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

31, 39, 40

Geographic Range

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

In MZ39 and MZ40, this system goes northwest from ECOMAP subsection 332Bb. It is northwest of Yankton, South Dakota, which is a break in the Missouri River. The 11-mile-wide floodplain with eastern trees stops at Yankton; then, going west, the floodplain is 1-mi wide and only has cottonwood as early tree species.

It is difficult to determine geographically where the western model ends and the eastern model (BpS 1469) starts, but it probably starts/ends around Yankton, South Dakota, or perhaps up to Fort Randall Dam, which might be a good dividing line for eastern versus western on the Missouri River.

See “Adjacency or Identification Concerns” regarding smaller second- and third-order prairie streams and where they occur or what they are classified as. Also see “Adjacency or Identification Concerns” to describe how to distinguish this from Rocky Mountain riparian systems and the Eastern Floodplain 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 systems are at lower elevations in the plains matrix.

Dominant communities within this system range from floodplain forests to wet meadows to gravel/sand flats; however, they are linked by underlying soils and the flooding regime.

Vegetation Description

Dominant types in this system are cottonwood and willow. This system consists of broadleaf deciduous forests dominated by cottonwood (primarily *Populus deltoides*), yellow willow, or peachleaf 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 occurs in upper (inter-mountain valley) reaches of the Marias and Yellowstone rivers. Black cottonwood (*Populus trichocarpa*) is found along the Milk and Yellowstone rivers, 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 on slightly higher elevation (1-3m above low water line or slightly higher elevation possibly due to sedimentation over the original recruitment surface). Other species found in the floodplain riparian zone include sandbar willow, boxelder, and green ash, typically associated with late seral stages. Boxelder is present in the Dakotas.

*P. deltoides* and *Fraxinus pennsylvanica* are characteristic of Great Plains riparian forests. *Fraxinus* becomes a dominant species in MZ30 riparian areas, where it comes in after *P. deltoides* and grows much more slowly, but persists after *P. deltoides* because it can recruit into shaded, relatively undisturbed sites.

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 the 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 is dominated by SYOC, RHAR (in the uppermost reaches, but not in the Plains), and other shrubs. Among the grasses, *Spartina pectinata*, *Elymus canadensis*, and *Muhlenbergia racemosa* are important. 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 sage might be present in this system in the late successional stage. American elm is also a secondary successional species and is co-dominant. Understory species in these later seral stages may include dogwood, currant, snowberry, wild rose, and chokecherry.

The 11-mi-wide floodplain with eastern trees stops at Yankton, South Dakota, then, going west, the floodplain is 1mi wide and has cottonwood and peachleaf willow as early tree species. With the absence of fire and occasional overgrazing, silver sagebrush has locally invaded upland sites, which is how some range ecologists interpret it. It is unclear how extensive silver sagebrush was historically. The fact that sage grouse were historically collected all the way east to the Missouri River gives cause to wonder about the previous extent of sagebrush (Dave Ode, pers. comm.).

ARCA/PASM is fairly extensive along the floodplain of the Little Missouri River and along the first and possibly second terrace of some of the more major tributaries of the Little Missouri (Jack Butler, USFS, pers. comm.).

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 of flooding. 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. They are also produced in other ways. There are two kinds of rivers: meandering and those that occur on areas of sediment deposition. If the river has a large flood and bare area is created, then the system is established; silt deposition assists establishment (Scott et al. 1996). On braided rivers (e.g., the Platte River), recruitment might occur most often during low-flow periods, when vegetation colonizes and stabilizes bars within the active channel (Johnson 1994).

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

Extreme drought can also kill cottonwood stands originally established under high-water table conditions. When drought is severe enough, available water in arid soil textures (coarse river deposits) is exhausted and shallow root systems are no longer able to reach the fallen water table. Such drought was not modeled.

