13730
Acadian Low-Elevation Spruce-Fir-Hardwood Forest

BpS Model/Description Version: Aug. 2020

Update: 4/19/2018

Modelers		Reviewers	
Colleen Ryan	colleenryan@post.harvard.edu	None	None
None	None	None	None
None	None	None	None

Vegetation Type
Forest and Woodland

Map Zones
63, 64

Model Splits or Lumps
This BpS is lumped with 1465

Geographic Range
This system is found in Maine, New Hampshire, Vermont and the northern New York, and north to the southern boreal region of southeastern Canada. It is a matrix forest type at low elevations in the core of its range in northernmost New England and northernmost New York. In these areas, it is often found alongside Biophysical Setting (BpS) 1465, Acadian Near-Boreal Spruce Flat, which is included in this model.

In map zone (MZ)64, this system is found on lower mountain slopes and upper margins of flats in the Adirondack and Catskill mountains, and in the Tug Hill plateau (subsections M211D, 211Ia 211Jb and 211Jc).

Biophysical Site Description
Mesic to somewhat xeric sites over a broad range of topographic conditions including from steep slopes at lower elevations to valley flats and low gentle hills. The upland soils are acidic and usually rocky, mostly well- to moderately well-drained but with some somewhat poorly drained patches at the slope bottoms. Soil texture and depth can range widely, from silt clay over ledge to deep sandy loams (much less common). On steep slopes this type often occurs growing in thin organic soil perched by a network of roots over rocks and boulders. This system may be associated with ground-covering feather mosses where organic layers vary from <1in (2cm) to >1ft (30cm) in thickness.

BpS 1465, Acadian Near-Boreal Spruce Flat (also included in this model), is found in the colder regions of the northern Appalachians-Acadian region, in areas of imperfectly drained soils. It often forms extensive flats along valley bottoms. The nutrient-poor acidic soils are typically saturated at snowmelt but are moderately well-drained for much of the growing season and may be reasonably dry at the soil surface (NatureServe 2007).

Vegetation Description

These low- to mid-elevation forests are dominated by *Picea rubens* and *Abies balsamea. Picea mariana* and *Picea glauca* may be present. *Betula alleghaniensis* is the most common codominant. Common early-seral associates are paper birch (*Betula papyrifera*) and aspen (*Populus tremuloides* and *P. grandidentata*). Other common associates include sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), striped maple (*A. pensylvanicum*), red maple (*A. rubrum*), mountain maple (*A. spicatum*) and eastern hemlock (*Tsuga canadensis*), mostly in the southern portions of its range. Eastern white pine (*Pinus strobus*) is found occasionally towering over the older growth scattered throughout this landscape, although never common. Short-lived early successional shrubby trees include pin cherry (*Prunus serotina*), black cherry (*Prunus serotina*), elderberry (*Sambucus pubescens*) and on wet sites speckled alder (*Alnus incana* ssp. *rubra*). Open exposed soils often become dominated by sweet fern (*Comptonia peregrina* -- an atmospheric Nitrogen-fixer), several raspberry and blackberry species (*Rubus alleghaniensis, ideaus, fragellans, hispidus*) and two common ferns with reputed allelopathic properties are bracken (*Pteridium aquilinum*) and hay-scented fern (*Dennstaedtia punctilobula*).

Red spruce can persist in a shady understory for 100yrs (called umbrella spruce), and then quickly fill a gap when an opportunity arises. It can then grow into the canopy over a short period. White and black spruce do not do this. While black spruce grows slowly in the understory and can outlive fir, if it is suppressed to too long it remains dwarfed even with canopy release. Balsam fir is an early competitor and grows faster than young red spruce, but dies at ~90yrs or earlier, and the residual red or black spruce will persist to dominate the stand.

BpS 1465, Acadian Near-Boreal Spruce Flat, also included in this model, is a closely related system found in the northern portion of the range of BpS 1373. These systems are u
The mostly closed-canopy forests have *Picea rubens, Picea mariana*, and *Abies balsamea* as the dominant trees; other conifers are often present. Bryophytes are abundant in the ground layer; other layers are typically rather sparse.

