11550
North American Warm Desert Riparian Systems

BpS Model/Description Version: Aug. 2020

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None	None	None	None

Vegetation Type

Woody Wetland

Map Zone

4

Geographic Range

Found in the warm deserts of the southwestern United States. In perennial and intermittent warm desert (Mojave and Sonoran deserts) drainages in southern California, Nevada, Arizona, and southwest Utah.

Biophysical Site Description

Riparian systems occur primarily along perennial streams/rivers along the Colorado, Salt, Virgin, Muddy, and Mojave river corridors adjacent to low-elevation shrublands. Elevation is typically <4,000ft. Other examples of intermittent streams can be found in the Amargosa Gorge, Whitewater River, Andreas Canyon, Paiute Creek, and Palm Canyon. Oasis woodlands occur in isolated stands such as the Palm Canyon, Thousand Palms, and Twentynine Palms oases. When mesquite bosque is the dominant type outside of perennial waterways, it is also found at elevations <1,100m along intermittent streams or in valleys bottoms along playa edges with a perched water table.

Vegetation Description

The vegetation is a mix of riparian woodlands, shrublands, and grasslands. Vegetation is very patchy in rivers with active flood regimes. Dominant species are *Salix gooddingii*, *Salix laevigata*, *Populus fremontii*, *Salix exigua*, *Pluchea sericea*, *Distichlis spicata*, *Sporobolis airoides*, *Carex* spp., *Typha* spp., *Prosopis* spp., *Cercidium* spp., *Acacia* ssp., and *Washingtonia filifera* (in oases primarily). Halophytic shrub-dominated patches occur on drier sediment deposits or saltier surfaces. Late-successional riparian woodlands are mesquite bosque, with different species of mesquite present, and riparian tree species a minor component (Richter 1992; Stromberg 1992). Acacia may be important in the mid-story and tree canopy. Vegetation is dependent upon periodic flooding. Native Americans also had a strong influence on vegetation composition and structure by favoring edible plants (e.g., mesquite), collecting fuel wood, and burning to flush game animals and increase accessibility to open water and agricultural fields.

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
POFR2	*Populus fremontii*	Fremont cottonwood

PLSE	*Pluchea sericea*	Arrowweed
ATLEB	*Atriplex lentiformis ssp. breweri*	Quailbush
SAEX	*Salix exigua*	Narrowleaf willow
TYAN	*Typha angustifolia*	Narrowleaf cattail
PROSO	*Prosopis*	Mesquite
WAFI	*Washingtonia filifera*	California fan palm

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

Disturbance Description

This biophysical setting (BpS) is a flood-dependent ecosystem. The entire range of flood magnitudes contributes to ecological processes such as nutrient cycling, recruitment, and species composition. Two- to 10-yr events primarily impact herbaceous vegetation, 7- to 50-yr events result in patchy removal of shrubs and saplings, and 50+-yr events remove stands of larger trees. Cottonwood return to pole size within 10yrs of disturbance. Cottonwood is considered mature around 60yrs. Mesquite bosque on higher terraces was assumed removed by 500-yr flood events because mesquite is deeply rooted and a very hard wood.

New mud/silt flats created by flooding were cultivated for corn, bean, and squash. Farming was a stand-replacing event that prevented cottonwood and willow seedling establishment.

Fuel characteristics and fire behavior are extremely variable due to the wide range of vegetation types that characterize the riparian zone and due to Native American manipulations. In general, fuels are typically continuous and fuel loads are high, but fuel moisture content is also often high. Wildfires may not carry except under extreme fire weather conditions (average fire return interval [FRI] for replacement fire, 500-1,000yrs). For stands not recently tended by Native Americans, higher fuels loads allow for more frequent fire than in areas of intense collection of fuel wood (late-development cottonwood) and prescribed burning for hunting and agricultural purposes.

Native Americans had a profound influence on these systems, developing irrigation ditches, producing crops on silt/mud flats deposited by yearly floods, burning willow for basketry (only first-year willow can be used for weaving) and to maintain open irrigation ditches and agricultural fields, and burning to facilitate access and flush rodents (e.g., *Sigmodon* spp. and *Neotoma* spp), jackrabbits, game birds, and deer. Fire was applied in the fall when fuels would be cured and dry. Thus, the historical fire regime is characterized by small to moderate, complete, high-intensity passive crown fires, and small moderate-intensity fires set frequently by Native Americans. Mesquite bosque were important fuel and food sources for Native Americans and were often tended through the clearing of mid-story shrubs and limbering of lower branches of mesquite. Native Americans, such as the Pima in map zones (MZs) 14 and 15, avoided burning mesquite (A. Rea, pers. comm.). It was assumed this was generally true of most tribes.

