15010

Central Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest

BpS Model/Description Version: Aug. 2020

|  |  |  |  |
| --- | --- | --- | --- |
| **Modelers** |  | **Reviewers** |  |
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Vegetation Type

Woody Wetland

Map Zones

58, 60

Model Splits or Lumps

This BpS is split into multiple models:

This BpS is split out of the aggregate BpS 1480 (NatureServe CES203.636 Gulf and Atlantic Coastal Plain Swamp Systems) .

Geographic Range

This BpS, as defined here, is restricted to MZs 58 and 60 from just south of the Chesapeake Bay in VA, through eastern NC and a small part of northeastern SC. Related BpS include habitats for Atlantic white cedar and other peatland tree species as far north as central Maine and along the panhandle of FL, south to the Ocala National Forest.

Biophysical Site Description

Note: efforts were made to split the system based on mineral vs. organic soils, but this proved difficult given LANDFIRE modeling limitations. Therefore, it was decided that the swamp/wetter/peatier end of the system is modeled and described here. The mineral, nonriverine wet hardwood end of this system has been ignored since in effect it behaves like a bottomland and is little influenced by fire which is why it was originally part of the Gulf and Atlantic Coastal Plain Swamp System aggregate. If not for the part of this system that involves Atlantic White Cedar and its distinctive fire regime, this system may have stayed part of the aggregate (BpS 1480).

Original extent: up to 1 million acres of which at least 400,000ac were Atlantic white cedar in MZs 58 and 60. This is a long-interval, fire-dependent, forested peatland with its greatest extent found on the Pamlico Terrace of Virginia and North Carolina. The largest sites lie at less than 30ft (9m) above sea level. Substrate is typically mucky peat (Terric or Typic Medisaprists) up to 3m deep and occasionally mucky sand or wet mineral soils with an organic epipedon. Atlantic White Cedar (Chamaecyparis thyoides) was the most common dominant species, but it occurred in a fire-generated patch mosaic in which the various patch dominants can be white cedar, swamp black gum (Nyssa sylvatica), pond pine (Pinus serotina), red maple (Acer rubrum) and cypress, mostly pond cypress (Taxodium ascendens). While this is a fire-dominated system it is only found in substantially fire-sheltered portions of the landscape where scarp or water body factors prevent easy access by fire, resulting in a long fire return interval. The original vegetation constituted a true shifting mosaic.

Vegetation Description

In these large peatlands, white cedar occurs as one element of a landscape scale patch mosaic with the patch type dependent upon the depth of the water table at the time of the fire that regenerated the stand (see Disturbance Description). It occupies a rather narrow hydrologic position toward the wet end of the moisture gradient, intermediate between that of the wetter non-pyrophytic cypress-gum swamp and various drier or more fire-exposed wetland vegetation types such as canebrake and pocosin. In the great peatlands, white cedar requires periodic replacement fire for establishment of new stands, for expansion of existing stands and for recapturing patches lost to adjacent communities. Stand replacement can occur by catastrophic crown fire under extreme burning conditions and by consumption of peat by ground fire. Hurricanes can break up stands but initiate little regeneration because shade from existing broadleaf understory blocks the full sun needed for regeneration of this species. Only the small central openings of larger blowdowns might be expected to result in new stands of white cedar, while most of the incompletely-opened peripheral areas are likely to be captured by other patch elements. Only fire can fully maintain or expand the stand. In coastal stands, rising sea level appears to prevent stand replacement on the seaward side, while the stand may expand upslope on the inland side.

Atlantic white cedar and its lumber were formerly known as “juniper” in the boatbuilding and timber industry, and a few juniper fishing boats still ply the waters of the Chesapeake Bay.

Stands that regenerated from crown fire often have nearly pure cover of white cedar. The most common subcanopy species are red maple (Acer rubrum), red bay (Persea palustris) and sweet bay (Magnolia virginiana). Typical shrubs include gallberry (Ilex glabra), Inkberry (Ilex coriacea), fetterbush (Leucothoe racemosa), Virginia willow (Itea virginica) and Lyonia lucida. Herbs, chiefly ferns and sedges, are typically sparse but mosses may be common.

