USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

FVS Updates 2025 - 2026

Integration of FIA volume, biomass, and carbon (FIAVBC)

FIA – NFS volume comparisons

Brief exploration of tree record limit expansion

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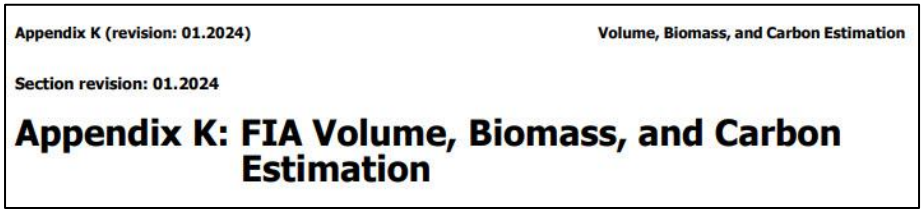
FIA Volume, Biomass, and Carbon (FIAVBC)

Included in **20250930** version of FVS

- National Scale Volume and Biomass Estimators (NSVB) for timber species
- Regional equations used by FIA for woodland species

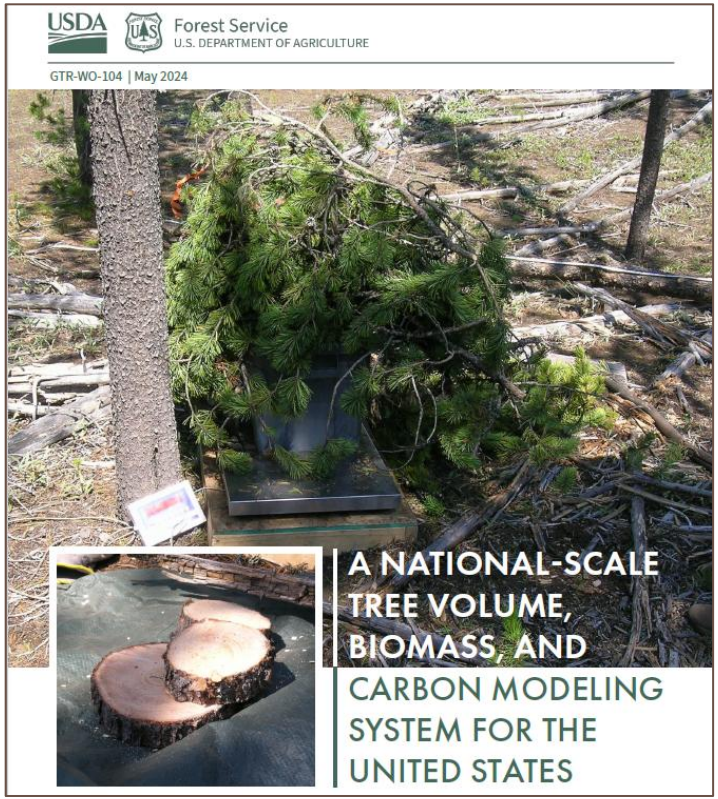
Appendix K of FIADB guide provides overview of both these systems



Appendix K (revision: 01.2024) Volume, Biomass, and Carbon Estimation

Section revision: 01.2024

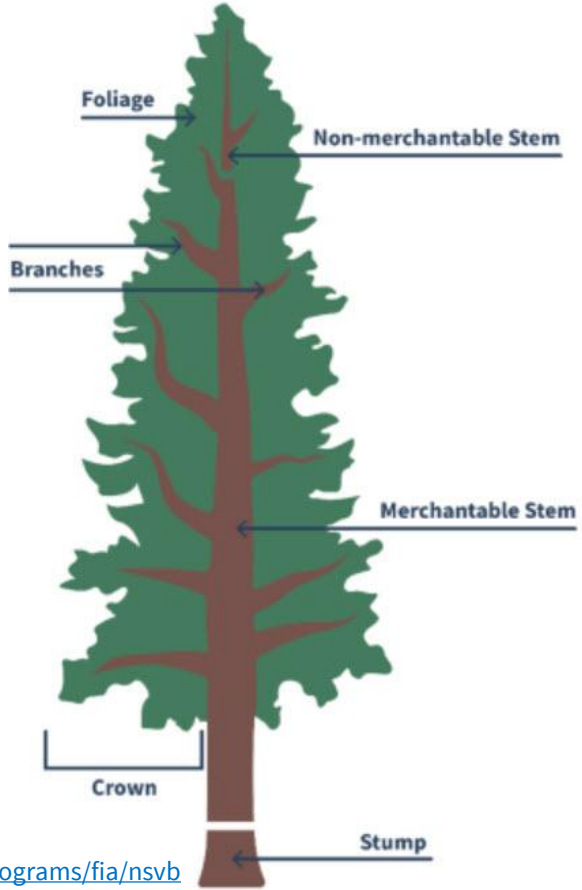
Appendix K: FIA Volume, Biomass, and Carbon Estimation



