Achnatherum 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.

Limestone – Dolostone Great Plains Xeric Cliff Sparse Vegetation (CNHP)

Short Citation

- D. Ode pers. comm. 2000

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: 390097, 391017, 391019, 591009

Map Class: MNRR MC402

Local Environmental Description

Plot/Sample Data Environmental Summary

Elevation: Mean 1347.25 ft Range 1225 ft to 1567 ft

Aspect: Mean 159.5˚ Range 0˚ to 217˚

Slope: Mean 77˚ Range 68˚ to 85˚

Macro Topography: Backslope, Channel Wall, Midslope

Geology: Carlile Shale, Till

Soil Texture: Sand

Environment: This community occurs on mainly south facing cliffs with slopes ranging from 68˚ to 85˚. The cliffs are composed of sandstone or siltstone.

Local Vegetation Description

Structure: Herbaceous (0%-20%)

Vegetation Floristics: This cliff community is defined by sandstone or siltstone cliffs with slopes >60%. Vegetation is sparse with occasional *Mentzelia decapetala* and *Penstemon glaber*.

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

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* (Steinauer and Rolfsmeier 2000).

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.

Sandstone Great Plains Dry Cliff Sparse Vegetation (CNHP)

Short Citation

- Steinauer and Rolfsmeier 2000

Appendix B. Field Key to Community Associations/Types

Introduction

The vegetation classification and key of Missouri National Recreation Area (MNRR) has been developed as part of the Vegetation Classification and Mapping project for MNRR. The field key is one of the products developed during the classification phase of the project. It was developed using the compiled field data, which was analyzed to identify the vegetation types that occur within MNRR. The vegetation types identified during analysis have been 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 and associations within MNRR. 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 thematic accuracy assessment of the map. This key can also be used for other projects within MNRR to type vegetation communities. The key is based on classification of new data collected by the Colorado Natural Heritage Program (CNHP) vegetation mapping field crew in 2015 and additional surveys conducted by the Center for the Environmental Management of Military Lands (CEMML) in 2016.

The key may not denote all vegetation types that occur within MNRR, nor explain the full range of variation of vegetation types as they appear on the ground. The descriptions in the key are neither comprehensive of all species that may occur in any given type, nor do they define a list of species that must be present. Species interact in a continuum based on a complex set of habitat preferences, and they can intermix in wide or narrow zones within the landscape. While the association concepts in this key attempt to reflect this complexity, unusual or site-specific assemblages of plants may exist in the landscape and may not be easily keyed.

The following paragraphs define the conventions for how certain terminology and concepts are used in the key. Be sure to consider these usage conventions as you work through the key. 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 height. If it is <5 m in height but single stemmed, *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 in 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 hard cutoffs. Forests may have cover ~55% if you happen to catch a gap in the canopy, and woodlands may have cover values of ~15% if the trees are exceptionally sparse. When deciding on whether an area is a forest or woodland, consider the surrounding area and whether or not the cover of the plot is representative of 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. Key indicators of disturbance include dense monocultures, old stumps, lots of woodchips, or species planted in rows. 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 *Elaeagnus 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 symbol 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 MNRR without an appropriate USNVC type are labeled as “park specials” and are recognized under a 10-digit code beginning with “NPSMNRR” followed by a sequential number (NPSMNRR001).

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 are co-dominant 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 are broken down into 5 strata: Emergent, Canopy, Subcanopy, Shrub, and Herbaceous (Figure B1).

Emergent: Emergent stratum is characterized by tall trees that are distinctly above a canopy. Cover is typically low and should not be greater than 30%. 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. Emergent height is usually >30 m.

Canopy: A canopy is the main layer of trees formed by mature crowns. The majority of trees fall into this stratum. Canopy height typically ranges from 10 m to 25 m.

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 include *Ostrya virginiana* and *Cornus drummondii*. Subcanopy height generally ranges from 5 m to 10 m.

Shrub: The shrub layer is often underneath the canopy/subcanopy, but it may occur without either. The shrub canopy is composed of shrubs between 0.5 m and 5 m 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 MNRR, graminoids and forbs are the most common plants in the herbaceous layer.

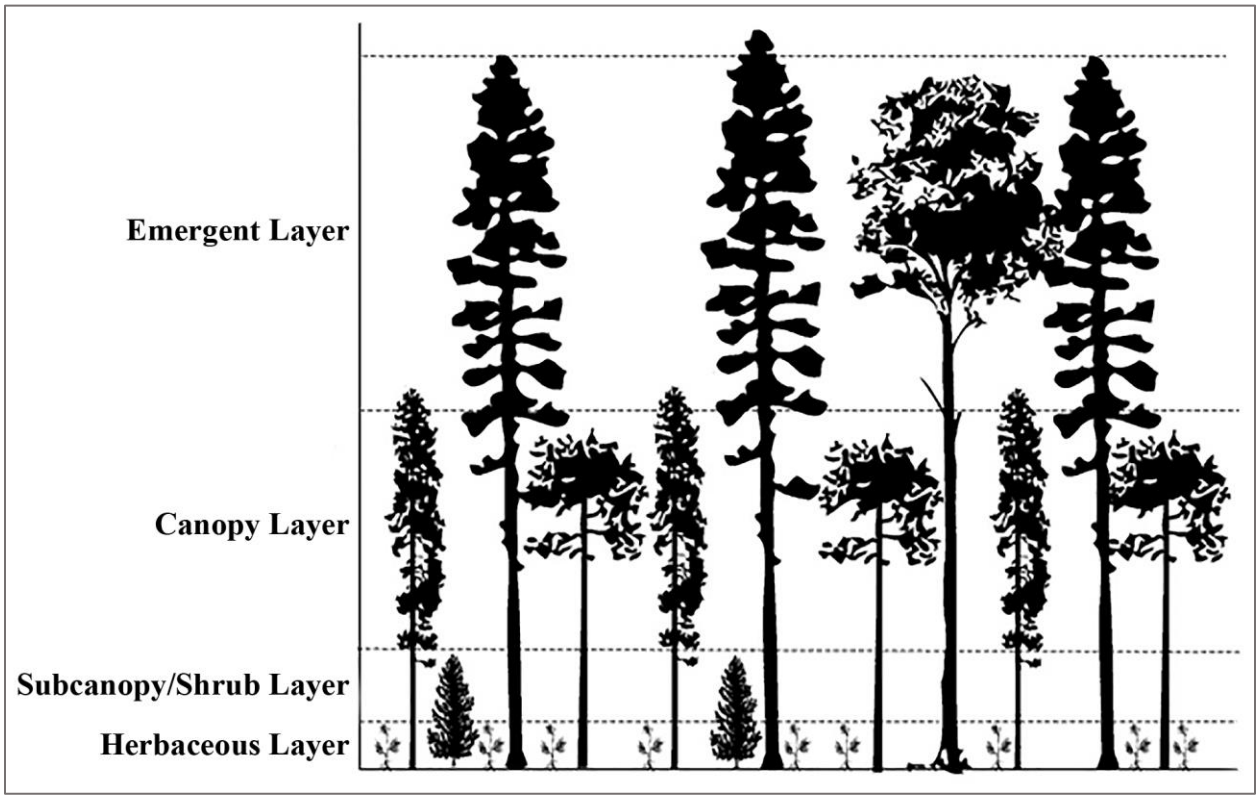


Figure B-1. Vegetation structure terminology used to describe and define associations..

Another thing to consider when using this key is the patchiness and heterogeneity of the plot. Ideally, the area in which you use this key should be relatively uniform throughout the community. However, this may not always occur and some types are intrinsically more heterogeneous than others. When deciding on a site, avoid edges of community types where adjacent communities blend together. Furthermore, the minimum mapping unit is 0.5 ha, so if a patch is less than 0.5 ha, it was included in another map class and the key should not be used for that area.

The mapped area encompasses MNRR's administrative boundary. 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 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 USGS (2011) and Anderson et al. (2001)

The following land use classes are large areas that do not fall into typical vegetation types. These tend to be heavily developed areas such agricultural crops and pastures, and urban/commercial development such as roads, parking lots, houses, parks, etc. Additionally, open water is one of the land use classes; even though bodies of water are not developed, they are large un-vegetated areas.

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 (grasses, legumes) (*Phleum pratense*, *Bromus inermis*, *Medicago sativa*).....….(3a)

2b Vegetation is developed turf grass for parks, golf courses, campgrounds, or other…..(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**

3b 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**

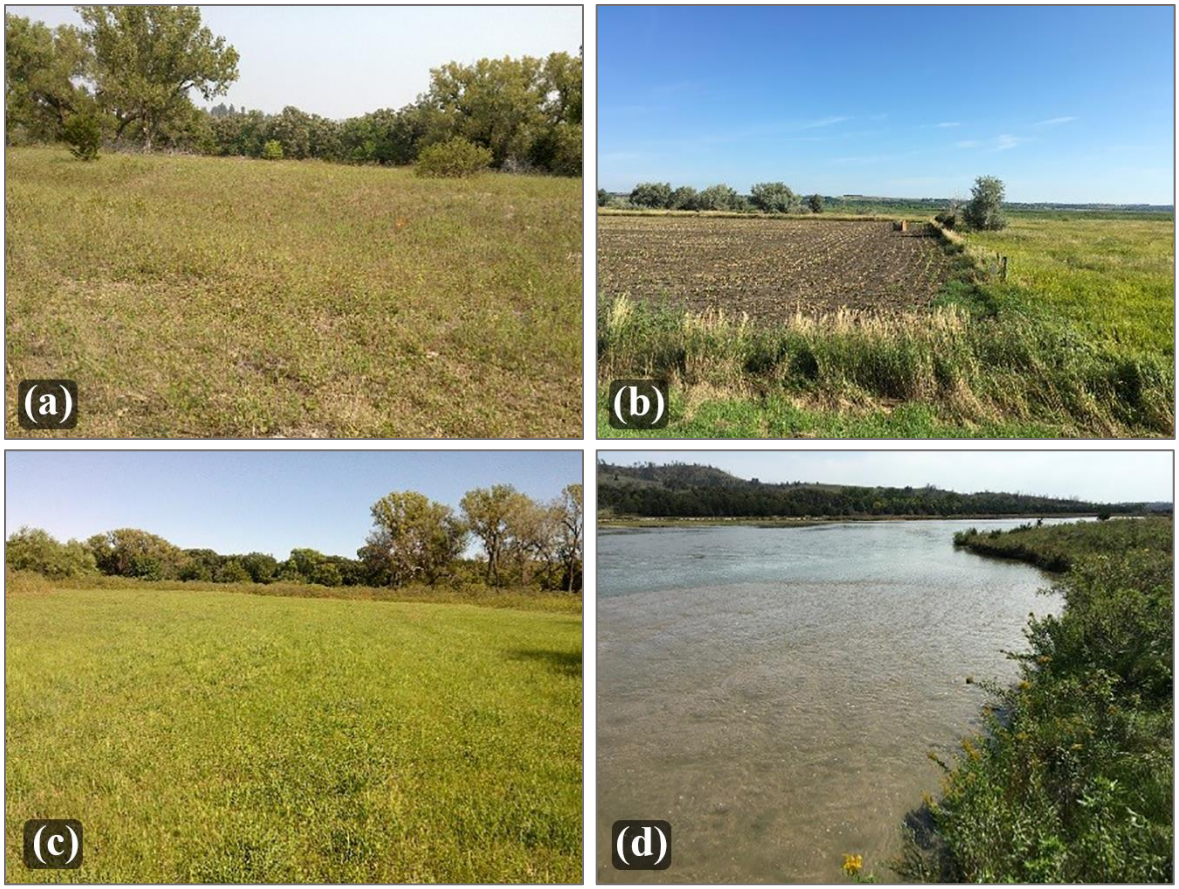
4b All other developed areas. Developed turf, trees, or flowers may be present, but these areas typically include 20% to 100% impervious surfaces. These areas most commonly include urban/commercial development, roads, parking lots, etc. Areas such as the mowed margins of roadways are classified as developed, despite the presence of natural or semi-natural vegetation…..... .**LC005 Developed, Low, Medium, and High Intensity**

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 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 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 to start from an alternative Division.

Physiognomic Classes

I. Deciduous and/or coniferous tree species, or a combination of the two, form an open to dense 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**

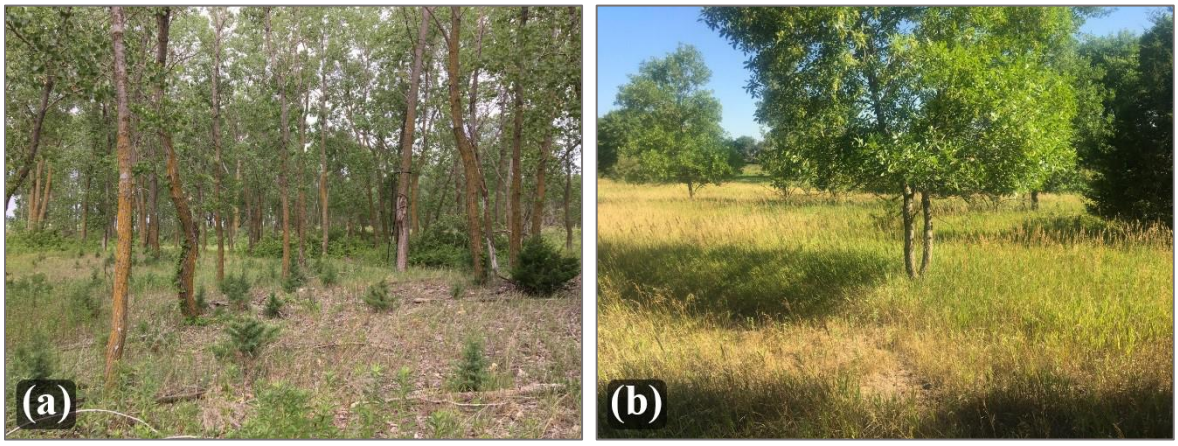
III. Total vegetation cover on the site is <10% and the surface of the substrate is easily visible. Typically, located in dynamic settings where disturbance occurs regularly (e.g. sandbars) or where substrates are not favorable for plant growth (e.g. solid rock) .....**Division D – Sparse associations**

Examples of a (a) deciduous and/or coniferous tree association, (b) shrub association, (c) herbaceious association, and (d) sparse association (CNHP)

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 species, such as *Juniperus virginiana* and *Cornus drummondii*, 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. Other species, such as *Rhamnus cathartica* and *Prunus virginiana*, are always considered shrubs despite their height.

