11620

Western Great Plains Floodplain Systems

BpS Model/Description Version: Aug. 2020

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| --- | --- | --- | --- |
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Vegetation Type

Mixed Upland and Wetland

Map Zones

29, 30

Geographic Range

Great Plains river systems from eastern Montana west to the Rocky Mountain front. Such river systems include the Missouri, Mussell, Yellowstone, Teton, Marias, and Sun rivers. The major tributaries to these river systems are in this Biophysical Setting (BpS): Cheyenne River in map zone (MZ) 31 into MZ29, Belle Fourche in Wyoming into South Dakota, Little Missouri in North Dakota/South Dakota, and Yellowstone River. In MZ30, these systems are in section 331Md, along the floodplain of the Little Missouri River. They occur throughout MZ29 in Montana, including Yellowstone and its major tributaries in Big Horn, Tongue, Powder, and the Little Missouri. In MZ30, it includes the Yellowstone and Missouri rivers (331E, 331M; Cleland et al. 2007).

See Adjacency/Identification Concerns box regarding smaller second- and third-order prairie streams and where they occur or what they’re classified as. See same box to determine how to distinguish this from Rocky Mountain riparian systems.

Biophysical Site Description

Alluvial surfaces, usually bare, within broad floodplains are present as low-elevation shorelines and barforms. The slightly higher fluvial landform adjacent to the channel forms the first terrace for fluvial-dependent species. Over time, laterally migrating point bars form bench platforms that may become late-seral-stage floodplain forests.

Great Plains riparian and floodplain areas are at lower elevations/in the plains matrix.

Vegetation Description

Dominant types are cottonwood and willow. Broadleaf deciduous forest dominated by cottonwood (primarily *Populus deltoides*), yellow willow, or peach leaf willow and sandbar willow. In the Milk River drainages, narrowleaf cottonwood (*Populus angustifolia*) is common (but rare or absent in MZ29 and MZ30). Narrowleaf cottonwood occur in upper (inter-mountain valley) reaches of the Marias and Yellowstone rivers. Black cottonwood (*Populus* *trichocarpa*) are found along the Milk and Yellowstone, but only occasionally along the Marias (and not in MZ29 and MZ30). Early-seral-stage phreatophytic vegetation becomes established on low-elevation flood deposits; however, long-term survival is possible only on bare, moist sites at slightly higher elevation (1-3m above lower limit of perennial vegetation) Other species found in the floodplain riparian zone include sandbar willow, boxelder, and green ash, typically associated with late seral stages. Boxelder is more common along the Milk than along some of the other drainages. Boxelder, however, is also seen today in the Musselshell/Little Missouri River, but it is questionable as to whether it would have occurred historically. Girard et al. (1989) do not report boxelder for cottonwood forests, and Hansen et al. do not report boxelder for plains cottonwood forests in Montana.

*Populus deltoides* and *Fraxinus pennsylvanica* are characteristic of Great Plains riparian forests. *Fraxinus* becomes a dominant in MZ30 riparian areas, where it comes in after *P. deltoides*, grows much more slowly, but persists after *P. deltoides* because it can recruit into shaded, relatively undisturbed sites. FRPE was therefore added as a dominant for MZ29 and MZ30, and PASM was removed.

Green ash commonly forms a sub-canopy in older stands and can eventually dominate if stands persist for >150-200yrs without major flood disturbance.

PODE is a pioneer species along Missouri River in central North Dakota, in southeast South Dakota, and near Omaha, Nebraska, and is replaced successionally by various combinations of *Fraxinus*, *Ulmus*, *Acer*, and *Celtis* (Hansen et al. 1984). Undergrowth dominated by SYOC, RHAR, and other shrubs. Among the grasses, *Calamovilfa longifolia*, *Elymus canddensis*, and *Muhlenbergia racemosa* are important (Hansen et al. 1984).

In Theodore Roosevelt National Park in North Dakota, *Poa pratensis* is the most important grass, and *Melilotus officinalis* is the most important forb (Hansen et al. 1984).

Silver sagebrush is present in this system in the late successional stage. Understory species in these later seral stages may include dogwood, currents, snowberry, wild rose, and chokecherry.

