USFWS. Brent Lawrence. "Diablo Lake in the Northern Cascades" Flickr, 3 November 2023, https://www.flickr.com/photos/52133016@N08/53450162751/

Methods for Initial Scenario Modeling

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ESSA

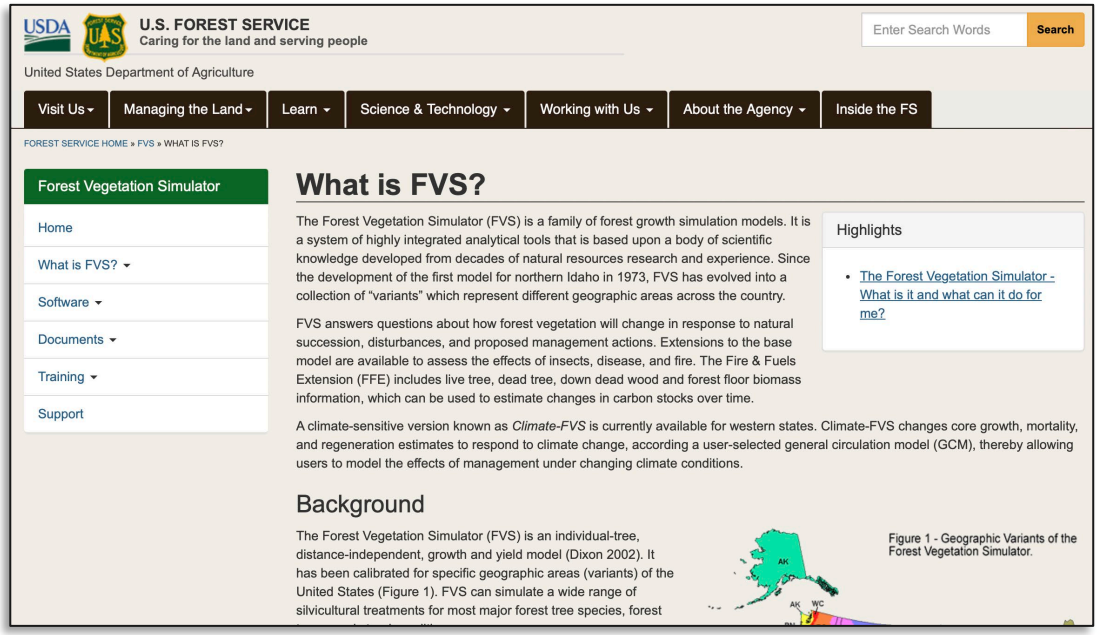
Outline

- Introduction (3min)
- Model Process Overview (5min)
- Prepare Inputs & Simulate Key Processes (20min)
- Post-Processing & Outputs (5min)
- Scenarios Review & Questions

Today's Goal

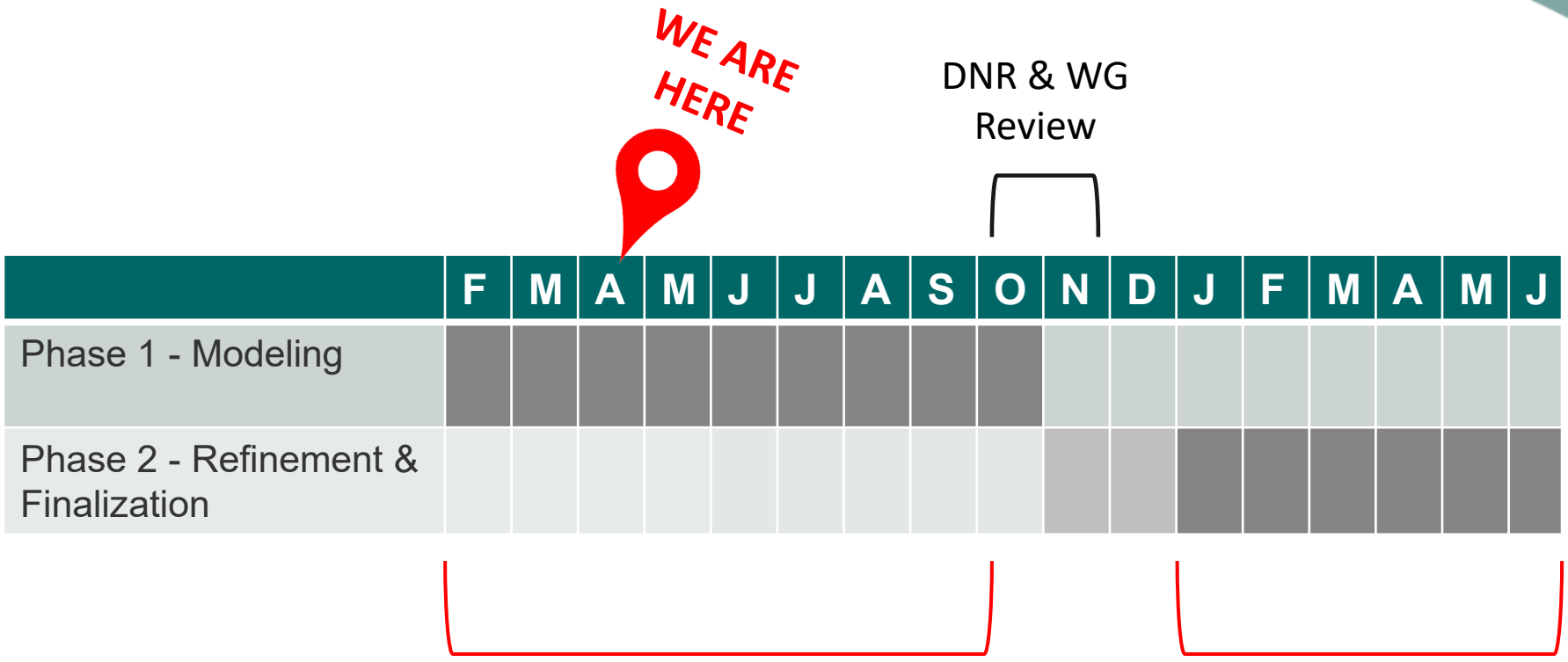
- Continue building understanding about how the forest carbon modeling works to aid in informing voting decisions about management scenarios

Selected modeling tool



https://www.fs.usda.gov/fvs/index.shtml

Modeling phases



Basic Model Process

Basic model process

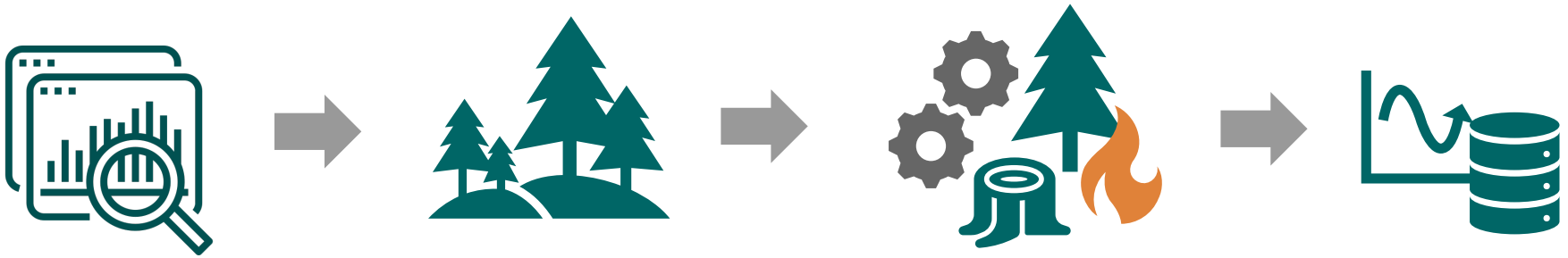
PREPARATION	MODELING	RESULTS

Prepare Inputs

Stand Initialization

Simulation

Outputs and Post-processing



- Growth
- Carbon fluxes
- Disturbance
- Harvest
- Silviculture

Preparation data icon by monkik

Basic model process

PREPARATION	MODELING		RESULTS
Prepare Inputs	Stand Initialization	Simulation	Post-processing

