Development of native bee identification keys for the Pacific Northwest

Presenting:

Lincoln R. Best

James W. Rivers

Collaborators:

Josh Dunlap

August Jackson

Paul W. Williams

Oregon State University
Extension Service
Master Melittologist

Bombus ashtoni J.Gatten 2023

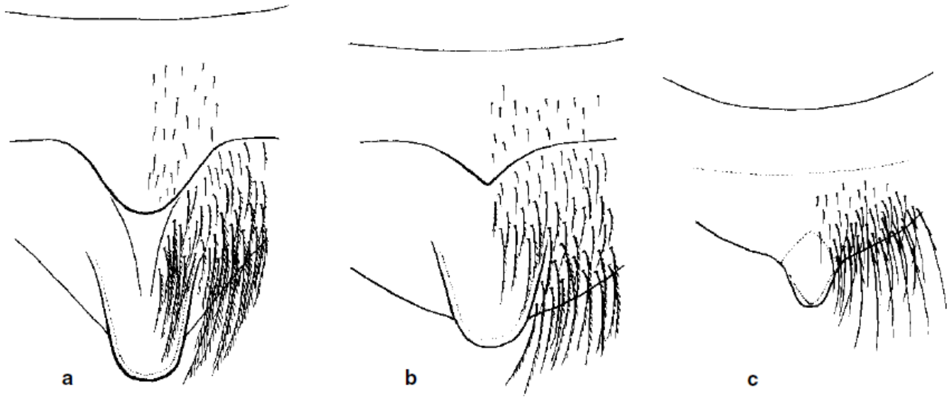
Oregon State University
College of Forestry

Available bee identification keys are challenging to use, even for experts

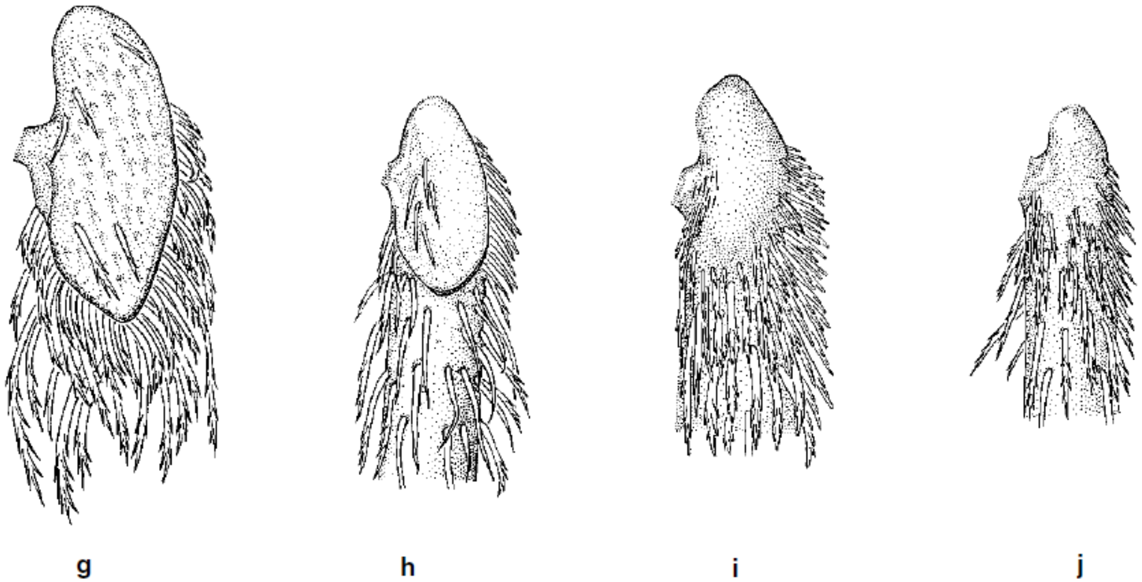
1. Scopa weak (Figs. 8-5a, 8-6) or absent; T5 with longitudinal median zone of fine punctation and short hairs weakly developed or absent; apical labral process without keel (as in Fig. 65-1i) or keel reduced to weak carina 2

—. Scopa present from hind trochanter to tibia (Fig. 8-5b), forming corbicula on underside of femur; T5 with well-developed longitudinal median zone of fine punctation and commonly short, dense hairs, this zone dividing prepygidial fimbria (Fig. 65-1j); apical labral process with strong longitudinal keel on anterior surface (Fig. 65-1a, b, e) 5

Idealized drawings often don’t work well in the real world



Pygidial plates



Basitibial plates

Key used to teach bee identification in Oregon Bee School

CANPOLIN - Bee Course 2012

Key to Bee Genera in Canada

The sexes in bees can generally be differentiated by counting the number of metasomal terga – 6 in females, 7 in males, or the number of apparent segments of the antenna – 12 in females, 13 in males (excluding *Holcopasites*). The second antennal segment is sometimes largely retracted within the first, particularly in some wasp-like bees.

1. Three submarginal cells (Fig. 1)...2

   One or two submarginal cells (Fig. 2)...33

Our project will create two wild bee identification keys, in both online and print formats

Generic-level key
for the PNW fauna

Species-level keys for:
Bombus ♀ and *Bombus* ♂

Images courtesy of ODA

Joshua Dunlap ODA

1

Abdomen with long ovipositor (females) (**a**)…..**2**

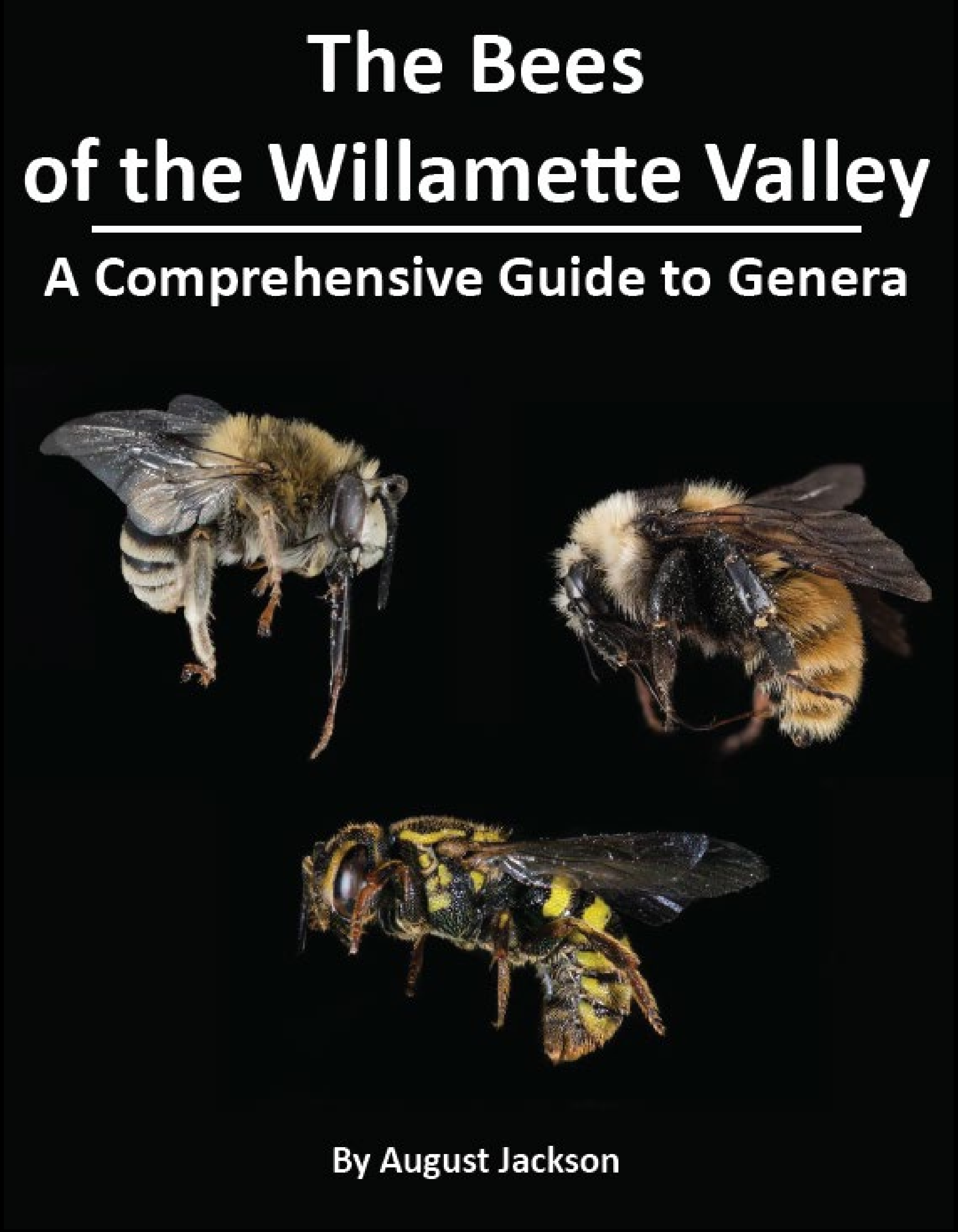
Abdomen without long ovipositor (males) (**b**)…...**Males***

*Males are rarely encountered or collected. Consequently, they will not be included in this key.

a.

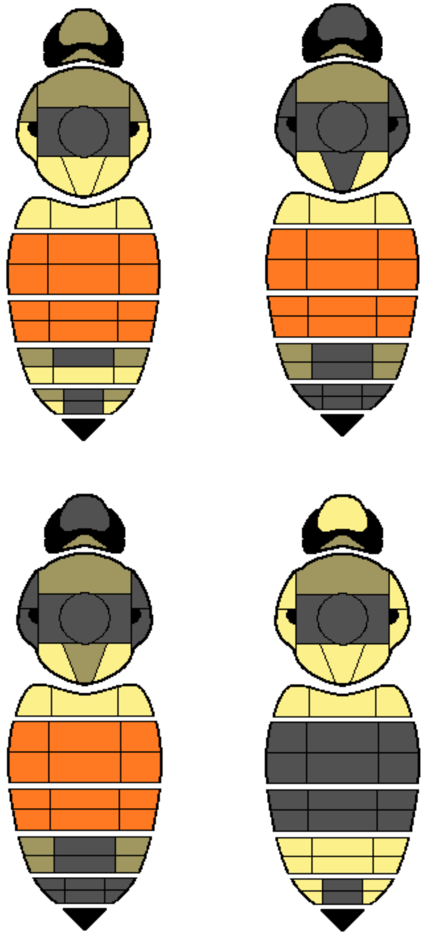
b.


August Jackson


The Bees
of the Willamette Valley
A Comprehensive Guide to Genera
By August Jackson

Bumble bee key encompasses 28 species and will leverage 473 existing ID templates from Paul Williams (NHM, London, UK)

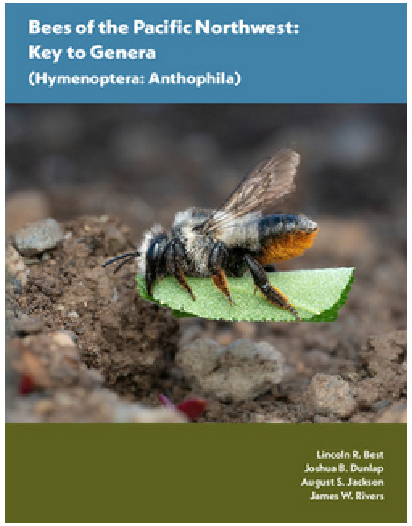
Black-tailed Bumble Bee
(Bombus melanopygus)



Images courtesy of ODA and Paul Williams

Technical Report

Bees of the Pacific Northwest : key to genera (Hymenoptera : Anthophila) Public Deposited



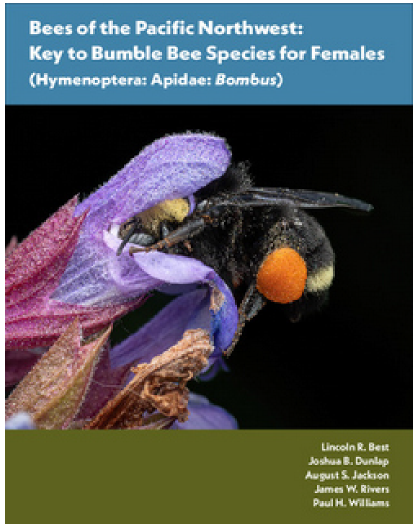
Citeable URL: https://ir.library.oregonstate.edu/concern/technical_reports/xg94hz59f

Descriptions

Attribute Name	Values
Creator	Best, Lincoln R. Dunlap, Joshua B. Jackson, August S. Rivers, James W.
Abstract	This key to the bee genera of the Pacific Northwest provides dichotomous couplets which aid the user in identifying 60 genera of bees which occur or may occur in the region. The key architecture is based strongly on the key to the genera of North and Central America published in McGinley, Michener, and Danforth (1994). Stephen, Bohart, and Torchio (1969) provided the first key to bee genera in the Pacific Northwest. Despite numerous taxonomic revisions, identification tools for the region have not been updated in more than 50 years.

Technical Report

Bees of the Pacific Northwest : key to bumble bee species for females (Hymenoptera : Apidae : Bombus) Public Deposited



Descriptions

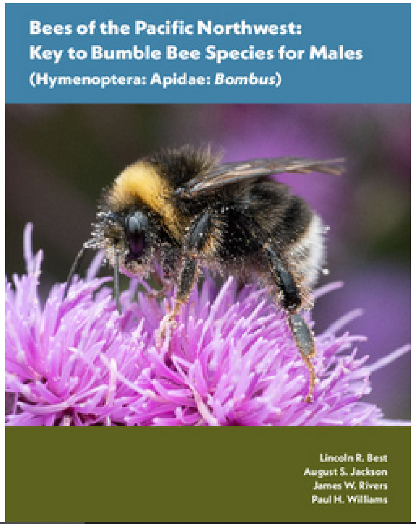
Attribute Name	Values
Creator	Best, Lincoln R. Dunlap, Joshua B. Jackson, August S. Rivers, James W. Williams, Paul H.

Abstract This species key to female bumble bees of the Pacific Northwest provides dichotomous couplets which aid the user in identifying 27 species which occur or have occurred historically, and may still be present in the region. The key architecture is based strongly on the key to species for females

Technical Report

Bees of the Pacific Northwest : key to bumble bee species for males (Hymenoptera : Apidae : Bombus)

Public Deposited



Citeable URL: https://ir.library.oregonstate.edu/concern/technical_reports/6q182v23p

Descriptions

Attribute Name	Values
Creator	Best, Lincoln R. Jackson, August S. Rivers, James W. Williams, Paul H.
Abstract	This species key to male bumble bees of the Pacific Northwest provides dichotomous couplets which aid the user in identifying 27 species which occur or have occurred historically, and may still be present in the region. The key architecture is based strongly on the key to species for males found in Williams et al. (2014).

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To Do

Nothing for now

REQUIREMENT 1: COMPLETE SIX SELF-PACED TRAINING MODULES

Six self-paced online modules are provided in Canvas. All six modules must be completed and passed with a minimum grade of 85% for certification. It is strongly encouraged that modules 1-3 be completed prior to attending your first field training event.

Suggested to complete in spring (before field season begins):

Module 1: Why become a Master Melittologist

Module 2: Catching bees and preparing specimens

Module 3: Entering and verifying records

Suggested to complete during summer:

Module 4: Surveying for wild bees

Suggested to complete in the fall and winter:

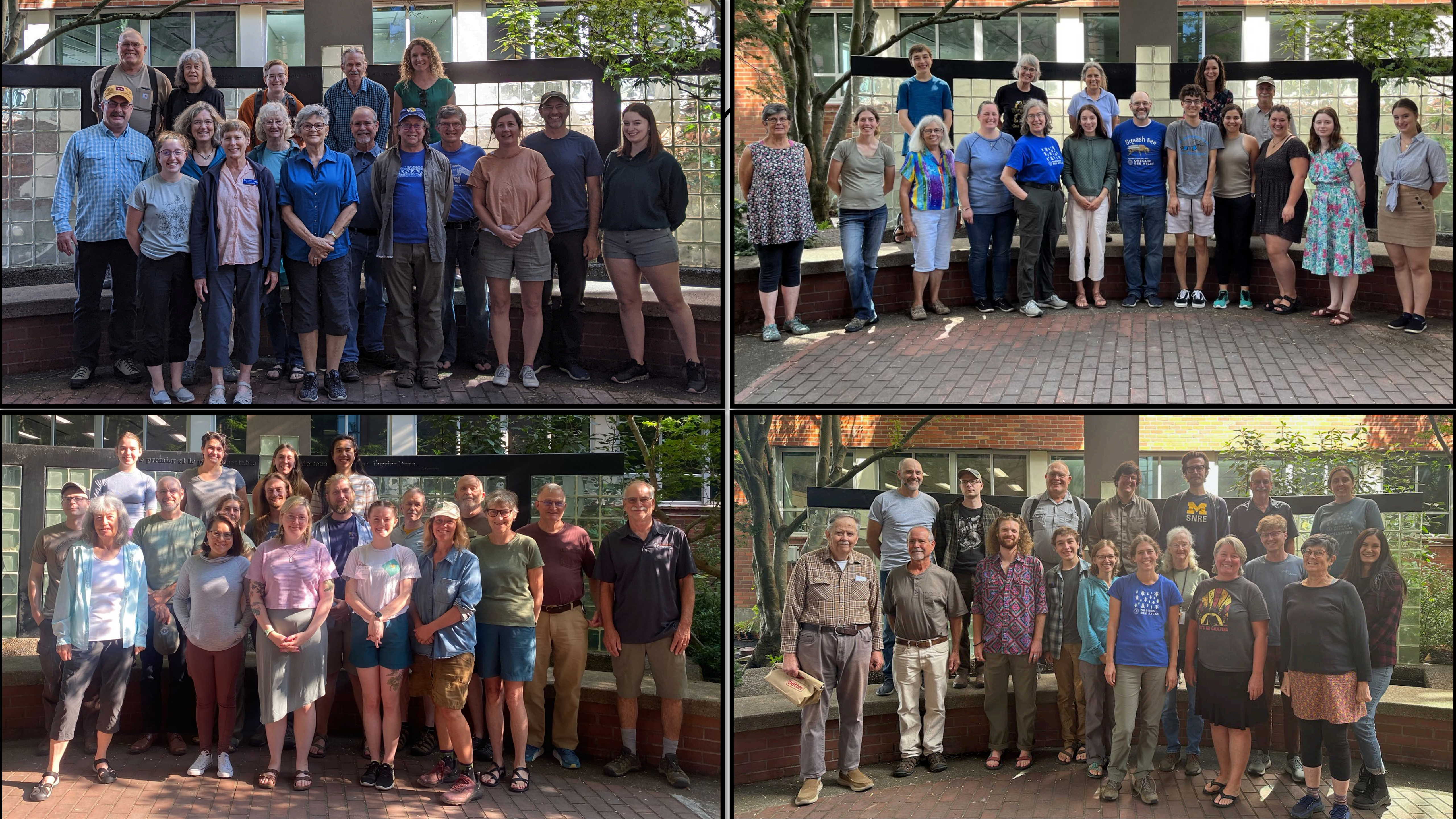
Module 5: Intro to taxonomy and curating your first collection of bees

Module 6: Bee Biology 101

To satisfy this requirement, module completion should be reported here.

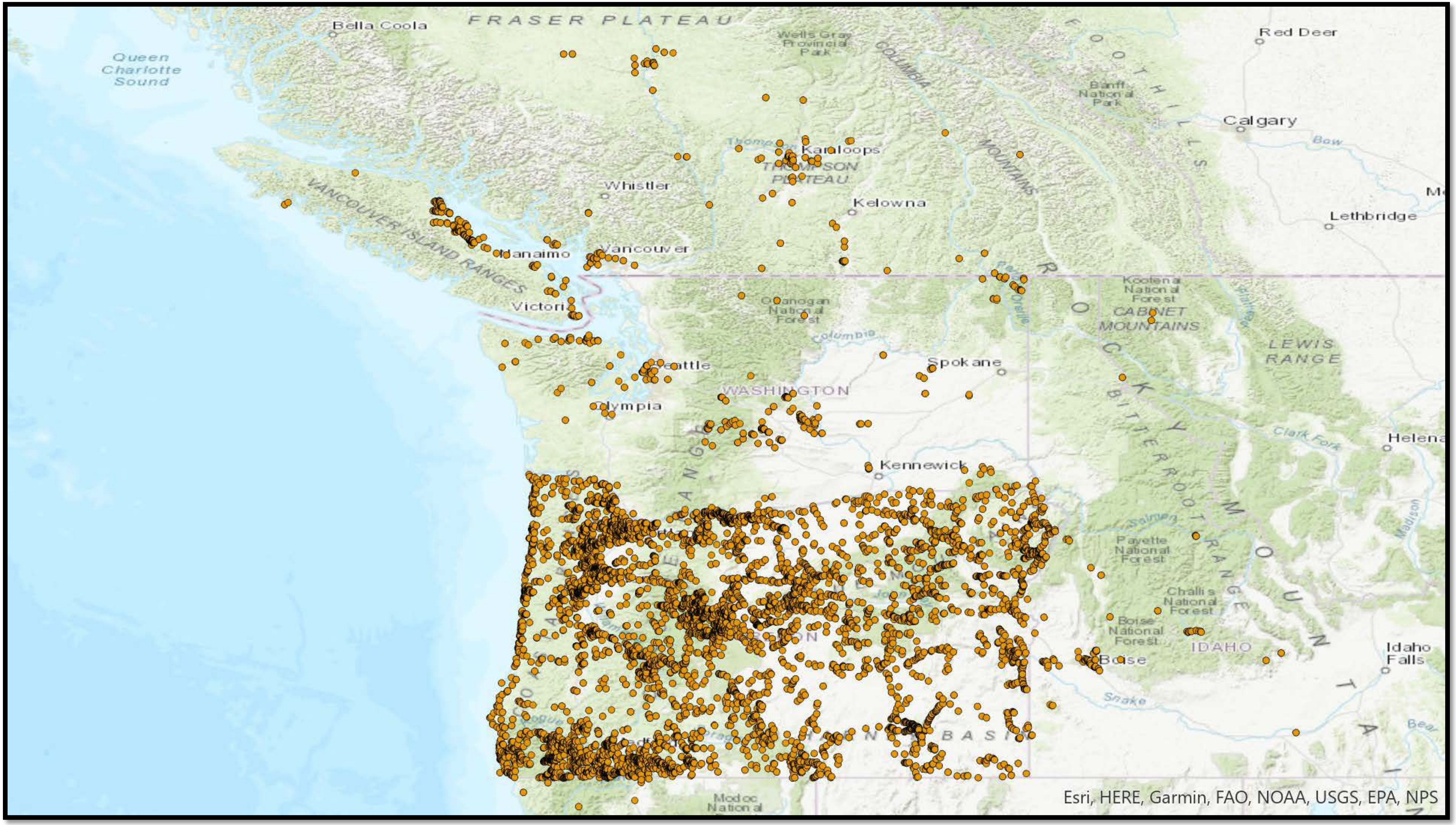
REQUIREMENT 2: ATTEND A MINIMUM OF (1) FIELD TRAINING EVENT

A variety of field training events are offered throughout the collection season (typically spring through fall). To learn about these events, including how to sign up, see the Calendar of Events in


Squash Bee
OREGON BEE ATLAS
SNRE


NO SMOKING
OCEANSIDE
SURF CO.
AILEY ISLAN


Native Bee Society
of British Columbia


Bella Coola
FRASER PLATEAU
Queen Charlotte Sound
Wells Gray Provincial Park
COLUMBIA
FOOTHILLS
Red Deer
Banff National Park
Calgary
Bow
Kamloops
THOMPSON PLATEAU
Whistler
VANCOUVER ISLAND RANGES
Kelowna
MOUNTAINS
Lethbridge
Nanaimo
Vancouver
Victoria
Okanogan National Forest
Kootenai National Forest
CABINET MOUNTAINS
Columbia
LEWIS RANGE
Seattle
Spokane
WASHINGTON
Olympia
Clark Fork
Helena
Kennewick
Payette National Forest
Challis National Forest
Boise National Forest
IDAHO
Boise
Idaho Falls
Snake
BASIN
Modoc National
Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, NPS

What’s next?