Westfall et al. 2024

NSVB

- M odels developed by Forest Service and external partners. Replaced previous FIA methods in September 2023 (timber species)
- Developed from a comprehensive, national database
- M odel forms can derive volume/biomass attributes for individual tree components
- Includes procedures to account for structural loss (cull, broken tops, and extent of decay)
- Uses more precise species-specific carbon conversion factors

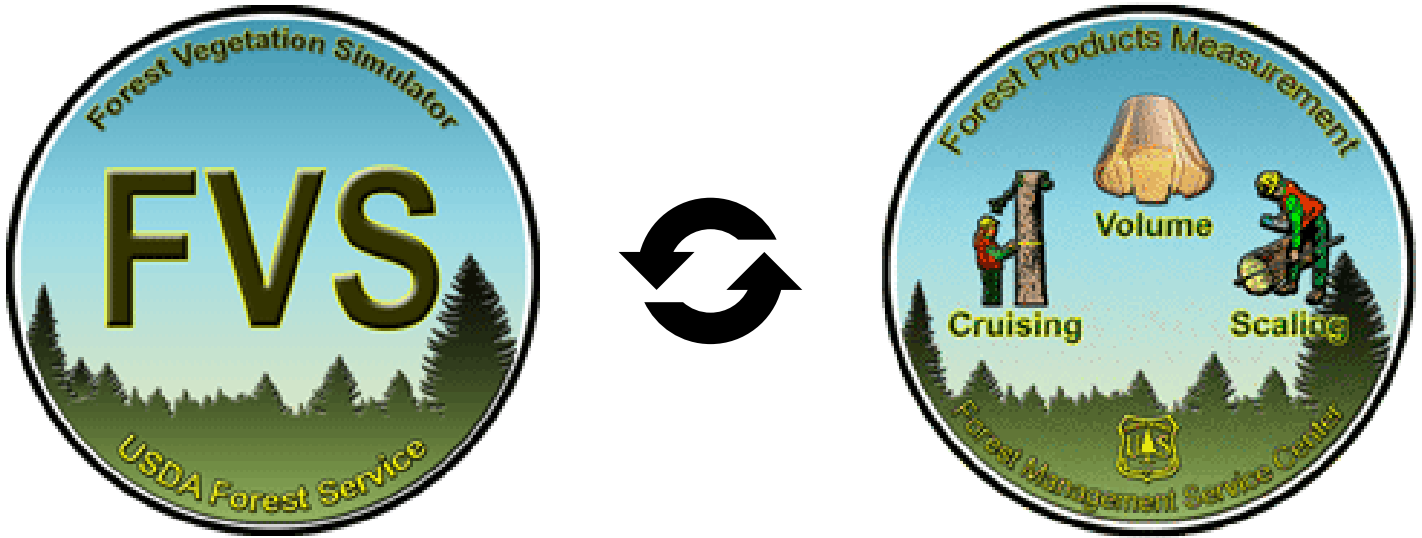


https://research.fs.usda.gov/programs/fia/nsvb

Getting FIAVBC in FVS

National Volume Estimator Library (NVEL) is used as the engine for calculating FIA volume, biomass, and carbon estimates

NVEL has (and continues) to calculate volume with NFS equations used in timber sales