- Growth
- Carbon fluxes
- Disturbance
- Harvest
- Silviculture

WE ARE HERE

Preparation data icon by monkik

Basic model process

PREPARATION	MODELING		RESULTS
Prepare Inputs	Stand Initialization	Simulation	Post-processing

- Growth
- Carbon fluxes
- Disturbance
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- Silviculture

WHAT WE WANT TO TALK ABOUT TODAY

Preparation data icon by monkik

Basic model process

PREPARATION	MODELING		RESULTS
Prepare Inputs	Stand Initialization	Simulation	Post-processing

- Growth
- Carbon fluxes
- Disturbance
- Harvest
- Silviculture

FOCUSING ON

HOW?

Preparation data icon by monkik

Basic model process

PREPARATION	MODELING		RESULTS
Prepare Inputs	Stand Initialization	Simulation	Post-processing

1

- Growth
- Carbon fluxes
- Disturbance
- Harvest
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FOCUSING ON

HOW?

Preparation data icon by monkik

Basic model process

PREPARATION	MODELING		RESULTS
Prepare Inputs	Stand Initialization	Simulation	Post-processing

1

- Growth
- Carbon fluxes
- Disturbance
- Harvest
- Silviculture

2

FOCUSING ON

HOW?

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Prepare Inputs

Main Inputs

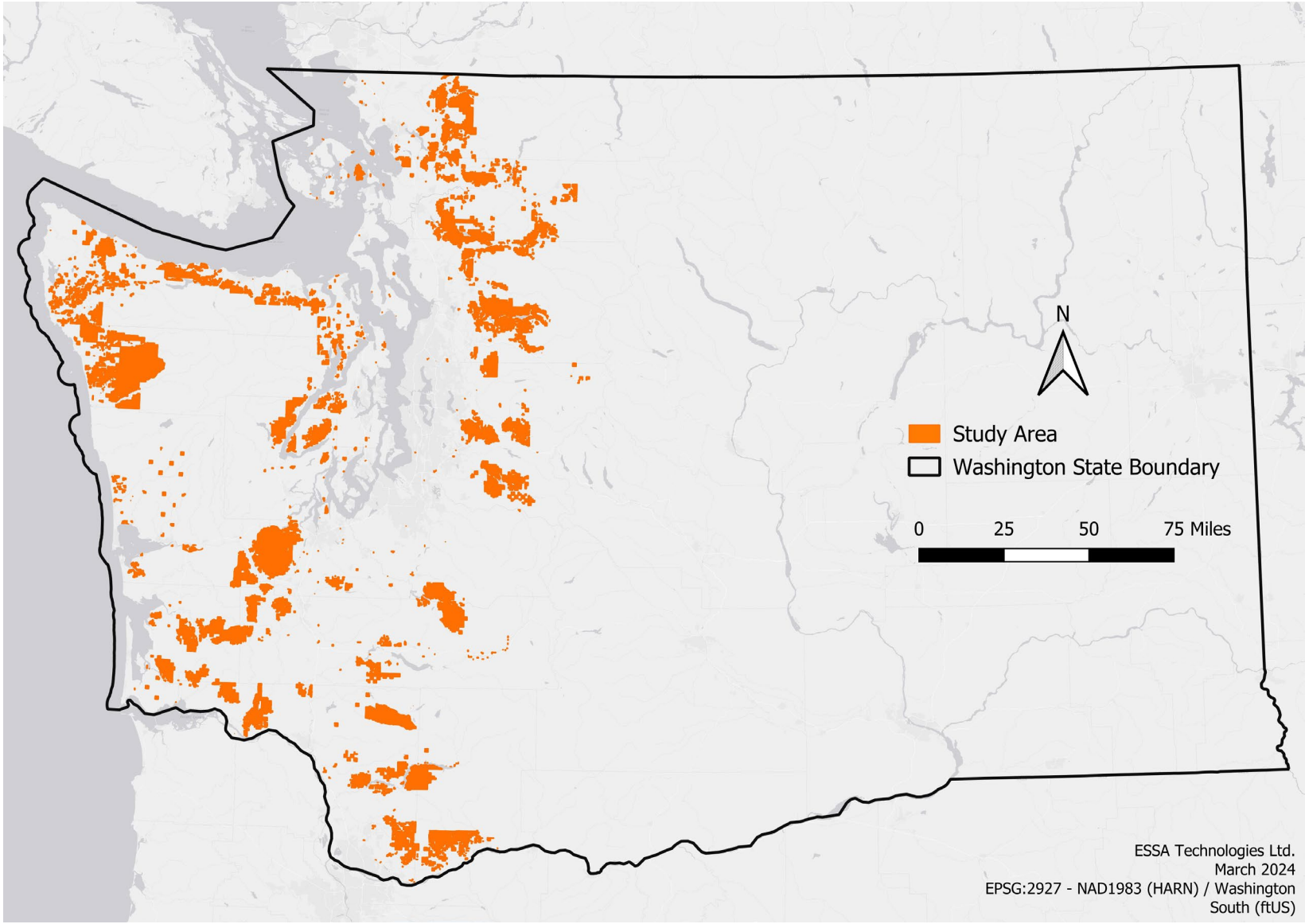
External Data

- Study area boundary
- Forest inventory
- Historical disturbance
- Land use boundaries
- Habitat mgmt. boundaries
- Deferrals
- Harvest limits

Internal Configuration

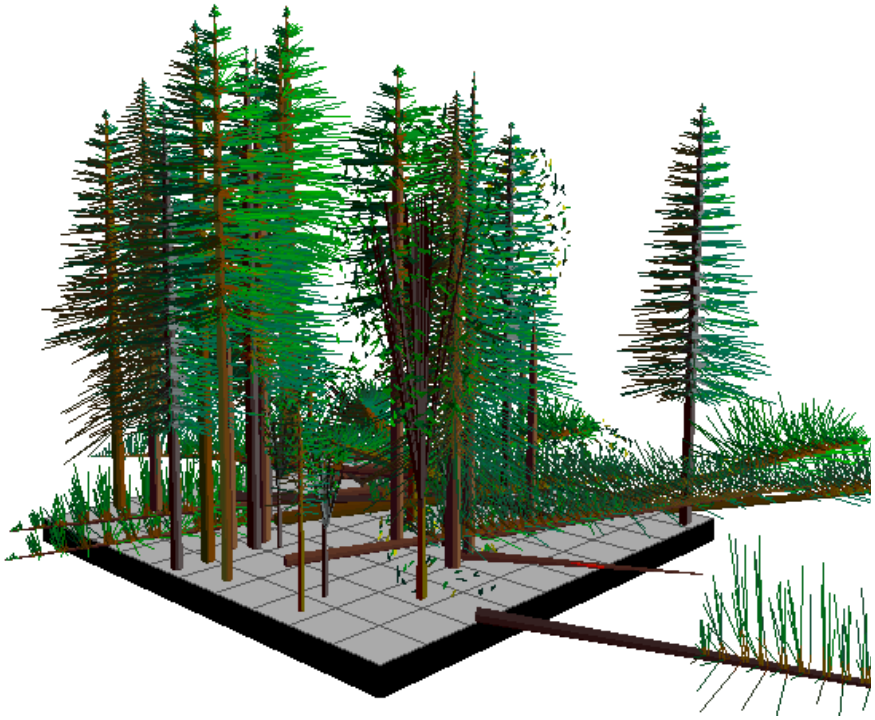
- Tree growth
- Harvest
- Silviculture
- Natural disturbance
- Climate change

