USDA Natural Resources
Conservation Service

Ecological site F108XC513IA
Till Backslope 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): 108X–Illinois and Iowa Deep Loess and Drift

The Illinois and Iowa Deep Loess and Drift, West-Central Part (MLRA 108C) encompasses the eastern portion of the Southern Iowa Drift Plain and the Lake Calvin basin of the Mississippi Alluvial Plain landforms (Prior 1991). It lies entirely in one state (Iowa), containing approximately 9,805 square miles (Figure 1). The elevation ranges from approximately 1,110 feet above sea level (ASL) on the highest ridges to about 505 feet ASL in the lowest valleys. Local elevation difference is mainly 10 to 20 feet. However, some valley floors can range from 80 to 200 feet, while some upland flats and valley floors only range between 3 and 6 feet. The MLRA is underlain by Pre-Illinoian glacial till, deposited more than 500,000 years ago and since undergone extensive erosion and dissection. In the northern half of the area the till thickness ranges from 150 to 350 feet and grades to less than 150 feet thick in the southern half. The till is covered by a mantle of Peoria Loess on the hillslopes and Holocene alluvium in the drainageways. Paleozoic bedrock, comprised of limestone, shale, and mudstones, lies beneath the glacial material (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: Central Dissected Till Plains (251C) Section, Central Dissected Till and Loess Plain (251Cc), Mississippi River and Illinois Alluvial Plains (51Cf), Southeast Iowa Rolling Loess Hills (251Ch) Subsections (Cleland et al. 2007)

U.S. EPA Level IV Ecoregion: Rolling Loess Prairies (47f), Upper Mississippi Alluvial Plain (72d) (USEPA 2013)

National Vegetation Classification – Ecological Systems: North-Central Interior Dry-Mesic Oak Forest and Woodland (CES202.046) (NatureServe 2015)

National Vegetation Classification - Plant Associations: Quercus alba – Quercus rubra – Carya ovata Glaciated Forest (CEGL002068) (Nature Serve 2015)

Biophysical Settings: North-Central Interior Dry-Mesic Oak Forest and Woodland (BpS 4213100) (LANDFIRE 2009)

Natural Resources Conservation Service – Iowa Plant Community Species List: Forest, Midwestern White Oak – Red Oak (USDA-NRCS 2007)

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

Ecological site concept

Till Backslope Forests are located within the green areas on the map (Figure 1). They occur on mid to lower upland hillslopes and high stream terraces. The soils are Alfisols that are somewhat poorly to well-drained and deep, formed in glacial till or valley fill sediments.

The historic pre-European settlement vegetation on this ecological site was dominated by oak-hickory forests with a shade-tolerant herbaceous understory. White oak (Quercus alba L.) and shagbark hickory (Carya ovata (Mill.) K. Koch) are the dominant tree species, but bur oak (Quercus macrocarpa Michx.), northern red oak (Quercus rubra L.), and bitternut hickory (Carya cordiformis (Wangenh.) K. Koch) can also be present (LANDFIRE 2009; NatureServe 2015). Hophornbeam (Ostrya virginiana (Mill.) K. Koch) and black cherry (Prunus serotina Ehrh.) are the dominant subcanopy and shrub species, and nodding fescue (Festuca subverticillata (Pers.) Alexeev) and mayapple (Podophyllum peltatum L.) are characteristic herbaceous species of this closed canopy forest. Forbs representative of an undisturbed plant community associated with this ecological site can include ramp (Allium tricoccum (Aiton)), wood anemone (Anemone quinquefolia L.), bluntleaf sandwort (Moehringia lateriflora (L.) Fenzi), and downy arrowwood (Viburnum rafinesqueanum Schult.) (Drobney et al. 2001). Fire is the primary disturbance factor that maintains this ecological site, while storm damage and drought are secondary factors (LANDFIRE 2009).