FIA Volume Attributes Reported in FVS

3 measures of FIA cubic foot volume attributes reported in all FVS variants:

- Total stem cubic foot volume (TCuFt)
- Merchantable stem cubic foot volume (MCuFt)
- Sawlog cubic foot volume (SCuFt)

Estimates of sound cubic foot volume can be obtained when cull and height to topkill is included in inventory data

	StandID	Year	TCuFt	MCuFt	SCuFt
1	160400984390	2025	5706.497	5078.188	4421.443
2	160400986470	2025	9669.516	9122.419	8000.649
3	160401780128	2025	5868.874	5516.331	4761.577
4	160401784478	2025	6506.134	5503.077	2806.354
5	160402186549	2025	1090.999	776.61	80.401
6	160403580728	2025	1228.248	794.831	395.563
7	160403580871	2025	6792.407	6331.877	5362.535
8	160403581788	2025	1048.239	661.394	230.377
9	160403582346	2025	6205.492	5969.564	5704.509
10	160403582570	2025	1314.962	1021.076	460.35
11	160403583368	2025	836.038	677.176	370.727
12	160403583388	2025	1752.596	1231.941	645.251
13	160403585188	2025	3321.864	3145.253	2608.299
14	160403585233	2025	113.919	96.166	0
15	160403585717	2025	1098.376	1025.656	963.15

Per acre estimates of TCuFt, MCuFt and SCuFt from FVS_Summary2 table

FIA Biomass and Carbon Calculations

Reporting estimates of standing FIA biomass and carbon is better suited for the **base FVS system**

- **Aboveground** (stem wood + bark + branches)
- **Merchantable stem wood**
- **Sawlog stem wood**
- **Foliage**

FIA belowground biomass/carbon **not reported since calculation method is not currently available in the NVEL

FVS_FIAVBC_Summary and Event Monitor
(Stand level)

FVS_FIAVBC_ Treelist / Cutlist / Atrtlist
(Tree level)

FVS Statistical Summary Tables
(Stand and species level)

FIAVBC Summary and Event Monitor Variables

FIA volume, biomass, and carbon in live trees is reported for the following conditions:

- Before thinning
- After thinning
- Removals

Attributes are also available as pre-defined stand variables in Event Monitor (FVS_Compute)

FVS_FIAVBC_Summary

StandID	Year	RmvCode	AbvGrdCarb	MerchCarb	RAbvGrdCarb	RMerchCarb
160902188423	2025	1	52.273	38.219	35.517	26.05
160902188423	2025	2	16.756	12.169	0	0
160902188423	2035	0	18.27	13.24	0	0
160902188423	2045	0	19.899	14.375	0	0
160902188423	2055	0	21.822	15.484	0	0
160902188423	2065	0	24.781	16.746	0	0
160902188423	2075	0	29.414	19.093	0	0

FVS_Compute

StandID	Year	BABVCRB_	BMERCRB_	RABVCRB_	RMERCRB_	AABVCRB_	AMERCRB_
160902188423	2025	52.273	38.219	35.517	26.05	16.756	12.169
160902188423	2035	18.27	13.24	0	0	18.27	13.24
160902188423	2045	19.899	14.375	0	0	19.899	14.375
160902188423	2055	21.822	15.484	0	0	21.822	15.484
160902188423	2065	24.781	16.746	0	0	24.781	16.746
160902188423	2075	29.414	19.093	0	0	29.414	19.093

FIAVBC Tree Level Output (TreeList, CutList, AtrtList)