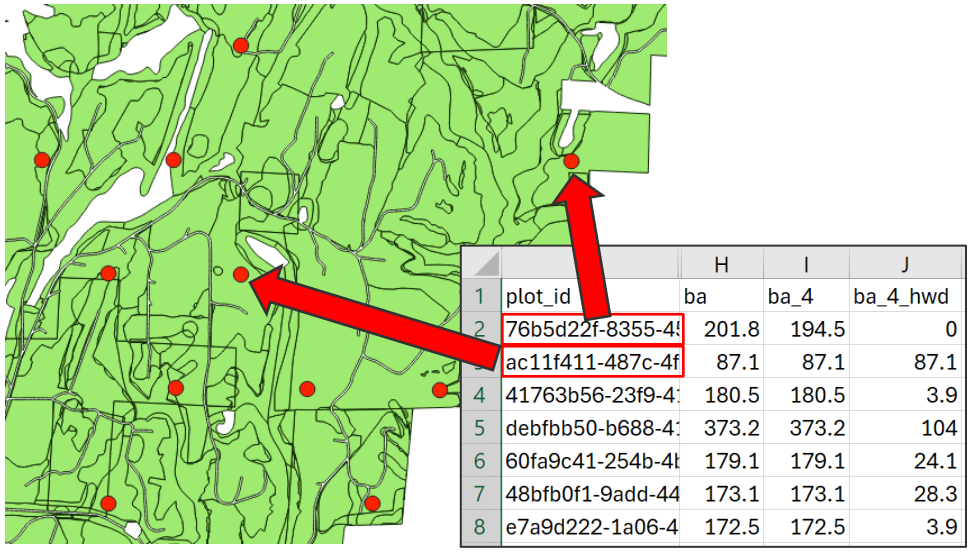
Study Area Boundary



Forest Inventory

- General stand and tree characteristics
- Spatial processing happens outside FVS





		H	I	J
1	plot_id	ba	ba_4	ba_4_hwd
2	76b5d22f-8355-4	201.8	194.5	0
3	ac11f411-487c-4f	87.1	87.1	87.1
4	41763b56-23f9-4	180.5	180.5	3.9
5	debfbb50-b688-4	373.2	373.2	104
6	60fa9c41-254b-4	179.1	179.1	24.1
7	48bfb0f1-9add-44	173.1	173.1	28.3
8	e7a9d222-1a06-4	172.5	172.5	3.9

Forest Inventory

Dataset	What it contains
February **2024 forest inventory** data from WA DNR	• **Tree-level characteristics** (diameter, height, species, etc.) • **Plot-level characteristics** (tree density, basal area, leading species, snag density, etc.)
Resource Inventory Units in a **Large Data Overlay** (spatial polygons, updated to 2023)	• Stand boundaries • Land use management boundaries • Habitat management boundaries • Additional inventory details
10m Digital Elevation Model (from USGS)	• Slope • Aspect • Elevation

Harvest & Silviculture Rules

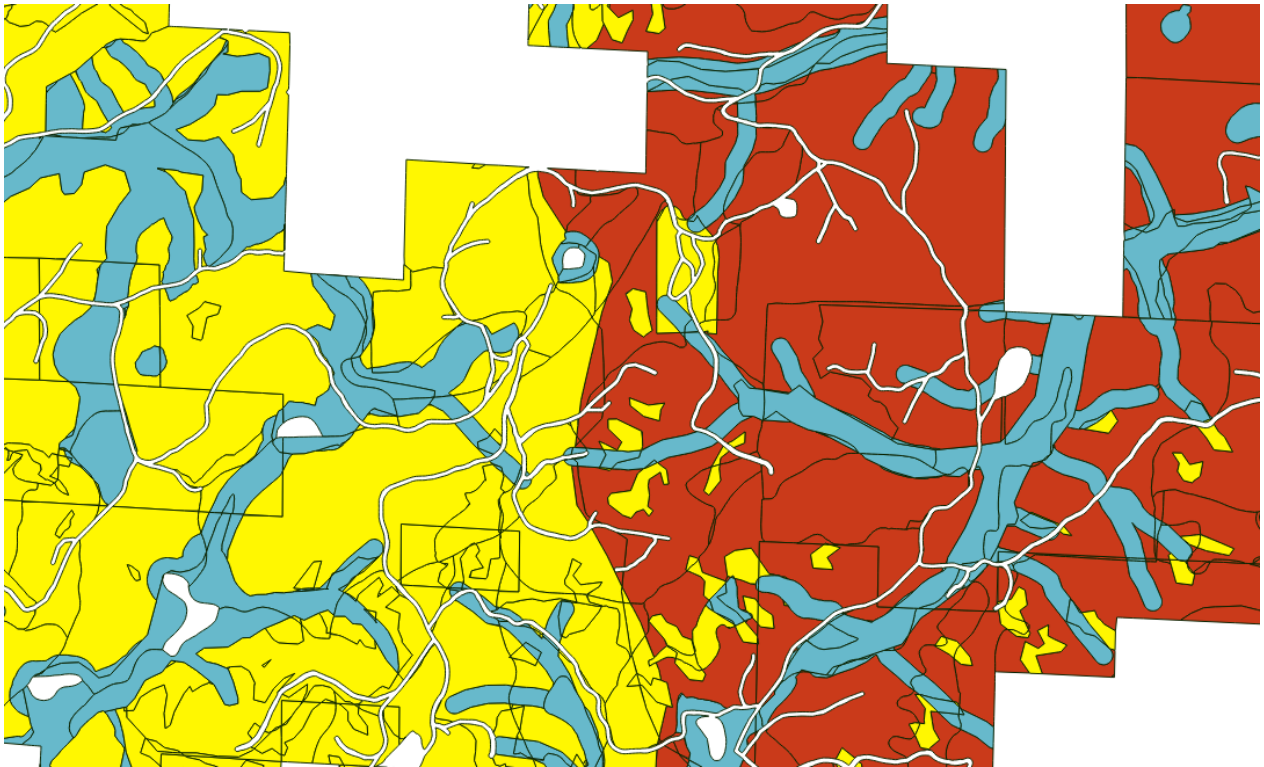
- Control harvesting and thinning
- Control replanting
- Stop-restart described later

```
IF
MOD(AGE,100) EQ 0)
THEN
YARDLOSS          0          0.0        0.0        0.0
THINBBA           0          0.0
RESETAGE          0          0
ESTAB
PLANT             0          DF         100        100                 1.00
PLANT             0          DF         200        100                 2.00
PLANT             0          DF         100        100                 3.00
END
FMIN
SALVAGE           0           0         20         0         0         1.0       1.0
SALVAGE           0          20        999         0         2         1.0       1.0
SALVAGE           0          20        999         0         1         1.0       0.5
END
ENDIF
```