Changes in hydrology due to the activities of beaver are also an important ecological process in the Great Plains Floodplain, particularly in the tributaries (Little Missouri) to the Missouri River, as well as tributaries of the Yellowstone River (Powder, Tongue, and Big Horn rivers). Beaver are present on the main-stem 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 or willow stands, or may 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 disturbance 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 (Jack Butler, USFS, 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, and 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-year 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 be 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 in portions of the 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. One reviewer (Steve Barrett, pers. corresp.) for Montana MZs 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 (Jack Butler, USFS, pers. comm.). Upon review in MZ39 and MZ40, it was stated that fire was probably not a very important feature in the floodplain forest (Dave Ode, pers. comm.). Another reviewer for MZ31, MZ39, and MZ40 stated that these sites were often somewhat protected from fire in three directions by being located within river bends, and such sites were considered highly valuable by Native Americans, especially for protected winter occupation, complete with firewood and even some supplemental forage for a few select horses (ca. 1700 and after) in the form of young cottonwood bark. It would have been a fairly trivial exercise for Native Americans to protect these sites from wildfire/upland fires by essentially blacklining a grass/tree boundary under appropriate weather conditions. Some such protection probably was provided, given that even light surface fires are extremely destructive to mature cottonwood. If the highly flammable bark is ignited, it will debark the entire tree. Mature trees do not resprout. Younger trees are easily top-killed, but can still resprout. Mature cottonwood stands might have been, to a large degree, a human artifact (i.e., they were protected by native managers). Associated “seral-stage” trees (e.g., green ash, elm, and hackberry) also are quite fire intolerant and a successional pathway could only exist in virtual absence of fire, human regulated (John Ortman, TNC, pers. comm.).

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 245 | 20 |  |  |
| Moderate (Mixed) | 92 | 54 |  |  |
| Low (Surface) | 192 | 26 |  |  |
| All Fires | 50 | 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

This system consists of a 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 the floodplain, which is covered by a 10-yr event. Surrounding vegetation could vary from forested to grass prairie transition, or bare rock or rock outcrops, for instance, in the Badlands, White River in South Dakota, and on the Cheyenne River. It is adjacent to grassland with some woody draws in the river breaks. In the western part of MZ20, there could be narrowleaf cottonwood and hybrids between this system and narrowleaf.

This system might be very difficult to distinguish from 1469 Eastern Great Plains Floodplain Systems. There is actually only a Midwestern Floodplain and a Great Plains Floodplain, not an Eastern and Western Great Plains Floodplain. The Missouri River downstream from Yankton or even Fort Randall might qualify as Midwestern Floodplain. This 1162 Western Great Plains Floodplain is akin to Great Plains Floodplain, whereas 1469 Eastern Great Plains Floodplain is akin to Midwestern Floodplain. It’s difficult to determine geographically where the western model ends and the eastern model starts, but probably around Yankton, South Dakota, or perhaps up to Fort Randall Dam might be a good dividing line for eastern versus western on the Missouri River.

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.

Eastern red cedar is invasive in the floodplain forest along the Missouri River at Yankton and below, and on reaches farther upstream. Indications are that eastern red cedar would have been less prevalent historically than today due to fires and less grazing pressure. Eastern red cedar has increased on floodplains, especially due to fire suppression. Also, flood control and channel degradation have been dominant influences favoring historic red cedar increases on the Missouri River floodplain, at least below Yankton. Many of the eastern red cedar trees on the river below Yankton appear to be 30-40yrs old, tying in well with the period that the dams have been in place. Frequent flooding likely kept eastern red cedar scarce on lower floodplain surfaces in the pre-dam era. How far north and west eastern red cedar would have occurred along our rivers originally is questionable (Gary Larson, pers. comm.).

Leafy spurge, smooth brome, and Canada thistle might invade, especially along lower reaches. Russian knapweed might also invade.

The 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. The main-stem Missouri River effectively does not flood any more. 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 vs. 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 of this system. There are thousands of smaller dams on watersheds in addition to the large control structures that are altering hydrology today.

American elms are mostly gone today in some areas. On the river downstream of Yankton, however, elm is still a very common species, but does not grow to be a large tree anymore because of Dutch elm disease. It is likely that the value, average diameter, and height of elm has decreased substantially.

Livestock grazing is now different versus historically. The effects of cattle versus bison grazing on the floodplains is very different.

Currently, unpalatable sagebrush cover might be greater today, but chokecherry and associates might be getting wiped out. Bison would have grazed on top and wouldn’t have hung out in the floodplain, whereas cattle are there regularly. Depending on management, cows can graze all tree and shrub seedlings, and the seedling re-establishment is episodic, and now re-establishment is stretched out further due to the livestock. They are removing much of the woody vegetation and they are also hammering the grassland more intensely (Dave Ode, pers. comm.).

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 old) comprised 47% of the forest, older pioneer stands (40-80yrs old) comprised 25% of the forest, transitional forest (80-150yrs old) comprised 21% of the forested acreage, and equilibrium stands (dominated by green ash, elm, oak, etc.; >150yrs.old) 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 junipers and, to some extent, green ash have 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). Regardless of the dominance of green ash in the future forest, it will likely be overwhelmed, if not overshadowed, by the massive number of junipers that are 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 Plain Floodplain systems typically have broader floodplains and more terrace development.

