Acadian Variant of the Forest Vegetation Simulator (FVS-ACD)

Aaron Weiskittel[1*], John Kershaw[2], Nick Crookston[1,3],
Ben Rice[4], Ian Prior[5]

[1]University of Maine, Center for Research on Sustainable Forests, [2]University of New Brunswick, [3]USDA Forest Service (retired), [4]Midgard Natural Resources, [5]Seven Islands Land Company,
*aaron.weiskittel@maine.edu

Overview:

- The Acadian Region of North America is a complex transitional ecosystem that spans numerous ecoregions, forest types, and management regimes with a high diversity of owners.
- The Acadian Variant of the Forest Vegetation Simulator (FVS-ACD) development initiated in 2008 and has been continually refined since.
- General modeling architecture and approach like other variants of FVS, but with some important differences.
- Implementation of FVS-ACD within FVS-Online is viable framework for the development, refinement, and extension of future FVS variants.

Summary:

The Acadian Region of North America, which includes Maine and the Maritime Provinces of eastern Canada, is a complex transitional ecosystem that bridges the more hardwood-dominated temperate forests of the southern U.S. with the more softwood-dominated boreal forests of northern Canada. The region also has a long history of private ownership and mixed management, which has created a highly mixed landscape of forest conditions. Since 2008, the University of Maine has led the development of the Acadian Variant of the Forest Vegetation Simulator (FVS-ACD), which has seen continued development and use since its initial inception. In recent years, particular focus has been on the refinement of the diameter/height increment and mortality equations, while additional enhancements for simulating the effects of spruce budworm defoliation and hardwood stem form or risk have also been included. Consequently, model projection behavior has evolved over time yet shows reasonable alignment with regional expectations and available long-term benchmarking data. Future efforts will focus on refining stand-level growth along with regional estimates maximum stand density index and site productivity. FVS-ACD is available as stand-alone R package or an option under the NE Variant of FVS within FVS-Online.

Key Concepts for FVS Users:

- Robust and flexible modeling approach applicable to existing or new variants of FVS
    - Annualized, realized, and species-specific increment outperforms periodic potential times multiplier approaches.
    - Use of a climate-sensitive measure of potential site productivity allows for the use of more consistent estimates, while avoiding the need for species conversions and addressing possible future conditions due to climate change.
    - Multi-stage approach to mortality predictions outperforms more traditional approaches including methods currently used by other FVS variants.
    - Constraint of growth by stand-level equations is helpful in ensuring proper behavior especially for long-term projections (50-100 years).
    - Growth and mortality modifiers are helpful for modeling effects of management or other novel conditions such as tree form or risk.
    - Ingrowth is a critical component for regions dependent on natural regeneration.
- Novel incorporation into FVS-Online based on available Open-FVS framework and custom R function.
- Development of a broader framework for model testing and deployment within the existing FVS structure, which may help with the speed and ease of getting new growth models and model improvements into users' hands.

Management Applications/Future Directions:

- Flexible modeling approach for capturing the dynamic effect of alternative management regimes, climate change, and potential influences of disturbances like spruce budworm defoliation in a complex region.
- Regional inventories should be expanded to include assessments of tree-stem form and risk using the developed protocol given their influence on tree-level growth and mortality trends.
- Future efforts will focus on better constraining tree-level growth predictions, improved representation of high-resolution site productivity differences, and development of additional modifiers, particularly extending form and risk to a greater number of species in the region.