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
PIRU	*Picea rubens*	Red spruce
ABBA	*Abies balsamea*	Balsam fir
BEAL2	*Betula alleghaniensis*	Yellow birch
FAGR	*Fagus grandifolia*	American beech
BEPA	*Betula papyrifera*	Paper birch
POTR5	*Populus tremuloides*	Quaking aspen
POGR4	*Populus grandidentata*	Bigtooth aspen
ACRU	*Acer rubrum*	Red maple

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

Disturbance Description

The primary disturbance types impacting this system are insect damage, wind throw, ice damage and fire. Insects, wind and fire often act in concert, with budworm outbreaks increasing susceptibility to wind storms and either or both of these disturbances increasing dead fuel and predisposing the forest to catastrophic fire. In the Rainbow Flora book, susceptibility to fire is estimated to be highest 5-8yrs after tree mortality; then flammability gradually decreases as fuel decomposes and new understory develops.

Overall mean fire return interval (MFRI) for this system is estimated to be ~1200yrs (Lorimer and White, 2003). A moist, cool climate precludes frequent fire. However, rare fire disturbances are severe and affect large patch sizes, at 150-300yrs+ intervals. Surface fires are extremely uncommon. Fire may occur in the spring or later in the growing season under drought conditions, with the former favoring a pathway to early successional aspen-birch and delaying spruce-fir regeneration. This pathway is modeled as Alternate Succession via classes C and D. Sustained crown fire runs covering several hundred ac can occur, with severe damage at the ground surface, depending on time of year. Drought spring conditions produce the most severe effects, whereas late summer or fall burns may temper effects due to presence of live fuel moisture. Large fires (10-100ac) and some wind events could extend class D to 130yrs before the paper birch finally senesces and the dense fir understory emerges. It is then a further 50-150yrs before the fir either senesces or is knocked back by budworm.

Wind events, insect attack and ice storms -- on a small patch-to-stand scale -- are more important than fire, and they may predispose the forest to fire especially when coupled with drought. Stand replacing wind events (severe hurricane damage or microbursts) are expected to occur with a mean return interval of about 1000yrs (Lorimer and White, 2003). Severe hurricane damage is less common in this system's range than in southern and central New England. Boose, et al. (2001) estimate the return interval for hurricanes capable of causing extensive blowdowns to be 380yrs for coastal Maine and higher for the rest of this system's range.

Less damaging wind and ice storms are more common. Wind disturbance often results in an abundance of mountain ash (*Sorbus decora* and *S. canadensis*) as well as elderberry (*Sambucus pubescens* and *S. canadensis*).

Spruce budworm sometimes destroys whole stands of spruce-fir forest. The preferred host plant of spruce budworm is balsam fir, but this native insect also attacks over-mature spruce. Minor spruce budworm outbreaks are also of considerable importance particularly in classes B and D where fir is at its peak of attractiveness to the budworm. One or two cycles of budworm over a 50- 50yr period slowly decreases the dominance or co-dominance of fir and increases in waves the strong dominance of red and potentially some black spruce. Spruce beetle attacks trees >18 in DBH. Over-mature or stressed spruce is susceptible to witch's broom, Armillaria, and in severe outbreaks the stand can collapse. In the relatively stable late-closed class, moderate disturbances from wind, spruce budworm, spruce bark beetle, Armillaria, and ice storm impact on this community but not to stand-replacing severity.

On deep and coarse glacial outwash where MFRIs can be quicker and more intense it may take much longer to get back to the Spruce forest type. The more intense fires will often strip organic soils and spruce resulting in red and white pine domination for periods of between 100-200yrs.

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	1039	100	50	200
Moderate (Mixed)				
Low (Surface)				
All Fires	1039	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

The type occupies patches from a few acres to 10s-1000s of acres, depending on growing site quality, soils, elevation, and moisture.

Adjacency or Identification Concerns

In northern New England and northern New York, this system may be difficult to distinguish from BpS 1374, Acadian-Appalachian Montane Spruce-Fir Forest. In concept, this system may be identified by the absence or lower abundance of montane species such as *Sorbus americana* or *Sorbus decora, Dryopteris campyloptera, Oxalis montana*, etc., and by occurring at lower positions in the toposequence. This system may be found below, or at similar elevations to, northern hardwood forests, while 1374 is typically found above northern hardwood forests.