Willow resprouts more vigorously from fire than cottonwood. Woodland dominants such as cottonwood (*Populus* spp.), honey mesquite (*Prosopis glandulosa*), and willow (*Salix* spp.) typically resprout after being top-killed. Freemont cottonwood resprouts at fairly low rates compared to willow and other cottonwood species. For mesquite, the ability to resprout may depend on season of burn. However, resprouting individuals and seedlings are susceptible to mortality during recurrent fires.

Severe freezing is another important source of stand-replacing disturbance, sometimes followed by basal resprouting. Severe freezing in 1978 caused aboveground mortality of many riparian mesquite in southern Arizona.

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	797	3	500	1000
Moderate (Mixed)	24	97		
Low (Surface)				
All Fires	23	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

These systems can exist as small to large linear features in the landscape. In larger, low-elevation riverine systems, this system may exist as mid-large patches.

Adjacency or Identification Concerns

Water diversion and groundwater pumping have greatly modified hydrologic regimes and water levels, perhaps permanently.

Livestock grazing can be a major influence in the alteration of structure, composition, and function of the community.

Exotic trees of *Elaeagnus angustifolia* and *Tamarix* spp. are common in some stands.

In some riparian woodlands, the invasives saltcedar (*Tamarix* spp.) and, less frequently, giant reed (*Arundo donax*) can create ladder fuels that allow fire to spread from surface fuels of willow (*Salix* spp.), saltbush (*Atriplex* spp.), sedge (*Carex* spp.), reed (*Juncus* spp.), and arrowweed (*Pluchea sericea*) into the crowns of overstory Fremont cottonwood, top-killing them. After an initial fire, these invasives quickly recover and surpass their pre-fire dominance, promoting increasingly more frequent and intense fires that can eventually displace most native plants.

In palm oases, Washington fan palms depend on surface fire to clear understory species and facilitate recruitment. However, these sites can be pre-empted by saltcedar because it recovers rapidly after fire. The ladder fuels saltcedar creates can also carry fire into the crown of Washington fan palms, increasing the incidence of crown fires lethal to other species.

Issues or Problems

Mesquite bosque that develop adjacent to dry lake beds (playas) where a shallow water table allows germination and growth occurs in the Mojave Desert and is not associated with riparian successional dynamics. Examples are found in Corn Creek, Nevada, and near Pahrump, Nevada.

We are uncertain about the average return interval of severe freezes that kill mesquite, a sub-tropical tree. Model results are sensitive to this parameter. Because several experts and the literature indicated that mesquite trees older than 100yrs are uncommon in MZs 13 and 14 -- even in non-riparian, non-flooding systems, despite their ability to live longer -- it is suggested that stand-replacing events may have a role in limiting stand age. Therefore, fire and/or severe freezes with return intervals of at least 100yrs were assumed and the total probability was divided by two (i.e., 200-yr return interval).

Much uncertainty exists about probabilities associated with farming extent, the effect of fuel wood collection, and Native mixed-severity burning. Ethnobiologists emphasized many small areas for burning, whereas fuel collection was very widespread and persistent.

One reviewer pointed out that fire may have been more frequent before the era of livestock grazing because grasslands, and therefore fine fuels, were more commonly distributed in riparian corridors. Descriptions of these systems by Anglos started after this period of intense grazing.

Native Uncharacteristic Conditions

Canopy cover can reach 100% in Classes B, D, and E without being uncharacteristic. Mesquite cover <50% is uncharacteristic in Class E. Cover <50% in Class B is uncharacteristic.

Comments

Model assumptions include the following:

- A mixed-severity FRI of 10-20yrs was assumed, respectively, for late development (not in mesquite bosque, Class E) and mid development, and was calculated by assuming that Native Americans burned every year but affected only 10% and 5%, respectively, of the floodplain per year. It was also assumed that older stands received more burning than younger stands, which provided less fuel wood.
- Intense collection of fuel wood was assumed to occur on 30% of the area in the Late-Development cottonwood class (Class D).
- Cultivation of mud/silt flats created by flooding was assumed at a level of 10% utilization of Early-Development vegetation class per year to imitate 50% utilization during the first of 5yrs.