1a *Populus deltoides* is the dominant canopy tree on the site and has >10% cover. The canopy forms an open to closed woodland to forest and may occur as scattered individuals that stand above the crowns of any other trees on the site. *Salix amygdaloides* may also be present in the overstory with less cover than *Populus deltoides*. .....(2a)

1b Tree species other than *Populus deltoides* are dominant on the site. *Populus deltoides* may be present in the overstory with cover of less than 15% .....(9a)

2a There is no obvious subcanopy of trees and/or shrubs, the understory vegetation is primarily herbaceous or bare ground.....(3a)

2b Not as above. Usually there are other trees or shrubs present with enough cover to form a stratum. .....(4a)

3a *Populus deltoides* form a sparse to open canopy typically with cover <60% with an herbaceous stratum dominated (cover >50%) by graminoids usually *Panicum virgatum* or *Schizachyrium scoparium*. However, other graminoids that may be present include *Elymus canadensis*, *Bromus inermis*, *Bromus tectorum*, *Carex nebrascensis*, *Carex pellita*, *Bouteloua curtipendula*, and *Pascopyrum smithii*. Cover of shrubs is non-existent or extremely sparse and if present amounts to less than 15% total cover.....
CEGL001454 *Populus deltoides/Panicum virgatum-Schizachyrium scoparium* Floodplain Woodland [MNRR MC305]

3b Non-native invasive species may be present to prevalent with often large patches of *Euphorbia esula*. Mature *Populus deltoides* forms an open canopy on dynamic sites within or adjacent to the river channel where periodic flooding causes repeated disturbance. Sites may include a high percentage of bare ground and large woody debris (>2cm diameter) where a site has had *Juniperus virginiana* recently masticated. .....
...**NPSMNRR009 *Populus deltoides* Ruderal Forest and Woodland [MNRR MC301]**

4a *Populus deltoides* is present in the canopy with cover >10%. Other mesic trees such as *Fraxinus pennsylvanica*, *Celtis occidentalis*, *Ulmus* spp., *Acer negundo*, etc. occur in the canopy or sub-canopy .....(5a)

4b *Populus deltoides* forms the canopy, and there is usually a subcanopy composed of any combination of *Salix* spp., *Cornus drummondii*, *Symphoricarpos occidentalis*, or *Juniperus virginiana*.....(6a)

5a *Populus deltoides* forms canopy with cover between 20% and 50%. *Fraxinus pennsylvanica* may either co-dominate in the canopy or subcanopy, other subcanopy trees with less cover than *F. pennsylvanica* may include *Ulmus* spp., *Morus rubra*, *Acer negundo*, *Cornus drummondii*, *Juniperus virginiana*, and *Tilia americana*. The herbaceous layer is fairly sparse with generally 20% or less cover of *Ageratina altissima*, *Nepeta cataria*, and *Elymus virginicus* .....
…**CEGL000658 *Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest [MNRR MC302]**

5b *Populus deltoides* occupies the canopy with ~ 30% cover. Canopy co-dominants may include *Fraxinus pennsylvanica*, *Celtis occidentalis*, and *Ulmus* spp. *Rhamnus cathartica* typically dominates a tall shrub stratum with cover of about 65%, which is diagnostic for this type.

Other shrub species may be present as well. .....
NPSMNRR001 *Populus deltoides-Fraxinus pennsylvanica/Rhamnus cathartica* Ruderal Forest [MNRR MC301]

6a *Populus deltoides* dominates the canopy with cover ranging from about 15% to 60%. *Juniperus virginiana* co-dominates the canopy or tall shrub stratum with >35% cover. Individual *Ulmus americana* trees may also occasionally occur in this same stratum.....
…**CEGL002152 *Populus deltoides/Juniperus scopulorum* Floodplain Forest [MNRR MC304]**

6b The understory vegetation includes a subcanopy or tall shrub layer dominated by *Salix* spp., *Symphoricarpos occidentalis*, or *Cornus drummondii*. The cover of *Juniperus virginiana* is typically <35%.....(7a)

7a The understory vegetation includes a subcanopy or dwarf shrub layer containing *Cornus drummondii* or *Symphoricarpos occidentalis* without any *Salix* spp. present.....(8a)

7b Young *Populus deltoides* may be co-dominant to dominant in the overstory with *Salix amygdaloides*. Tall or short shrub layer is composed of *Salix interior* and/or *Salix eriocephala* with cover of at least 25%. The common plants in the herbaceous layer have cover values between 30% and 80% and include *Phalaris arundinacea* and *Melilotus officinale* .....
…**CEGL000659 *Populus deltoides*-(*Salix amygdaloides*)/*Salix* (*exigua, interior*) Floodplain Woodland [MNRR MC305]**

8a The communities we observed were dominated by a canopy of widely spaced cottonwood with occasional to rare subcanopy trees, including *Morus alba*, *Fraxinus pennsylvanica*, *Celtis occidentalis*, *Juniperus virginiana*. A dense layer of rough leaf dogwood (*Cornus drummondii*, 2–4 m tall) was a consistent feature of these sites along with the occasional *Amorpha fruticosa*, *Prunus virginiana/Prunus americana*, and shrub height *Juniperus virginiana*. Vines were usually present and included *Parthenocissus quinquefolia* and *Toxicodendron radicans*. Some areas vine growth overtopped most of the shrubs forming an impenetrable vine wall. The understory was composed of litter and bare ground with a sparse herbaceous layer. .....
..**NPSMNRR005 *Populus deltoides-Cornus drummondii* Open Floodplain Woodland [MNRR MC303]**

8b The canopy is dominated by *Populus deltoides*; common associates include *Acer negundo* and *Fraxinus pennsylvanica*. This type is defined by a distinct dwarf shrub layer of *Symphoricarpos occidentalis*. Other shrubs may include *Juniperus virginiana* and *Rosa* spp. The herbaceous layer tends to be dominated by *Pascopyrum smithii*, *Melilotus officinalis*, and *Taraxacum officinale*. .....
...**CEGL000660 *Populus deltoides/Symphoricarpos occidentalis* Floodplain Forest [MNRR MC302]**

9a The canopy is dominated by *Juniperus virginiana or Elaeagnus angustifolia.* Native species such as *Fraxinus pennsylvanica*, *Ulmus* spp., *Celtis occidentalis*, etc. have cover <20%. If *Populus deltoides* is present, it has less than 10% cover in the overstory.....(10a)

9b The canopy is dominated by *Salix amygdaloides*, *Quercus macrocarpa*, *Celtis occidentalis*, *Fraxinus pennsylvanica*, or other broadleaf hardwoods. If *Populus deltoides* is present it has less than 10% cover in the overstory…… .....(11a)

10a *Juniperus virginiana* is clearly dominant with cover values >80%. Other canopy species that may occur here include *Populus deltoides*, *Fraxinus pennsylvanica*, *Ulmus americana*, and *Quercus macrocarpa*, but these species typically do not occur with cover >10%. The herbaceous stratum can be quite variable and ranges from sparse to vigorous. ..... …**CEGL002593 *Juniperus virginiana* Midwest Ruderal Woodland and Forest [MNRR MC308]**

10b 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 [MNRR MC309]**

11a *Salix amygdaloides* is the only tree in the canopy with cover between 40% and 60%. The herbaceous layer is dense and mainly composed of *Phalaris arundinacea* .... **CEGL000947 *Salix amygdaloides* Riparian Woodland [MNRR MC305]**

11b Canopy is composed of hardwoods such as *Quercus macrocarpa*, *Fraxinus pennsylvanica*, or others.....(12a)

12a *Quercus macrocarpa* occurs in the canopy with a minimum of 25% cover .....(13a)

12b *Fraxinus pennsylvanica* or other hardwoods such as *Ulmus* spp., *Celtis occidentalis*, etc. dominate or co-dominate the canopy.....(18a)

13a *Quercus macrocarpa* and other common species, such as *Tilia americana*, *Juniperus virginiana*, *Fraxinus pennsylvanica*, and *Ostrya virginiana* form a forest canopy with greater than about 60% cover .....(14a)

13b Cover of *Quercus macrocarpa* and other canopy species is less than about 60% and forms a woodland with an herbaceous stratum dominated by graminoids. Graminoids are indicative of a tall grass dry prairie with species such as *Andropogon gerardii*, *Sorghastrum nutans*, and *Hesperostipa spartea*. However, many areas may have been invaded by *Bromus inermis* and other weedy species ....**CEGL002053 *Quercus macrocarpa*/*Andropogon gerardii-Hesperostipa spartea* Woodland [MNRR MC313]**

14a *Tilia americana* dominates or co-dominates the canopy with *Quercus macrocarpa*. Other trees within the canopy may include *Celtis occidentalis*, *Ostrya virginiana*, and *Juglans nigra*. The

herbaceous stratum is variable and ranges from absent to 90% cover. When present, forbs dominate the herbaceous stratum with *Viola canadense*, *Ageratina altissima*, and *Laportea canadensis*. This type was found in great abundance at Ponca State Park. It usually lines the bottom of narrow drainages along slopes ranging from 20˚ and 40˚ ..... …**CEGL002012 *Tilia americana*-(*Quercus macrocarpa*)/*Ostrya virginiana* Forest [MNRR MC311]**

14b Canopy is not as above, *Tilia americana* is minor component or is absent. .....(15a)

15a *Juniperus virginiana* comprises less than 35% of the cover in the canopy, subcanopy, or tall shrub strata.....(16a)

15b *Juniperus virginiana* dominates or co-dominates the canopy or subcanopy with *Quercus macrocarpa*. Cover of *Juniperus virginiana* is >35% .....(17a)

16a *Quercus macrocarpa* occurs in the canopy with *Ostrya virginiana* usually occurring as a co-dominant. The subcanopy may include other tree species such as *Celtis occidentalis*, *Fraxinus pennsylvanica*, *Ulmus* spp., etc. Herbaceous stratum is typically dominated by *Carex* spp. .....**CEGL000555 *Quercus macrocarpa*/*Ostrya virginiana* Forest [MNRR MC310]**

16b *Quercus macrocarpa* dominates or co-dominates the canopy with *Fraxinus pennsylvanica*, *Celtis occidentalis*, *Ostrya virginiana*, and *Gymnocladus dioecious*. The cover of the herbaceous stratum ranges between 20% and 90%, and is typically dominated by graminoids, usually *Carex molesta*. Sites usually occurred on slopes between 6˚ to 30˚ ..... ……**CEGL002072 *Quercus macrocarpa*/*Cornus drummondii*/*Aralia nudicaulis* Forest [MNRR MC310]**

17a *Quercus macrocarpa* dominates the canopy with *Juniperus virginiana* in the subcanopy or tall shrub stratum. *Juniperus virginiana* has between 35 and 80% cover ....**NPSMNRR006 *Quercus macrocarpa*/*Juniperus virginiana* Forest [MNRR MC312]**

17b *Juniperus virginiana* is abundant in the canopy with greater than about 80% cover. Other weedy species that typically occur with *Juniperus virginiana* include *Rhamnus cathartica* and *Ulmus pumilla*. The herbaceous stratum may be variable and ranges from 30% to 50% cover, with *Ageratina altissima*, *Carex* spp., and *Urtica dioica* as the most abundant species..... …**CEGL002593 *Juniperus virginiana* Midwest Ruderal Woodland and Forest [MNRR MC308]**

18a *Fraxinus pennsylvanica* and/or *Ulmus* spp. may dominate the canopy along with a variety of native species such as *Ulmus americana*, *Acer negundo*, *Celtis occidentalis*, *Tilia americana*, and/or *Juglans nigra*.....(19a)

18b *Fraxinus pennsylvanica* and/or *Ulmus* spp. may dominate the canopy, but weedy species such as *Juniperus virginiana*, *Ulmus pumilla*, and *Morus alba* tend to occur with high abundance in the canopy or shrub layer, respectively. Additionally, there is low species diversity.(20a)

19a Canopy is dominated by *Fraxinus pennsylvanica* and/or *Ulmus americana*, usually with *Acer negundo*. Canopy co-dominants may 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 [MNRR MC306]**

19b *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 subcanopy. *Juniperus virginiana* has <40% cover. Herbaceous stratum ranges from 50% to 70% and is dominated by graminoids 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 [MNRR MC306]**

20a This community occurs along terraces of river bottoms and floodplains with brief flooding. This community tends to have low species diversity. The canopy is dominated by *Fraxinus pennsylvanica* and *Ulmus americana*. Common associates include *Ulmus pumila*, *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 [MNRR MC306]**

20b This community often occurs on terraces and river bottoms. *Fraxinus americana* or *Ulmus* spp. form an open to closed canopy. *Celtis occidentalis*, *Juniperus virginiana*, and *Cornus drummondii* may occur in the subcanopy 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*, *Ulmus pumila*, or others are vigorous and usually have >40% cover. If there is an open canopy, a weedy understory including *Phalaris arundinacea*, *Bromus tectorum*, *Bromus inermis*, *Poa pratensis*, and/or *Euphorbia esula* may be prevalent. .....
..... **CEGL005239 *Fraxinus pennsylvanica-Ulmus americana*-(*Juglans nigra, Celtis occidentalis*) Ruderal Forest [MNRR MC307]**

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). Height is also used to separate out shrubs within the stratum into tall shrubs (2m-5m), short shrubs (0.5m-2m), and dwarf shrubs (<0.5m).