Associated sites

F108XC505IA	**Loess Upland Woodland** Loess parent material on upland summits, shoulders, and upper to mid backslopes including Clinton, Exette, Hayette, Mula, Rozetta, Seaton, and Timula
F108XC501IA	**Shallow Limestone Backslope Glade** Silty or loamy sediments that are shallow to limestone bedrock including Dubuque, Dunbarton, and Nordness
F108XC508IA	**Sandy Upland Woodland** Eolian sandy deposit parent material including Chelsea, Lamont, Tell, and Thebes
R108XC511IA	**Till Backslope Savanna** Glacial till or valley fill sediment parent material in a more fire-rprone landscape including Armstrong, Caleb, Gara, Mystic, and Waubeek
F108XC514IA	**Till Backslope Seep Forest** Glacial till parent material that is shallow to a perched water table including Ashgrove

Similar sites

F108XC505IA	**Loess Upland Woodland** Loess Upland Woodlands occur higher on the landscape, and parent material is loess
F108XC508IA	**Sandy Upland Woodland** Sandy Upland Woodlands occur in a similar landscape position, but parent material is eolian sandy deposits
F108XC514IA	**Till Backslope Seep Forest** Till Backslope Seep Forests occur higher on the landscape and are shallow to a perched water table

Table 1. Dominant plant species

Tree	(1) *Quercus alba* (2) *Carya ovata*
Shrub	(1) *Ostrya virginiana* (2) *Prunus serotina*
Herbaceous	(1) *Festuca subverticillata* (2) *Podophyllum peltatum*

Physiographic features

Till Backslope Forests occur on mid to lower upland hillslopes and high stream terraces (Figure 2). They are situated on elevations ranging from approximately 476 to 1948 feet ASL. The site does not experience flooding, but rather generates runoff to adjacent, downslope ecological sites.

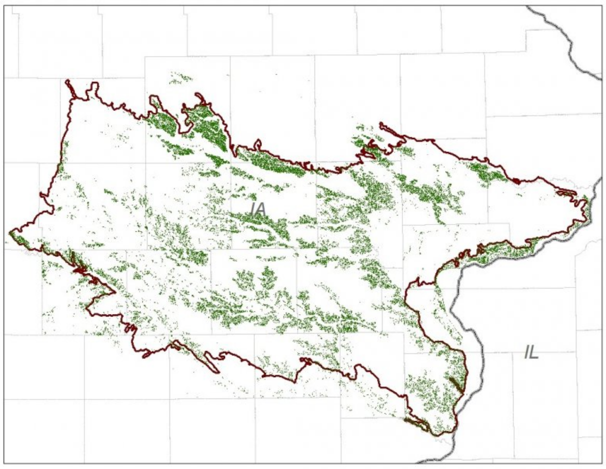


Figure 2. Figure 1. Location of Till Backslope Forest ecological site within MLRA 108C.

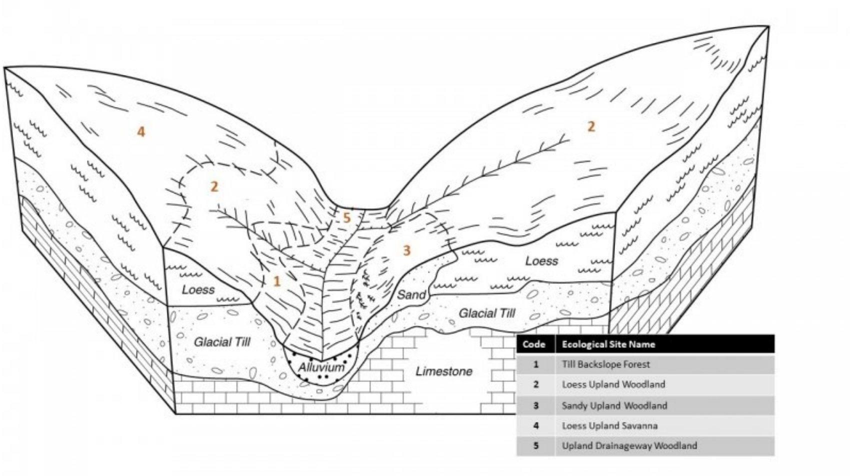


Figure 3. Figure 2. Representative block diagram of Till Backslope Forest and associated ecological sites.