Stand/Plot identification: StandID, PlotID, ActPt

TreeID/Species: TreeID, TreeIndex, species codes

Tree size: DBH, tree heights, crown ratio

Other attributes: TPA, mortality TPA, cull, decay code, carbon fraction

Volume: Total, merchantable, sawlog cubic foot

Biomass/carbon: Aboveground, foliage, merchantable, sawlog

StandID	Species	TPA	DBH	Ht	Cull	DecayCd	CarbFrac	AbvGrdBio	AbvGrdCarb
162204982807	ABGR	6	10.2	79	0	0	0.481	636.771	306.287
162204982807	PIEN	6	21	123	0	0	0.481	3280.303	1577.826
162204982807	ABGR	6	14.4	82	24	0	0.481	1318.943	634.412
162204982807	ABGR	225	0.1	1.01	0	0	0.481	0	0
162204982807	ABLA	0	7.4	55	8	2	0.504	184.771	93.124
162204982807	PIEN	0	31.9	164	5	1	0.501	8411.847	4214.335
162204982807	ABGR	6	16.5	109	24	0	0.481	2081.929	1001.408
162204982807	THPL	6	15.7	89	0	0	0.504	1083.571	546.12
162204982807	THPL	6	11.6	51	0	0	0.504	391.682	197.408
162204982807	ABGR	150	0.1	1.01	0	0	0.481	0	0
162204982807	ABLA	150	0.1	1.01	0	0	0.482	0	0
162204982807	PSME	75	0.1	1.01	0	0	0.516	0	0
162204982807	ABLA	0	19.8	113	3	2	0.504	2471.601	1245.687
162204982807	ABLA	0	9.6	90	10	3	0.506	361.238	182.786
162204982807	ABLA	0	16.7	107	20	3	0.506	1324.742	670.32

***** Dead tree information from inventory can be found in FIAVBC_TreeList table (inventory year only)**

User Beware

FIAVBC is not fully compatible with the Fire and Fuels Extension…

FFE biomass and carbon calculation procedures are significantly different than FIA's (geared towards use of NFS volume equations)

If you want **standing** biomass and carbon calculation estimates equivalent to FIA, use the outputs from the base FVS model **NOT FFE**

FIAVBC_Summary and Event Monitor

FVS_Fuels

FIAVBC TreeList, CutList, AtrtList

FVS_Carbon / FVS_HrvCarbon

Input Variables

Stand level

ECOREGION: Ecological unit code from Cleland et al. 2007 or from Nowacki et al. 2002.

STDORGCD: Indicator if stand is naturally (0; default value) or artificially regenerated (1).

STATE: FIPS state code used to determine which equation should be used in FVS/NVEL for woodland species.

Tree level

CULL: The percent of the cubic-foot volume in a live or dead tree that is rotten or missing. No cull is assumed if not entered for tree record.

DECAYCD: Decay class code (1 – 5). DECAYCD of 3 is assumed if not entered for dead tree record.

WDLND_STEMS (WDLDSTEM): Woodland stem count.

FIAVBC Keyword

You will need to include the FIAVBC keyword

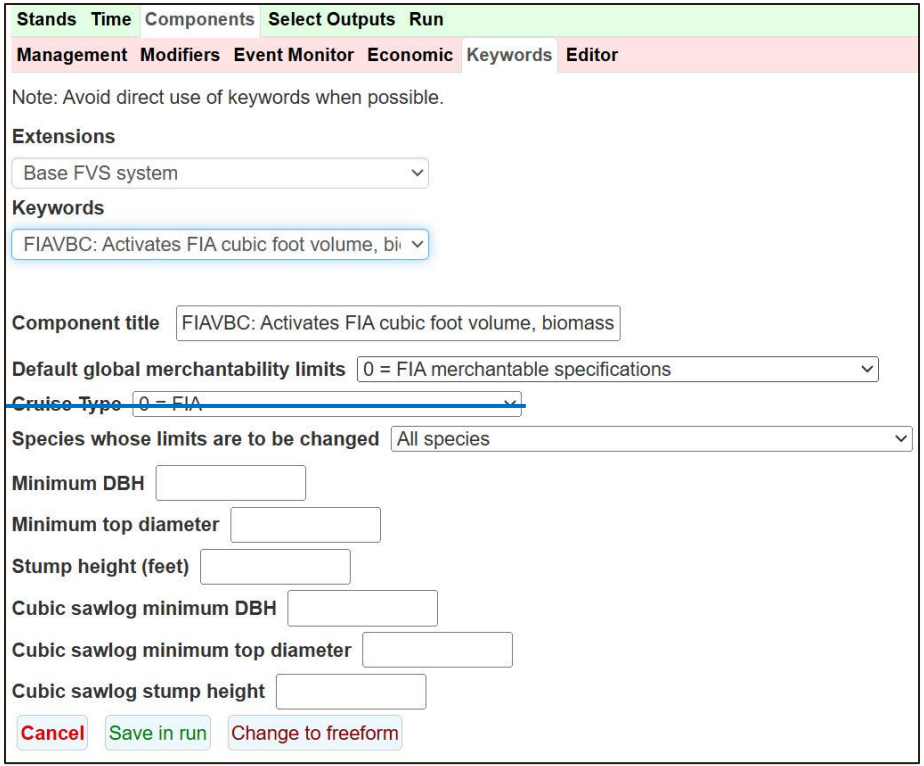
1. Sets merchantability standards
2. Has FVS report FIA cubic foot volume and allows FIAVBC event monitor variable use
3. Produce FIAVBC stand and tree level output tables with new database keywords:

   VBCSUMDB: FVS_FIAVBC_Summary

   VBCATRDB: FVS_FIAVBC_AtrtList

   VBCCUTDB: FVS_FIAVBC_CutList

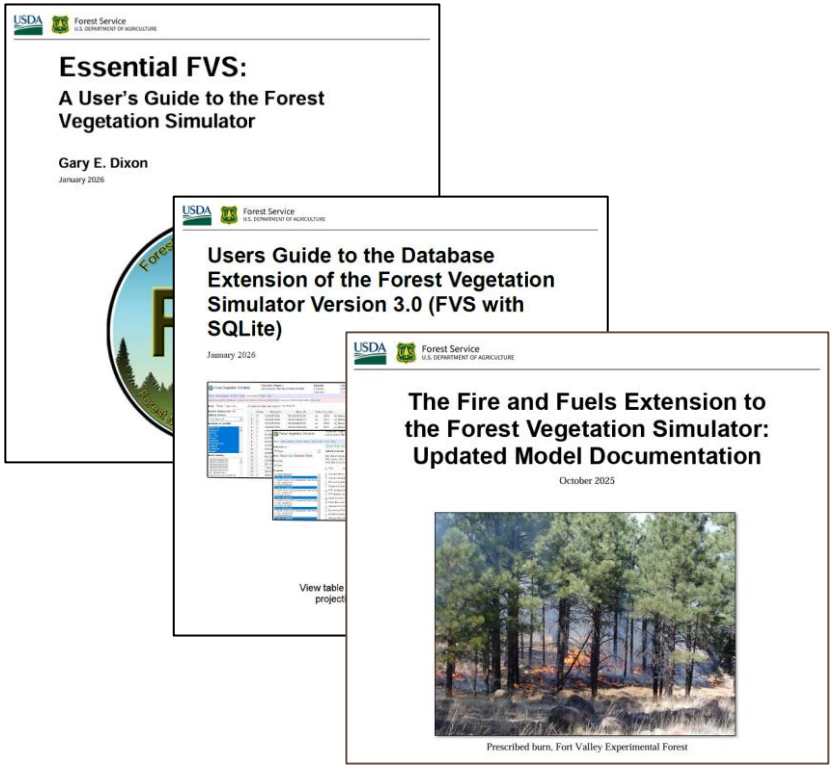