EXAMPLE

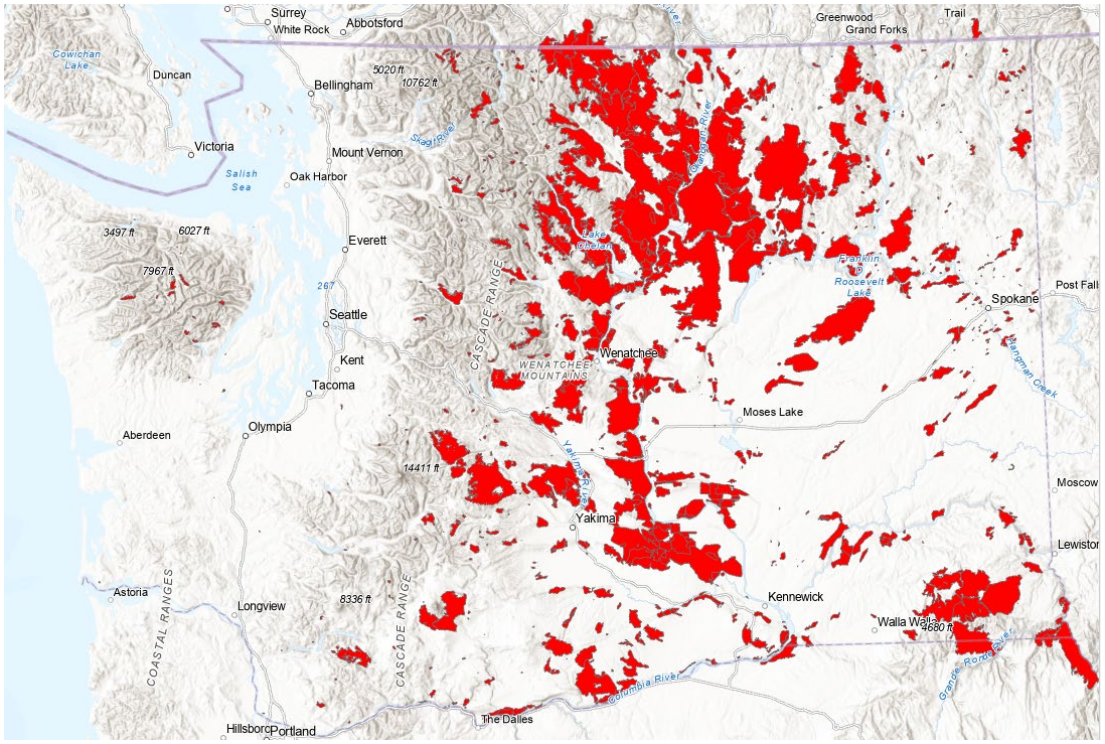
Land Use and Habitat Management Boundaries

- Provided by DNR
- Part of the Large Data Overlay (LDO)



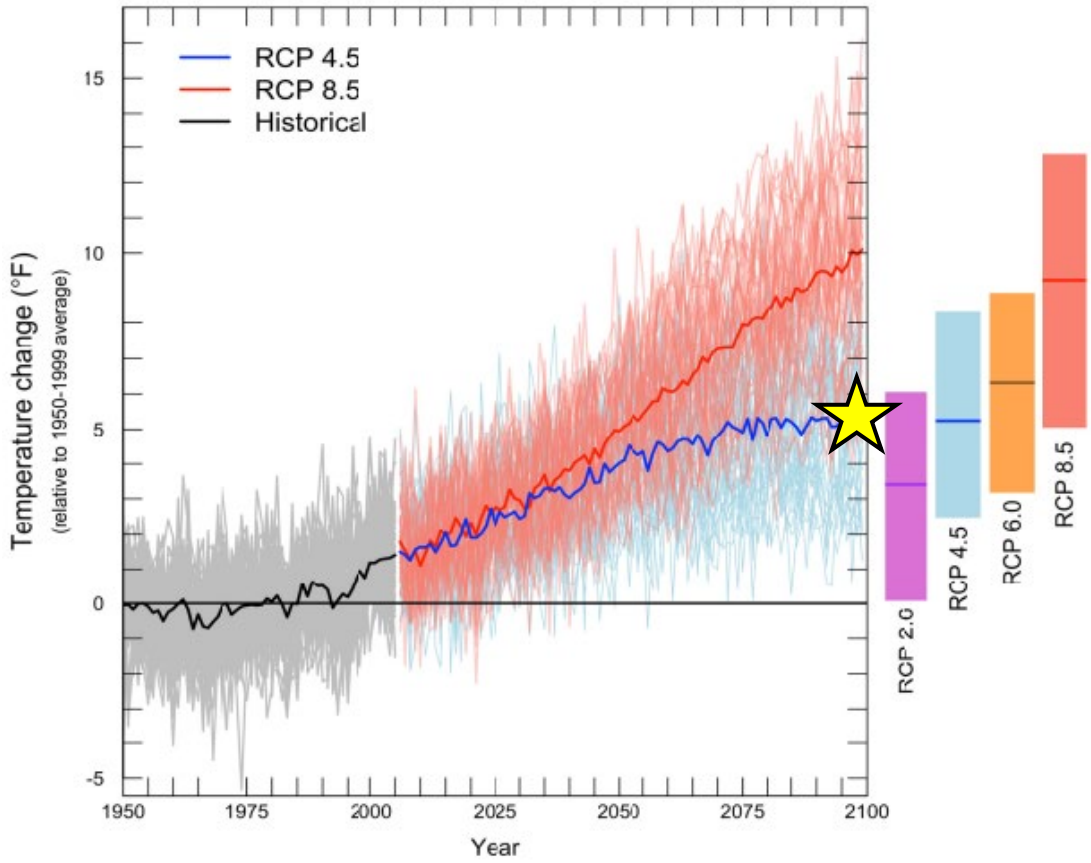
Natural Disturbance

- Wildfire (fire return interval)*, insect mortality (% basal area), blowdown
- Calculated from historical data and expected to change under RCP4.5
- Disaggregated by management class (GEM, upland, riparian)



Climate Change

- Climate-FVS default data for RCP4.5
- Ensemble of 17 General Circulation Models (GCM)
- Adjusted disturbance rates TBD