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| PODE3 | *Populus deltoides* | Eastern cottonwood |
| SALU2 | *Salix lutea* | Yellow willow |
| SAEX | *Salix exigua* | Narrowleaf willow |
| SAAM2 | *Salix amygdaloides* | Peachleaf willow |
| CORNU | *Cornus* | Dogwood |
| ROSA5 | *Rosa* | Rose |
| FRPE | *Fraxinus pennsylvanica* | Green ash |
| ARCA13 | *Artemisia cana* | Silver sagebrush |

Species names are from the NRCS PLANTS database. Check species codes at http://plants.usda.gov.

Disturbance Description

The development and maintenance of this system is dependent on fluvial geomorphic processes such as channel meandering/erosional processes of river flooding, sedimentation, erosion, channel avulsion, and barform accretion driven by hydrologic variability. This variability incorporates the features of timing, duration, frequency, magnitude, and intensity. Regeneration of the dominant species (cottonwood and willow) is dependent on flooding and movement of river channels, which creates bare, moist soil needed for seedling establishment. Oxbow and slough development also influence the floodplain system and create variability in plant community composition. Upper terraces have infrequent flooding and scouring events whereas the lower terraces nearest the river flood frequently.

Early-seral-stage development stands are produced on point bars via channel meandering, which occurs most often during moderately frequent high flows. Also produced in other ways. In other words, two kinds of rivers -- meandering and in areas of sediment deposition -- if river has large flood and bare area created, then system established; or via silt deposit that assists establishment (Scott et al 1996).

Scouring caused by ice jams during the winter, channel meandering, oxbows, and slough development greatly influence this system. Ice jams and ice scouring were not modeled.

Changes in hydrology due to the activities of beaver are also an important ecological process in the Great Plains Floodplain, particularly on the tributaries (Little Missouri) to the Missouri River, as well as tributaries of the Yellowstone (Powder, Tongue, and Big Horn). Beaver are present on the main stem of the Yellowstone River, but are not critically important because bank dens are frequently flooded and destroyed. Beaver impoundments kill trees (sometimes over large areas) and may create open-water habitat and willow stands or contribute to channel meandering. The effects of beaver ponds on forest dynamics in this system are also poorly understood at the landscape level, especially in the pre-settlement context. Note that beaver populations might have been maintained at artificially low levels on the Great Plains due to constant harvesting by humans. Beaver activity could have been a large influence in this system historically. It could have contributed to the system going from the mid seral stage to the silver sagebrush stage. However, this would happen if they were old stands on higher terraces close to the channel, not if they were younger stands on lower, moister terraces. Cottonwood on lower, moister terraces would resprout and there would be a willow-cottonwood, beaver-induced dis-climax. Beaver damage could be highly extensive in areas in this system (Lesica and Miles 2004, 1999). The effects of beaver activity on forest dynamics in this system are also not well understood at the landscape level, especially in the pre-settlement context.

Traveling ungulate herds and Native American activities locally impacted seral-stage development. However, not enough is known about such disturbances to attempt modeling. Native Americans likely camped along rivers and used fire to attract game, with low-severity fires in early spring probably more frequent than 50-75yrs (Butler, pers. comm.).

This seral community is most affected by fluvial geomorphic processes such as flooding, avulsion and deposition, and channel movement. The floodplain valley was modeled up to the last high terrace that rarely floods to reset to an early successional seral stage. The model does include shallow wetlands, sloughs, or oxbows. Deepwater habitat and the wetted width of the active river were not included in the model. Different flooding regimes were used in the model. The rivers flood to some extent almost every year. This annual, spring, snowmelt flooding is the primary driver of point bar formation. Fifty- or 100-yr floods can wipe out point bars, but they form lots of habitat for cottonwood and willow establishment through scouring and deposition. Minor, point bar-forming floods occur almost every year whereas serious, scouring, high-terrace depositing events may occur every 20-50yrs. Flood frequency is also based on location on the floodplain, with higher terraces being subject to longer flood cycles.

Fire was a disturbance mechanism within portions of floodplain; however, the frequency and intensity are unknown. We can, however, infer mixed-severity fires in general, given the highly variable species and varying fuel amounts and spatial arrangements. The role of fire was less important, with relatively infrequent and patchy, low- to mixed-severity fires. A reviewer (Barrett, pers. corresp.) commented that the overall mean fire return interval (MFRI) was probably approximately 50-75yrs, given the presumably abundant ignition opportunities in the neighborhood (i.e., occasional fires spreading into this BpS from adjacent, frequently burned grasslands). The overall MFRI was thus modeled as such. However, Butler commented that Native Americans likely camped along rivers and used fire to attract game, with low-severity fires in early spring probably more frequent than 50-75yrs (Butler, pers. comm.).