Table 2. Representative physiographic features

Slope shape across	(1) Convex (2) Linear
Slope shape up-down	(1) Convex
Landforms	(1) Upland > Hillslope (2) River valley > Terrace
Runoff class	Medium to high
Elevation	145–594 m

Slope	5–40%
Water table depth	30–203 cm
Aspect	Aspect is not a significant factor

Climatic features

The Illinois and Iowa Deep Loess and Drift, West-Central Part falls into the hot humid continental climate (Dfa) Köppen-Geiger climate classification (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 108C 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 176 days, while the frost-free period is about 156 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 38 inches, which includes rainfall plus the water equivalent from snowfall (Table 3). The average annual low and high temperatures are 38 and 60°F, respectively.

Climate data and analyses are derived from 30-year averages gathered from five 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)	134-141 days
Freeze-free period (characteristic range)	164-170 days
Precipitation total (characteristic range)	889-965 mm
Frost-free period (actual range)	133-147 days
Freeze-free period (actual range)	163-181 days
Precipitation total (actual range)	889-965 mm
Frost-free period (average)	138 days
Freeze-free period (average)	168 days
Precipitation total (average)	940 mm

Climate stations used

- (1) IOWA CITY [USC00134101], Iowa City, IA
- (2) OSKALOOSA [USC00136327], Oskaloosa, IA
- (3) BELLE PLAINE [USC00130600], Belle Plaine, IA
- (4) TIPTON [USC00138266], Tipton, IA
- (5) TOLEDO 3N [USC00138296], Toledo, IA

Influencing water features

Till Backslope Forests are not influenced by wetland or riparian water features. Precipitation is the main source of water for this ecological site. Infiltration is slow (Hydrologic Groups C), and surface runoff is medium to high. Precipitation infiltrates the soil surface and percolates downward through the horizons unimpeded by any restrictive layer. The underlying Mississippian bedrock aquifer has few creviced openings throughout the MLRA, restricting recharge from this ecological site. However, there are numerous surficial aquifers that are shallow and allow recharge via percolation (Prior et al. 2003). Surface runoff contributes some water to downslope ecological sites

(Figure 5).

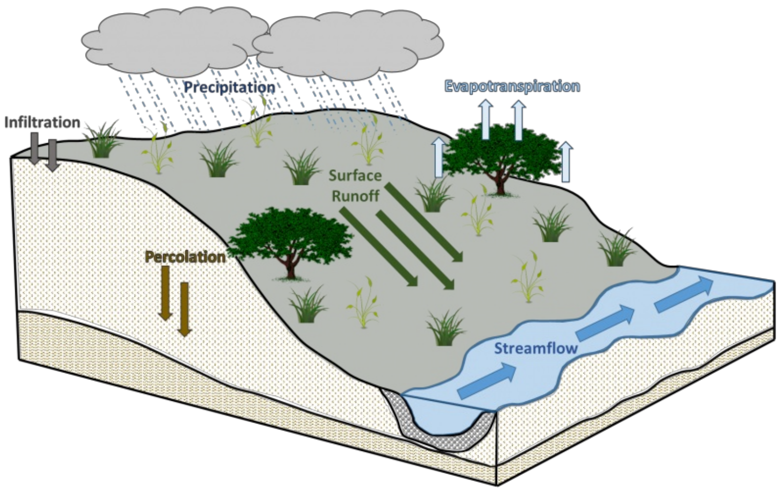


Figure 8. Figure 5. Hydrologic cycling in Till Backslope Forest ecological site.

Soil features

Soils of Till Backslope Forests are in the Alfisols orders, further classified as Aquertic Chromic Hapludalfs and Typic Hapludalfs with slow infiltration and medium to high runoff potential. The soil series associated with this site includes Bertrand, Douds, Galland, Keswick, Lindley, and Russell (Figure 6). The parent material is glacial till or valley fill sediments, and the soils are somewhat poorly to well-drained and deep. Soil pH classes are very strongly acid to slightly alkaline. No rooting restrictions are noted for the soils of this ecological site (Table 5).

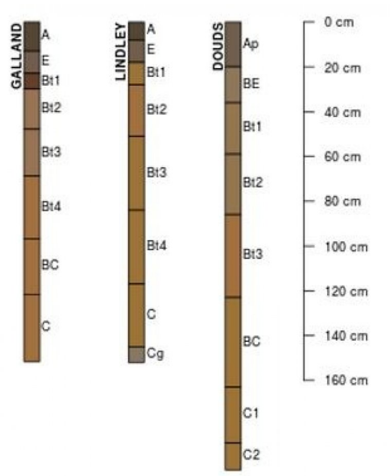


Figure 9. Figure 6. Profile sketches of soil series associated with Till Backslope Forest.

