

A photograph of a forest landscape. In the foreground, there is a dense stand of tall, thin evergreen trees, likely Douglas firs, with their characteristic yellowish-green needles. Behind them, the forest continues up a hillside. In the background, there are several layers of mountains, with the closest ones appearing in a hazy blue and the furthest in a clear, pale blue. The sky is a light, pale blue.

Using Climate FVS to Assess Climate Change Risks and Develop Adaptation Strategies on Stimson's Inland Forests

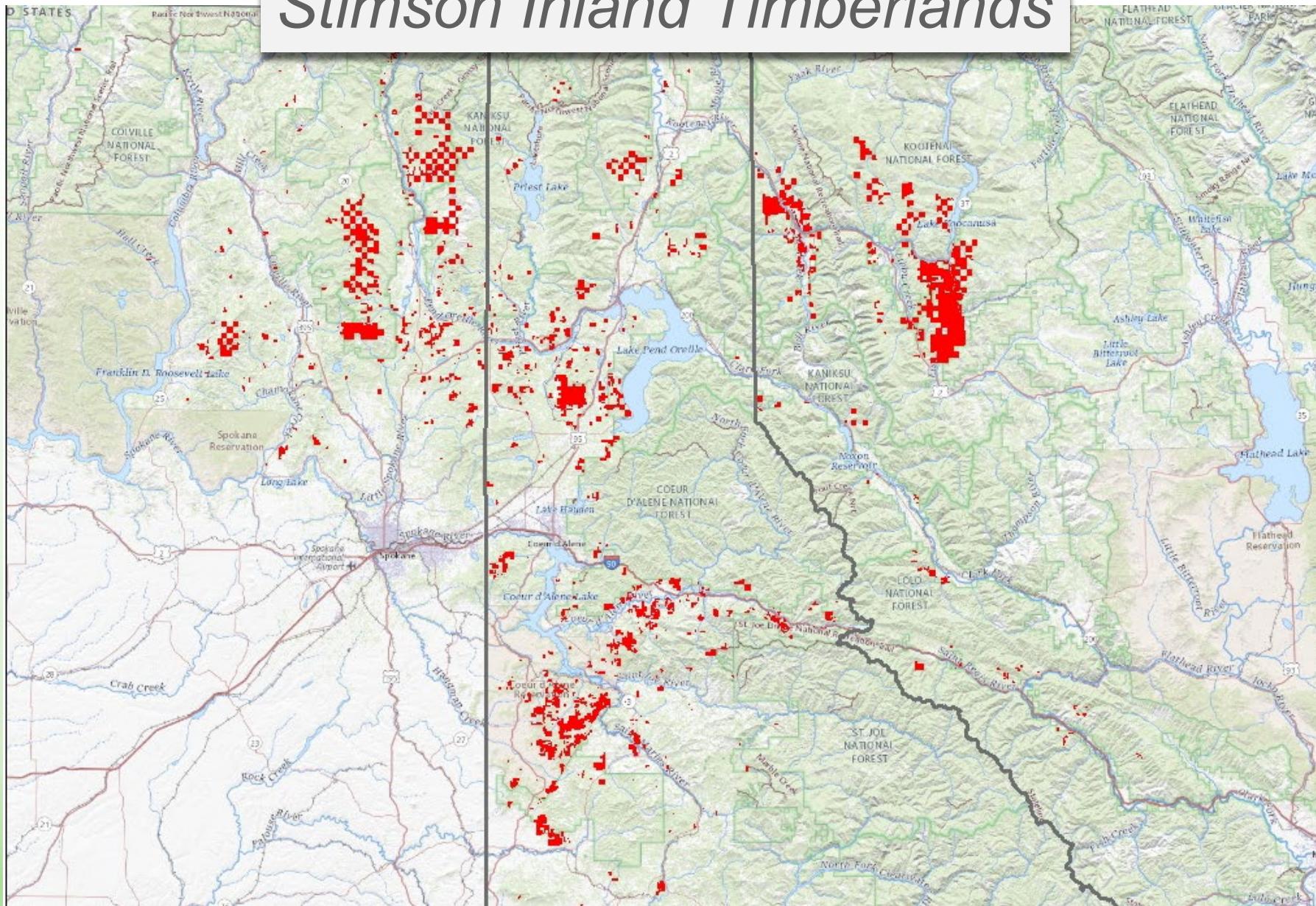
Climate Adjusted Projections

(to help meet SFI Obligations)

- SFI Objective 1 – Forest Management Planning
 - Performance Measure 1.1 – Forest management planning including a *long-term* resource analysis to address climate-induced ecosystem change.
- SFI Objective 9 – Climate Smart Forestry
 - Performance Measure 9.1 – Certified Organizations shall address the climate change risks to forests and develop appropriate adaptation objectives strategies.
 - Indicator 1 - Certified Organizations shall identify climate change risks and severity of their expected impact to their forest lands.
 - Indicator 2 - Certified Organizations shall develop an adaptation plan to address priority climate change risks including recalculation of planned harvests to account for changes in growth due to climate change.

