

Dendroecology of a mixed conifer forest in Bumthang Valley, Bhutan

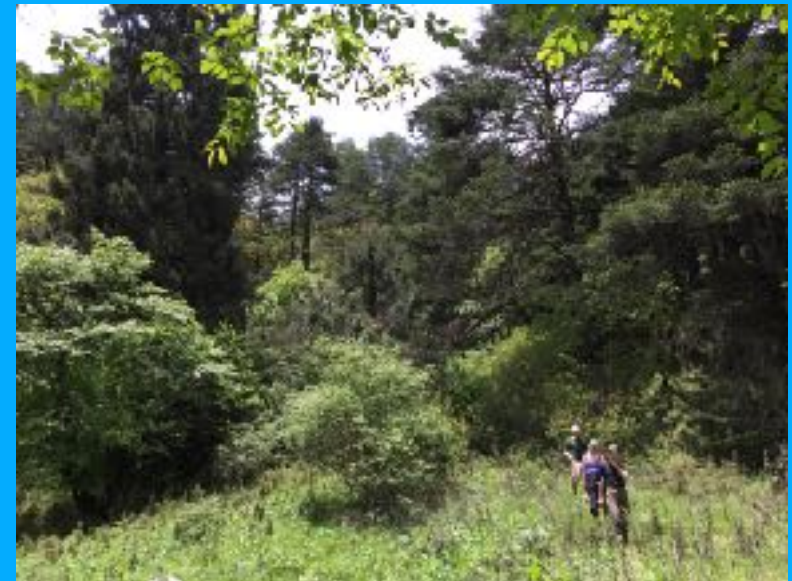
World Dendro Fieldweek

2018

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Why Does Dendroecology Matter?



Field sites

- UPP: fir, rhododendron and hemlock
- UPM: fir and hemlock
- UPL: primarily hemlock and some birch

UPP



UPM



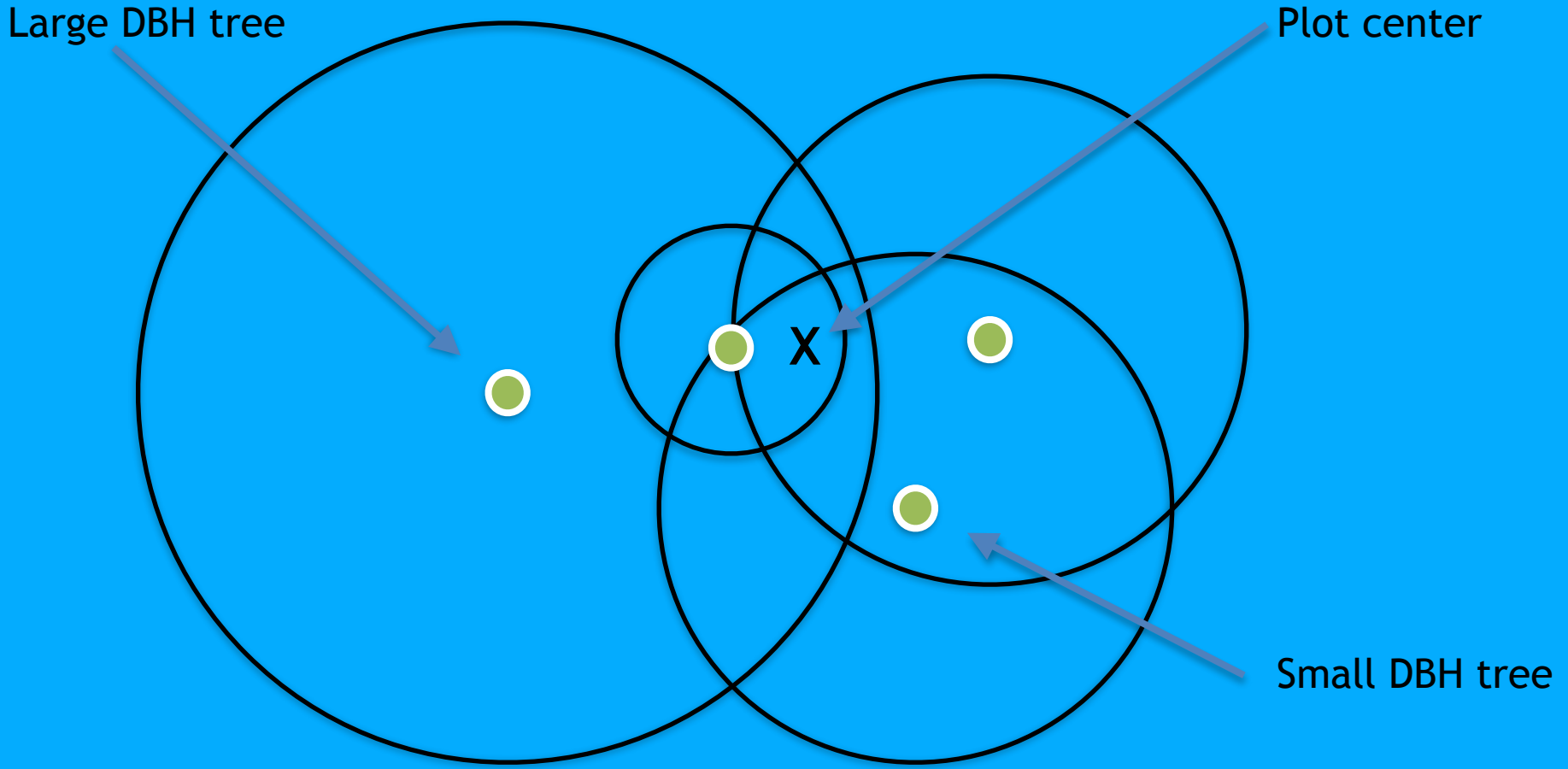
UPL



Sampling

- Sampling design - Variable radius plot
- Measured characteristics:
 - DBH;
 - canopy status;
 - distance from the plot center
- Collected material
 - 2 cores/tree in opposite directions at DBH
 - 2cores/tree at root collar in at least 1 tree/plot

The “Thumb” Method



Trees with larger DBH have larger plots

DBH



Coring



Canopy



Canopy



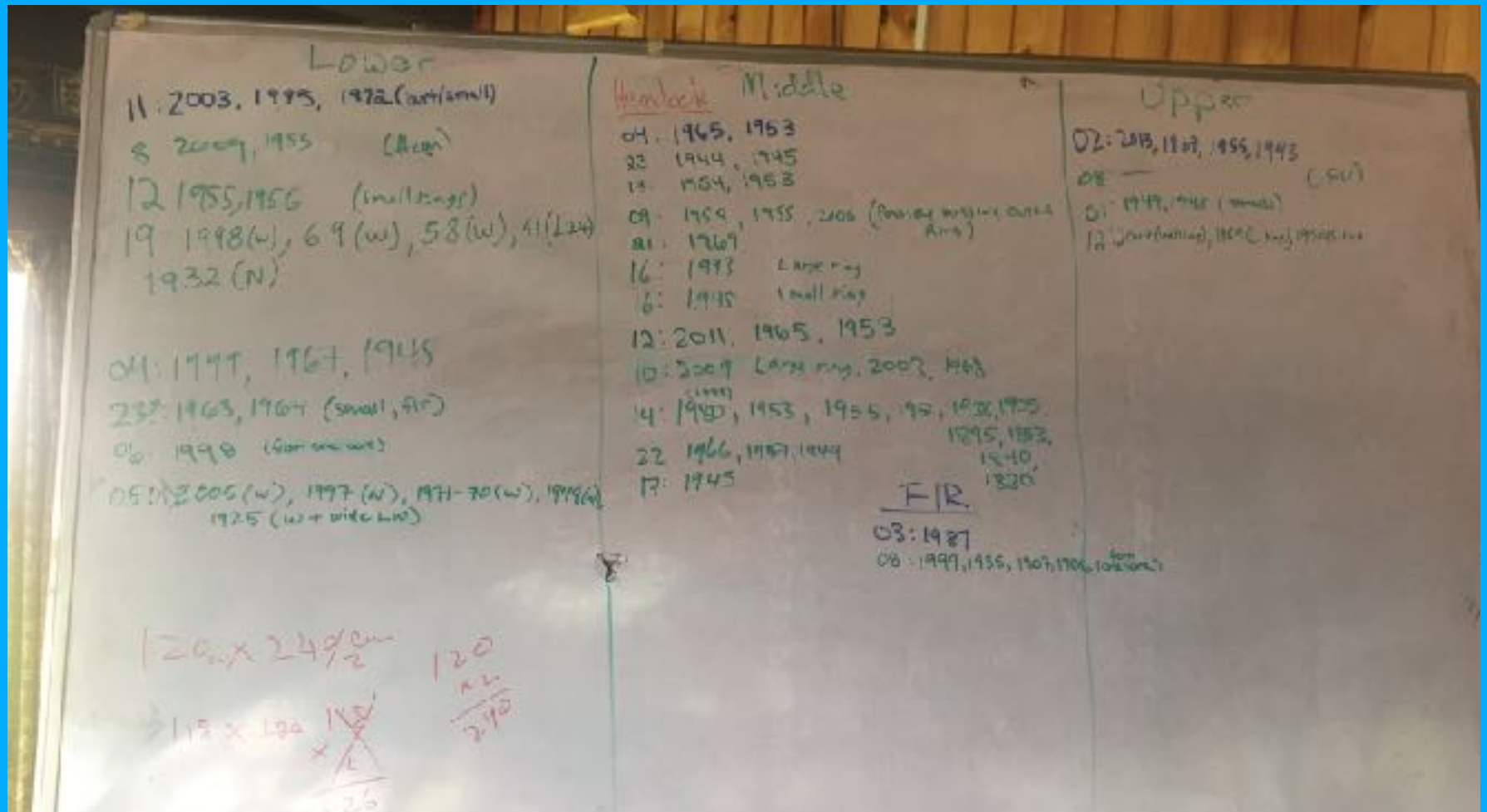
Canopy



Sites characterization

Plot	Nr. trees	Species	Age (years)		DBH (cm)	
			Min.	Max.	Min.	Max.
UPP	11	Fir (5)	56	123	26,1	87,8
		Rhododendron (4)	78	141	12,7	34,6
		Maple (2)	ND		32,3	40,2
UPM	23	Fir (9)	74	221	20,3	99
		Hemlock (14)	80	203	18	47,2
UPL	25	Birch (1)	ND		21,9	
		Hemlock (24)	75	632	23,9	202

