Development of a Fort Bragg Variant of the Forest Vegetation Simulator

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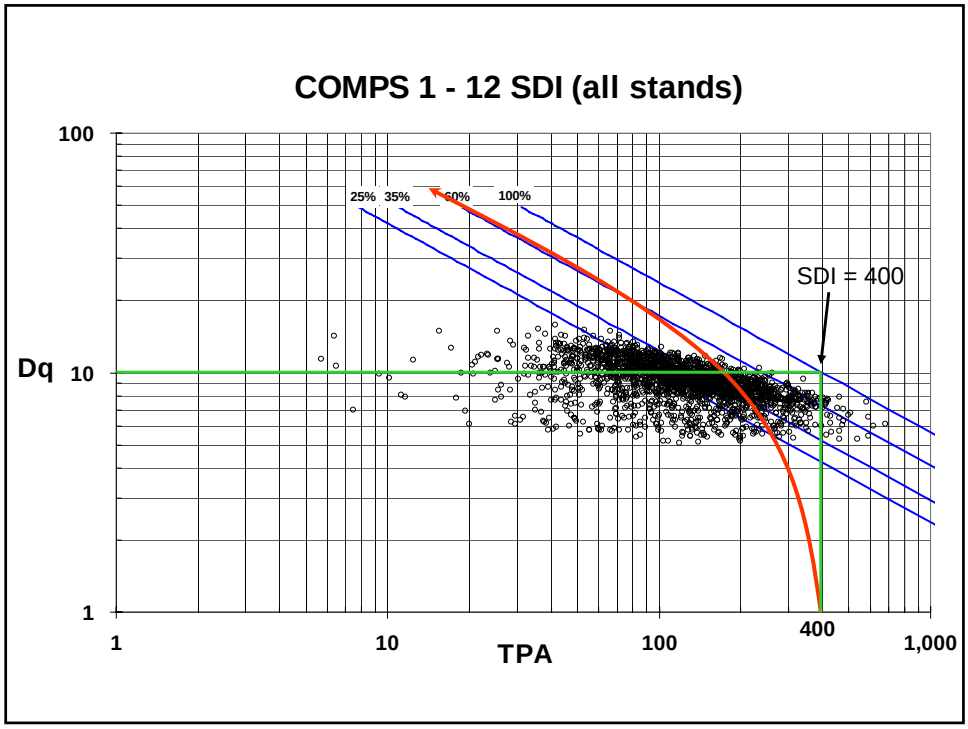
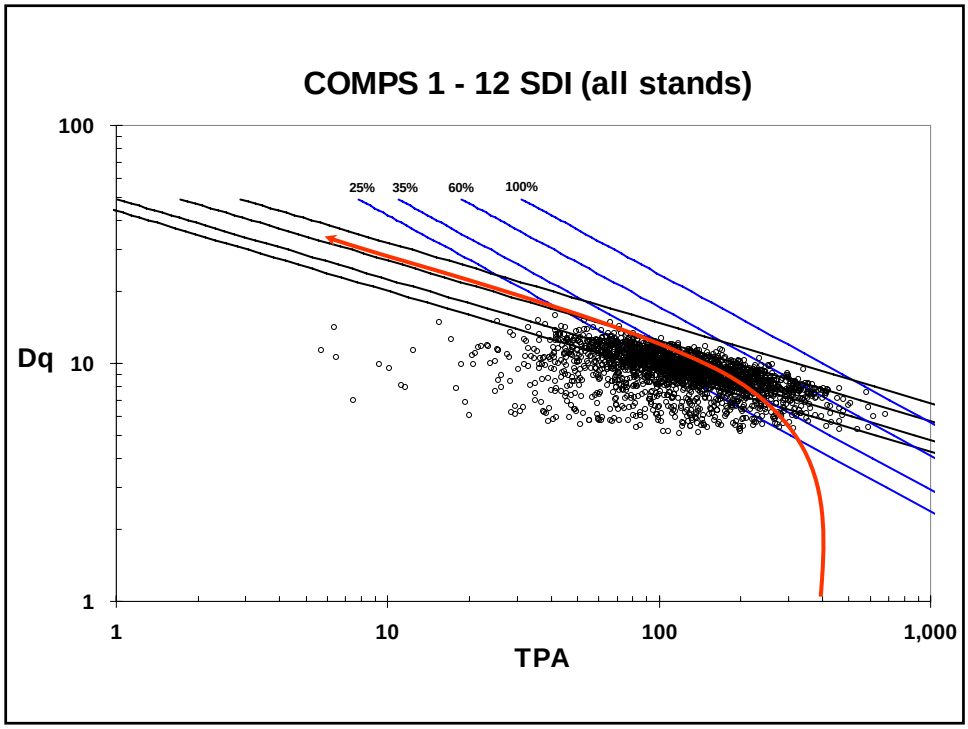
History of the Project

- 1990s inventory
  - RCW habitat assessment
  - Included growth projections
  - Future growth appeared to be overstated
  - Auburn model test – same problem
  - Stand structure evaluation
    - Stand dynamics “unexpected”
    - Might be a big issue for future management
    - Overhills inventory confirmed findings


COMPS 1 - 12 SDI (all stands)
100
Dq
10
1
25%
35%
60%
100%
SDI = 400
400
1
10
100
1,000
TPA


COMPS 1 - 12 SDI (all stands)
100
Dq
10
1
25%
35%
60%
100%
1
10
100
1,000
TPA

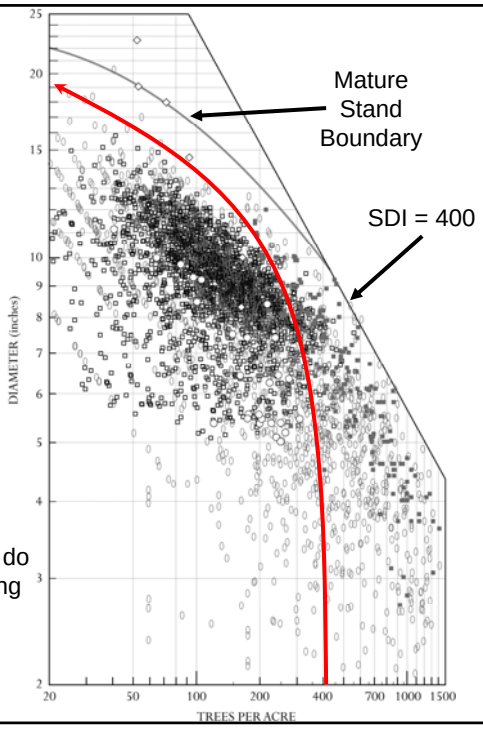
History of the Project

- 2000s inventory
  - Opportunity for adjustments
  - Assistance with new inventory design
  - Experience with Forest Vegetation Simulator
  - Suggested dual-purpose inventory
    - Standard variables
    - Additional variables needed for FVS
  - Consulted with USFS Forest Mgt. Service Center
    - Recent (1997) development of SN variant
    - Variable list and development timeline
  - Collection of FVS-ready data included in contract
  - Data collected 2001-2004