Keys to subgenera and species for Oregon *Lasioglossum* subgenera: *Evylaeus, Hemihalictus,* and *Sphecodogastra*

Many thanks…

<u>Funding and in-kind support:</u>

Oregon Department of Agriculture, Oregon State Arthropod Collection, Oregon Bee Project, Oregon Forest Resources Institute, OSU Extension

<u>Logistical support:</u>

J. Labonte, C. Marshall, A. Melathopoulos, J.Vlach

Images courtesy of ODA

Red Tree Voles in Fragmented Forests

Jason Piasecki[1,2], John Bailey PhD[2], Katie Dugger PhD[2], Katie Moriarty PhD[1,2]

[1] National Council for Air and Stream Improvement (NCASI)
[2] Oregon State University, College of Forestry

NCASI
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OSU
Oregon State UNIVERSITY
College of Forestry

7 August 2023
MS Defense – Sustainable Forest Management

Red tree vole (*Arborimus longicaudus*)

Tree vole nests

- Construct nests in live crown
- Spend most of their time in nests
  - Reproduction and rearing young
  - Cover and concealment from predators
  - Sleeping/resting
- Often supported by tree structures (e.g. cavities, split trunks)
- Indicator of tree vole population dynamics

Old forests (≥80 years)

Young forests (<80 years)

Study Objectives

1. **Estimate arboreal and tree vole nest persistence (survival)**

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2. **Evaluate nest construction and use by other arboreal species**

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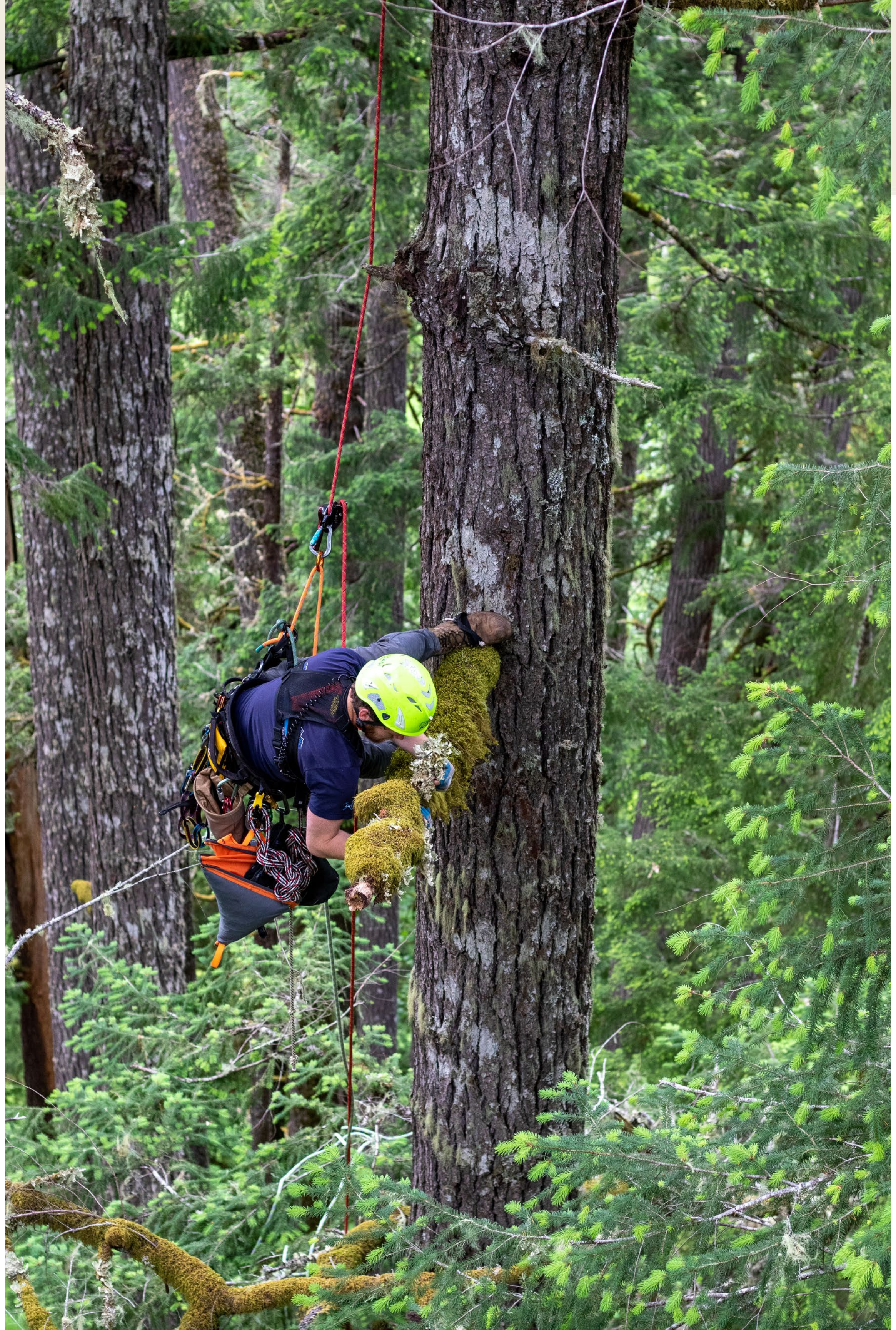
1. Estimate arboreal and tree vole nest persistence (survival)
2. Evaluate nest construction and use by other arboreal species
3. **Estimate detection rates of arboreal nests**



Study Objectives

1. Estimate arboreal and tree vole nest persistence (survival)
2. Evaluate nest construction and use by other arboreal species
3. Estimate detection rates of arboreal nests
4. **Assess survey effort required to classify stand occupancy by tree voles**

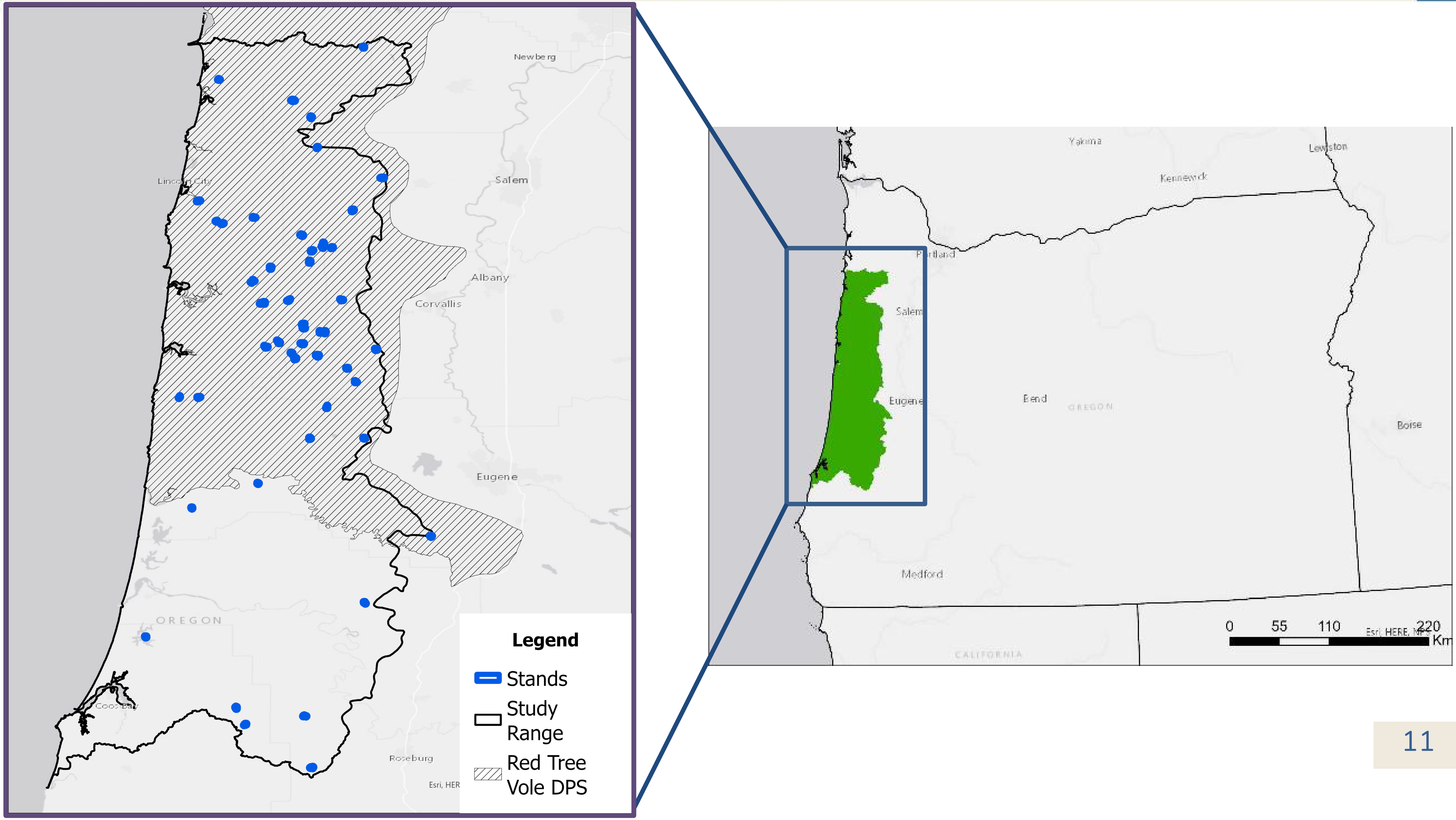
Study Objectives

1. Estimate arboreal and tree vole nest persistence (survival)
2. Evaluate nest construction and use by other arboreal species
3. Estimate detection rates of arboreal nests
4. Assess survey effort required to classify stand occupancy by tree voles
5. **Estimate tree vole occupancy in young forest**

Study Objectives

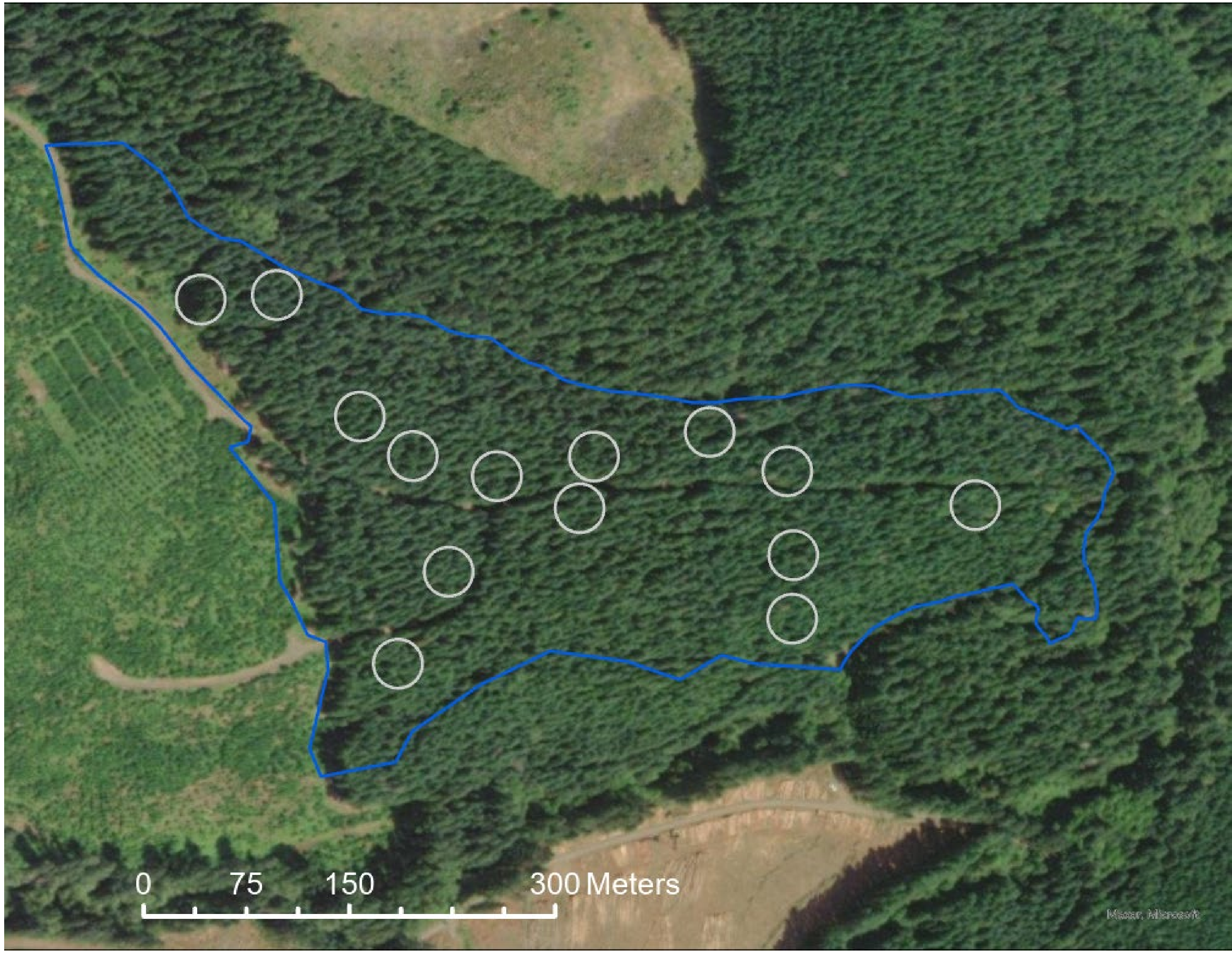
1. Estimate arboreal and tree vole nest persistence (survival)
2. Evaluate nest construction and use by other arboreal species
3. Estimate detection rates of arboreal nests
4. Assess survey effort required to classify stand occupancy by tree voles
5. Estimate tree vole occupancy in young forest
6. **Estimate arboreal and tree vole nest density**

Project Study Range



Stand selection

- Collaboration!
  - Federal (USFS, BLM)
  - State (ODF)
  - Private (Weyerhaeuser, Manulife, Starker, Hampton, Lone Rock)
- Age classes 20-29, 30-39, 40-49, 50-59, 60-79, >80
- Distance from old forest 0-5000m
- Random 1km^2 plots (1/ha)



Surveying for arboreal nests and red tree voles

Surveying for nests in young forests

- Ground based search
- All nests in live crown climbed
- Cameras installed to confirm tree vole occupancy

Surveying for nests in old forests

- Canopy based search
- All nests in live crown climbed
- Cameras installed to confirm tree vole occupancy

Resin ducts

Douglas-fir cuttings

Project Summary

- 2019 to 2022 (22 months total)
- 63 stands surveyed (153 surveys)
- 6179 trees surveyed
- 1044 individual nests climbed
- 2048 nest survey points over study

Objective 1: Arboreal and tree vole nest persistence

Arboreal nest persistence and red tree voles

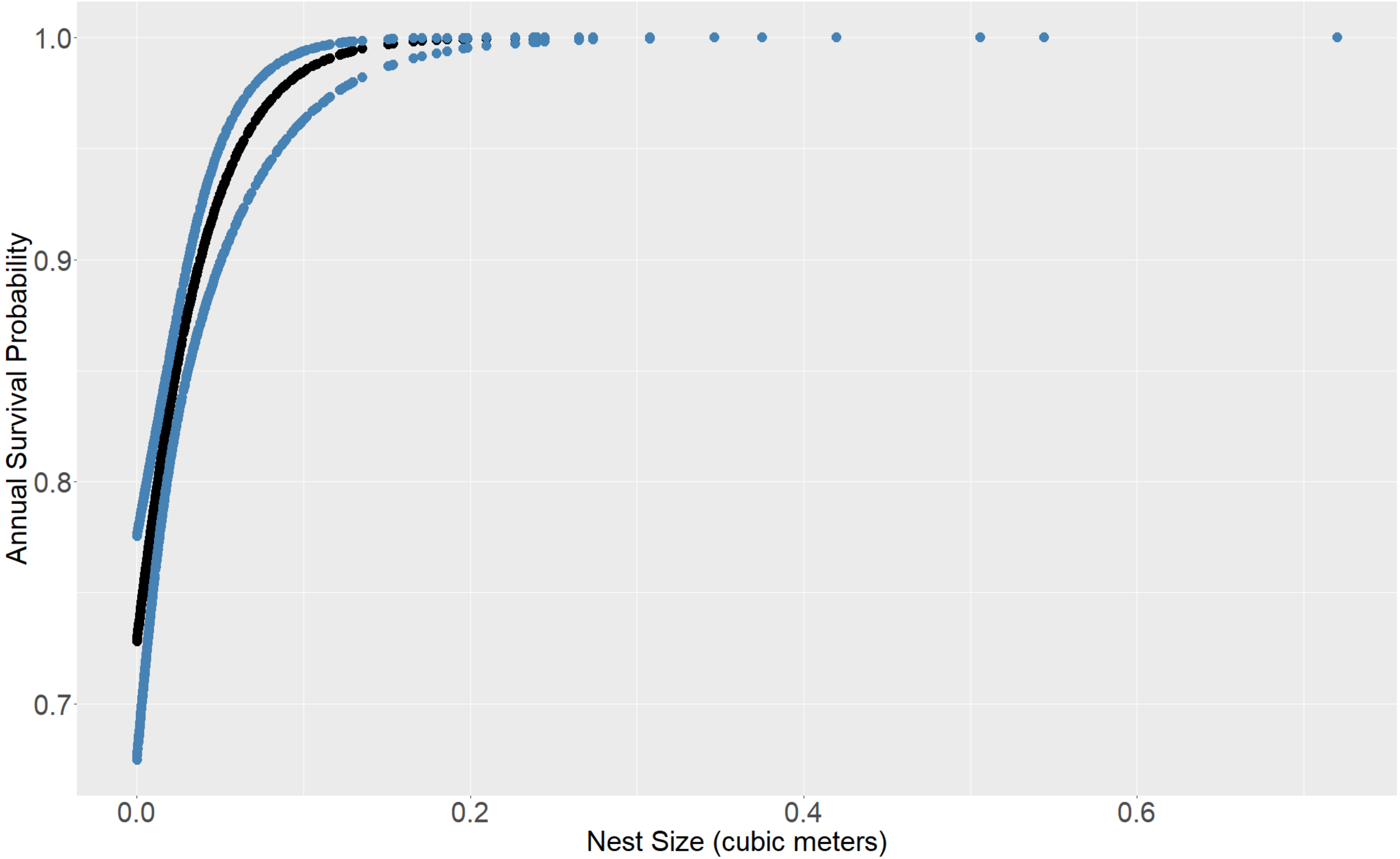
- Longevity of nests on the landscape

- Nest platform availability

- Limited nest space in young forest (Linnell et al. 2018)

Arboreal nests

S(nest_size), AICc 61.79%



Arboreal nests

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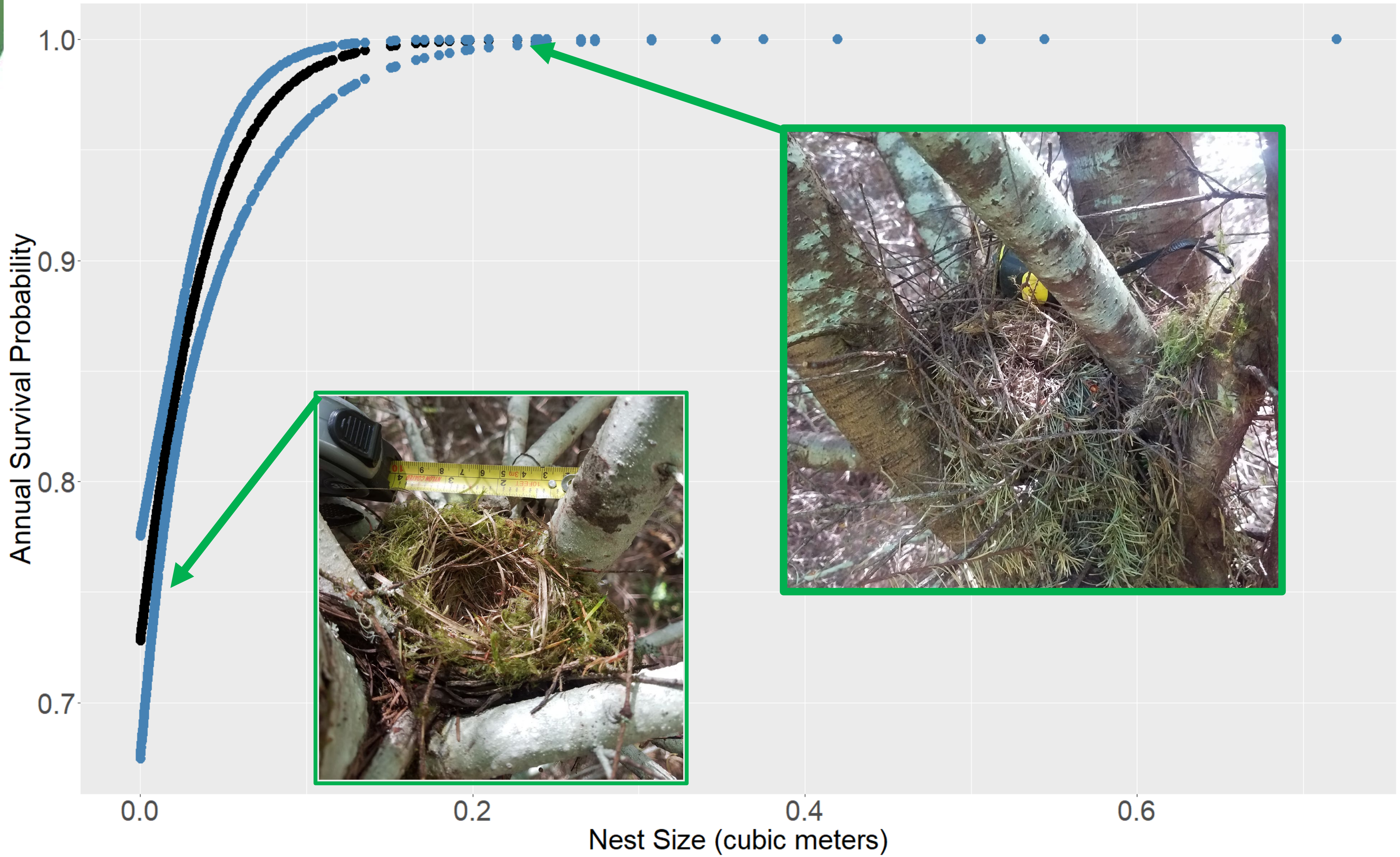

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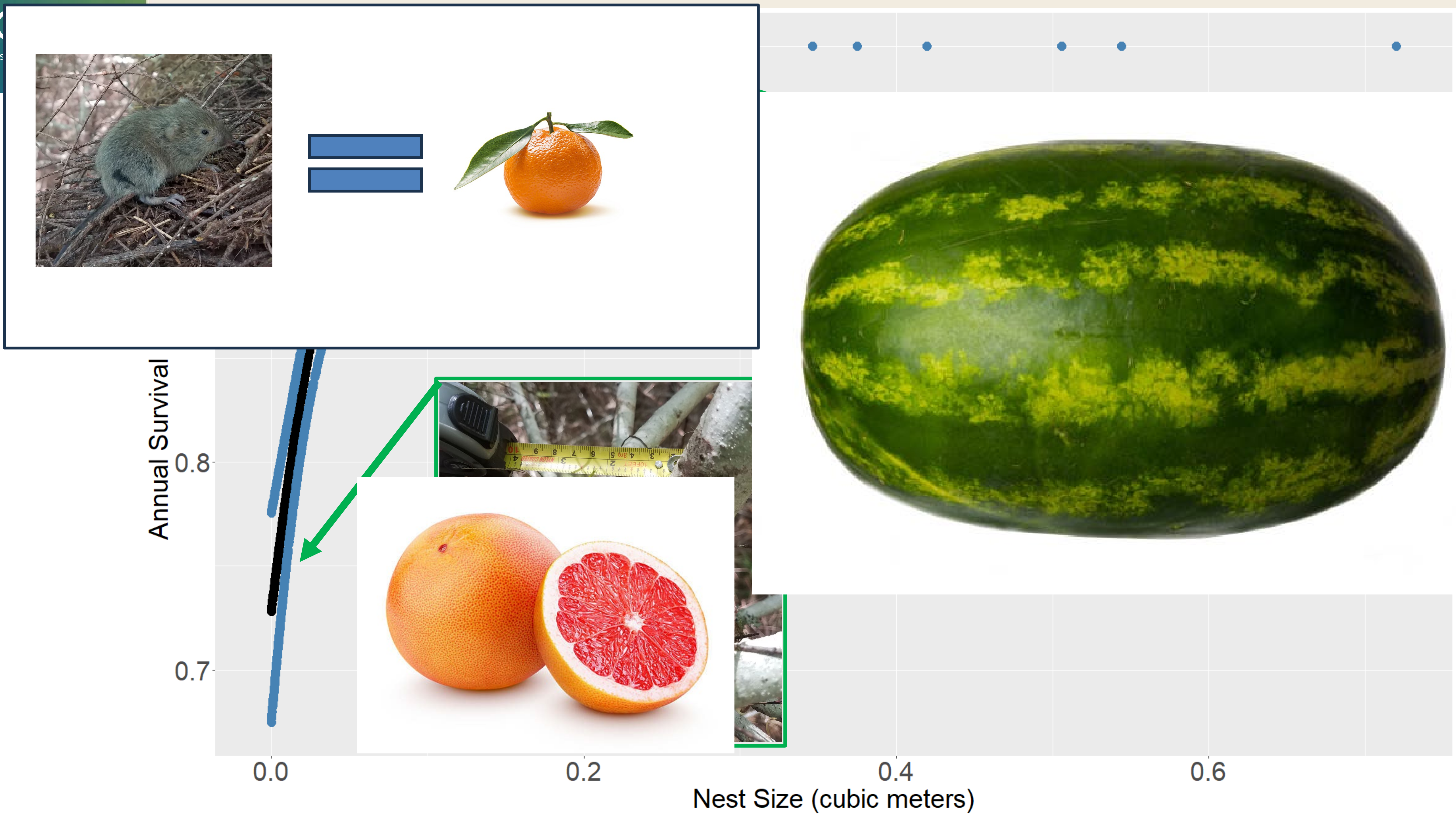
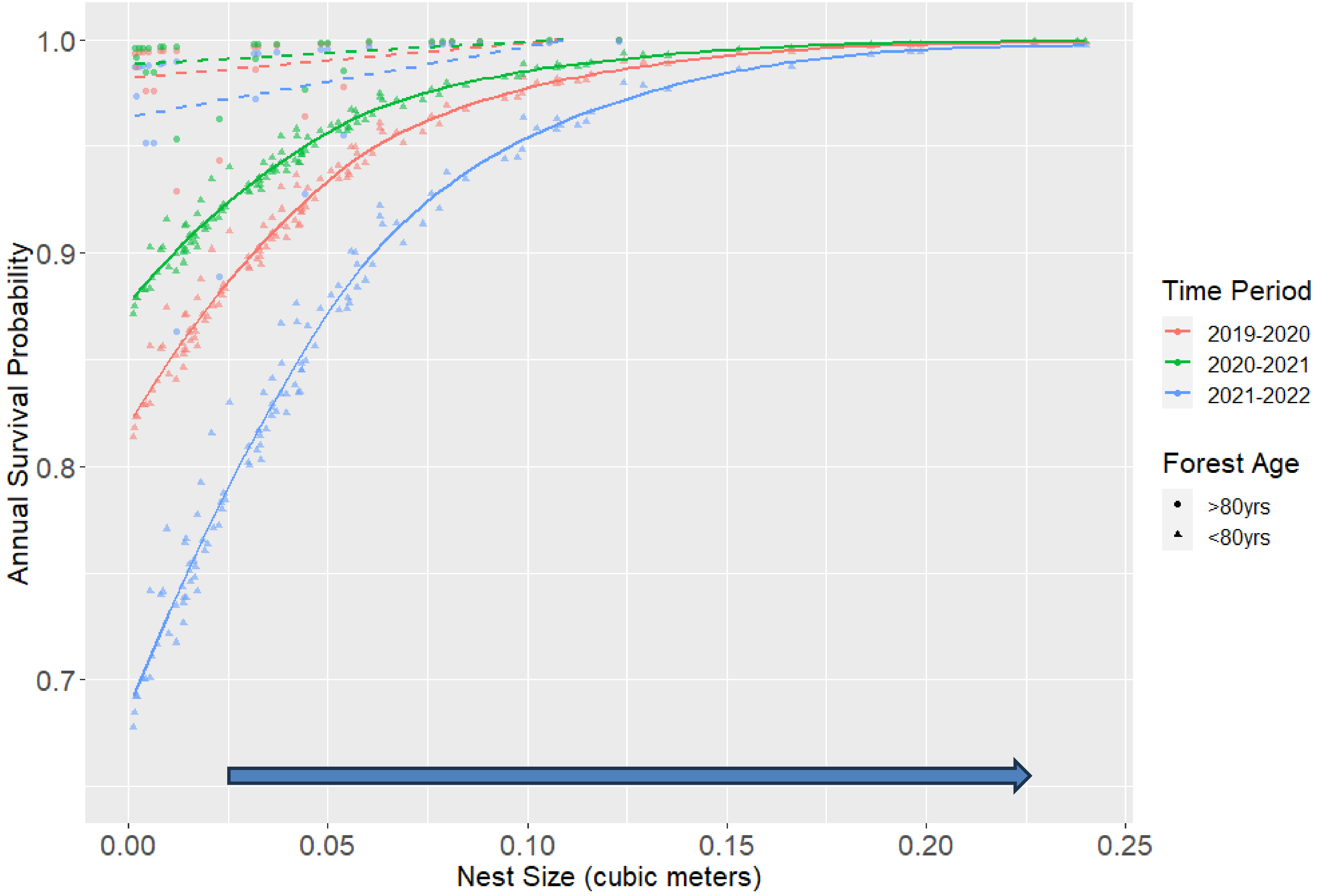