Methods/data collected



Methods/data collected



Dating uncertainty



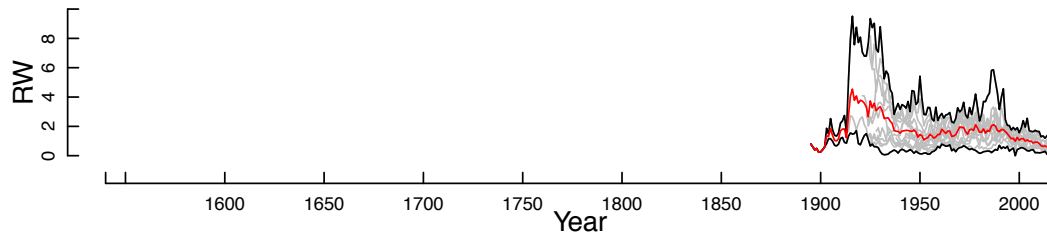
Dating uncertainty



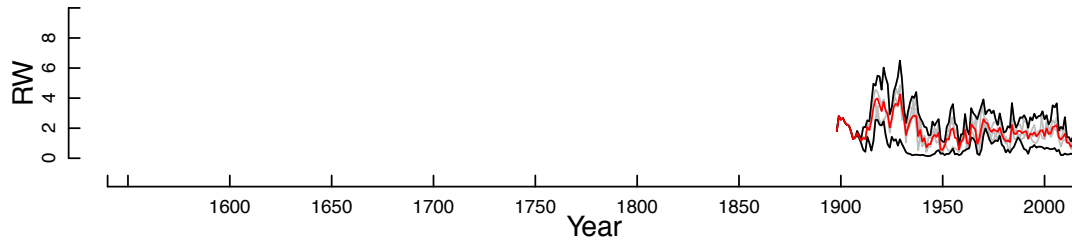
Dating uncertainty

- Low correlation among cores
- Closed canopy
- Compaction and release

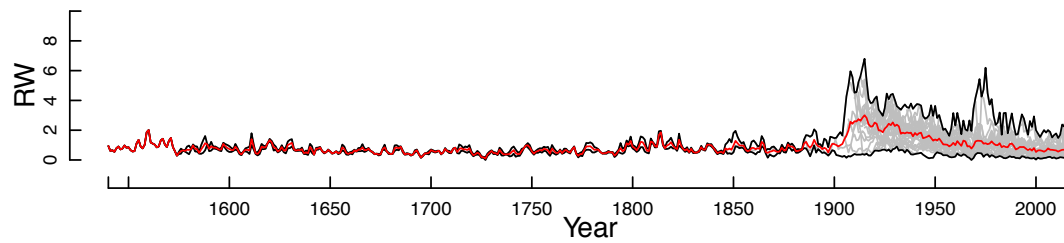
Middle site Fir



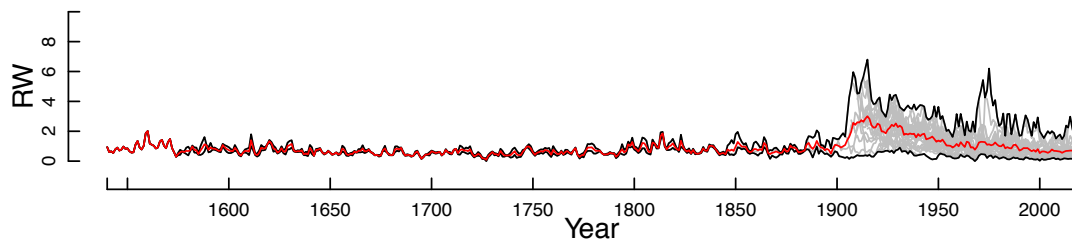
Upper site Fir



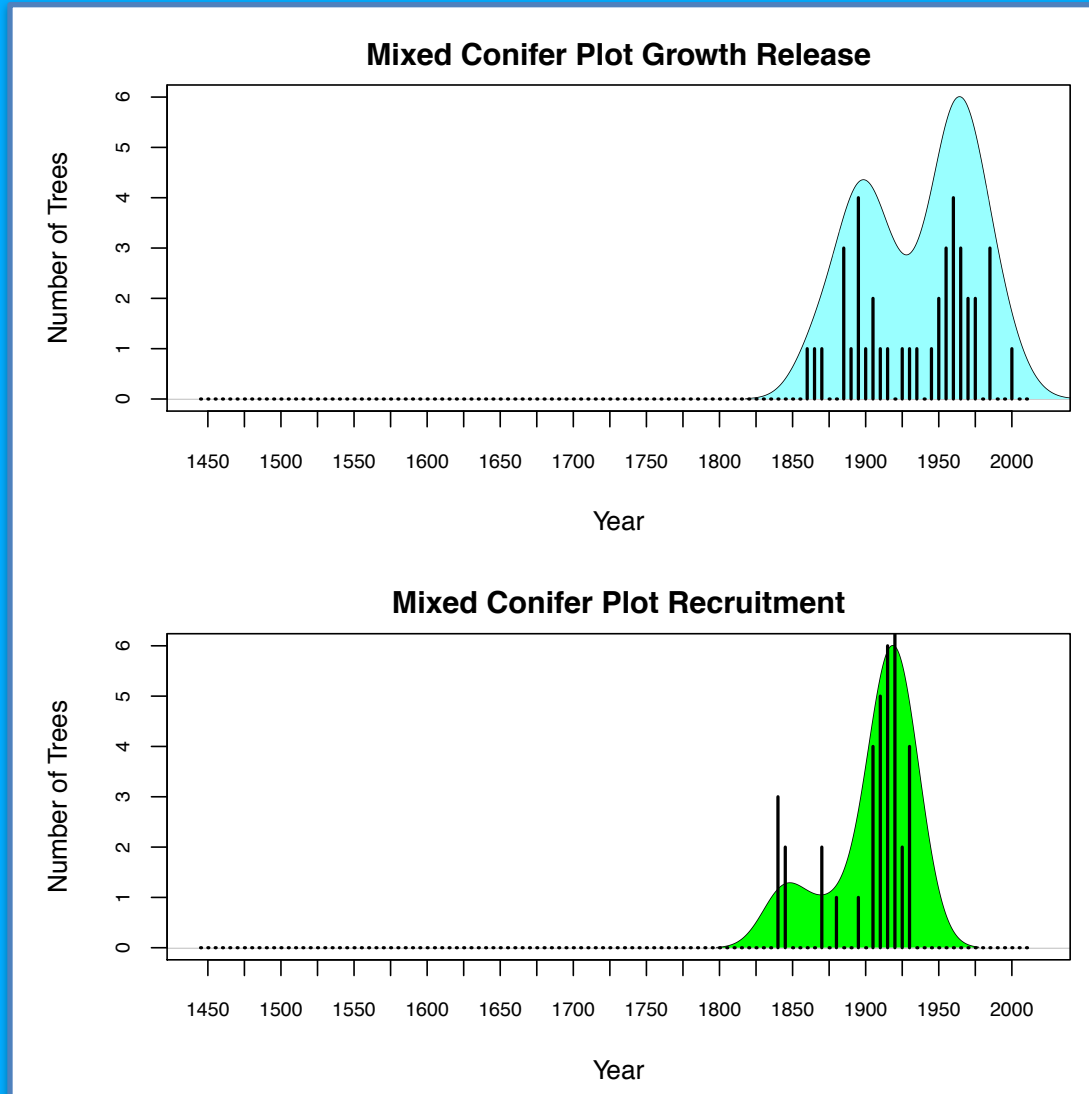
Middle site Hemlock



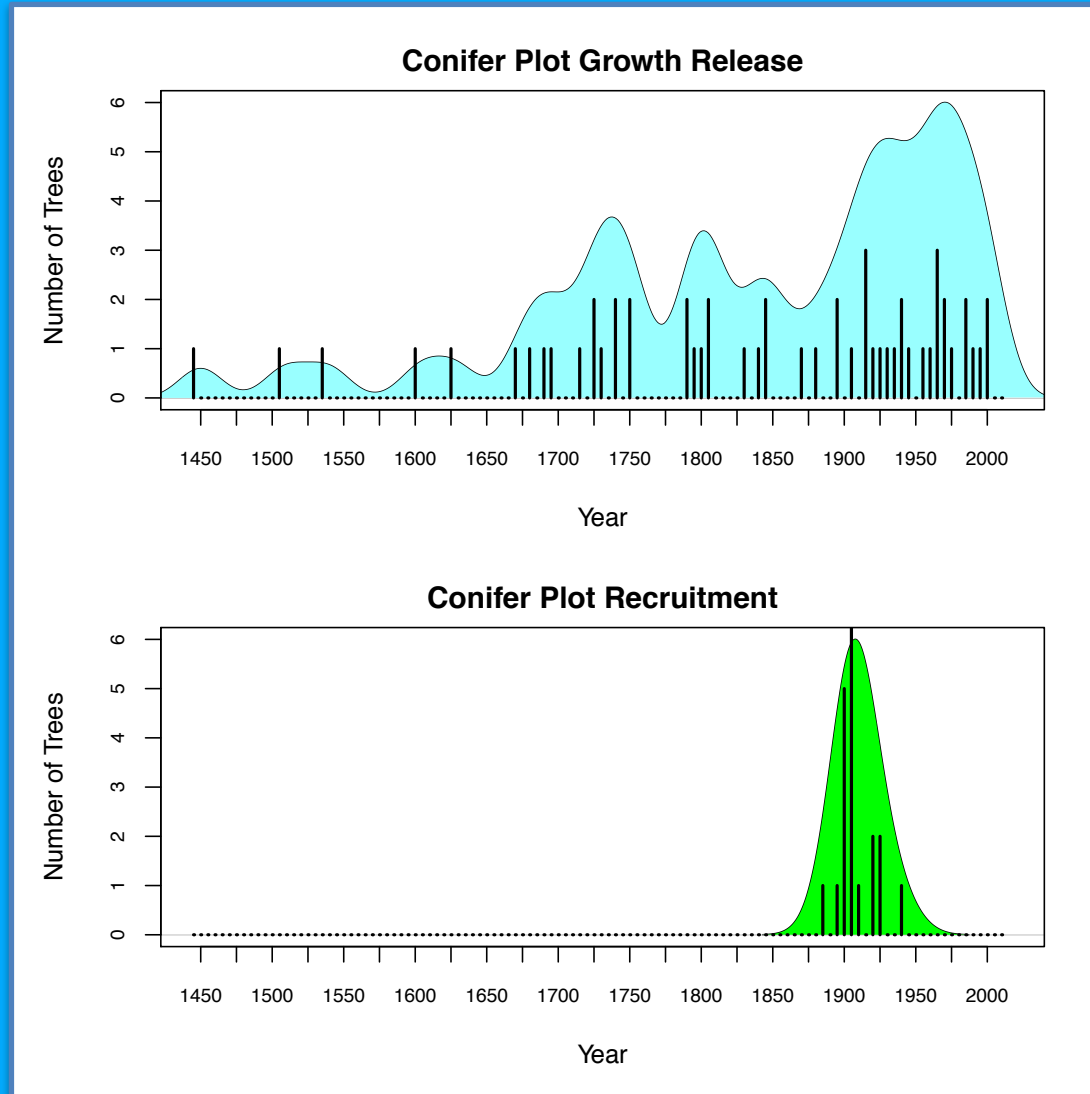
Lower site Hemlock

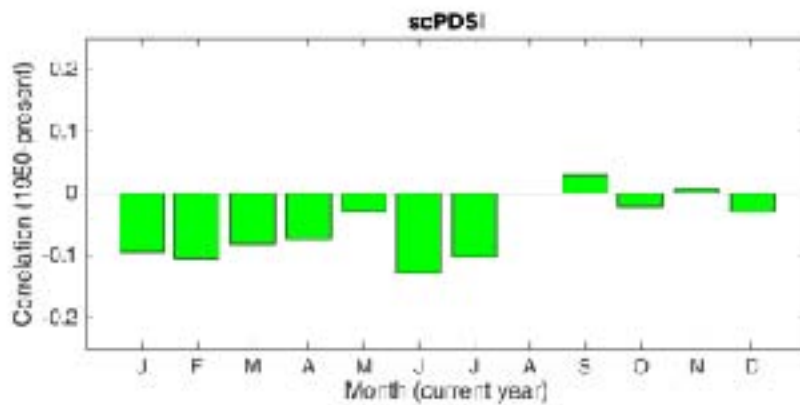
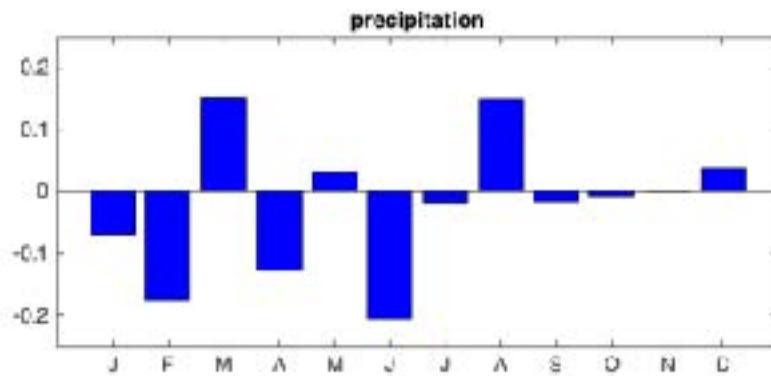
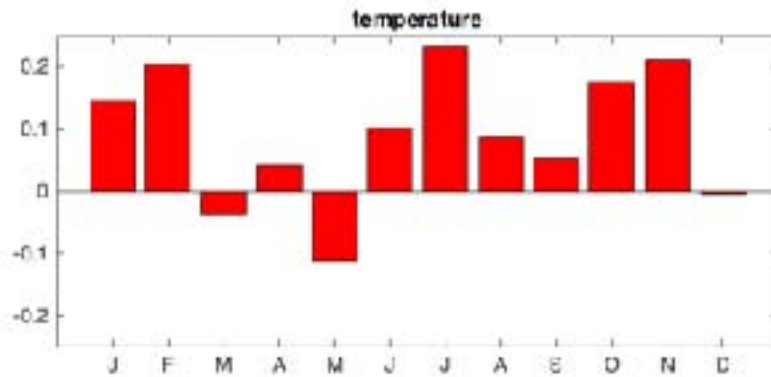


