Natural Resources
Conservation Service

Ecological site F104XY020IA
Loamy Floodplain Forest

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General information

Provisional. A provisional ecological site description has undergone quality control and quality assurance review. It contains a working state and transition model and enough information to identify the ecological site.

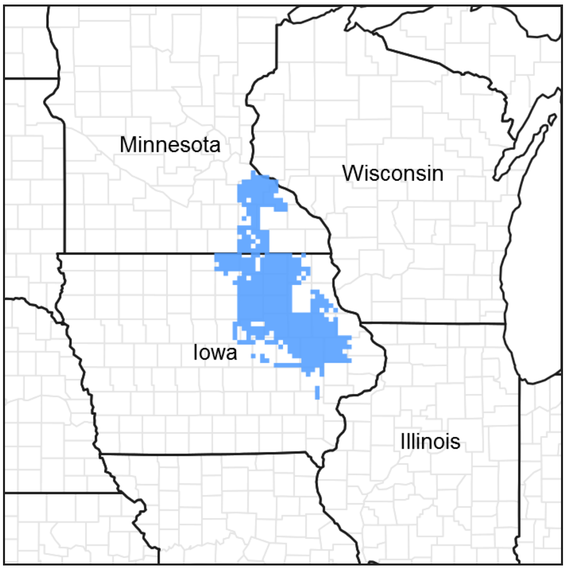


Figure 1. Mapped extent

Areas shown in blue indicate the maximum mapped extent of this ecological site. Other ecological sites likely occur within the highlighted areas. It is also possible for this ecological site to occur outside of highlighted areas if detailed soil survey has not been completed or recently updated.

MLRA notes

Major Land Resource Area (MLRA): 104X–Eastern Iowa and Minnesota Till Prairies

The Eastern Iowa and Minnesota Till Prairies (MLRA 104) includes the Iowan Surface, Oak Savanna, and Western Coulee and Ridges landforms (Prior 1991; MDNR 2005; WDNR 2015). It spans three states (Iowa, 74 percent; Minnesota, 22 percent; Wisconsin, 4 percent), encompassing approximately 9,660 square miles (Figure 1). The elevation ranges from approximately 1,310 feet above sea level (ASL) on the highest ridges to about 985 feet ASL in the lowest valleys. Local relief is mainly 10 to 20 feet. Glacial till and outwash deposits cover the uplands of the MLRA with recent alluvium located in the major river valleys. Paleozoic bedrock sediments, comprised primarily of shale and limestone, lies beneath the glacial material. The depth to limestone is shallow, resulting in karst topography across much of the area (USDA-NRCS 2006).

The vegetation in the MLRA has undergone drastic changes over time. Spruce forests dominated the landscape 30,000 to 21,500 years ago. As the last glacial maximum peaked 21,500 to 16,000 years ago, they were replaced with open tundras and parklands. The end of the Pleistocene Epoch saw a warming climate that initially prompted the return of spruce forests, but as the warming continued, spruce trees were replaced by deciduous trees (Baker et al. 1990). Not until approximately 9,000 years ago did the vegetation transition to prairies as climatic conditions continued to warm and subsequently dry. Between 4,000 and 3,000 years ago, oak savannas began intermingling within the prairie landscape, while the more wooded and forested areas maintained a foothold in sheltered areas. This prairie-forest transition ecosystem formed the dominant landscapes until the arrival of European settlers (Baker et al. 1992).

Classification relationships

USFS Subregions: North Central U.S. Driftless and Escarpment (222L), Minnesota and Northeast Iowa Morainal-Oak Savannah (222M), Central Dissected Till Plains (251C) Sections; Menominee Eroded Pre-Wisconsin Till (222La), Oak Savannah Till and Loess Plains (222Me), Southeast Iowa Rolling Loess Hills (251Ch) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Eastern Iowa and Minnesota Drift Plains (47c), Rolling Loess Prairies (47f), Lower St. Croix and Vermillion Valleys (47g), Rochester/Paleozoic Plateau Upland (52c) (USEPA 2013)

National Vegetation Classification – Ecological Systems: North-Central Interior Floodplain (CES202.694) (NatureServe 2015)

National Vegetation Classification - Plant Associations: Quercus macrocarpa – Quercus bicolor – Carya laciniosa/Leersia spp. – Cinna spp. Floodplain Forest (CEGL002098) (Nature Serve 2018)

Biophysical Settings: Central Interior and Appalachian Floodplain Systems (BpS 4214710) (LANDFIRE 2009)

Natural Resources Conservation Service – Iowa Plant Community Species List: Forest, Bur Oak – Swamp White Oak Mixed Bottomland (USDA-NRCS 2007)

Iowa Department of Natural Resources: Floodplain Forest (INAI 1984)

Minnesota Department of Natural Resources: FFs68 Floodplain Forest (MDNR 2005)

U.S. Army Corps of Engineers: Floodplain Forests (Eggers and Reed 2015)

Ecological site concept

Loamy Floodplain Forests are located within the green areas on the map (Figure 1). They occur on floodplains in river valleys. The soils are Mollisols and Entisols that are somewhat poorly to moderately well-drained and deep, formed from silty or fine-loamy alluvium. The site experiences occasional flooding that can last up to 7 days.