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 111 | 46 |  |  |
| Moderate (Mixed) | 147 | 34 |  |  |
| Low (Surface) | 257 | 20 |  |  |
| All Fires | 51 | 100 |  |  |

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Percent of all fires is the percent of all fires modeled in that severity class. Minimum and Maximum FIs show the relative range of fire intervals as estimated by model contributors, if known.

Scale Description

Landscape adequate in size to contain natural variation in vegetation and disturbance regime. This BpS occurred in a linear dimension along the Missouri River floodplain and Little Missouri River (MZ30), with smaller areas covered in tributary rivers and streams. Wetland complexes include oxbow lakes, sloughs, and marshes.

Adjacency or Identification Concerns

This system is easily identified by using floodplain, which is covered by a 10-yr event. Surrounding vegetation could vary from forested to grass prairie transition. In the western part of MZ20, there could be narrowleaf cottonwood and hybrids between this system and narrowleaf.

Russian olive and tamarisk may be invaders. Tamarisk comes in with cottonwood and willow in earliest post-disturbance stage. Russian olive might affect later successional stages -- after 10yrs -- usually at approximately the time that green ash and Rocky Mountain juniper come in. Rocky Mountain juniper also invades along the Little Missouri River in MZ29. Leafy spruce, smooth brome, Canada thistle, and Russian knapweed might also invade.

Natural flooding frequencies have been changed by modern water control structures (dam and irrigation projects). Flooding intensity has been altered by construction of small impoundments on tributaries as well as larger impoundments on the main-stem rivers. Decreased flood frequency along the Little Missouri River decreased cottonwood abundance and increased distribution of silver sage in MZ29 currently. However, this trend has just started (i.e., increase of silver stage today versus historically).

Agricultural activities have changed seral development and introduced invasive plant species to the BpS.

Woodcutters along the system operated from the earliest days (1860s) to supply wood to the paddle wheelers plying the river. They cut many of the early stands along the river and perhaps threw the balance to POPDEL regeneration as opposed to ACENEG. It is very difficult to model the pre-settlement conditions of these river systems, not knowing their original composition. Currently, there is higher cover and taller shrubs on the landscape today, versus historically, in MZ29 and MZ30.

Johnson (1992), in a study of Missouri River floodplain forests in central North Dakota, determined that the pre-settlement forest was, in fact, dominated by early successional stages. He reported that young pioneer stands (<40yrs) comprised 47% of the forest, older pioneer stands (40-80yrs) comprised 25% of the forest, transitional forest (80-150yrs) comprised 21% of the forested acreage, and that equilibrium stands (dominated by green ash, elm, oak, etc.; >150yrs) comprised only 7%of the forested acreage. Johnson (1992) also demonstrated that, with construction of Garrison Dam and subsequent cessation of flooding, there is a continuing shift to older forest stages and very little recruitment of new, early successional forest -- the very types that once dominated the Missouri River floodplain and provided habitat for its varied native wildlife (Ode 2004).

Over the past 37yrs, much has changed in the cottonwood forest of LaFramboise Island in South Dakota. As the density of cottonwood has declined (at a rate of about two per acre per year), the number of juniper and, to some extent, green ash has dramatically increased. In cottonwood forests throughout much of the upper Missouri River Valley, green ash is one of the most important tree species to colonize cottonwood forests and, over time, becomes the dominant forest tree (Ode 2004). Whatever the dominance of green ash in the future forest, it will likely be overwhelmed if not overshadowed by the massive number of juniper now developing in the LaFramboise Island forest understory (Ode 2004). Cottonwood is declining.

Juniper is notoriously vulnerable to fire. On the pre-settlement landscape of the northern plains, where prairie fires were frequent events, juniper woodlands were restricted to fire-protected environments like river breaks, badland escarpments, buttes, and islands (Ode 2004).

This system should be distinguished from 1159 by geographic range/ecoregions. The Great Plains Floodplain systems are in the Northwestern Glaciated Plains and the Northern Great Plains; the Rocky Mountain Montane Riparian systems are in the lower elevations (i.e., not alpine) of the Northern and Middle Rockies, some of which occur as isolated mountain ranges in the Great Plains. Broadly generalized, the Great Plains Floodplain systems typically have broader floodplains and more terrace development.