   VBCTRLDB: FVS_FIAVBC_TreeList



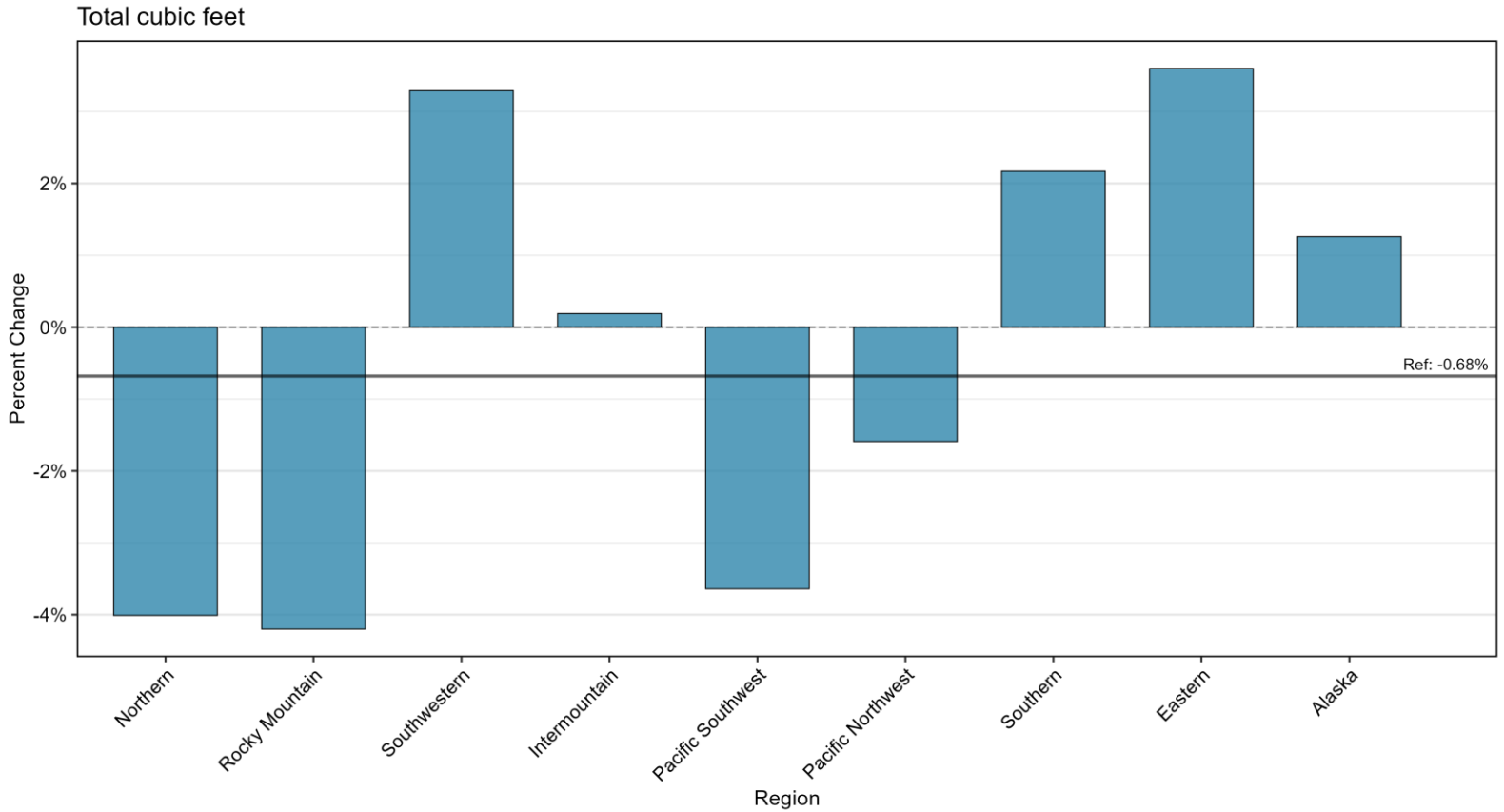
Field 2 will be deprecated in July 2026 release