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 MNRR or 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 is dominated by *Populus deltoides* saplings or *Salix interior* (or *Salix exigua*). .....(2a)

1b Shrubland not as above. Shrub cover is dominated by *Cornus drummondii*, *Prunus virginiana*, *Elaeagnus angustifolia*, *Juniperus virginiana*, *Rhus glabra*, or *Symphoricarpos occidentalis* .....(4a)

2a This successional shrubland can have moderate to dense cover of young *Populus deltoides saplings* usually <5m tall. Short or dwarf shrubs of *Fraxinus pennsylvanica* may be present as well. If there is an herbaceous layer, it tends to be dominated by weedy species such as C*onyza canadensis*, *Solidago* spp., *Ambrosia psilostachya*, *Poa pratensis*, *Bromus tectorum*, etc.….**NPSMNRR010 *Populus deltoides* Successional Shrubland [MNRR MC201]**

2b Not as above. Shrubland is dominated by *Salix interior*. Other shrubs such as *Populus deltoides*, *Salix amygdaloides*, *Elaeagnus angustifolia*, and *Cornus drummondii* may be present but tend to not co-dominate. ….....(3a)

3a *Salix interior* is the dominant plant with cover between 20% and 50%. Site may have an herbaceous layer with up to 30% cover. Other shrub species that may be present with low abundance include *Populus deltoides*, *Salix amygdaloides*, and *Elaeagnus angustifolia*. Common herbaceous species include *Xanthium strumarium*, *Polygonum lapathifolium*, and *Eupatorium* spp. This type occurs on riverine sandbars with sand covering 70% to 90% of the ground..... **CEGL008562 *Salix interior* Wet Shrubland [MNRR MC201]**

3b *Salix interior* is the dominant shrub with cover between 25% and 70%. Other shrub species may be present in low abundances including *Cornus drummondii* or *Elaeagnus angustifolia*. Herbaceous layer is dense 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 within proximity to the river..... …**CEGL005282 *Salix interior/Pascopyrum smithii-Equisetum hyemale* Wet Shrubland [MNRR MC201]**

4a Shrub layer is composed partly or entirely of *Elaeagnus angustifolia*, *Cornus drummondii*, or *Juniperus virginiana*.....(6a)

4b Shrub layer composed of *Prunus virginiana*, *Prunus americana*, *Rhus glabra*, *Symphoricarpos occidentalis*, or other species.....(9a)

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 [MNRR MC309]**

5b Shrub layer is partly or entirely dominated by *Juniperus virginiana* or *Cornus drummondii* .....(6a)

6a *Juniperus virginiana* dominates the shrub layer as either short shrubs <2m tall or tall shrubs/ short trees.....(7a)

6b *Cornus drummondii* dominates the shrub layer.....(8a)

7a Shrub height or sub-shrub height *Juniperus virginiana* has invaded native or ruderal grasslands. Total *Juniperus virginiana* shrub cover is typically >30%, and can be much higher. Important here is evidence of an herbaceous understory dominated by graminoids. .....**NPSMNRR004 *Juniperus virginiana* Ruderal Shrub Invaded Grassland [MNRR MC101]**

7b Tall shrub or small tree *Juniperus virginiana* occurs 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 [MNRR MC308]**

8a *Cornus drummondii* and *Amorpha fruticosa* are the dominant shrubs with cover ~40%. This tends to be a patchy landscape with clumps of *Cornus drummondii* or *Amorpha fruticosa*. Other shrubs that may occur with limited cover include *Cornus sericea*, *Salix interior*, and saplings of *Populus deltoides.* Herbaceous stratum is often dominated by forbs that are quite diverse. In disturbed areas, *Ambrosia psilostachya*, *Cannabis sativa*, and *Euphorbia esula* tend to dominate ..... …**CEGL005220 *Cornus drummondii-Amorpha fruticosa-Cornus sericea* Wet Shrubland [MNRR MC202]**

8b *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 orbiculatus*, 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 [MNRR MC203]**

9a *Symphoricarpos occidentalis* is the dominant species in the short shrub stratum with a cover value of >50%, often approaching 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 [MNRR MC204]**

9b Not as above. Other shrub species such as *Prunus* spp. or *Rhus glabra* dominate the area, but some *Symphoricarpos occidentalis* may be present .....(10a)

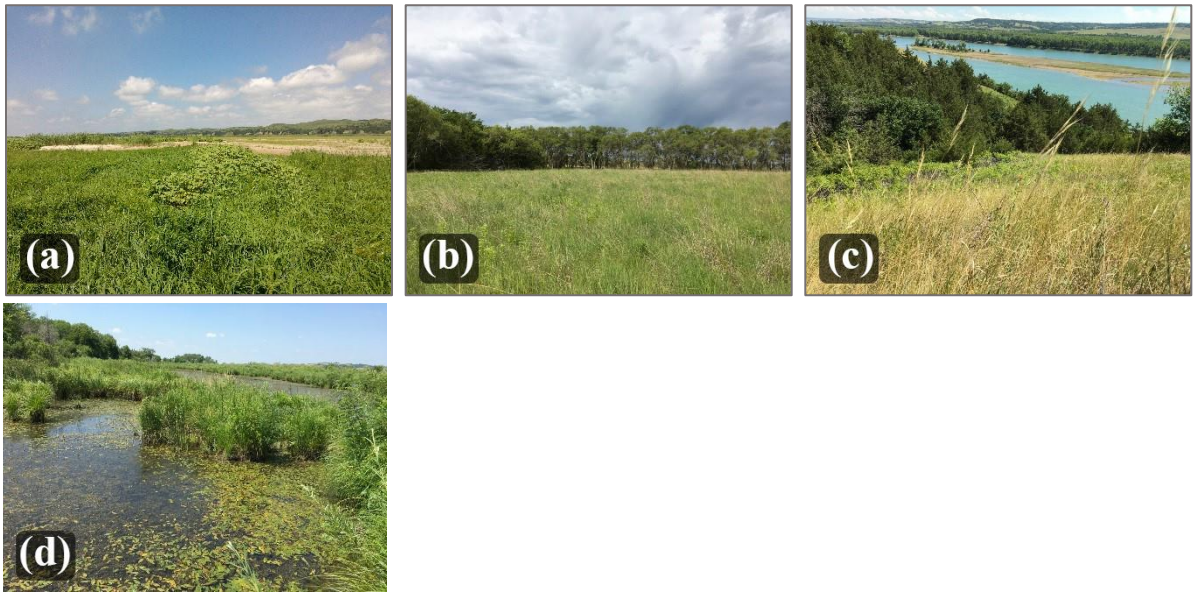
10a *Prunus virginiana* is the dominant shrub. Total shrub cover may be open with a low of about 30% to dense with cover approaching 100%. Other shrubs that may be present to nearly co-dominant include *Prunus americana*, *Rhus trilobata*, *Salix interior*, *Amorpha canescens*, *Rosa woodsii*, *Symphoricarpos occidentalis*, and *Toxicodendron rydbergii*..... ..... **CEGL005453 *Prunus virginiana* Great Plains Shrubland [MNRR MC203]**

10b *Rhus glabra* typically forms a moderate to dense cover (30%-80%) and *Symphoricarpos occidentalis* is often present. Graminoids typically have greater abundance than forbs with *Poa pratensis* and *Bromus inermis* as the main graminoids; however, the herbaceous layer can be variable and other species may be prevalent. This community often occurred in areas with *Juniperus virginiana* clearing and potentially prescribed fire .... **NPSMNRR007 *Rhus glabra* Mixedgrass Shrubland [MNRR MC205]**

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 MNRR 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) forb-land, (b) grassland, (c) upland, (d) wetland.

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. .....(15a)

2a Shrub height or sub-shrub height *Juniperus virginiana*, typically <2m, has invaded native or ruderal grasslands. Total *Juniperus virginiana* shrub cover is generally >30%..... .....**NPSMNRR004 *Juniperus virginiana* Ruderal Shrub Invaded Grassland [MNRR MC101]**

2b *Juniperus virginiana* has <30% cover and is not composed of more than a few individuals .....(3a)

3a Herbaceous stratum is dominated by non-native or ruderal species. These may include *Poa pratensis*, *Bromus inermis*, *Bromus tectorum*, *Helianthus annuus*, *Ambrosia psilostachya*, *Euphorbia esula*, or others.....(4a)

3b Herbaceous stratum is co-dominated or dominated by native species such as *Andropogon gerardii*, *Andropogon hallii*, *Panicum virgatum*, *Schizachyrium scoparium*, *Hesperostipa comata*, *Sorghastrum nutans*, or others. .....(10a)

4a Site is dominated by one or more of the following forb 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 may have some component of ruderal grasses (*Poa pratensis*, *Bromus inermis*, *Bromus tectorum*, *Bromus japonicus*) but is dominated by forbs. Bare ground may also be common with up to 25% in most areas. *M. officinalis* monocultures may have bare ground estimates greater than 65%.....
.....**NPSMNRR003 Weedy Forb Ruderal Herbaceous Vegetation [MNRR MC101]**

4b Herbaceous stratum is dominated by non-native graminoids.....(5a)

5a Site is dominated by a mix of grass species and often occurs in old fields. Common species include *Koeleria macrantha*, *Agropyron cristatum*, *Thinopyrum intermedium*, *Elymus canadensis*. *Bromus inermis*, *Bromus tectorum*, and/or *Poa pratensis* may also be present
.....**NPSMNRR002 Ruderal Herbaceous Grassland [MNRR MC101]**

5b Site is dominated by one or two graminoids such as *Bromus inermis*, *Bromus tectorum*, or *Poa pratensis*.....(6a)

6a The herbaceous layer is dominated by one or more *Bromus* species .....(7a)

6b The herbaceous layer is dominated or co-dominated by *Poa pratensis* and may include one to several species of native tallgrasses.....(8a)

7a *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 [MNRR MC101]

7b *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 [MNRR MC101]**

8a Site is relatively mesic due to occasional flooding, proximity to groundwater, or slope position, but 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 and introduced forage species. Remnants of the original natural community may occasionally be present with low cover such as *Pascopyrum smithii*, *Deschampsia caespitosa*, and *Carex* spp. Occasional trees and shrubs may also be present..... .....**CEGL003081 *Poa pratensis* Ruderal Marsh [MNRR MC101]**

8b Plot composition not as above .....(9a)

9a *Bromus inermis* and *Poa pratensis* are dominant to co-dominant and form a moderately dense to dense cover. Other ruderal species such as *Cirsium arvense*, *Verbascum thapsus*, and *Nepeta cataria* 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 [MNRR MC101]**

9b *Poa pratensis* and/or *Bromus inermis* are dominant to co-dominant with cover of about 50% or more. Other co-dominate to sub-dominant species include the native tall grasses *Sorghastrum nutans* and *Andropogon gerardii*. 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 [MNRR MC103]**

10a Grassland is dominated by cool season grasses, mainly *Pascopyrum smithii* and *Hesperostipa comata*. Common associates may include *Andropogon gerardii*, *Bouteloua curtipendula*, *Bouteloua gracilis*, *Yucca glauca*, and *Schizachyrium scoparium*. Sparse shrubs may be found throughout this community and include *Artemisia frigida*, *Rosa arkansana*, or *Symphoricarpos occidentalis*..... **CEGL002034 *Pascopyrum smithii-Hesperostipa comata* Central Mixedgrass Grassland [MNRR MC104]**

10b Herbaceous stratum is dominated or co-dominated by warm season grasses such as *Andropogon* spp., *Sorghastrum nutans*, *Calamovilfa longifolia*, and/or *Schizachyrium scoparium*. Non-native graminoids may be present. .....(11a)

11a Herbaceous stratum is dominated by the native grasses *Andropogon hallii* and *Calamovilfa longifolia*. Other graminoids present may include *Bouteloua gracilis*, *Bouteloua hirsuta*, *Carex duriuscula*, *Carex filifolia*, *Carex inops* ssp. *heliophila*, *Cyperus schweinitzii*,

Eragrostis trichodes, *Hesperostipa comata*, *Koeleria macrantha*, *Muhlenbergia pungens*, *Redfieldia flexuosa*, and *Schizachyrium scoparium*. Site is located on very sandy soils and sand hills. Forbs and shrubs are a minor component of the total vegetation. .....
…**CEGL001467 *Andropogon hallii-Calamovilfa longifolia* Grassland [MNRR MC103]**

11b Herbaceous stratum is dominated or co-dominated by *Andropogon gerardii*. Other grasses present may include *Sorghastrum nutans*, *Schizachyrium scoparium*, *Panicum virgatum*, *Poa pratensis*, or others.....(12a)

12a *Andropogon gerardii* is the dominant species with cover greater than 50%. Other graminoids present with less than 50% cover may include *Carex* spp. Forb diversity is moderate but mainly contains weedy species such as *Ambrosia psilostachya*, *Chamaecrista fasciculata*, *Cirsium arvense*, and others .....
…**CEGL002024 *Andropogon gerardii-Panicum virgatum-Helianthus grosseserratus* Wet Meadow [MNRR MC103]**

12b Not as above. *Andropogon gerardii* co-dominates with either *Sorghastrum nutans*, *Panicum virgatum*, and/or *Schizachyrium scoparium* .....(13a)

13a *Sorghastrum nutans* is usually present. It dominates or co-dominates with *Andropogon gerardii*, *Poa pratensis*, and/or *Bromus inermis*, which may have cover >50%. Other graminoids such as *Panicum virgatum* and *Schizachyrium scoparium* may be present but do not co-dominate. Forbs may include *Medicago sativa* and *Ratibida pinnata*. The native forb associates are usually not abundant and typically have cover of less than about 30%.....
…**CEGL002023 *Andropogon gerardii – Panicum virgatum* Sandhills Grassland [MNRR MC103]**

13b Not as above. *Andropogon gerardii* co-dominates with *Schizachyrium scoparium* and/or *Panicum virgatum. Sorghastrum nutans* is not co-dominant .....(14a)

14a Usually occurring on flat or gentle slopes near the river, *Andropogon gerardii* co-dominates with *Schizachyrium scoparium* and *Panicum virgatum*. Many of these sites have been disturbed, and often *Bromus inermis* co-dominates with *Andropogon gerardii* instead of *Schizachyrium scoparium* and *Panicum virgatum*, but remnant *Schizachyrium scoparium* and *Panicum virgatum* are typically present within the plot.....
.....**CEGL002205 *Andropogon gerardii – Schizachyrium scoparium* Northern Plains Grassland [MNRR MC103]**

14b Usually occurring on south facing slopes (>20˚), this community is dominated by a large diversity of graminoids with a vigorous herbaceous stratum (~80% cover). Either *Schizachyrium scoparium* or *Andropogon gerardii* have the greatest cover values (~70%). All plots contain *Bouteloua curtipendula*, and other common graminoids include *Nassella viridula*, *Hesperostipa spartea*, and *Dichanthelium oligosanthes*. *Yucca glauca* tends to be present at these sites. Forbs tend to not be as abundant or diverse as the graminoids, and the most abundant forbs are *Ambrosia psilostachya* and *Verbena stricta*.....