Stand Initialization

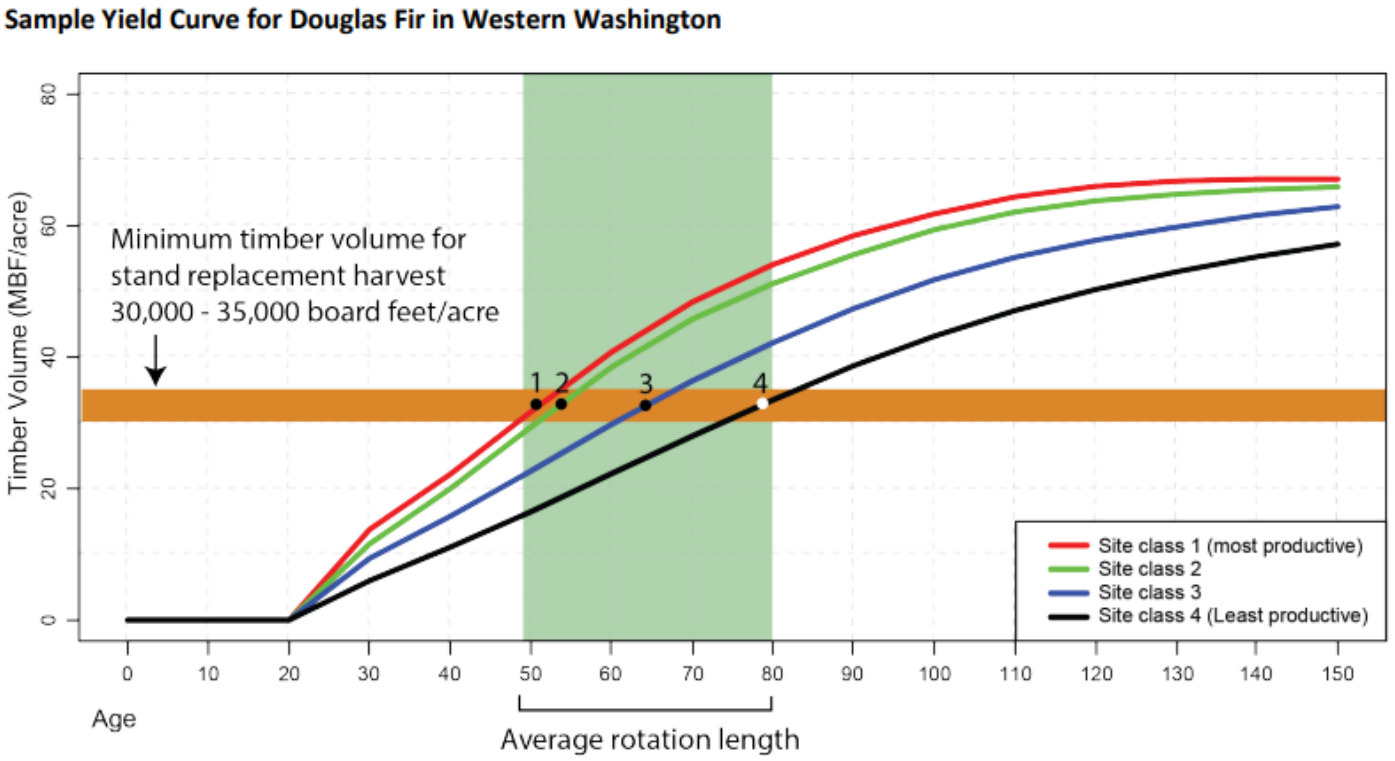
Stand Initialization

- Generating initial forest conditions as a starting point
- Done using forest inventory data:
  - Tree diameter
  - Species
  - Density
  - Down wood

Model Simulation

Rotation Length

- Can be done based on volume, age or year thresholds
- We will use volume (board feet) thresholds



Thinning

- Precommercial and commercial thinning to be implemented
- Eligibility for precommercial thinning could be by stand age, or using a volume or basal area threshold
- Eligibility for commercial thinning uses a BF threshold
- Commercial thinning is 30% removal

Deferral

- Methods in progress
- DNR defines “structurally-complex” as:

A forest in the ‘botanically diverse’ ‘niche diversification’ or ‘fully functional’ stage of stand development. Forests in these phases have varying sizes of trees, understory vegetation and lichen, downed wood and snags, etc.

- Needs to be translated to FVS language

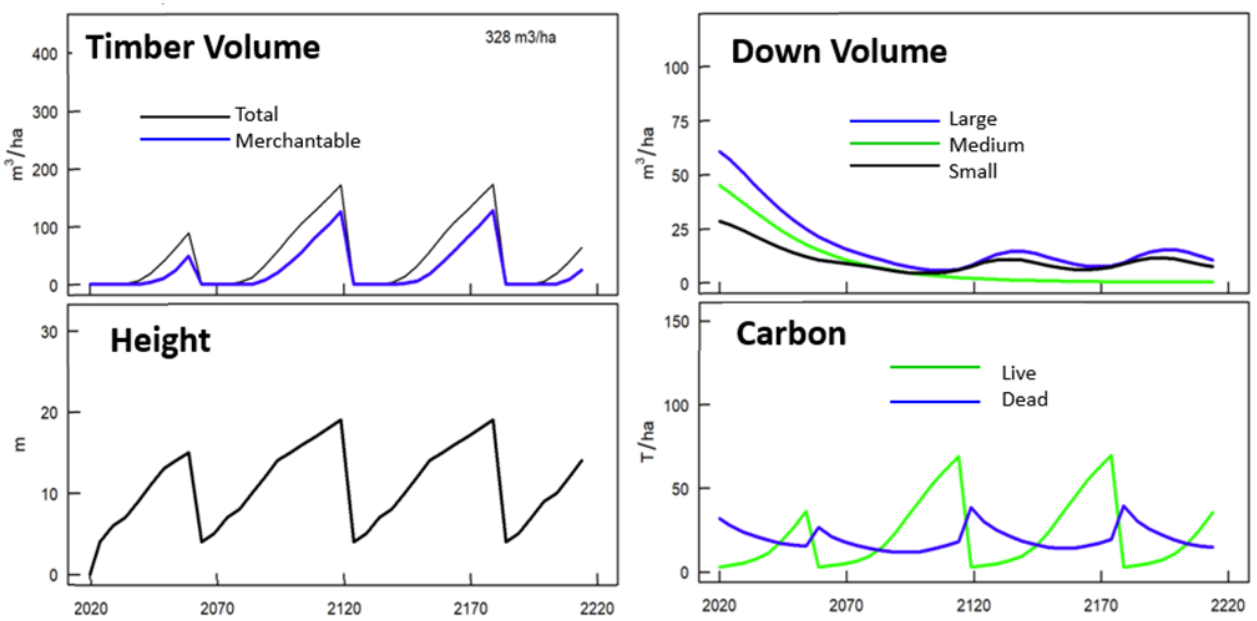
Regeneration

- Planting (set density)
- Natural infill (following partial harvest)

```
IF
MOD(AGE,40) EQ 0
THEN
ESTAB
PLANT                0          PARMS(3,400,100,2,0.5)
END
ENDIF
```

Tree Growth

- Controlled by internal equations in FVS
  - Simulates diameter and height growth and changes in crown ratios
- Default growth parameters in FVS-PN variant
- Growth adjusted based on site conditions, disturbances and climate change