Repeated logging has resulted in replacement of the peatland mosaic with more homogeneous mixed stands of swamp black gum, red maple, loblolly pine, pond pine, baldcypress, sweet bay and red bay. In MZs 58 and 60, around 97% of the largest patch element, Atlantic white cedar, has been extirpated. White cedar historically occurred in peatlands of coastal North Carolina and southeastern Virginia, where the Great Dismal Swamp once supported 112,000 acres (Akerman 1923). In NC, virtually nothing remains of the numerous former stands of several hundred to several thousand acres. Rivaling the white cedar of the Dismal Swamp, there were tens of thousands of acres in the central portion of the Terrell-Beaufort-Washington county portion of the 2-3 thousand square mile “Pamlimarle Peninsula”, and similarly large tracts on the peatlands surrounding the Alligator River. There were 20,000ac in Chowan Swamp, of which only scattered trees and tiny patches remain. Similarly, of the large stands in the swamps along the tributaries on the north side of the Albemarle Sound, only scattered trees remain. To the south, no tree is known to remain of a 3000ac stand in Gum Swamp on the Beaufort/Pamlico county line. A 1903 timber survey of the Green Swamp vicinity reported several thousand acres of white cedar where perhaps only a hundred acres remain today. Outside the range of this BpS, large stands of Atlantic white cedar were found even along some of the middle coastal plain and sandhills streams. Some, such as Drowning Creek, had extensive stands of which only scattered trees can now be found. A timber survey reported in Hale (1883) estimated a surprising 60,000,000 board feet of juniper in the Sandhills of Cumberland and part of Hoke counties. The presettlement extent range-wide was likely well over 1 million acres, of which only about 5-7% remains rangewide. In MZ58, however, where the largest stands occurred, only around three percent of Atlantic white cedar-dominated stands remain after 400yrs of exploitation and wetland alteration.

In addition, loblolly pine (Pinus taeda) plays a role on associated wet mineral soils with black organic epipedons.

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| CHTH2 | *Chamaecyparis thyoides* | Atlantic white cedar |
| PISE | *Pinus serotina* | Pond pine |
| ACRU | *Acer rubrum* | Red maple |
| NYBI | *Nyssa biflora* | Swamp tupelo |
| TADI2 | *Taxodium distichum* | Bald cypress |
| TAAS | *Taxodium ascendens* | Pond cypress |
| PITA | *Pinus taeda* | Loblolly pine |

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

Disturbance Description

This BpS is classified as fire regime type IV (with some V), with a fire return interval of 25-300yrs+. Fire frequency is driven by where the stand occurs in the fire landscape. In this peatland model the path A, B, E represents Atlantic white cedar succession as found in pure dominant stands. Path A, C, D represents successional pathways for alternate patch dominants such as swamp black gum, red maple, pond pine or cypress. With fire, the dynamics of the patch mosaic depend stochastically on conditions at time of burn. If the water table is high when a crown fire passes through, a pure, dense stand of white cedar can quickly repopulate the site from the seed bank and from any remnant seed trees. If the peat is dry enough for the surface layer to burn off to a depth of perhaps 5-20cm, the seed bank may be destroyed and the site may be captured by red maple, swamp black gum or pond pine, depending upon composition of forest around the margins of the former white cedar stand. If the water table has been drawn down to a meter or more by evapotranspiration, as often happens in the summer (Otte 1982, 1984), peat burnouts a meter or more deep may occur and the depressions may be pooled and colonized by cypress when the water table returns. Such cypress pockets, being less flammable than white cedar, may persist for hundreds of years, resisting later fires that flow around them in younger stands of white cedar. One such pocket in mainland Dare county was dated to a fire 330yrs ago (Frost 1995).

Strong hurricanes can affect this BpS, especially the white cedar component, with the stems in a patch sometimes appearing as though scattered like matchsticks when viewed from the air, while swamp hardwoods surrounding the damaged patch might be less affected. An assessment of damage to coastal swamp forest with swamp black gum and red maple, showed that most damage to swamp hardwoods was in the form of broken limbs rather than blowdowns (Frost, unpub. data). In such cases, a former white cedar patch will recover typically to a natural mixed stand of white cedar, red maple, and swamp black gum with occasional stems of loblolly pine and cypress.