Table 4. Representative soil features

Parent material	(1) Till
Family particle size	(1) Fine-loamy
Drainage class	Somewhat poorly drained to well drained
Permeability class	Slow
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 are able to support prairies, savannas, woodlands, and forests. Till Backslope Forests form an aspect of this vegetative continuum. This ecological site occurs on mid to lower upland hillslopes and high stream terraces on moderately well to well-drained soils. Species characteristic of this ecological site consist of a closed oak-hickory canopy with shade-tolerant herbaceous vegetation.

Fire is a critical factor that maintains Till Backslope Forests. Fire typically consisted of low-severity surface fires every 25 to 50 years (LANDFIRE 2009). Ignition sources included summertime lightning strikes from convective storms and bimodal, human ignitions during the spring and fall seasons. Native Americans regularly set fires to improve sight lines for hunting, drive large game, improve grazing and browsing habitat, agricultural clearing, and enhance vital ethnobotanical plants (Barrett 1980; LANDFIRE 2009).

Drought and wind and ice storm damage have also played a role in shaping this ecological site. The periodic episodes of reduced soil moisture in conjunction with the moderately well to well-drained soils have favored the proliferation of plant species tolerant of such conditions. Drought can also slow the growth of plants and result in dieback of certain species. Damage to trees from 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). When coupled with fire, periods of drought and catastrophic storm damage can greatly delay the establishment and maturation of woody vegetation (Pyne et al. 1996).

Today, Till Backslope Forests have been reduced from their pre-settlement extent. Low to moderate slopes have been converted to cropland, while steeper slopes have been converted to forage lands. Remnants that do exist have had fire suppressed long enough to allow the site to convert to a mesophytic forest with an understory invaded by non-native species. A return to the historic plant community may not be possible following extensive land modification, but long-term conservation agriculture or forest reconstruction efforts can help to restore some biotic diversity and ecological function. 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 1 – REFERENCE STATE

The reference plant community is categorized as an oak-hickory forest, dominated by deciduous trees and shade-tolerant herbaceous vegetation. The one community phase within the reference state is dependent on recurring fire intervals. The severity and intensity of fire alters species composition, cover, and extent, while regular fire intervals keep the canopy from succeeding to mesophytic, fire-intolerant species. Drought and catastrophic storm damage have more localized impacts in the reference phases, but do contribute to overall species composition, diversity, cover, and productivity.

Community Phase 1.1 White Oak – Shagbark Hickory/Hophornbeam – Black Cherry/Nodding Fescue - Mayapple – Sites in this reference community phase are a closed canopy forest. White oak and shagbark hickory are the dominant species, but bur oak, northern red oak, and bitternut hickory are common canopy associates. Trees are large (21 to 33-inch DBH), and cover is approximately 80 percent (LANDFIRE 2009). Hophornbeam and black cherry are common subcanopy components, and low shrubs – e.g., Missouri gooseberry (*Ribes missouriense* Nutt.) and black raspberry (*Rubus occidentalis* L.) – may be occasionally present. The herbaceous layer can be nearly continuous with shade-tolerant species such as nodding fescue, eastern woodland sedge (*Carex blanda* Dewey), broadleaf enchanter's nightshade (*Circaea lutetiana* L.), Canadian honewort (*Cryptotaenia canadensis* (L.) DC.), clustered blacksnakeroot (*Sanicula odorata* (Raf.) K.M. Pryer & L.R. Phillippe), and pointedleaf ticktrefoil (*Desmodium glutinosum* (Muhl. ex Willd.) Alph. Wood). Spring ephemerals, such as mayapple, Greek valerian (*Polemonium reptans* L.), bloodroot (*Sanguinaria canadensis* L.), and wild blue phlox (*Phlox divaricata* L.), can be very abundant in the early spring before the trees have leafed out. Low-severity surface fires every 25 to 50 years will maintain this community phase.

Transition 1A – Long-term fire suppression in excess of 50 years transitions the site to the fire-suppressed state (2).

Transition 1B – Cultural treatments to enhance forage quality and yield transitions the site to the forage state (3).

Transition 1C – Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).