History of the Project

- Starting the Project
  - Potential funding for variant development
  - Incoming talent pool at USU
  - Proposal for 2-year project
    - Evaluate performance of FVS
      - Simulation-level
      - Submodel-level
    - Fix where necessary (most submodels?)
    - Stay inside FVS framework
      - Fort Bragg as administrative unit
      - Brought forward w/ SN variant improvements

Fort Bragg (1990s)
Sandhills NWR
Reineke (1933)
Overhills
Schwarz (1907)
FIA database
- unbiased, south-wide coverage
- use to develop DMD

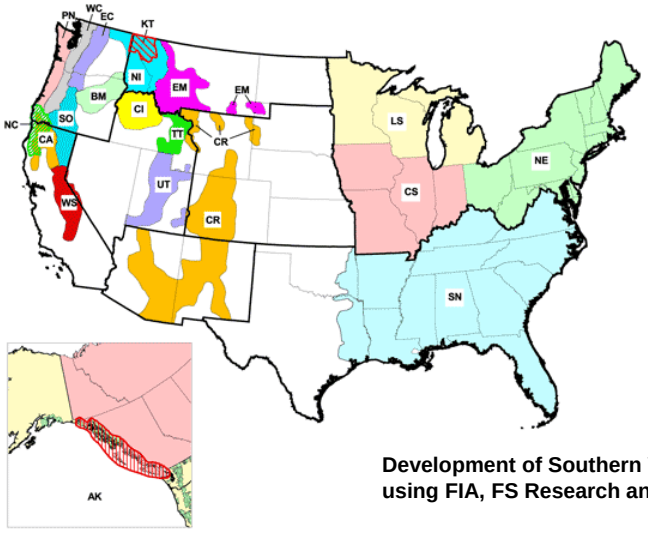


Fort Bragg (2000s)
- Fits MSB perfectly
- Fort Bragg LL not so unusual?
- Graphical version of what FVS should do
- Can be used now for treatment planning

Objectives

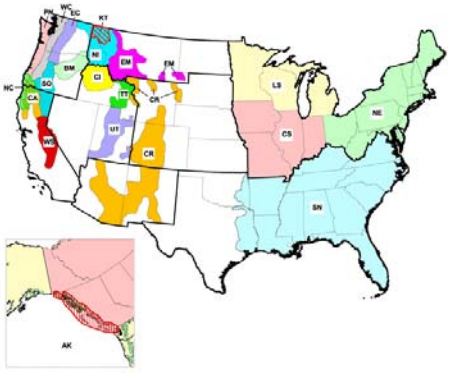
- Project Objectives
  - Give Fort Bragg the best available simulation tool
  - Give managers a working knowledge of FVS
    - Current capabilities (lots)
    - Applied to local issues
    - Future enhancements
- Visit Objectives
  - Briefing on methods
  - Update on progress (and what to expect next)
  - Initial familiarization with FVS
  - Introduction to other useful tools (LLDMD)

Regional Variants



Development of Southern Variant began in 1997 using FIA, FS Research and BIA plot data

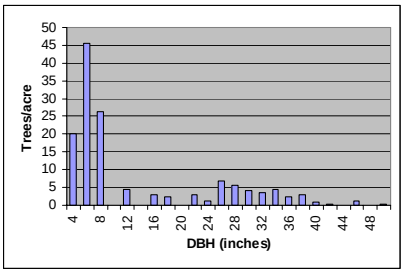
Individual tree – distance independent



- Data intensive
- Extremely flexible

Sierra mixed conifer

- Existing stand condition
  - 1379 tpa
  - SDI = 531
  - BA = 229 ft^2/ac



Sierra mixed conifer

- Goals have to do with *fire behavior* and *restoration of reference condition*

Sierra mixed conifer

- Open, stands dominated by large diameter, early seral trees
- Frequent low-severity fires (10-20 years)

Sierra mixed conifer

- Objective: Create and maintain forest structure and fuels to prevent active crown fire under severe burning conditions

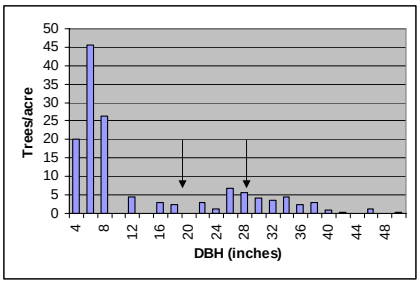
  Evaluation criteria, e.g.,:
  crowning index > 90th percentile wind speed

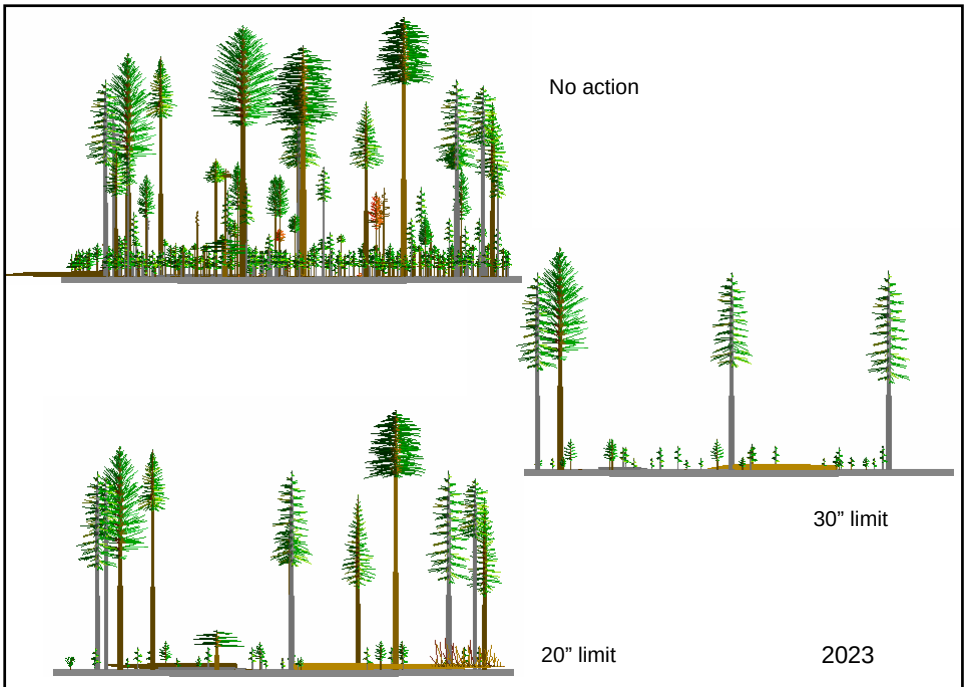
- Objective: restoration of reference condition (w/ respect to tree species composition and stand structure)