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 93 | 82 |  |  |
| Moderate (Mixed) | 425 | 18 |  |  |
| Low (Surface) |  |  |  |  |
| All Fires | 76 | 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

Historical stands ranged in size from the Great Dismal Swamp of VA and NC which included the largest white cedar stand of 112,000ac, associated with a considerable acreage of swamp black gum and baldcypress, as well as smaller peatlands of only a 50-100ac. The scale of disturbances included fires, ranging in size from 50-10,000ac+, and winds, especially those associated with hurricanes, in which effects were more limited, typically consisting of locally intense small blowdowns of a few acres each.

Adjacency or Identification Concerns

On its wetter and more fire sheltered side, this BpS merges into nonpyrophytic cypress/gum swamp. On the more fire-exposed side it abuts the more frequent-fire vegetation types of the pocosin-canebrake BpS. To the north this BpS transitions into less extensive white cedar wetlands with different associated species, ranging from the New Jersey Pine Barrens to Appleton Bog in east central Maine, the northern limit of white cedar (Stockwell 1999). To the south, in the Florida Panhandle and inland in the sandhills of North and South Carolina similar vegetation types of much more limited extent are found in infrequently burned small stream swamps adjacent to frequently burned longleaf pine uplands.

This BpS excludes the small swamp forests of sandy and mucky sloughs through the Fall Line Sandhills of the Carolinas and Georgia even though all of the dominant species may be found there. It also excludes the stands once found in the muck lands along the linear stream swamps of the middle Coastal Plain such as those along Drowning Creek in NC, and the white cedar of small blackwater streams in the panhandle of FL at the southern end of the range for the species.

Küchler had no type corresponding to this BpS. Portions of the Atlantic White Cedar forest were included in his type 113, Southern floodplain forest; type 114, Pocosin and several other types.

Issues or Problems

Note: efforts were made to split this BpS system based on mineral vs. organic soils, but this proved difficult given LANDFIRE modeling limitations. Therefore, it was decided that the swamp/wetter/peatier end of the system is modeled and described here. The mineral, nonriverine wet hardwood end of this system has been ignored since in effect it behaves like a bottomland and is little influenced by fire which is why it was originally part of the Gulf and Atlantic Coastal Plain Swamp System aggregate. If not for the part of this system that involves Atlantic White Cedar and its distinctive fire regime, this system may have stayed part of the aggregate (BpS 1480).

Within MZs 58 and 60, about 97% of the patch mosaic once dominated by Atlantic white cedar has been exchanged for mixed stands of swamp tree species that once made up the other patch elements. Most of this BpS now consists of post-logging rather than post-fire stands. Historical records and historical ground photos suggest that many of the original stands were nearly pure white cedar. Today these sites are often dominated by mixed species stands, sometimes with only a few stems of white cedar. Despite the natural mixture that can result from hurricane damage described above, most modern mixed stands are uncharacteristic and might be misinterpreted as natural mixed stands. Repeated logging as fire exclusion has resulted in changing species composition. While seed dispersal may occasionally produce a cedar tree or two in other forest types, most sites with Chamaecyparis scattered among other wetland species can be shown to be post-logging remnants of preexisting dense stands rather than natural mixed species community types. In the peatlands, logging usually leads to capture of the site by existing understory stems of hardwood species such as red maple, swamp black gum, red bay and sweet bay because white cedar regeneration is prevented by shading from logging slash.

Were it not for fire, cumulative hurricane damage might convert all white cedar stands to mixed species and then, without opportunity to reproduce, stands with no white cedar. Fire, on the other hand, opens new patches, providing a sunny seedbed for a new stand to exploit, and perpetuates the mosaic of pure patches of white cedar typical of the species, as well as the other patch elements.

There are a number of factors implicated in the decline of white cedar (Frost 1985, 1995). In some cases ditching and road building caused large scale disruption of hydrology and produced flooding (if near sea level), or on higher sites drainage resulted in deep peat burns, peat subsidence, oxidation and even exposure of mineral soil in some cases. Additional lands with shallow peat were lost by conversion to agriculture. Logging contributed to the decline of white cedar through post logging site preemption by understory or stump sprouting species, shading of the seed bed by logging slash, and destruction of saplings by post logging fires in slash. The typical approach was to log only the valuable cedar patches, leaving adjacent noncommercial swamp forest or pocosin communities intact. This eliminated the possibility for expansion of the cedar stand into adjacent habitat: at best a new stand could reoccupy 100% of the original site. Historical and field evidence from the larger stands of white cedar show that there has been a stepwise reduction in stand area, with a large percent of the site lost to other species each time a stand was logged.