Tree vole nests

S(t + stand_age + nest_size), AICc weight 35.42%



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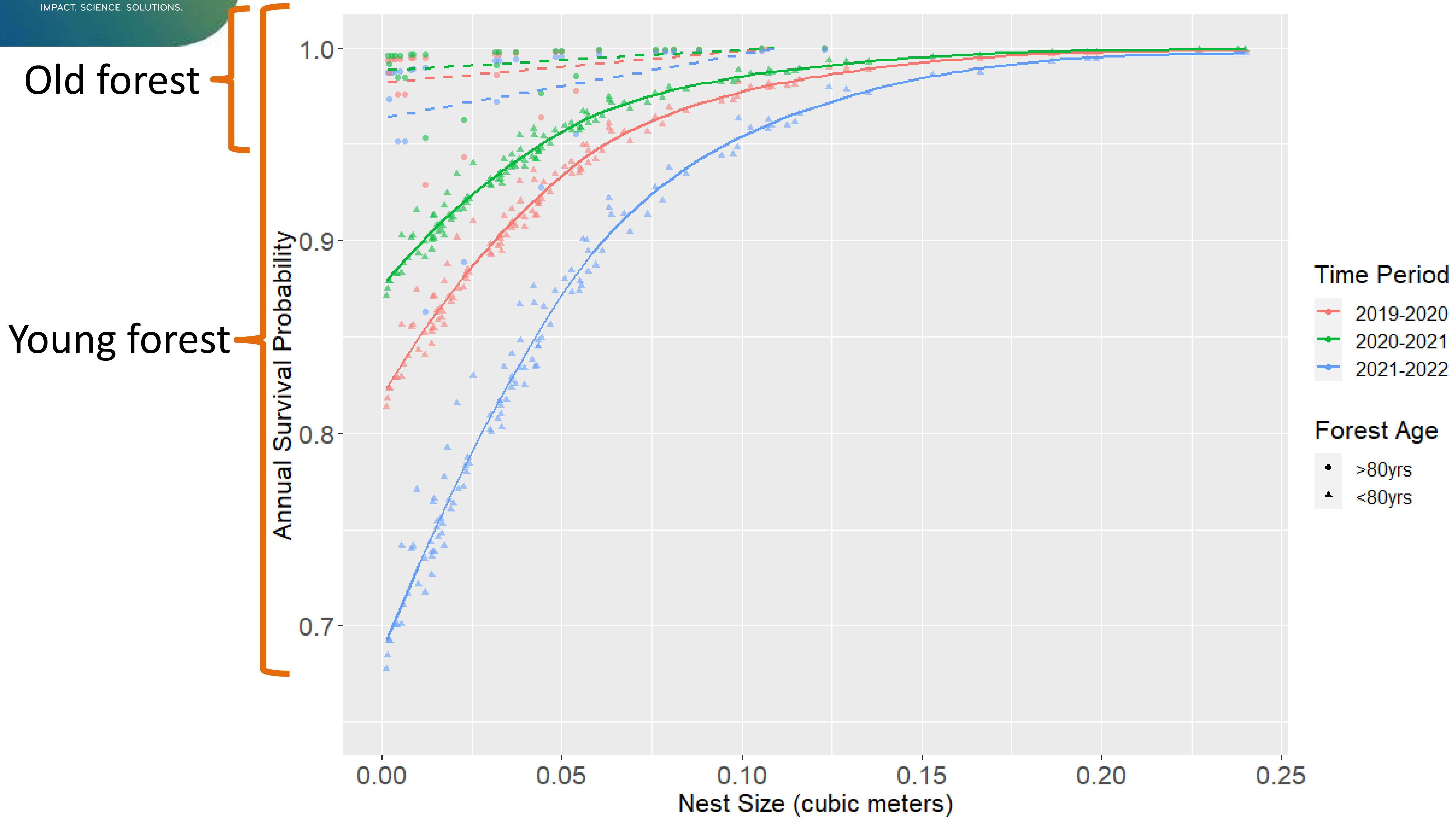

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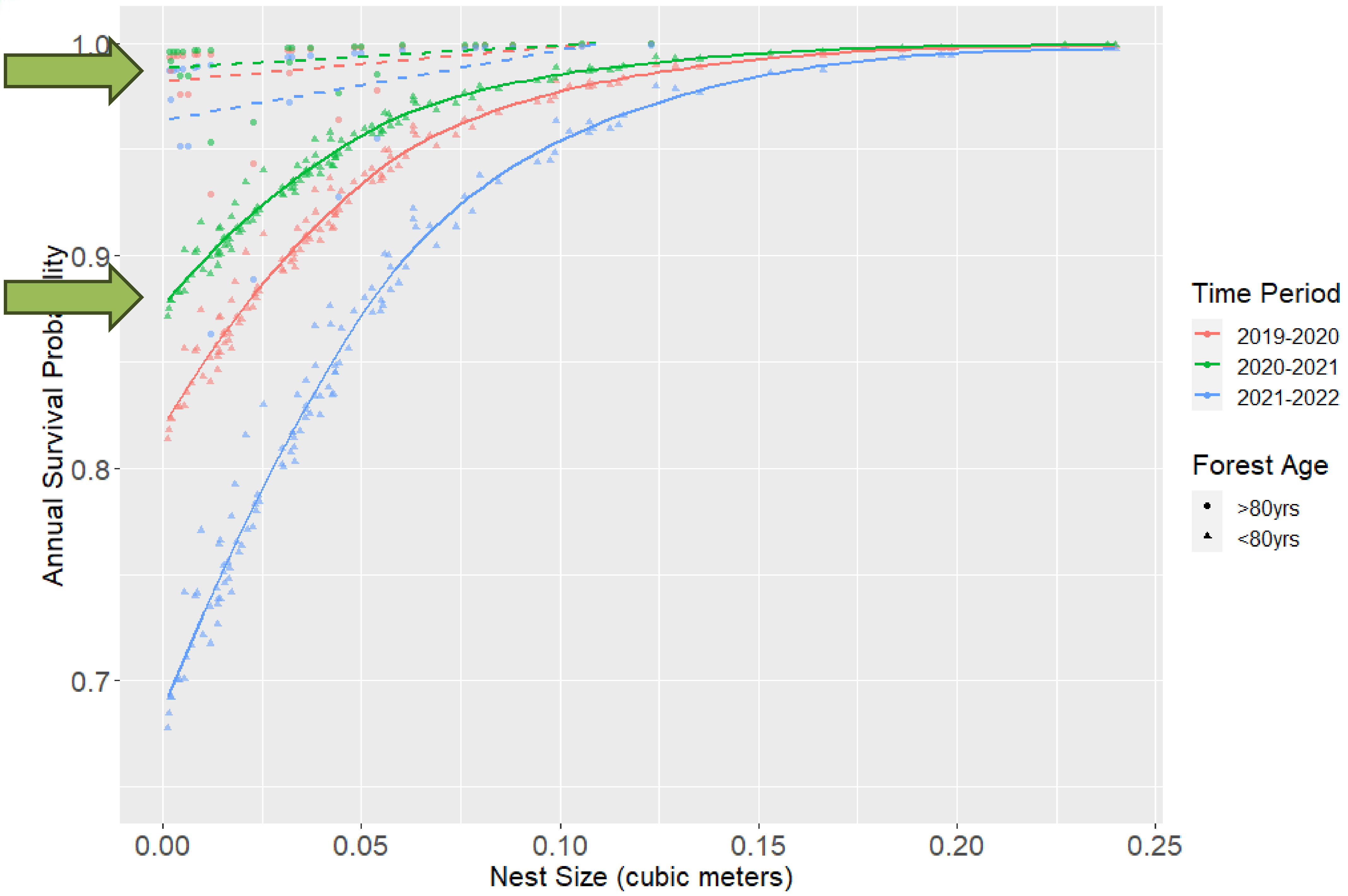
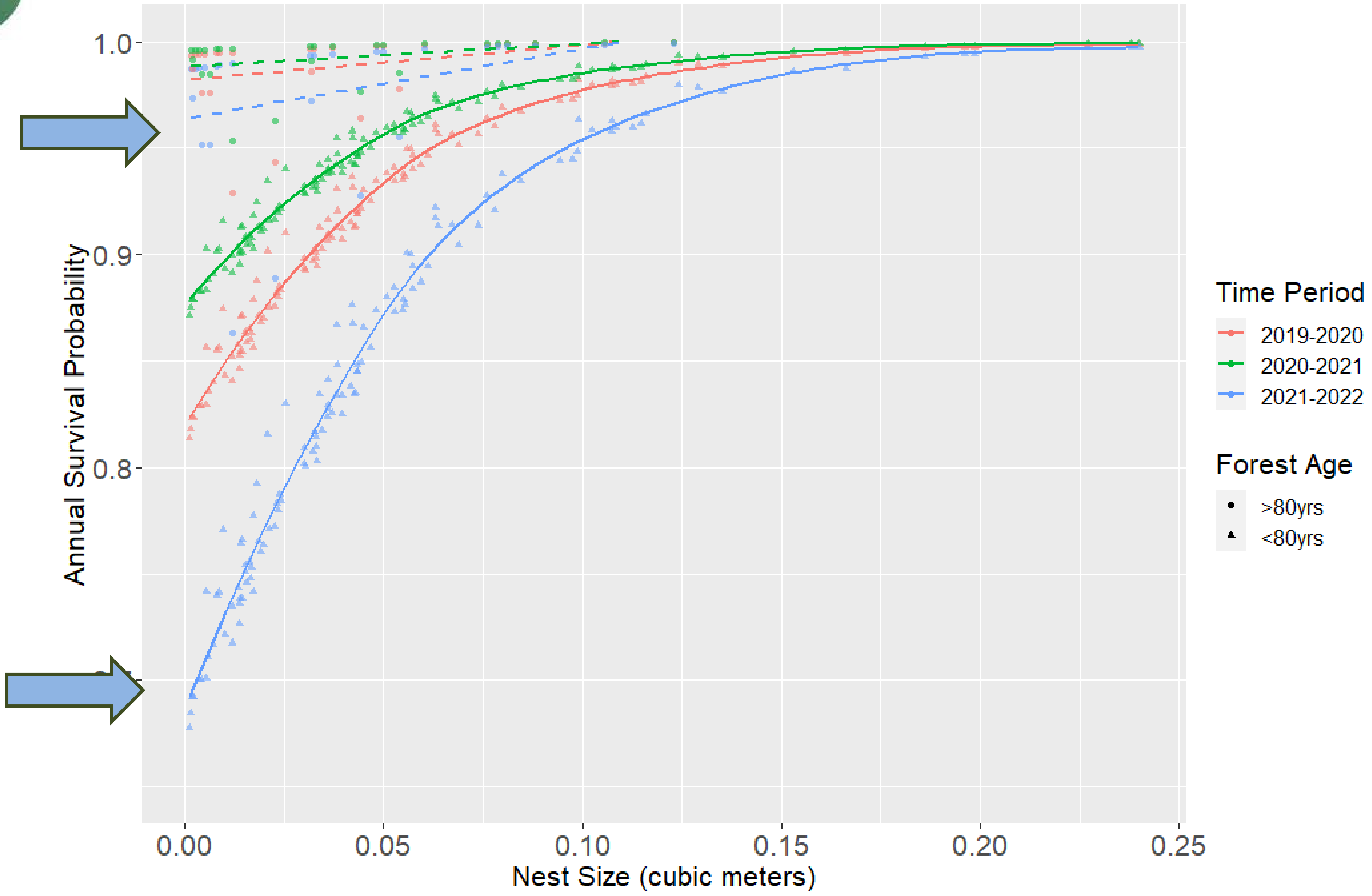
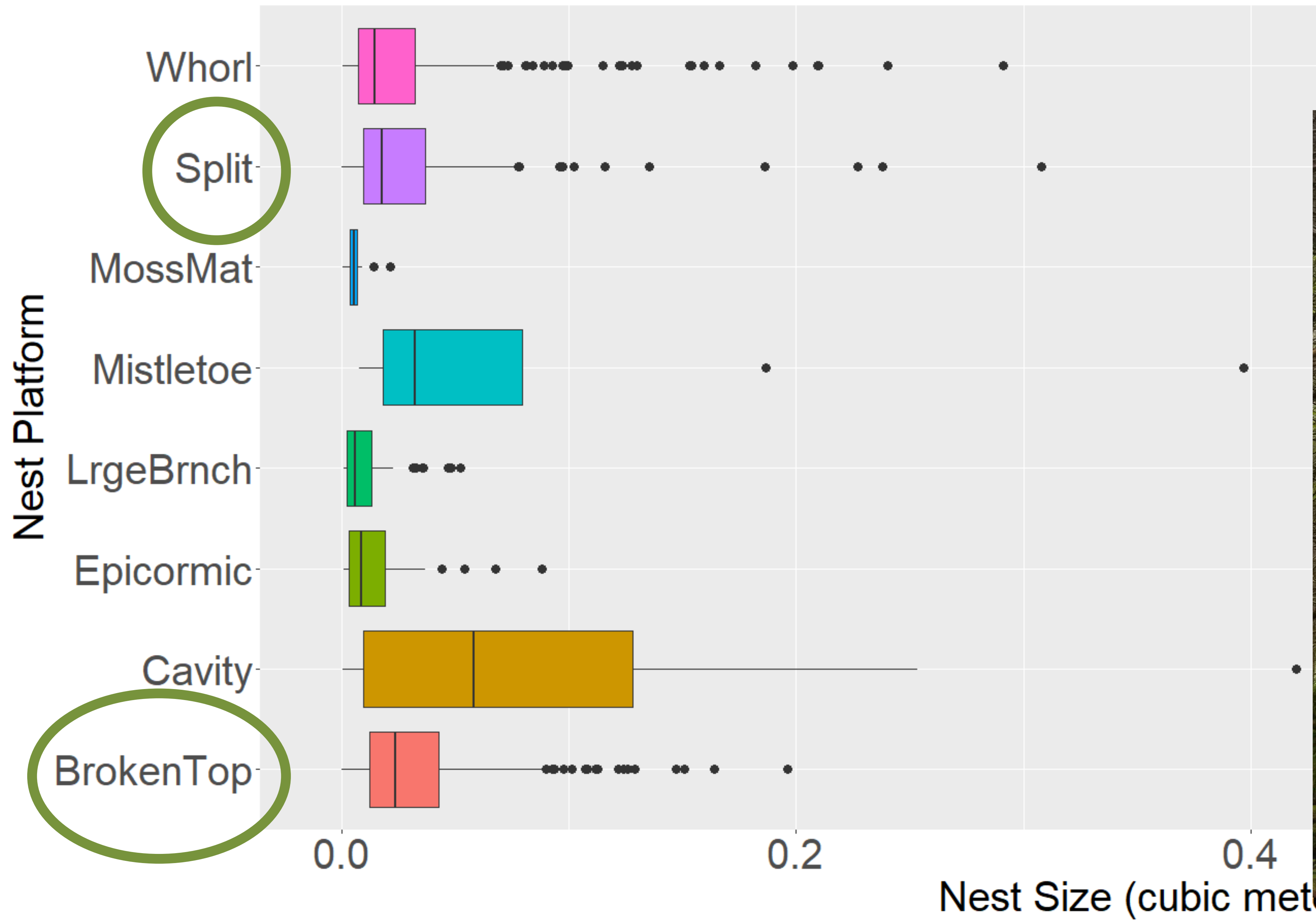


Tree vole nests

S(t + stand_age + nest_size), AICc weight 35.42%



Supporting large nests in young forests



Objective 2: Nest Construction and Use by Other Species

Tree vole nest tree selection

Young forest structures per tree

Random sample	Nest trees	
0.24	0.81	ANOVA $p < 0.05$

Old forest structures per tree

Random sample	Nest trees	
3.4	5.57	ANOVA $p < 0.05$

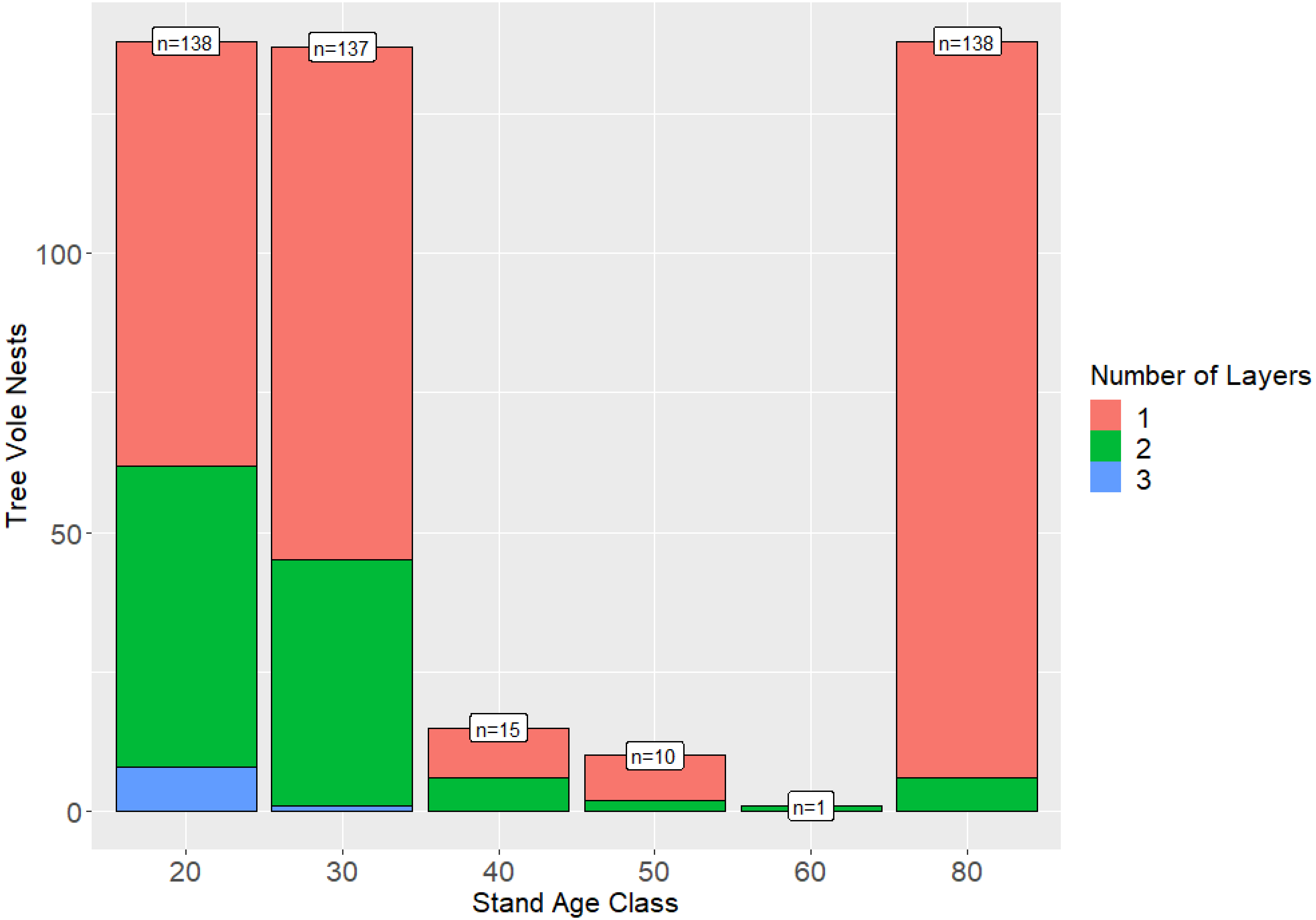
Nest construction and use by other arboreal species

Humboldt's flying squirrel

Bald eagle

Bushy-tailed woodrat

Multi-layer tree vole nests



Niche Overlap?

43% of tree vole nests originally constructed by Humboldt’s flying squirrel

29% of tree vole nests re-colonized by Humboldt’s flying squirrel


00 WINS
99
PUSH START
Red Tree Vole
Flying Squirrel
FIGHT !!

Objective 3: Arboreal Nest Detectability

Known-fate Huggins *p* and *c* model (Program MARK)

18 stands
56 plots
n = 25 nests

Top model: p(.) (AICc weight = 32.9%)

↓

Detection rates in young forest were not affected by stand age

↓

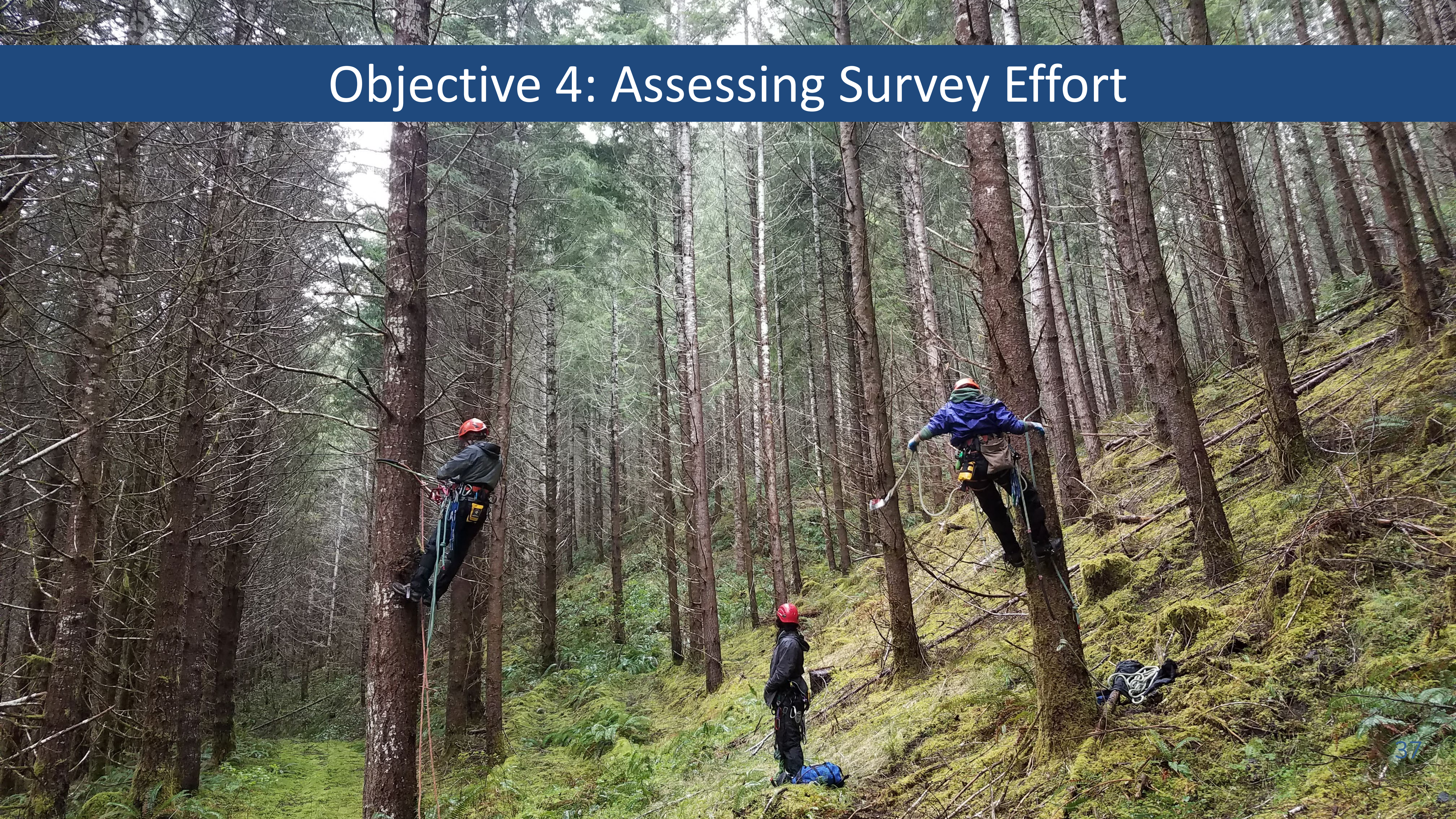
Detectability = 0.84, 95% CI (0.72, 0.96)

Lincoln-Peterson Equation

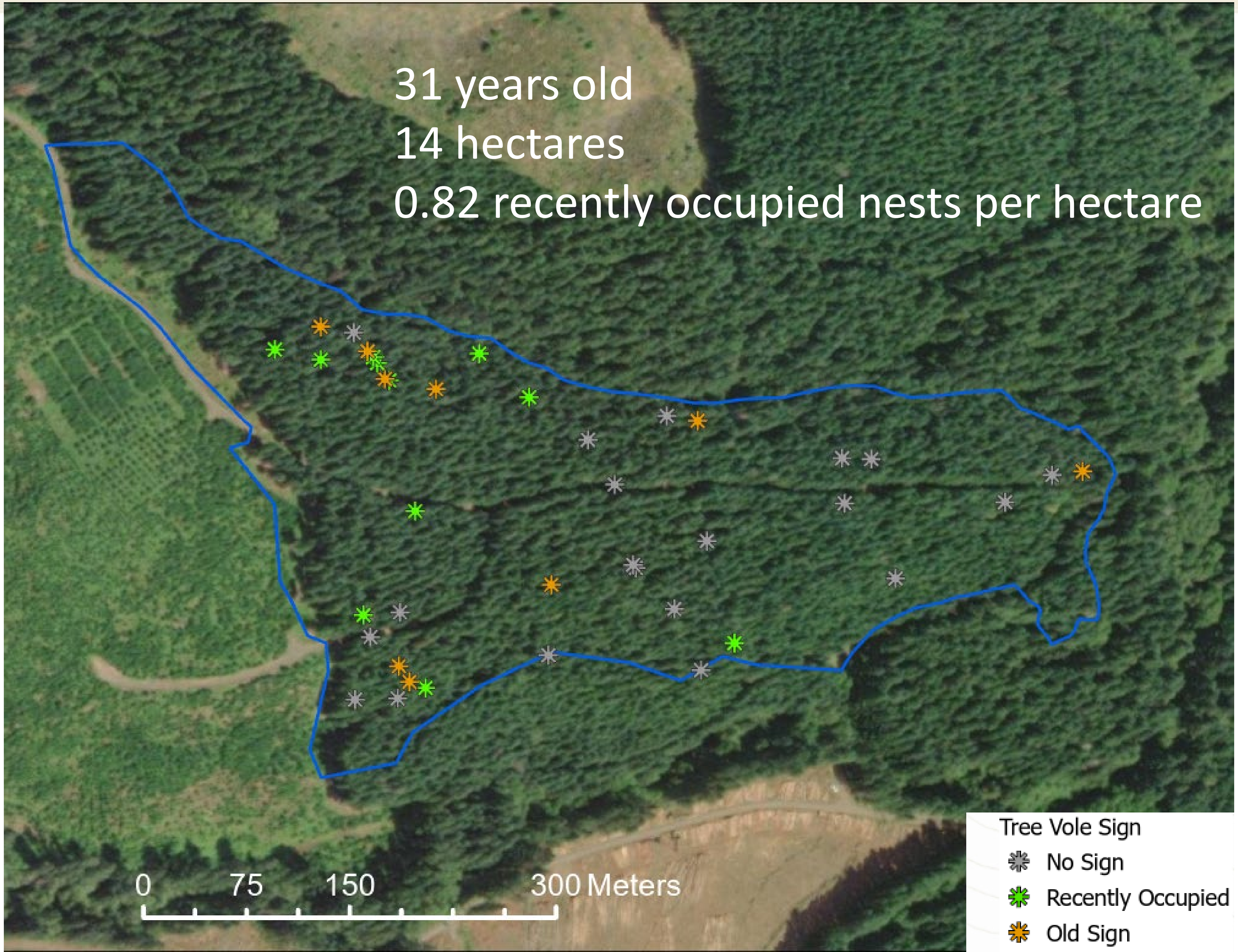
3 stands
n = 9 plots
131 trees
35 nests

$\bar{p}$ = 0.055 (95%CI 0.0, 0.12)