STATE 2 – FIRE-SUPPRESSED STATE

Fire suppression can transition the reference plant community from an oak-hickory forest to an oak-maple mesophytic forest. As the natural fire regime is removed from the landscape, encroachment and dominance by shade-tolerant, fire-intolerant species ensues. This results in a positive feedback loop of mesophication whereby plant community succession continuously creates cool, damp shaded conditions that perpetuate a closed canopy ecosystem (Nowacki and Abrams 2008). Succession to this forested state can occur in as little as 50 years from the last fire (LANDFIRE 2009).

Community Phase 2.1 Northern Red Oak – Sugar Maple/Honeysuckle – Multiflora Rose/Woodbine – This community phase represents the early stages of long-term fire suppression. Mature white and bur oaks are still present, but the more shade tolerant northern red oak and sugar maple (*Acer saccharum* Marshall) begin to dominate. The tree canopy closes to 100 percent cover and basal area increases (LANDFIRE 2009). The subcanopy supports fire-intolerant species such as black cherry and American basswood (*Tilia americana* L.). Non-native shrubs can rapidly colonize including honeysuckle (Lonicera L.) and multiflora rose (*Rosa multiflora* L.). The herbaceous layer continues to support shade-tolerant grasses and forbs, but species diversity can be reduced, oftentimes resulting in a dominance by a few species such as woodbine (*Parthenocissus vitacea* (Knerr) Hitchc.).

Pathway 2.1A – Continued fire suppression.

Community Phase 2.2 Sugar Maple – Elm/American Basswood – Honeysuckle/Woodbine – Sites falling into this community phase have a well-established, fire-intolerant canopy dominated by sugar maple, elms (Ulmus L.), and common hackberry (*Celtis occidentalis* L.). Hophornbeam, American basswood, honeysuckle, and multiflora rose regularly occur in the subcanopy and shrub layers. Without recurring fire, downed woody debris and herbaceous and leaf litter are frequently encountered on the forest floor.

Pathway 2.2A – Severe disturbance event such as a replacement fire, severe drought, or windstorm.

Transition 2A – Cultural treatments to enhance forage quality and yield transitions the site to the forage state (3).

Transition 2B – Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).

Restoration 2A – Site preparation, tree planting, invasive species control, and seeding native species transition this site to the reconstructed oak-hickory forest state (5).

STATE 3 – FORAGE STATE

The forage state occurs when the site is converted to a farming system 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) and grazing by domesticated livestock transition and maintain this state (USDA-NRCS 2003). Early settlers seeded non-native species, such 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, the non-native species were able to spread and expand across the landscape, reducing the native species diversity and ecological function. This state is most common on the steeply sloping sites.

Community Phase 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).

Pathway 3.1A – Mechanical harvesting is replaced with domestic livestock utilizing continuous grazing.

Pathway 3.1B – Mechanical harvesting is replaced with domestic livestock utilizing rotational grazing.

Community Phase 3.2 Continuous Pastured Grazing System – 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.

Pathway 3.2A – Domestic livestock are removed, and mechanical harvesting is implemented.

Pathway 3.2B – Rotational grazing replaces continuous grazing.

Community Phase 3.3 Rest-Rotation Pastured Grazing System – This community phase is characterized by rotational grazing where the pasture has been subdivided into several smaller paddocks. Through the development of a grazing plan, livestock 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). Rest-rotation pastured grazing systems include deferred rotation, rest rotation, 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 3.3A – Continuous grazing replaces rotational grazing.

Pathway 3.3B – Domestic livestock are removed, and mechanical harvesting is implemented.

Transition 3A – Land abandonment transitions the site to the fire-suppressed state (2).

Transition 3B – Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).

Restoration 3A – Site preparation, tree planting, invasive species control, and seeding native species transition this site to the reconstructed oak-hickory forest state (5).

STATE 4 – CROPLAND STATE

The low topographic relief across the MLRA has resulted in nearly the entire area being converted to agriculture (Eilers and Roosa 1994). The continuous use of tillage, row-crop planting, and chemicals (i.e., herbicides, fertilizers, etc.) has effectively eliminated the reference community and many of its natural ecological functions in favor of crop production. Corn and soybeans are the dominant crops for the site, and oats (Avena L.) and alfalfa (*Medicago sativa* L.) may be rotated periodically. These areas are likely to remain in crop production for the foreseeable future. This state is most common on the gently sloping sites.