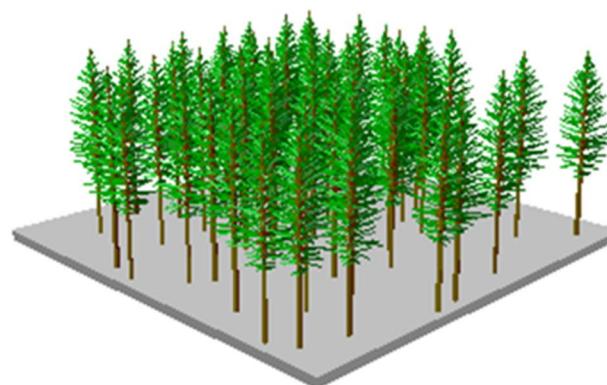


Stimson Inland Timberlands

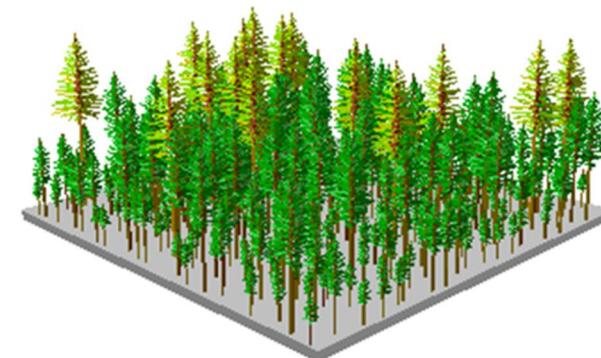


Past Management of Partial Harvest and Natural Regeneration

Intensively Managed Stand



Naturally Regenerated Stand



* Intensively managed over past decade and prior to mid-1980s

Climate-FVS Version 2.0

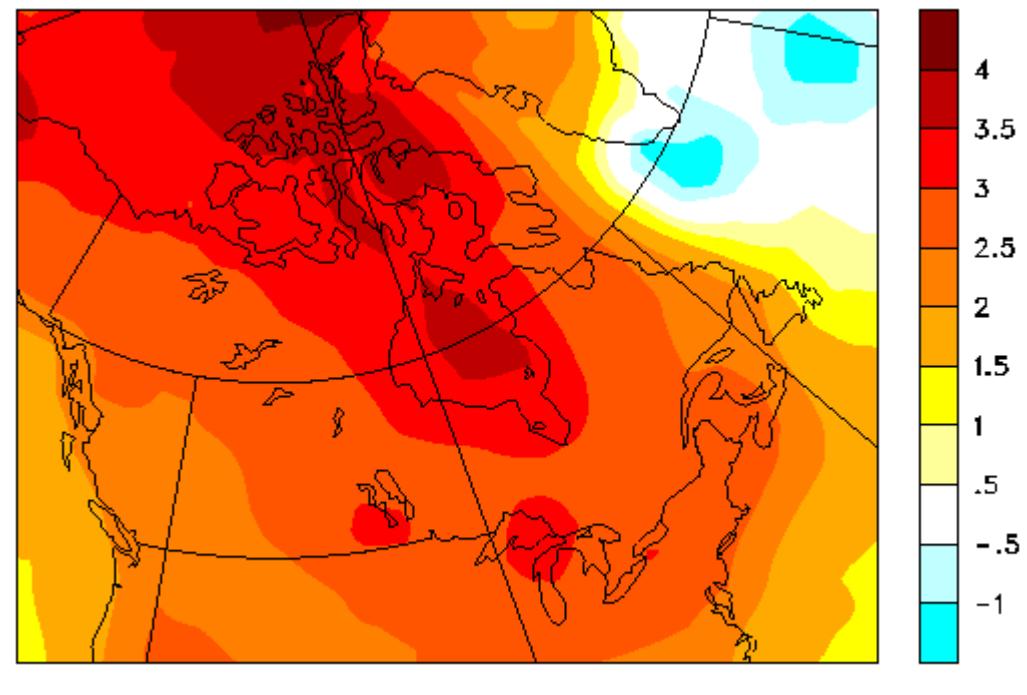
VERSION 3856 – INLAND EMPIRE EXPANDED

- Site variables for the Inland Empire Variant (*it doesn't use site index*)
 - Slope
 - Aspect
 - Elevation
 - Habitat Type (*ADP code*)
 - Geographic location (*forest location code*)
- Obtain file of species viability scores based of geographic location of the stands in the projection (*climate ready data*)
- Select which Global Circulation Model scenario to use (*there are several*)