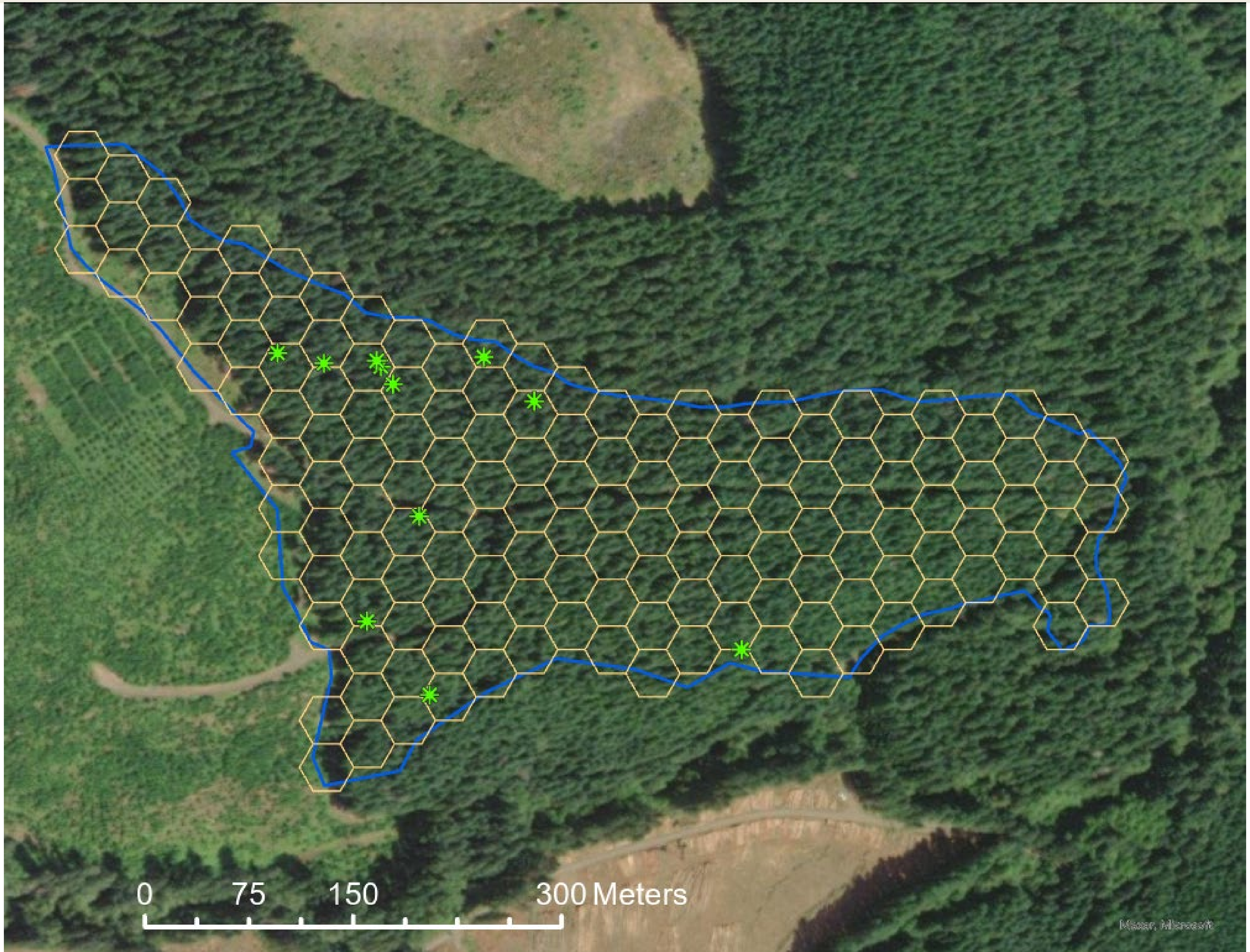
Objective 4: Assessing Survey Effort



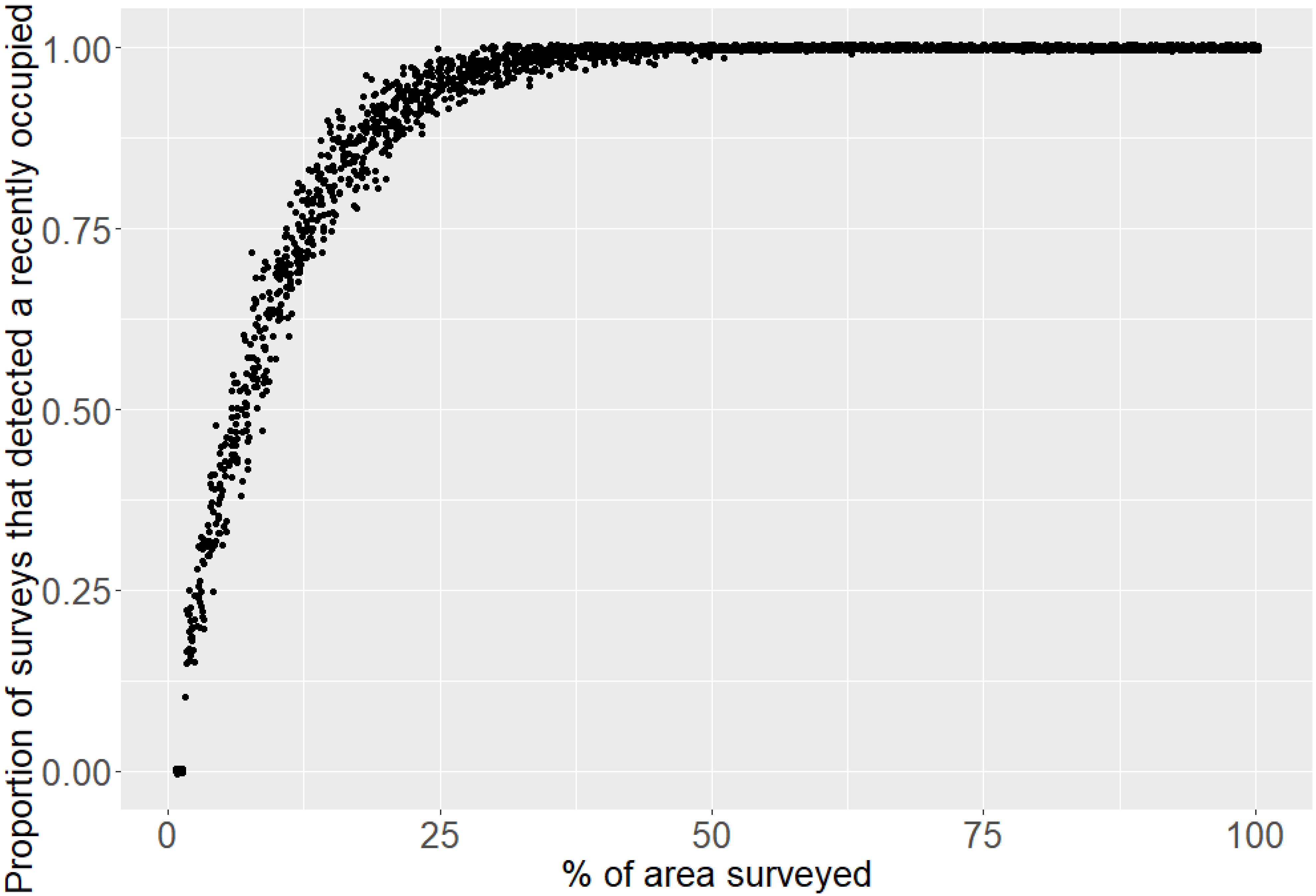
Survey Effort and Occupancy (Case Study)



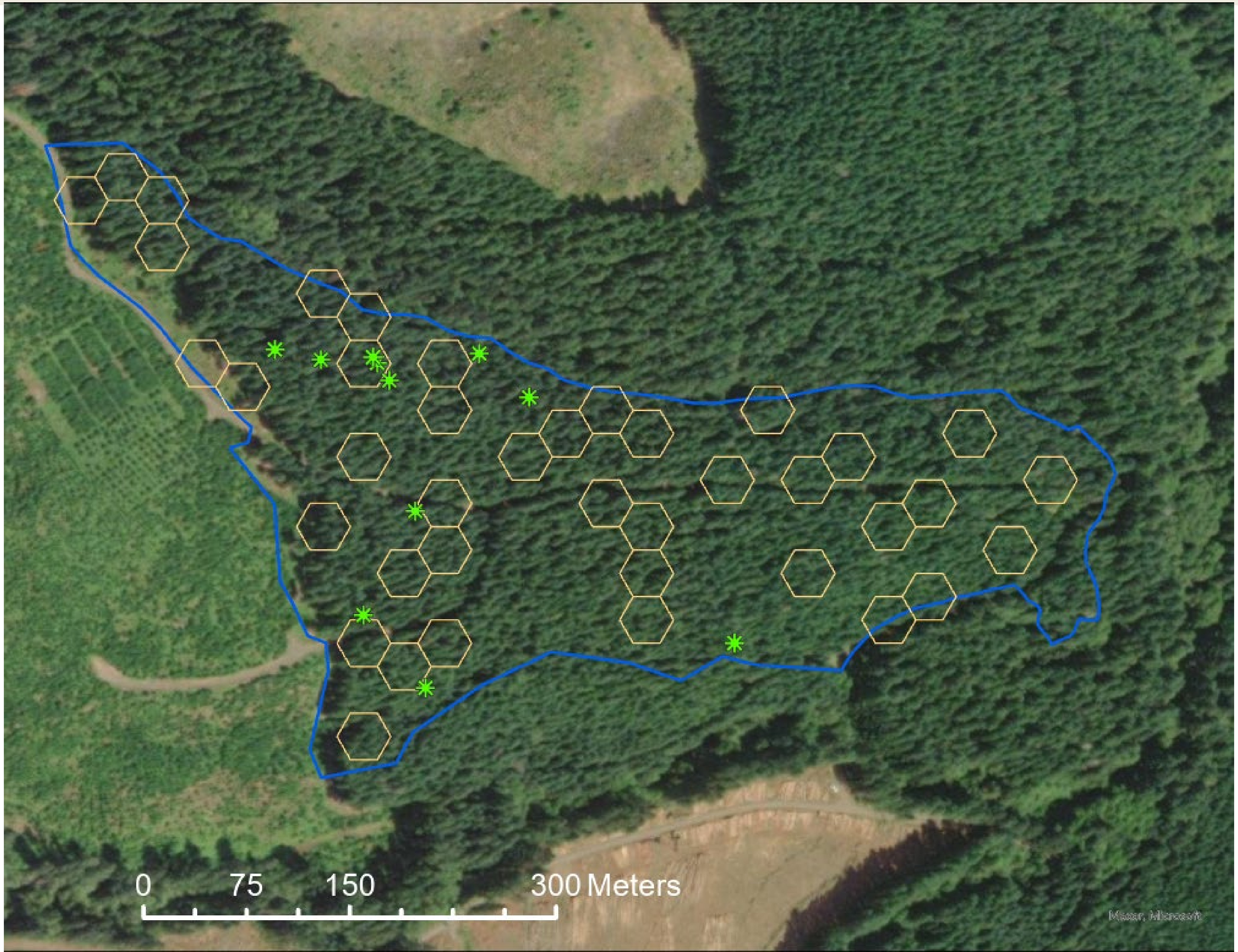
Simulating plot-based surveys



250000 surveys, 2500 data points



38% Survey Effort – near 100% accurate



Objective 5: Estimating Stand Occupancy

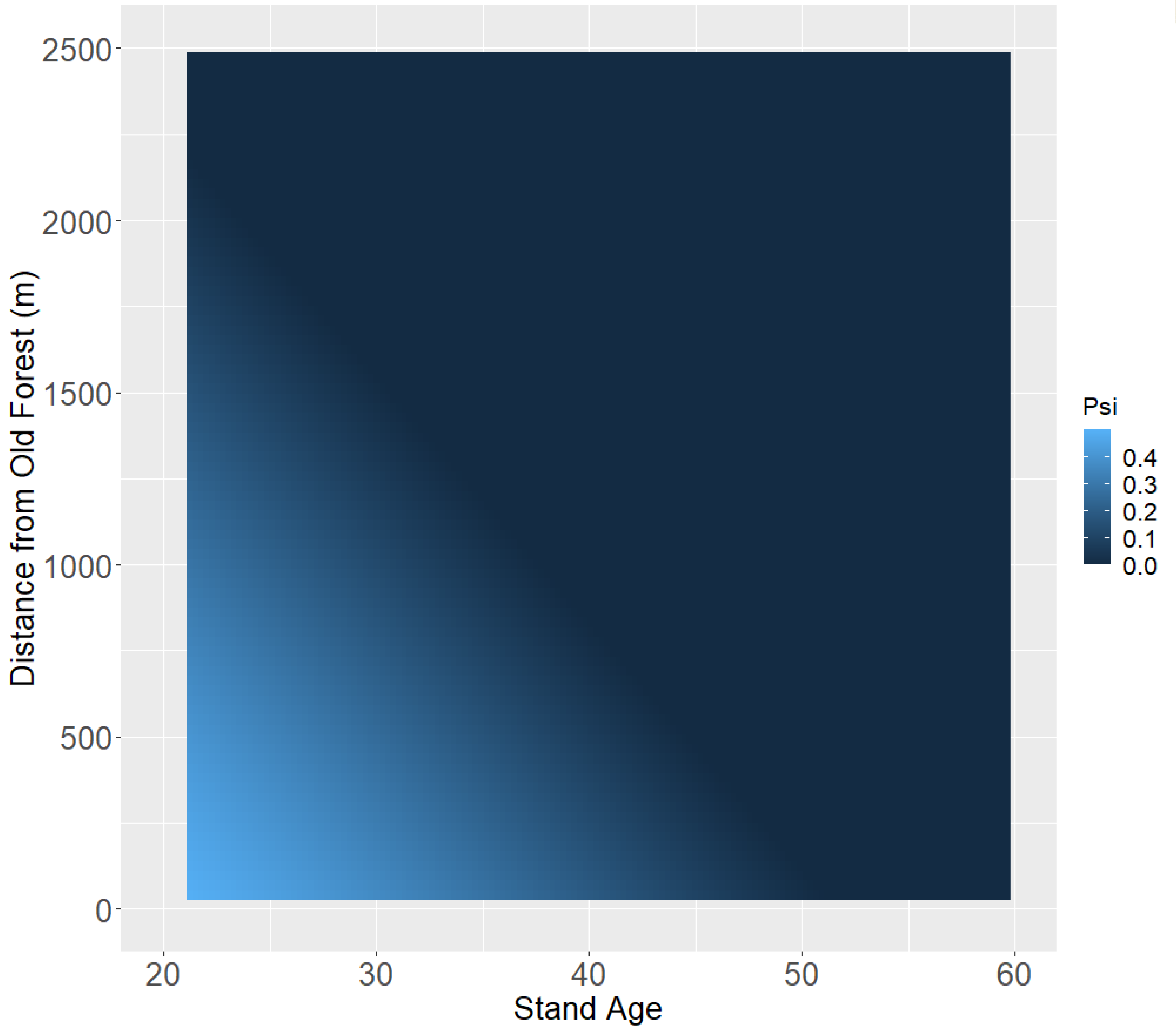
Single-season Occupancy Model (MacKenzie et al. 2002)

- 2022 field season
- 48 young forest stands
- Covariates: Stand age and distance from old forest

Top model: *ψ(stand age + distanceOF) p(.)*
AICc weight (39.7%)

Adjusted ψ for bias introduced by 'space for time' approach
0.3 Root mean square error (Guillera-Arroita 2011)

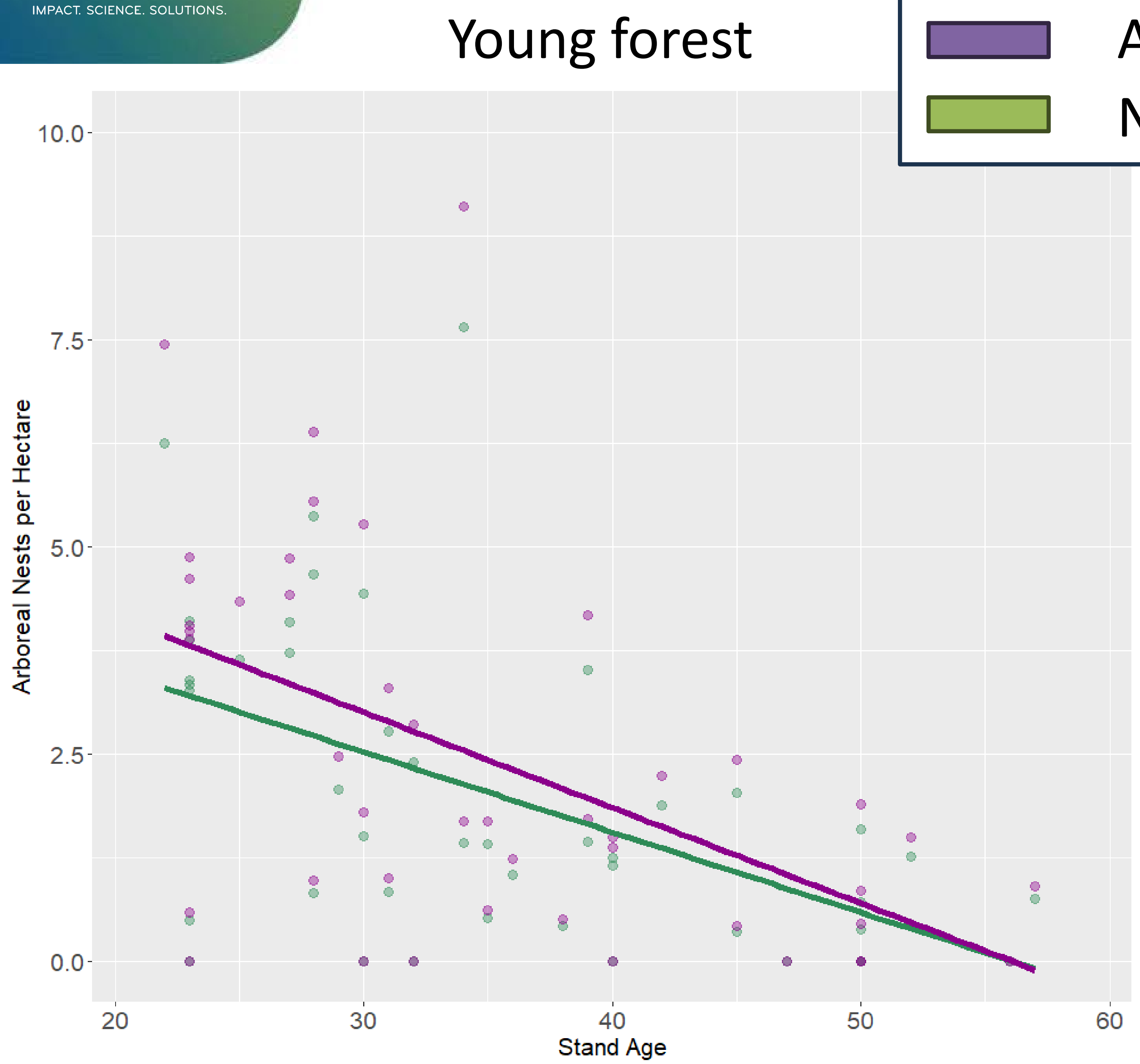
Single-season Occupancy Model (MacKenzie et al. 2002)



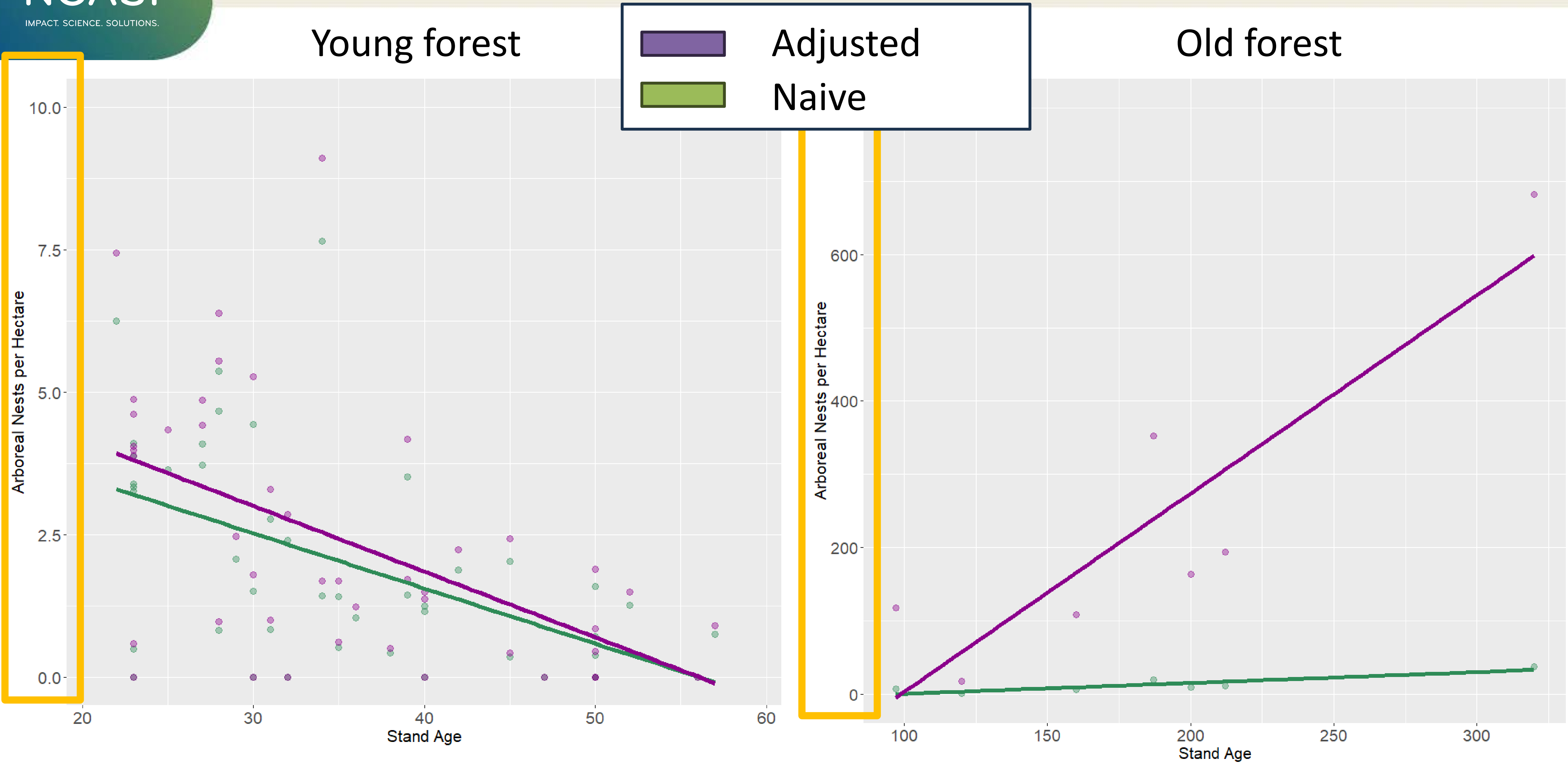
Objective 6: Estimating Nest Density

Arboreal nest density

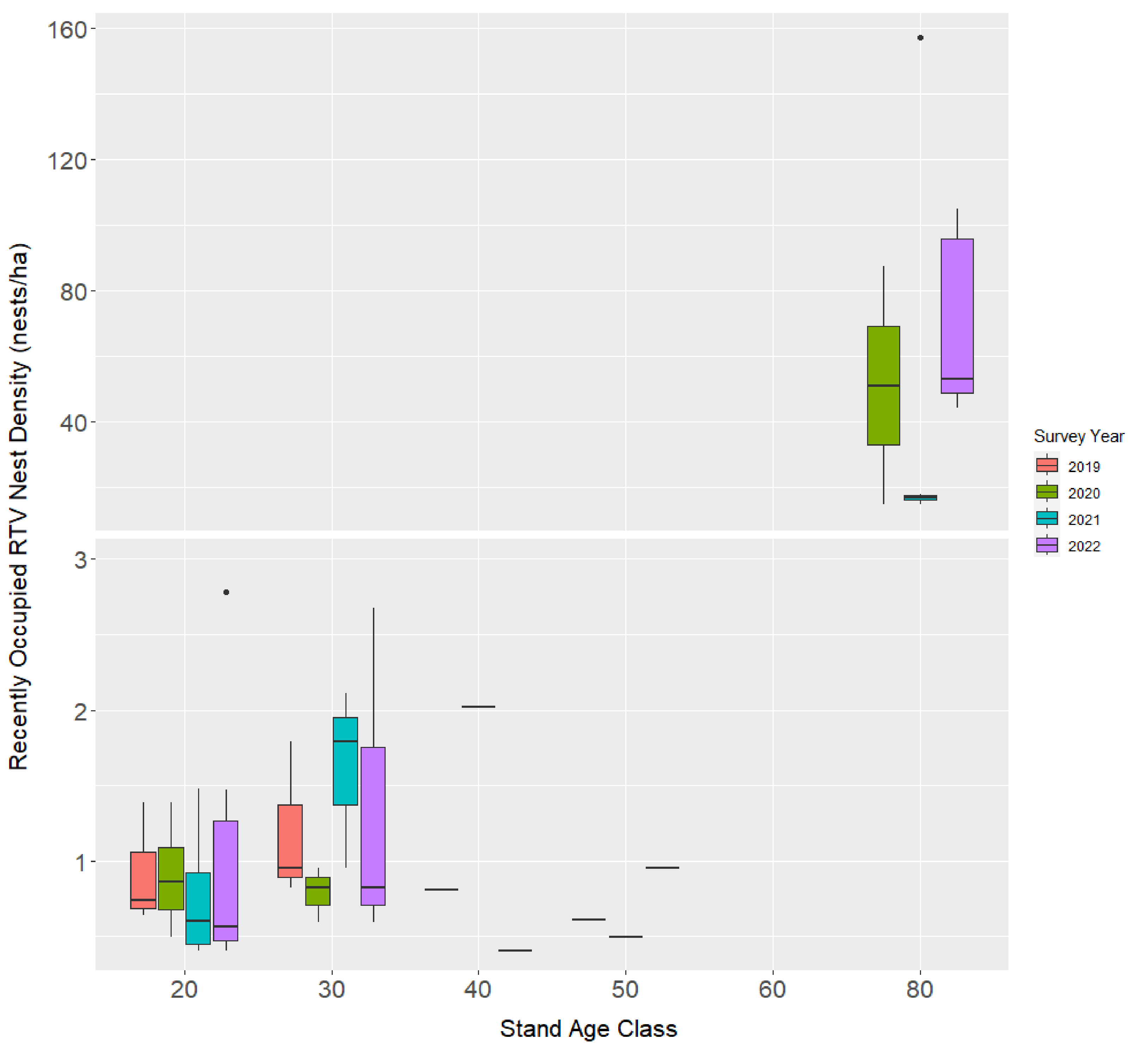
Adjusted
Naive



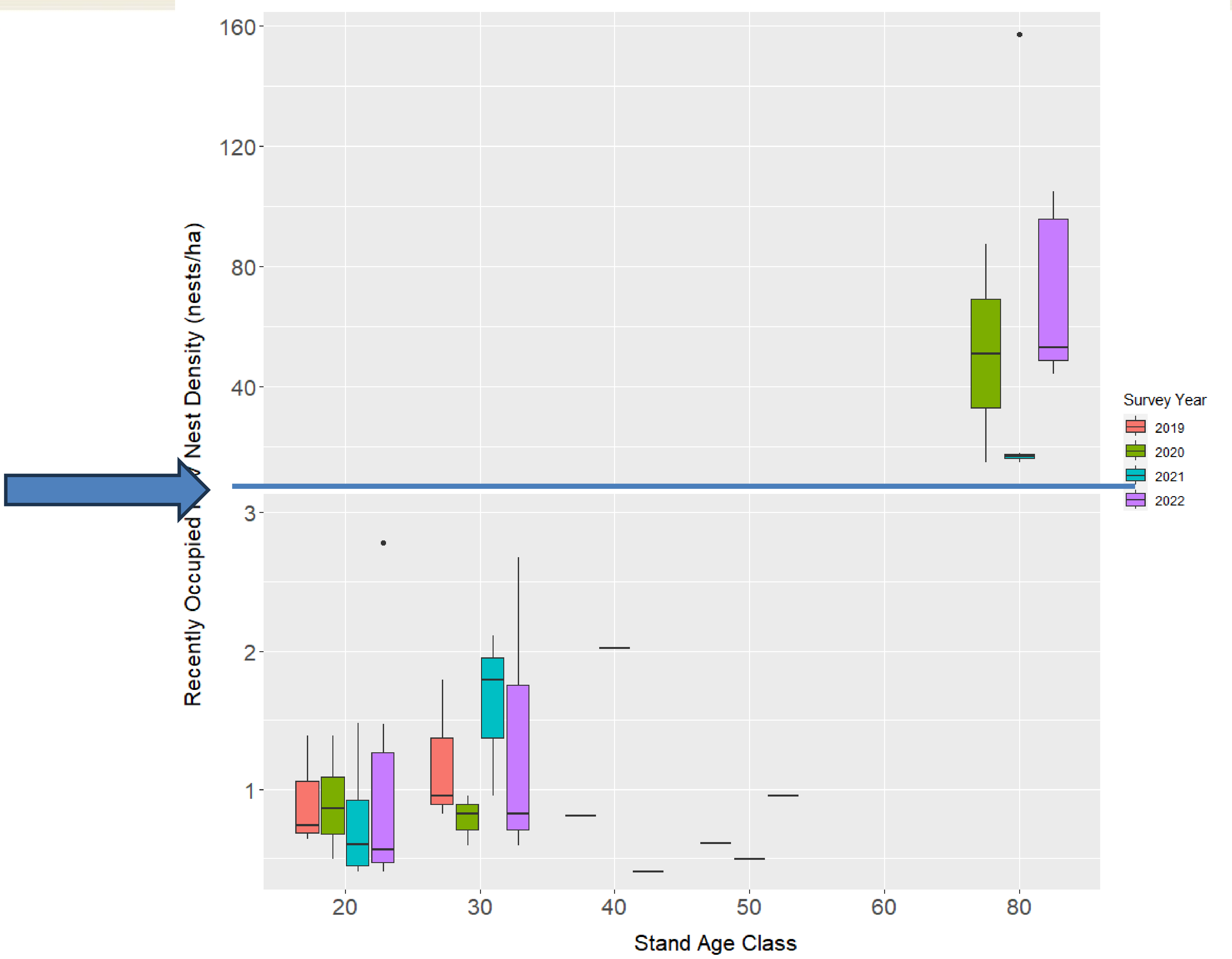
Arboreal nest density



Recently occupied tree vole nest density



Recently occupied tree vole nest density



Conclusions

Conclusion and Recommendations

- **Old forests provide far superior habitat than young forests**

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- **Young forests can provide habitat and support tree voles at low densities**
  - **20 and 30 year age classes**
  - **<1425m from old forest**