The historic pre-European settlement vegetation on this ecological site was dominated by a dense, closed canopy of deciduous trees and an understory of flood-tolerant, hydrophytic herbaceous plants. American elm (Ulmus americana L.) and bur oak (Quercus macrocarpa Michx.) are the main canopy species. Other tree species that may occur can include green ash (Fraxinus pennsylvanica Marshall), plains cottonwood (Populus deltoides L.), silver maple (Acer saccharinum L.), and slippery elm (Ulmus rubra Muhl.). Common hackberry (Celtis occidentalis L.) is a common subcanopy component (MDNR 2005). The understory is comprised of species tolerant of occasional flood disturbances such as Virginia wildrye (Elymus virginicus L.) and cutleaf coneflower (Rudbeckia laciniata L.). Brief, seasonal flooding is the primary disturbance factor that maintains this site, while damage from storms and periodic pest outbreaks are secondary disturbances (LANDFIRE 2009).

Associated sites

R104XY017IA	**Floodplain Prairie** Alluvial soils on floodplains that are moderately well to well-drained, rarely to occasionally flooded, located furthest from the stream channel including Ankeny, Turlin, and Turlin variant soils
R104XY018IA	**Wet Floodplain Sedge Meadow** Alluvial soils that are poorly drained and rarely to occasional flooded including Calco, Coland, Sawmill, and Udifluvents soils
F104XY021IA	**Sandy Floodplain Forest** Alluvial soils that are moderately well to excessively drained and frequently flooded including Hanlon, Klum, Perks, Shellwood, and Sigglekov soils

R104XY014IA	**Ponded Floodplain Marsh** Mineral soils on floodplains that are flooded and ponded including Aquents, Aquolls, Epsom, Fluvaquents, Granby, and Shandep soils
R104XY015IA	**Terrace Savanna** Alluvial soils on stream terraces that are rarely flooded including Bertrand, Bixby, Coloma, Curran, Dakota, Dells, Ely, Finchford, Hayfield, Hoopeston, Judson, Lawler, Nevin, Oakton, Raddle, Radford, Richwood, Snider, Terril, Wapsie, Wapsie variant, Waukee, Waukegan, Wiota, and Worthen soils

Similar sites

F104XY019IA	**Floodplain Swamp Forest** Floodplain Swamp Forests are in a similar landscape position, but the fine-silty soils are poorly-drained and rarely to occasionally flooded
F104XY021IA	**Sandy Floodplain Forest** Sandy Floodplain Forests are in a similar landscape position, but the coarse-loamy soils are somewhat poorly to excessively-drained and frequently flooded

Table 1. Dominant plant species

Tree	(1) *Ulmus americana* (2) *Quercus macrocarpa*
Shrub	(1) *Vitis riparia*
Herbaceous	(1) *Elymus virginicus* (2) *Rudbeckia laciniata*

Physiographic features

Loamy Floodplain Forests occur on floodplains in river valleys (Figure 2). They are situated on elevations ranging from approximately 341 to 2886 feet ASL. The site experiences occasional flooding that lasts up to seven days (Table 1).

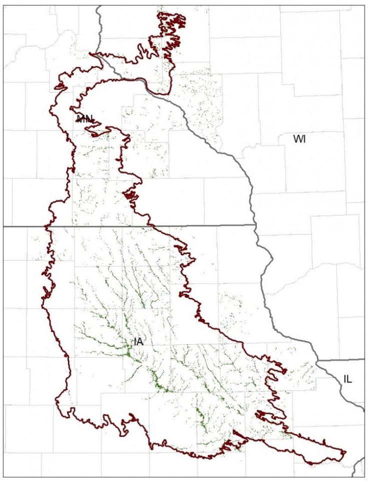


Figure 2. Figure 1. Location of Loamy Floodplain Forest ecological site within MLRA 104.

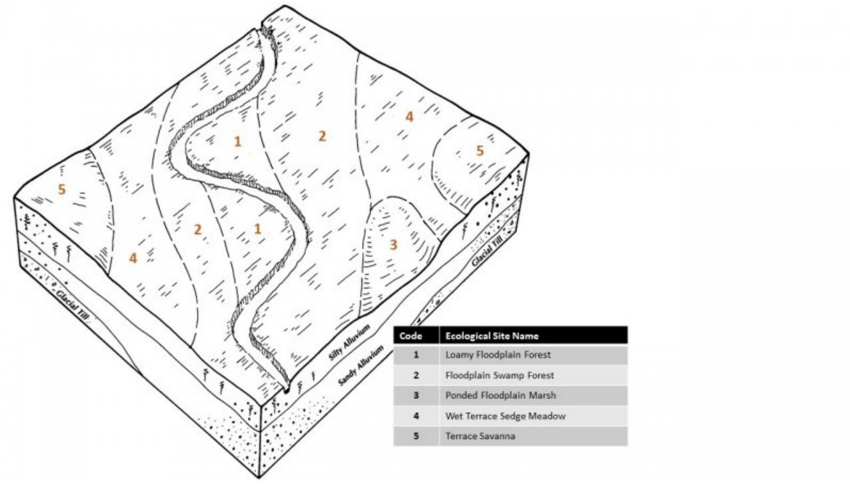


Figure 3. Figure 2. Representative block diagram of Loamy Floodplain Forest and associated ecological sites.

