11620

Western Great Plains Floodplain Systems

BpS Model/Description Version: Aug. 2020

|  |  |  |  |
| --- | --- | --- | --- |
| **Modelers** |  | **Reviewers** |  |
| Peter Lesica | peter.lesica@mso.umt.edu | Brian Martin | bmartin@tnc.org |
| Vinita Shea | vinita\_shea@blm.gov | Steve Cooper | scooper@mt.gov |
| None | None | Linda Vance | livance@mt.gov |

Vegetation Type

Mixed Upland and Wetland

Map Zones

20

Geographic Range

Great Plains river systems from eastern MT 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 would be in this BpS.

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.

Vegetation Description

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. Narrowleaf cottonwood occurs in upper (intermountain valley) reaches of the Marias and Yellowstone rivers. Black cottonwood (*Populus trichocarpa*) is found along the Milk and Yellowstone, but only occasionally along the Marias. 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 lower limit of perennial vegetation) Other species found in the floodplain riparian zone include sandbar willow and box elder, typically associated with late seral stages. (Green ash is not a late seral stage species in MZ20.) Box elder is more common along the Milk and Marias than along some of the other drainages. Box elder, however, is also seen today in the Musselshell/Missouri River, but it is questionable as to whether that would have occurred historically.

Understory species in these later seral stages may include dogwood, currents, snow berry, wild rose and choke cherry.

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 |
| PASM | *Pascopyrum smithii* | Western wheatgrass |
| 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, 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, while 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 - ie, two kinds of rivers - meandering and as well as occurring on areas of sediment deposition - if the river has large flood and a bare area created, then the system is 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 to the Missouri River. Beaver impoundments kill trees (sometimes over large areas) and may create open water habitat, 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 presettlement 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 stagebrush stage. However, this would happen if they were old stands on higher terraces close to the channel, but not if they were younger stands on lower, moister terraces. Cottonwoods on lower moister terraces would resprout and there would be a willow-cottonwood, beaver-induced disclimax. Beaver damage could be highly extensive in areas in this system (Lesica and Miles 2004; 1999).

Traveling ungulate herds and Native American activities locally impacted seral stage development. However, not enough is known about about such disturbance to attempt modeling.

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. Deep water 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. 50-yr 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, while serious, scouring, high-terrace depositing events may be 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 is 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, personal correspondence) commented that the overall FRI was probably approximately 50-75yrs given the presumably abundant ignition opportunities in the neighborhood (ie, occasional fires spreading into this BpS from adjacent frequently burned grasslands). The overall FRI was thus modeled as such.

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 107 | 54 |  |  |
| Moderate (Mixed) | 249 | 23 |  |  |
| Low (Surface) | 249 | 23 |  |  |
| All Fires | 58 | 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 is adequate in size to contain natural variation in vegetation and disturbance regime. This BpS occurrs in a linear dimension along the Missouri River floodplain, with smaller areas covered in tributary rivers and streams. Wetland complexes include oxbow lakes, slough and marshes.

Adjacency or Identification Concerns

This system is easily identified by using the flood plain which is covered by a 10yr 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. Russian olive might affect later successional stages - after 10yrs.

Smooth brome, Canada thistle and 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.

Agricultural activities have change 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 paddlewheelers 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 presettlement conditions of these river systems, not knowing their original composition.

The best guide for mappers to distinguish between floodplain systems versus riparian systems is the 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 (ie, 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. Also - montane riparian systems of central MT and probably the Black Hills as well will have steeper gradients, narrower floodplains, and be dominated by *Populus angustifolia* or *P. alsamifera* as opposed to *P. deltoides* for Great Plains floodplains. Rivers like the Powder, Tongue and probably Little Missouri start as montane rivers and become Great Plains rivers.

Issues or Problems

Assumptions: Rapid Assessment model developed with the recognition that the Great Plains Floodplain forest (cottonwood-willow community) is a seral community. 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. Deep water 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.

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Native Uncharacteristic Conditions

Comments

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 significantly modified 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, 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 to not exist in MZ20. Other reviewers for MZ20 were 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 | 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 | E | E | E | E | E | E |
| Shrub | 0-0.5 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 0.5-1.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 0.5-1.0 | E | E | E | E | E | E | E | E | E | E |
| Shrub | 1.0-3.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 1.0-3.0 | E | E | E | E | E | E | E | E | E | E |
| Shrub | >3.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | >3.0 | E | E | E | E | E | E | E | E | E | E |
| Tree | 0-5 | B | B | B | B | B | B | B | B | B | B |
| Tree | 5-10 | C | C | C | C | C | C | C | C | C | C |
| Tree | 10-25 | C | C | C | C | C | C | C | C | C | C |
| Tree | 25-50 | D | D | D | D | D | D | D | D | D | D |
| Tree | >50 | D | D | D | D | D | D | D | D | 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 5 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 |

Description

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

The upper layer lifeform is comprised of a seedling and sapling shrub (willows) and tree component. Trees might be more abundant/frequent. However, to abide by mapping rules, we used shrubs as the upper layer lifeform. Short trees approximately one meter or less are also in this class.

Pioneer tree and shrub species of cottonwoods and willows. Herbaceous understory of sedges (bulrushes) and native annuals in wet areas. In this early 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. It is probably only every 10-20yrs that flooding occurs up high enough on point bars and low terraces to establish cottonwoods and then allow them to escape flooding until they are large enough to persist. This was modeled as alternate succession occurring every 20yrs, and advancing this stage to B.