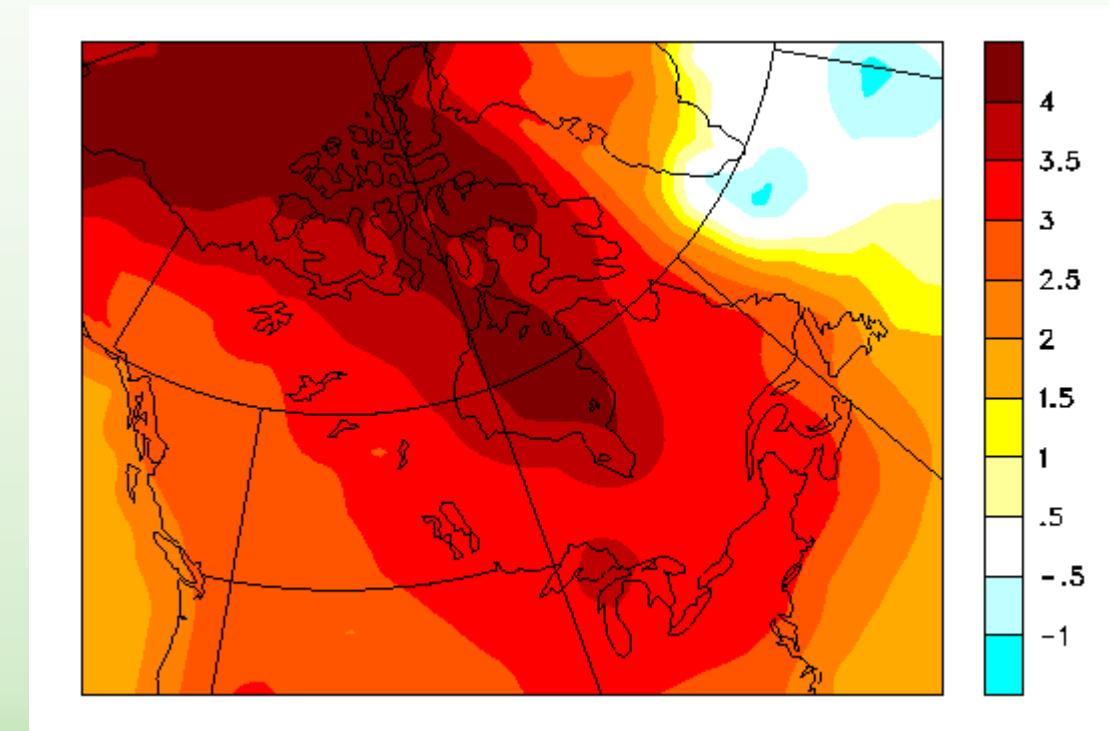


Canadian Global Circulation Models

GCM Scenario B1



GCM Scenario A1B

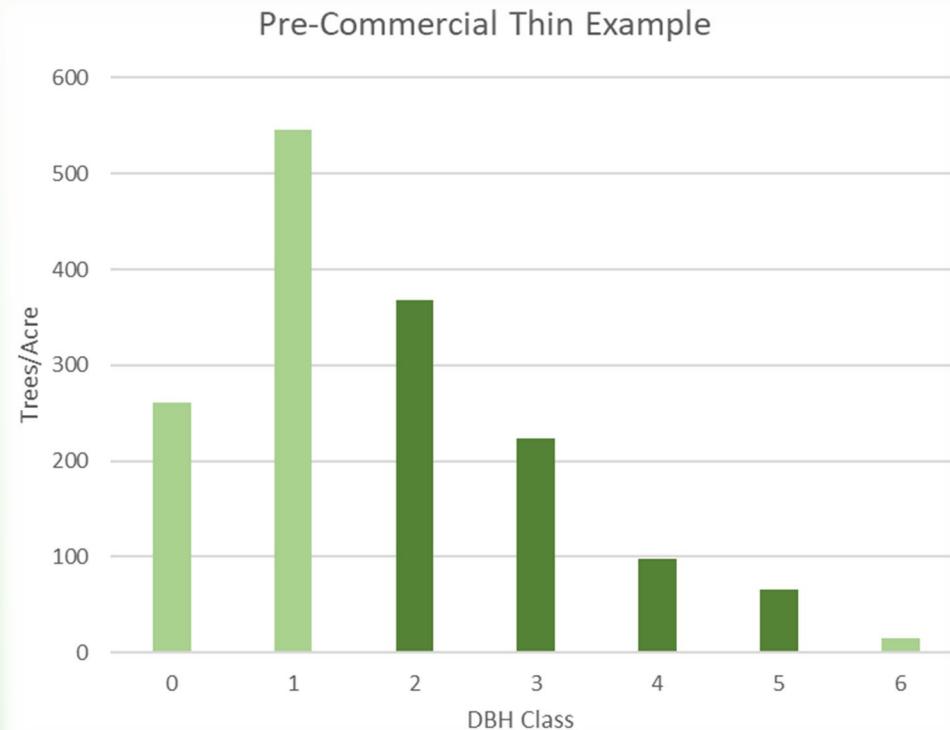


Stimson Inland's Long-Term Resource Analysis

- Developed FVS Event Monitor prescriptions based on narrative of a desired management life cycle of a stand of timber within Stimson Inland's Company Principles document.
- All stands were run through the same set of prescriptions with treatments taking place when projected stand characters met specific criteria.
- Stands were projected based on tree data and site characteristic data present within the Stimson's inventory management database.
- Stimson used in-house software to process the stands.
- The timing of treatment types and associated removals were written to a database and summarized using Excel.



Example PCT Prescription



Event Monitor Logic

```
SPGROUP      CNFR
DF PP WP WL WH AF GF RC ES LP

PCTTREE = SPMCDBH(1,CNFR,0,2.0,5.0)
```

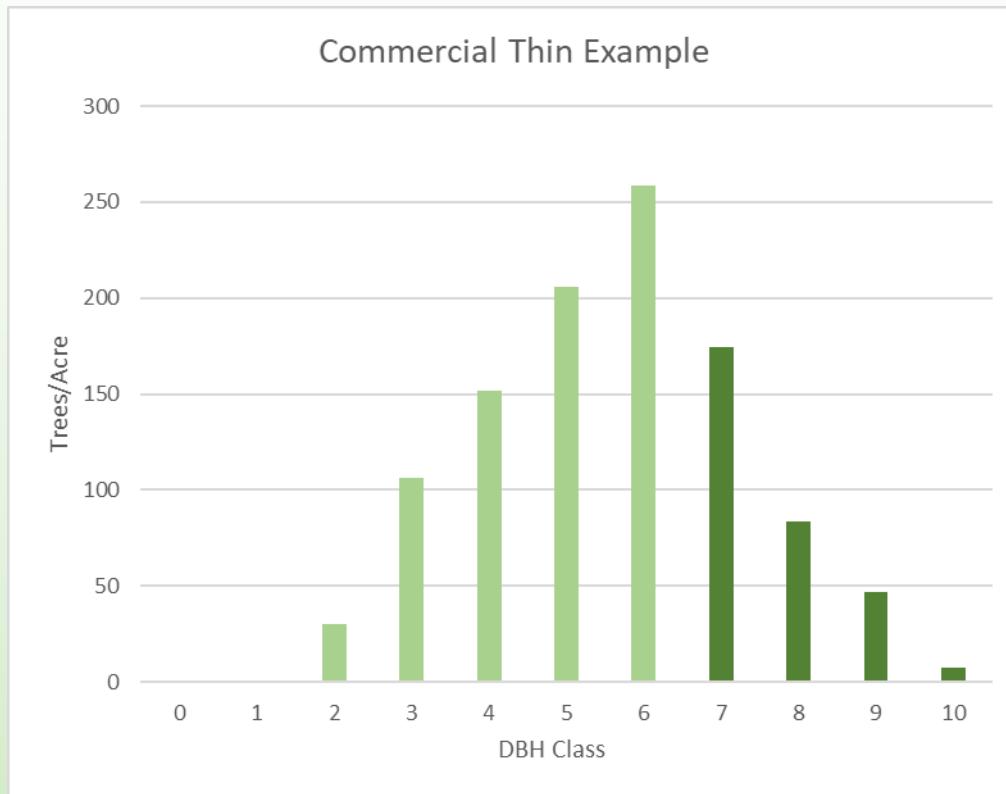
```
IF
  PCTTREE GT 500
THEN
  THINBTA      0   312.0   0.95   0.0   5.0
END
```

Note: The SPMCDBH function returns many different stand characteristics for a specific range of diameters.