Following further discussions with Jeri Kruger (jkruger@fws.edu) and Julie Stromberg, and literature reviews, Louis Provencher (lprovencher@tnc.org) modified the model by adding a fifth class resulting from stand-replacement fire that does not cause cottonwood and willow germination because this case is not associated with flooding. Many changes were done to the original model by M. Brooks. Floods causing stand-replacing events were more frequent (5-50yrs and 50+-yrs, for, respectively, Mid- and Late-Development classes). Classes C and D in 131155a were merged into new Class D (mature cottonwood and willow; still accounting for Native American influences). Class E was added for mesquite bosque, which is the last successional phase in the floodplain, with 500-yr flood events and replacement fire every 250yrs on average; and, although Native American influences were maintained, the importance of mixed severity was implicitly reduced by removing time-since-disturbance from the original BpS. In the original model and its revision from 18 September 2005, replacement fire was assumed to cause a return to Class A, which is impossible. Class A is the result of stand-replacing flood events only, when cottonwood and willow germination only is possible. Replacement fire does not change the elevation of a terrace or create a seedbed for willow and cottonwood, but does allow resprouting and seed establishment by mesquite and other shrubs (e.g., *Salix gooddingii*). Therefore, Class C is the recipient of all replacement fire and eventually succeeds to mesquite bosque unless a 50-yr flood event scours the more fragile soils of Class C. To accommodate the

LANDFIRE limit for one early S-class, Class C starts at age one and is considered mid-development. In reality, Class C behaves as an alternative Early-Development class.

One LANDFIRE National reviewer suggested several changes to clarify the geographic location of the BpS, its elevation, and species/patch composition. The reviewer indicated that pre-settlement warm desert riparian systems were very patchy (Jeri Krueger from Fish and Wildlife Service, Nevada, forwarded accounts from early explorers of the Virgin River that support the patchy nature of the vegetation and importance of mesquite) and probably contained more grasslands and shrub patches than found today, and therefore may have supported a greater amount of fine fuels and fire. These issues were addressed, although the fire frequency was not changed because it is frequent enough in the current version. The reviewer also recommended adding references on southwestern riparian systems by Busch, Ellis, and Davis, which was done.

Native American burning was introduced as a very plausible disturbance. However, no data or expertise were available at the creation of the original model. Reviews by ethnobiologists Kay Fowler and Amadeo Rea resulted in important modifications to the original model and description (Fowler 2003; Rea 1983). Native American influence was greater than initially thought, with farming of mud flats (not in late-development stands as initially modeled), irrigation, massive fuel wood collection, and extensive small-scale burning for willow control, basketry, general access, and hunting. Therefore, very frequent mixed-severity fire was added by Louis Provencher to all Mid-Development and Late-Development classes (except mesquite bosque, Class E), and farming and fuel collection were added, respectively, as model parameters in Early- and Late-Development Open classes. Amadeo Rea explained that warm desert rivers of MZs 14 and 15 were more heavily farmed by the Pima Indians than those of MZ13 (Mohave and Shoshone Indians) (also suggested by Dr. Fowler). In all cases, he agreed that native people probably modified the vegetation structure and composition of warm desert river floodplains far more than currently understood. Dr. Rea also explained that native burning was used to flush rodents, even more than jackrabbits, and that fire was avoided in mesquite bosque, in cultivated fields, and near fences. Burning was especially intense in riparian grasslands dominated by *Sporobolus* spp., marshes, and shrubby areas.

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	A	A	A	A	A	B	B	B	B	B
Shrub	0.5-1.0	A	A	A	A	A	B	B	B	B	B
Shrub	1.0-3.0	A	A	A	A	A	B	B	B	B	B
Shrub	>3.0	A	A	A	A	A	B	B	B	B	B
Tree	0-5	E	E	E	E	E	C	C	C	C	C
Tree	5-10	E	E	E	E	E	C	C	C	C	C

Tree	10-25	D	D	D	D	D	D	D	D	D	D
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 15 Early Development 1 - All Structures

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
SAGO	Salix gooddingii	Goodding's willow	Upper
POFR2	Populus fremontii	Fremont cottonwood	Upper
BASA	Baccharis salicina	Great Plains false willow	Upper

Description

Immediate post-disturbance responses are dependent on pre-disturbance vegetation composition. *Salix gooddingii* and *Populus fremontii* favored by flooding. This class is typically shrub/seedling dominated, but grasses or wetland graminoids may co-dominate. This class also exists as recently deposited mud/silt flats that were farmed for corn, squash, and beans. Farming was applied to new mud flats and prevented germination of cottonwood and willow.