Fire suppression, also implicated in the decline of white cedar, eliminates the opportunity for it to retake patches lost to other species. Long-term, there is no evidence that white cedar can succeed itself or persist indefinitely without fire. The severity of fire required to duplicate the natural, long-interval crown fires which maintained these stands in nature make this BpS perhaps the most challenging to restore of any in the US.

Native Uncharacteristic Conditions

The original patch mosaic has been almost completely taken over after logging and fire suppression by mostly mixed stands of red maple, swamp black gum, pond pine, loblolly pine, baldcypress and pond cypress without white cedar.

Comments

This model re-named by M.H. Weber at MFSL from 14802 to 15010 according to ESP and BpS mapping rename of model in this zone. This model replaces and expands on the Rapid Assessment model (R9AWCF). It corresponds in part with Schafale & Weakley’s Peatland Atlantic White Cedar and Nonriverine Swamp Forest.

Ecological Systems: It is suggested that this system, which was of major importance in MZs 58 and 60 in the past and is now reduced to only about three percent of its original extent in the region, be split out of BpS 1480 where it seems, in part, to reside now.

For MZ60, this BpS model and description has been adopted as is from map zone 58 (6014802 - Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest) and renamed (6015010 - Central Atlantic Coastal Plain Nonriverine Swamp and Wet Hardwood Forest) October 4th, 2007.

This model was reviewed during a review meeting held in Durham, NC on Jan. 23, 2007. Margit Bucher, Cecil Frost, Mike Schafale, Milo Pyne and Rob Evans were in attendance and this model was discussed. Cecil Frost provided a revised version of the model description on Feb. 3, 2007. The VDDT model itself was modified during the January meeting.

Note to LANDFIRE Mappers:

1) Mike Schafale of NC Natural Heritage has element occurrences (Eos) for most of the Nonriverine Wet Hardwood Forests. One could potentially use these points to remove patches in which they occur which would get you a bit closer to the extent of the system described here. However, the bulk of nonriverine swamps and wet hardwood forests would burn.

2) The peatland types could best be mapped using SURGO data when it becomes available. Since rangewide, only 3-7% of Atlantic white cedar remains and about one percent of canebrake, satellite imagery alone will not suffice to distinguish their habitats from the more common signatures that have taken their place.

Suggested reviewers for the portion of the range from VA south are Mike Schafale, Alan Weakley and Milo Pyne. Suggested reviewers for a northern version would include William Patterson, III, and Glenn Motzkin.

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 | A | A | A | A | A |
| Shrub | 0.5-1.0 | A | A | A | A | 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 | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf | C brdlf |
| Tree | 5-10 | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix | C mix |
| Tree | 5-10 | B con | B con | B con | B con | B con | B con | B con | B con | B con | B con |
| Tree | 10-25 | D brdlf | D brdlf | D brdlf | D brdlf | D brdlf | D brdlf | D brdlf | D brdlf | D brdlf | D brdlf |
| Tree | 10-25 | D mix | D mix | D mix | D mix | D mix | D mix | D mix | D mix | D mix | D mix |
| Tree | 10-25 | B con | B con | B con | B con | B con | B con | B con | B con | B con | B con |
| Tree | 25-50 | E | E | E | E | E | E | E | E | E | E |
| Tree | >50 | E | E | E | E | E | E | E | E | E | E |

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 8 Early Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| CHTH2 | Chamaecyparis thyoides | Atlantic white cedar | Upper |

Description

Characterized by potentially dense seedlings of Atlantic white cedar on moist peat that can form a nearly closed layer within 5-7yrs. Other species such as swamp black gum, red maple or pond pine may capture the site if there is no white cedar seed source or if the seed bank was destroyed in a shallow peat burn. Taxodium ascendens may capture the site if the water table is low enough at time of fire, allowing peat to burn out to some depth and resulting later in pooled shallow water. So, in a five-box model A has to represent all of these alternatives.