Disturbance results

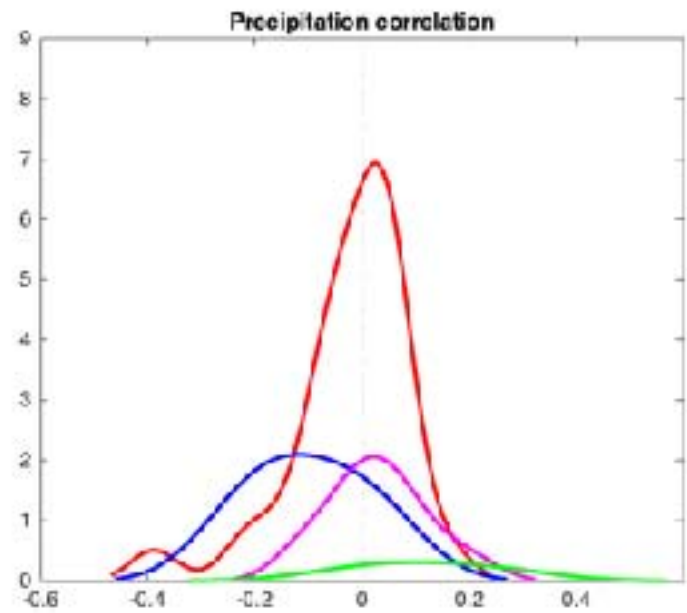
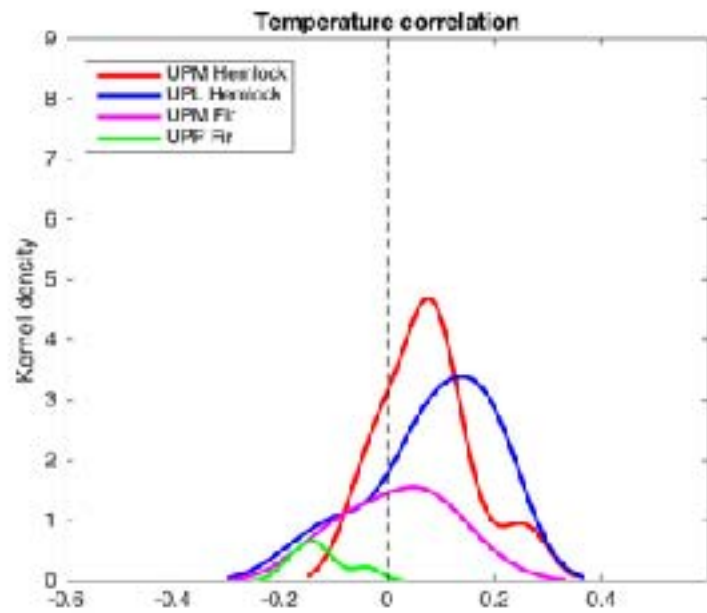


Disturbance results



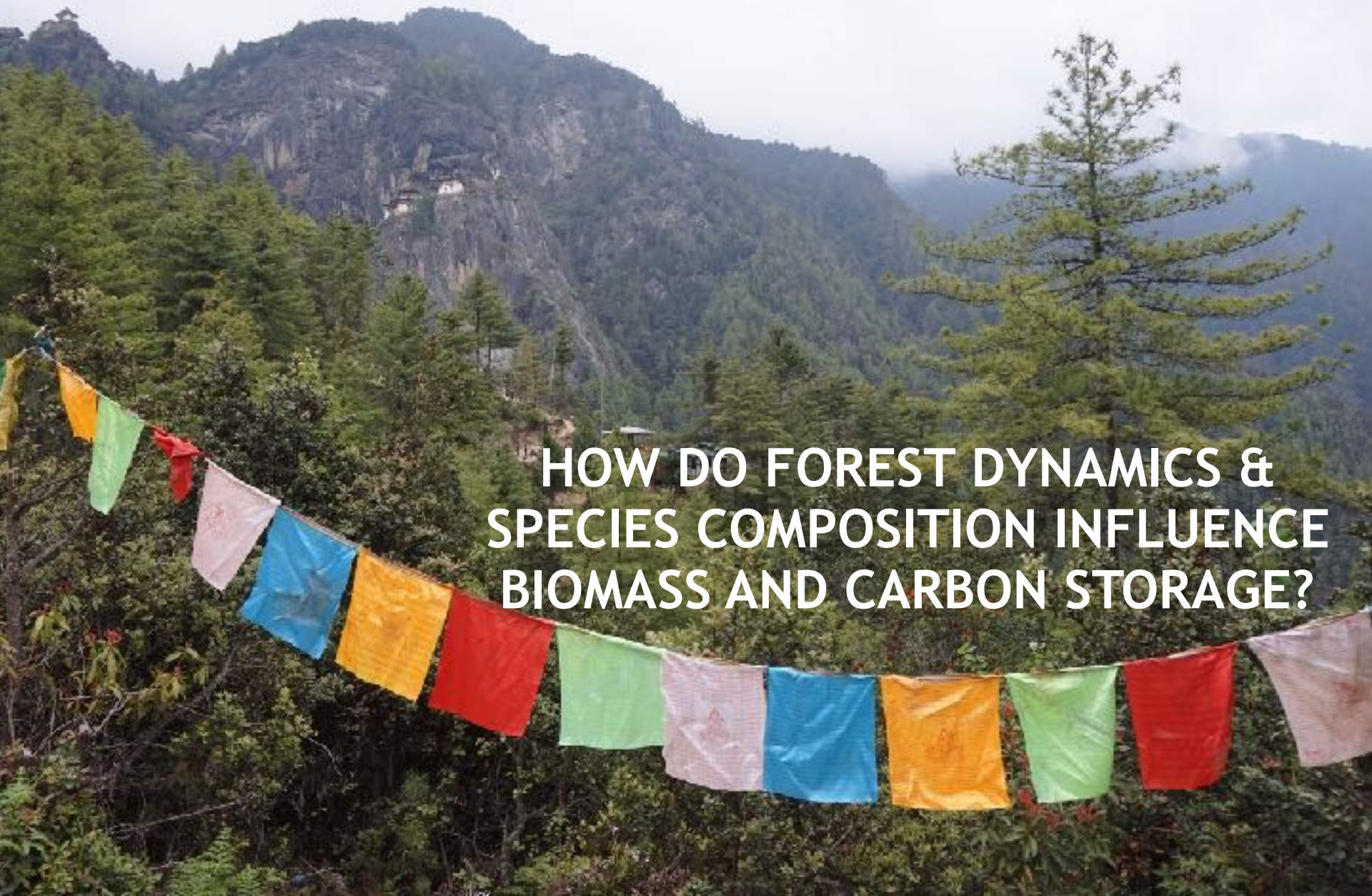


Hemlock chronology from all sites which is energy limited (ie Temp)



BHUTAN IS THE WORLD'S ONLY CARBON NEGATIVE COUNTRY IN THE WORLD

HOW DO FOREST DYNAMICS & SPECIES COMPOSITION INFLUENCE BIOMASS AND CARBON STORAGE?



Biomass

The total quantity or weight of organisms in a given area or volume

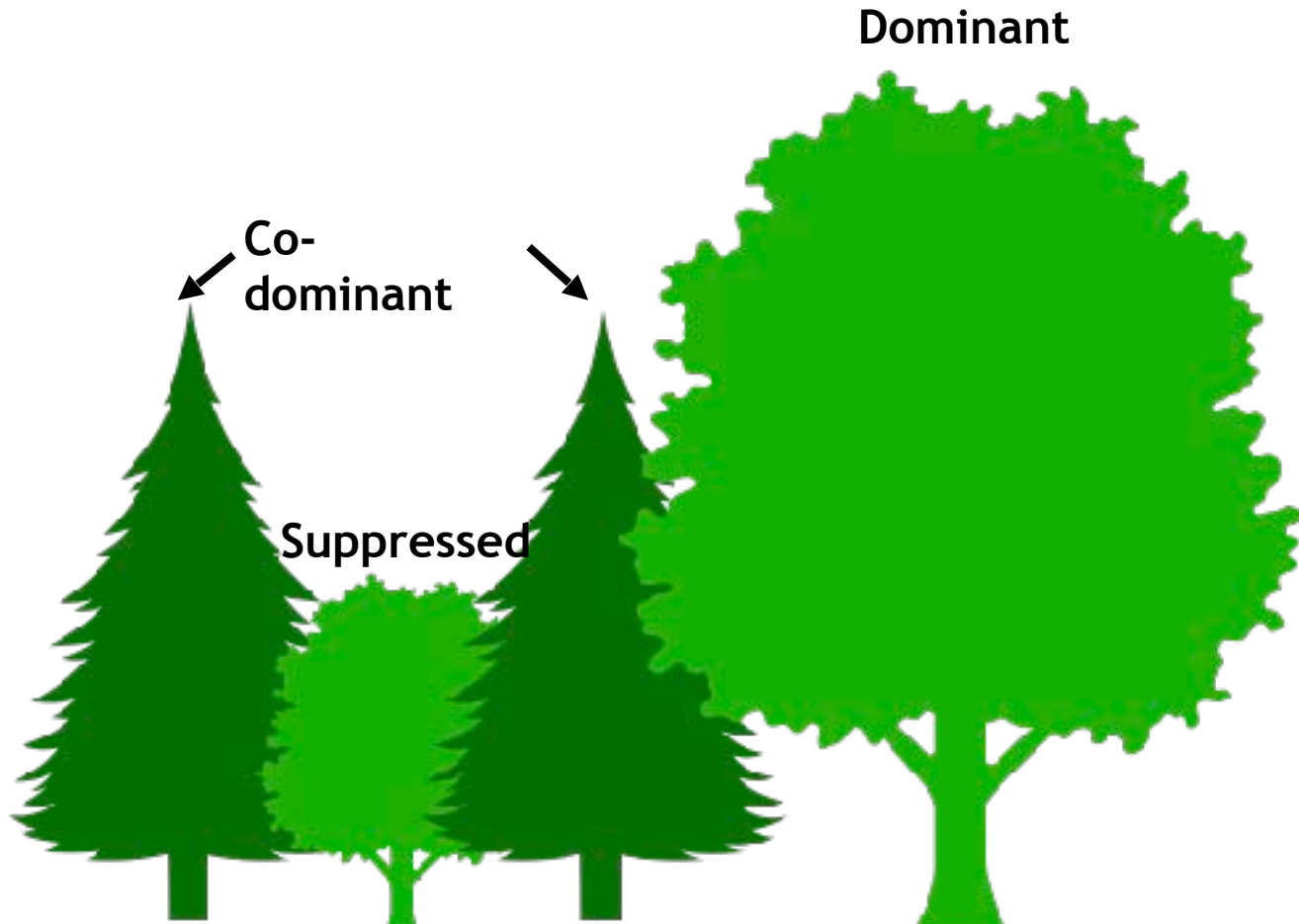
Carbon

Carbon is absorbed from the atmosphere through photosynthesis and is deposited in living forest biomass, dead organic matter (litter and dead wood), and in soils.