Table 2. Representative physiographic features

Slope shape across	(1) Linear
Slope shape up-down	(1) Linear
Landforms	(1) Flood plain
Runoff class	Low
Flooding duration	Brief (2 to 7 days)
Flooding frequency	Occasional
Elevation	104–880 m
Slope	0–2%
Water table depth	30–203 cm
Aspect	Aspect is not a significant factor

Climatic features

The Eastern Iowa and Minnesota Till Prairies falls into the hot-summer humid continental climate (Dfa) and warm-summer humid continental climate (Dfb) Köppen-Geiger climate classifications (Peel et al. 2007). In winter, dry, cold air masses periodically shift south from Canada. As these air masses collide with humid air, snowfall and rainfall result. In summer, moist, warm air masses from the Gulf of Mexico migrate north, producing significant frontal or convective rains. Occasionally, hot, dry winds originating from the Desert Southwest will stagnate over the region, creating extended droughty periods in the summer from unusually high temperatures. Air masses from the Pacific Ocean can also spread into the region and dominate producing mild, dry weather in the autumn known as Indian Summers (NCDC 2006).

The soil temperature regime of MLRA 104 is classified as mesic, where the mean annual soil temperature is between 46 and 59°F (USDA-NRCS 2006). Temperature and precipitation occur along a north-south gradient, where temperature and precipitation increase the further south one travels. The average freeze-free period of this ecological site is about 154 days, while the frost-free period is about 127 days (Table 2). The majority of the precipitation occurs as rainfall in the form of convective thunderstorms during the growing season. Average annual precipitation is approximately 36 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 36 and 57°F, respectively.

Climate data and analyses are derived from 30-year averages gathered from six National Oceanic and Atmospheric Administration (NOAA) weather stations contained within the range of this ecological site (Table 4).

Table 3. Representative climatic features

Frost-free period (characteristic range)	119-135 days

Freeze-free period (characteristic range)	141-167 days
Precipitation total (characteristic range)	889-965 mm
Frost-free period (actual range)	115-137 days
Freeze-free period (actual range)	139-169 days
Precipitation total (actual range)	864-965 mm
Frost-free period (average)	127 days
Freeze-free period (average)	154 days
Precipitation total (average)	914 mm

Climate stations used

- (1) TRIPOLI [USC00138339], Tripoli, IA
- (2) OSAGE [USC00136305], Osage, IA
- (3) CEDAR RAPIDS NO 1 [USC00131319], Marion, IA
- (4) BYRON 4NORTH [USC00211174], Byron, MN
- (5) AUSTIN WWT FAC [USC00210355], Austin, MN
- (6) ANAMOSA 1 WNW [USC00130213], Anamosa, IA

Influencing water features

Loamy Floodplain Forests are classified as a RIVERINE: Occasionally Flooded; forested wetland under the Hydrogeomorphic (HGM) classification system (Smith et al. 1995; USDA-NRCS 2008) and as a Palustrine, Forested, Broad-leaved Deciduous, Temporarily Flooded wetland under the National Wetlands Inventory (FGDC 2013). Overbank flow from the channel and subsurface hydraulic connections are the main sources of water for this ecological site (Smith et al. 1995). Infiltration is slow to moderate (Hydrologic Groups B and C) for undrained soils, and surface runoff is low (Figure 5).

Primary wetland hydrology indicators for an intact Loamy Floodplain Forest may include: A1 Surface water, B1 Water marks, B2 Sediment deposits, B3 Drift deposits, and B9 Water-stained leaves. Secondary wetland hydrology indicators may include: D5 FAC-neutral test (USACE 2010).

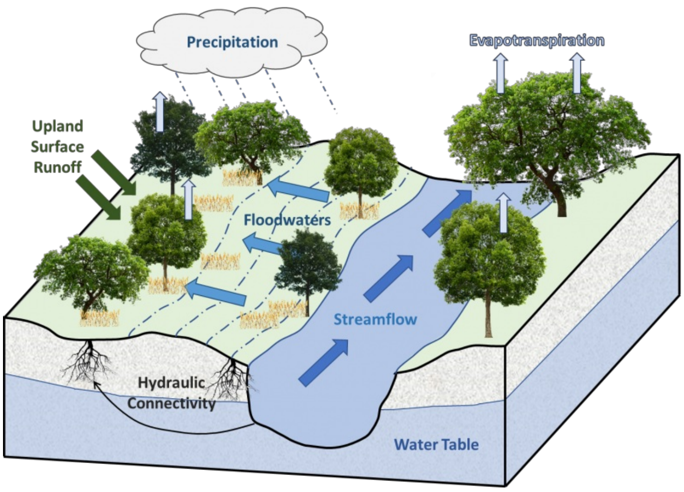


Figure 10. Figure 5. Hydrologic cycling in Loamy Floodplain Forest ecological site.

Soil features

Soils of Loamy Floodplain Forests are in the Mollisols and Entisols orders, further classified as Aquic Cumulic Hapludolls, Cumulic Hapludolls, Mollic Fluvaquents, and Typic Udifluvents with slow to moderate infiltration and low runoff potential. While some of these soils are classified as Mollisols, their dark surfaces and increased thickness of the epipedon are not the result of prairie vegetation but rather alluvial deposition and slope wash. The soil series associated with this site includes Ackmore, DuPage, Huntsville, Kennebec, Lawson, and Spillville series and Alluvial land mapunits. The parent material is alluvium, and the soils are somewhat poorly to moderately well-drained and deep. Soil pH classes are moderately acid to moderately alkaline. No rooting restrictions are noted for the soils of this ecological site (Table 5).