In addition, montane riparian systems of central Montana and probably the Black Hills will also have steeper gradients and more narrow floodplains, and may be dominated by *Populus* *angustifolia* or *P. balsamifera*, as opposed to *P. deltoides* for Great Plains floodplains. Rivers like the Powder, Tongue, and probably the Little Missouri start as montane rivers and become Great Plains rivers.

There might be some difficulty distinguishing the floodplain systems from the riparian from the wooded draws/ravines and where to assign smaller, second- and third-order prairie streams. The second- and third-order prairie streams can sometimes have cottonwood and be like small rivers (riparian, floodplain). Sometimes they are dominated by other woodies such as water birch, boxelder, green ash (wooded draw/ravine), and willow, depending on how far east you go; sometimes they have very few woody plants other than silver sagebrush (Floodplain box E). Streams in the eastern half of Montana (east of the Big Snowy Mountains) could probably be modeled as either a cottonwood successional sequence or a woody draw successional sequence, depending on the size of the drainage basin. If the basin is big enough, there will eventually be a flood big enough to result in cottonwood regeneration. This may not happen very often naturally, so these types of drainages would be in Class E floodplains (silver sagebrush) a lot of the time. This is especially true now that we have all the impoundments in the headwaters of these prairie streams. Drainages that just don’t have the area to get a serious flood would probably have been some sort of woody draw, dominated by green ash in the eastern third of the state or by other woodies like hawthorn or chokecherry in the more western part of the Great Plains. In terms of assigning the drainage to one or the other type of system, this depends on basin size.

The Rocky Mountain riparian systems occur in the mountains whereas Great Plains riparian and floodplain 1162 are at lower elevations/in the plains matrix of eastern Wyoming and east Montana plains grasslands, and are better described by 1162. The exception to this is the strings of narrowleaf cottonwood (*P. angustifolia*) found along the Laramie River and other rivers in the Wyoming portions of MZ29, which are Rocky Mountain in character despite being surrounded by grasslands and sage-steppe. The riparian zones in the middle of sage-steppe are really Rocky Mountain systems, not Great Plains.

Rivers and streams that have had impoundments (current conditions) for 50yrs or more probably have more Class D and Class E than pre-settlement, but less Class A and Class B. Class A and Class B currently have tamarisk. Class C and Class D have Russian olive currently. Several exotics, such as Canada thistle, Kentucky bluegrass, and quackgrass are ubiquitous in Class B through Class E currently.

Issues or Problems

Assumptions: Rapid Assessment odel developed with the recognition that the Great Plains Floodplain forest (cottonwood-willow community) is a seral community affected primarily by fluvial geomorphic processes such as flooding, avulsion and deposition, and channel movement. The floodplain valley was modeled up to the last high terrace, which rarely floods, to reset to an early successional seral stage. The model does include shallow wetlands, sloughs, or oxbows. Deepwater habitat and the wetted width of the active river were not included in the model. Flood frequency for a class is based on location on the floodplain, with higher terraces being subject to longer flood cycles.

Woodcutters along the system operated from the earliest days (1860s) to supply wood to the paddle wheelers plying the river. They cut many of the early stands along the river and perhaps threw the balance to POPDEL regeneration as opposed to ACENEG. It is very difficult to model the pre-settlement conditions of these river systems, not knowing their original composition.

Native Uncharacteristic Conditions

Rivers such as the Missouri below Fort Peck Dam and the Big Horn and Tongue below their dams probably have more late-seral and less early-seral vegetation because of the reduced flooding frequency and severity.

Comments

This model for MZ29 and MZ30 was adopted from the same BpS from MZ20 created by Peter Lesica and Vinita Shea, and reviewed by Brian Martin, Steve Cooper, and Linda Vance. Slight model changes made.

This model for MZ20 was adapted from the Rapid Assessment Model R4NOFP Great Plains Floodplain created by George Cunningham (gcunningham@mail.unomaha.edu) and reviewed by John Ortmann (jortmann@tnc.org). The model for MZ20 was modified greatly descriptively and quantitatively by Vinita Shea (vshea@blm.gov) and Ben Pratt (ben\_pratt@fws.gov). The model is also reflective of the upper Missouri River region. Upon review for MZ20 by Peter Lesica, Brian Martin, and Steve Cooper, other major quantitative changes were made and successional classes were changed to encompass the silver sage component of Class E instead of a green ash community, which was thought not to exist in MZ20. Another reviewer for MZ20 was Steve Barrett.