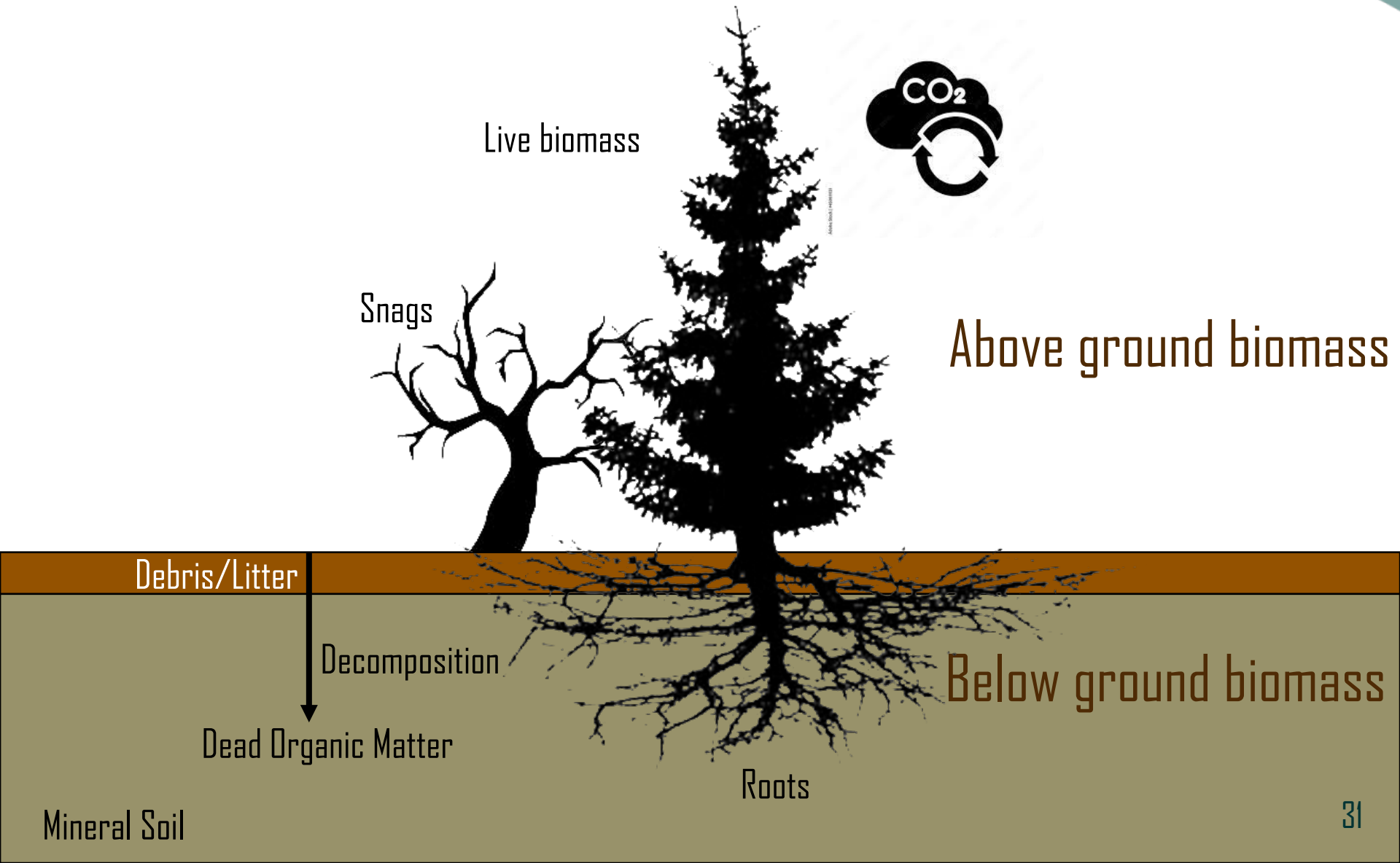
Natural Disturbance

- Simulated using keywords in FVS and Fire and Fuels Extension

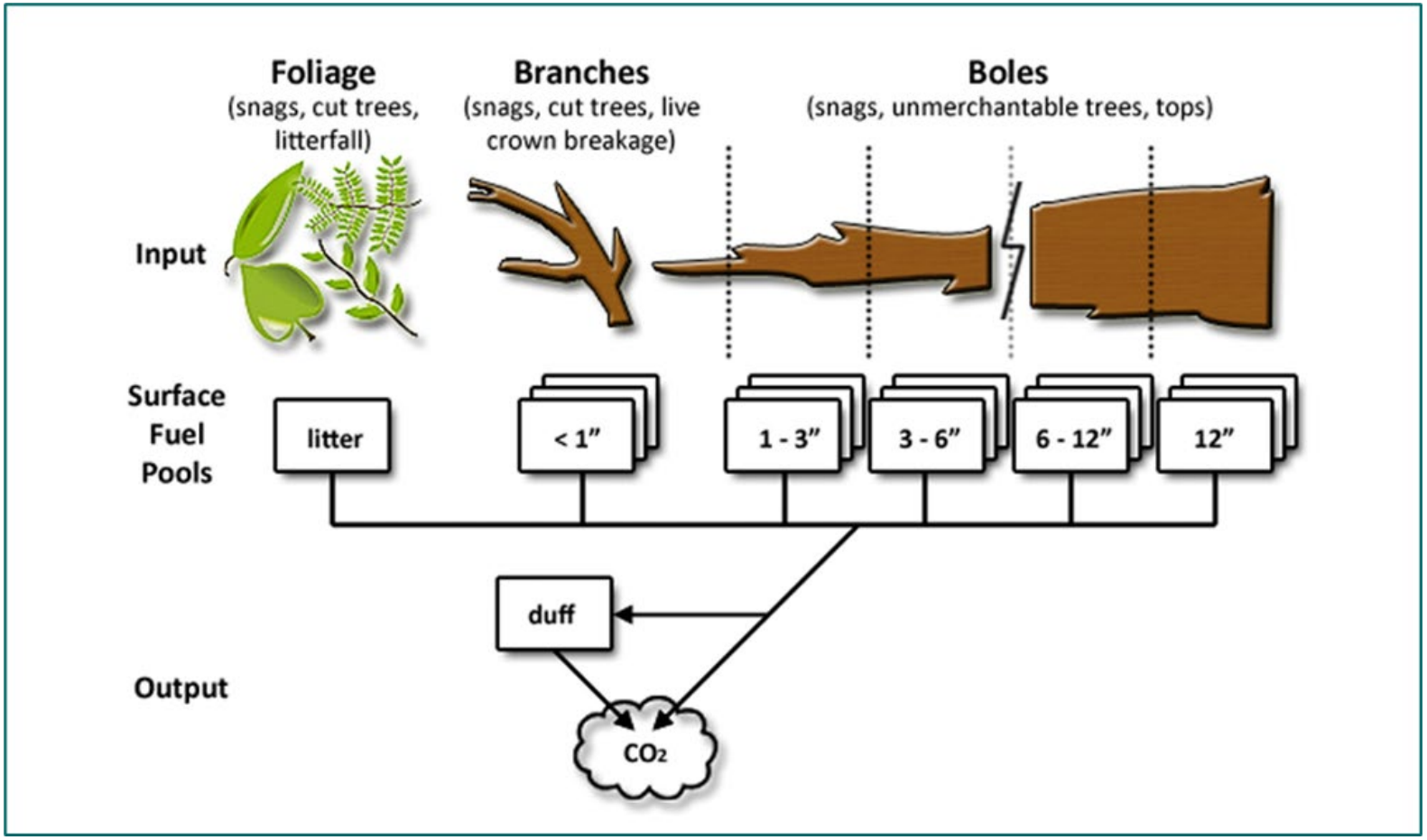
```
COMPUTE             0
FDBEETLE=SPMCDBH(1,3,0,12,999,0)*0.950
SNOWSNAP=SPMCDBH(1,3,0,8,999,0)*0.975
END
* Fir Beetle; all remain snags
IF
AGE GT 10 AND MOD(AGE,20) EQ 0
THEN
YARDLOSS            0          1          0
THINDBH             0         PARMS(12,999,0,3,FDBEETLE,0)
ENDIF
* Windthrow/Snowsnap; 1/3 snags, 2/3 down
IF
AGE GT 15 AND MOD(AGE,20) EQ 0
THEN
YARDLOSS            0          1         .67
THINDBH             0         PARMS(8,999,0,3,SNOWSNAP,0)
ENDIF
```