Some soil map units in this ecological site, if not drained, may meet the definition of hydric soils and are listed as meeting criteria 4 of the hydric soils list (77 FR 12234).

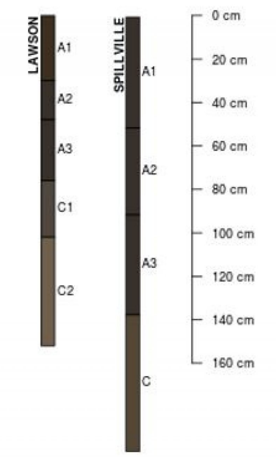


Figure 11. Figure 6. Profile sketches of soil series associated with Loamy Floodplain Forest.

Table 4. Representative soil features

Parent material	(1) Alluvium
Family particle size	(1) Fine-silty (2) Coarse-silty (3) Fine-loamy
Drainage class	Somewhat poorly drained to moderately well drained
Permeability class	Slow to moderately slow
Depth to restrictive layer	203 cm
Soil depth	203 cm

Ecological dynamics

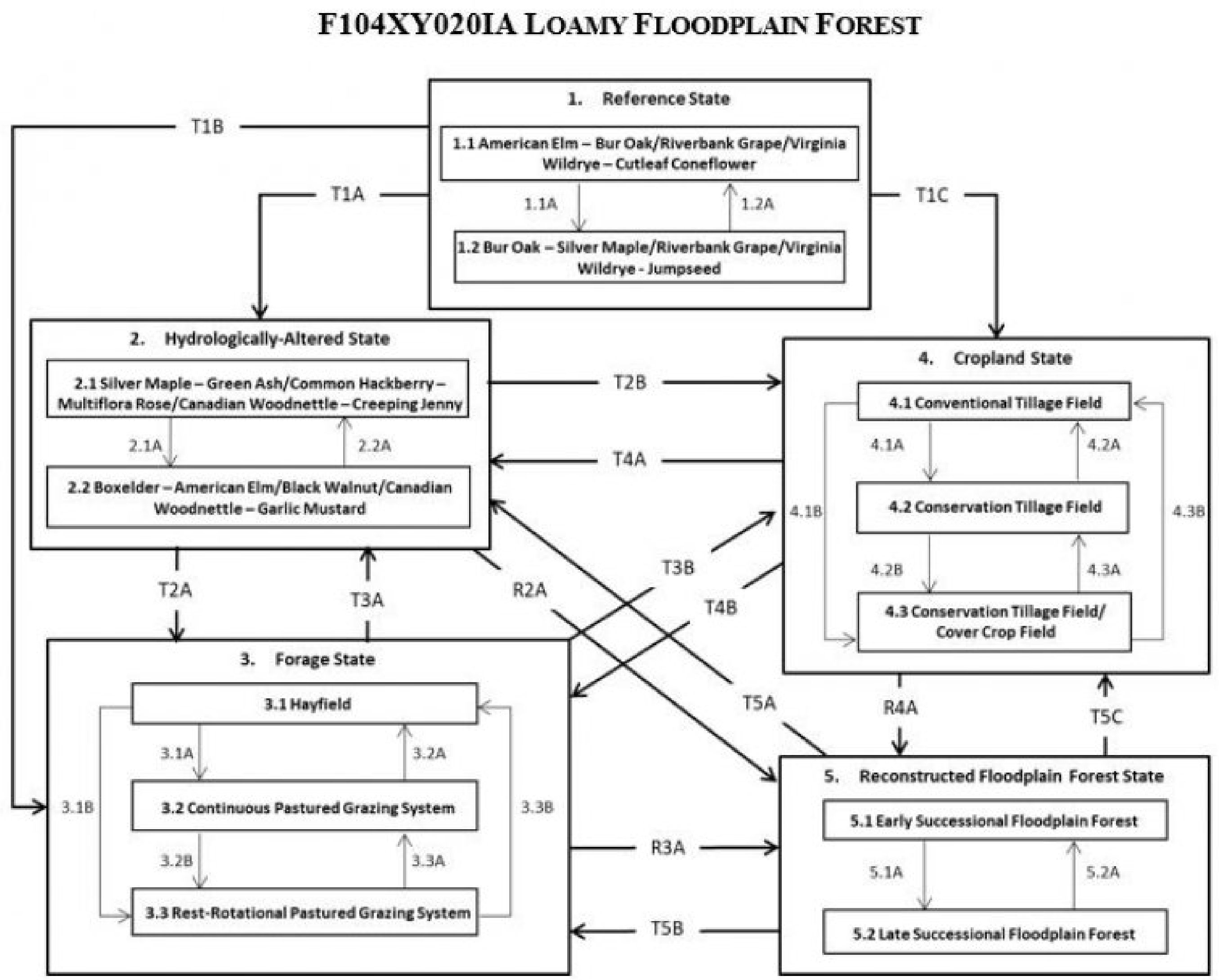
The information in this Ecological Site Description, including the state-and-transition model (STM), was developed based on historical data, current field data, professional experience, and a review of the scientific literature. As a result, all possible scenarios or plant species may not be included. Key indicator plant species, disturbances, and ecological processes are described to inform land management decisions.