BpS 1465, Acadian Near-Boreal Spruce Flat, has been lumped into this model. According to NatureServe (2007), this system might be considered as a component of 1373, Acadian Low-Elevation Spruce-Fir-Hardwood Forest, but differs from that type *sensu stricto* in its hydrology (wetland vs. upland) and in that its range is somewhat more boreal.

Issues or Problems

The historic distribution of this type, if defined by red spruce dominance, is not well-known. Pollen data from cores are not able to differentiate spruce species. Perhaps there was less abundance of balsam fir and red maple in reference conditions. These two species appear to respond especially well to anthropogenic disturbance.

Native Uncharacteristic Conditions

Spruce budworm outbreaks today are thought to be on a much shorter cycle (40-60yrs) than would have occurred under presettlement conditions. Before the late 1800s, outbreaks appear to have been of smaller size and intensity, and with a greater interval between outbreaks. Twentieth century harvesting created many large openings, which along with later century stand treatments favored extensive coniferous and in this case fir-dominated stands (Fraver 2007). This created abnormally large and mono-typic stands of nearly even-aged fir dominating large parts of the landscape creating a pallet for run-away budworm epidemics whose impacts were much more intensive and wide ranging then we assume would occur under prior condition.

Comments

Succession Classes

Mapping Rules

Upper Layer Lifeform	Height (m)	Canopy Cover (%)									
		0-10	11-20	21-30	31-40	41 - 50	51-60	61-70	71-80	81-90	91-100
Herb	0-0.5	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Herb	0.5-1.0	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Herb	>1.0	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN

Shrub	0-0.5	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Shrub	0.5-1.0	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Shrub	1.0-3.0	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Shrub	>3.0	UN	UN	UN	UN	UN	UN	UN	UN	UN	UN
Tree	0-5	A	A	A	A	A	A	A	A	A	A
Tree	5-10	A	A	A	A	A	A	A	A	A	A
Tree	10-25	UN	UN	C	C	C	C	C	B	B	B
Tree	25-50	UN	UN	UN	UN	UN	D	D	D	E	E
Tree	>50	UN	UN	UN	UN	UN	D	D	D	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 **4** **Early Development 1 - All Structures**

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
POTR5	Populus tremuloides	Quaking aspen	Upper
BEPA	Betula papyrifera	Paper birch	Upper
ABBA	Abies balsamea	Balsam fir	Low-Mid
PIRU	Picea rubens	Red spruce	Low-Mid

Description

This class occupies an opening that followed stand replacement fire, microburst, or another major disturbance. Young stands characterized by birch (paper, gray) and aspen (trembling, big-tooth). Understory has spruce (red/white/black, but especially red) and balsam fir.

Maximum Tree Size Class

Pole 5-9" DBH

Class B **4** **Mid Development 1 - Closed**

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
POTR5	Populus tremuloides	Quaking aspen	Upper
BEPA	Betula papyrifera	Paper birch	Upper
ABBA	Abies balsamea	Balsam fir	Low-Mid
PIRU	Picea rubens	Red spruce	Low-Mid

Description

This class represents intermediate stands dominated by birch, aspen and possibly fir, with spruce and fir in the understory.

Maximum Tree Size Class
Medium 9-21"DBH

Class C 4 Mid Development 2 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
POTR5	Populus tremuloides	Quaking aspen	Upper
BEPA	Betula papyrifera	Paper birch	Upper

Description
This class reflects suppressed establishment of spruce-fir. The canopy will be dominated by birch and aspen. The understory initially lacks spruce and fir, but the conifers establish later in the class, perhaps around 40yrs.
Maximum Tree Size Class
Medium 9-21"DBH

Class D 5 Late Development 1 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
BEPA	Betula papyrifera	Paper birch	All
ABBA	Abies balsamea	Balsam fir	All
POTR5	Populus tremuloides	Quaking aspen	All
PIRU	Picea rubens	Red spruce	All

Description
This class represents closed stands dominated in the early years of the class by mature birch, with the aspen dying out. The understory fir and spruce are beginning to take over. By the end of this class the early successional hardwoods have senesced, and the canopy is mostly fir and spruce, mixed with other hardwoods. Where this class has followed a budworm outbreak, the fir may be missing from the canopy. Occasional white pines present in this class may exceed 25m in height. In nature, cover overlaps with C, as trees have reached maximum height in C. Canopy cover could be greater than 60%.