Carbon = 50% of biomass

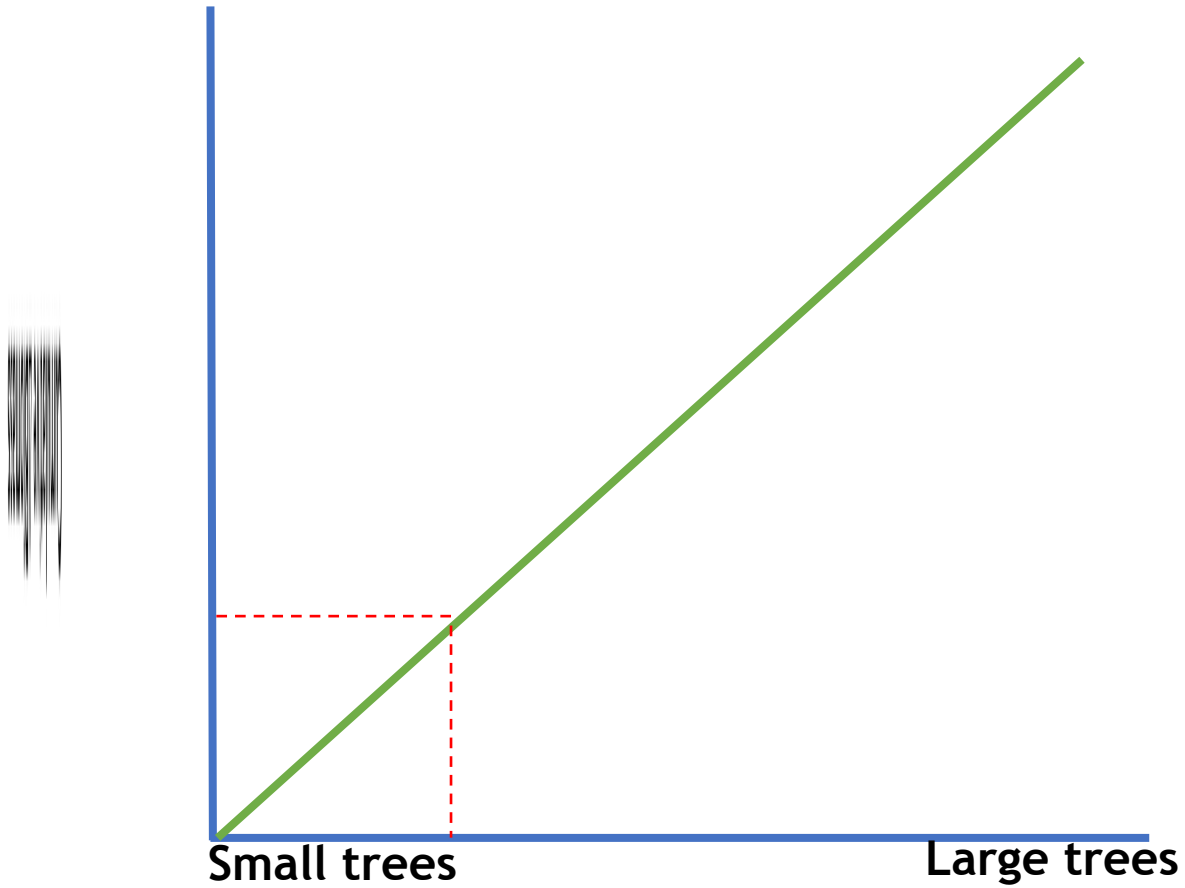


Structural vs. Functional Dominance



Growth Dominance

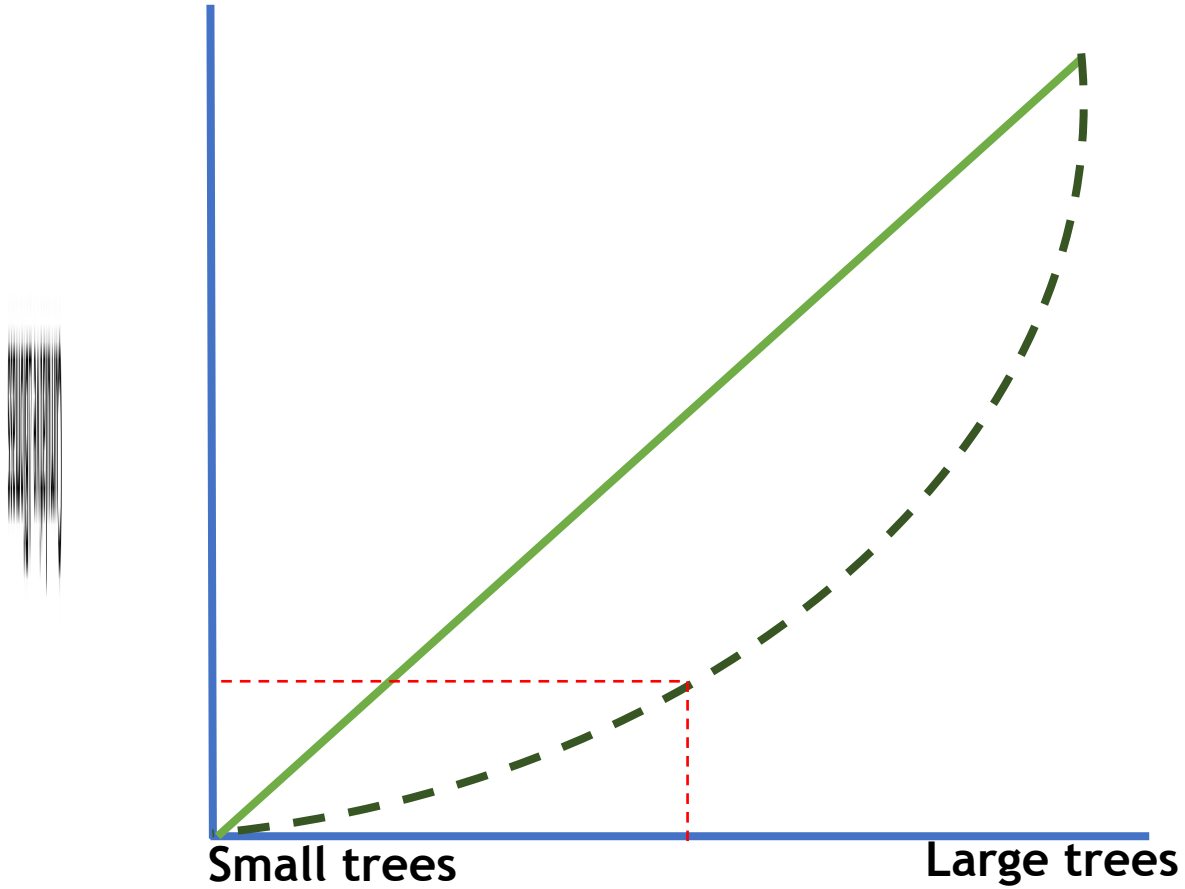
Cumulative Delta Biomass



Cumulative Stand Biomass

Growth Dominance

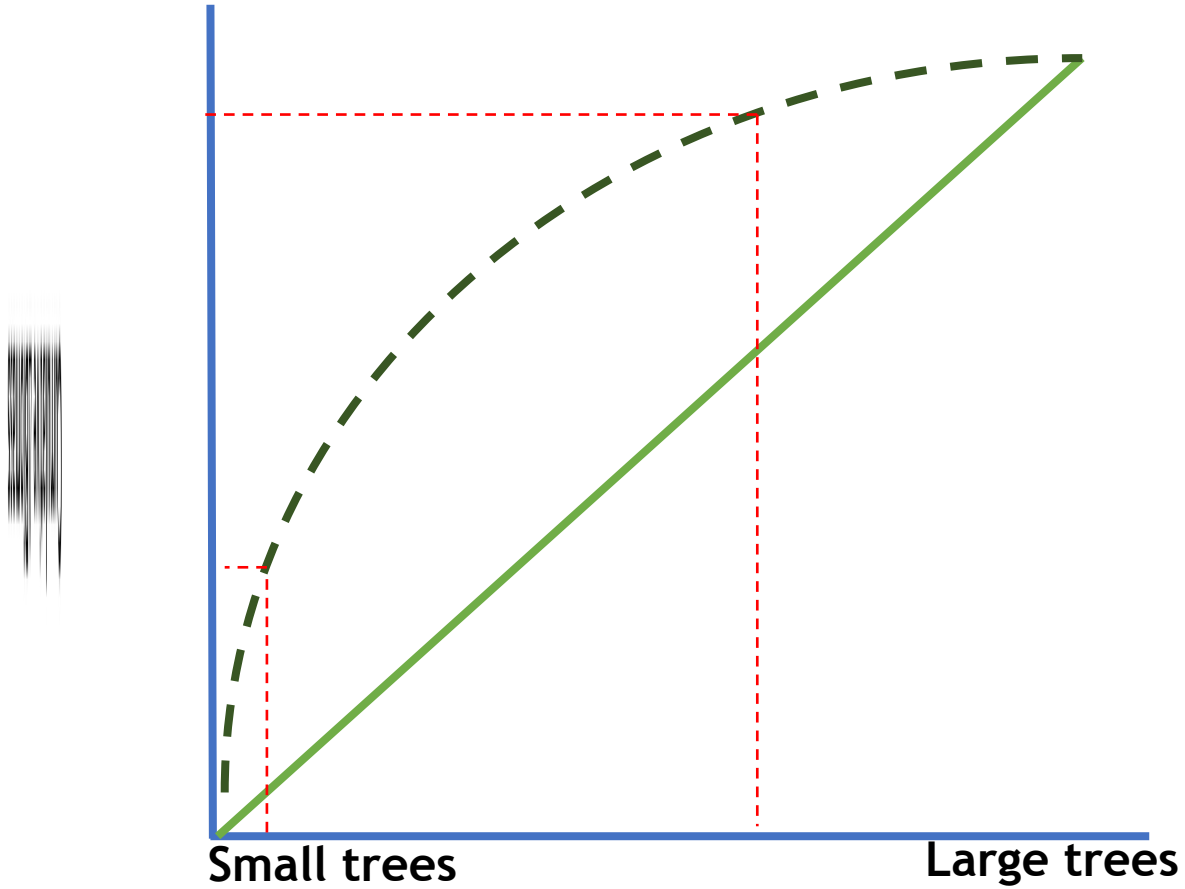
Cumulative Delta Biomass



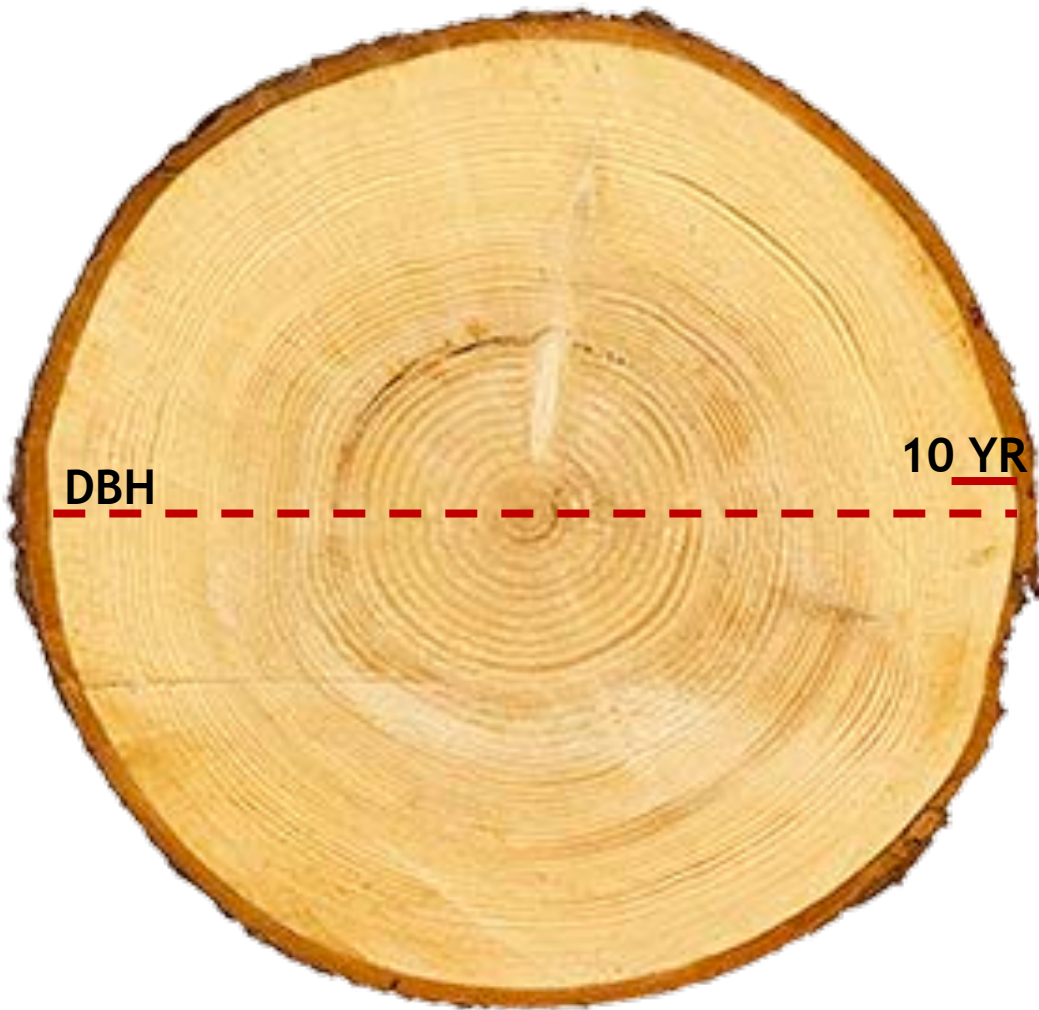
Cumulative Stand Biomass

Growth Dominance

Cumulative Delta Biomass



Cumulative Stand Biomass