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

Class B 33 Mid Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| CHTH2 | Chamaecyparis thyoides | Atlantic white cedar | Upper |

Description

Class B is characterized by dense, even-aged, closed canopy stands with little thinning, the stands mostly getting taller with small diameter stems being overtopped and suppressed. The dominant canopy species in the A, B, E pathway is white cedar resulting from the pattern of site capture described for A. The understory includes scattered stems of red maple, and thinly scattered shrubs such as Ilex glabra, Vaccinium corymbosum, and Itea virginica.

*Maximum Tree Size Class*  
Pole 5-9" DBH

Class C 16 Mid Development 2 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PISE | Pinus serotina | Pond pine | Upper |
| TADI2 | Taxodium distichum | Bald cypress | Upper |
| TAAS | Taxodium ascendens | Pond cypress | Upper |
| ACRU | Acer rubrum | Red maple | Upper |

Description

Patch mosaic of any of the species listed above. Class C represents the alternative path of succession after fire if the white cedar seed bank and canopy seed source is destroyed, or after hurricane blowdowns. Such stands may also have scattered stems and clumps of Atlantic white cedar and loblolly pine.

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

Class D 26 Late Development 2 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| NYBI | Nyssa biflora | Swamp tupelo | Upper |
| TADI2 | Taxodium distichum | Bald cypress | Upper |
| TAAS | Taxodium ascendens | Pond cypress | Upper |
| ACRU | Acer rubrum | Red maple | Upper |

Description

Class D represents old growth in the same small wetland sites and sloughs as in class C and follows the same possible alternatives that open up after fire or blowdown. Old-growth cypress are not unusually tall on peat soils and do not tend toward the emergent tree form seen in more fertile riparian swamps. Such stands may also have scattered stems of Atlantic white cedar and loblolly pine.

*Maximum Tree Size Class*  
Large 21-33"DBH

Class E 17 Late Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| CHTH2 | Chamaecyparis thyoides | Atlantic white cedar | Upper |
| TAAS | Taxodium ascendens | Pond cypress | Upper |
| NYBI | Nyssa biflora | Swamp tupelo | Upper |
| ACRU | Acer rubrum | Red maple | Upper |

Description

This old growth alternative was the more extensive type found in the largest peatlands such as the Great Dismal Swamp and mainland Dare county, where peat depth ranges 1-3m in depth. Class E is a closed stand with patch dominant trees up to 500yrs old and 80cm DBH (see photo of virgin white cedar in FRCC model at www.FRCC.gov). In old stands that have gone 100-300yrs+ without fire, trees that die begin to be replaced with other species including red maple, swamp black gum and bald cypress, leading to a mixed stand. Most trees are around 30m tall, even large diameter, old-growth trees being limited in height on these relatively infertile soils.

*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 | 7 |
| Mid1:CLS | 8 | Late1:CLS | 70 |
| Mid2:CLS | 8 | Late2:CLS | 70 |
| Late1:CLS | 71 | Late1:CLS | 500 |
| Late2:CLS | 71 | Late2:CLS | 350 |

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** |
| Replacement Fire | Early1:ALL | Early1:ALL | 0.01 | 100 | Yes | 0 |
| Alternative Succession | Early1:ALL | Mid2:CLS | 0.04 | 25 | Yes | 0 |
| Wind or Weather or Stress | Mid1:CLS | Mid2:CLS | 0.001 | 1000 | Yes | 0 |
| Wind or Weather or Stress | Mid1:CLS | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Replacement Fire | Mid1:CLS | Early1:ALL | 0.015 | 67 | Yes | 0 |
| Mixed Fire | Mid2:CLS | Mid2:CLS | 0.01 | 100 | No | 0 |
| Replacement Fire | Mid2:CLS | Early1:ALL | 0.01 | 100 | Yes | 0 |
| Wind or Weather or Stress | Late1:CLS | Late2:CLS | 0.005 | 200 | Yes | 0 |
| Replacement Fire | Late1:CLS | Early1:ALL | 0.005 | 200 | Yes | 0 |
| Wind or Weather or Stress | Late1:CLS | Early1:ALL | 0.007 | 143 | Yes | 0 |
| Mixed Fire | Late2:CLS | Late2:CLS | 0.003 | 333 | No | 0 |
| Replacement Fire | Late2:CLS | Early1:ALL | 0.01 | 100 | Yes | 0 |

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