The MLRA lies within the transition zone between the eastern deciduous forests and the tallgrass prairies. The heterogeneous topography of the area results in variable microclimates and fuel matrices that in turn support prairies, savannas, woodlands, and forests. Loamy Floodplain Forests form an aspect of this vegetative continuum. This ecological site occurs on floodplains on somewhat poorly to moderately well-drained soils. Species characteristic of this ecological site consist of a mix of hydrophytic and upland woody and herbaceous vegetation.

Occasional flooding is the dominant disturbance factor in Loamy Floodplain Forests, and storm damage and pests are secondary disturbances. Seasonal flooding occurs every two to twenty years, and flooding can persist for up to seven days at a time. Damage to trees from wind storms can vary from minor, patchy effects of individual trees to stand effects that temporarily affect community structure and species richness and diversity (Irland 2000; Peterson 2000). Oaks are susceptible to a variety of pests (e.g., insects, fungi, cankers, wilts), therefore periodic insect and disease outbreaks play an important role in local canopy structure (Snyder 1992).

Today, many Loamy Floodplain Forests have been reduced due to conversion to pasture or have been cleared and drained for agricultural production. Remnant sites have been degraded due to significant changes to the natural hydrologic regime and diminished water quality in the watershed. The state-and-transition model that follows provides a detailed description of each state, community phase, pathway, and transition. This model is based on available experimental research, field observations, literature reviews, professional consensus, and interpretations.

State and transition model



Code	Process
1.1A	Major flood event
1.2A	Natural succession as a result of no disturbances
T1A, T3A, T4A, T5A	Changes to natural hydroperiod and/or land abandonment
2.1A	Increasing frequency of disturbances
2.2A	Decreasing frequency of disturbances
T1B, T2A, T4B, T5B	Cultural treatments are implemented to increase forage quality and yield
3.1A	Mechanical harvesting is replaced with domestic livestock and continuous grazing
3.1B	Mechanical harvesting is replaced with domestic livestock and rest-rotational grazing
3.2A, 3.3B	Tillage, forage crop planting, and mechanical harvesting replace grazing
3.2B	Implementation of rest-rotational grazing
3.3A	Implementation of continuous grazing
T1C, T2B, T3B, T5C	Agricultural conversion via tillage, seeding, and non-selective herbicide
4.1A	Less tillage, residue management
4.1B	Less tillage, residue management, and implementation of cover cropping
4.2B	Implementation of cover cropping
4.2A, 4.3B	Intensive tillage, remove residue, and reinitiate monoculture row cropping
4.3A	Remove cover cropping
R2A, R3A, R4A	Site preparation, tree planting, repair hydrology, non-native species control
5.1A	Timber stand improvement practices implemented
5.2A	Setback from extreme weather event or improper timing of management actions

State 1
Reference State

The reference plant community is categorized as a bottomland forest community, dominated by upland and hydrophytic woody and herbaceous vegetation. The two community phases within the reference state are dependent on a regular flood regime. The amount and duration of flooding alters species composition, cover, and extent. Periodic pest outbreaks and wind storms have more localized impacts in the reference phases, but do contribute to overall species composition, diversity, cover, and productivity.

Community 1.1
American Elm – Bur Oak/Riverbank Grape/Virginia Wildrye – Cutleaf Coneflower

Sites in this reference community phase are a closed canopy forest (80 to 100 percent cover) dominated by American elm, bur oak, plains cottonwood, green ash, slippery elm, and silver maple. Common hackberry may be a frequent component of the subcanopy. Trees are large (21 to 33-inch DBH) and range in height from 30 to over 80 feet tall (LANDFIRE 2009). Vines, like riverbank grape, are prominent vegetative components. Virginia wildrye and cutleaf coneflower may be dominant and characteristic species, respectively (Runkel and Roosa 2014). Other herbaceous species can include nodding fescue (*Festuca subverticillata* (Pers.) Alexeev), fowl mannagrass (*Glyceria striata* (Lam.) Hitchc.), Gray’s sedge (*Carex grayi* Carey), and jumpseed (Polygonum virginanum L.) (NatureServe 2018). Occasional flooding every 2 to 20 years will maintain this phase, but a major flood event can shift the community to an earlier successional floodplain forest, phase 1.2 (Myers and Buchman 1984).

Community 1.2
Bur Oak – Silver Maple/Riverbank Grape/Virginia Wildrye – Jumpseed

This reference community phase represents a plant community in recovery from a major flood event. Mature bur oaks and American elm may still be present, but disturbance-tolerant species – such as silver maple and green ash – become important co-dominant in the canopy and subcanopy. Immediately following the flood event, the herbaceous layer is likely to be comprised mostly of annuals. Frequent flooding will maintain this community phase, but an extended flood interval will allow this site to shift back to phase 1.1 (Myers and Buchman 1984).

Pathway 1.1A
Community 1.1 to 1.2

Major flood event.

Pathway 1.2A
Community 1.2 to 1.1

Natural succession as a result of extended flood intervals.