Maximum Tree Size Class
Large 21-33"DBH

Class E 83 Late Development 2 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIRU	Picea rubens	Red spruce	Mid-Upper

ABBA	Abies balsamea	Balsam fir	Mid-Upper
BEAL2	Betula alleghaniensis	Yellow birch	Mid-Upper

+Description

This is a closed spruce/fir stand (with a variable component of late successional hardwoods) from 70-175+yrs. Individual fir trees drop out after age 70-100, but spruce and fir regenerate in gaps, eventually to spruce and secondarily to fir. Moderate disturbances from wind, spruce budworm, spruce bark beetle, Armillaria, and ice storms impact on this community but not to stand-replacing severity.

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	29
Mid1:CLS	30	Late2:CLS	69
Mid2:OPN	30	Late1:CLS	68
Late1:CLS	69	Late1:CLS	119
Late2:CLS	70	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
Replacement Fire	Early1:ALL	Early1:ALL	0.0005	2000	Yes	0
Alternative Succession	Early1:ALL	Mid2:OPN	0.015	67	Yes	0
Wind or Weather or Stress	Mid1:CLS	Early1:ALL	0.0007	1429	Yes	0
Replacement Fire	Mid1:CLS	Early1:ALL	0.0007	1429	Yes	0
Wind or Weather or Stress	Mid1:CLS	Mid1:CLS	0.004	250	No	0
Insects or Disease	Mid1:CLS	Mid2:OPN	0.005	200	Yes	0
Replacement Fire	Mid2:OPN	Early1:ALL	0.0005	2000	Yes	0
Wind or Weather or Stress	Mid2:OPN	Early1:ALL	0.001	1000	Yes	0
Wind or Weather or Stress	Mid2:OPN	Mid2:OPN	0.004	250	No	0

Wind or Weather or Stress	Late1:CLS	Early1:ALL	0.0005	2000	Yes	0
Replacement Fire	Late1:CLS	Early1:ALL	0.0007	1429	Yes	0
Insects or Disease	Late1:CLS	Mid2:OPN	0.004	250	Yes	0
Wind or Weather or Stress	Late1:CLS	Late1:CLS	0.004	250	No	0
Alternative Succession	Late1:CLS	Late2:CLS	0.015	67	Yes	0
Wind or Weather or Stress	Late2:CLS	Early1:ALL	0.001	1000	Yes	0
Replacement Fire	Late2:CLS	Early1:ALL	0.001	1000	Yes	0

References

Bergeron, Y. 2000. Species and dynamics in the mixed woods of Quebec's southern boreal forest. Ecology 81: 1500-1516.

Boose, E.R., K.E. Chamberlin and D.R. Foster. 2001. Landscape and regional impacts of hurricanes in New England. Ecol. Monographs 71: 27–48.

Brown, James K. and Jane Kapler-Smith, eds. 2000. Wildland fire in ecosystems: effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station. 257 pp.

Heinselman, M. L. 1981. Fire intensity and frequency as factors in the distribution and structure of Northern ecosystems. In: Mooney, H. A., T. M. Bonnickson, N. L. Christensen, J. E. Lotan and R. A. Reiners, tech. coords. Fire regimes and ecosystem properties: proceedings of the conference; 1978 Dec 11-15. Honolulu, HI. Gen. Tech. Rep.WO-26, Washington, DC: USDA Forest Service. 7-57.

Kuchler, A.W. 1964. Northern hardwoods (Acer-Betula-Fagus-Tsuga). #106 In: Manual to accompany the map Potential Natural Vegetation of the United States. New York, NY: The American Geographical Society. 156 pp.

NatureServe. 2007. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. Data current as of 10 February 2007.

Lorimer and White. 2003. Scale and Frequency of natural disturbances in the northeastern United States. Forest Ecology and Management 185: 41-64

Patterson, W.A. III, K.E. Saunders and L.J. Horton. 1983. Fire Regimes of the Coastal Maine Forests of Acadia National Park. USDI/NPS - North Atlantic Region Office of Scientific Studies Report OSS 83-3. 259 pp.

USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2002, December). Fire Effects Information System, [Online 12 February 2004]. Available: http://www.fs.fed.us/database/feis/.