Community Phase 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 corn-soybean rotations. 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).

Pathway 4.1A – Tillage operations are greatly reduced, crop rotation occurs on a regular interval, and crop residue remains on the soil surface.

Pathway 4.1B – Tillage operations are greatly reduced or eliminated, crop rotation occurs on a regular interval, crop residue remains on the soil surface, and cover crops are planted following crop harvest.

Community Phase 4.2 Conservation Tillage Field – This community phase is characterized by rotational crop production that utilizes 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 systems. 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 systems 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 systems, conservation tillage methods can improve soil ecosystem function by reducing soil erosion, increasing organic matter and water availability, improving water quality, and reducing soil compaction.

Pathway 4.2A – Intensive tillage is utilized, and monoculture row-cropping is established.

Pathway 4.2B – Cover crops are implemented to minimize soil erosion.

Community Phase 4.3 Conservation Tillage with Cover Crop Field – This community phase 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 ecosystem. 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 cropland system.

Pathway 4.3A – Cover crop practices are abandoned.

Pathway 4.3B – Intensive tillage is utilized, cover crops practices are abandoned, monoculture row-cropping is established, and crop rotation is reduced or eliminated.

Transition 4A – Land abandonment transitions the site to the fire-suppressed state (2).

Transition 4B – Cultural treatments to enhance forage quality and yield transitions the site to the forage state (3).

Restoration 4A – Site preparation, tree planting, invasive species control, and seeding native species transition this site to the reconstructed oak-hickory forest state (5).

STATE 5 – RECONSTRUCTED OAK-HICKORY FOREST STATE

The combination of natural and anthropogenic disturbances occurring today has resulted in numerous forest health issues, and restoration back to the historic reference condition may not be possible. Forests are being stressed by non-native diseases and pests, habitat fragmentation, permanent changes in soil hydrology, 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; timber, fiber, and fuel products; as well as a variety of cultural activities (e.g., hiking, camping, hunting) (Millennium Ecosystem Assessment 2005; Flickinger 2010). Therefore, conservation of forests and woodlands should still be pursued. Forest reconstructions are an important tool for repairing natural ecological functioning and providing habitat protection for numerous species associated with Till Backslope 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 oak-hickory forest state is the result of a long-term commitment involving a multi-step, adaptive management process.

Community Phase 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.

Pathway 5.1A – Application of stand improvement practices in line with a developed management plan.

Community Phase 5.2 Late Successional Reconstructed Forest – Appropriately timed management practices (e.g., prescribed fire, hazardous fuels management, 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 woodland will have an uneven-aged canopy and a well-developed shrub layer and understory.

Pathway 5.2A – Reconstruction experiences a setback from extreme weather event or improper timing of management actions.