State 2
Hydrologically-altered State

Agricultural tile drainage, stream channelization, and levee construction in hydrologically-connected waters have drastically changed the natural hydrologic regime of Loamy Floodplain Forests. In addition, increased amounts of precipitation and intensity have amplified flooding events (Pryor et al. 2014). This has resulted in a type conversion from the species-rich forest to a ruderal floodplain forest state. In addition, exotic species have encroached and continuously spread, reducing native diversity and ecosystem stability (Eggers and Reed 2015).

Community 2.1
Silver Maple – Green Ash/Common Hackberry – Multiflora Rose/Canadian Woodnettle – Creeping Jenny

This community phase represents a transition in plant community composition as a result of an altered hydrologic regime. Silver maple, green ash, American elm, and slippery elm become the dominant tree canopy species. Common hackberry, honeylocust (*Gleditsia triacanthos* L.), and boxelder (*Acer negundo* L.) are dominant subcanopy species, while roughleaf dogwood (*Cornus drummondii* C.A. Mey) and multiflora rose (*Rosa multiflora* L.) are dominant shrubs. The herbaceous layer is nearly continuous but lacking in diversity. Canadian woodnettle (*Laportea canadensis* (L.) Weddell) and Canadian honewort (*Cryptotaenia canadensis* (L.) DC.) are common native species, and creeping jenny (*Lysimachia nummularia* L.) can be a frequently encountered non-native species.

Community 2.2
Boxelder – American Elm/Black Walnut/Canadian Woodnettle – Garlic Mustard

This community phase represents persisting changes to the natural hydrology of the watershed. The overstory canopy continues to shift, becoming dominated by boxelder due to frequent disturbances (Rosario 1988). American elm can be a co-dominant canopy species, and black walnut (*Juglans nigra* L.) can be present in the subcanopy. The understory may continue to be invaded by more non-native species, such as garlic mustard (*Alliaria petiolata* (M. Bieb.) Cavara & Grande), as a result of the frequent disturbances.

Pathway 2.1A
Community 2.1 to 2.2

Increasing frequency of disturbances.

Pathway 2.2A
Community 2.2 to 2.1

Decreasing frequency of disturbances.

State 3
Forage State

The forage state arises when the site is converted to a farming operation that emphasizes domestic livestock production, known as grassland agriculture. Fire suppression, periodic cultural treatments (e.g., clipping, drainage, soil amendment applications, planting new species and/or cultivars, mechanical harvesting), hydrologic alterations and grazing by domesticated livestock transition and maintain this state (USDA-NRCS 2003). Early settlers seeded non-native species, as smooth brome (*Bromus inermis* Leyss.) and Kentucky bluegrass (*Poa pratensis* L.), to help extend the grazing season (Smith 1998). Over time, as lands were continuously harvested or grazed by herds of cattle, these species were able to spread and expand across the landscape, reducing the native species diversity and ecological function.

Community 3.1
Hayfield

Sites in this community phase consist of forage plants that are planted and mechanically harvested. Mechanical harvesting removes much of the aboveground biomass and nutrients that feed the soil microorganisms (Franzluebbers et al. 2000; USDA-NRCS 2003). As a result, soil biology is reduced leading to decreases in nutrient uptake by plants, soil organic matter, and soil aggregation. Frequent biomass removal can also reduce the site's carbon sequestration capacity (Skinner 2008).

Community 3.2
Continuous Pastured Grazing

This community phase is characterized by continuous grazing where domestic livestock graze a pasture for the entire season. Depending on stocking density, this can result in lower forage quality and productivity, weed invasions, and uneven pasture use. Continuous grazing can also increase the amount of bare ground and erosion and reduce soil organic matter, cation exchange capacity, water-holding capacity, and nutrient availability and retention (Bharati et al. 2002; Leake et al. 2004; Teague et al. 2011). Smooth brome, Kentucky bluegrass, and white clover (*Trifolium repens* L.) are common pasture species used in this phase. Their tolerance to continuous grazing has allowed these species to dominate, sometimes completely excluding the native vegetation.

Community 3.3
Periodic-rest Pastured Grazing

This community phase is characterized by periodic-rest grazing where the pasture has been subdivided into several smaller paddocks. Subdividing the pasture in this way allows livestock to utilize one or a few paddocks, while the remaining area is rested allowing plants to restore vigor and energy reserves, deepen root systems, develop seeds, as well as allow seedling establishment (Undersander et al. 2002; USDA-NRCS 2003). Periodic-rest pastured grazing includes deferred periods, rest periods, and periods of high intensity – low frequency, and short duration methods. Vegetation is generally more diverse and can include orchardgrass (*Dactylis glomerata* L.), timothy (Phleum pretense L.), red clover (*Trifolium pratense* L.), and alfalfa (*Medicago sativa* L.). The addition of native prairie species can further bolster plant diversity and, in turn, soil function. This community phase promotes numerous ecosystem benefits including increasing biodiversity, preventing soil erosion, maintaining and enhancing soil quality, sequestering atmospheric carbon, and improving water yield and quality (USDA-NRCS 2003).

Pathway 3.1A
Community 3.1 to 3.2

Mechanical harvesting is replaced with domestic livestock utilizing continuous grazing.

Pathway 3.1B
Community 3.1 to 3.3

Mechanical harvesting is replaced with domestic livestock utilizing periodic-rest grazing.