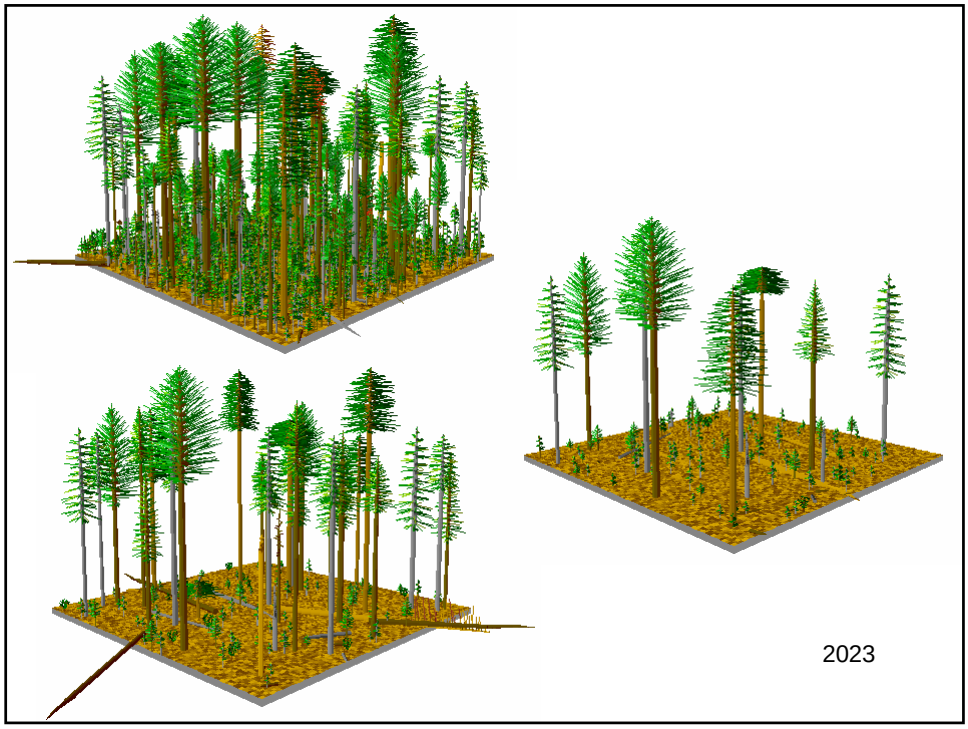
  Evaluation criteria, e.g.,:
  SDI between 25-35% of SDI_{max}

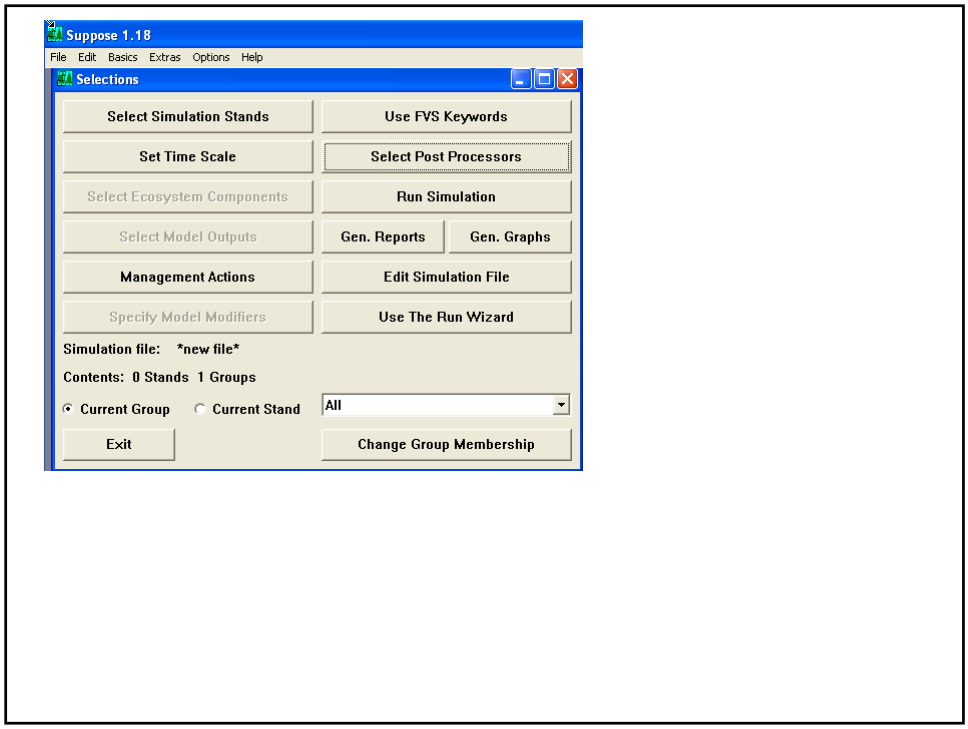
Sierra mixed conifer

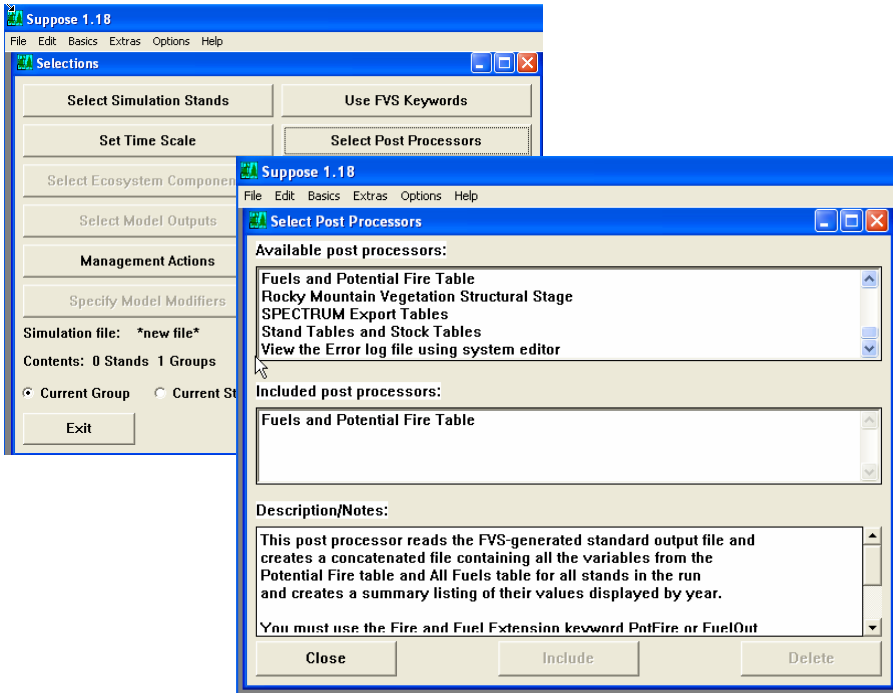
- No action
- Low thinning & Rx fire every 20 yrs
  - *20” limit*
  - *30” limit*