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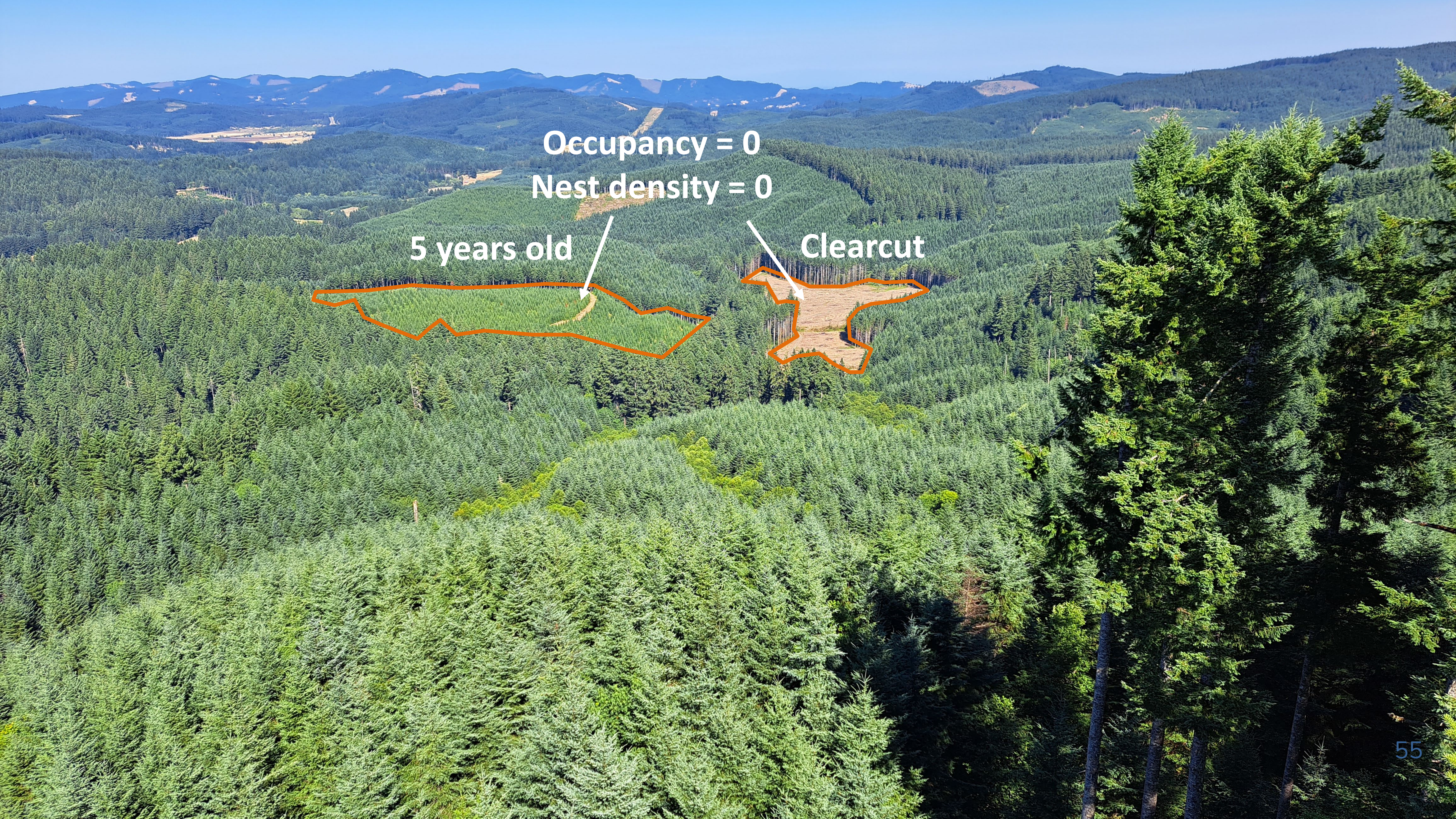
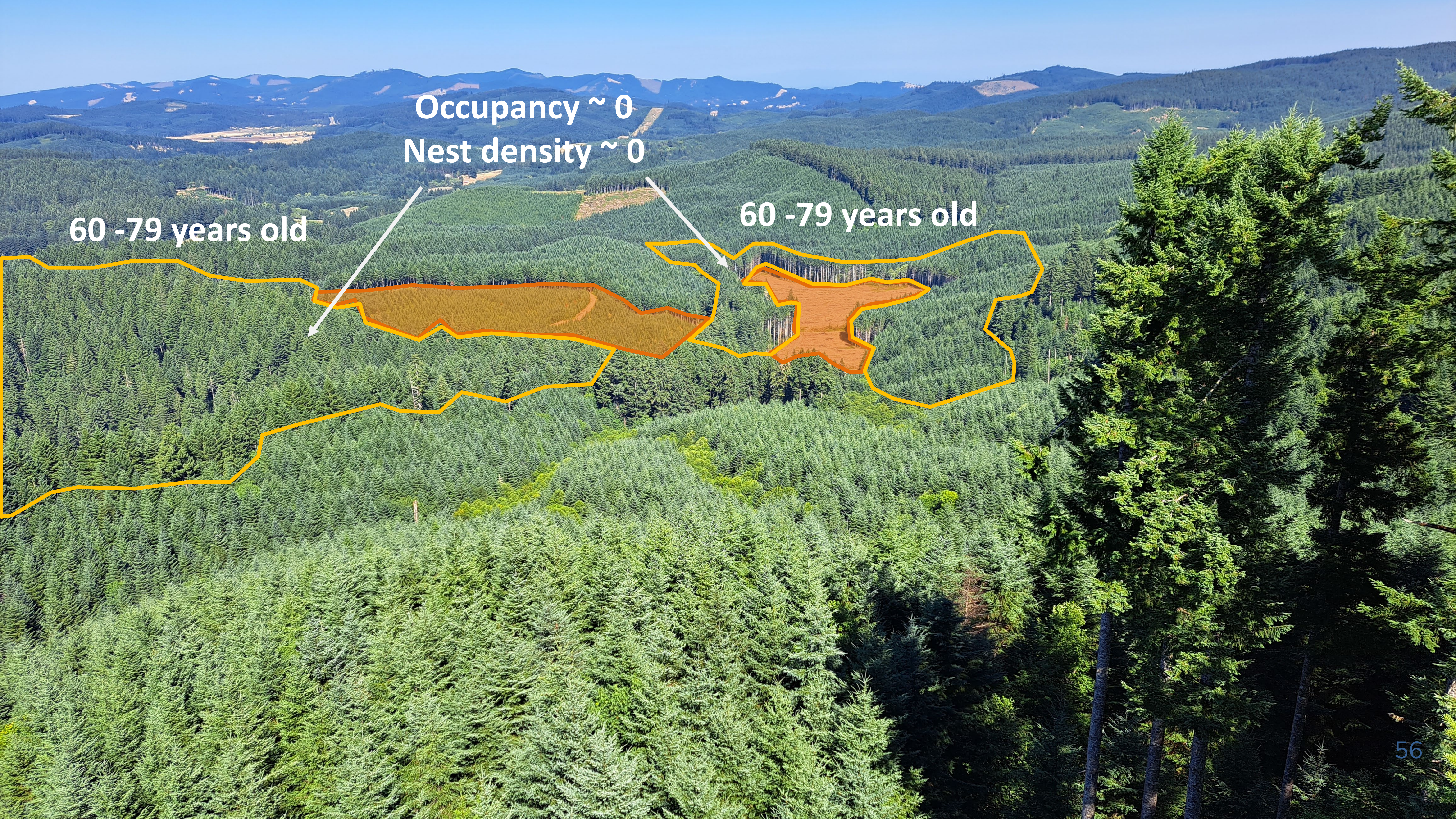
Conclusion and Recommendations

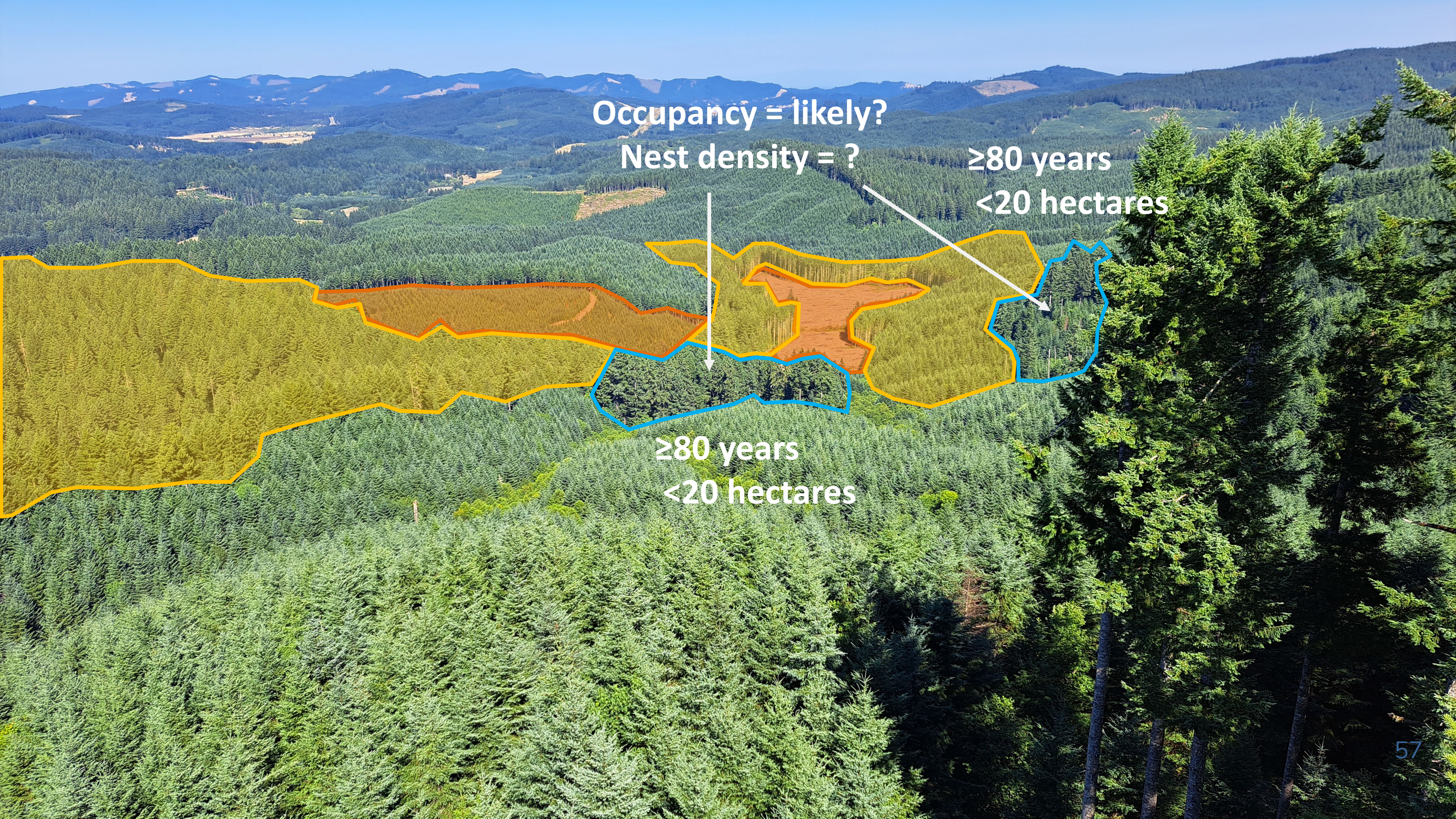
- Old forests provide far superior habitat than young forests

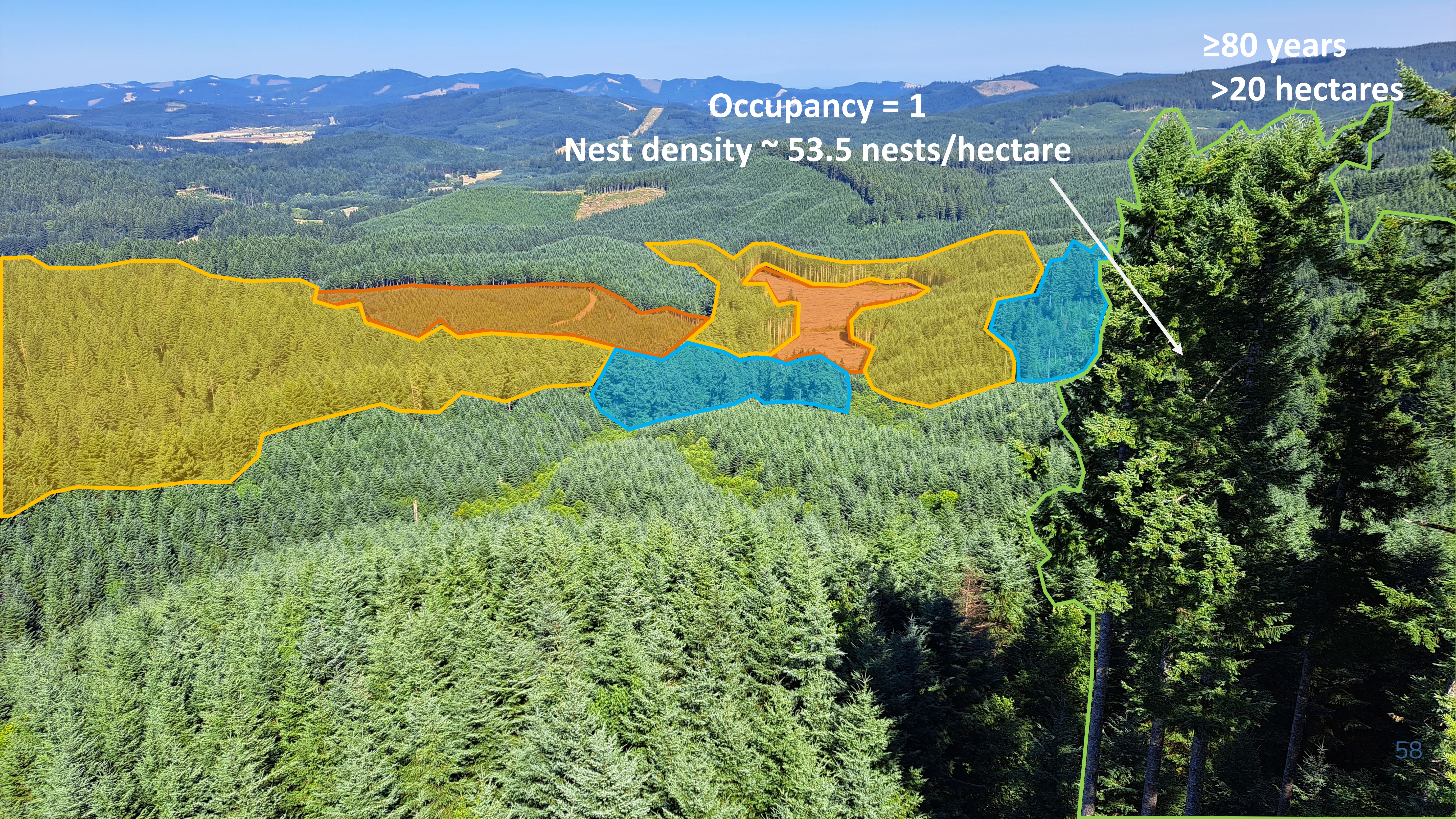
- Young forests can provide habitat and support tree voles at low densities
    - 20 and 30 year age classes
    - <1425m from old forest

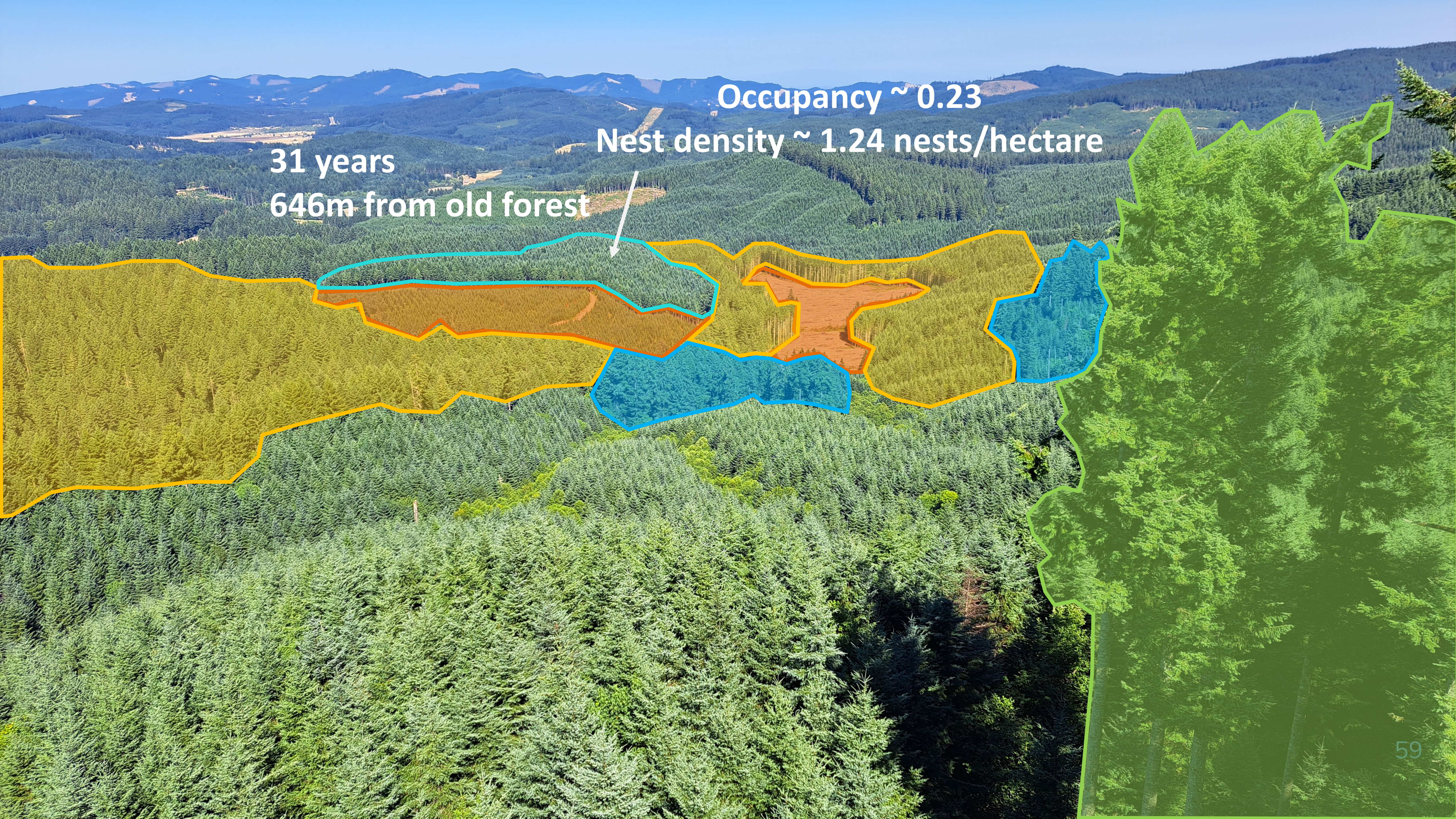
- **Manage to improve and maintain structural complexity**
    - **Increase nesting space**
    - **Facilitate movement**
    - **Support large nests**


Occupancy = 0
Nest density = 0
5 years old
Clearcut

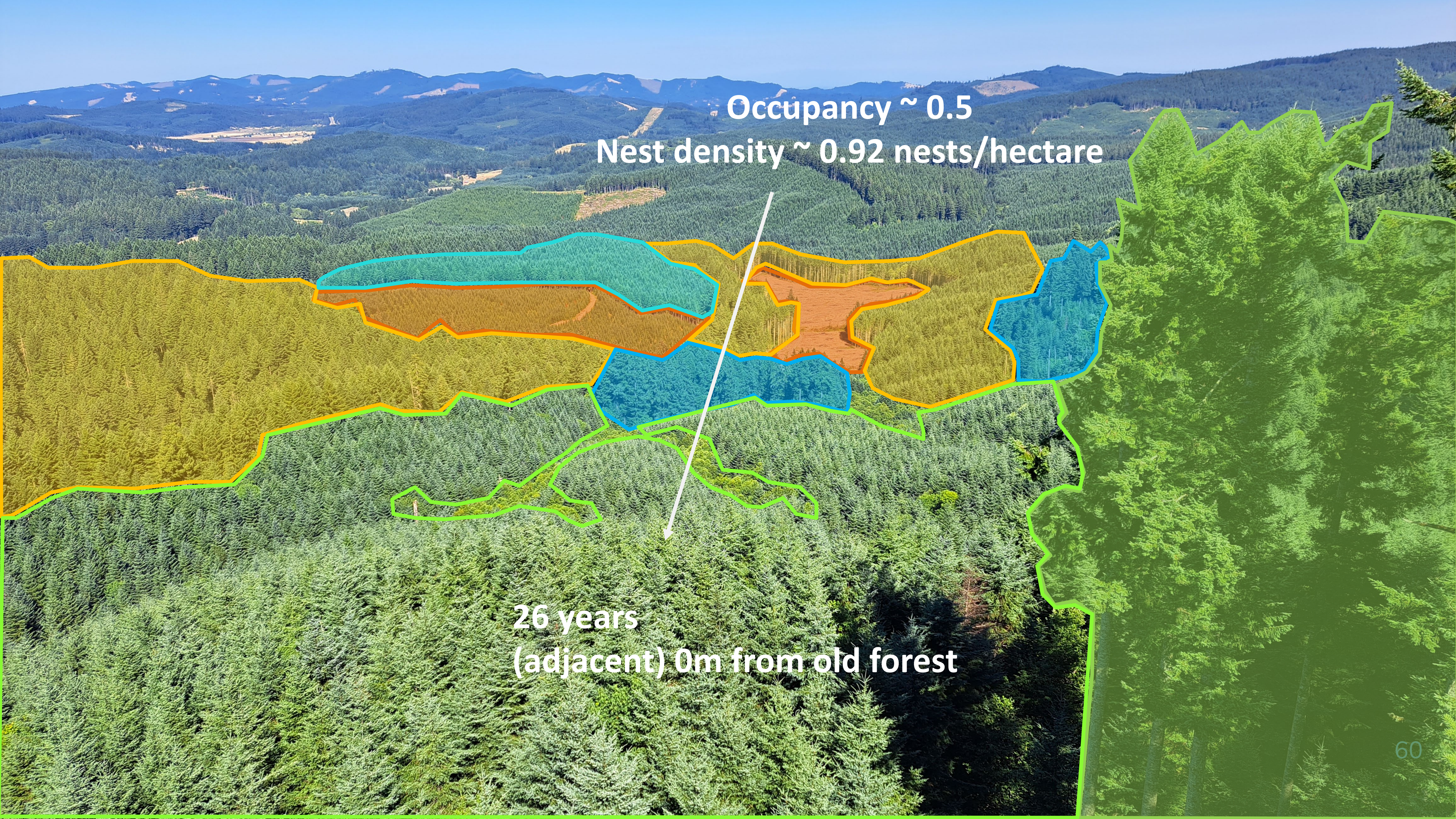

Occupancy ~ 0
Nest density ~ 0
60 -79 years old
60 -79 years old

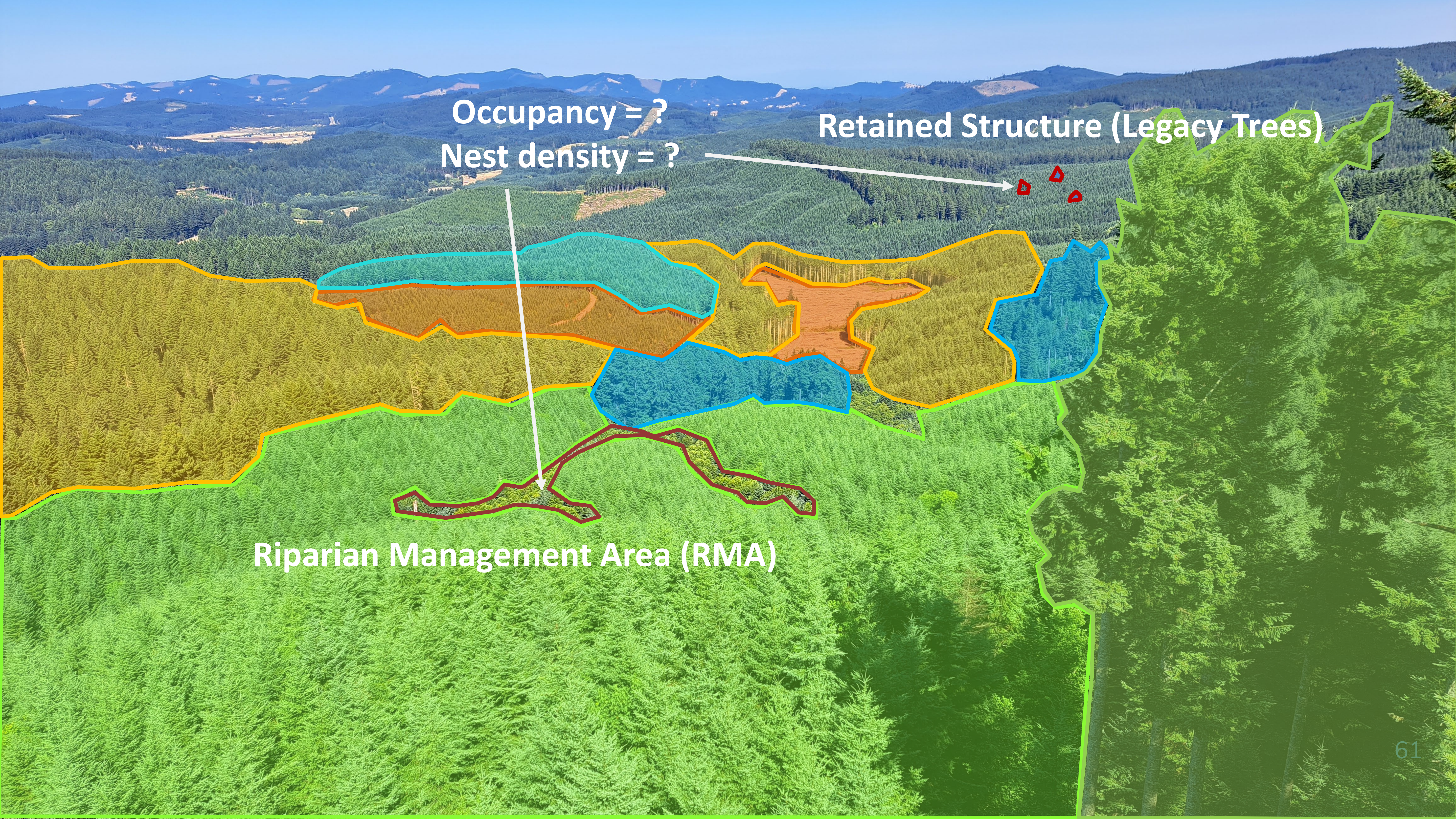

Occupancy = likely?
Nest density = ?
≥80 years
<20 hectares
≥80 years
<20 hectares