Pathway 3.2A
Community 3.2 to 3.1

Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 3.2B
Community 3.2 to 3.3

Periodic-rest grazing replaces continuous grazing.

Pathway 3.3B
Community 3.3 to 3.1

Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 3.3A
Community 3.3 to 3.2

Continuous grazing replaces periodic-rest grazing.

State 4
Cropland State

The Midwest is well-known for its highly-productive agricultural soils, and as a result, much of the MLRA has been converted to cropland, including portions of this ecological site. Hydrologic alterations and the continuous use of tillage, row-crop planting, and chemicals (i.e., herbicides, fertilizers, etc.) have effectively eliminated the reference community and many of its natural ecological functions in favor of crop production. Corn (*Zea mays* L.) and soybeans (*Glycine max* (L.) Merr.) are the dominant crops for the site. These areas are likely to remain in crop production for the foreseeable future.

Community 4.1
Conventional Tillage Field

Sites in this community phase typically consist of monoculture row-cropping maintained by conventional tillage practices. They are cropped in either continuous corn or alternating periods of corn and soybean crops. The frequent use of deep tillage, low crop diversity, and bare soil conditions during the non-growing season negatively impacts soil health. Under these practices, soil aggregation is reduced or destroyed, soil organic matter is reduced, erosion and runoff are increased, and infiltration is decreased, which can ultimately lead to undesirable changes in the hydrology of the watershed (Tomer et al. 2005).

Community 4.2
Conservation Tillage Field

This community phase is characterized by periodically alternating crops and utilizing various conservation tillage methods to promote soil health and reduce erosion. Conservation tillage methods include strip-till, ridge-till, vertical-till, or no-till planting operations. Strip-till keeps seedbed preparation to narrow bands less than one-third the width of the row where crop residue and soil consolidation are left undisturbed in-between seedbed areas. Strip-till planting may be completed in the fall and nutrient application either occurs simultaneously or at the time of planting. Ridge-till uses specialized equipment to create ridges in the seedbed and vegetative residue is left on the surface in between the ridges. Weeds are controlled with herbicides and/or cultivation, seedbed ridges are rebuilt during cultivation, and soils are left undisturbed from harvest to planting. Vertical-till operations employ machinery that lightly tills the soil and cuts up crop residue, mixing some of the residue into the top few inches of the soil while leaving a large portion on the surface. No-till management is the most conservative, disturbing soils only at the time of planting and fertilizer application. Compared to conventional tillage operations, conservation tillage methods can reduce soil erosion, increase organic matter and water availability, improve water quality, and reduce soil compaction.

Community 4.3
Conservation Tillage with Cover Crop Field

This condition applies conservation tillage methods as described above as well as adds cover crop practices. Cover crops typically include nitrogen-fixing species (e.g., legumes), small grains (e.g., rye, wheat, oats), or forage covers (e.g., turnips, radishes, rapeseed). The addition of cover crops not only adds plant diversity but also promotes soil health by reducing soil erosion, limiting nitrogen leaching, suppressing weeds, increasing soil organic matter, and improving the overall soil. In the case of small grain cover crops, surface cover and water infiltration are increased, while forage covers can be used to graze livestock or support local wildlife. Of the three community phases for this state, this phase promotes the greatest soil sustainability and improves ecological functioning within a row crop operation.

Pathway 4.1A
Community 4.1 to 4.2

Tillage operations are greatly reduced, alternating cropsoccurs on a regular schedule, and crop residue remains on the soil surface.

Pathway 4.1B
Community 4.1 to 4.3

Tillage operations are greatly reduced or eliminated, alternating crops is either reduced or eliminated, and crop residue remains on the soil surface, and cover crops are implemented to prevent soil erosion.

Pathway 4.2A
Community 4.2 to 4.1

Intensive tillage is utilized, and monoculture row-cropping is established.

Pathway 4.2B
Community 4.2 to 4.3

Cover crops are implemented to prevent soil erosion.

Pathway 4.3B
Community 4.3 to 4.1

Intensive tillage is utilized, cover crops practices are abandoned, monoculture row-cropping is established on a more-or-less continuous basis.

Pathway 4.3A
Community 4.3 to 4.2

Cover crop practices are abandoned.

State 5
Reconstructed Floodplain Forest State

The combination of natural and anthropogenic disturbances occurring today has resulted in numerous ecosystem health issues, and restoration back to the historic reference state may not be possible. Many natural forest communities are being stressed by non-native diseases and pests, habitat fragmentation, permanent changes in hydrologic regimes, and overabundant deer populations on top of naturally-occurring disturbances (severe weather and native pests) (Flickinger 2010). However, these habitats provide multiple ecosystem services including carbon sequestration; clean air and water; soil conservation; biodiversity support; wildlife habitat; as well as a variety of cultural activities (e.g., hiking, hunting) (Millennium Ecosystem Assessment 2005; Flickinger 2010). Therefore, conservation of floodplain forests should still be pursued. Habitat reconstructions are an important tool for repairing natural ecological functioning and providing habitat protection for numerous species of Loamy Floodplain Forests. Therefore, ecological restoration should aim to aid the recovery of degraded, damaged, or destroyed ecosystems. A successful restoration will have the ability to structurally and functionally sustain itself, demonstrate resilience to the ranges of stress and disturbance, and create and maintain positive biotic and abiotic interactions (SER 2002). The reconstructed forest state is the result of a long-term commitment involving a multi-step, adaptive management process.