Maximum Tree Size Class

None

Class B 21 Mid Development 1 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
SAGO	Salix gooddingii	Goodding's willow	Upper
POFR2	Populus fremontii	Fremont cottonwood	Upper
PROSO	Prosopis	Mesquite	Lower

Description

Highly dependent on the hydrologic regime. Vegetation composition includes tall shrubs and small trees (willow and cottonwood), with patches of graminoids and halophytic shrubs.

Native American mixed-severity burning in the fall for basketry, clearing of irrigation ditches, and hunting were conducted and favored *Salix gooddingii*. Shrubs resprouted vigorously the year after burning. This class is an ideal bed for mesquite germination and establishment.

Maximum Tree Size Class
Pole 5-9" DBH

Class C 10 Mid Development 2 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PROSO	Prosopis	Mesquite	Middle
SAGO	Salix gooddingii	Goodding's willow	Upper

Description
Post-fire replacement community dominated by species that resprout after fire: mesquite and *Salix gooddingii*. Fremont cottonwood is not present because it is sensitive to fire. Patches of graminoids may be frequent after fire. Vegetation is open and shrub dominated during the first decades, then becomes progressively closed as mesquite bosque (Class E) forms.

Maximum Tree Size Class
Medium 9-21" DBH

Class D 32 Late Development 1 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
POFR2	Populus fremontii	Fremont cottonwood	Upper
SAGO	Salix gooddingii	Goodding's willow	Upper
PROSO	Prosopis	Mesquite	Middle

Description
This class is represented by mature, large cottonwood and willow riparian woodlands, with patches of graminoids in saturated soils and halophytic shrubs on drier sediment deposits or saltier surfaces. Mesquite increases in importance in the mid-story and lower canopy. When Native Americans used this class, the mid-story shrub component was tended and open, but the tree canopy was generally unaffected. Native American burning occurred annually in small patches, most likely to flush jackrabbit, rodents, and deer, and to control willow encroachment near waterways (irrigation ditches or side channels) and agricultural fields situated on nearby alluvial deposits. Fuel collection was an important activity resulting in understory thinning and fuel load reduction.

Maximum Tree Size Class
Large 21-33" DBH

Class E 22 Late Development 2 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position

PROSO	Prosopis	Mesquite	Upper

Description

Mesquite dominates the riparian floodplain. *Salix goodingii* and *Populus fremontii* are a minor component in this class.

Native American fuel collection is an important activity in Class E. When mesquite bosque were tended by Native Americans, stand mid-stories were open like orchards and less prone to stand-replacing fire, although the tree canopy would be similar to untended bosques.

Maximum Tree Size Class

Large 21-33" DBH

Model Parameters

Deterministic Transitions

From Class	Begins at (yr)	Succeeds to	After (years)
Early1:ALL	0	Mid1:CLS	4
Mid2:CLS	1	Late2:OPN	89
Mid1:CLS	5	Late1:CLS	19
Late1:CLS	20	Late2:OPN	89
Late2:OPN	90	Late2:OPN	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	0.1	10	Yes	0
Wind or Weather or Stress	Early1:ALL	Early1:ALL	0.13	8	Yes	0
Mixed Fire	Mid1:CLS	Mid1:CLS	0.05	20	No	0
Wind or Weather or Stress	Mid1:CLS	Early1:ALL	0.05	20	Yes	0
Wind or Weather or Stress	Mid2:CLS	Early1:ALL	0.02	50	Yes	0
Replacement Fire	Late1:CLS	Mid2:CLS	0.0013	769	Yes	0
Wind or Weather or Stress	Late1:CLS	Early1:ALL	0.02	50	Yes	0
Optional 2	Late1:CLS	Late1:CLS	0.0333	30	No	0
Mixed Fire	Late1:CLS	Late1:CLS	0.1	10	No	0
Wind or Weather or Stress	Late2:OPN	Early1:ALL	0.002	500	Yes	0
Replacement Fire	Late2:OPN	Mid2:CLS	0.004	250	Yes	0

Wind or Weather or Stress	Late2:OPN	Mid2:CLS	0.005	200	Yes	0
Optional 2	Late2:OPN	Late2:OPN	0.0333	30	No	0

Optional Disturbances
Optional 1: Native farming
Optional 2: Native fuel wood collection

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