More Information on FIAVBC

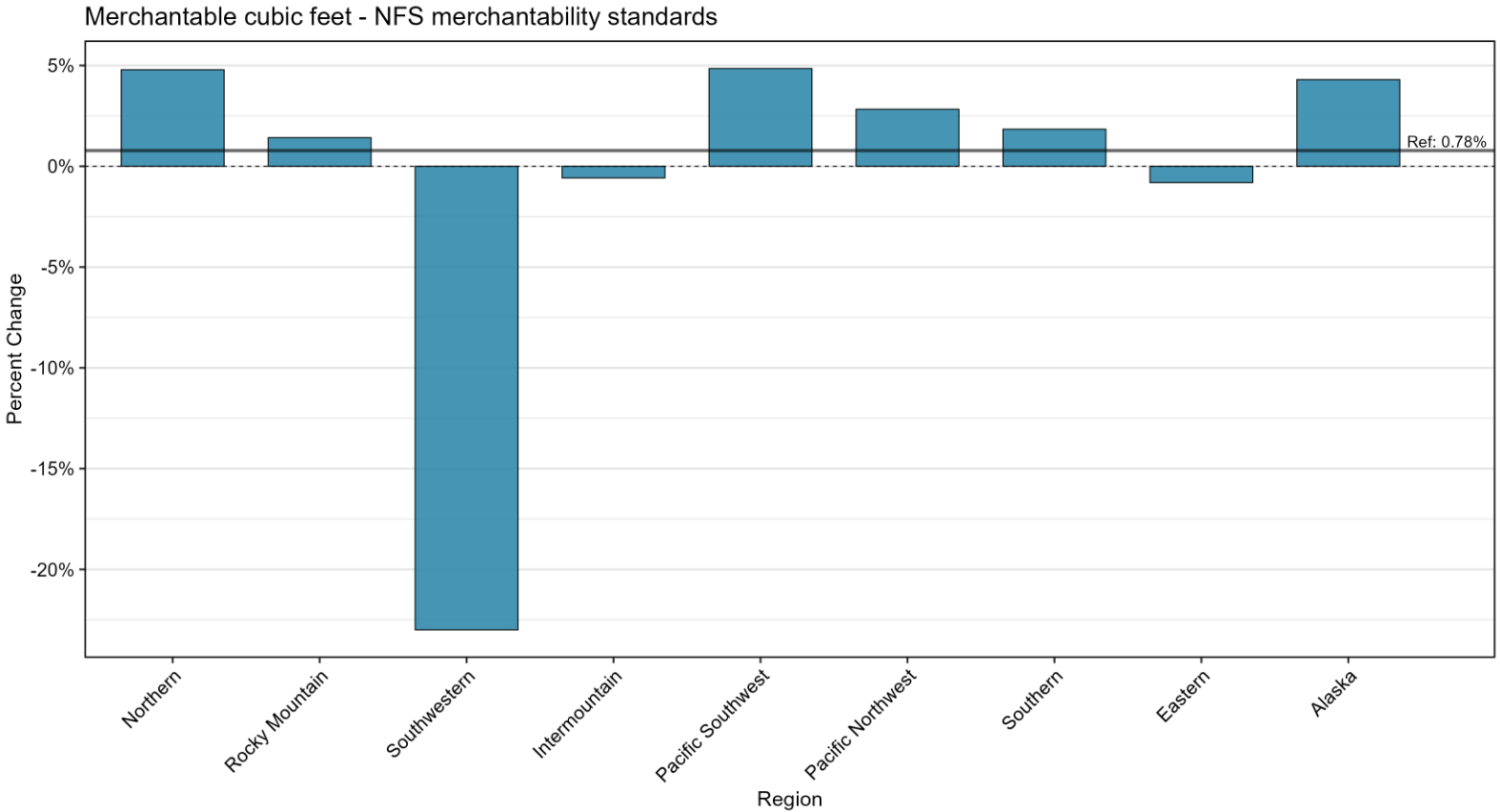
- Start with Section 5.3.1.3 of Essential FVS
- Users Guide to the Database Extension provides more detail on new FIAVBC output tables
- Sections 2.4.11 and 2.6.3 of the FFE guide explain how submodels interact with FIAVBC
- Webinar materials from January



FIA – NFS Volume Comparisons



FIA – NFS Volume Comparisons



Switching Gears…

We have been hearing more and more about the need to have FVS accommodate larger tree lists…

FVS13 ERROR: THE MAXIMUM NUMBER OF USABLE TREE RECORDS HAVE BEEN PROCESSED. NUMBER READ = XXXX; PLOT COUNT = XXX

Program Action

The Forest Vegetation Simulator can handle 3,000 projectable tree records and 500 plots from a given stand. When either of these values is exceeded the projection is terminated. Error severity = 20.

How Are Arrays in FVS Defined?