≥80 years
>20 hectares
Occupancy = 1
Nest density ~ 53.5 nests/hectare



Occupancy ~ 0.23
Nest density ~ 1.24 nests/hectare
31 years
646m from old forest


Occupancy ~ 0.5
Nest density ~ 0.92 nests/hectare
26 years
(adjacent) 0m from old forest


Occupancy = ?
Nest density = ?
Retained Structure (Legacy Trees)
Riparian Management Area (RMA)

Acknowledgements

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Wildlife Conservation Initiative NAFO

Lone Rock Resources

Weyerhaeuser

Manulife Investment Management

Oregon Wildlife Foundation

Starker Forests, Inc.

Oregon Department of Forestry

U.S. Department of the Interior Bureau of Land Management

Forest Service U.S. Department of Agriculture

Cafferata Consulting

OSU Oregon State University

College of Forestry

NCASI

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Questions?

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Where is it the Most Effective to Restore Streams? Salmon Habitat Restoration using Large Wood: Linking Stream Geomorphic Change and Restoration Effectiveness

Madelyn Maffia[1], Catalina Segura[1], Chris Lorion[2], and Erik Suring[2]
Oregon State University[1] and Oregon Department of Fish and Wildlife[2]
FWHMF Progress Report

Background

- LW restoration efforts are increasingly popular due to the numerous ecosystem services provided
  - Improve stream hydraulics during winter flow conditions
  - Create habitat heterogeneity through sediment fluxes
  - Have lasting impacts on the aquatic biota
- Knowledge gap on cumulative benefits experienced instream at an increased time scale

Name of Ecosystem Service	**The Presence of LW Enable/Enhance**
Increased channel heterogeneity	Channel heterogeneity by amount and orientation of LW
Specific habitat creation	Creation of unique habitat
Channel sediment flux	Controls sediment flux and accumulation
Erosion control	Control of possible river reach erosion.
Invertebrates	A habitat for population of invertebrates
Flood regulation	Flood risk and regulation
Organic matter input	An input of organic matter (e.g., DOM)
Water quality	A quality of flowing water
Carbon sequestration	To study a carbon sequestration
Fish provisioning	A habitat for fish population
Educational	Possibility to study and train knowledge
Recreation	Possibility to enjoy free time
Aesthetics	Experience of beauty of the environment

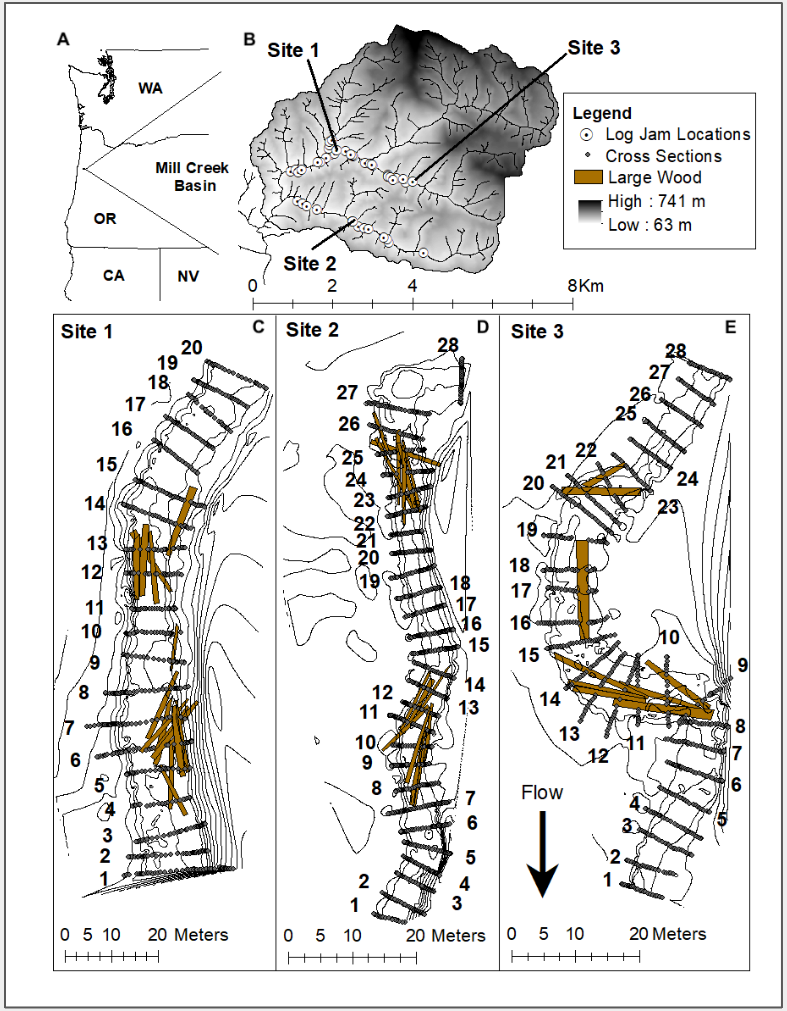
Poledniková, Z., Galia, T., 2021. Ecosystem Services of Large Wood: Mapping the Research Gap. Water 13, 2594. https://doi.org/10.3390/w13182594

Research Objectives

1. Assess the stability/resilience of the stream **hydraulics**
2. Investigate the changes in the **geomorphology**
3. Assess the stability of **LW** structures
4. Investigate the **fish** response

Mill Creek Basin

- Weyerhaeuser Timberland in Oregon Coast Range
- Perennial and fish bearing
  - ODFW monitoring since 1997
- Entire basin restored with 63 large wood (LW) jams in 2015



Mill Creek Reaches

Site 1:

- DA: 16 km^2
- **$Q_{Bankfull}$: 8.7 m^3s^{-1}**
- Low sinuosity
- 20 XS
- $Volume_{LW}$: 198.2 m^3
- **Sandstone and basalt**

Site 2:

- DA: 5 km^2
- **$Q_{Bankfull}$: 2.4 m^3s^{-1}**
- Medium sinuosity
- 28 XS
- $Volume_{LW}$: 72.9 m^3
- **100% sandstone**

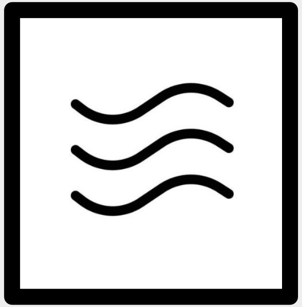
Site 3:

- DA: 5 km^2
- **$Q_{Bankfull}$: 2.5 m^3s^{-1}**
- High sinuosity
- 28 XS
- $Volume_{LW}$: 108.6 m^3
- **Sandstone and basalt**






Objective 1



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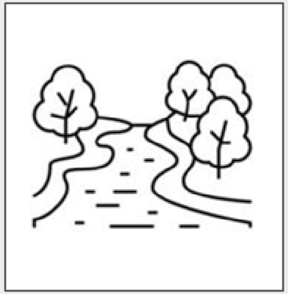

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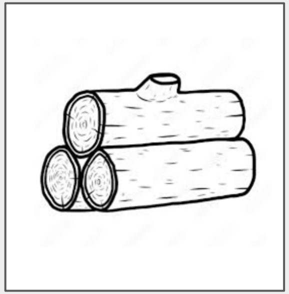

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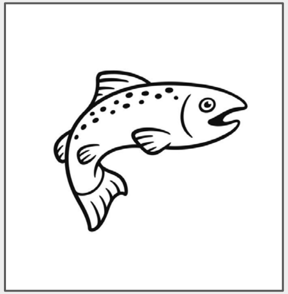
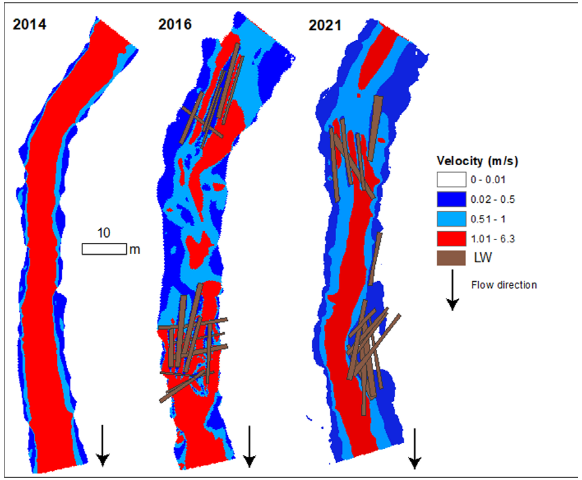


Objective 1 Methods

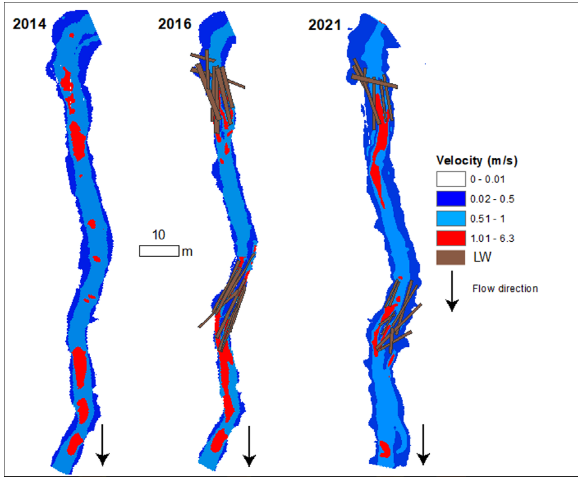
- **Field methods:**
  - Detailed topographic surveys of streambed and banks in 2014, 2016, and 2021 for model boundary
  - Pebble counts for manning's roughness coefficients
  - Stage-discharge rating curve at peak flow
  - WSE at several flows for calibration
- **Analysis:**
  - iRIC Nays2DH (2-dimensional, quasi-steady hydraulic model)
  - Thresholds of habitat velocities considering juvenile coho salmon limitation:
    - Desirable velocity (0.02 – 0.5 m/s)
    - Survivable velocity (0.51 – 1.0 m/s)
    - Undesirable velocity (1.01 – 6.3 m/s)

Desirable Survivable Undesirable

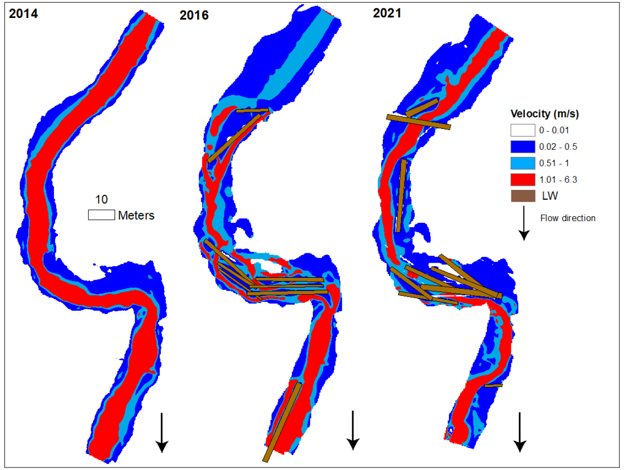
Site 1



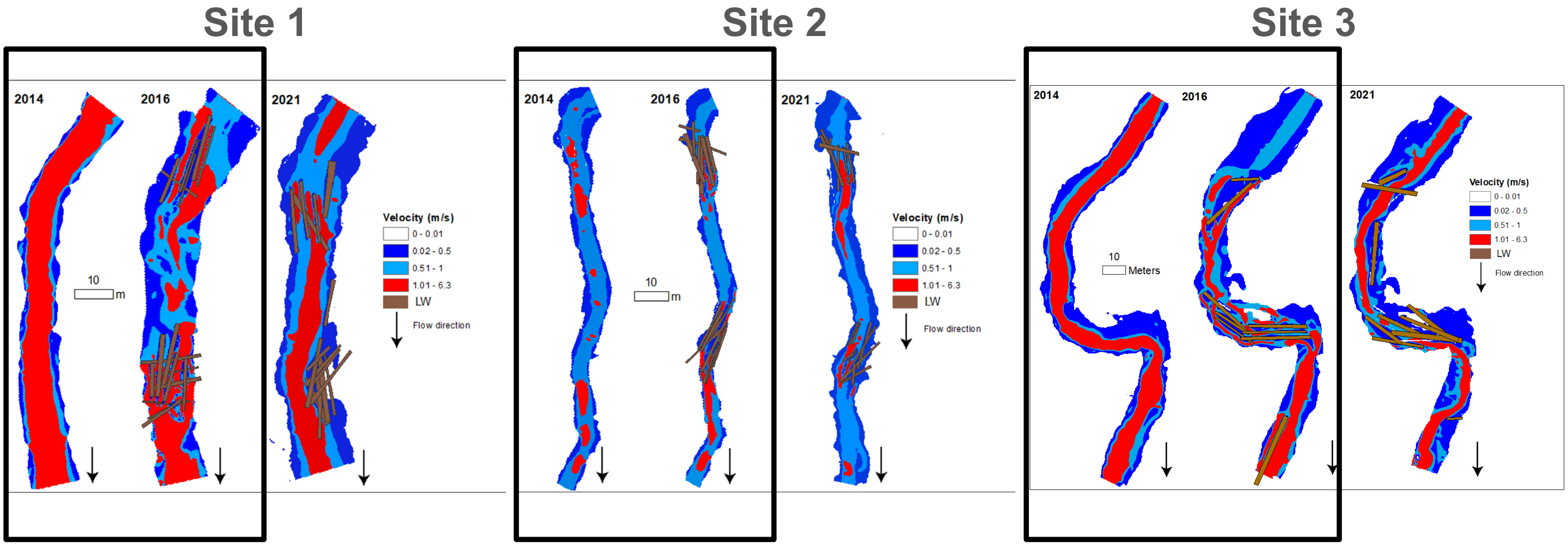
Site 2



Site 3

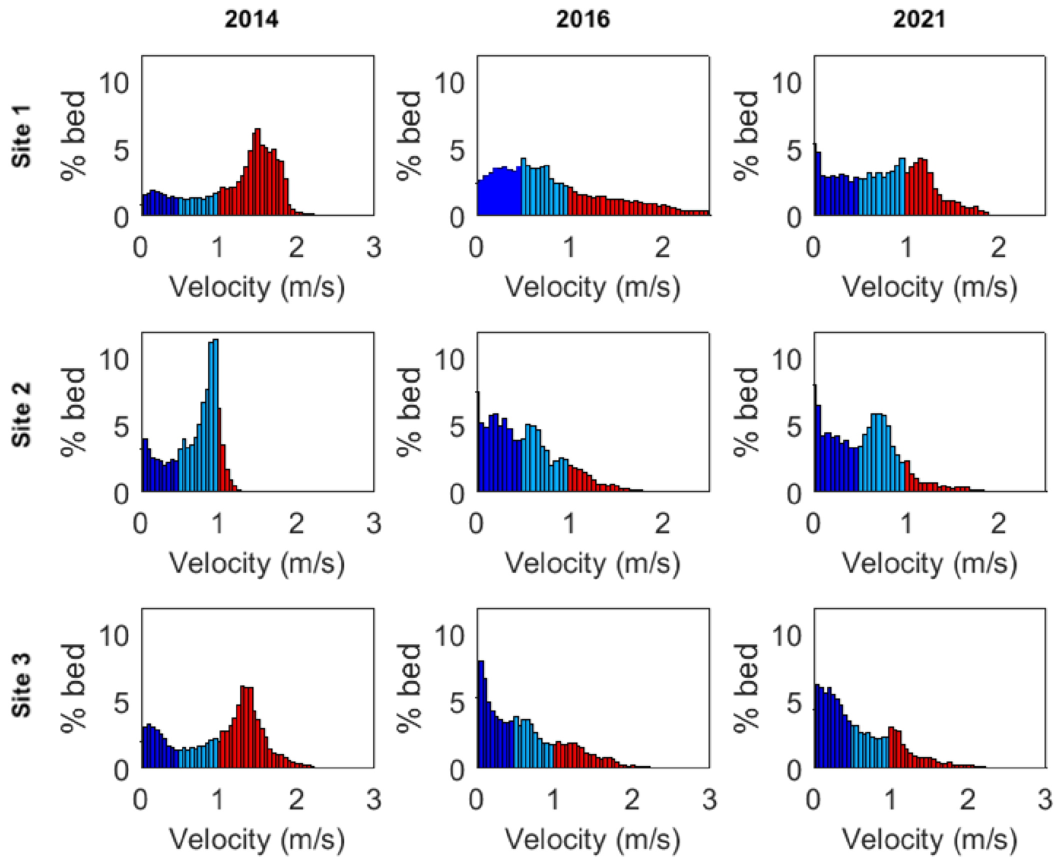


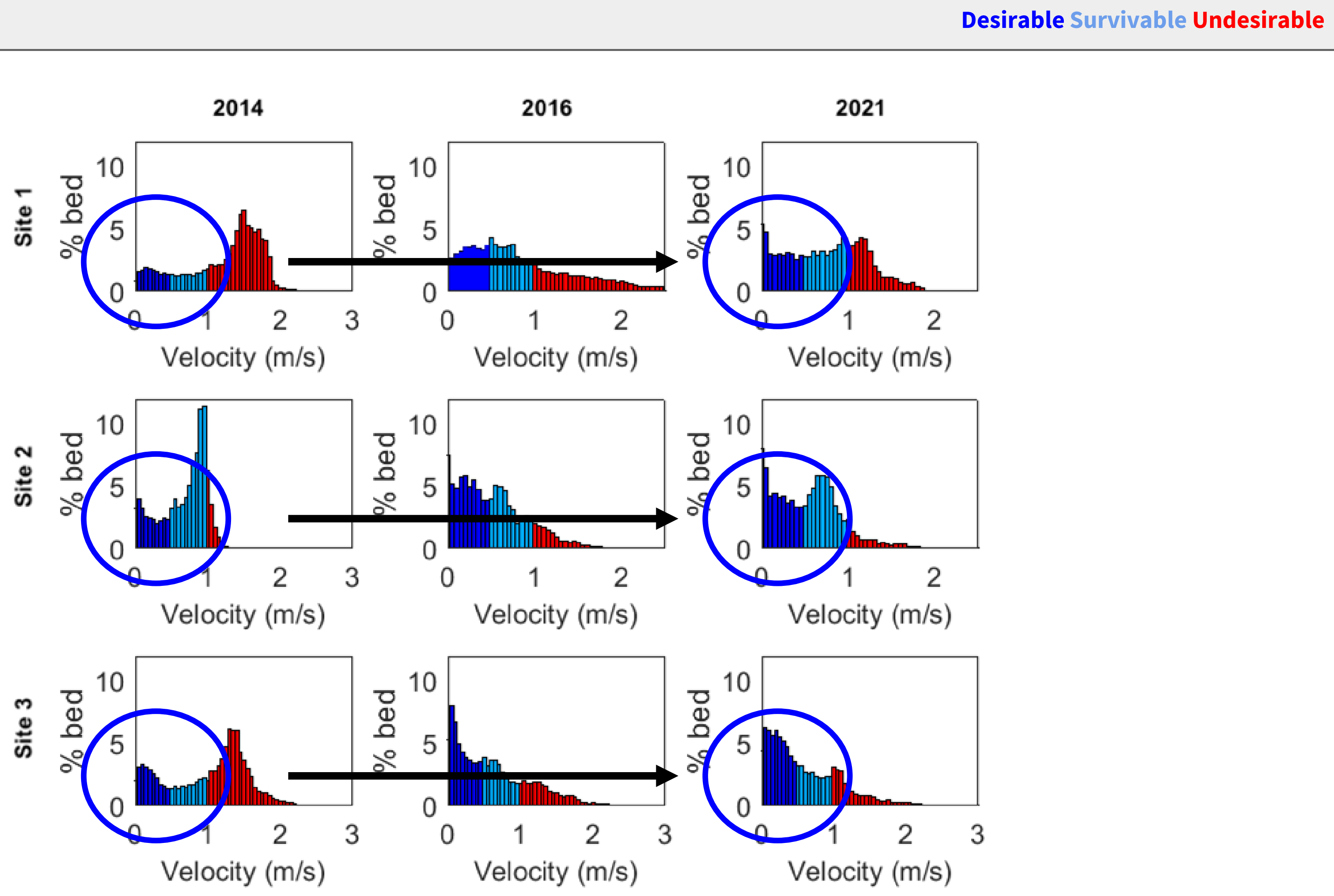
Desirable Survivable Undesirable



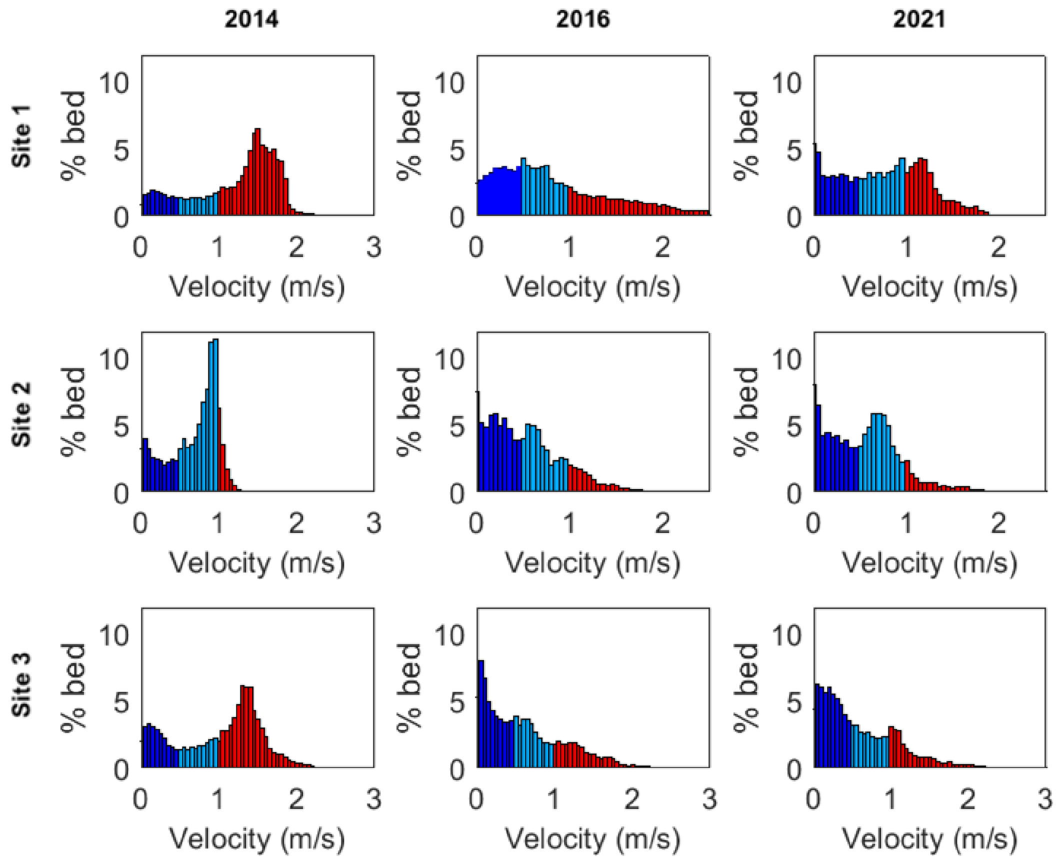
↑ S1 **desirable** velocities ↓ S1 in **undesirable** velocities