* targets based on size, not age



Example Commercial Thin Prescription



* targets based on size, not age

Event Monitor Logic

```
SPGROUP      CNFR
DF PP WP WL WH AF GF RC ES LP

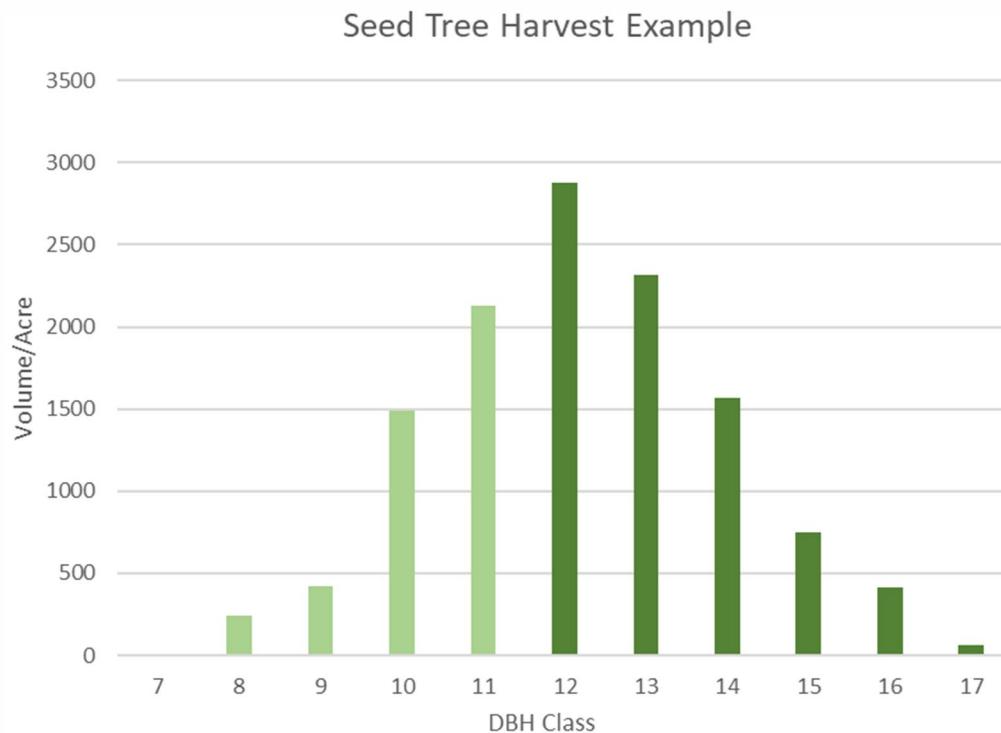
POLETREE = SPMCDBH(1,CNFR,0,7.0,12.0)
```

```
IF
  POLETREE GT 300
THEN
  THINBTA      0   200.0   0.95   0.0   12.0
END
```

Note: The SPMCDBH function returns many different stand characteristics for a specific range of diameters.



Example Seed Tree Prescription



* targets based on size, not age

Event Monitor Logic

SPGROUP CNFR
DF PP WP WL WH AF GF RC ES LP

SPGROUP STREE
DF PP WP WL

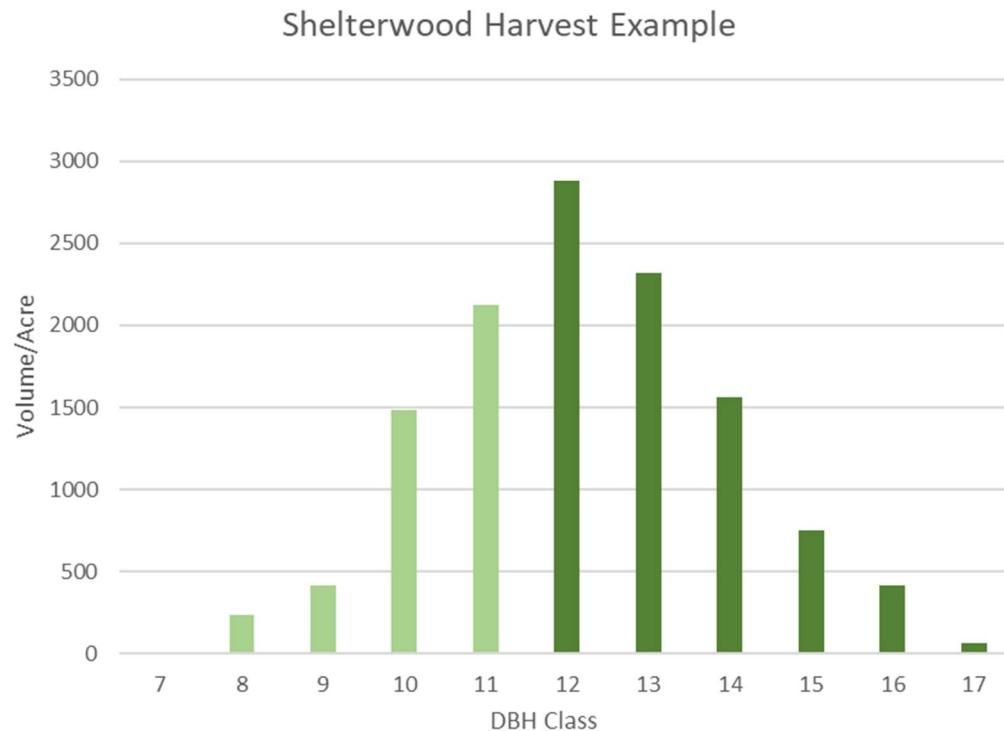
SAWVOL = SPMCDBH(4,CNFR,0,12.0,99.0)

SEEDTREE = SPMCDBH(1,STREE,0,14.0,99)