All arrays in FVS are static, and their size is determined when an FVS variant is compiled

xx/common/PRGPRM.F77 contains variables used to control array sizes for FVS variant

```
C     PARAMETERS FOR THE PROGNOSIS MODEL ARE:
C
      INTEGER MAXTRE,MAXTP1,MAXPLT,MAXSP,MAXCYC,MAXCY1,MAXSTR,MXFRCDS
      PARAMETER (MAXTRE=3000)
      PARAMETER (MAXTP1=MAXTRE+1)
      PARAMETER (MAXPLT=500)
      PARAMETER (MAXSP =23)
      PARAMETER (MAXCYC=40)
      PARAMETER (MAXCY1=MAXCYC+1)
```

MAXTRE is used to set tree-level array size throughout **many** routines in the FVS software system

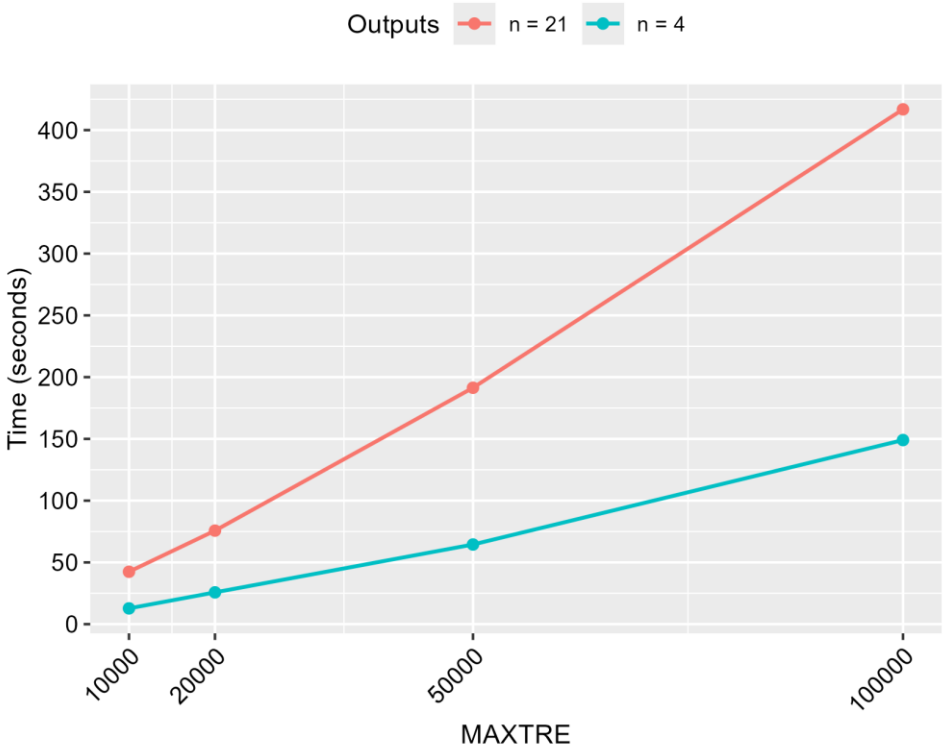
Increasing Tree Record Limit

You can compile variants with a different MAXTRE value

Processing times and memory used by system will increase with larger MAXTRE value

Simulation timeframe and model features used will also impact processing time

Question: How many tree records is enough?



Options for Increasing Tree Records

1. Change MAXTRE at run time (keyword or otherwise)

    - Not feasible without switching to a paradigm where FVS uses dynamic arrays…

2. **Compile FVS variants with larger MAXTRE value**

    - Would it be helpful to have documentation on how to compile variants with larger MAXTRE values?

    - If we were to increase the size of MAXTRE in the version of FVS that USFS distributes, what should a new MAXTRE limit be?

Questions or Comments?

Thanks for Listening!

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Other Model Enhancements

1. **Increase in Event Monitor capacity (20250701)**
   - 4000 activities and 8000 activity parameters are now supported
2. **Updates to FVS_Summary2 table and DMD (20260401)**
   - SDIMax: Maximum SDI
   - ZeideSDI: Zeide stand density index
   - ReinekeSDI: Reineke stand density index
   - RDSDI: Relative density (SDI/SDIMax)
   - GMD: Generalized Mean Diameter (Zeide 1983)