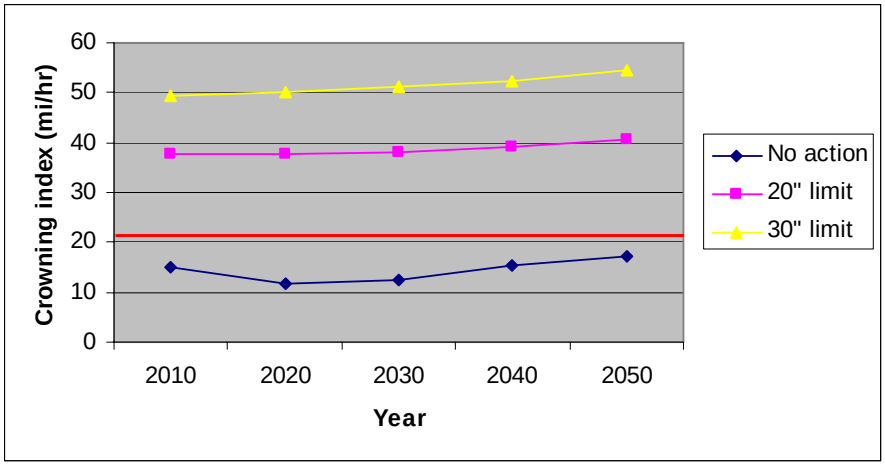




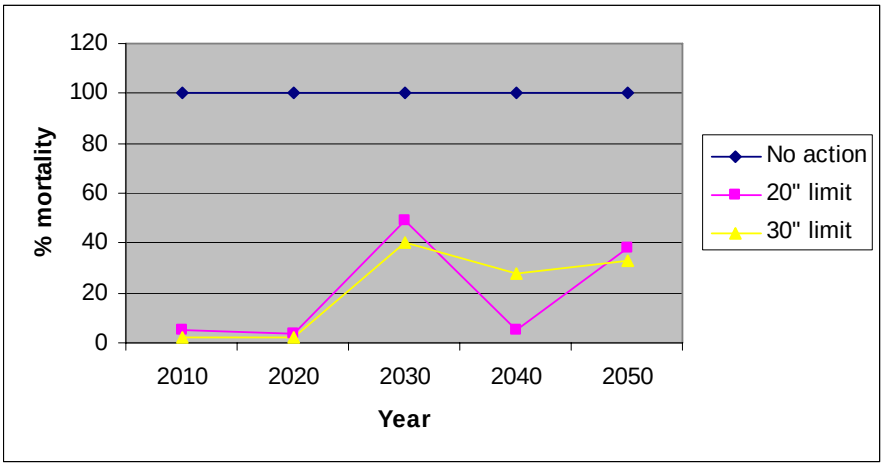

2023

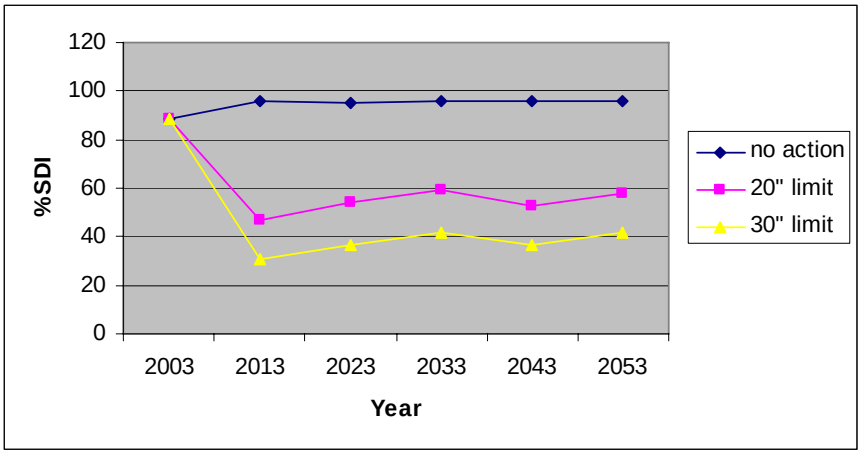

Suppose 1.18
File Edit Basics Extras Options Help
Selections
Select Simulation Stands
Use FVS Keywords
Set Time Scale
Select Post Processors
Select Ecosystem Components
Run Simulation
Select Model Outputs
Gen. Reports
Gen. Graphs
Management Actions
Edit Simulation File
Specify Model Modifiers
Use The Run Wizard
Simulation file: *new file*
Contents: 0 Stands 1 Groups
Current Group
Current Stand
All
Exit
Change Group Membership





What is the critical wind speed – based on %weather?

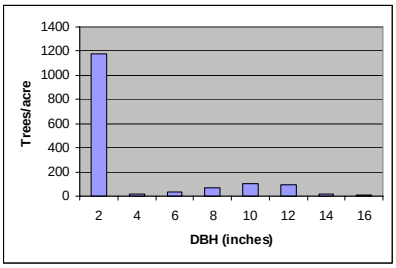




What if we relaxed the diameter constraint?

Rocky Mountain Lodgepole pine

- Existing stand condition
  - 1530 tpa
  - SDI = 450
  - BA = 203 ft^2/ac



Fire behavior

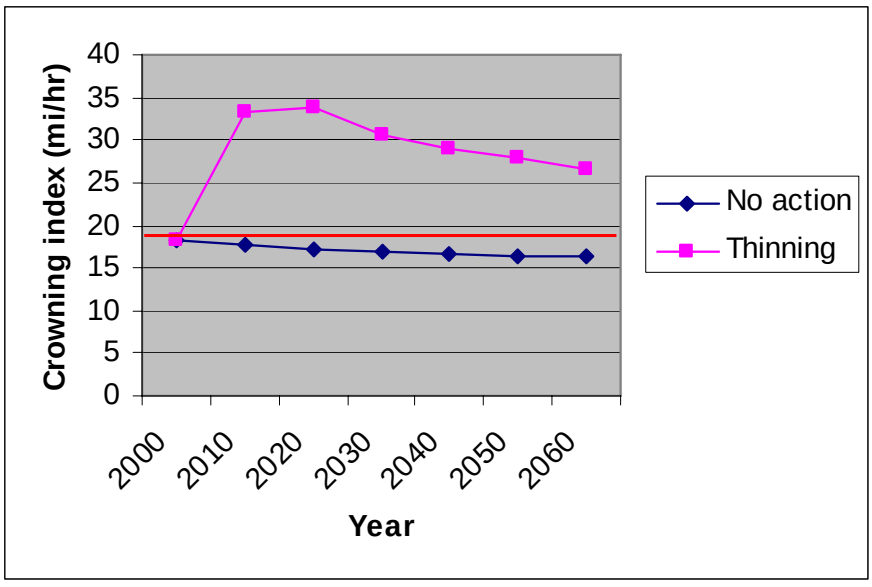
Objective: Create and maintain forest structure and fuels to prevent active and passive crown fire under severe burning conditions