IF
SAWVOL GT 8000 AND SITE LT 75 AND SEEDTREE GE 15
THEN
THINATA 1 0.0 1.0 16.0 99.0
THINBTA 1 15.0 1.0 0.0 16.0
ENDIF



Example Shelterwood Prescription



* targets based on size, not age

Event Monitor Logic

SPGROUP CNFR
DF PP WP WL WH AF GF RC ES LP

SPGROUP STREE
DF PP WP WL

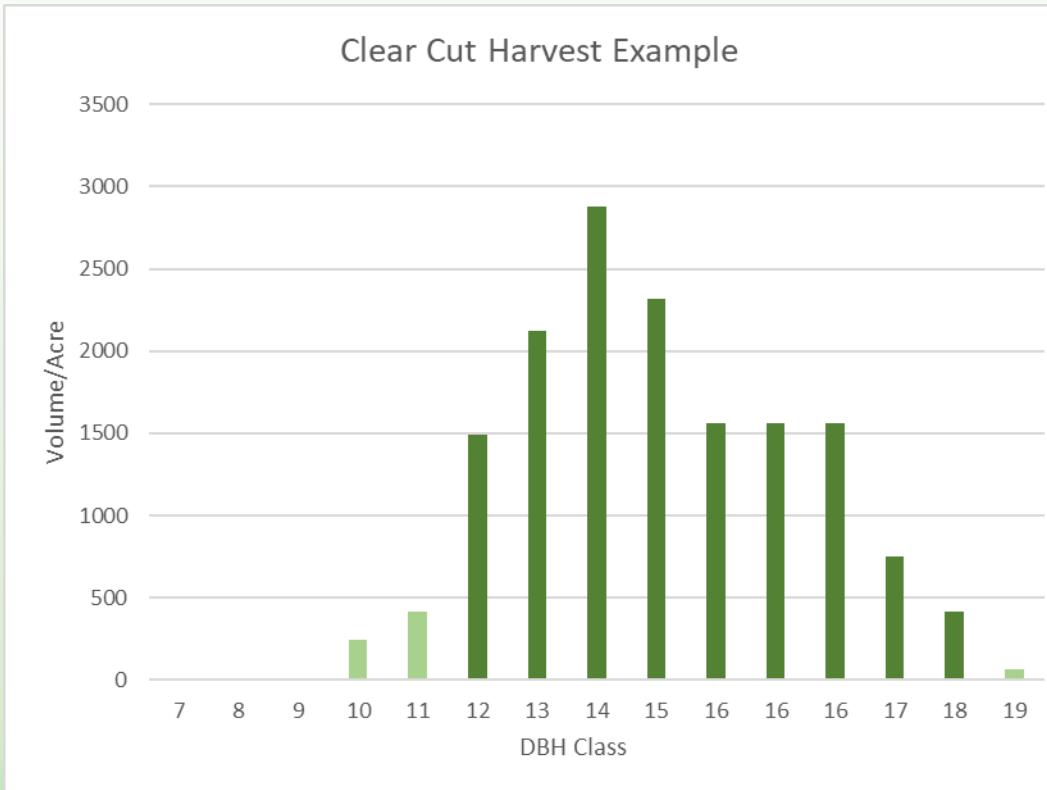
SAWVOL = SPMCDBH(4,CNFR,0,12.0,99.0)

SEEDTREE = SPMCDBH(1,STREE,0,14.0,99)

IF
SAWVOL GT 8000 AND SITE LT 75 AND SEEDTREE LT 15
THEN
THINATA 1 0.0 1.0 16.0 99.0
THINBTA 1 40.0 1.0 0.0 16.0
ENDIF



Example Clear Cut and Plant Prescription



* targets based on size, not age

Event Monitor Logic

```
SPGROUP      CNFR
DF PP WP WL WH AF GF RC ES LP

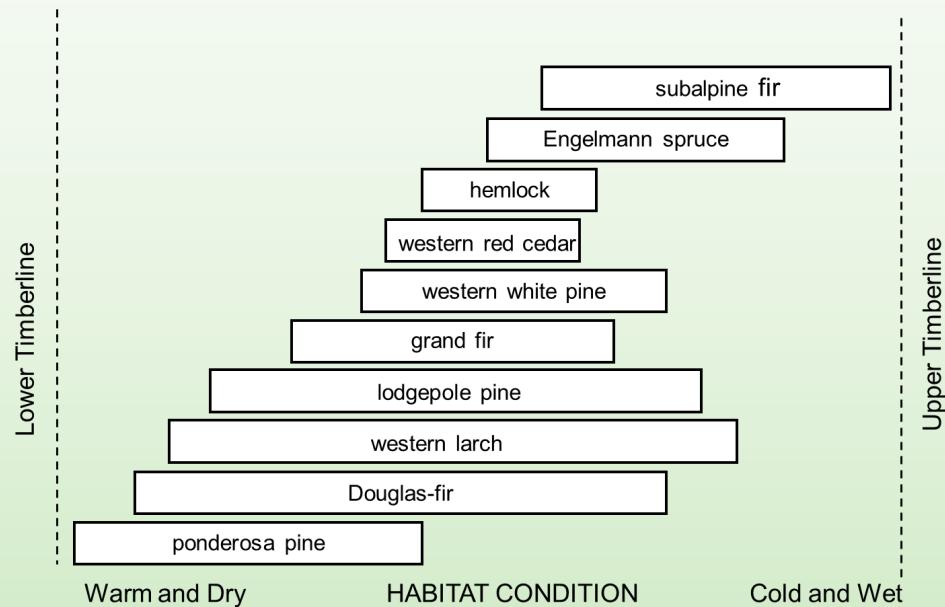
SAWVOL = SPMCDBH(4,CNFR,0,12.0,99.0)

IF
  SAWVOL GT 10000 AND SITE GE 75
THEN
  THINATA      1   0.0   1.0   14.0   99.0
  THINBTA      1   4.0   1.0   0.0    14.0
  ESTAB
  PLANT        1   1    100.0  95.0
  PLANT        1   2    100.0  95.0
  PLANT        1   3    234.0  95.0
END
END
```