…**CEGL002036 *Schizachyrium scoparium – Bouteloua curtipendula* Loess Mixedgrass Grassland [MNRR MC102]**

15a Area is either a vegetated sandbar in the river or inundated or regularly flooded, usually with standing water >4”.....(16a)

15b Area is saturated but not regularly flooded such as a wet meadow.....(20a)

16a Herbaceous stratum is dominated by *Phalaris arundinacea*, *Phragmites australis*, or *Cyperus* spp.....(17a)

16b Herbaceous stratum is dominated by *Schoenoplectus tabernaemontani* or *Typha* spp. ....(19a)

17a This sparse vegetation typically includes some herbaceous cover (~10%) with species such as *Cyperus erythrorhizos*, *Cyperus odoratus*, and *Leersia oryzoides.* Young saplings of *Populus deltoides* <1m in height may occur here as well. However, when this type occurs on large stable point bars such as those near the confluence of the Missouri and Niobrara Rivers, herbaceous cover sometimes reaches 90% with the main species of *Cyperus erythrorhizos*, *Cyperus odoratus*, and *Leersia oryzoides*..... ..... **CEGL002049 Riverine Sand Flats-Bars Sparse Vegetation [MNRR MC401]**

17b Herbaceous stratum is dominated by *Phalaris arundinacea* or *Phragmites australis* ....(18a)

18a *Phalaris arundinacea* is the dominant plant with cover ranging from 40% to 100%. *Phragmites australis* may be present with cover of about 20% or less. Common forbs may include *Polygonum* spp., *Rumex* sp., or others. ....**CEGL001474 *Phalaris arundinacea* Western Marsh [MNRR MC105a]**

18b *Phragmites australis* co-dominates with *Phalaris arundinacea* with roughly equal cover. Total cover is about 90%. Other plants that may be present are *Xanthium strumarium*, *Euphorbia esula*, and *Cirsium canadensis* ..... …**CEGL001475 *Phragmites australis* Western Ruderal Wet Meadow [MNRR MC105b]**

19a *Schoenoplectus tabernaemontani* is dominant and may be the only species present. *Typha* spp. may also be present with cover <25%. In areas of deeper water, total cover is generally between 90% and 100%. In shallower waters, a variety of other hydrophilic plants may be present such as *Sparganium* spp., *Eleocharis palustris*, and *Juncus* spp. ..... …**CEGL002026 *Schoenoplectus tabernaemontani-Typha* spp.-(*Sparganium* spp., *Juncus* spp.) Marsh [MNRR MC105c]**

19b *Typha* spp. dominates this type, although *Schoenoplectus tabernaemontani* often co-dominates this type in shallower waters. Additionally, *Phalaris arundinacea* or *Phragmites australis* may invade this type. Common associates include *Eleocharis* spp. and *Sagittaria latifolia*..... **CEGL002389 *Typha* spp. Great Plains Marsh [MNRR MC105c]**

20a Vegetation is dominated by a moderate to dense cover of *Poa pratensis* with additional cover of other ruderal species and introduced forage species. 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 [MNRR MC101]**

20b Herbaceous stratum is dominated by *Phalaris arundinacea*, *Phragmites australis*, or *Carex* spp.....(21a)

21a This type has mesic *Carex* spp. present. Total cover ranges between 70% and 90%. The main species are *Carex pellita*, *Carex vulpinoidea*, *Carex molesta*, *Carex stipata*, and *Carex tribuloides*, but *Eleocharis* spp. along with *Juncus interior* and *Juncus torreyi* are typically present as well. Common forbs may include *Solidago* spp., *Polygonum* spp., etc..... ...**CEGL005272 *Carex* spp.-(*Carex pellita, Carex vulpinoidea*) Wet Meadow [MNRR MC105d]**

21b The vegetation is dominated by *Phalaris arundinacea* or *Phragmites australis* .....(22a)

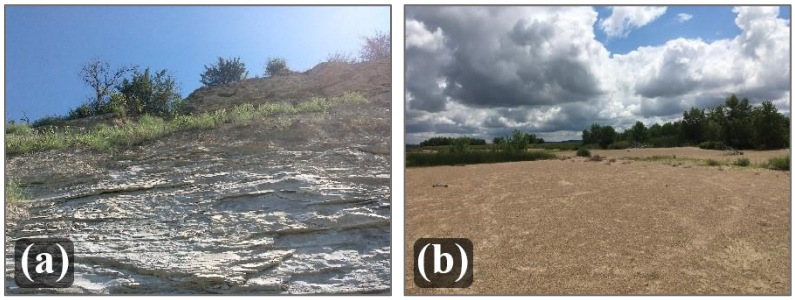
22a *Phalaris arundinacea* is the dominant plant with cover ranging from 40% to 100%. It may take over the entire area, but occasionally *Phragmites australis* occurs within the type as well .....**CEGL001474 *Phalaris arundinacea* Western Marsh [MNRR MC105a]**

22b *Phragmites australis* forms a dense monoculture, or *Phragmites australis* co-dominates with *Phalaris arundinacea* with roughly equal cover. Total cover is typically about 90%. Other plants that may be present are *Xanthium strumarium*, *Euphorbia esula*, and *Cirsium canadensis* ..... …**CEGL001475 *Phragmites australis* Western Ruderal Wet Meadow [MNRR MC105b]**

Division D – Sparse Associations

Sparse associations generally have <10% vegetated cover and tend to occur on rock outcrops or sandbars. Many of the rock outcrops present in MNRR are steep cliffs with slopes >60˚. Within the boundary there are several different rock formations composed of shale (Pierre, Carlile, Granerous), limestone (Niobrara chalk), and sandstone (Dakota sandstone).

Sparse vegetation on alluvial sandbars can vary due to the dynamic nature of the river. Peak flooding season occurs in the spring, and many of the sandbars are scoured clean during such flooding events. However, these bars are quickly colonized, and as the summer continues the vegetation becomes denser. Most of the sparse sandbars along the Missouri River are dominated by *Carex* spp. Stable sand bars colonized by *Phragmites australis* or *Phalaris arundinacea* can be keyed out in the herbaceous division.



Examples of (a) outcrops and (b) sandbars (CNHP)

1a Area is next to or on a rock outcrop or cut slope.....(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, but may include *Salsola collina*, *Solanum rostratum*, *Euphorbia marginata*, and *Astragalus racemosus* with very low cover or only a few individuals.....
…**CEGL002047 Siltstone-Sandstone Rock Outcrop Sparse Vegetation [MNRR MC402]**

3b This cliff community is defined by 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 [MNRR MC402]**

4a This community occurs on eroded slopes and cliffs of exposed 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**

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 [MNRR MC402]**

5a This sparse vegetation typically includes some herbaceous cover (~10%) with species such as *Cyperus erythrorhizos*, *Cyperus odoratus*, and *Leersia oryzoides.* However, when this type occurs on large stable point bars such as those near the confluence of the Missouri and Niobrara Rivers, herbaceous cover sometimes reaches 90% with the main species of *Cyperus erythrorhizos*, *Cyperus odoratus*, and *Leersia oryzoides* .....
..... **CEGL002049 Riverine Sand Flats-Bars Sparse Vegetation [MNRR MC401]**

5b Sand bar appears relatively young (was recently deposited) and lacks any vegetation.....
.....(6a)

6a Areas of gravel deposited on sand bars downstream of the James River confluence. Species tend to be sparse but may include *Cyperus erythrorhizos*, *Cyperus odoratus*, and *Leersia oryzoides*. Other common forbs that may occur include *Ambrosia artemisiifolia*, *Chamaesyce serpyllifolia*, *Froelichia gracilis*, and *Opuntia macrorhiza*.....
…**CEGL005223 Great Plains Riverine Gravel Flats Sparse Vegetation [MNRR MC401]**

6b 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.....
.....**NPSMNRR008 Bare Alluvial Depositional Bar [MNRR MC401]**

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Appendix C. List of Plant Species Documented on Classification and Accuracy Assessment Plots at MNRR

Scientific Name	Taxon Code
Acer negundo	ACNE2
Acer saccharinum	ACSA2
Agastache nepetoides	AGNE2
Ageratina altissima	AGALA
Agrostis scabra	AGSC5
Alopecurus arundinaceus	ALAR
Amaranthus tuberculatus	AMTU
Ambrosia artemisiifolia	AMAR2
Ambrosia psilostachya	AMPS
Ambrosia trifida	AMTR
Amorpha canescens	AMCA6
Amorpha fruticosa	AMFR
Amorpha sp.	AMORP
Amphicarpaea bracteata	AMBR2
Andropogon gerardii	ANGE
Anemone canadensis	ANCA8
Apocynum cannabium	APCA
Aquilegia canadensis	AQCA
Arisaema triphyllum	ARTR
Artemisia frigida	ARFR4
Artemisia ludoviciana	ARLU
Asclepias syriaca	ASSY
Asclepias verticillata	ASVE
Asparagus officinalis	ASOF
Aster sp.	ASTER
Astragalus canadensis	ASCA11
Astragalus racemosus	ASRA2

Scientific Name	Taxon Code
Bidens frondosa	BIFR
Bidens sp.	BIDEN
Bolboschoenus fluviatilis	BOFL3
Bouteloua curtipendula	BOCU
Bouteloua dactyloides	BODA2
Bromus arvensis	BRAR5
Bromus inermis	BRIN2
Bromus tectorum	BRTE
Bryophyte	BRYO
Calamovilfa longifolia	CALO
Calystegia sepium	CASE13
Cannabis sativa	CASA3
Carex blanda	CABL
Carex brevior	CABR10
Carex davisii	CADA
Carex hystericina	CAHY4
Carex laeviconica	CALA12
Carex molesta	CAMO11
Carex normalis	CANO
Carex oligocarpa	CAOL2
Carex pellita	CAPE42
Carex sp.	CAREX
Carex sprengelii	CASP7
Carex vulpinoidea	CAVU2
Catalpa speciosa	CASP8
Celastrus scandens	CESC
Celtis occidentalis	CEOC
Cenchrus longispinus	CELO3
Chamaecrista fasciculata	CHFA2
Chamaecrista fasciculata	CHFAF

Scientific Name	Taxon Code
Chamaesyce sp.	CHAMA
Chenopodium album	CHAL7
Chenopodium simplex	CHSI2
Chenopodium sp.	CHENO
Circaea lutetiana	CILU
Cirsium altissimum	CIAL2
Cirsium arvense	CIAR4
Cirsium undulatum	CIUN
Cirsium vulgare	CIVU
Convolvulus arvensis	COAR4
Conyza canadensis	COCA5
Corispermum villosum	COVI5
Cornus drummondii	CODR
Cornus obliqua	COOB9
Cornus sericea	COSE16
Croton texensis	CRTE4
Cryptotaenia canadensis	CRCA9
Cycloloma atriplicifolium	CYAT
Cyperus erythrorhizos	CYER2
Cyperus odoratus	CYOD
Cyperus sp.	CYPER
Cystopteris tenuis	CYTE7
Dalea enneandra	DAEN
Dalea purpurea	DAPU5
Desmanthus illinoensis	DEIL
Desmodium canadense	DECA7
Dichanthelium oligosanthes	DIOLS
Echinaceae angustifolia	ECAN2
Echinochloa crus-galli	ECCR
Echinochloa muricata	ECMU2

Scientific Name	Taxon Code
Elaeagnus angustifolia	ELAN
Elaeagnus umbellata	ELUM
Eleocharis acicularis	ELAC
Eleocharis erythropoda	ELER
Eleocharis palustris	ELPA3
Eleocharis sp.	ELEOC
Elymus canadensis	ELCA4
Elymus elymoides	ELEL5
Elymus hystrix	ELHY
Elymus repens	ELRE4
Elymus sp.	ELYMU
Elymus trachycaulus	ELTR7
Elymus virginicus	ELVI3
Equisetum arvense	EQAR
Equisetum hyemale	EQHY
Equisetum laevigatum	EQLA
Erigeron philadelphicus	ERPH
Erigeron strigosus	ERST3
Eupatorium perfoliatum	EUPE3
Euphorbia esula	EUES
Euphorbia marginata	EUMA8
Euthamia gymnospermoides	EUGY
Festuca rubra	FERU2
Festuca subverticillata	FESU3
Fraxinus pennsylvanica	FRPE
Galium aparine	GAAP2
Galium circaezans	GACI2
Geum canadense	GECA7
Gleditsia triacanthos	GLTR
Glycyrrhiza lepidota	GLLE3

Scientific Name	Taxon Code
Grindelia squarrosa	GRSQ
Gymnocladus dioicus	GYDI
Hackelia virginiana	HAVI2
Hedeoma hispida	HEHI
Helianthus annuus	HEAN3
Helianthus pauciflorus	HEPA19
Helianthus sp.	HELIA
Heliopsis helianthoides	HEHE5
Hesperostipa comata	HECOC8
Hesperostipa spartea	HESP11
Hordeum jubatum	HOJU
Hordeum pusillum	HOPU
Impatiens capensis	IMCA
Impatiens pallida	IMPA
Ipomoea leptophylla	IPLE
Juglans nigra	JUNI
Juncus dudleyi	JUDU2
Juncus interior	JUIN2
Juncus sp.	JUNCU
Juncus torreyi	JUTO
Juniperus virginiana	JUVI
Koeleria macrantha	KOMA
Lactuca floridana	LAFL
Lactuca serriola	LASE
Lactuca sp.	LACTU
Laportea canadensis	LACA3
Leersia oryzoides	LEOR
Leersia virginica	LEVI2
Lemna sp.	LEMNA
Leonurus cardiaca	LECA2

Scientific Name	Taxon Code
Lespedeza capitata	LECA8
Liatris aspera	LIAS
Lonicera x *bella*	LOBE
Lotus unifoliolatus	LOUN
Lygodesmia juncea	LYJU
Lythrum salicaria	LYSA2
Maianthemum racemosum	MARAR
Maianthemum stellatum	MAST4
Medicago lupulina	MELU
Medicago sativa	MESA
Melilotus officinalis	MEOF
Menispermum canadense	MECA3
Mentha arvensis	MEAR4
Mimosa nuttallii	MINU6
Monarda fistulosa	MOFI
Morus alba	MOAL
Morus rubra	MORU2
Muhlenbergia mexicana	MUME2
Muhlenbergia racemosa	MURA
Mustard	MUSTA
Nassella viridula	NAVI4
Nepeta cataria	NECA2
Nuphar sp.	NUPHA
Nymphaea odorata	NYOD
Onosmodium bejariense	ONBEB
Opuntia macrorhiza	OPMA2
Osmorhiza claytonii	OSCL
Osmorhiza sp.	OSMOR
Ostrya virginiana	OSVI
Oxalis stricta	OXST

Scientific Name	Taxon Code
Panicum dichotomiflorum	PADI
Panicum virgatum	PAVI2
Parietaria pensylvanica	PAPE5
Parthenocissus quinquefolia	PAQU2
Pascopyrum smithii	PASM
Paspalum setaceum	PASE5
Pediomelum esculentum	PEES
Penstemon sp.	PENST
Phalaris arundinacea	PHAR3
Phleum pratense	PHPR3
Phragmites australis	PHAU7
Phryma leptostachya	PHLE5
Physalis heterophylla	PHHE5
Physalis sp.	PHYSA
Physalis virginiana	PHVI5
Pilea pumila	PIPU2
Piptatheropsis micrantha	PIMI
Plantago rugelii	PLRU
Plantago sp.	PLANT
Poa pratensis	POPR
Polygonatum biflorum	POBI2
Polygonum amphibium	POAM8
Polygonum persicaria	POPE3
Polygonum sp.	POLYG
Populus alba	POAL7
Populus deltoides	PODE3
Potentilla paradoxa	POPA15
Potentilla sp.	POTEN
Prunella vulgaris	PRVU
Prunus americana	PRAM