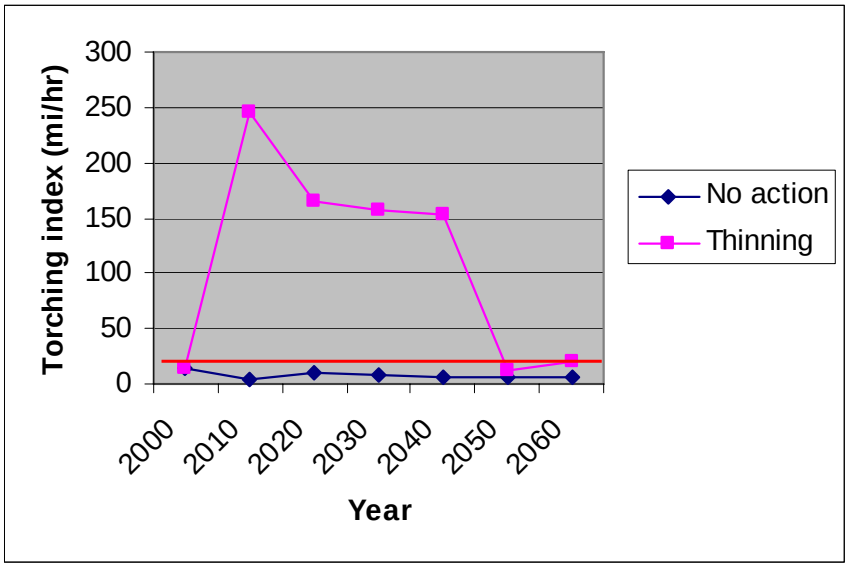
Evaluation criteria, e.g.,:

crowning index > wind speed
torching index > wind speed

Fire behavior

- No action
- Low thinning w/ 80 tpa residuals





Simulated fire under severe weather - 2020

Unthinned

Thinned

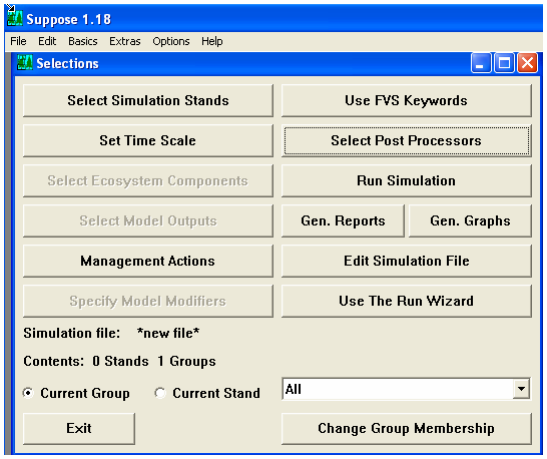
Elk hiding cover

- Existing stand condition
  - 2917 tpa
  - 5 feet

Elk hiding cover

- Objective: Provide elk hiding cover
  - "90% of adult standing animal at 200 feet"

Evaluation criterion:
Years of hiding cover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Simulation file: *new file*
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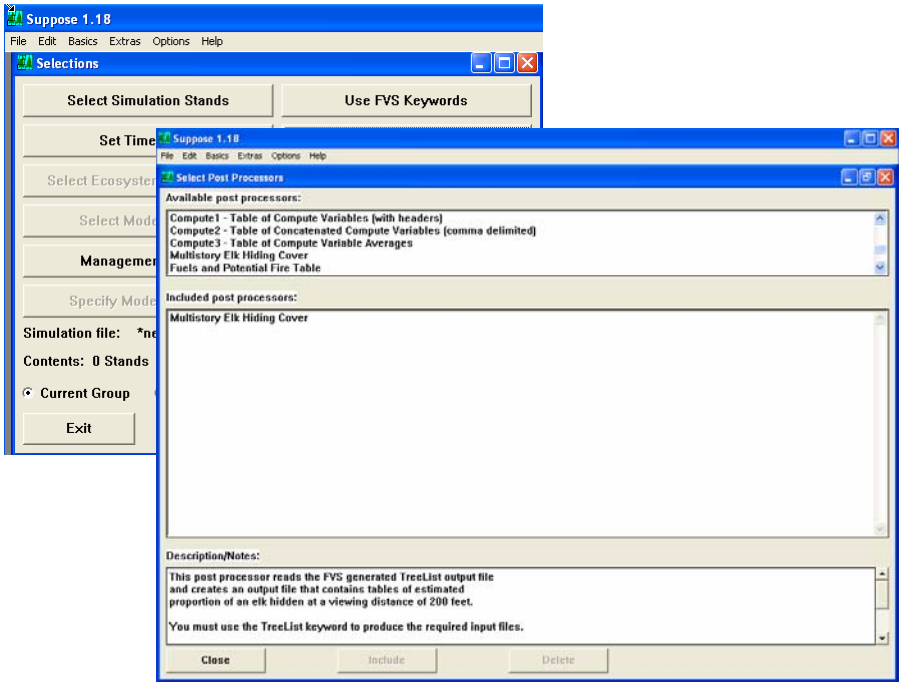
Change Group Membership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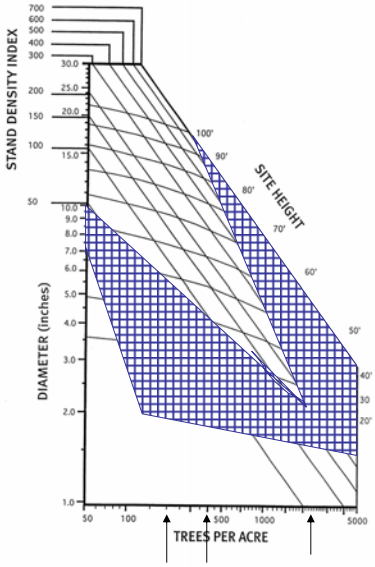
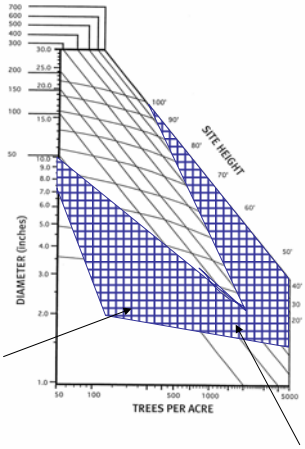
Selections
Select Simulation Stands
Use FVS Keywords
Simulation file:
Contents: 0 Stands
Current Group
Exit
Suppose 1.18
File Edit Basics Extras Options Help
Select Post Processors
Available post processors:
Compute1 - Table of Compute Variables (with headers)
Compute2 - Table of Concatenated Compute Variables (comma delimited)
Compute3 - Table of Compute Variable Averages
Multistory Elk Hiding Cover
Fuels and Potential Fire Table
Included post processors:
Multistory Elk Hiding Cover
Description/Notes:
This post processor reads the FVS generated TreeList output file
and creates an output file that contains tables of estimated
proportion of an elk hidden at a viewing distance of 200 feet.
You must use the TreeList keyword to produce the required input files.
Close
Include
Delete