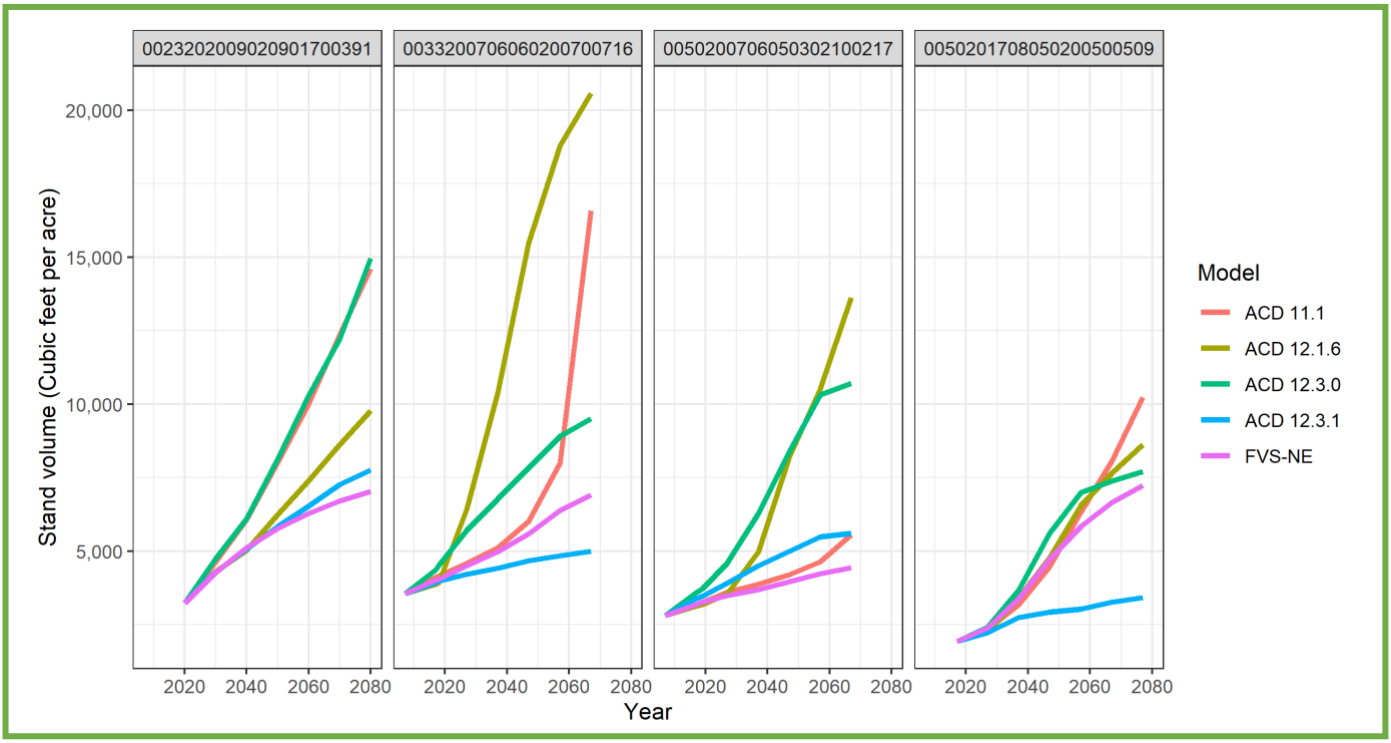

Figure 1—Fifty-year projections of stand total volume (ft^3 ac^{-1}) for selected USDA Forest Service, Forest Inventory & Analysis plots in Maine covering the range of typical conditions across different versions of the Acadian Variant of the Forest Vegetation Simulator (FVS-ACD).

Table 1—Comparison of key equations for the previous and current version of the Acadian Variant of the Forest Vegetation Simulator (FVS-ACD) with key references provided. The 2017 version was described in Weiskittel et al. 2018.

Equation	FVS-ACD Version	
	2017	2023
Base Equations		
Climate site index	Weiskittel et al. (2011)	
Crown width	Russell and Weiskittel (2011)	
Total tree height	Rijal et al. (2012a) (Modified)	
Height to crown base	Rijal et al. (2012b) (Modified)	
Diameter increment	Weiskittel et al. (2012)	Kuehne et al. (2022)
Height increment	Russell et al. (2014)	Kuehne et al. (2022)
Crown recession	Russell et al. (2014)	
Mortality	Weiskittel et al. (2012)	Chen et al. (2023)
Ingrowth	Li et al. (2011)	
Stem taper	Li et al. (2012); Weiskittel and Li (2012)	
Bark thickness	Li and Weiskittel (2011); Weiskittel and Li (2012)	
Modifier Equations		
Spruce budworm	Chen et al. (2017)	Chen et al. (2018)
Hardwood form and risk	—	Castle et al. (2018)

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