Scientific Name	Taxon Code
Prunus virginiana	PRVI
Psoralidium lanceolatum	PSLA3
Quercus macrocarpa	QUMA2
Ratibida columnifera	RACO3
Ratibida pinnata	RAPI
Rhamnus cathartica	RHCA3
Rhus aromatica	RHAR4
Rhus glabra	RHGL
Ribes americanum	RIAM2
Ribes missouriense	RIMI
Robinia pseudoacacia	ROPS
Rosa woodsii	ROWO
Rubus occidentalis	RUOC
Rudbeckia hirta	RUHI2
Rudbeckia laciniata	RULA3
Rudbeckia triloba	RUTR2
Rumex sp.	RUMEX
Sagittaria latifolia	SALA2
Salix amygdaloides	SAAM2
Salix eriocephala	SAER
Salix exigua	SAEX
Salix interior	SAIN3
Salix lutea	SALU2
Salix sp.	SALIX
Salsola collina	SACO8
Sanguinaria canadensis	SACA13
Sanicula canadensis	SACA15
Schizachyrium scoparium	SCSC
Schoenoplectus acutus	SCACA
Schoenoplectus pungens	SCPU10

Scientific Name	Taxon Code
Schoenoplectus tabernaemontani	SCTA2
Scirpus pallidus	SCPA8
Scutellaria parvula	SCPA7
Setaria viridis	SEVI4
Shepherdia argentea	SHAR
Silphium laciniatum	SILA3
Silphium perfoliatum	SIPE2
Sinapis arvensis	SIAR4
Sisymbrium altissimum	SIAL2
Sisymbrium loeselii	SILO3
Sisyrinchium campestre	SICA9
Smilax lasioneura	SMLA3
Smilax sp.	SMILA
Smilax tamnoides	SMTA2
Solanum nigrum	SONI
Solanum rostratum	SORO
Solanum sp.	SOLAN
Solidago canadensis	SOCA6
Solidago gigantea	SOGI
Solidago missouriensis	SOMI2
Solidago mollis	SOMO
Solidago sp.	SOLID
Sorghastrum nutans	SONU2
Sparganium eurycarpum	SPEU
Sparganium sp.	SPARG
Spartina pectinata	SPPE
Sphenopholis obtusata	SPOB
Sporobolus compositus	SPCOC2
Sporobolus cryptandrus	SPCR
Strophostyles helvola	STHE9

Scientific Name	Taxon Code
Symphoricarpos occidentalis	SYOC
Symphyotrichum ericoides	SYERE
Taraxacum officinale	TAOF
Tephrosia virginiana	TEVI
Teucrium canadense	TECA3
Thalictrum dasycarpum	THDA
Thlaspi arvense	THAR5
Tilia americana	TIAM
Toxicodendron radicans	TORA2
Typha angustifolia	TYAN
Typha latifolia	TYLA
Typha sp.	TYPHA
Ulmus americana	ULAM
Ulmus pumila	ULPU
Ulmus rubra	ULRU
Urtica dioica	URDI
Verbascum thapsus	VETH
Verbena hastata	VEHA2
Verbena stricta	VEST
Verbena urticifolia	VEUR
Vernonia fasciculata	VEFA2
Veronica americana	VEAM2
Veronica sp.	VERON
Viola canadensis	VICA4
Viola pubescens	VIPU3
Viola sororia	VISO
Viola sp.	VIOLA
Vitis riparia	VIRI
Vulpia octoflora	VUOC
Xanthium strumarium	XAST

Scientific Name	Taxon Code
Yucca glauca	YUGL
Zanthoxylum americanum	ZAAM

Appendix D. List of Plots and Classified Vegetation Associations

Classification Plot code	USNVC or Park Special Classified Code	Scientific Name
390001	CEGL002014	*Fraxinus pennsylvanica-Ulmus* spp.-*Celtis occidentalis* Floodplain Forest
390004	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
390006	CEGL002152	*Populus deltoides*/*Juniperus scopulorum* Floodplain Forest
390007	CEGL002024	*Andropogon gerardii-Panicum virgatum-Helianthus* grosseserratus Wet Meadow
390010	CEGL002014	*Fraxinus pennsylvanica-Ulmus* spp.-*Celtis occidentalis* Floodplain Forest
390012	CEGL000658	*Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest
390016	CEGL005239	*Fraxinus pennsylvanica-Ulmus americana*-(*Juglans nigra*, *Celtis occidentalis*) Ruderal Forest
390017	CEGL005239	*Fraxinus pennsylvanica-Ulmus americana*-(*Juglans nigra*, *Celtis occidentalis*) Ruderal Forest
390022	no good association fit	–
390024	CEGL002205	*Andropogon gerardii-Schizachyrium scoparium* Northern Plains Grassland
390028	CEGL005239	*Fraxinus pennsylvanica-Ulmus americana*-(*Juglans nigra*, *Celtis occidentalis*) Ruderal Forest
390037	CEGL001474	*Phalaris arundinacea* Western Marsh
390038	CEGL002205	*Andropogon gerardii-Schizachyrium scoparium* Northern Plains Grassland
390039	CEGL005264	*Bromus inermis*-(*Pascopyrum smithii*) Ruderal Grassland
390045	CEGL002072	*Quercus macrocarpa*/*Cornus drummondii*/*Aralia nudicaulis* Forest
390050	CEGL002036	*Schizachyrium scoparium-Bouteloua curtipendula* Loess Mixedgrass Grassland
390067	CEGL000658	*Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest
390073	CEGL005272	*Carex* spp.-(*Carex pellita*, *Carex vulpinoidea*) Wet Meadow
390074	CEGL001475	Phragmites australis Western Ruderal Wet Meadow
390075	CEGL002205	*Andropogon gerardii-Schizachyrium scoparium* Northern Plains Grassland

Classification Plot code	USNVC or Park Special Classified Code	Scientific Name
390083	CEGL005264	*Bromus inermis*-(*Pascopyrum smithii*) Ruderal Grassland
390085	CEGL002152	*Populus deltoides*/*Juniperus scopulorum* Floodplain Forest
390092	CEGL001474	*Phalaris arundinacea* Western Marsh
390096	CEGL002047	Siltstone-Sandstone Rock Outcrop Sparse Vegetation
390097	no good association fit	–
390098	CEGL000658	*Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest
390101	CEGL002036	*Schizachyrium scoparium-Bouteloua curtipendula* Loess Mixedgrass Grassland
390102	CEGL002036	*Schizachyrium scoparium-Bouteloua curtipendula* Loess Mixedgrass Grassland
390106	CEGL002014	*Fraxinus pennsylvanica-Ulmus* spp.-*Celtis occidentalis* Floodplain Forest
390109	no good association fit	–
390112	no good association fit	–
390113	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
390114	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
390115	CEGL000658	*Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest
390116	CEGL000658	*Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest
390117	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
390123	CEGL002593	*Juniperus virginiana* Midwest Ruderal Forest
390130	CEGL008562	*Salix interior* Wet Shrubland
390133	CEGL002023	*Andropogon gerardii-Panicum virgatum* Sandhills Grassland
390134	CEGL001475	Phragmites australis Western Ruderal Wet Meadow
390135	CEGL002389	*Typha* spp. Great Plains Marsh
390136	CEGL001475	Phragmites australis Western Ruderal Wet Meadow
390137	CEGL001475	Phragmites australis Western Ruderal Wet Meadow
390138	CEGL000659	*Populus deltoides*-(*Salix amygdaloides*)/*Salix* (*exigua*, *interior*) Floodplain Woodland

Classification Plot code	USNVC or Park Special Classified Code	Scientific Name
390139	CEGL000659	*Populus deltoides*-(*Salix amygdaloides*)/*Salix* (*exigua*, *interior*) Floodplain Woodland
390146	CEGL002593	*Juniperus virginiana* Midwest Ruderal Forest
390154	CEGL000947	*Salix amygdaloides* Riparian Woodland
390157	CEGL005264	*Bromus inermis*-(*Pascopyrum smithii*) Ruderal Grassland
391001	no good association fit	–
391002	CEGL002389	*Typha* spp. Great Plains Marsh
391003	CEGL005272	*Carex* spp.-(*Carex pellita*, *Carex vulpinoidea*) Wet Meadow
391012	CEGL002389	*Typha* spp. Great Plains Marsh
391013	CEGL002049	Riverine Sand Flats-Bars Sparse Vegetation
391014	CEGL001475	Phragmites australis Western Ruderal Wet Meadow
391015	CEGL008562	*Salix interior* Wet Shrubland
391016	CEGL000947	*Salix amygdaloides* Riparian Woodland
391017	no good association fit	–
391018	CEGL005239	*Fraxinus pennsylvanica*-*Ulmus americana*-(*Juglans nigra*, *Celtis occidentalis*) Ruderal Forest
391019	no good association fit	–
392002	CEGL002205	*Andropogon gerardii*-*Schizachyrium scoparium* Northern Plains Grassland
392003	no good association fit	–
392004	CEGL002389	*Typha* spp. Great Plains Marsh
392005	CEGL005272	*Carex* spp.-(*Carex pellita*, *Carex vulpinoidea*) Wet Meadow
392012	CEGL005282	*Salix interior*/*Pascopyrum smithii*-*Equisetum hyemale* Wet Shrubland
392013	no good association fit	–
392014	CEGL002026	*Schoenoplectus tabernaemontani*-*Typha* spp.-(*Sparganium* spp., *Juncus* spp.) Marsh

Classification Plot code	USNVC or Park Special Classified Code	Scientific Name
392015	CEGL002026	*Schoenoplectus tabernaemontani-Typha* spp.-(*Sparganium* spp., *Juncus* spp.) Marsh
392016	no good association fit	–
392018	CEGL002389	*Typha* spp. Great Plains Marsh
392020	CEGL000658	*Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest
590001	NPSMNRR002	Ruderal Herbaeceous Grassland
590003	CEGL002024	*Andropogon gerardii-Panicum virgatum-Helianthus* grosseserratus Wet Meadow
590005	CEGL005239	*Fraxinus pennsylvanica-Ulmus americana*-(*Juglans nigra*, *Celtis occidentalis*) Ruderal Forest
590006	CEGL002025	*Andropogon gerardii-Sorghastrum nutans-Hesperostipa spartea* Loess Hills Grassland
590007	CEGL000555	*Quercus macrocarpa*/*Ostrya virginiana* Forest
590008	no good association fit	–
590012	CEGL002014	*Fraxinus pennsylvanica-Ulmus* spp.-*Celtis occidentalis* Floodplain Forest
590014	CEGL002014	*Fraxinus pennsylvanica-Ulmus* spp.-*Celtis occidentalis* Floodplain Forest
590016	CEGL002014	*Fraxinus pennsylvanica-Ulmus* spp.-*Celtis occidentalis* Floodplain Forest
590018	CEGL002593	*Juniperus virginiana* Midwest Ruderal Forest
590020	CEGL002152	*Populus deltoides*/*Juniperus scopulorum* Floodplain Forest
590023	CEGL005264	*Bromus inermis*-(*Pascopyrum smithii*) Ruderal Grassland
590025	CEGL002014	*Fraxinus pennsylvanica-Ulmus* spp.-*Celtis occidentalis* Floodplain Forest
590027	CEGL002072	*Quercus macrocarpa*/*Cornus drummondii*/*Aralia nudicaulis* Forest
590028	NPSMNRR001	*Populus deltoides-Fraxinus pennsylvanica*/*Rhamnus cathartica* Ruderal Forest
590029	CEGL005239	*Fraxinus pennsylvanica-Ulmus americana*-(*Juglans nigra*, *Celtis occidentalis*) Ruderal Forest
590032	CEGL000555	*Quercus macrocarpa*/*Ostrya virginiana* Forest
590037	CEGL002072	*Quercus macrocarpa*/*Cornus drummondii*/*Aralia nudicaulis* Forest

Classification Plot code	USNVC or Park Special Classified Code	Scientific Name
590039	CEGL000658	*Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest
590041	CEGL005239	*Fraxinus pennsylvanica-Ulmus americana-*(*Juglans nigra*, *Celtis occidentalis*) Ruderal Forest
590043	CEGL000658	*Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest
590047	CEGL005264	*Bromus inermis-*(*Pascopyrum smithii*) Ruderal Grassland
590048	CEGL002072	*Quercus macrocarpa*/*Cornus drummondii*/*Aralia nudicaulis* Forest
590055	no good association fit	–
590057	NPSMNRR002	Ruderal Herbaeceous Grassland
590058	CEGL005264	*Bromus inermis-*(*Pascopyrum smithii*) Ruderal Grassland
590059	CEGL002072	*Quercus macrocarpa*/*Cornus drummondii*/*Aralia nudicaulis* Forest
590060	CEGL005239	*Fraxinus pennsylvanica-Ulmus americana-*(*Juglans nigra*, *Celtis occidentalis*) Ruderal Forest
590061	CEGL005220	*Cornus drummondii-Amorpha fruticosa-Cornus sericea* Wet Shrubland
590062	CEGL002152	*Populus deltoides*/*Juniperus scopulorum* Floodplain Forest
590064	NPSMNRR001	*Populus deltoides-Fraxinus pennsylvanica*/*Rhamnus cathartica* Ruderal Forest
590067	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
590069	CEGL002205	*Andropogon gerardii-Schizachyrium scoparium* Northern Plains Grassland
590071	CEGL002152	*Populus deltoides*/*Juniperus scopulorum* Floodplain Forest
590073	CEGL005220	*Cornus drummondii-Amorpha fruticosa-Cornus sericea* Wet Shrubland
590081	CEGL002072	*Quercus macrocarpa*/*Cornus drummondii*/*Aralia nudicaulis* Forest
590091	CEGL002072	*Quercus macrocarpa*/*Cornus drummondii*/*Aralia nudicaulis* Forest
590093	CEGL002012	*Tilia americana-*(*Quercus macrocarpa*)/*Ostrya virginiana* Forest
590097	no good association fit	–
590099	CEGL000555	*Quercus macrocarpa*/*Ostrya virginiana* Forest
590100	CEGL002025	*Andropogon gerardii-Sorghastrum nutans-Hesperostipa spartea* Loess Hills Grassland
590103	CEGL002072	*Quercus macrocarpa*/*Cornus drummondii*/*Aralia nudicaulis* Forest