Also, montane riparian systems of central Montana and probably the Black Hills, too, will have steeper gradients, narrow floodplains, and may be dominated by *Populus angustifolia* or *P. x acuminata* (the hybrid between plains and narrowleaf cottonwood), as opposed to *P. deltoides* for Great Plains floodplains. Rivers like the Powder and Tongue 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 may 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. Drainages that just don’t have the area to get a good flood would probably have been some sort of woody draw dominated by green ash or other woodies such as 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, it depends on basin size.

Rivers and streams that have had impoundments (current conditions) for 50yrs or more probably have more Class D and E than pre-settlement, but less Class A and B. Classes A and B currently have tamarisk. Classes C and 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 Model developed with the recognition that the Great Plains Floodplain forest (cottonwood-willow community) is a seral community most affected by fluvial geomorphic processes such as flooding, avulsion and deposition, and channel movement. 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.

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 MZs 31, 39, and 40 was adapted from the model from the same BpS 1162 from MZs29 and 30 created by Peter Lesica and reviewed by Carolyn Sieg and Jack Butler. Quantitative changes made for MZs 31, 39, and 40 due to different conception of species and alternative climax stages (Class E). Regional lead Elena Contreras made quantitative changes to model based on conversations with experts.

This model for MZs 29 and 30 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.

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 | A | A | A | A | A | A | A | A | A | A |
| Herb | 0.5-1.0 | A | A | A | A | A | A | A | A | A | A |
| Herb | >1.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 0-0.5 | E | E | E | E | A | A | A | A | A | A |
| Shrub | 0.5-1.0 | E | E | E | E | A | A | A | A | A | A |
| Shrub | 1.0-3.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | >3.0 | A | A | A | A | A | A | A | A | A | A |
| Tree | 0-5 | A | A | A | A | A | A | A | A | A | A |
| 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 | C | C | C | C | D | D |
| Tree | >50 | UN | UN | UN | UN | C | C | C | C | D | D |

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 13 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

This class is 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. *Salix amygdaloides* (peachleaf willow) is also an upper layer indicator species. Shrubs of any cover and 0-1m are in this class.

This class consists of sandbar willow. *Salix interior* is invariably the first, which 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. They grow remarkably close and, in some instances, so much so that they form a thicket almost impenetrable (from Meriwether Lewis during the Lewis & Clark expedition in 1804 to 1806; Ode 2004).

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

Most of the area is seasonally flooded. Much bare, wet-alluvium habitat for cottonwood establishment is created each year during spring floods. However, most all of these are 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 up 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 every 50yrs, bringing it 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 less than 10yrs old 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.

*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. Green ash begins to establish in cottonwood stands (Lesica and Miles 1999). The understory vegetation is highly variable.

Willow slows current and creates deposition on top. Vegetation helps anchor and causes deposition, which decreases flood frequency. Flooding leading to deposition occurs every few decades, promoting succession to the next stage by raising the level of the terrace (modeled as alternate succession). Major flooding also occurs approximately as frequently.

Replacement fire was modeled as occurring relatively infrequently. It would probably only burn in drought, as fires would be very rare. 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 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, combined, would not cause 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 in 1% of this class on the landscape each year, thus maintaining this class.

It has been suggested that Native Americans likely burned (low-severity fires) these areas more often. However, another reviewer questioned that and stated they probably didn’t burn these areas, but rather the surrounding area, because this area would be too difficult to burn due to too much shade and humidity. 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 confirming feedback was received.

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

Class C 37 Late Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PODE3 | Populus deltoides | Eastern cottonwood | Upper |
| SYOC | Symphoricarpos occidentalis | Western snowberry | None |
| FRPE | Fraxinus pennsylvanica | Green ash | Middle |

Description

This class is a mature, late-seral closed-canopy cottonwood floodplain forest. Overstory is dominated by cottonwood and green ash. Boxelder is a frequent component of this class for MZ39 and MZ40, but is not as common as green ash. (Some modelers/reviewers thought the system is becoming drier in this class, allowing western wheatgrass to come in; however, others questioned that.) Tree height maximum probably only goes to approximately 30-35m. Western portions will be shorter.