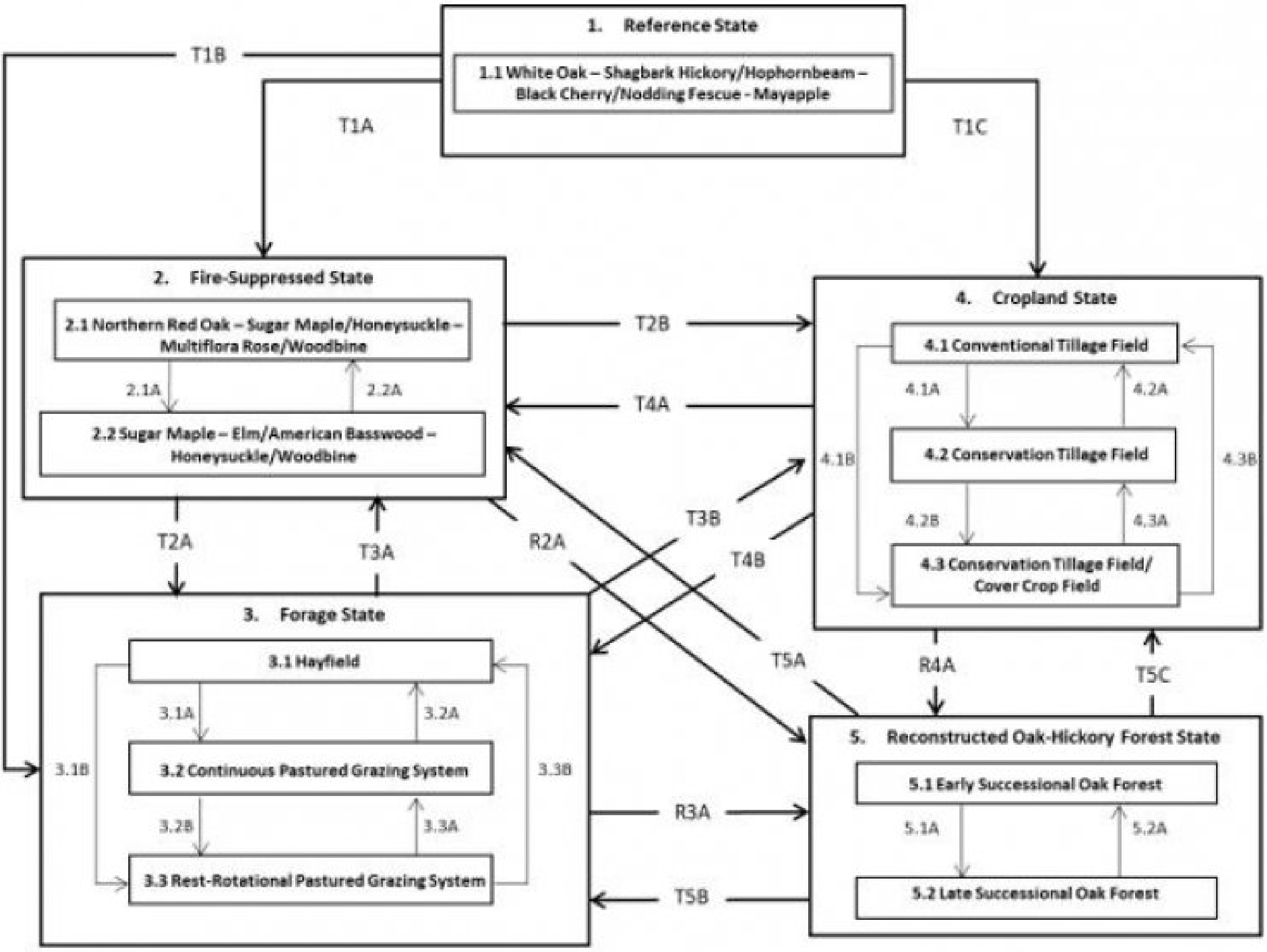
Transition 5A – Fire suppression and removal of active management transitions this site to the fire-suppressed state (2).

Transition 5B – Cultural treatments to enhance forage quality and yield transition the site to the forage state (3).

Transition 5C – Tillage, seeding of agricultural crops, and non-selective herbicide transition this site to the cropland state (4).

State and transition model

F108CY513IA Till Backslope Forest



Code	Process
T1A, T3A, T4A, T5A	Long-term fire suppression and/or land abandonment
2.1A	Continued fire suppression
2.2A	Severe disturbance event such as fire, drought, or windstorm
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	Domestic livestock grazing is replaced by mechanical harvesting
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, non-native species control, and native seeding
5.1A	Invasive species control and implementation of disturbance regimes
5.2A	Drought or improper timing/use of management actions

Inventory data references

Tier 3 Sampling Plots used to develop the reference state, community phases 1.1 and 1.2 and alternative state, community phase 2.1:

State County Ownership Legal Description Easting Northing
Iowa Jasper Rhodes Timber – Marshall County Conservation Board T82N R20W S8 483721 4642726
Iowa Warren Lake Ahquabi State Park – Iowa Department of Natural Resources T75N R24W S23 450170 4569923
Iowa Des Moines Big Hollow Creek Recreation Area – Des Moines County Conservation Board T71N R3W S18 648313 4534486
Iowa Des Moines Hickory Bend Recreation Area – Des Moines County Conservation Board T71N R3W S32 649014 4530646
Iowa Madison Clanton Creek Wildlife Area – Madison County Conservation Board T74N R27W S16 419103 4561571

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Approval

lisa kluesner, 7/01/2019

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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	
Approved by	
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:**