Succession Classes

**Mapping Rules**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Upper Layer Lifeform** | **Height (m)** | **Canopy Cover (%)** | | | | | | | | | |
| **0-10** | **11-20** | **21-30** | **31-40** | **41 - 50** | **51-60** | **61-70** | **71-80** | **81-90** | **91-100** |
| Herb | 0-0.5 | UN | UN | UN | UN | UN | UN | UN | UN | UN | UN |
| Herb | 0.5-1.0 | UN | UN | UN | UN | UN | UN | UN | UN | UN | UN |
| Herb | >1.0 | UN | UN | UN | UN | UN | UN | UN | UN | UN | UN |
| Shrub | 0-0.5 | E | E | E | E | UN | UN | UN | UN | UN | UN |
| Shrub | 0.5-1.0 | E | E | E | E | UN | UN | UN | UN | UN | UN |
| Shrub | 1.0-3.0 | E | E | E | E | UN | UN | UN | UN | UN | UN |
| Shrub | >3.0 | UN | UN | UN | UN | UN | UN | UN | UN | UN | UN |
| Tree | 0-5 | A | A | A | A | A | A | UN | UN | UN | UN |
| Tree | 5-10 | B | B | B | B | B | B | B | D | D | D |
| Tree | 10-25 | B | B | B | B | B | B | B | D | D | D |
| Tree | 25-50 | UN | UN | UN | UN | UN | C | C | C | C | UN |
| Tree | >50 | UN | UN | UN | UN | UN | C | C | C | C | UN |

Succession class letters A-E are described in the Succession Class Description section. Some classes use a leafform distinction where a qualifier is added to the class letter: Brdl (broadleaf), Con (conifer), or Mix (mixed conifer and broadleaf). UN refers to uncharacteristic native or a combination of height and cover that would not be expected under the reference condition. NP refers to not possible or a combination of height and cover which is not physiologically possible for the species in the BpS.

**Description**

Class A 14 Early Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PODE3 | Populus deltoides | Eastern cottonwood | Upper |
| SAEX | Salix exigua | Narrowleaf willow | Upper |
| SALU2 | Salix lutea | Yellow willow | Upper |
| SCHOE6 | Schoenoplectus | Bulrush | Low-Mid |

Description

Created by deposition, stream meander changes, point bar formation, and scouring.

The upper layer lifeform is comprised of a seedling and sapling shrub (willow) and tree component and is dominated by a young canopy of tree saplings and shrubs after a few years. Trees might be more abundant/frequent. Shrubs of any cover and 0-1m are in this class.

Sandbar willow, *Salix* interior, is invariably the first that makes its appearance on the newly made lands on the borders of the Mississippi and Missouri rivers and seems to contribute much toward facilitating the operation of raising this ground still higher. It grows remarkably close and, in some instances, so much so that the willows form an almost impenetrable thicket (from Meriwether Lewis during the Lewis & Clark expedition in 1804 to 1806; Ode 2004).

Pioneer tree and shrub species of cottonwood and willow. The understory is highly variable and consists of bare sand, annuals, or perennial hydrophytes. Species include various grasses, sedges, and rushes. Annuals become less and less common as the rhizomatous perennials take hold. Herbaceous understory of sedges (bulrushes) and native annuals in wet areas. In the few early years of this stage, most of the area is bare sand.

Most of area is seasonally flooded. Much bare, wet-alluvium habitat for cottonwood establishment is created each year during spring floods. However, most all of these will be swept away by the next year’s flood in the early part of this class. It is probably only every 10-20yrs that flooding occurs high enough on point bars and low terraces to establish cottonwood and then allow them to escape flooding until they are large enough to persist -- in the early part of this class.

During the second part of this class, minor flooding occurs, advancing this stage to the next. Deposition causes the terrace to build and become higher and drier. This was modeled as alternate succession. Lack of flooding actually maintains the stage.

Major flooding occurs less often, bringing the class back to the beginning of this stage. This was modeled as wind/weather stress.

Beaver disturbance occurs in this class. The closer to the river, the more likely it is. Beaver, however, do not have as much of an impact in stands this young unless there is nothing else in the area. Beaver activity is quite variable. It was modeled as occurring in 1% of this class on the landscape each year, maintaining this class.

Johnson (1992) states that young pioneer stands comprised 47% of the forest historically.