Classification Plot code	USNVC or Park Special Classified Code	Scientific Name
590105	CEGL002072	*Quercus macrocarpa*/*Cornus drummondii*/*Aralia nudicaulis* Forest
590107	CEGL002072	*Quercus macrocarpa*/*Cornus drummondii*/*Aralia nudicaulis* Forest
590112	NPSMNRR001	*Populus deltoides-Fraxinus pennsylvanica*/*Rhamnus cathartica* Ruderal Forest
590113	CEGL005264	*Bromus inermis*-(*Pascopyrum smithii*) Ruderal Grassland
590118	no good association fit	–
590119	no good association fit	–
590120	CEGL002152	*Populus deltoides*/*Juniperus scopulorum* Floodplain Forest
590121	CEGL005264	*Bromus inermis*-(*Pascopyrum smithii*) Ruderal Grassland
590122	no good association fit	–
590123	CEGL002152	*Populus deltoides*/*Juniperus scopulorum* Floodplain Forest
590124	CEGL002205	*Andropogon gerardii-Schizachyrium scoparium* Northern Plains Grassland
590125	CEGL002152	*Populus deltoides*/*Juniperus scopulorum* Floodplain Forest
590126	CEGL005282	*Salix interior*/*Pascopyrum smithii-Equisetum hyemale* Wet Shrubland
590128	CEGL002205	*Andropogon gerardii-Schizachyrium scoparium* Northern Plains Grassland
590129	CEGL002205	*Andropogon gerardii-Schizachyrium scoparium* Northern Plains Grassland
590130	CEGL005264	*Bromus inermis*-(*Pascopyrum smithii*) Ruderal Grassland
590131	CEGL001131	Symphoricarpos *occidentalis* Shrubland
590138	CEGL002152	*Populus deltoides*/*Juniperus scopulorum* Floodplain Forest
590139	CEGL005272	*Carex* spp.-(*Carex pellita*, *Carex vulpinoidea*) Wet Meadow
590140	CEGL005220	*Cornus drummondii-Amorpha fruticosa-Cornus sericea* Wet Shrubland
590143	CEGL002012	*Tilia americana*-(*Quercus macrocarpa*)/*Ostrya virginiana* Forest
590148	CEGL002072	*Quercus macrocarpa*/*Cornus drummondii*/*Aralia nudicaulis* Forest
590149	CEGL002012	*Tilia americana*-(*Quercus macrocarpa*)/*Ostrya virginiana* Forest
590150	CEGL002012	*Tilia americana*-(*Quercus macrocarpa*)/*Ostrya virginiana* Forest

Classification Plot code	USNVC or Park Special Classified Code	Scientific Name
590151	CEGL002012	*Tilia americana*-(*Quercus macrocarpa*)/*Ostrya virginiana* Forest
590152	CEGL002593	*Juniperus virginiana* Midwest Ruderal Forest
590153	CEGL002072	*Quercus macrocarpa*/*Cornus drummondii*/*Aralia nudicaulis* Forest
590154	CEGL002012	*Tilia americana*-(*Quercus macrocarpa*)/*Ostrya virginiana* Forest
590159	CEGL002012	*Tilia americana*-(*Quercus macrocarpa*)/*Ostrya virginiana* Forest
591004	CEGL000659	*Populus deltoides*-(*Salix amygdaloides*)/*Salix* (*exigua*, *interior*) Floodplain Woodland
591005	CEGL005264	*Bromus inermis*-(*Pascopyrum smithii*) Ruderal Grassland
591006	CEGL002014	*Fraxinus pennsylvanica*-*Ulmus* spp.-*Celtis occidentalis* Floodplain Forest
591007	CEGL000947	*Salix amygdaloides* Riparian Woodland
591008	CEGL002047	Siltstone-Sandstone Rock Outcrop Sparse Vegetation
591009	no good association fit	–
591010	CEGL002025	*Andropogon gerardii*-*Sorghastrum nutans*-*Hesperostipa spartea* Loess Hills Grassland
591011	CEGL002036	*Schizachyrium scoparium*-*Bouteloua curtipendula* Loess Mixedgrass Grassland
591021	CEGL002014	*Fraxinus pennsylvanica*-*Ulmus* spp.-*Celtis occidentalis* Floodplain Forest
591022	CEGL001474	*Phalaris arundinacea* Western Marsh
591023	no good association fit	–
591024	no good association fit	–
592001	no good association fit	–
592006	CEGL001454	*Populus deltoides*/*Panicum virgatum*-*Schizachyrium scoparium* Floodplain Woodland
592007	CEGL005269	*Elaeagnus angustifolia* Ruderal Riparian Woodland
592008	CEGL005269	*Elaeagnus angustifolia* Ruderal Riparian Woodland

Classification Plot code	USNVC or Park Special Classified Code	Scientific Name
592009	no good association fit	–
592017	CEGL002023	*Andropogon gerardii-Panicum virgatum* Sandhills Grassland
592019	CEGL002014	*Fraxinus pennsylvanica-Ulmus* spp.-*Celtis occidentalis* Floodplain Forest
592021	CEGL002205	*Andropogon gerardii-Schizachyrium scoparium* Northern Plains Grassland
592022	CEGL000658	*Populus deltoides-Fraxinus pennsylvanica* Floodplain Forest

Appendix E. Vegetation Classification Plot Field Form

PLOT LOCATION AND DESCRIPTION

Plot Code: MNRR.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 MNRR

MNRR VEGETATION SAMPLING **PLOT CODE MNRR.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 MNRR

SPECIES LIST PlotCode MNRR.VMP._____

Stratum Codes			
T1 Emergent	S1 Tall Shrub	H1 Graminoids	N Non-vascular
T2 Canopy	S2 Short Shrub	H2 Forbs	V Vine/liana
T3 Sub-canopy	S3 Dwarf-shrub	H3 Ferns	E Epiphyte
		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 MNRR

Appendix F. Accuracy Assessment Field Form

MNRR ACCURACY ASSESSMENT PLOT FORM
(Data were collected using a digital field form in Collector for ArcGIS; digital field form was based off this form)

AA Point Code: MNRR-_____ 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 MNRR

MNRR 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%
01	<0.5 m	P	>1-5%
02	0.5-1m	1	>5-15%
03	1-2 m	2	>15-25%
04	2-5 m	3	>25-35%
05	5-10 m	4	>35-45%
06	10-15 m	5	>45-55%
07	15-20 m	6	>55-65%
08	20-35 m	7	>65-75%
09	35-50 m	8	>75-85%
10	>50 m	9	>85-95%
		10	> 95%

Second page of the accuracy assessment point form used at MNRR

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 MNRR (k=known, p=potential)	NatureServe Element Code
Deciduous Forest	*Acer saccharum - Tilia americana* - (*Quercus rubra*) Forest Alliance	A.220	*Tilia americana - (Quercus macrocarpa) / Ostrya virginiana* Forest	Bur Oak - Basswood - Ironwood Forest	–	k	CEGL002012
	Fraxinus pennsylvanica - Ulmus americana - Celtis (*occidentalis, laevigata*) Temporarily Flooded Forest Alliance	A.286	*Fraxinus pennsylvanica - Ulmus americana - (Acer negundo, Tilia americana)* Northern Forest	–	w	p	CEGL002089
	Fraxinus pennsylvanica - Ulmus americana - Celtis (*occidentalis, laevigata*) Temporarily Flooded Forest Alliance	A.286	*Fraxinus pennsylvanica - Ulmus* spp. - *Celtis occidentalis* Forest	Eastern Riparian Forest	w	k	CEGL002014
	Fraxinus pennsylvanica - (*Ulmus americana*) Forest Alliance	A.259	*Fraxinus pennsylvanica - Ulmus americana / Symphoricarpos occidentalis* Forest	–	–	p	CEGL002082
	Populus deltoides Temporarily Flooded Forest Alliance	A.290	*Populus deltoides / Cornus sericea* Forest	Eastern Cottonwood- Dogwood Riparian Woodland	w	k	CEGL000657
	Populus deltoides Temporarily Flooded Forest Alliance	A.290	*Populus deltoides - Fraxinus pennsylvanica* Forest	–	w	k	CEGL000658
	Populus tremuloides Forest Alliance	A.274	*Populus tremuloides - Quercus macrocarpa / Aralia nudicaulis* Forest	–	–	p	CEGL002065

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 MNRR (k=known, p=potential)	NatureServe Element Code
Deciduous Forest (continued)	*Quercus alba* - (*Quercus rubra, Carya* spp.) Forest Alliance	A.239	*Quercus alba - (Quercus velutina) - Carya ovata / Ostrya virginiana* Forest	–	–	p	CEGL002011
	Quercus macrocarpa Forest Alliance	A.245	*Quercus macrocarpa / (Amelanchier alnifolia, Cornus drummondii) / Aralia nudicaulis* Forest	Dry-Mesic Bur Oak Forest and Woodland	–	k	CEGL002072
Evergreen Woodland	*Juniperus scopulorum* Woodland Alliance	A.506	–	–	–	p	–
	Pinus ponderosa Woodland Alliance	A.530	–	–	–	p	–
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
	Fraxinus pennsylvanica - (*Ulmus americana*) Woodland Alliance	A.629	*Fraxinus pennsylvanica - Ulmus americana / Prunus virginiana* Woodland	Green ash - Elm - Hackberry Canyon Bottom Woodland	–	p	CEGL000643
	Quercus macrocarpa Woodland Alliance	A.620	*Quercus macrocarpa / Andropogon gerardii - Hesperostipa spartea* Woodland	Dry-Mesic Bur Oak Forest and Woodland	–	k	CEGL002053
	Quercus macrocarpa Woodland Alliance	A.620	*Quercus macrocarpa / Andropogon gerardii - Panicum virgatum* Woodland	–	–	p	CEGL002052
	Salix amygdaloides Temporarily Flooded Woodland Alliance	A.645	*Salix amygdaloides* Woodland	–	w	p	CEGL000947

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 MNRR (k=known, p=potential)	NatureServe Element Code
Deciduous Woodland (continued)	*Salix amygdaloides* Temporarily Flooded Woodland Alliance	A.645	–	Cottonwood -Diamond Willow Woodland	–	k	–
Evergreen Shrubland	*Artemisia cana* Temporarily Flooded Shrubland Alliance	A.843	–	–	w	p	–
Deciduous Shrubland	*Betula pumila* - (*Salix* spp.) Saturated Shrubland Alliance	A.1021	*Betula pumila* - *Salix* spp. Prairie Fen Shrubland	–	w	p	CEGL002189
	Cornus sericea Temporarily Flooded Shrubland Alliance	A.968	–	–	w	p	–
	Cornus sericea Temporarily Flooded Shrubland Alliance	A.968	*Cornus drummondii* - *Amorpha fruticosa* - *Cornus sericea* Shrubland	Riparian Dogwood-False Indigobush Shrubland	w	k	CEGL005220
	Prunus virginiana Shrubland Alliance	A.919	*Prunus virginiana* - *(Prunus americana)* Shrubland	Chokecherry - Plum Shrub Thicket	–	p	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
	Symphoricarpos occidentalis Temporarily Flooded Shrubland Alliance	A.961	*Symphoricarpos occidentalis* Shrubland	Buckbrush Shrubland	w	p	CEGL001131

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 MNRR (k=known, p=potential)	NatureServe Element Code
Perennial Graminoid Vegetation	*Andropogon gerardii* - (*Calamagrostis canadensis, Panicum virgatum*) Herbaceous Alliance	A.1191	*Andropogon gerardii - Panicum virgatum - Helianthus grosseserratus* Herbaceous Vegetation	Lowland Tallgrass Prairie	–	k	CEGL002024
	Andropogon gerardii - (*Calamagrostis canadensis, Panicum virgatum*) Herbaceous Alliance	A.1191	*Andropogon gerardii - (Panicum virgatum) - Muhlenbergia richardsonis* Herbaceous Vegetation	–	–	p	CEGL002199
	Andropogon gerardii - (*Calamagrostis canadensis, Panicum virgatum*) Herbaceous Alliance	A.1191	*Andropogon gerardii - Panicum virgatum* Sand*hills* Herbaceous Vegetation	–	–	p	CEGL002023
	Andropogon gerardii - (*Sorghastrum nutans*) Herbaceous Alliance	A.1192	*Andropogon gerardii - Hesperostipa spartea - Sporobolus heterolepis* Herbaceous Vegetation	–	–	p	CEGL002202
	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 - Schizachyrium scoparium* Northern Plains Herbaceous Vegetation	–	–	p	CEGL002205
	Andropogon gerardii - (*Sorghastrum nutans*) Herbaceous Alliance	A.1192	*Andropogon gerardii - Sorghastrum nutans - Hesperostipa spartea* Loess Hills Herbaceous Vegetation	Upland Tallgrass Prairie	–	k	CEGL002025

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 MNRR (k=known, p=potential)	NatureServe Element Code
Perennial Graminoid Vegetation (continued)	*Andropogon gerardii* - (*Sorghastrum nutans*) Herbaceous Alliance	A.1192	*Andropogon gerardii* - *Sorghastrum nutans* - *(Sporobolus heterolepis)* - *Liatris* spp. - *Ratibida pinnata* Herbaceous Vegetation	Lowland Tallgrass Prairie	–	k	CEGL002203
	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	–	p	CEGL001467
	Calamagrostis canadensis Seasonally Flooded Herbaceous Alliance	A.1400	–	–	–	–	–
	Calamovilfa longifolia Herbaceous Alliance	A.1201	*Calamovilfa longifolia* - *Hesperostipa comata* Herbaceous Vegetation	Eastern Sand Prairie and Sandhills Dry Valley Prairie	–	k	CEGL001473
	Carex aquatilis Seasonally Flooded Herbaceous Alliance	A.1404	*Carex aquatilis* - *Carex* spp. Herbaceous Vegetation	–	w	k	CEGL002262
	Carex atherodes Seasonally Flooded Herbaceous Alliance	A.1396	*Carex atherodes* Herbaceous Vegetation	–	w	k	CEGL002220
	Carex (*rostrata, utriculata*) Seasonally Flooded Herbaceous Alliance	A.1403	*Carex (rostrata, utriculata)* - *Carex lacustris* - *(Carex vesicaria)* Herbaceous Vegetation	–	w	p	CEGL002257

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 MNRR (k=known, p=potential)	NatureServe Element Code
Perennial Graminoid Vegetation (continued)	*Carex nebrascensis* Seasonally Flooded Herbaceous Alliance	A.1417	–	–	w	p	–
	Carex lasiocarpa Saturated Herbaceous Alliance	A.1453	*Carex lasiocarpa* - *Calamagrostis* spp. - *(Eleocharis rostellata)* Herbaceous Vegetation	–	w	p	CEGL002383
	Carex pellita - (*Carex nebrascensis*) - *Schoenoplectus* spp. Saturated Herbaceous Alliance	A.1466	*Carex pellita* - *Carex* spp. - *Schoenoplectus tabernaemontani* Fen Herbaceous Vegetation	–	w	p	CEGL002041
	Carex pellita - (*Carex nebrascensis*) - *Schoenoplectus* spp. Saturated Herbaceous Alliance	A.1466	*Carex interior* - *Eleocharis elliptica* - *Thelypteris palustris* Herbaceous Vegetation	–	w	p	CEGL002390
	Carex pellita Seasonally Flooded Herbaceous Alliance	A.1414	*Carex pellita* - *Calamagrostis stricta* Herbaceous Vegetation	–	w	p	CEGL002254
	Carex pellita Seasonally Flooded Herbaceous Alliance	A.1414	*Carex* spp. - *(Carex pellita, Carex vulpinoidea)* Herbaceous Vegetation	Eastern Sedge Wet Meadow	w	k	CEGL005272
	Carex spp. - *Plantago eriopoda* Temporarily Flooded Herbaceous Alliance	A.1350	*Calamagrostis stricta* - *Carex sartwellii* - *Carex praegracilis* - *Plantago eriopoda* Saline Herbaceous Vegetation	–	w	p	CEGL002255
	Carex spp. - *Typha* spp. Saturated Herbaceous Alliance	A.1465		–	w	p	–