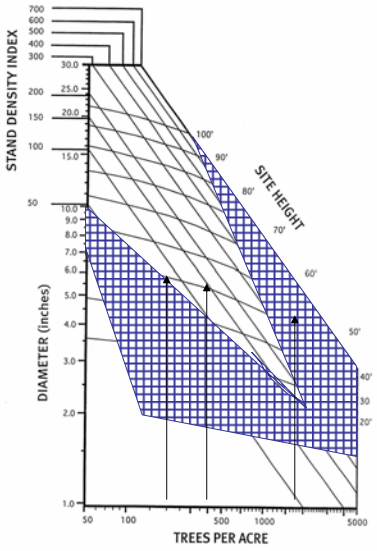
- Alternatives
  - No thinning
  - PCT to:
    400 tpa
    200 tpa

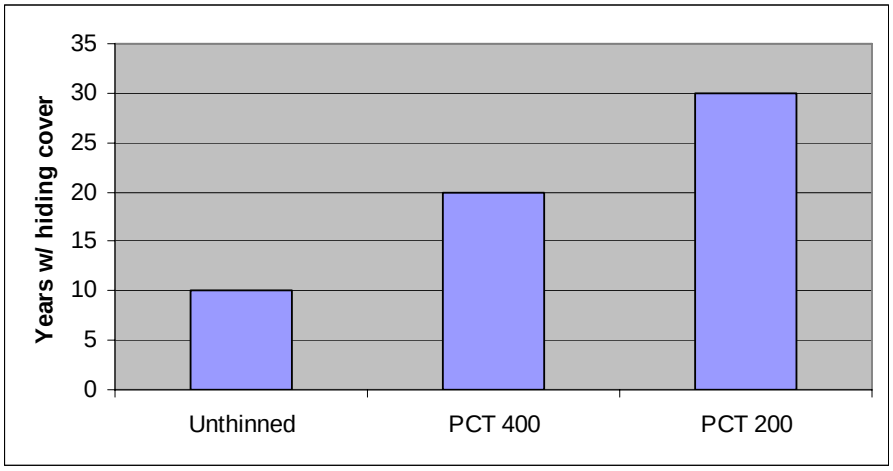




Elk hiding cover

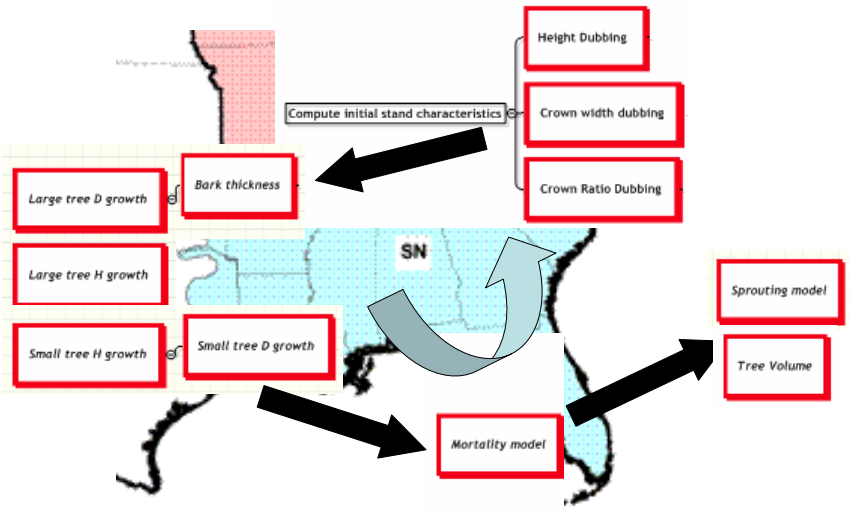
- No thinning
- PCT to:
  - 400 tpa
  - 200 tpa





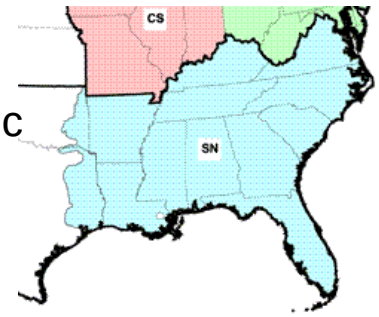
Submodel Development

A system of submodels



Southern Variant

- 13 states
- Submodels represent average conditions
- Species-specific
- Forest type specific
- Ecological Unit specific
  - Sandhills



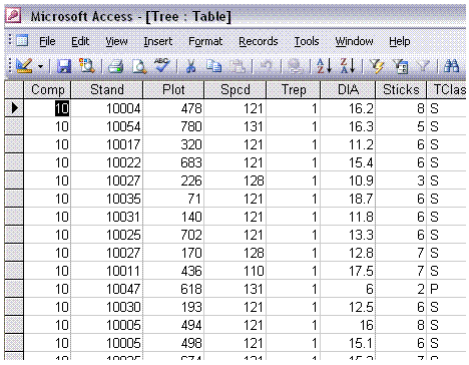
Modeling Challenges

- Region wide models
- Bias at local level (Ft. Bragg)
- Possible considerable submodel bias
- Some southern variant submodels need refitted (Donnelly et al. 2001)
- Many submodels simply ‘mapped’
  - crown width
  - site index

Data Screening & Preparation

- Standard data
  - DBH, Spp, Ht
- FVS ready data
  - Crown
- Submodel fitting
  - Crown width, Age, Bark thickness