*Maximum Tree Size Class*  
Seedling <4.5ft

Class B 11 Early Development 2 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PODE3 | Populus deltoides | Eastern cottonwood | Upper |
| SAEX | Salix exigua | Narrowleaf willow | Middle |
| SALU2 | Salix lutea | Yellow willow | Middle |
| SCPUL4 | Schoenoplectus pungens | Common threesquare | Low-Mid |

Description

Dominated by young canopy of tree saplings and shrubs. 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 after 4-5yrs as the rhizomatous perennials take hold.

Minor flooding occurs every 20yrs, 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 class A. This was modeled as wind/weather stress.

Beaver disturbance occurs in this class. The closer to the river, the more likely it is. Beavers, 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 on one percent of this class on the landscape each year, maintaining this class.

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

Class C 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 |
| GLLE3 | Glycyrrhiza lepidota | American licorice | Low-Mid |

Description

This stage develops as the stand starts to mature. This community tends to be partially open, with scattered cottonwoods and willows. Stands of cottonwoods 20-50yrs old 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. The understory vegetation is highly variable.

Flooding occurs every 50yrs, and advances the class to the next stage; flooding promotes the class to the next stage by raising the level of the terrace. Minor flooding leads to deposition. This was therefore modeled as alternate succession. Major flooding occurs every 50yrs, bringing this class back to the early class A stage. This was modeled as wind/weather stress.

Replacement fires were modeled at occurring every 150yrs. 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 fires were kept in the model. It is questionable as to whether replacement fire would set this stage back to class A, as the terrace would be too high and dry to provide conditions for successful establishment of cottonwood and willow from seed. If the cottonwoods resprouted, it would be more like class B because the understory would be more mature than class A; if the cottonwoods didn't resprout, it would probably just be a willow stand. Replacement fire was therefore modeled as taking this class to class B.

Low severity and mixed fire also occur every 100yrs, combined, and does 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 on one percent of this class on the landscape each year, maintaining this class.

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

Class D 27 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 |

Description

This class is a mature, late seral closed canopy cottonwood floodplain forest. Overstory is dominated by cottonwood. (Original MZ20 modelers included box elder 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; green ash is also not common in riparian cottonwood forests in this mapzone. Box elder, however, is seen today in the Musselshell/Missouri River, but it is questionable as to whether that would have occurred historically.) System becoming drier, so western wheatgrass coming in.

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 every 50-100yrs, bringing this class back to class A. This was modeled as wind/weather stress.

Replacement fire occurs every 150yrs (this interval is speculative, as not much data is available.) and takes this class to E, the silver sagebrush class. 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 as it was in class C, causing no transition. Mixed severity fire was included with the same probability as low severity, every 100yrs. It is thought that mixed severity fire would cause a more open, drier stand that would allow invasion of silver sagebrush earlier, bringing it to E earlier; however, because that type of transition was captured in replacement fire, mixed severity fire was modeled as removing some of the overstory and thus causing a transition to C.

Optional 2 in this class represents erosional processes of river meandering that would bring this class eventually back to class A. The class/system will first be part of the river, but then will succeed to class A or a point bar state. This occurs with a frequency of several hundred years and was modeled at a frequency of 400yrs.

River meanders back and begins to cut away at the banks whereon 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. It was modeled as occurring on one percent of this class on the landscape each year, maintaining this class.

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

Class E 29 Late Development 2 - 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, personal correspondence) 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). 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 from D. If a replacement fire were to occur in D, it would come to this stage - which is why this stage therefore starts at age 50yrs. This is a stable community and 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.

Major flooding events were modeled as wind/weather stress occurring every 250yrs, bringing this class back to A.

Optional 2 in this class represents erosional processes of river meandering that would bring this class eventually back to class A. The class/system will first be part of the river, but then will succeed to class A or a point bar state. This occurs with a frequency of several hundred years and was modeled at a frequency of 400yrs.

Replacement fire was modeled at every 50yrs, similar to other silver sage communities, but maintaining this stage, as this class is stable, as stated above - and the silver sagebrush resprouts and thus maintains this stage.

Note for mappers: although height and cover overlap with class A, species are completely different.

*Maximum Tree Size Class*  
None

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:ALL | 0 | Early2:OPN | 4 |
| Early2:OPN | 5 | Mid1:CLS | 14 |
| Mid1:CLS | 15 | Late1:CLS | 50 |
| Late1:CLS | 51 | Late2:CLS | 200 |
| Late2:CLS | 51 | 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** |
| Alternative Succession | Early1:ALL | Early2:OPN | 0.05 | 20 | Yes | 0 |
| Optional 1 | Early2:OPN | Early2:OPN | 0.01 | 100 | No | 0 |
| Wind or Weather or Stress | Early2:OPN | Early1:ALL | 0.02 | 50 | Yes | 0 |
| Alternative Succession | Early2:OPN | 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 | Early2:OPN | 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 |
| Optional 2 | Late1:CLS | Early1:ALL | 0.0025 | 400 | Yes | 0 |
| Replacement Fire | Late1:CLS | Late2: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 |
| Optional 2 | Late2:CLS | Early1:ALL | 0.0025 | 400 | Yes | 0 |
| Wind or Weather or Stress | Late2:CLS | Early1:ALL | 0.004 | 250 | Yes | 0 |
| Replacement Fire | Late2:CLS | Late2:CLS | 0.02 | 50 | No | 0 |

Optional Disturbances

Optional 1: beaver

Optional 2: erosional processes of river meandering

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