Methods:

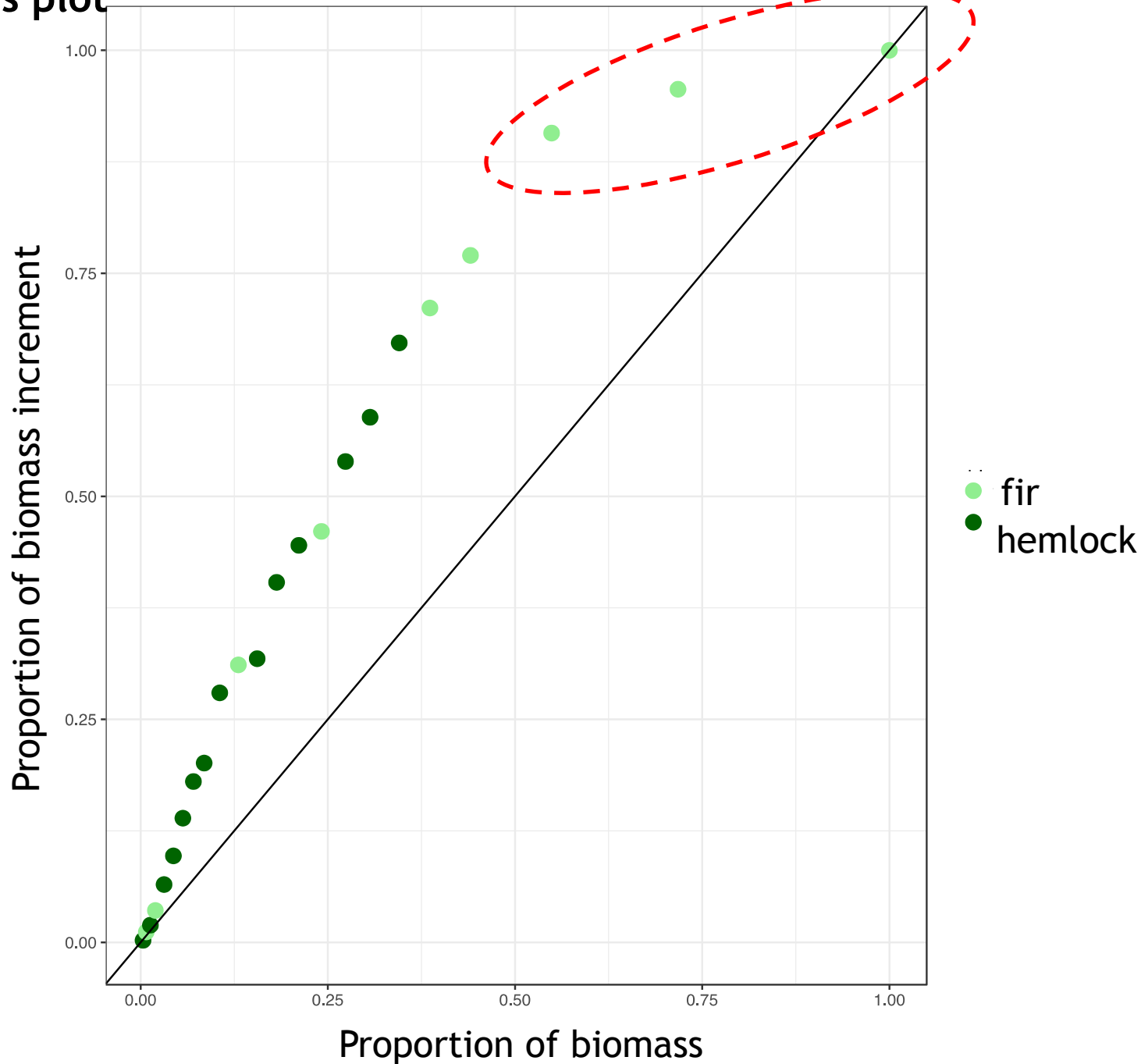
For each tree:

1. Measure and average outermost 10 rings (2008-2017)
2. Measure current DBH
3. Calculate 2008 DBH:
$$DBH_{2008} = DBH_{2017} - 2 * (\text{mean of 2008-2017 ring widths})$$
4. Estimate current year and 2008 biomass, we used allometric equations.
5. Calculate the difference in biomass between 2008 and 2017

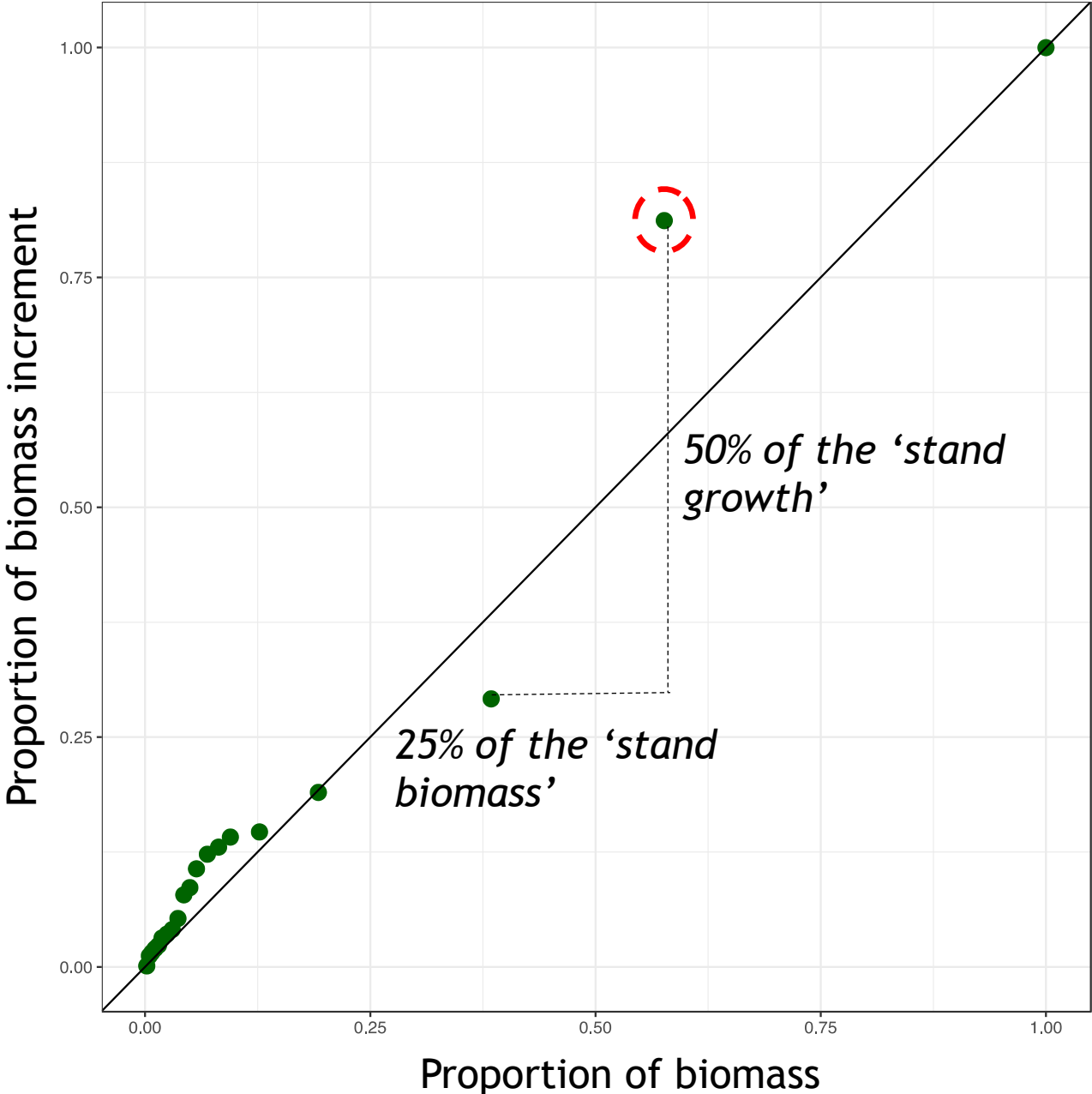
For each plot:

1. Calculate cumulative biomass

Mixed-species plot

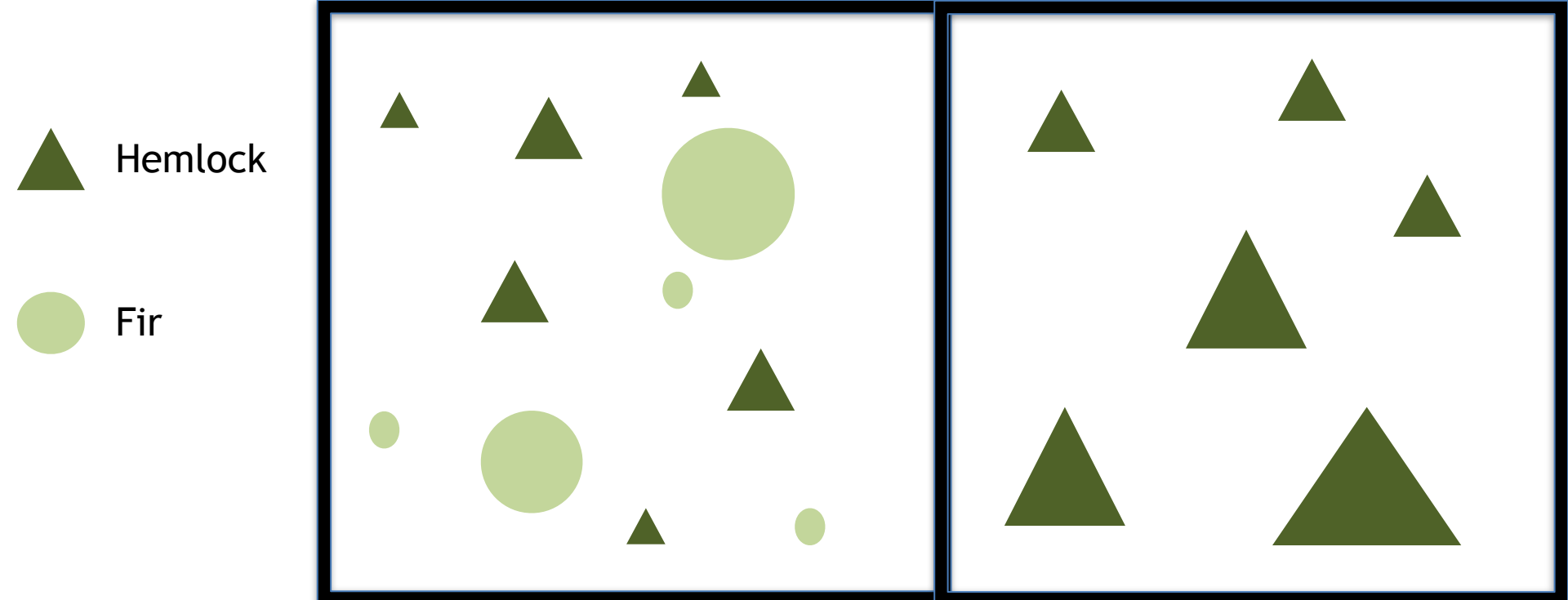


Hemlock plot






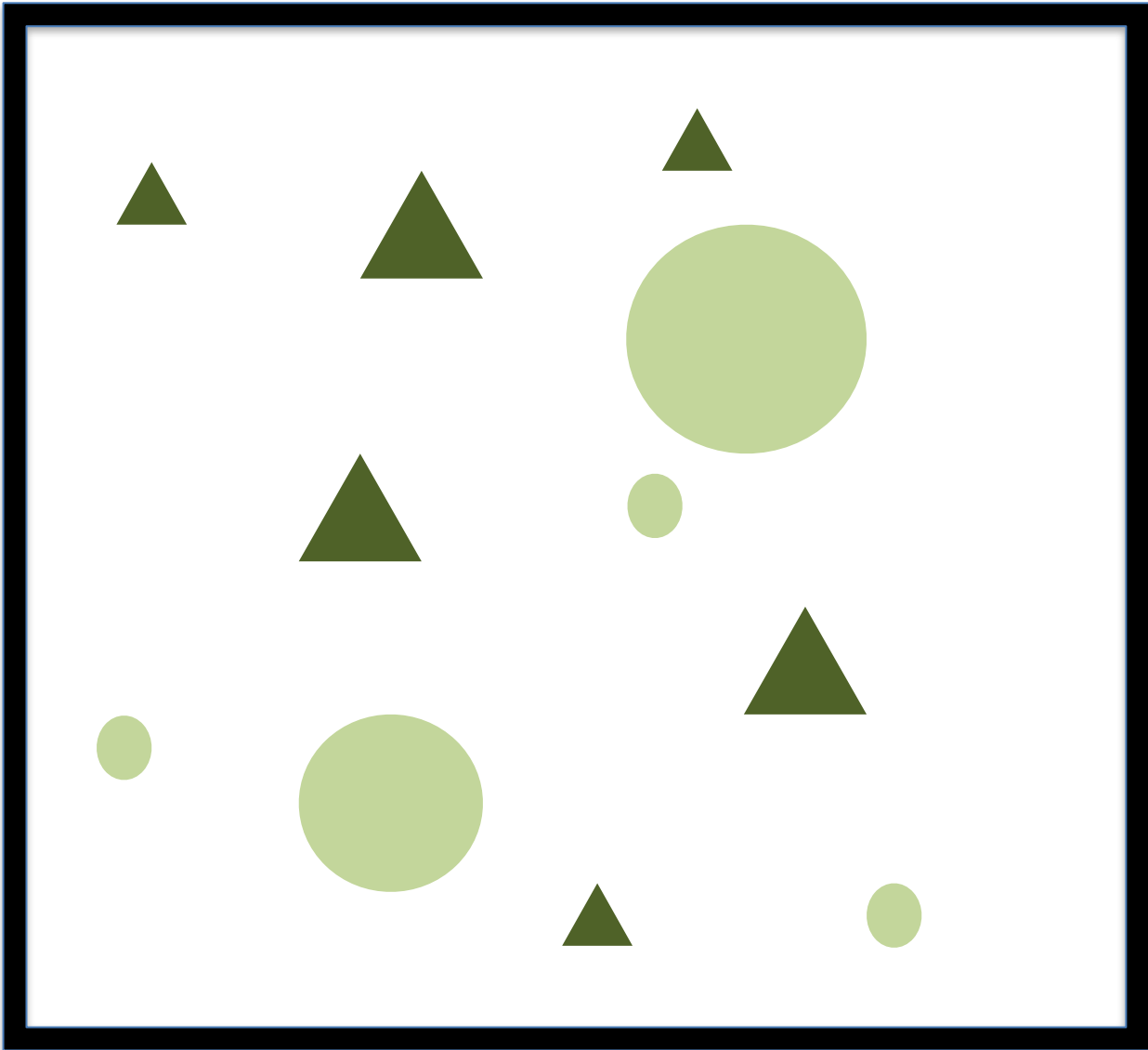
Amount per hectare	Mixed Conifer Stand	Hemlock Stand
kg of biomass	395,541	409,005
kg of carbon	197,770	204,502
# of trees	804	473
Annual kg biomass	5,758	3,674



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MIXED CONIFER STAND

-  Hemlock
-  Fir

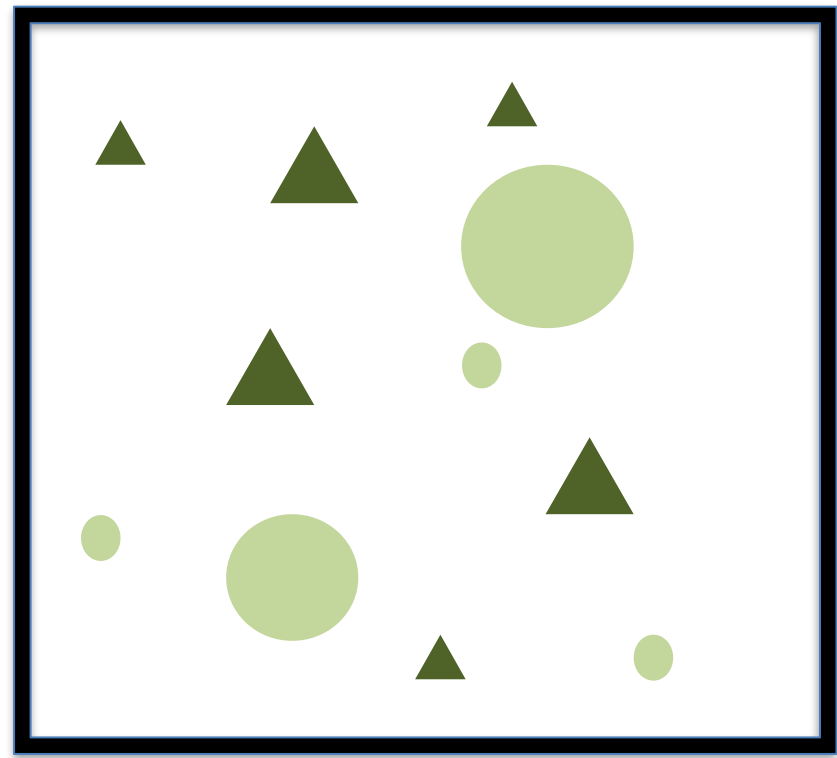




MIXED CONIFER STAND

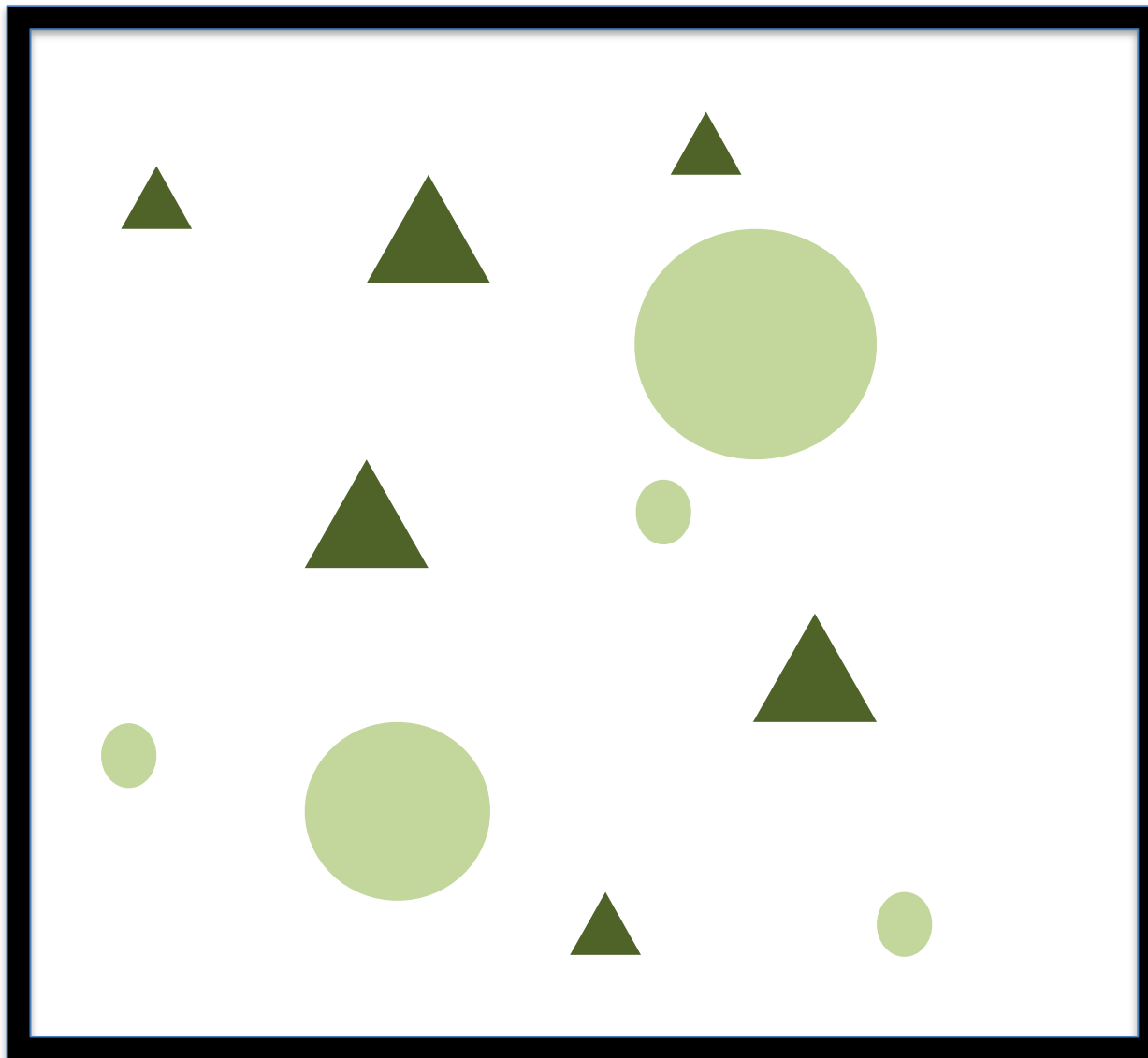
Size Class (DBH)	% of trees per hectare
0-32 cm	69%
32-68cm	28%
68+cm	3%