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 MNRR (k=known, p=potential)	NatureServe Element Code
Perennial Graminoid Vegetation (continued)	*Carex* spp. - *Typha* spp. Saturated Herbaceous Alliance	A.1465	*Typha latifolia - Equisetum hyemale - Carex (hystericina, pellita)* Seep Herbaceous Vegetation	Freshwater Seep	w	k	CEGL002033
	Carex spp. Saturated Herbaceous Alliance	A.1455	*Carex prairea - Schoenoplectus pungens - Rhynchospora capillacea* Herbaceous Vegetation	–	w	p	CEGL002267
	Carex spp. Saturated Herbaceous Alliance	A.1455	*Carex* spp. - *Triglochin maritima - Eleocharis quinqueflora* Marl Fen Herbaceous Vegetation	–	w	p	CEGL002268
	Distichlis spicata - (*Hordeum jubatum*) Temporarily Flooded Herbaceous Alliance	A.1341	*Distichlis spicata - (Hordeum jubatum, Poa arida, Sporobolus airoides)* Herbaceous Vegetation	–	w	p	CEGL002042
	Distichlis spicata - (*Hordeum jubatum*) Temporarily Flooded Herbaceous Alliance	A.1341	*Distichlis spicata - Hordeum jubatum - (Poa arida, Iva annua)* Herbaceous Vegetation	–	w	p	CEGL002031
	Distichlis spicata - (*Hordeum jubatum*) Temporarily Flooded Herbaceous Alliance	A.1341	*Distichlis spicata - Schoenoplectus maritimus - Salicornia rubra* Herbaceous Vegetation	–	w	p	CEGL002043
	Distichlis spicata - (*Hordeum jubatum*) Temporarily Flooded Herbaceous Alliance	A.1341	*Distichlis spicata - Hordeum jubatum - Puccinellia nuttalliana - Suaeda calceoliformis* Herbaceous Vegetation	–	w	p	CEGL002273

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 MNRR (k=known, p=potential)	NatureServe Element Code
Perennial Graminoid Vegetation (continued)	*Hesperostipa comata* - *Bouteloua gracilis* Herbaceous Alliance	A.1234	*Hesperostipa comata* - *Bouteloua gracilis* - *Carex filifolia* Herbaceous Vegetation	Threadleaf Sedge Western Mixedgrass Prairie	–	p	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
	Pascopyrum smithii Herbaceous Alliance	A.1232	*Pascopyrum smithii* - *Hesperostipa comata Central* Mixedgrass Herbaceous Vegetation	–	–	p	CEGL002034
	Pascopyrum smithii Herbaceous Alliance	A.1232	*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
	Pascopyrum smithii Temporarily Flooded Herbaceous Alliance	A.1354	*Polygonum* spp. - *Echinochloa* spp. - *Distichlis spicata* Playa Lake Herbaceous Vegetation	–	w	p	CEGL002039

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 MNRR (k=known, p=potential)	NatureServe Element Code
Perennial Graminoid Vegetation (continued)	*Phragmites australis* Semipermanently Flooded Herbaceous Alliance	A.1431	*Phragmites australis* Western North America Temperate Semi-natural Herbaceous Vegetation	Reed Marsh	w	k	CEGL001475
	Quercus macrocarpa - (*Quercus alba*) Wooded Herbaceous Alliance	A.1491	*Quercus macrocarpa - (Quercus alba, Quercus stellata) / Andropogon gerardii* Wooded Herbaceous Vegetation	–	–	p	CEGL002159
	Quercus macrocarpa - (*Quercus alba*) Wooded Herbaceous Alliance	A.1491	*Quercus macrocarpa* Northern Tallgrass Wooded Herbaceous Vegetation	–	–	p	CEGL002158
	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		k	CEGL002035
	Schizachyrium scoparium - Bouteloua curtipendula Herbaceous Alliance	A.1225	*Schizachyrium scoparium - Bouteloua curtipendula - Hesperostipa spartea - (Pascopyrum smithii)* Herbaceous Vegetation	–	–	p	CEGL002377

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 MNRR (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* spp. *- Hesperostipa spartea* Gravel Herbaceous Vegetation	–	–	p	CEGL002499
	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
	Schoenoplectus acutus - (*Schoenoplectus tabernaemontani*) Semipermanently Flooded Herbaceous Alliance	A.1443	*Schoenoplectus acutus - (Schoenoplectus fluviatilis)* Freshwater Herbaceous Vegetation	–	w	p	CEGL002225
	Schoenoplectus maritimus Semipermanently Flooded Herbaceous Alliance	A.1444	*Schoenoplectus maritimus - Schoenoplectus acutus - (Triglochin maritima)* Herbaceous Vegetation	–	w	p	CEGL002227

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 MNRR (k=known, p=potential)	NatureServe Element Code
Perennial Graminoid Vegetation (continued)	*Schoenoplectus pungens* Semipermanently Flooded Herbaceous Alliance	A.1433	*Schoenoplectus pungens* Herbaceous Vegetation	–	w	p	CEGL001587
	Schoenoplectus pungens Semipermanently Flooded Herbaceous Alliance	A.1433	*Schoenoplectus pungens - Suaeda calceoliformis* Alkaline Herbaceous Vegetation	–	w	p	CEGL002040
	Spartina pectinata Temporarily Flooded Herbaceous Alliance	A.1347	*Calamagrostis canadensis - Juncus* spp. - *Carex* spp. Sand*hills* 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	p	CEGL002027
	Spartina pectinata Temporarily Flooded Herbaceous Alliance	A.1347	*Spartina pectinata - Carex* spp. Herbaceous Vegetation		w	p	CEGL001477
	Spartina pectinata Temporarily Flooded Herbaceous Alliance	A.1347	*Spartina pectinata - Carex* spp. *- Calamagrostis canadensis - Lythrum alatum - (Oxypolis rigidior)* Herbaceous Vegetation	Eastern Cordgrass Wet Prairie	w	k	CEGL002224
	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	*Schoenoplectus acutus - Typha latifolia - (Schoenoplectus tabernaemontani)* Sandhills Herbaceous Vegetation	–	w	p	CEGL002030

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 MNRR (k=known, p=potential)	NatureServe Element Code
Perennial Graminoid Vegetation (continued)	*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	k	CEGL002228
	Typha (*angustifolia, latifolia*) - (*Schoenoplectus* spp.) Semipermanently Flooded Herbaceous Alliance	A.1436	*Typha* spp. - *Schoenoplectus acutus* - Mixed Herbs *Midwest* Herbaceous Vegetation	–	w	p	CEGL002229
	Typha (*angustifolia, latifolia*) - (*Schoenoplectus* spp.) Semipermanently Flooded Herbaceous Alliance	A.1436	*Typha* spp. Great Plains Herbaceous Vegetation	Eastern Bulrush Deep Marsh	w	k	CEGL002389
	Typha (*angustifolia, latifolia*) - (*Schoenoplectus* spp.) Semipermanently Flooded Herbaceous Alliance	A.1436	*Typha* spp. Midwest Herbaceous Vegetation	–	w	p	CEGL002233
	Typha spp. – (*Schoenoplectus* spp., *Juncus* spp.) Seasonally Flooded Herbaceous Alliance	A.1394	–	–	w	p	–
	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

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 MNRR (k=known, p=potential)	NatureServe Element Code
Perennial Graminoid Vegetation (continued)	*Yucca glauca* Shrub Herbaceous Alliance	A.1540	*Yucca glauca / Calamovilfa longifolia* Shrub Herbaceous Vegetation	–	–	k	CEGL002675
	Yucca glauca Shrub Herbaceous Alliance	A.1540	–	Missouri River Floodplain Terrace Grassland	–	k	–
	Yucca glauca Shrub Herbaceous Alliance	A.1540	–	Missouri River Valley Dune Grassland	–	k	–
Hydromorphic-Rooted Vegetation	*Sagittaria latifolia* Semipermanently Flooded Herbaceous Alliance	A.1675	*Sagittaria latifolia - Leersia oryzoides* Herbaceous Vegetation	–	w	p	CEGL005240
	Lemna spp. Permanently Flooded Herbaceous Alliance	A.1747	*Lemna* spp. Permanently Flooded Herbaceous Vegetation	–	w	p	CEGL003059
	Nelumbo lutea Permanently Flooded Temperate Herbaceous Alliance	A.1671	*Nelumbo lutea* Herbaceous Vegetation	American Lotus Aquatic Wetland	w	p	CEGL004323
	Nymphaea odorata - Nuphar spp. Permanently Flooded Temperate Herbaceous Alliance	–	*Nymphaea odorata - Nuphar (microphylla, variegata)* Herbaceous Vegetation	Water-lily Aquatic wetland	w	p	CEGL002562
	Potamogeton spp. - *Ceratophyllum* spp. - *Elodea* spp. Permanently Flooded Herbaceous Alliance	A.1754	*Potamogeton* spp. - *Ceratophyllum demersum* Great Plains Herbaceous Vegetation	Eastern Pondweed Aquatic Wetland	w	k	CEGL002044

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 MNRR (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* spp. Midwest Herbaceous Vegetation	–	w	p	CEGL002282
	Stuckenia pectinata Permanently Flooded Herbaceous Alliance	A.1764	*Stuckenia pectinata* - *Ruppia maritima* Herbaceous Vegetation	–	w	p	CEGL002004
Consolidated Rock + Sparse Vegetation	*Open Cliff Sparsely* Vegetated Alliance	A.1836	Limestone - Dolostone Great Plains Xeric Cliff Sparse Vegetation	Northern Chalk Bluff and Cliff	–	k	CEGL002046
	Open Cliff Sparsely Vegetated Alliance	A.1836	Sandstone Dry Cliff Sparse Vegetation	Eastern Sandstone Bluff		k	CEGL002045
	Rock Outcrop Sparsely Vegetated Alliance	A.1838	Quartzite - Granite Rock Outcrop Sparse Vegetation	–	–	p	CEGL002298
	Rock Outcrop Sparsely Vegetated Alliance	A.1838	Shale Barren Slopes Sparse Vegetation	–	–	p	CEGL002294
	Rock Outcrop Sparsely Vegetated Alliance	A.1838	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	–	–	p	CEGL005223
Unconsolidated Material Sparse Vegetation	Sand Flats Temporarily Flooded Sparsely Vegetated Alliance	A.1864	–	–	w	p	–
	Sand Flats Temporarily Flooded Sparsely Vegetated Alliance	A.1864	Riverine Sand Flats - Bars Sparse Vegetation	Sandbar/Mudflat	w	k	CEGL002049

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 MNRR (k=known, p=potential)	NatureServe Element Code
Unconsolidated Material Sparse Vegetation (continued)	Lowland Talus Sparsely Vegetated Alliance	A.1847	–	–	–	p	–
	Large Eroding Bluffs Sparsely Vegetated Alliance	A.1875	Eroding Great Plains Badlands Sparse Vegetation	–	–	p	CEGL002050
Semi Natural Vegetation	*Phragmites australis* Semi-permanently Flooded Herbaceous Alliance	A.1431	*Phragmites australis* Western North America Temperate *Semi-natural* Herbaceous Vegetation	–	–	–	CEGL001475
	Juniperus virginiana Semi-natural Forest Alliance	A.137	–	–	–	–	–
	Elaeagnus angustifolia Semi-natural Woodland Alliance	A.3566	–	–	–	–	–
	Bromus inermis Semi-natural Herbaceous Alliance	A.3561	–	–	–	–	–

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 H-1. Initial contingency table using raw accuracy assessment plot data. 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 H-2. Revised contingency tables using reconciled accuracy assessment data. 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 H-3. Accuracy contingency table using final aggregated map classes. 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

Agricultural Vegetation, Cultivated Crops

Map Code: LC001

Color: brown, tan, or green

Texture: smooth with linear features (rows)

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: –

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery.

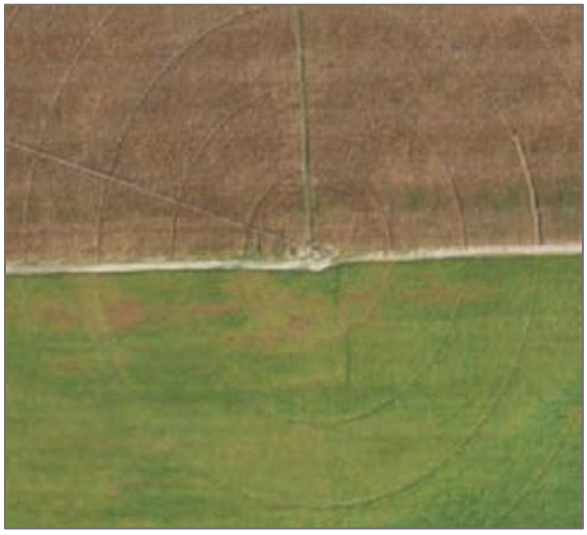

Photo signature example of the Agricultural Vegetation, Cultivated Crops map class.

Agricultural Vegetation, Pasture Land/Hay Field

Map Code: LC002

Color: brown and green

Texture: very smooth with linear features (swather lines)

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: Hay bales are often present in the imagery.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery.

Photo signature example of the Agricultural Vegetation, Pasture Land/Hay Field map class.

Non-vegetated, (Barren Land, Cut Bank, Borrow Pit)

Map Code: LC003

Color: brown, tan and sandy in color

Texture: moderate

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: Equipment often present in imagery.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the Non-vegetated, (Barren Land, Cut Bank, Borrow Pit) map class.

Developed, Open Space

Map Code: LC004

Color: variable

Texture: smooth

Crown Size: n/a

Crown Shape: n/a

Density: low to moderate

Notes: -

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the Developed, Open Space map class.

Developed, (Low, Medium, High) Intensity

Map Code: LC005

Color: variable

Texture: smooth, buildings, roads

Crown Size: n/a

Crown Shape: n/a

Density: low to moderate

Notes: -

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the Developed, (Low, Medium, High) Intensity map class.