*Maximum Tree Size Class*  
Sapling >4.5ft; <5" DBH

Class B 28 Mid Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PODE3 | Populus deltoides | Eastern cottonwood | Upper |
| SAAM2 | Salix amygdaloides | Peachleaf willow | Mid-Upper |
| SALU2 | Salix lutea | Yellow willow | Middle |
| FRPE | Fraxinus pennsylvanica | Green ash | Low-Mid |

Description

This stage develops as the stand starts to mature. This community tends to be partially open, with scattered cottonwood and willow. Stands of cottonwood can be fairly dense, although there are usually some openings. The shrub layer is highly variable and may include species such as rose, snowberry, chokecherry, and dogwood. *Glycyrrhiza* *lepidota* might also occur. *Elymus* *canadensis* might also occur. Green ash begins to establish in cottonwood stands (Lesica and Miles 1999). The understory vegetation is highly variable.

Flooding occurs and advances it to the next stage by raising the level of the terrace. Minor flooding leads to deposition. Major flooding occurs. This was modeled as wind/weather stress.

Replacement fire was modeled infrequently. However, it has been suggested that stand-replacing fires might not occur in this class because it might be too wet for fire. However, due to lack of data, replacement fire was kept in the model. It is questionable as to whether replacement fire would set this stage back, as the terrace would be too high and dry to provide conditions for successful establishment of cottonwood and willow from seed. If the cottonwood resprouted, the understory would be more mature; if the cottonwood didn’t resprout, it would probably just be a willow stand.

Low- and mixed-severity fire also occur and do not transition to another stage.

Beaver disturbance occurs in this class. The closer to the river, the more likely it is. Beaver activity is quite variable. It was modeled as occurring rarely and it maintains this class.

It has been suggested that Native Americans likely burned (low-severity fires) these areas more often. Also, some sites were likely heavily grazed by bison (low-severity-fire sites) and horses near camps. However, the model was retained as is, as no further feedback was received.

Johnson (1992) stated that young pioneer stands (<40yrs) comprised 47% of the forest historically.

*Maximum Tree Size Class*  
Medium 9-21" DBH

Class C 25 Late Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PODE3 | Populus deltoides | Eastern cottonwood | Upper |
| PASM | Pascopyrum smithii | Western wheatgrass | Low-Mid |
| SYOC | Symphoricarpos occidentalis | Western snowberry | Middle |
| FRPE | Fraxinus pennsylvanica | Green ash | Low-Mid |

Description

This class is a mature, late-seral, closed-canopy cottonwood floodplain forest. Overstory is dominated by cottonwood, green ash. (Original MZ20 modelers included boxelder ACENEG in this class; however, all other reviewers disagreed and said that ACENEG was a minor component historically. It might be present, but in small amounts; chokecherry is more common. Boxelder, however, is seen today in the Musselshell/Missouri River, but it is questionable as to whether it would have occurred historically.) System becoming drier, so western wheatgrass coming in.

At least four studies along the Missouri River in southeastern South Dakota have described aspects of a successional sequence that begins with colonization by cattails or sandbar willow, develops through transitional phases to a Plains cottonwood-dominated forest, and, finally, in the absence of stand-replacing floods, develops into a mixed deciduous forest that may contain the following tree species (in addition to aging cottonwood): green ash, American elm, boxelder, bur oak, slippery elm, hackberry, American basswood, black walnut, and eastern red cedar (Johnson 1950; Heckel 1963; Wilson 1965, 1970; Lawry 1973). Ecological studies along the Missouri River in central North Dakota have documented a similar successional pattern ultimately resulting in a forest dominated by green ash, boxelder, bur oak, and American elm (Johnson et al. 1976; Ode 2004). Some cottonwood stands have enough green ash that the next class is dominated by green ash and *Symphoricarpos occidentalis*. Of course, some stands would be a mosaic of these two late-seral types.

Minor flooding occurs and raises the level of the terrace. Because this is the last stage in this cottonwood portion of the system, this minor flooding was modeled as wind/weather stress, causing no transition. Major flooding occurs. This was modeled as wind/weather stress.

Replacement fire occurs. It is thought, however, that before it gets to silver sagebrush, there might be an intermediate stage dominated by western wheatgrass and snowberry before silver sagebrush establishes in significant amounts. However, due to the limitations of the five-box model, this intermediate stage was not modeled.

Low-severity fire was also modeled, causing no transition. Mixed-severity fire was also included with the same infrequent probability as low severity. It is thought that mixed-severity fire would cause a more open, drier stand that would allow invasion of silver sagebrush earlier.

Optional 2 in this class represents erosional processes of river meandering. The class/system is first part of the river, but then succeeds to a point bar state. This occurs with a low frequency.