Ecological studies along the Missouri River in central North Dakota have documented a similar successional pattern as that for at least four studies along the Missouri River in southeastern South Dakota, which 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 containing aging cottonwood, green ash, boxelder, bur oak (Johnson 1950; Heckel 1963; Wilson 1970), and American elm (Johnson et al. 1976) (Ode 2004). Some cottonwood stands follow the successional pathway and proceed to the silver sage component. Others have enough green ash that the next class, is dominated by green ash and *Symphoricarpos occidentalis*. Some stands are a mosaic of these two late-seral types.

When there is a 100-yr flood and high sand deposits occur, cottonwood die and then dry stands occur. Then, it is too dry for green ash, so it might succeed to juniper. In the past for these cases, they were islands, so they were protected from fire. Those that formed on terraces were probably affected by fire. But, islands didn’t burn and so juniper was retained.

Note that the forest might not succeed in eastern South Dakota. Class E is more appropriate for western parts of the mapzones where later successional species are more scarce.

Minor flooding occurs every 10-20yrs. Minor flooding 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 approximately every 200yrs. This was modeled as wind/weather stress.

Replacement fire occurs. It is thought that drought might convert this system to sagebrush, but that is speculative and geographic climaxes vary. Low-severity fire was also modeled, causing no transition. Mixed-severity fire was also included with the same probability as low severity. It is thought that mixed-severity fire might cause a more open, drier stand that would allow invasion of silver sagebrush earlier; however, that was not modeled for MZ39 and MZ40, as it is speculative.

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

River meanders back and begins to cut away at the banks where a mature or old-growth stand of POPDEL exists. 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. It was modeled as Optional 1. Beaver activity is quite variable. It was modeled as occurring and maintaining 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 11 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 | Upper |
| SYOC | Symphoricarpos occidentalis | Western snowberry | Lower |

Description

The trees are actually shorter as one moves west. Green ash and cottonwood in the central and western Dakotas are almost half the size of those in the Midwest.

This class is found along the upper terrace, which has been protected from most flood events except for rare high-intensity flooding. Species composition increases toward south and east within the region. Overstory species include hackberry, green ash, 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 aging cottonwood, green ash, American elm, boxelder, bur oak, and eastern red cedar (Johnson 1950; Heckel 1963; Wilson 1970), which is more prominent in the east but still present in the Dakotas. 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).

Components of hackberry, slippery elm, and bur oak are present downstream from Yankton in the Dakotas. These species occur in central to eastern North Dakota. In western North Dakota (and probably much of western South Dakota, too), species are green ash, American elm, boxelder, eastern red cedar, and *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 old *Populus*. Along the Missouri River, in central North Dakota, southeastern South Dakota, and near Omaha, Nebraska, PODE is a pioneer species and is replaced successionally by various combinations of *Fraxinus*, *Ulmus*, *Acer*, and *Celtis*. Among the grasses, CALO, ELCA, and MURA are important (Hansen et al.1984).

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 11 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

Note that the forest might not succeed in eastern South Dakota. Class E is more appropriate for western parts of the MZs where later successional species are scarcer.

This stage in Montana and the western Dakotas MZs was modeled as a silver sagebrush community. For MZ39 and MZ40, it is thought that there are a few historical alternative ends, of which silver sagebrush is only one. Silver sage is a common terrace shrub, but the events causing this system to move there are infrequent, and therefore the previous 25% from Montana MZs did not apply in the Dakotas. Another alternative end is this system going to juniper. These are examples of where the successional path might take a different turn due to rare flood events or geographically varying climaxes and variations dependent on habitat.

The cedar stage/forest is also another stage that might have been present historically but not anymore -- in all stages of this system (Dave Ode, pers. comm.).

The silver sagebrush climax community occurs on river terraces and along larger streams. It has been noted (Steve 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 stage starts after many decades.

This class is less likely to have depositional flooding than other stages. The class/system is first 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 similarly to other silver sage communities, but maintains this stage, as this class is stable, and the silver sagebrush resprouts.

It is thought that this stage might be more prevalent currently versus historically due to impoundments increasing the silver sage distribution. It is questionable as to how much this class occupied the historical landscape. In Montana and western Dakota MZs, it was modeled as 25%; however, it was thought that that was too much for the Dakotas.

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 | Late2:CLS | 149 |
| Late3:CLS | 100 | 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 | Late3:CLS | 0.002 | 500 | Yes | 0 |
| Wind or Weather or Stress | Late1:CLS | Early1:ALL | 0.005 | 200 | Yes | 0 |
| Optional 2 | Late1:CLS | Early1:ALL | 0.005 | 200 | 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 | 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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