Desirable Survivable Undesirable

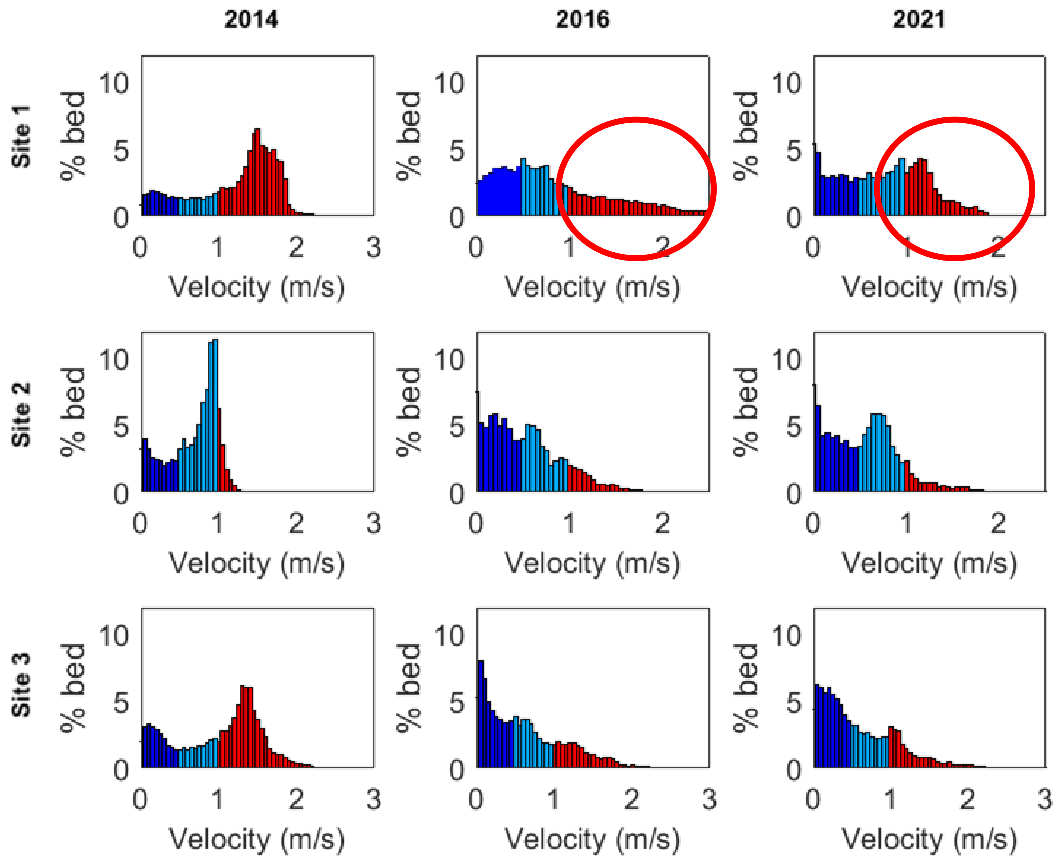


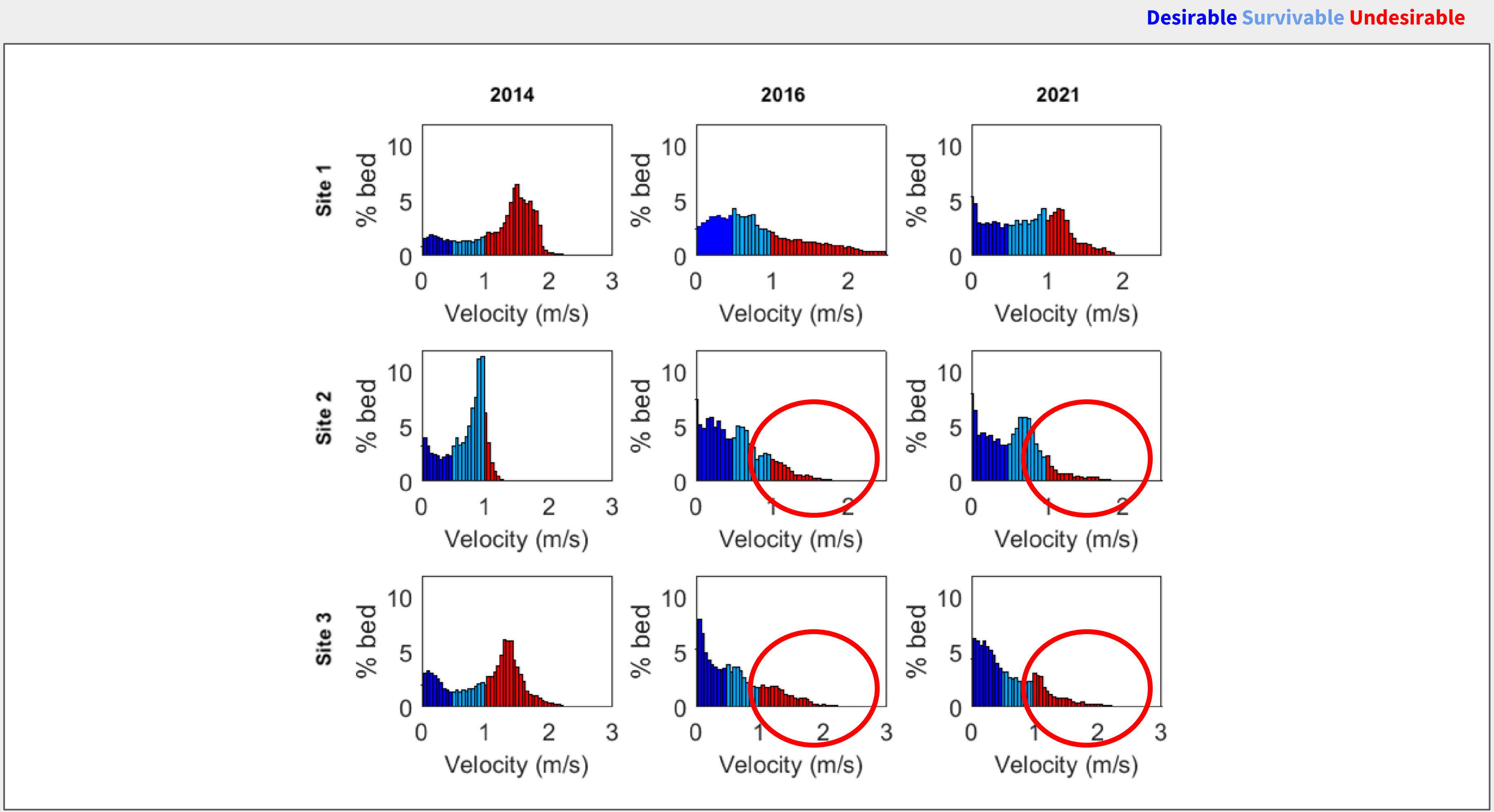

Desirable Survivable Undesirable
2014
2016
2021
Site 1
Site 2
Site 3
% bed
Velocity (m/s)

Desirable Survivable Undesirable

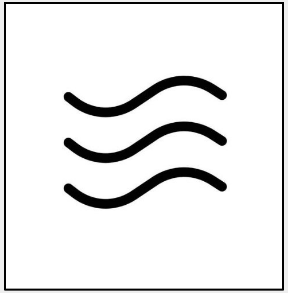

2014
2016
2021
Site 1
Site 2
Site 3
% bed
Velocity (m/s)
0
5
10
1
2
3

Desirable Survivable Undesirable




Desirable Survivable Undesirable
2014
2016
2021
Site 1
Site 2
Site 3
% bed
Velocity (m/s)

Objective 1



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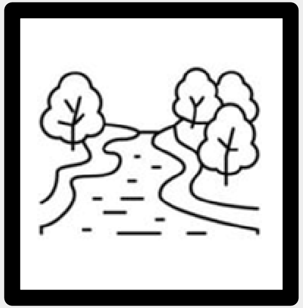

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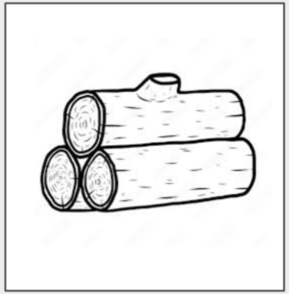
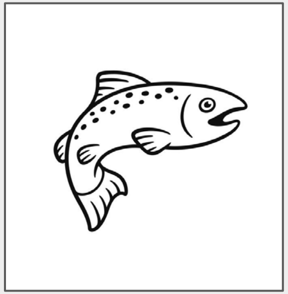
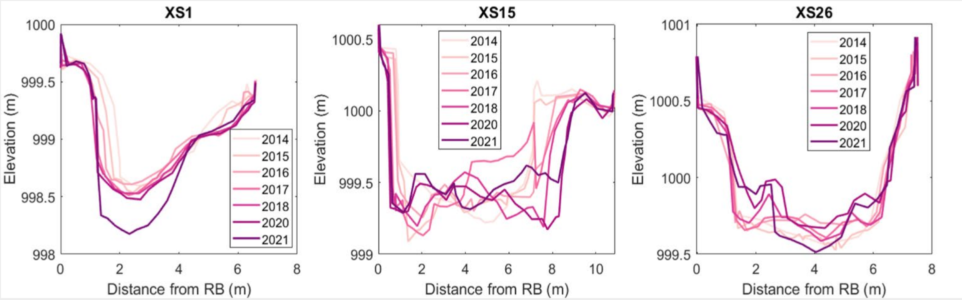


Objective 4

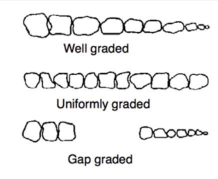


Objective 2 Methods

- **Field Methods**
  - Cross section surveys
    - Topographic surveys
    - Pebble counts
- **Analysis**
  - Calculate changes in cross sectional profiles from annual topographic surveys
    - Scour, deposition, total change, and net change
  - Investigate annual fluctuations in sediment sizes
    - Sediment percentiles (D_{84}, D_{50}, D_{16})
    - Gradation coefficient



$$\sigma_g = \sqrt{\frac{D_{84}}{D_{16}}}$$

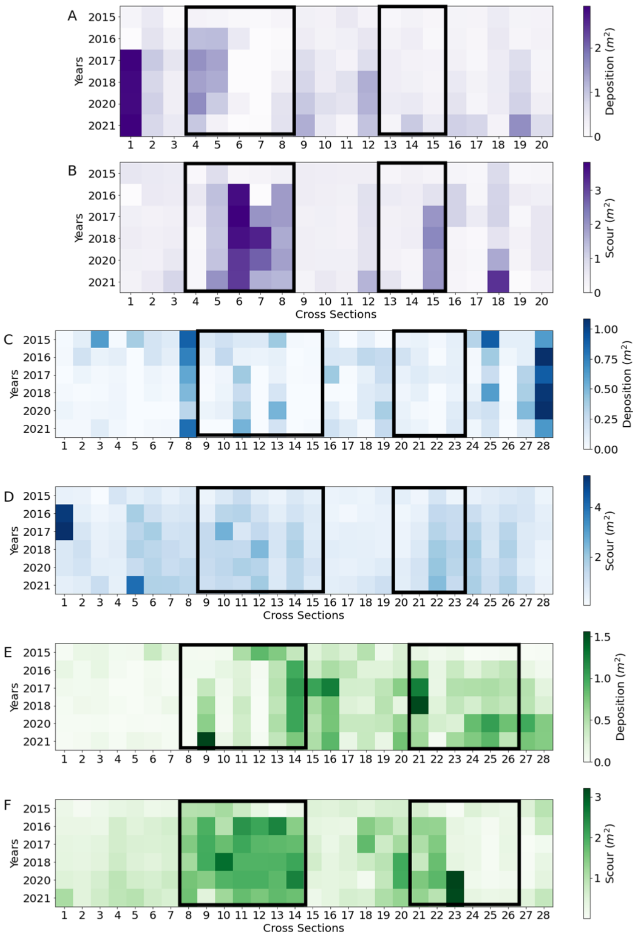


Site 1 Site 2 Site 3

Site 1

Site 2

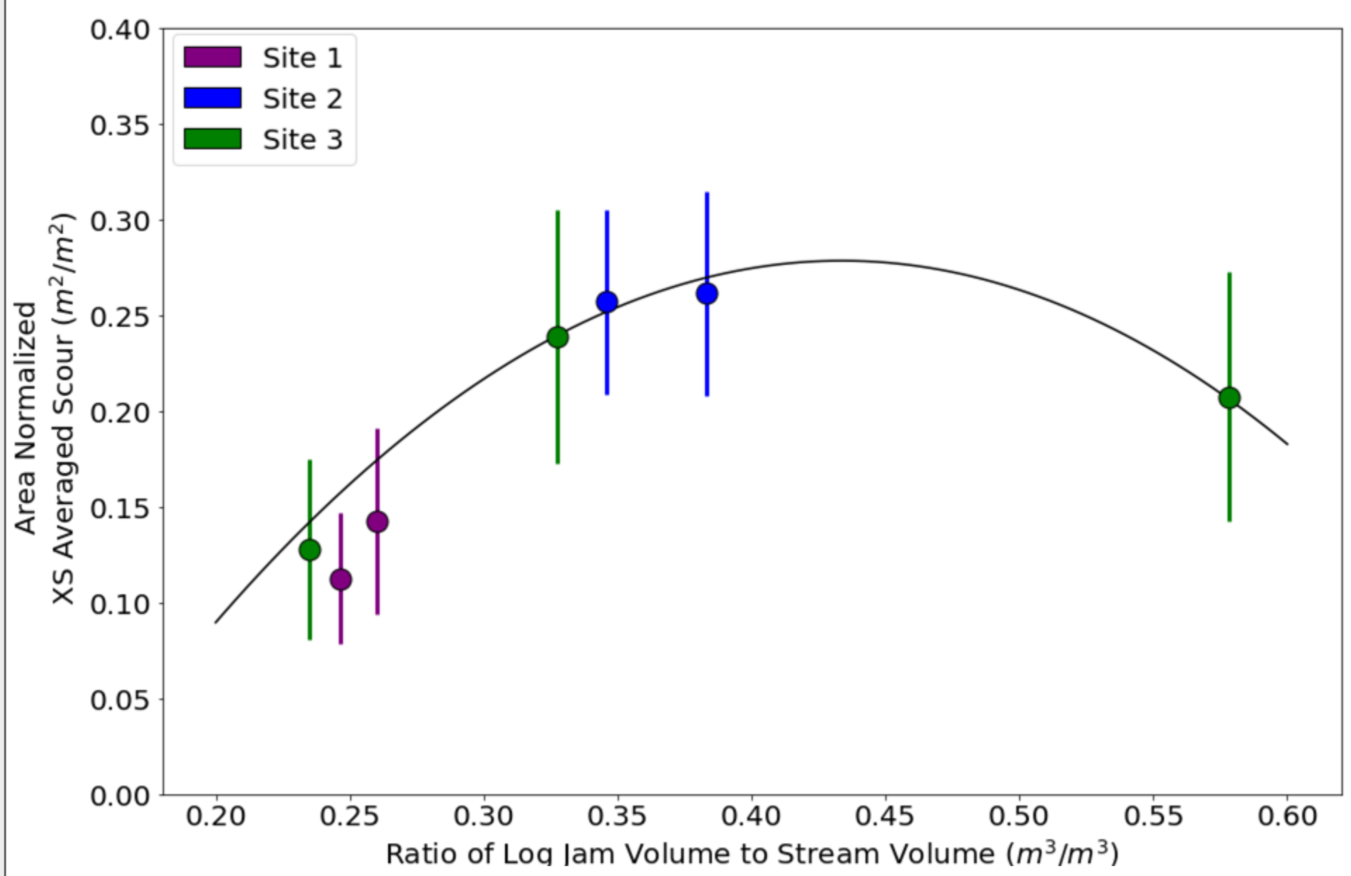
Site 3



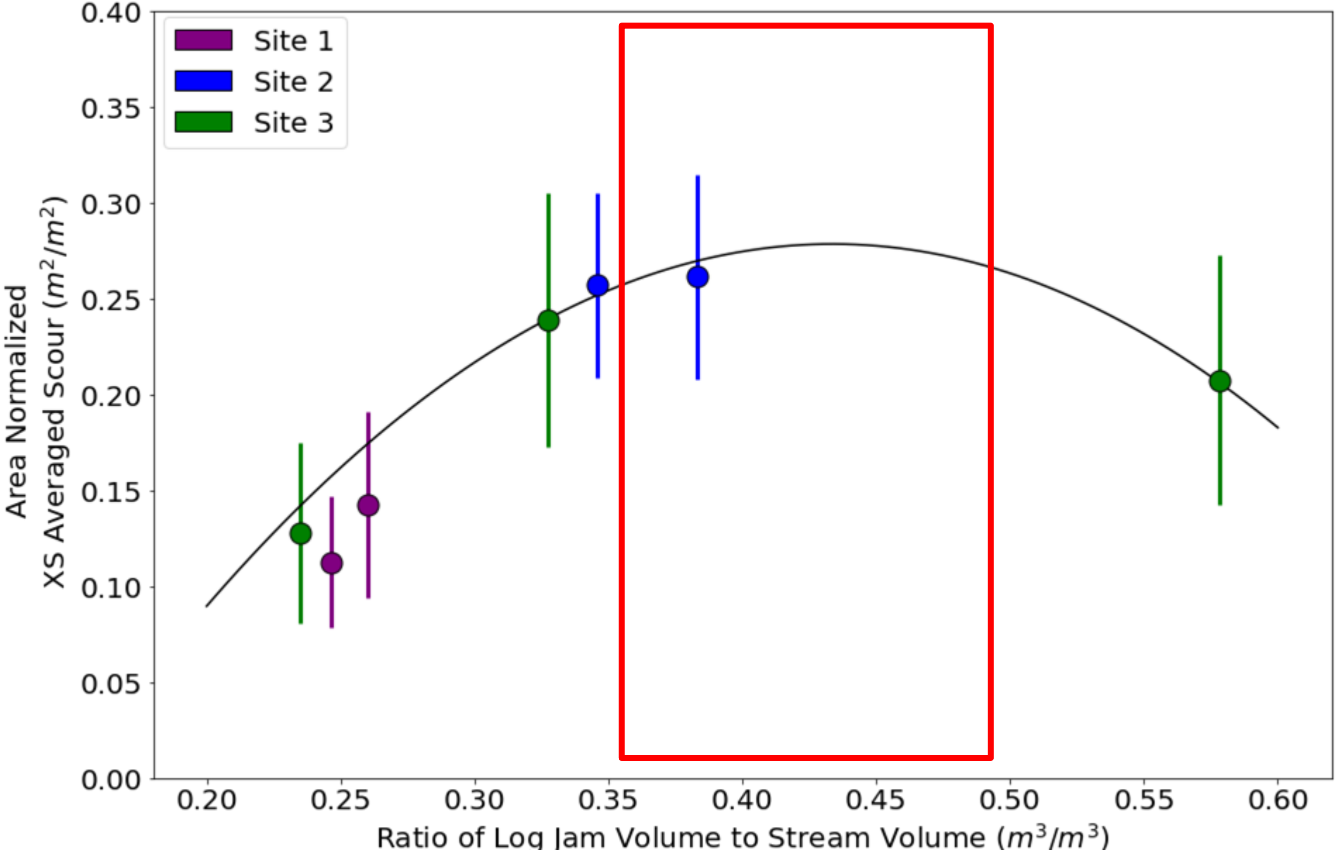
LW structures are statistically related to scour (CI = (-0.489, -0.263))

LW structures not related to deposition

Site 1 Site 2 Site 3

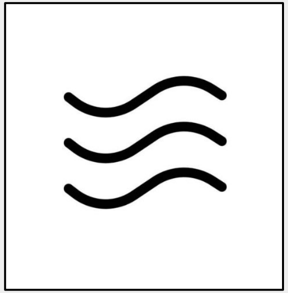


Site 1 Site 2 Site 3



LW structures that occupy between 35–50% of the stream elicit a maximized amount of scouring

Objective 1



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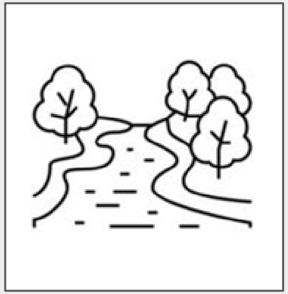

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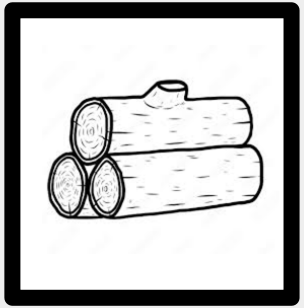
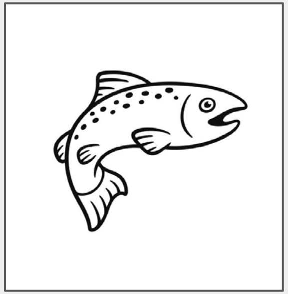


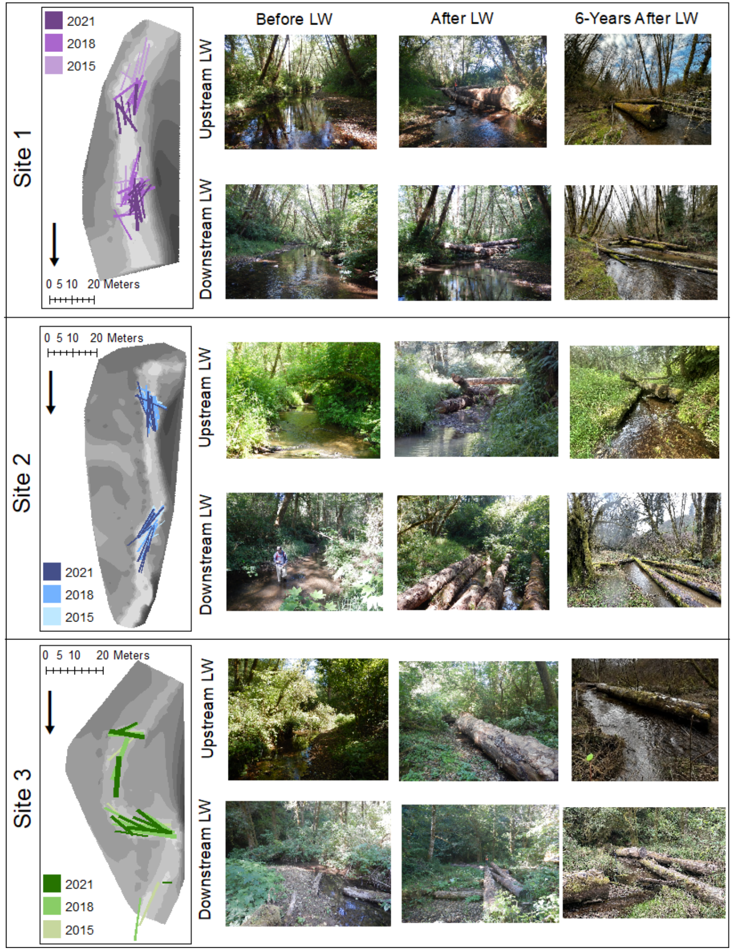
Objective 4



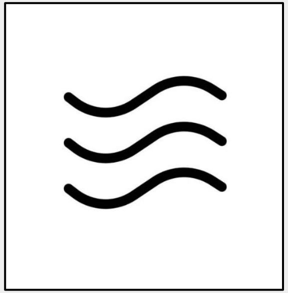
Objective 3 Methods

- Field Methods:
  - Detailed topographic surveys of LW structure movements
    - 2016
    - 2018
    - 2021
- Analysis:
  - Show movement and rearrangement over the years
  - Extrapolate to the basin scale

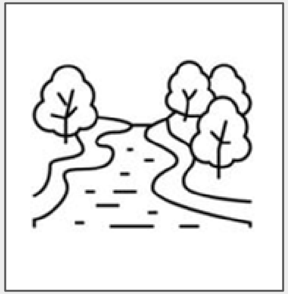
Increased downstream movement of the LW structures in the larger site.



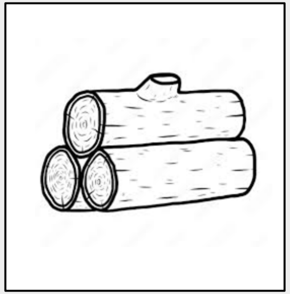
Objective 1



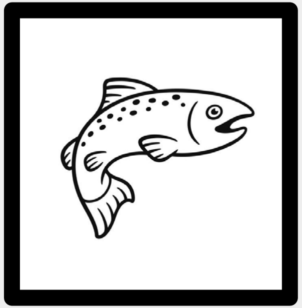
Objective 2



Objective 3



Objective 4



Objective 4 Methods

- Field methods from ODFW:
    - Screw trap on the mouth of the watershed
        - Traps migrating smolts
        - Captures rearing adults
    - Electrofishing surveys
- Analysis:
    - Look at variations in fish abundance, biomass, condition factor within Mill Creek and compared to Lobster Creek.