River meanders back and begins to cut away at the banks, where a mature or old-growth stand of POPDEL exists, and the living trees slowly are undercut and ultimately fall into the stream.

Beaver disturbance occurs in this class. The closer to the river, the more likely it is. Beaver activity is quite variable, but maintains this class.

Johnson (1992) stated that older pioneer stands comprised 25% of the forest, transitional forest comprised 21% of the forested acreage, and equilibrium stands (dominated by green ash, elm, oak, etc.) comprised only 7% of the forested acreage historically.

*Maximum Tree Size Class*  
Very Large >33" DBH

Class D 6 Late Development 2 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| FRPE | Fraxinus pennsylvanica | Green ash | Middle |
| ACNE2 | Acer negundo | Boxelder | Middle |
| PODE3 | Populus deltoides | Eastern cottonwood | Middle |
| SYOC | Symphoricarpos occidentalis | Western snowberry | Upper |

Description

Found along the upper terrace that has been protected from most flood events, except for rare high intensity flooding. Species composition increases toward the south and east within the region. Overstory species include hackberry, green ash, sycamore, black walnut, and elm. Understory species include vines and poison ivy.

In the absence of stand-replacing floods, this class is what has developed: a mixed deciduous forest that may contain the following tree species (in addition to aging cottonwood): green ash, American elm, boxelder, bur oak, slippery elm, hackberry, American basswood, black walnut, and eastern red cedar (Johnson 1950; Heckel 1963; Wilson 1965, 1970; Lawry 1973). Ecological studies along the Missouri River in central North Dakota have documented a similar successional pattern, ultimately resulting in a forest dominated by green ash, boxelder, bur oak, and American elm (Johnson et al. 1976; Ode 2004).

Hackberry, sycamore, slippery elm, basswood, burr oak, and black walnut are rare or absent in eastern Montana and (presumably) western North Dakota. These species occur in central to eastern North Dakota. The only trees you can count on in Class D in eastern Montana and western North Dakota (and probably much of western South Dakota too) are green ash, American elm, boxelder, and eastern red cedar (*Juniperus scopulorum*).

Hansen et al. (1984) stated that other dominants are *Toxicodendron rydbergii* and *Elymus* *canadensis*.

The FRPE/SYOC association is an edaphic climax on the floodplain adjacent to the Little Missouri River and its major tributaries. PODE currently dominates many stands but is no longer reproducing. It will be replaced by FRPE. The larger trees, some 6-7dm DBH are PODE, but the young trees establishing in the stands are FRPE. JUSC is tallied with the tree species, although it’s an understory species in the closed forest. Its current abundance is attributed to adequate light penetrating to the shrub and herb layers of the community as a result of wide spacing of the old *Populus*. Along the Missouri River, in central North Dakota, southeast South Dakota, and near Omaha, Nebraska, PODE is a pioneer species and is replaced successionally by various combos of *Fraxinus*, *Ulmus*, *Acer*, and *Celtis*. Among the grasses, CALO, ELCA, and MURA are important (Hansen et al 1984).

The disturbances are those from R4NOFP: Major flooding events can bring this class back. Flooding events can also cause a transition, modeled as wind/weather stress.

Mixed fire occurs but causes no transition.

Dominants of the green ash/western snowberry stands can resprout after fire. However, a very hot fire can kill the green ash (Lesica 2003), in which case it would probably become a stand of western snowberry-silver sagebrush-western wheatgrass (not modeled here).

*Maximum Tree Size Class*  
Medium 9-21" DBH

Class E 27 Late Development 3 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| ARCA13 | Artemisia cana | Silver sagebrush | Upper |
| SYOC | Symphoricarpos occidentalis | Western snowberry | Upper |
| PASM | Pascopyrum smithii | Western wheatgrass | Middle |

Description

This is a silver sagebrush climax community on river terraces and larger streams. It has been noted (Cooper, pers. corresp.) that the usual case in this system is for Plains cottonwood to die out and for the stand to go to silver sagebrush domination, with western wheatgrass in the undergrowth or western snowberry and rose (*Rosa* spp.) with grasses (mostly PASSMI). Therefore, that is what is modeled here. It is thought that, before this stage gets to silver sagebrush, there might be an intermediate stage dominated by western wheatgrass and snowberry before silver sagebrush establishes in significant amounts. However, due to the limitations of the five-box model, this intermediate stage was not modeled.