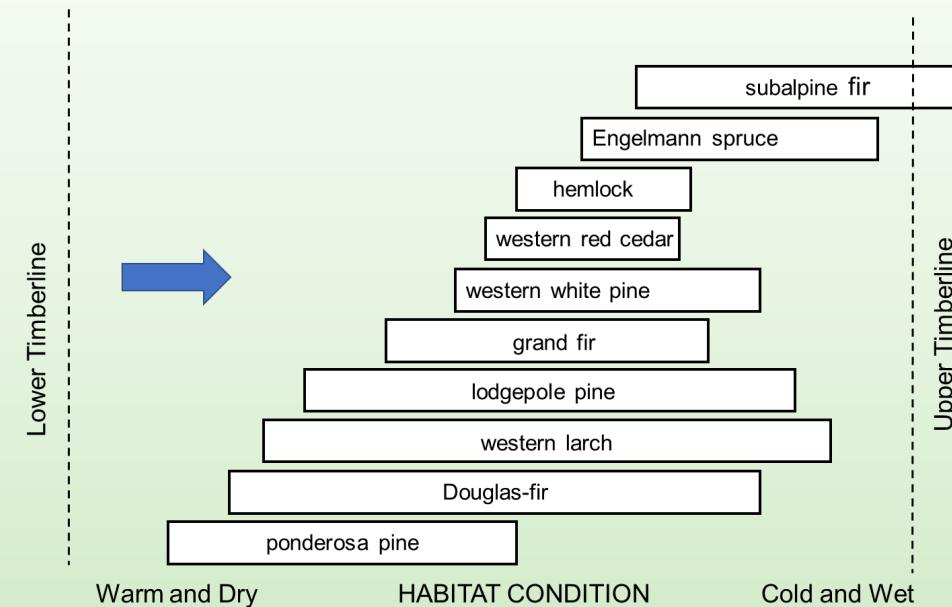


Climate FVS Species Viability Scores

Relative Ecological Position and Extent of Occurrence of Commercial Conifers in the “Inland Northwest”



Climate Warming Effects Upon Relative Ecological Position and Extent of Occurrence



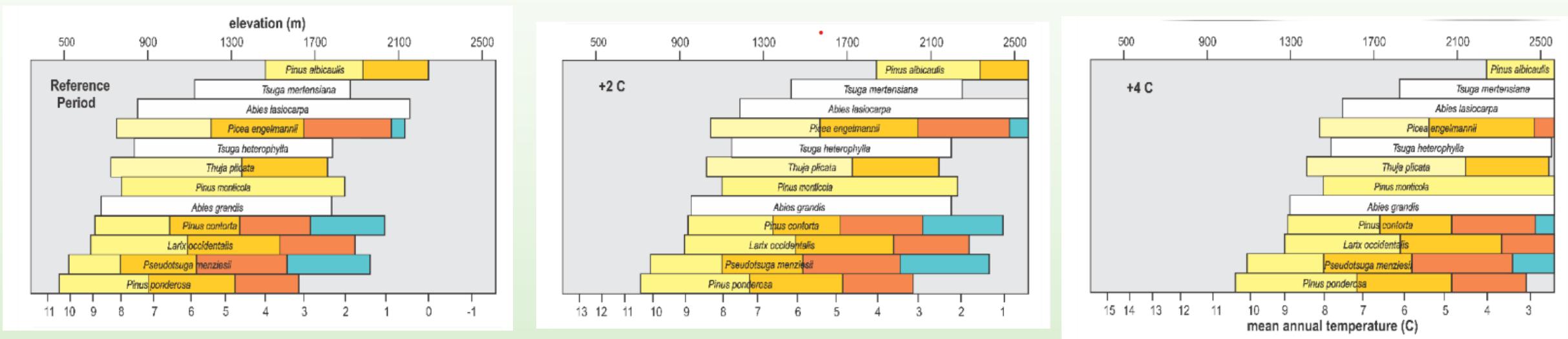
Climate FVS 2.0 - dClim Rule

If climate changes more in magnitude than an equivalent change in elevation of 300 meters, then trees start to die even if their viability score stays high.

- Based directly on climate change (*rather than just viability scores*)
- 50% mortality rate when climate changes more in magnitude of 600 meters
- Patterned after interior Douglas-fir seed zones
- Resets for newly regenerated trees (*assumed to be adapted to current climate*)



Inland Species Distributions Segmented into Climatypes



Species, Climatypes, Climate Change and Forest Health - Rehfeldt, Warwell and Monserud - Forests 2020



Rational for Modifying dClim Mortality by Species

Species	Climatype Breadth (m Elevation)
<i>Pseudotsuga menziesii</i>	Nonlinear: ca. 240 at low elevation, 350 at mid elevation, 1 climatype for elevation > 2000
<i>Pinus contorta</i>	300
<i>Pinus ponderosa</i>	400
<i>Picea engelmannii</i>	420
<i>Larix occidentalis</i>	450
<i>Pinus albicaulis</i>	450
<i>Thuja plicata</i>	600
<i>Pinus monticola</i>	no detectable climatypes