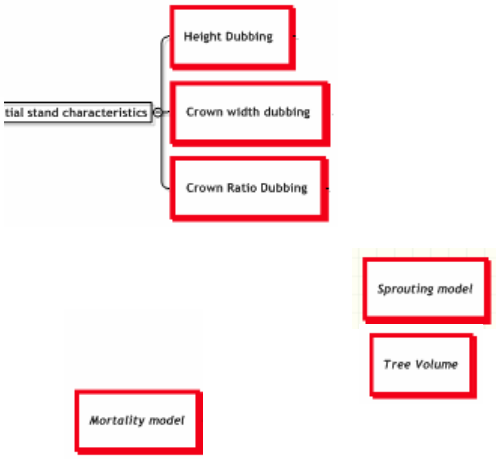
- Cleaned database
- Documented
- Updatable



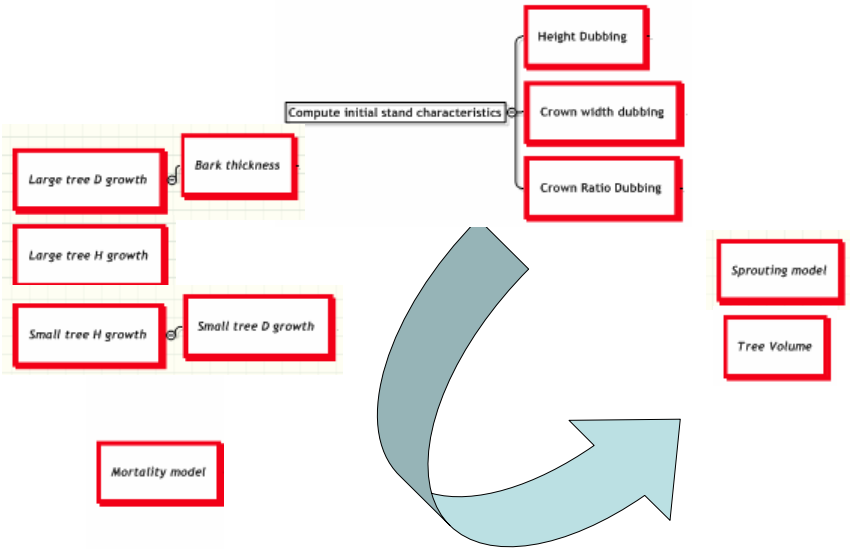
Comp	Stand	Plot	Spcd	Trep	DIA	Sticks	TClas
10	10004	478	121	1	16.2	8	S
10	10054	780	131	1	16.3	5	S
10	10017	320	121	1	11.2	6	S
10	10022	683	121	1	15.4	6	S
10	10027	226	128	1	10.9	3	S
10	10035	71	121	1	18.7	6	S
10	10031	140	121	1	11.8	6	S
10	10025	702	121	1	13.3	6	S
10	10027	170	128	1	12.8	7	S
10	10011	436	110	1	17.5	7	S
10	10047	618	131	1	6	2	P
10	10030	193	121	1	12.5	6	S
10	10005	494	121	1	16	8	S
10	10005	498	121	1	15.1	6	S

Improving FVS Southern Variant

- Well-documented variant
- Local, working knowledge
- Ft. Bragg database



Model architecture

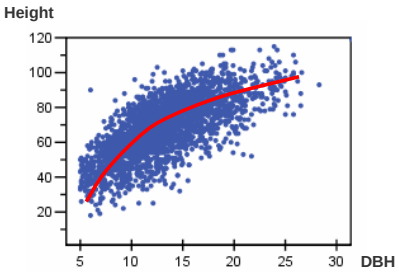


Model architecture

HDub Submodel

4 routines

- H as a function of DBH



- Species-specific
- South-wide parameters

HDub Submodel

Height Dubbing

- If dbh < 0.1'': H = 1ft.
- If 0.1'' ≤ dbh < 3'': Modified Curtis-Arney

$$H = 4.51 + \frac{\left(4.5 + p_2 e^{-p_3 * 3^{P4}}\right)\left(DBH - d_{BW}\right)}{3 - d_{BW}}$$

- If DBH ≥ 3'': Curtis-Arney $H = 4.5 + p_2 e^{-p_3 DBH^{P4}}$
- If DBH ≥ 3'' and ≥3 Height measurements are provided (undamaged top): Wykoff (1982)

Self-calibration ←

$$H = 4.5 + e^{\alpha_{is} + \gamma_s \left(\frac{1}{DBH + 1}\right)}$$

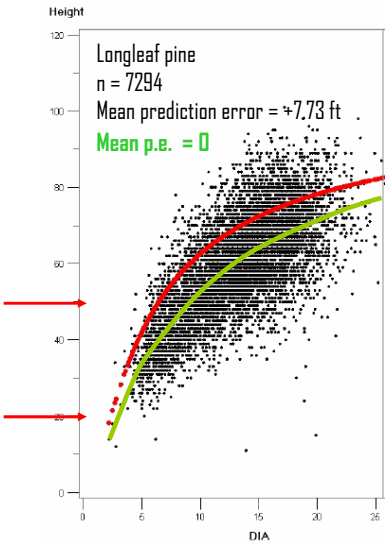
Model characteristics

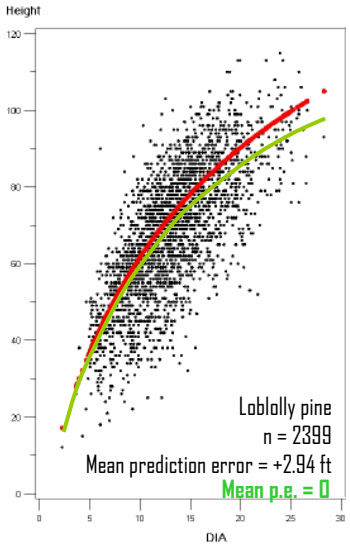
Height Dubbing

- DBH-driven: simple model, not taking into account…
  - Effect of age
  - Site fertility (steeper curve on better sites)
  - **Influence of density over DBH and H/D relationship**

  Ft.Bragg Database allows us to "fix" the submodel
- **What now:**
  - **Prediction error and how to take care of it**
  - **Expected trends: useful to know**

Model performance (Curtis-Arney)



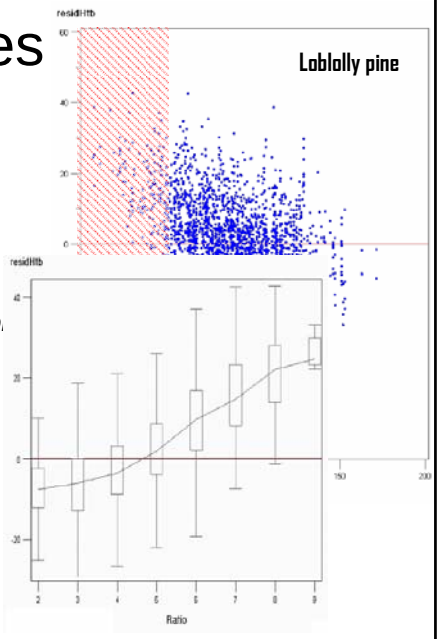


Biases

- Age / Dominant height
- Site index
- Density (competition affects DBH)
- Tree damage code
- Compartment?