This class also represents the post-replacement fire community. This is a stable community. It persists. Silver sagebrush resprouts after fire.

This class is less likely to have depositional flooding than other stages. It was therefore not modeled here.

Optional 2 in this class represents erosional processes of river meandering. The class/system is first be part of the river, but then succeeds to a point bar state. This occurs with a frequency of several hundred years.

Replacement fire was modeled at every 50yrs, similar to other silver sagebrush communities, but maintains this stage, as this class is stable, as stated earlier, and silver sagebrush resprout and thus maintain this stage.

It is thought that this stage might be more prevalent currently versus historically due to impoundments increasing the silver sage distribution.

It has been suggested that this class did not occupy 25% of the landscape, but rather a lesser portion historically. However, upon further consideration from modelers and experts, 25% seemed reasonable for big rivers, but may be a little low for smaller streams that don’t flood with the same frequency; in other words, there might be more than 25% historically for smaller streams.

Johnson (1992) stated that older pioneer stands comprised 25% of the forest, transitional forest comprised 21% of the forested acreage, and equilibrium stands (dominated by green ash, elm, oak, etc.) comprised only 7% of the forested acreage historically.

*Maximum Tree Size Class*  
None

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:ALL | 0 | Mid1:CLS | 14 |
| Mid1:CLS | 15 | Late1:CLS | 50 |
| Late1:CLS | 51 | Late3:CLS | 200 |
| Late3:CLS | 51 | Late3:CLS | 999 |
| Late2:CLS | 150 | Late2:CLS | 999 |

Probabilistic Transitions

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Disturbance Type** | **Disturbance occurs In** | **Moves vegetation to** | **Disturbance Probability** | **Return Interval (yrs)** | **Reset Age to New Class Start Age After Disturbance?** | **Years Since Last Disturbance** |
| Optional 1 | Early1:ALL | Early1:ALL | 0.01 | 100 | No | 0 |
| Wind or Weather or Stress | Early1:ALL | Early1:ALL | 0.02 | 50 | Yes | 0 |
| Alternative Succession | Early1:ALL | Mid1:CLS | 0.05 | 20 | Yes | 0 |
| Surface Fire | Mid1:CLS | Mid1:CLS | 0.005 | 200 | No | 0 |
| Mixed Fire | Mid1:CLS | Mid1:CLS | 0.005 | 200 | No | 0 |
| Replacement Fire | Mid1:CLS | Early1:ALL | 0.0067 | 149 | Yes | 0 |
| Optional 1 | Mid1:CLS | Mid1:CLS | 0.01 | 100 | No | 0 |
| Alternative Succession | Mid1:CLS | Late1:CLS | 0.02 | 50 | Yes | 0 |
| Wind or Weather or Stress | Mid1:CLS | Early1:ALL | 0.02 | 50 | Yes | 0 |
| Alternative Succession | Late1:CLS | Late2:CLS | 0.002 | 500 | Yes | 0 |
| Optional 2 | Late1:CLS | Early1:ALL | 0.0025 | 400 | Yes | 0 |
| Replacement Fire | Late1:CLS | Late3:CLS | 0.0067 | 149 | Yes | 0 |
| Mixed Fire | Late1:CLS | Mid1:CLS | 0.01 | 100 | Yes | 0 |
| Surface Fire | Late1:CLS | Late1:CLS | 0.01 | 100 | No | 0 |
| Optional 1 | Late1:CLS | Late1:CLS | 0.01 | 100 | No | 0 |
| Wind or Weather or Stress | Late1:CLS | Early1:ALL | 0.013 | 77 | Yes | 0 |
| Wind or Weather or Stress | Late1:CLS | Late1:CLS | 0.1 | 10 | No | 0 |
| Wind or Weather or Stress | Late2:CLS | Early1:ALL | 0.004 | 250 | Yes | 0 |
| Wind or Weather or Stress | Late2:CLS | Late1:CLS | 0.005 | 200 | Yes | 0 |
| Mixed Fire | Late2:CLS | Late2:CLS | 0.05 | 20 | No | 0 |
| Optional 2 | Late3:CLS | Early1:ALL | 0.0025 | 400 | Yes | 0 |
| Wind or Weather or Stress | Late3:CLS | Early1:ALL | 0.004 | 250 | Yes | 0 |
| Replacement Fire | Late3:CLS | Late3:CLS | 0.02 | 50 | No | 0 |

Optional Disturbances

Optional 1: Beaver

Optional 2: Erosional Processes of River Meandering

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