EXAMPLE

Carbon Dynamics



Carbon Dynamics



Carbon Dynamics

- Simulated using the Fire and Fuels Extension of FVS
- Can produce carbon outputs for various pools

****** CARBON REPORT VERSION 1.0 ******
STAND CARBON REPORT
ALL VARIABLES ARE REPORTED IN TONS/ACRE

STAND ID: 11P MGMT ID: NONE

	Aboveground Live		Belowground			Forest			Total	Total	Carbon
YEAR	Total	Merch	Live	Dead	Stand Dead	DDW	Floor	Shb/Hrb	Stand Carbon	Removed Carbon	Released from Fire
2005	46.8	30.0	10.4	0.7	3.3	4.6	7.1	0.3	73.3	0.0	0.0
2015	28.4	20.5	6.6	5.3	2.0	12.9	7.3	0.3	62.7	11.9	0.0
2025	30.5	21.9	7.2	3.4	0.4	6.6	6.7	0.3	55.1	0.0	0.0
2035	32.6	23.5	7.7	2.3	0.2	4.3	6.8	0.3	54.2	0.0	0.0
2045	34.9	25.3	8.3	1.5	0.2	3.2	7.0	0.3	55.4	0.0	0.0

Incorporating Climate Change

- Each management scenario run under RCP4.5
- Climate change will be incorporated using Climate-FVS
  - Requires climate and species viability data
  - Species viability score is manipulated (incorporates impacts on carrying capacity, mortality, growth and regeneration)
- Changes in disturbance rates calculated independently of Climate-FVS

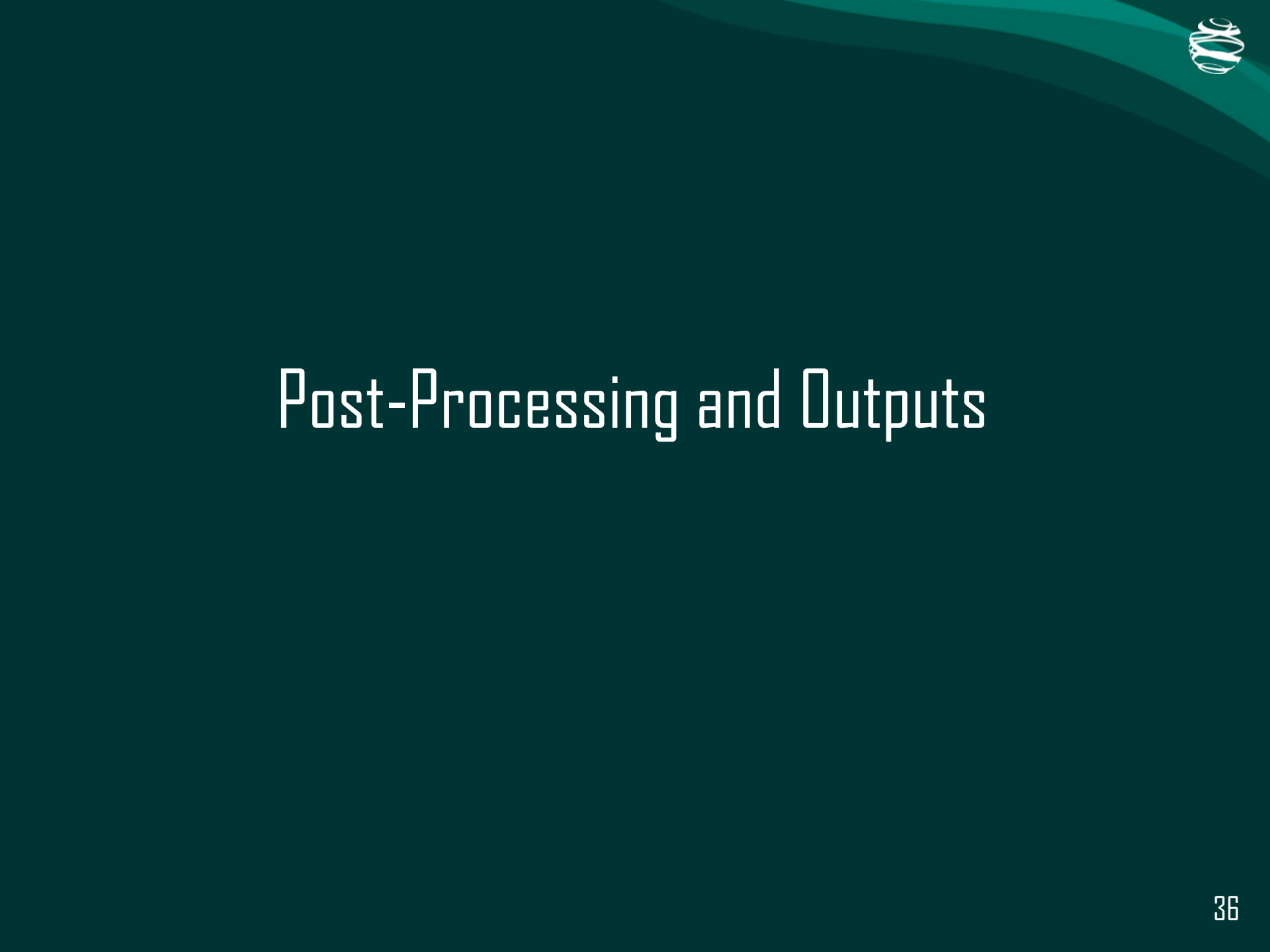
Stop-Restart Functionality

Problem:

- FVS will harvest all eligible stands leading to overharvesting

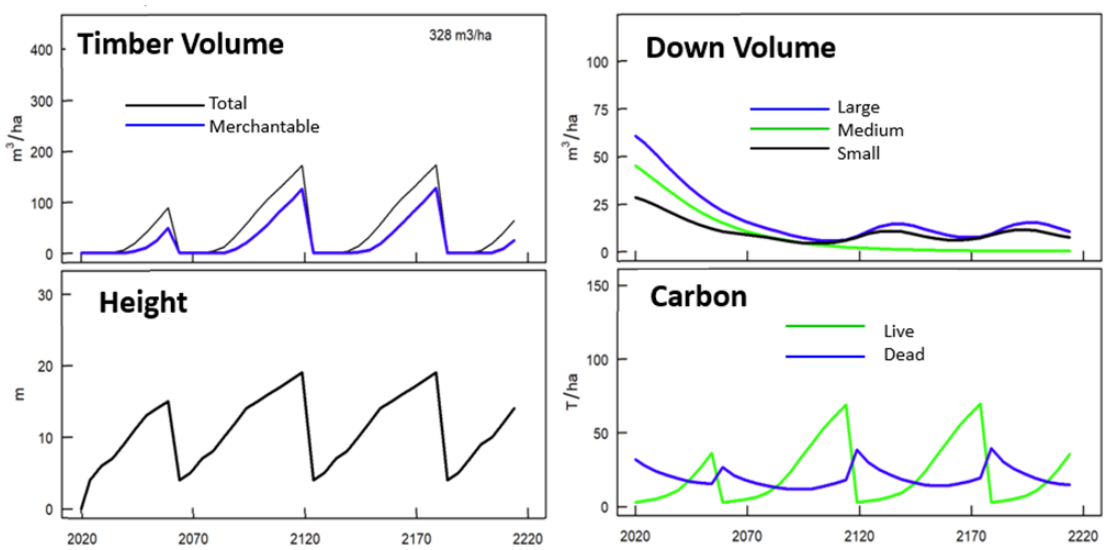
Solution:

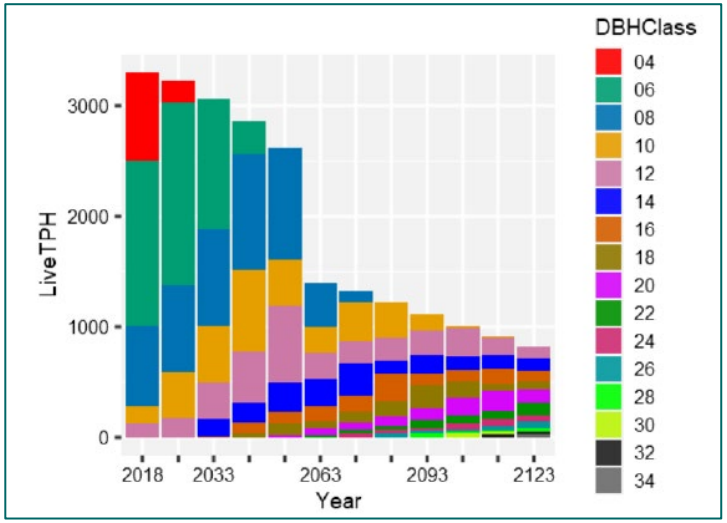
- Advanced method to stop FVS and harvest up to a set harvest target
- FVS starts up again after harvesting to continue growing the stands

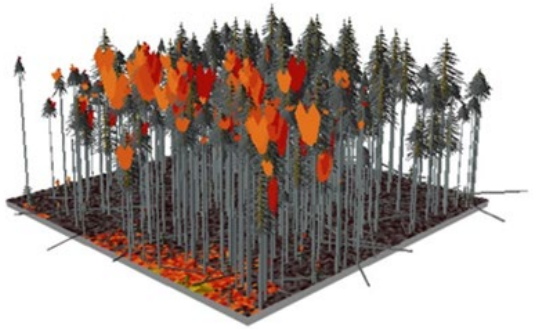

Post-Processing and Outputs

Where does this all lead?

- Examples of diagnostic plots:





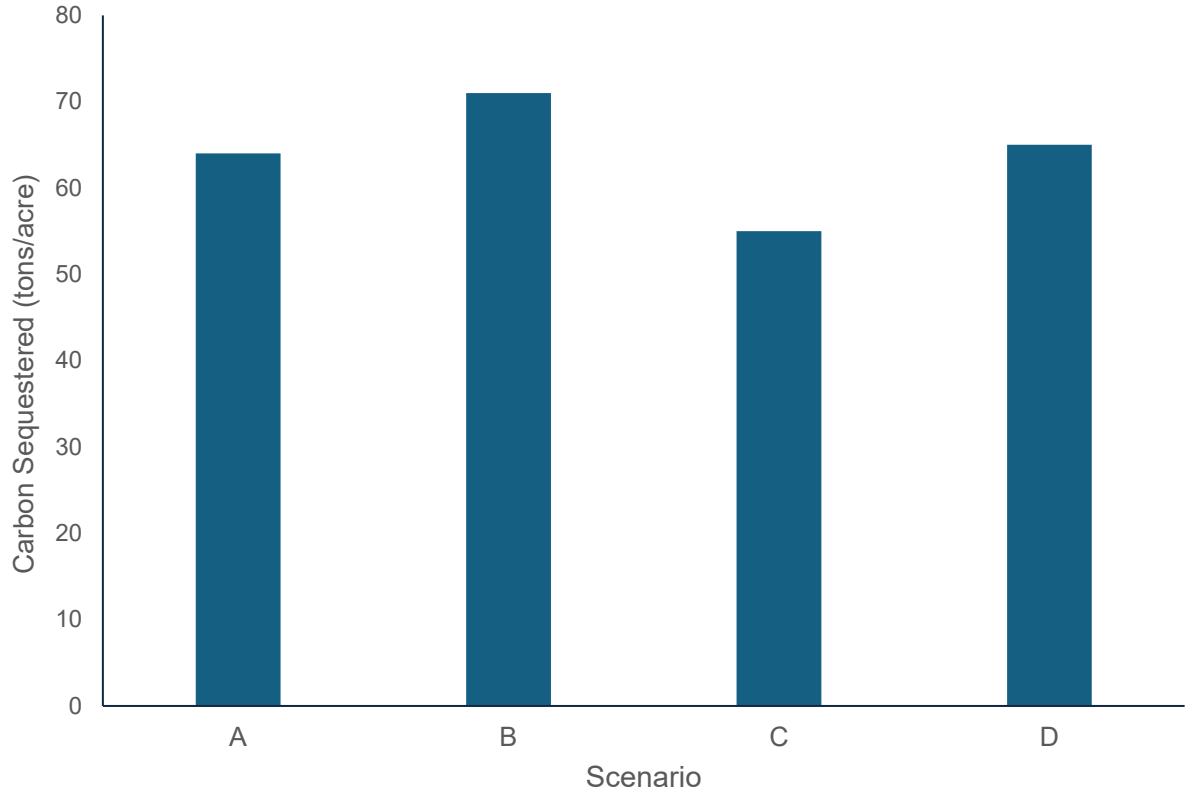


Wildfire only

With prescribed fire

Where does this all lead?

- Outputs for carbon will be produced and compared across all scenarios
- Example of a plot comparing scenarios:



NOT ACTUAL RESULTS

Management Scenarios

Scenarios So Far

Configuration Settings	Scenario #1: Current DNR Management Practice	Scenario #2: Lengthen Harvest Rotation	Scenario #3: Shorten Harvest Rotation	Scenario #4: Significantly Increase Thinning
Stand-replacement harvest BF/ac	30,000-35,000	50,000-55,000	20,000-25,000	30,000-35,000
Commercial thinning BF/ac	18,000-20,000			
Precommercial thinning eligibility requirement	TBD			
Stand-replacement harvest proportion (BA)	90% (minimum 8 leave trees/acre)			
Commercial thinning proportion (BA)	30%			
Harvest targets	10-year average for each harvest type	TBD	TBD	TBD
Stand-replacement harvest leave trees/acre	8			
Planting density (seedlings/acre)	360			
Fire return interval (years)	Average fire rates between 1984-2023 (*adjusted for RCP4.5)			
Insect mortality rate (% basal area loss)	Projections between 2013-2027 (*adjusted for RCP4.5)			
Blowdown rate	TBD			
Climate change	1 run no climate change, 1 run with RCP4.5 using Climate-FVS			


Questions?