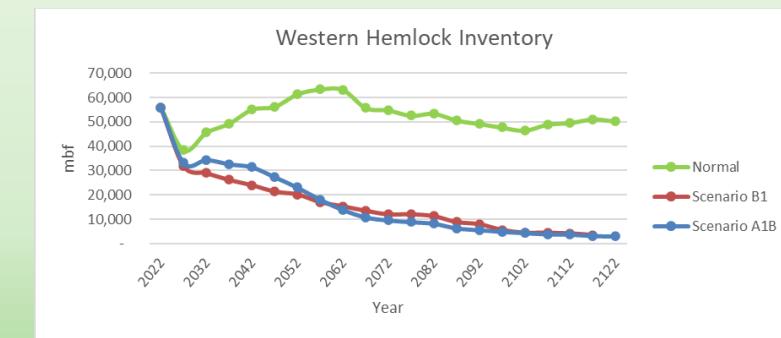
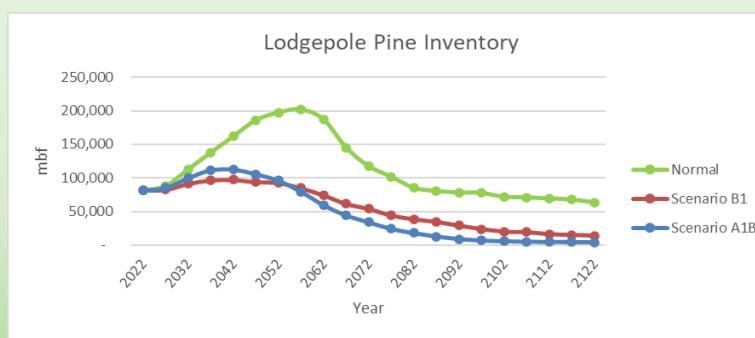
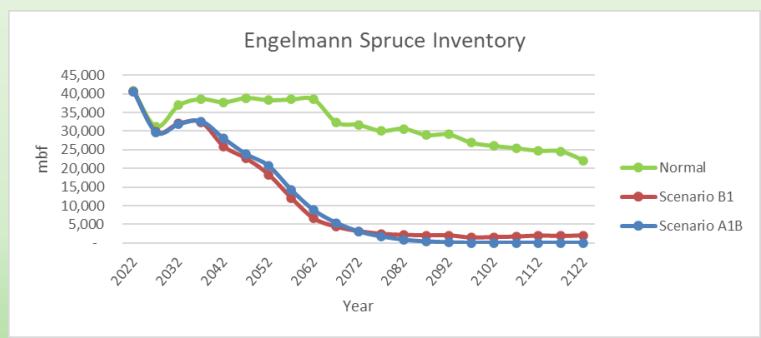
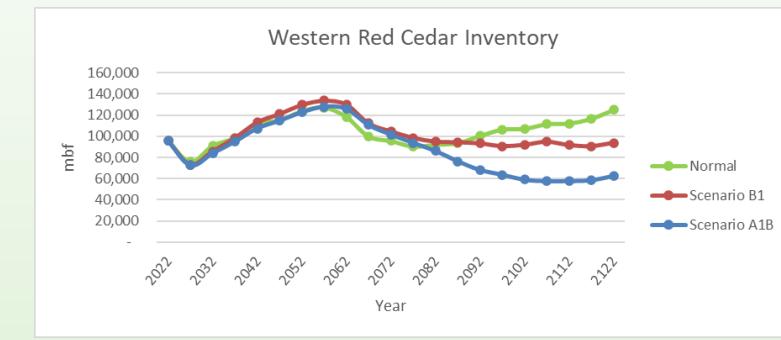
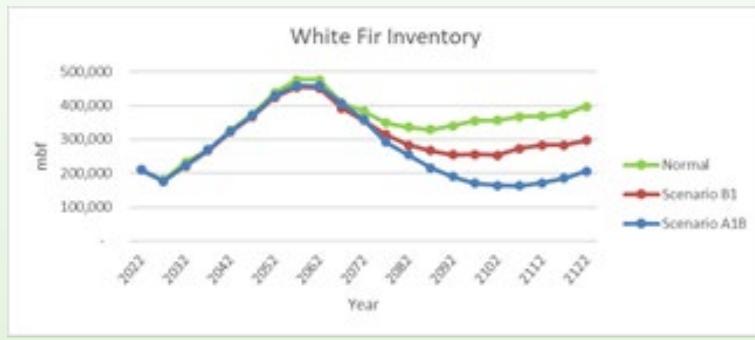
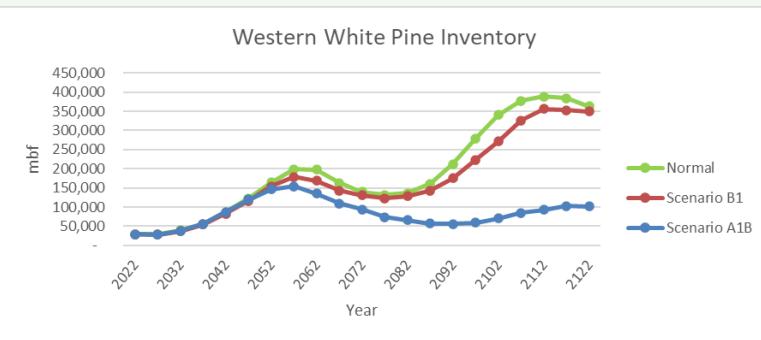
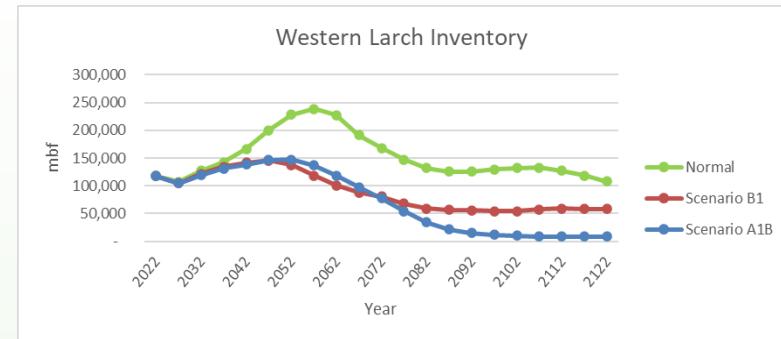
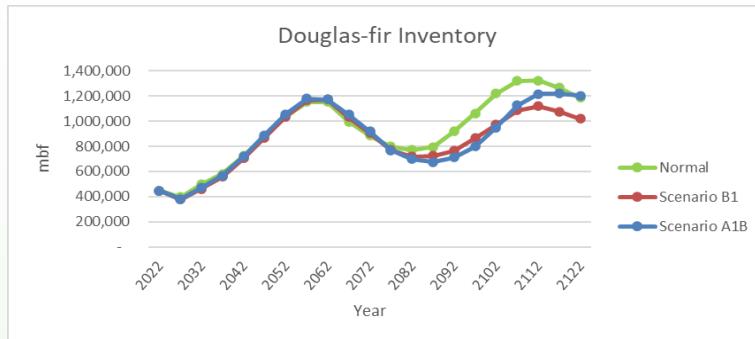
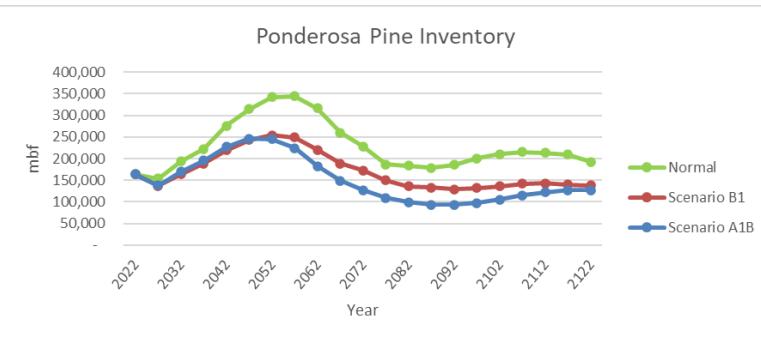
Note: low elevation, \approx 1000 m, mid elevation, \approx 1500 m, high elevation, $>$ 2000 m.