Community 5.1
Early Successional Reconstructed Forest

This community phase represents the early community assembly from forest reconstruction. It is highly dependent on the current condition of the site based on past and current land management actions, invasive species, and proximity to land populated with non-native pests and diseases. Therefore, no two sites will have the same early successional composition. Technical forestry assistance should be sought to develop suitable conservation management plans.

Community 5.2
Late Successional Reconstructed Forest

Appropriately timed management practices (e.g. forest stand improvement, continuing integrated pest management) applied to the early successional community phase can help increase the stand maturity, pushing the site into a late successional community phase over time. A late successional reconstructed forest will have an uneven-aged, closed canopy and a well-developed understory.

Pathway 5.1A
Community 5.1 to 5.2

Application of stand improvement practices in line with a developed management plan.

Pathway 5.2A
Community 5.2 to 5.1

Reconstruction experiences a setback from extreme weather event or improper timing of management actions.

Transition T1A
State 1 to 2

Altered hydrology throughout the watershed transitions the site to the hydrologically-altered state (2).

Transition T1B
State 1 to 3

Woody species removal and cultural treatments to enhance forage quality and yield transition the site to the forage state (3).

Transition T1C
State 1 to 4

Woody species removal, tillage, seeding of agricultural crops, and non-selective herbicide transition the site to the cropland state (4).

Transition T2A
State 2 to 3

Woody species removal and cultural treatments to enhance forage quality and yield transition the site to the forage state (3).

Transition T2B
State 2 to 4

Woody species removal, tillage, seeding of agricultural crops, and non-selective herbicide transition the site to the cropland state (4).

Restoration pathway R2A
State 2 to 5

Site preparation, tree planting, timber stand improvement, non-native species control, and water control structures installed to improve and regulate hydrology transition this site to the reconstructed forest state (5).

Transition T3A
State 3 to 2

Land is abandoned and left fallow; natural succession by opportunistic species transition this site the hydrologically-altered state (2).

Transition T3B
State 3 to 4

Tillage, seeding of agricultural crops, and non-selective herbicide transition the site to the cropland state (4).

Restoration pathway R3A
State 3 to 5

Site preparation, tree planting, timber stand improvement, non-native species control, and water control structures installed to improve and regulate hydrology transition this site to the reconstructed forest state (5).

Transition T4A
State 4 to 2

Land abandonment transitions the site to the hydrologically-altered state (2).

Transition T4B
State 4 to 3

Cultural treatments to enhance forage quality and yield transition the site to the forage state (3).

Restoration pathway R4A
State 4 to 5

Site preparation, tree planting, timber stand improvement, non-native species control, and water control structures installed to improve and regulate hydrology transition this site to the reconstructed forest state (5).

Transition T5A
State 5 to 2

Removal of water control structures and unmanaged invasive species populations transition this site to the hydrologically-altered state (2).

Transition T5B
State 5 to 3

Tree removal and cultural treatments to enhance forage quality and yield transition the site to the forage state (3).

Transition T5C
State 5 to 4

Tree removal, tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).

Additional community tables

Inventory data references

Tier 3 Sampling Plots used to develop the reference state, community phase 1.1:

State County Ownership Easting Northing
Iowa Linn Chain of Lakes Wildlife Management Area– Iowa Department of Natural Resources 6014406 4656298
Iowa Linn Wickiup Hill Learning Center – Linn County Conservation Board 602631 4661950

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Rangeland health reference sheet

Interpreting Indicators of Rangeland Health is a qualitative assessment protocol used to determine ecosystem condition based on benchmark characteristics described in the Reference Sheet. A suite of 17 (or more) indicators are typically considered in an assessment. The ecological site(s) representative of an assessment location must be known prior to applying the protocol and must be verified based on soils and climate. Current plant community cannot be used to identify the ecological site.

Author(s)/participant(s)	
Contact for lead author	
Date	05/03/2024
Approved by	Chris Tecklenburg
Approval date	
Composition (Indicators 10 and 12) based on	Annual Production

Indicators

1. **Number and extent of rills:**

2. **Presence of water flow patterns:**

3. **Number and height of erosional pedestals or terracettes:**

4. **Bare ground from Ecological Site Description or other studies (rock, litter, lichen, moss, plant canopy are not bare ground):**

5. **Number of gullies and erosion associated with gullies:**

6. **Extent of wind scoured, blowouts and/or depositional areas:**

7. **Amount of litter movement (describe size and distance expected to travel):**

8. **Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):**

9. **Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):**

10. **Effect of community phase composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:**

11. **Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):**

12. **Functional/Structural Groups (list in order of descending dominance by above-ground annual-production or live foliar cover using symbols: >>, >, = to indicate much greater than, greater than, and equal to):**

    Dominant:

    Sub-dominant:

    Other:

    Additional:

13. **Amount of plant mortality and decadence (include which functional groups are expected to show mortality or decadence):**

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14. **Average percent litter cover (%) and depth (in):**

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15. **Expected annual annual-production (this is TOTAL above-ground annual-production, not just forage annual-production):**

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16. **Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or co-dominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicators, we are describing what is NOT expected in the reference state for the ecological site:**

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17. **Perennial plant reproductive capability:**