**NET ANNUAL CARBON
ACCUMULATION:
2879 kg C**



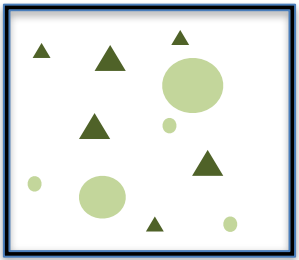
MIXED CONIFER STAND

-  Hemlock
-  Fir

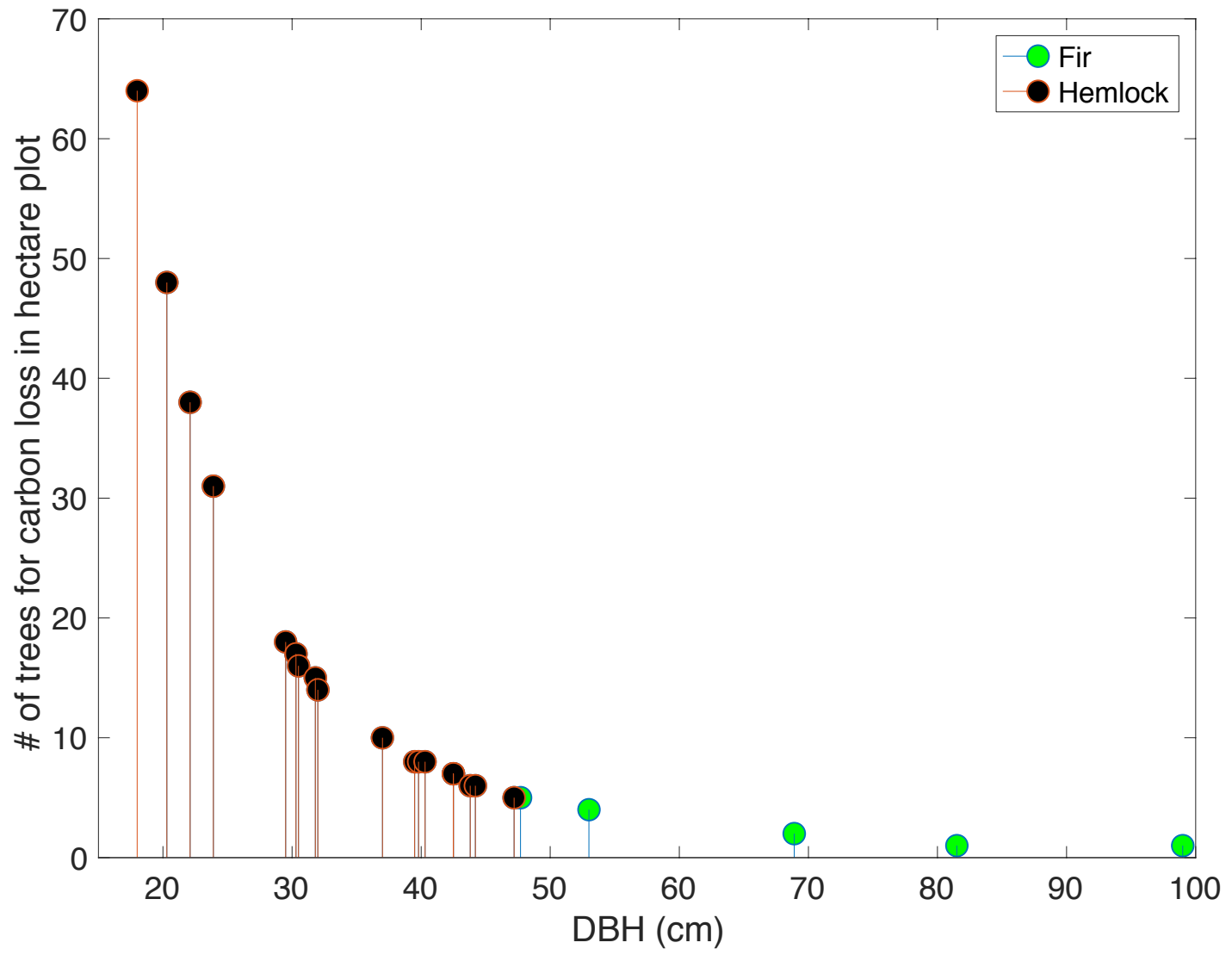


▲ Hemlock
● Fir

MIXED CONIFER STAND



2879 kg C

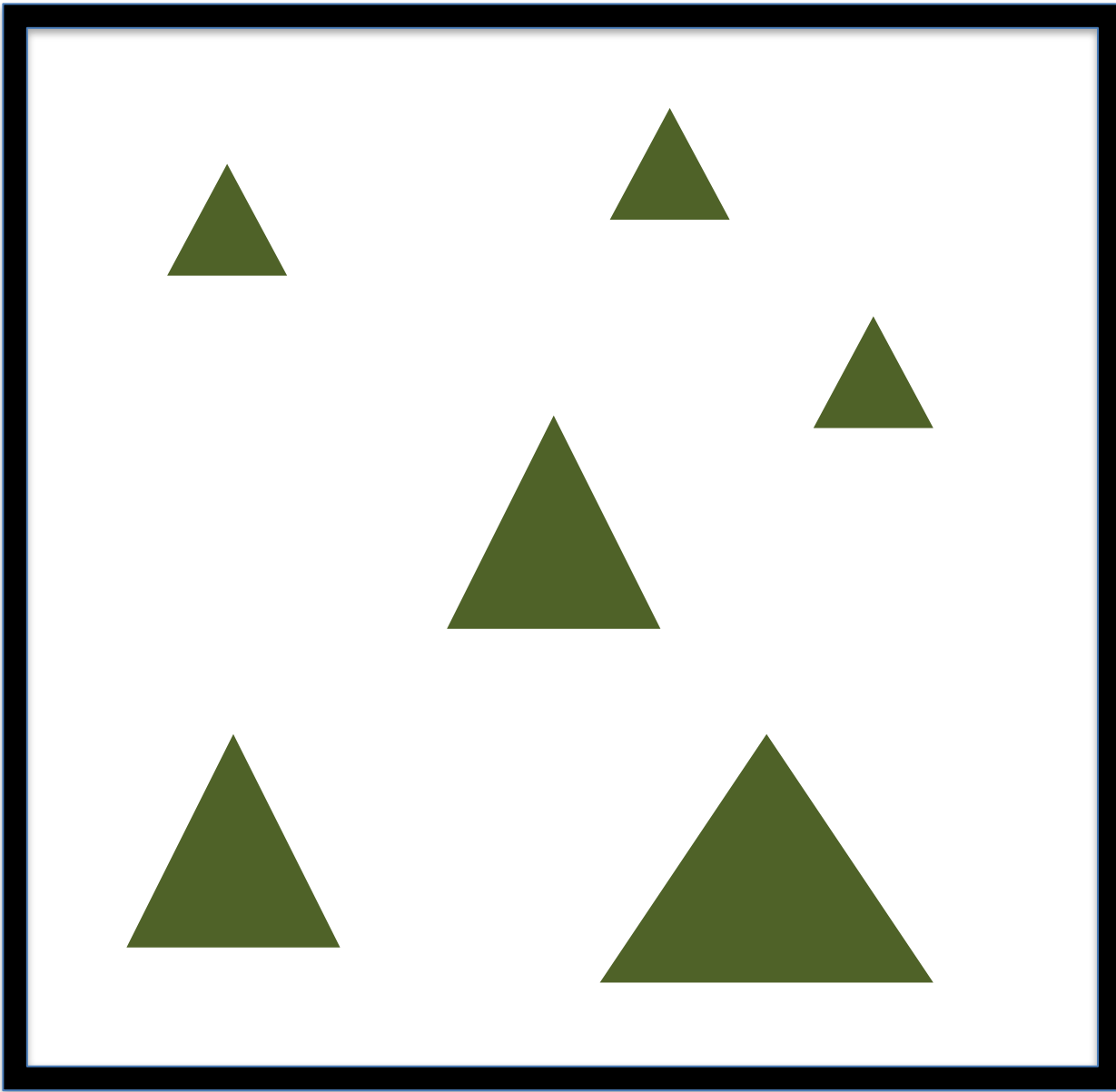




HEMLOCK STAND

 Hemlock

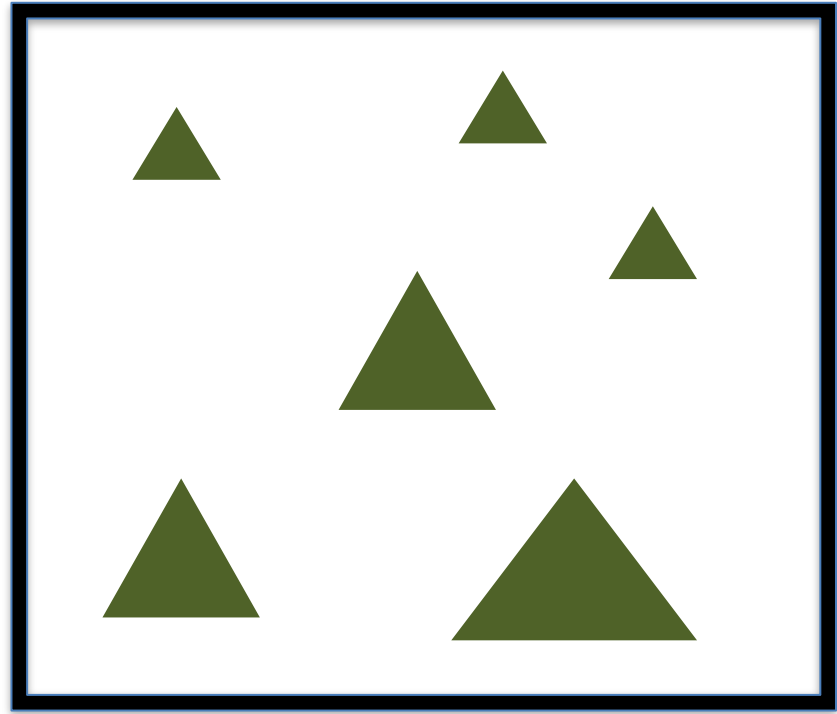
 Fir



 Hemlock
 Fir

HEMLOCK STAND

Size Class (DBH)	% of trees per hectare
0-32 cm	48%
32-68cm	48%
68+cm	3%

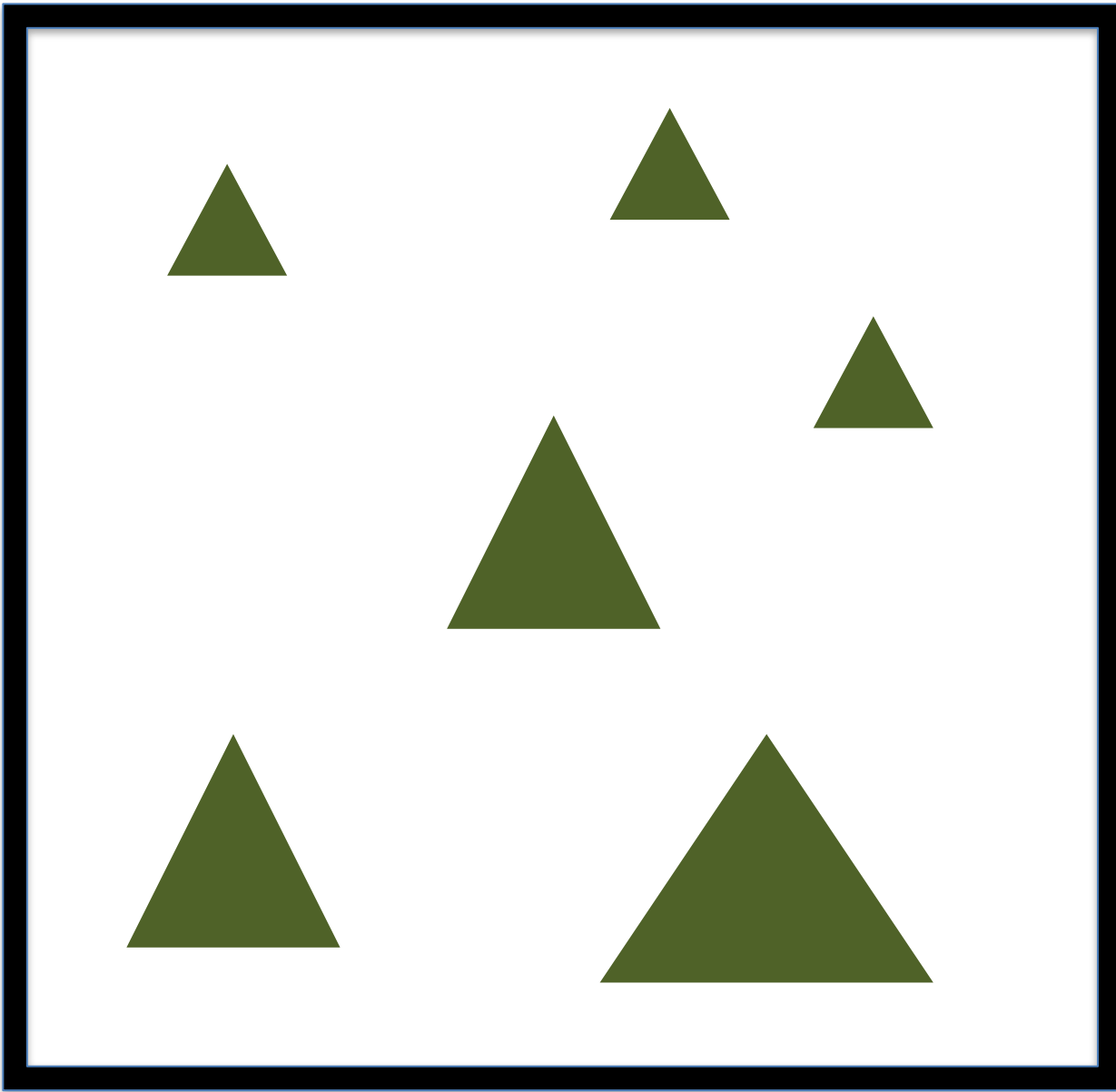


**NET ANNUAL CARBON
ACCUMULATION:
9184 kg C**

HEMLOCK STAND

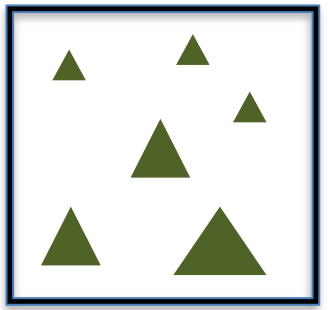
 Hemlock

 Fir

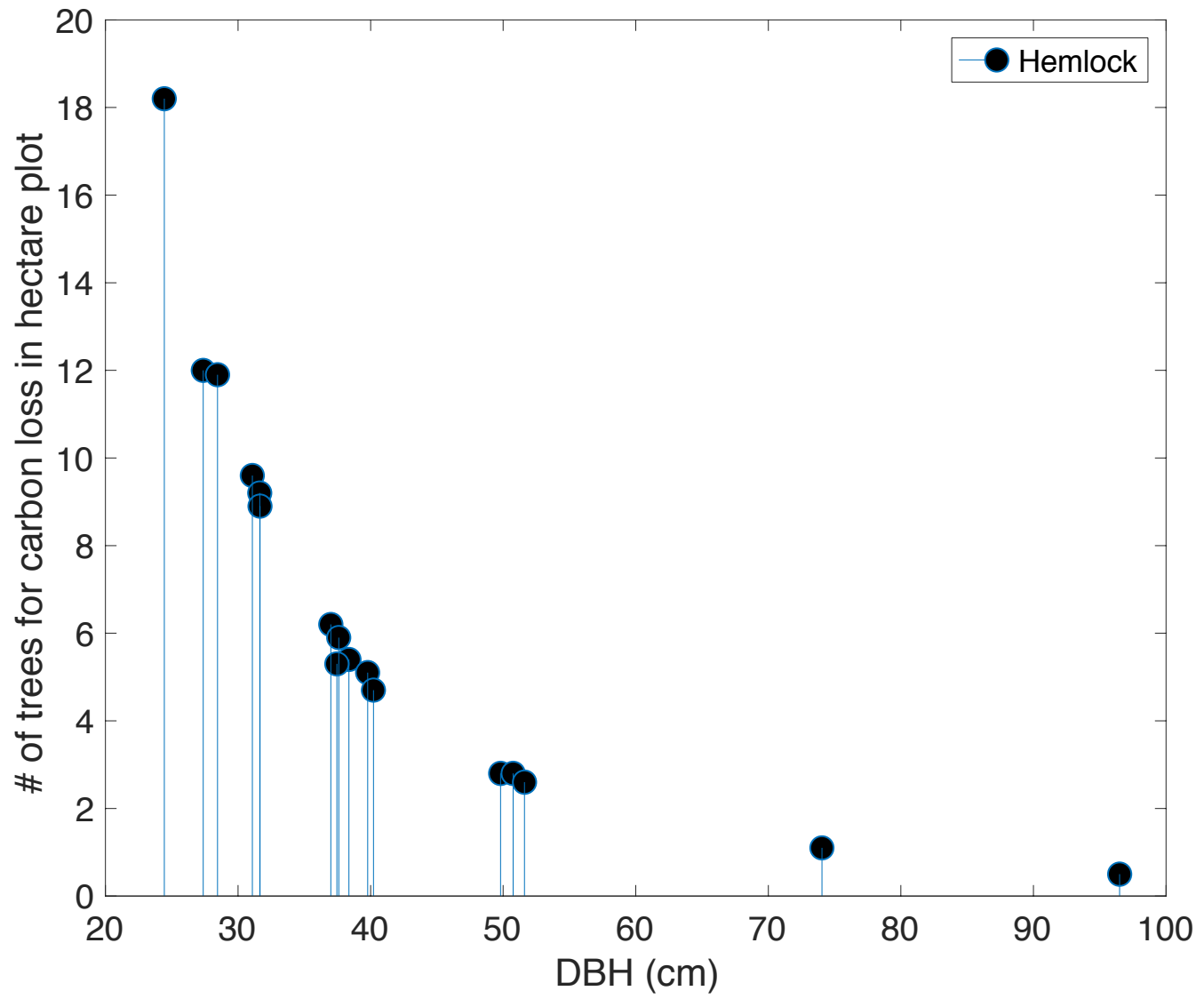


HEMLOCK STAND

▲ Hemlock
● Fir



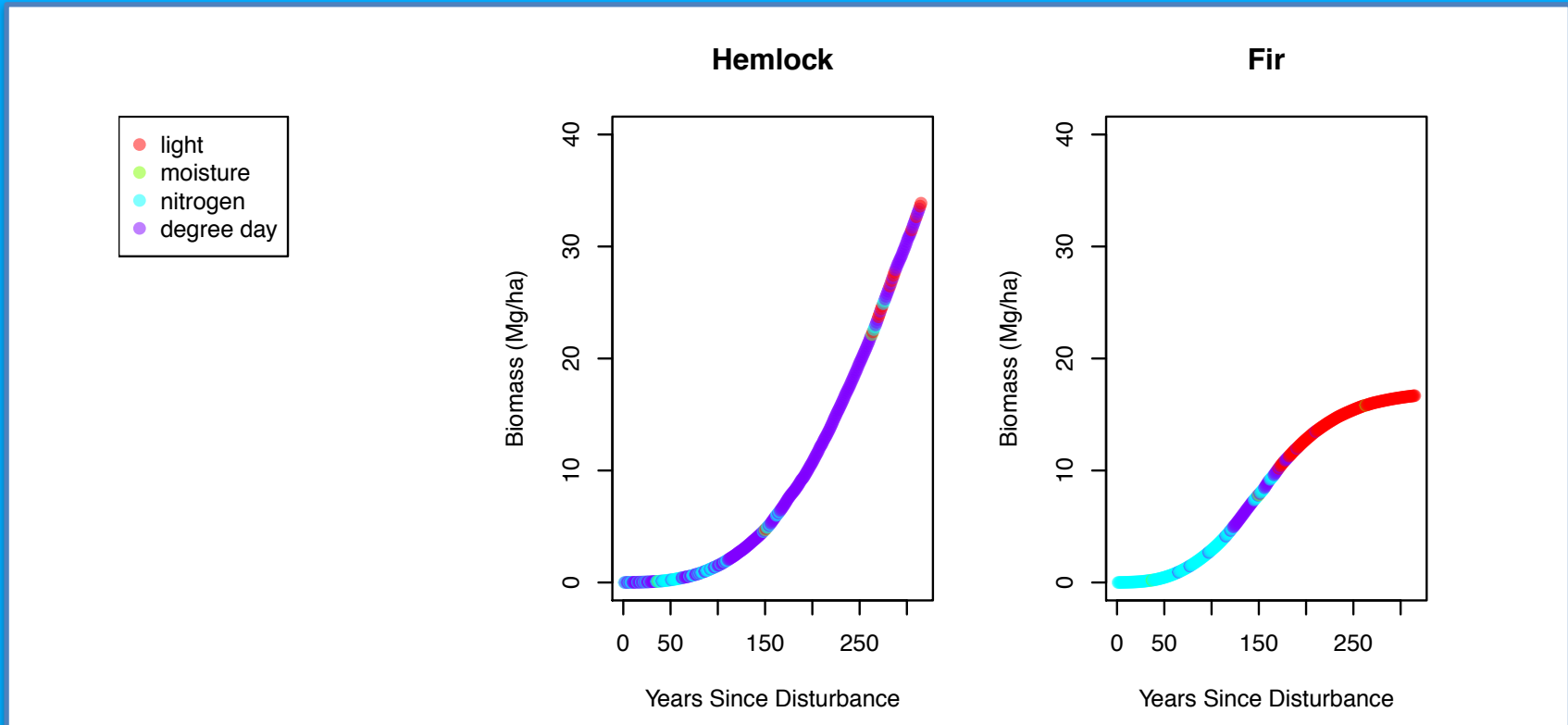
9184 kg C





LINKAGES

- forest gap model created in the 80's by John Pastor
- Uses Liebig's Law of the Minimum to determine which species dominates
- This simulation is parameterized using eastern forest information + max age from tree ring data collected in Bhutan
- LINKAGES hypothesizes that fir becomes light limited 150 years after disturbance while hemlock becomes light limited 300 years after disturbance
- Next step would be to incorporate *tree ring estimated biomass*.



Project Challenges

- Short time period
- New, unknown site, species, and climate
- Inexperience with dendroecology

conclusions

Future work



Tiger-yeti: Fact or Fiction?



Bumthang



Field sites/set up/pictures



Field sites/set up/pictures