Water

Map Code: LC006

Color: blue, gray, green

Texture: smooth, occasionally rough if chop on the water

Crown Size: n/a

Crown Shape: n/a

Density: moderate

Notes: -

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

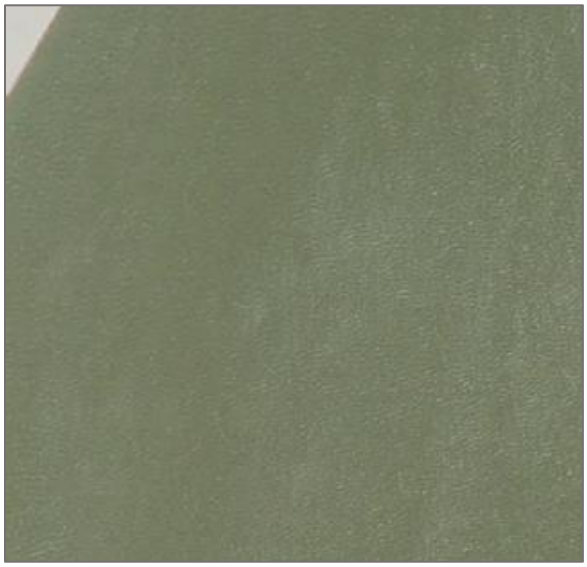

Photo signature example of the Water map class.

Ruderal Herbaceous Grassland

Map Code: MC101

Color: green, brown

Texture: low to smooth

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: Variety of textures and colors within ruderal grasslands.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the Ruderal Herbaceous Grassland map class.

Schizachyrium scoparium - Bouteloua (*curtipendula, gracilis*) Mixedgrass Grassland

Map Code: MC102

Color: green and brown, occasional orange tint

Texture: low to moderate

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: Orangish tint signature is mature little bluestem.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Schizachyrium scoparium - Bouteloua* (*curtipendula*, *gracilis*) Mixedgrass Grassland map class.

Andropogon gerardii Tall Grass Prairie Grassland

Map Code: MC103

Color: greenish brown

Texture: smooth

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: -

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Andropogon gerardii* Tall Grass Prairie Grassland map class.

Hesperostipa comata - Pascopyrum smithii Mixedgrass Grassland

Map Code: MC104

Color: green, brown, tan, dark green

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: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Hesperostipa comata - Pascopyrum smithii* Mixedgrass Grassland map class.

Marsh Complex

Map Code: MC105

Color: dark brown, dark green, light green, blue green, tan

Texture: smooth to coarse

Crown Size: n/a

Crown Shape: n/a

Density: high

Notes: Varied texture and color within this complex of NVCS types. Standing water is often present within the images.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the Marsh Complex map class.

Phalaris arundinacea Western Marsh

Map Code: MC105a

Color: dark brown, tan, light green

Texture: smooth

Crown Size: n/a

Crown Shape: n/a

Density: high

Notes: Varied texture and color within this type. Typically brown to tan with a smooth texture.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Phalaris arundinacea* Western Marsh map class.

Phragmites australis Western Ruderal Wet Meadow

Map Code: MC105b

Color: blueish green

Texture: smooth to coarse

Crown Size: n/a

Crown Shape: n/a

Density: high

Notes: Bluish green signature represents the invasive *Phragmites australis*.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Phragmites australis* Western Ruderal Wet Meadow map class.

Typha spp., *Schoenoplectus* spp. Great Plains Marsh

Map Code: MC105c

Color: dark green, dark brown, light green

Texture: coarse

Crown Size: n/a

Crown Shape: n/a

Density: high

Notes: - Varied texture and color within. Typically darker than adjacent communities. Standing water is often present within the images.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Typha* spp., *Schoenoplectus* spp. Great Plains Marsh map class.

Carex spp., *Juncus* spp., *Eleocharis* spp. Wet Meadow

Map Code: MC105d

Color: dark brown, dark green, light green, tan

Texture: smooth **Crown Size:** n/a

Crown Shape: n/a

Density: low

Notes: Varied texture and color within this type. Lower growing community with a smoother overall texture.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Carex* spp., *Juncus* spp., *Eleocharis* spp. Wet Meadow map class.

Salix interior Wet Shrubland

Map Code: MC201

Color: green, dark green

Texture: moderate

Crown Size: small to moderate

Crown Shape: flat, matted

Density: moderate to high

Notes: Varied texture, occasional taller cottonwood or Russian olive may be present within the image.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Salix interior* Wet Shrubland map class.

Cornus drummondii - Amorpha fruticosa - Cornus sericea Wet Shrubland

Map Code: MC202

Color: green and brown

Texture: low

Crown Size: small

Crown Shape: round

Density: moderate

Notes: Varied texture, darker brown coloration below shrub canopy.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Cornus drummondii - Amorpha fruticosa - Cornus sericea* Wet Shrubland map class.

Cornus drummondii - *Prunus* spp. Shrubland

Map Code: MC203

Color: brown, green, dark green

Texture: low to moderately coarse

Crown Size: small to medium

Crown Shape: round

Density: low

Notes: Patches of small to medium sized round shrub canopies. Coloration varies from dark to light green.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Cornus drummondii* - *Prunus* spp. Shrubland map class.

Symphoricarpos occidentalis Shrubland

Map Code: MC204

Color: green, tan, brown

Texture: moderate

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: Low, varied texture of green and tan. Cattle also present in imagery example.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Symphoricarpos occidentalis* Shrubland map class.

Rhus glabra Mixedgrass Shrubland

Map Code: MC205

Color: reddish brown

Texture: smooth

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: Images acquired during fall senescence period captured the red tone color phase of the *Rhus glabra* shurbland.

Imagery Used: 2016 NAIPS, 2015 Cornerstone Imagery.

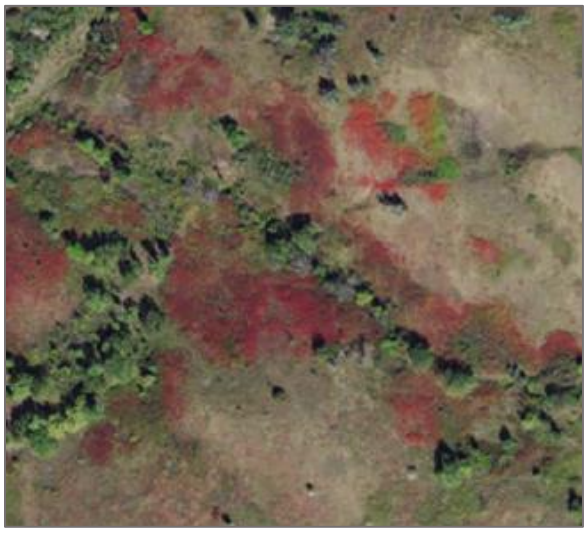

Photo signature example of the *Rhus glabra* Mixedgrass Shrubland map class.

Populus deltoides Ruderal Forest and Woodland

Map Code: MC301

Color: green, light green

Texture: moderately coarse

Crown Size: moderate to large

Crown Shape: irregular

Density: moderate to high

Notes: Large cottonwood crowns with smaller, silver Russian olive in the understory. Dead cottonwood skeletons are usually present in the image given the degraded nature of this community.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Populus deltoides* Ruderal Forest and Woodland map class.

Populus deltoides Floodplain Forest and Woodland

Map Code: MC302

Color: green, light green

Texture: moderate to highly coarse

Crown Size: moderate to large

Crown Shape: irregular

Density: 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 *Populus deltoides* Floodplain Forest and Woodland map class.

Populus deltoides / *Cornus drummondi* Open Floodplain Forest

Map Code: MC303

Color: green

Texture: moderately coarse

Crown Size: moderate

Crown Shape: round

Density: moderate

Notes: Open canopy forest with large cottonwoods. Understory contains a dense shrub layer dominated by rough-leaf dogwood.

Imagery Used: 2016 NAIPS.

Photo signature example of the *Populus deltoides* / *Cornus* drummondi Open Floodplain Forest map class.

Populus deltoides / *Juniperus virginiana* Floodplain Forest and Woodland

Map Code: MC304

Color: dark green

Texture: moderately coarse

Crown Size: small

Crown Shape: round

Density: moderate to high

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 *Populus deltoides* / *Juniperus virginiana* Floodplain Forest and Woodland map class.

Populus deltoides - Salix amygdaloides Floodplain Woodland and Forest

Map Code: MC305

Color: green, dark green

Texture: moderately very coarse

Crown Size: small

Crown Shape: irregular

Density: moderate

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 *Populus deltoides - Salix amygdaloides* Floodplain Woodland and Forest map class.

Fraxinus pennsylvanica - *Ulmus* spp. - *Celtis occidentalis* Floodplain Forest and Woodland

Map Code: MC306

Color: dark green, light green

Texture: small to moderately coarse

Crown Size: small to moderate

Crown Shape: round

Density: high

Notes: Varied canopy without the large, round cottonwood crowns. Mixture of greens and yellows dominate the diverse forest canopy.

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Fraxinus pennsylvanica* - *Ulmus* spp. - *Celtis occidentalis* Floodplain Forest and Woodland map class.

Fraxinus pennsylvanica Ruderal Forest and Woodland

Map Code: MC307

Color: dark green

Texture: moderately coarse

Crown Size: small

Crown Shape: triangular, round

Density: high

Notes: Were available, wintertime, leaf-off imagery was used to see the evergreen red cedar shrubs under the green ash canopy. Russian olives were also visible in certain images.

Imagery Used: Leaf-off Google Earth Imagery, 2016 NAIPS, 2015 Cornerstone Imagery.

Photo signature example of the *Fraxinus pennsylvanica* Ruderal Forest and Woodland map class.

Juniperus virginiana Midwest Ruderal Woodland and Forest

Map Code: MC308

Color: dark green

Texture: moderately coarse

Crown Size: moderate to large

Crown Shape: triangular

Density: low to extreme

Notes: Were available, wintertime, leaf-off imagery was used to see the evergreen red cedar shrubs and trees. NIR imagery was also used as red cedar had a dark red signature.

Imagery Used: Leaf-off Google Earth Imagery, 2016 NAIPS, 2015 Cornerstone Imagery.

Photo signature example of the *Juniperus virginiana* Midwest Ruderal Woodland and Forest map class.

Elaeagnus angustifolia Ruderal Riparian Woodland and Forest

Map Code: MC309

Color: bluish green to silver gray

Texture: moderately coarse

Crown Size: small

Crown Shape: irregular to round

Density: low to moderate

Notes: Bluish green to silver-gray in color

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Elaeagnus angustifolia* Ruderal Riparian Woodland and Forest map class.

Quercus macrocarpa Dry Mesic Upland Forest

Map Code: MC310

Color: pinks, reds, grays

Texture: moderately coarse

Crown Size: moderate to large

Crown Shape: irregular

Density: high

Notes: Were available, the 2015 Cornerstone imagery that was acquired for the project was used. Bur oak communities appeared pink to tan.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIPS, Google Earth Imagery.

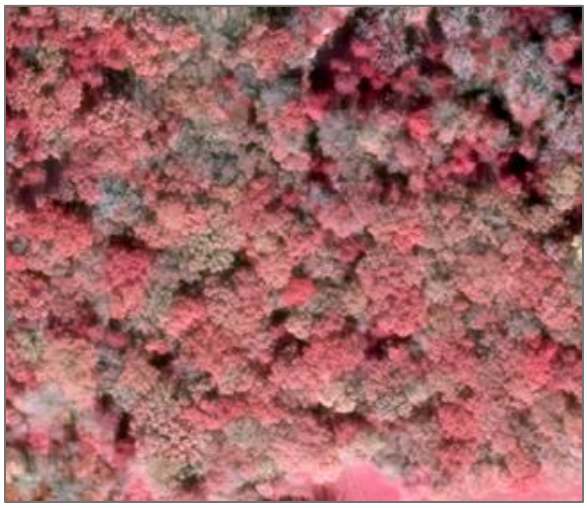

Photo signature example of the *Quercus macrocarpa* Dry Mesic Upland Forest map class.

Tilia americana - (*Quercus macrocarpa*) / *Ostrya virginiana* Forest

Map Code: MC311

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: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Tilia americana* - (*Quercus macrocarpa*) / *Ostrya virginiana* Forest map class.

Quercus macrocarpa / *Juniperus virginiana* Ruderal Forest and Woodland

Map Code: MC312

Color: pink, red, gray, dark red

Texture: moderately coarse

Crown Size: moderate to large

Crown Shape: round

Density: high

Notes: Were available, the 2015 Cornerstone imagery that was acquired for the project was used. Bur oak communities appeared pink to tan while the red cedar understory appeared dark red.

Imagery Used: 2015 Cornerstone Imagery, 2016 NAIPS, Google Earth Imagery.

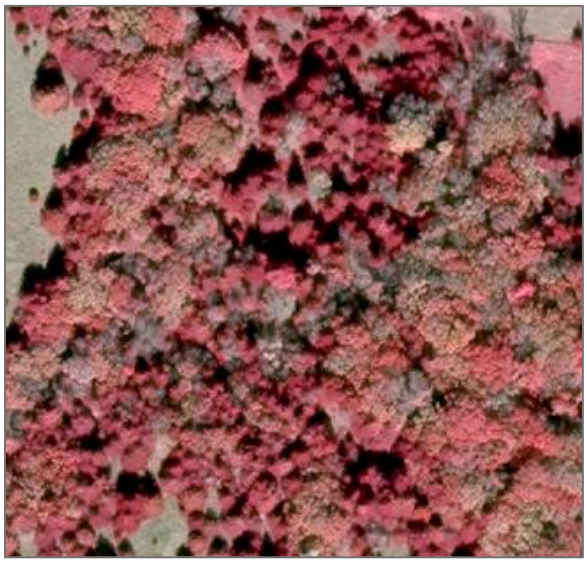

Photo signature example of the *Quercus macrocarpa* / *Juniperus virginiana* Ruderal Forest and Woodland map class.

Quercus macrocarpa Woodland and Wooded Grassland

Map Code: MC313

Color: dark green

Texture: moderate

Crown Size: moderate

Crown Shape: round

Density: low to moderate

Notes: -

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the *Quercus macrocarpa* Woodland and Wooded Grassland map class.

Riverine Sparse Bar Vegetation

Map Code: MC401

Color: tan

Texture: smooth

Crown Size: n/a

Crown Shape: n/a

Density: low

Notes: -

Imagery Used: 2016 NAIP Imagery, 2015 Cornerstone Imagery, Google Earth Imagery.

Photo signature example of the Riverine Sparse Bar Vegetation map class.

Sparse Cliff Vegetation

Map 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 Sparse Cliff Vegetation map class.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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National Park Service
U.S. Department of the Interior

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