Species, Climatypes, Climate Change and Forest Health - Rehfeldt, Warwell and Monserud - Forests 2020

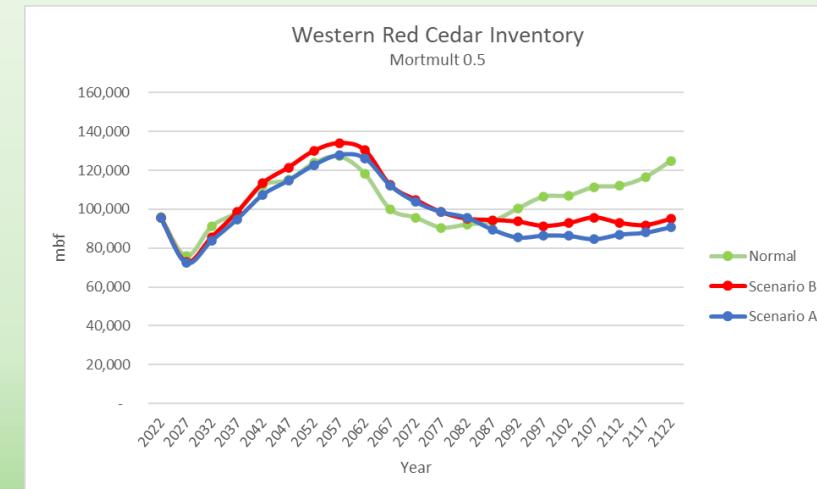
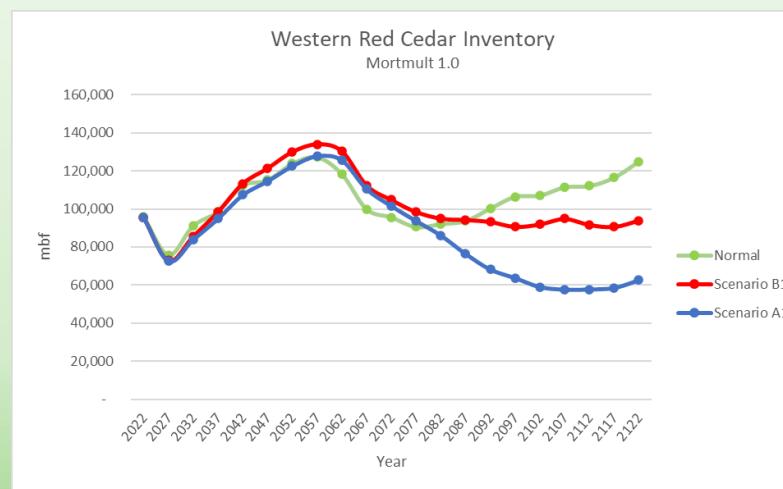
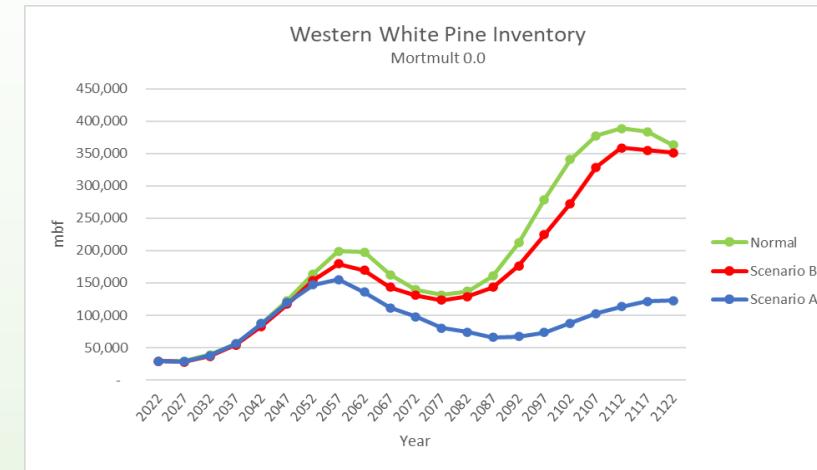
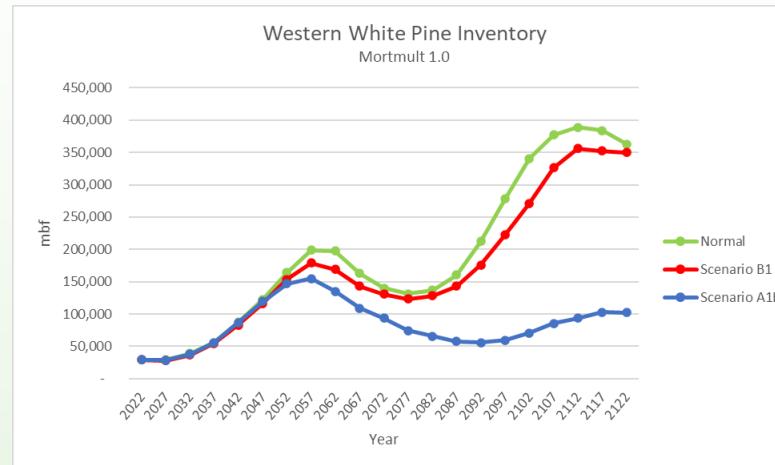


Projected Climate Impacts to Stimson Inland Inventory





Mortality Multiplier Altered Results



Conclusion

- Climate-FVS is a reasonably good tool for addressing the impact on future forest growth and mortality and provides global circulation scenario options.
- Climate-FVS projections can be useful for developing adaptation strategies.
- Climate-FVS Version 2.0 dClim rule provides direct climate change induced mortality estimates though the amount of mortality may need to be adjusted for some of the Inland species to obtain more realistic results.
- The amount of dClim mortality depends on the timing of tree establishment in relation to the amount of climate change. Shorter rotations will reduce the impact of the dClim rule.
- Projections of species with low viability scores may not exhibit much impact from incorporating the dClim rule.



References

Climate-FVS Version 2.0: Content, User's Guide, Applications and Behavior
Crookston - RMS GTR-319

Species, Climatypes, Climate Change and Forest Health
Rehfeldt, Warwell and Monserud - *Forests* 2020

Hundred Year Projected Carbon Loads and Species Compositions
Fekety, Crookston, Hudak, Filippelli and Vogeler - *Carbon Balance & Mgmt* 2020