- ***Hypothesis: open-grown conditio***
- ***Re-calibration does not help***

- ***Sampling recommendations (open-grown trees measure H!)***
- ***Include influential variables in the model***

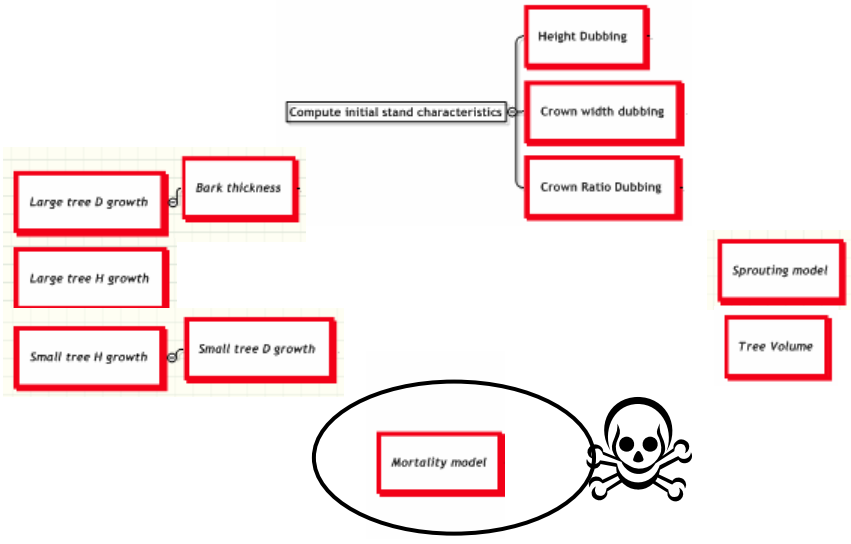


Methods

- Most sub-models will be analyzed and re-calibrated on local data using this procedure.

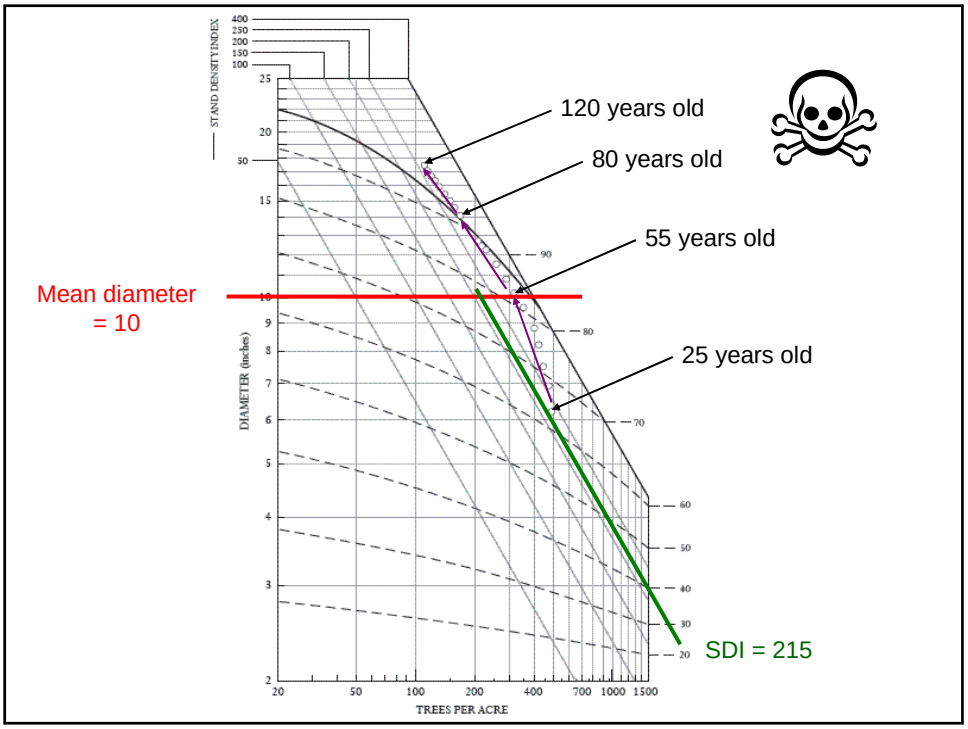
BUT…

Mortality submodels



Three ways to kill trees

- <55% SDI, background mortality (DBH)
- >55% SDI, density-dependent
  - Mean diameter < 10.0, use MaxSDI
  - Mean diameter > 10.0, use MaxBA
- All driven by density

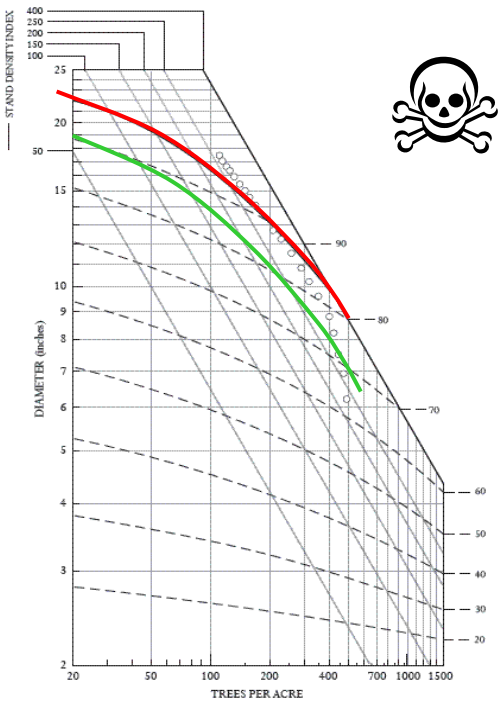


Potential Problems

- FVS Southern variant defaults
- Longleaf
  BAMax – 213 ft^2
  SDIMax – 390
- Ft. Bragg data
- Longleaf (range)
  BAs (11 – 158)
  SDIs (21 – 321)

Fixes

- Mature stand boundary line



Schedule for Completion

- Sep 2005 Authorization to proceed
- Nov 2005 Database (screening)
- May 2006 Evaluation of southern variant
- Mar 2007 Development of Ft. Bragg submodels
- Jul 2007 Evaluation of Ft. Bragg FVS
- Nov 2007 Training & implementation