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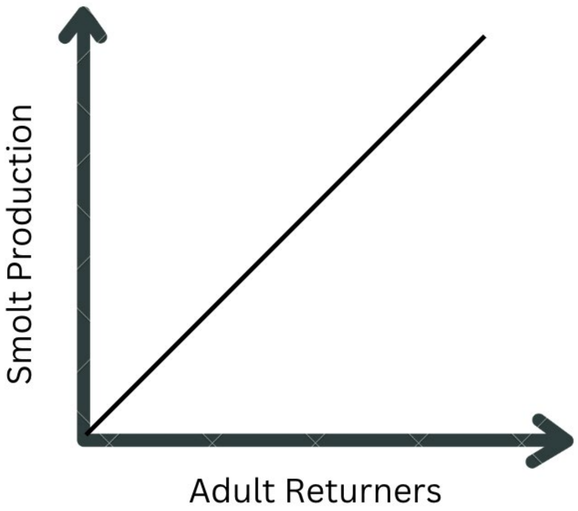
Fish & Wildlife

Objective 4 Background

Assume…

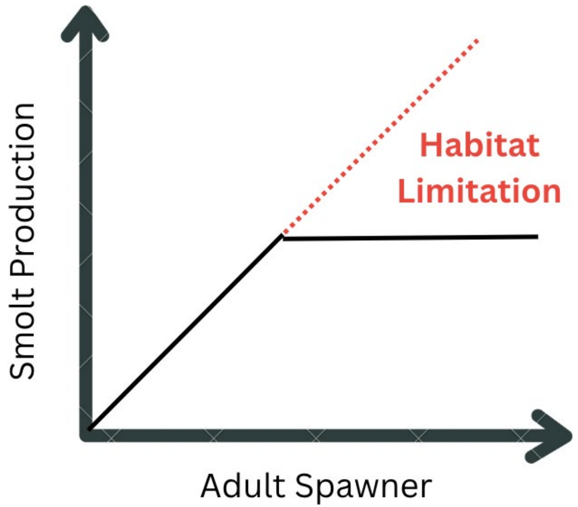
Low adult returners = low smolt production

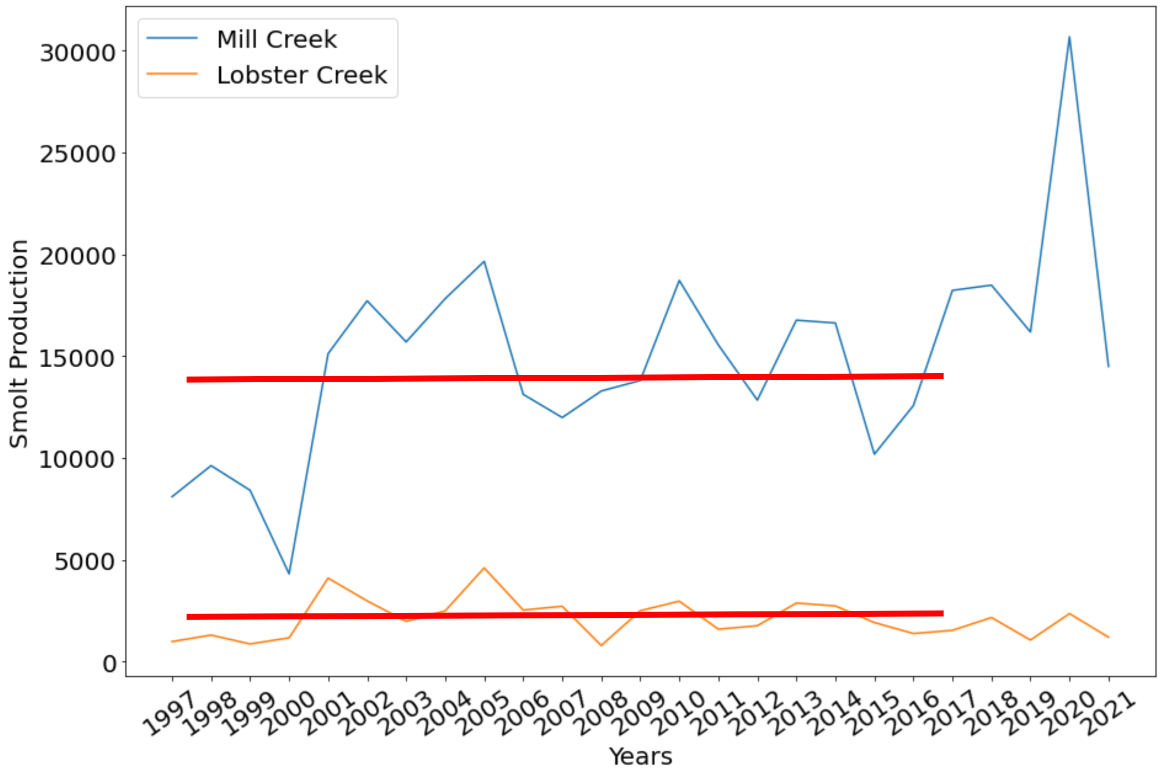
High adult returners = high smolt production



Objective 4 Background

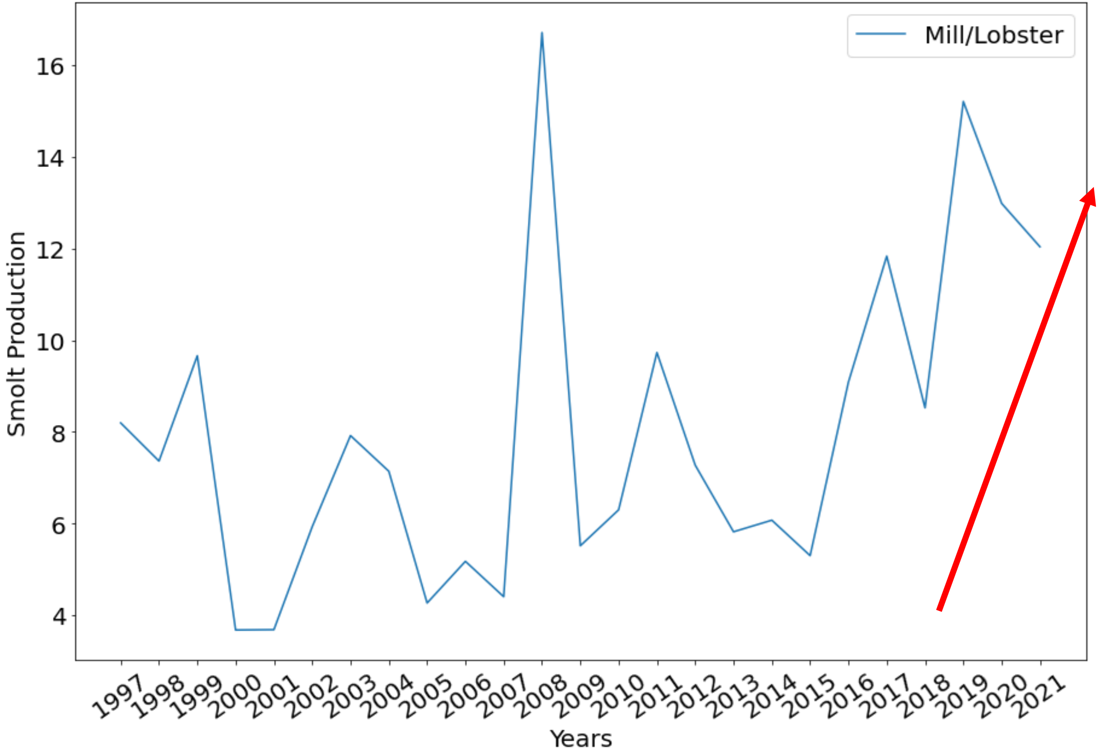
High adult spawners with low smolt production results from some sort of limiting factor





Coho smolt production was at a relative plateau in both Mill Creek and Lobster Creek

Relative to the Reference Reach, smolt production increased immediately after the LW introduction



Planned Work

- Objective 1:
  - Analyze streambed stability data
    - Thresholds for sediment entrainment
      - No sediment transport ($\tau < \tau_c$)
      - Partial sediment transport ($\tau_c < \tau < 2\tau_c$)
      - Full sediment transport ($\tau > 2\tau_c$)
- Objective 2:
  - Submit manuscript for publication.
- Objective 3:
  - Scale up the analysis of LW movement and stability data from the reach level to the basin level.
- Objective 4:
  - Continue analyzing data from 2014 to 2021 to identify patterns and explanations for coho salmon population changes.

Anticipated Publications

- Maffia, Segura, Warren, Suring, Yager, Bair. Restoring Streams with Large Wood: An Analysis of Geomorphic Changes 7 Years Post-Restoration in Streams of Differing Size; to be submitted to Geomorphology or Earth Surface Processes and Landforms in 2023.
- Maffia, Segura, Suring. Longevity of Large Wood Restoration Success to Improve Coho Salmon Habitat: A 2D Modeling Approach; to be submitted to Earth Surface Dynamics in 2024.
- Maffia, Warren, Segura, Lorion, Suring. Basin Response of Coho Population to Large Wood Restoration in the Oregon Coast Range; to be submitted to Journal of Fish Biology in 2025.

Thank you!

Thank you to everyone that has assisted with this project!

FWHPF

ODFW

Desiree Tullos, OSU

Dana Warren, OSU

Richard McDonald, USGS

Michal Tutka

Jonah Nicholas

Cedric Pimont

Jaime Ortega

Melissa Mauk

Ellen Luedloff

Sydney Anderson

Chris Neihof

Will Potter

Research Objectives

1. Assess the stability/resilience of the fish habitat changes observed 1-yr post Large Wood (LW) restoration to changes observed 6-yrs post restoration.
2. Investigate the geomorphological changes triggered by LW restoration in three reaches based on the comparison of annual topographic surveys conducted 1-yr pre- to 5-yrs post-restoration.
3. Assess the stability of LW structures at the basin scale by comparing wood surveys conducted between 2016 and 2021.
4. Investigate the relationship between local and basin scale habitat/geomorphic metrics and fish population response after the restoration in the context of long-term fish population data.

Quantifying the effects of wildfire on water quantity, water quality, and fish: The Hinkle Creek Watershed Study revisited

Kevin Bladon, Dana Warren, David Roon, Kate McCredie, and Jansen Ivie

Fish and Wildlife Habitat in Managed Forests Research Grant Program

November 17, 2023

Oregon State University

FOREST ECOHYDROLOGY AND WATERSHED SCIENCE LAB

OREGON FOREST & INDUSTRIES COUNCIL

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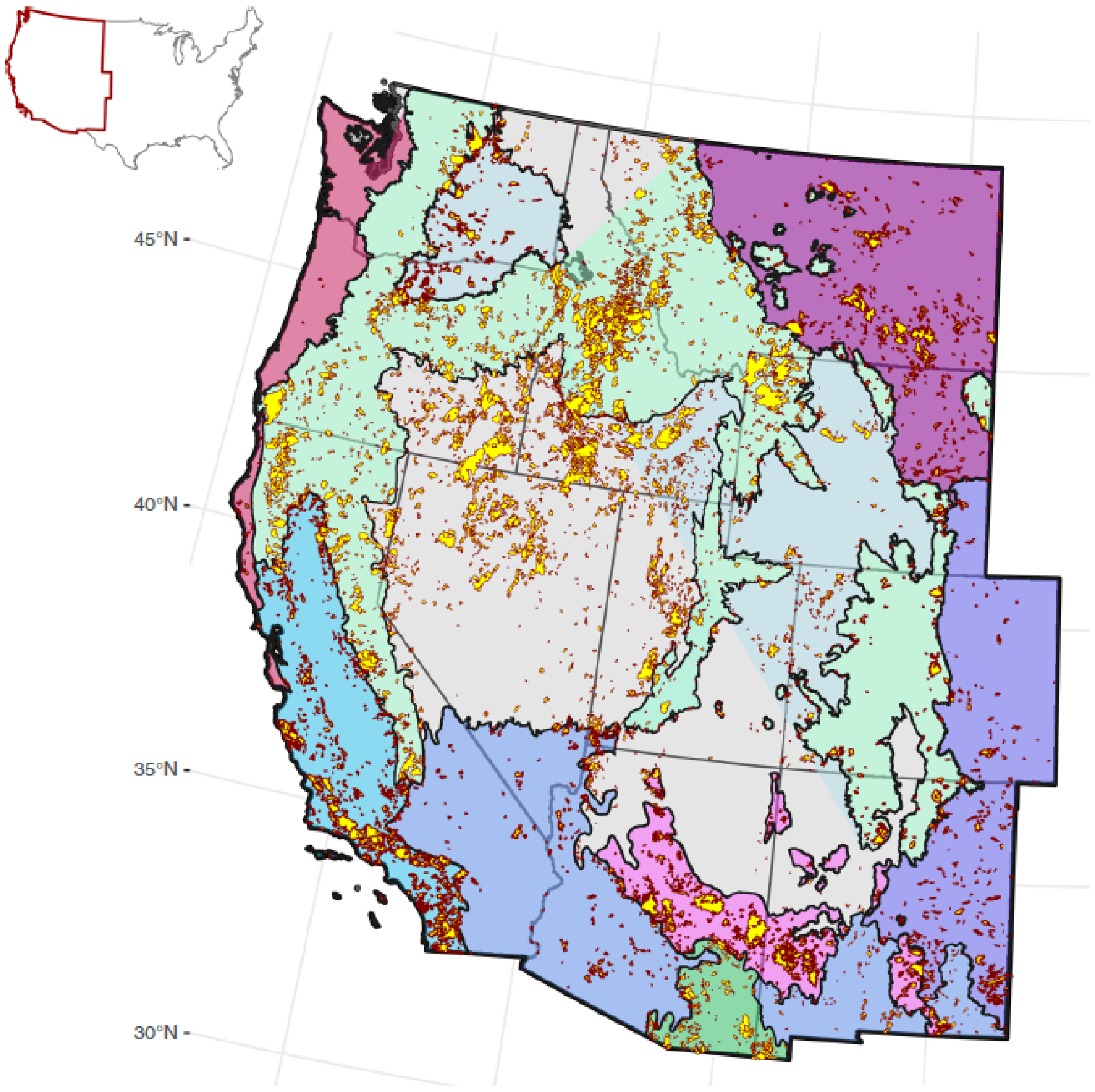
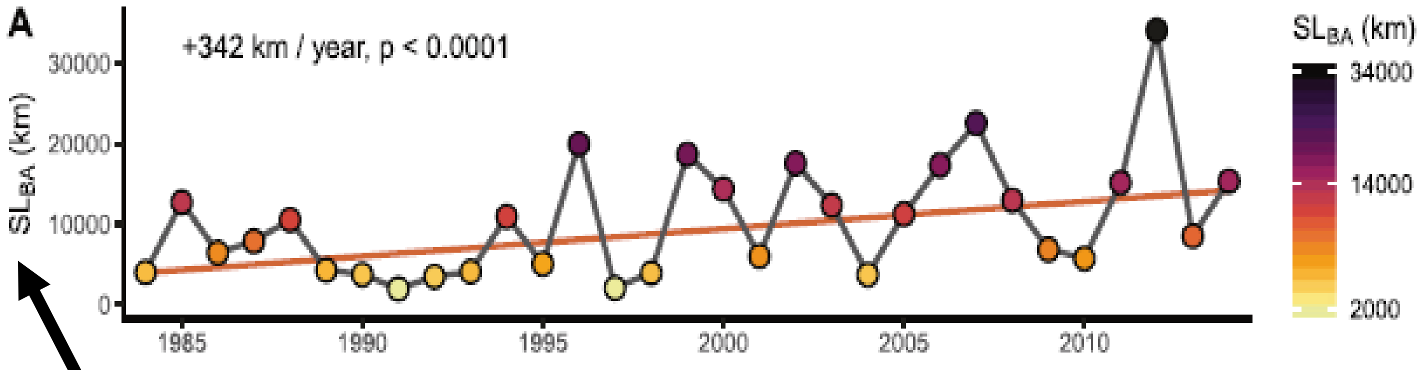
Roseburg

Wildfires are widespread natural disturbances that structure forested landscapes

Wildfires are increasingly affecting aquatic systems

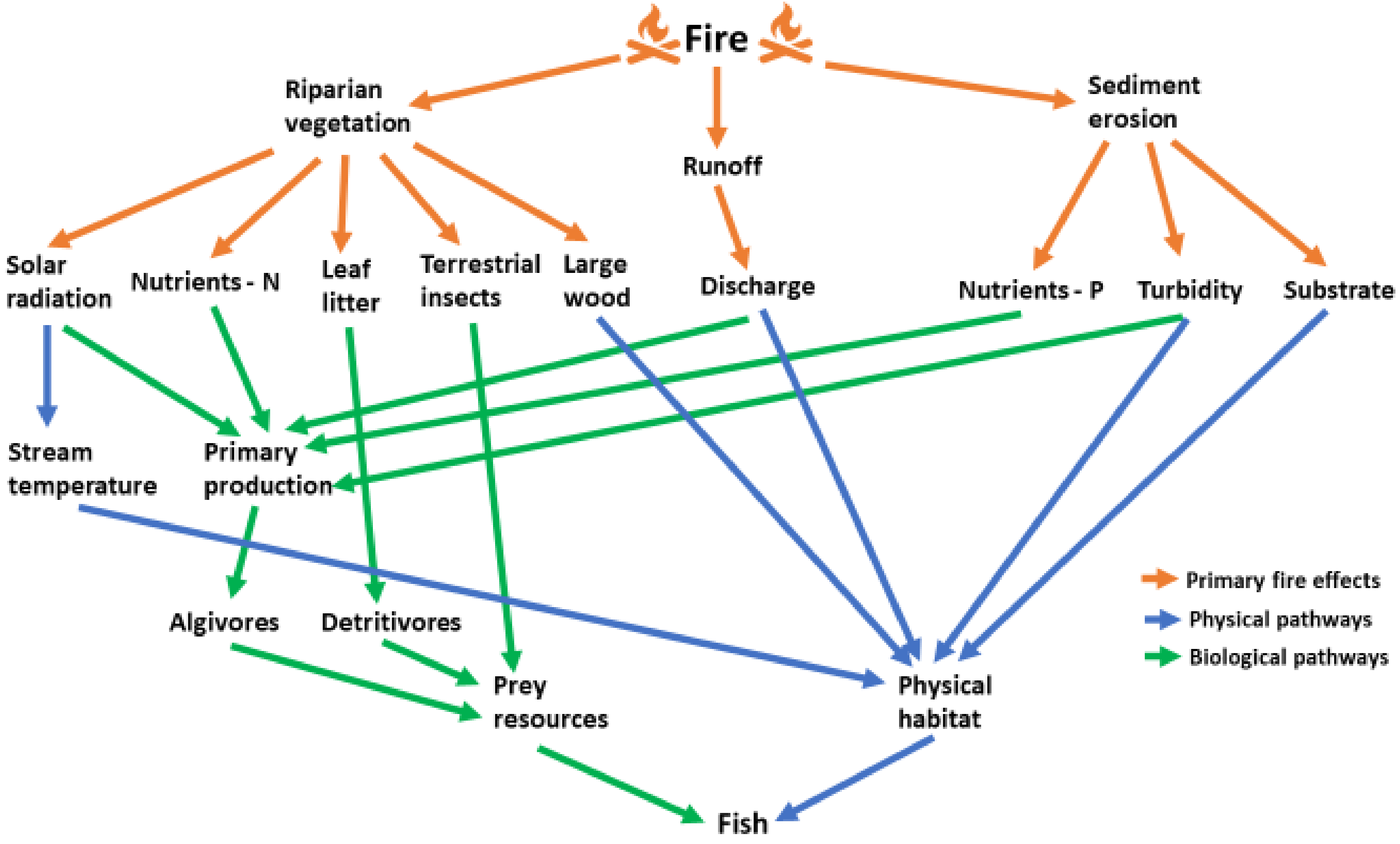




Total stream length affected by fire

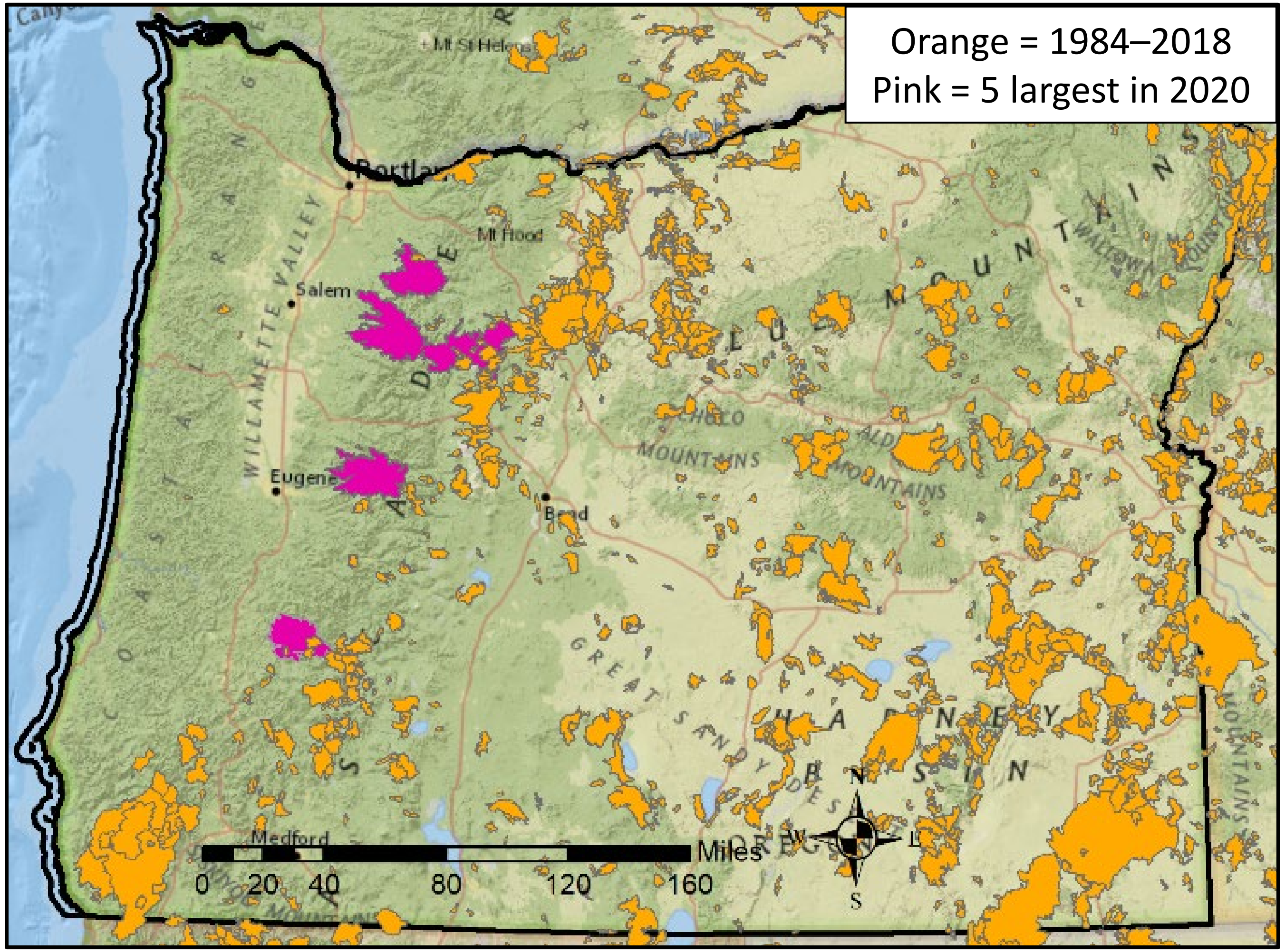
Ball et al. 2021

Fires can influence fish via a combination of *both* physical and biological pathways



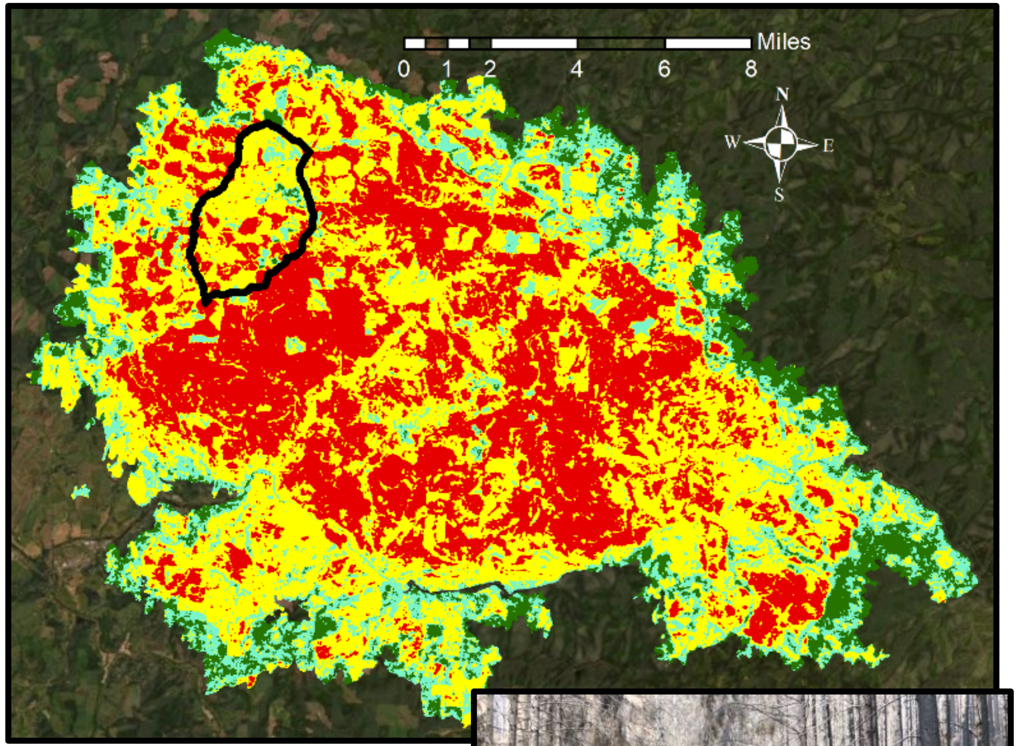
2020 fires in western Oregon a unique research opportunity

- Effects of fire remain poorly understood in westside forests of PNW
- One limiting factor is the lack of pre-fire data
- 2020 Oregon wildfires burned more than ~1.19M acres (4,815 km^2)



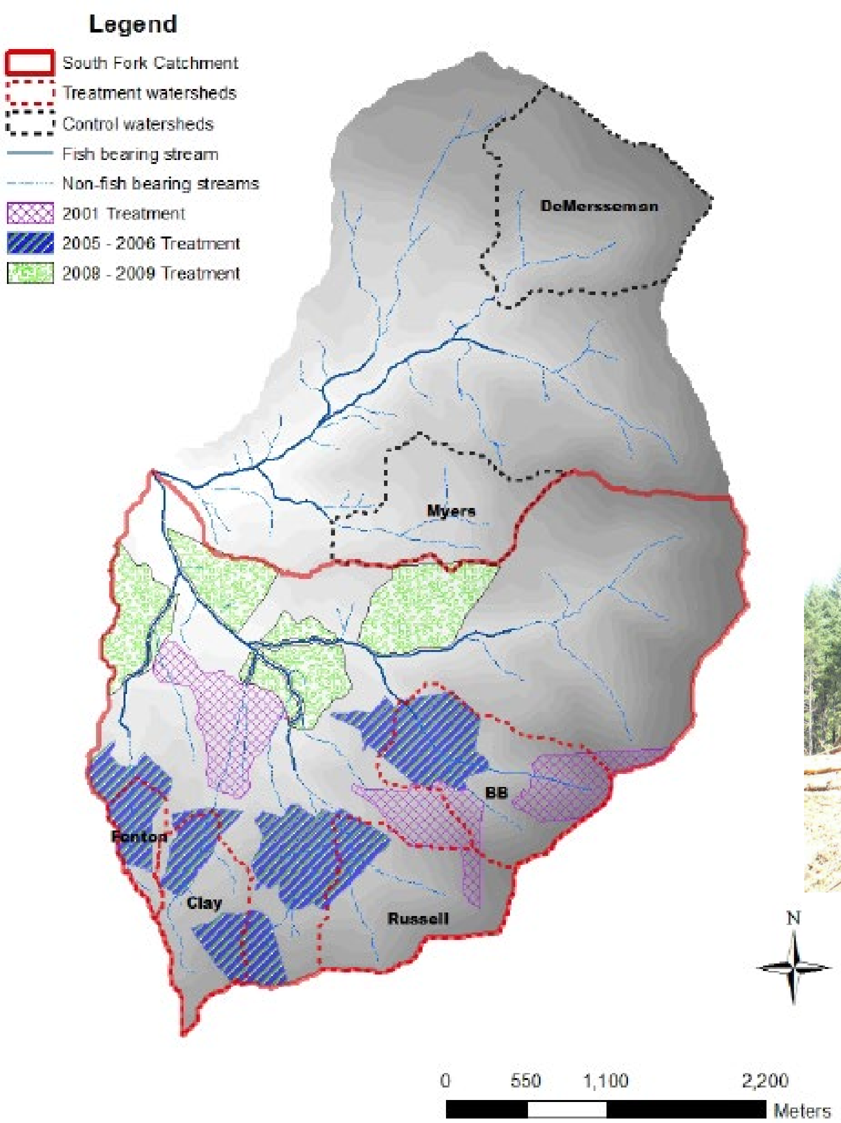
Hinkle Creek watershed

- Archie Creek Fire in Umpqua River Basin burned 131,542 acres (531 km^2)
- Burn severity
  - High: 32.9 %
  - Moderate: 44.0 %
  - Low: 14.2 %
  - Unburned: 8.9 %
- Burned area included sub-watersheds from the original Hinkle Creek Watershed Study



Original Hinkle Creek Watershed Study (2001–2011)

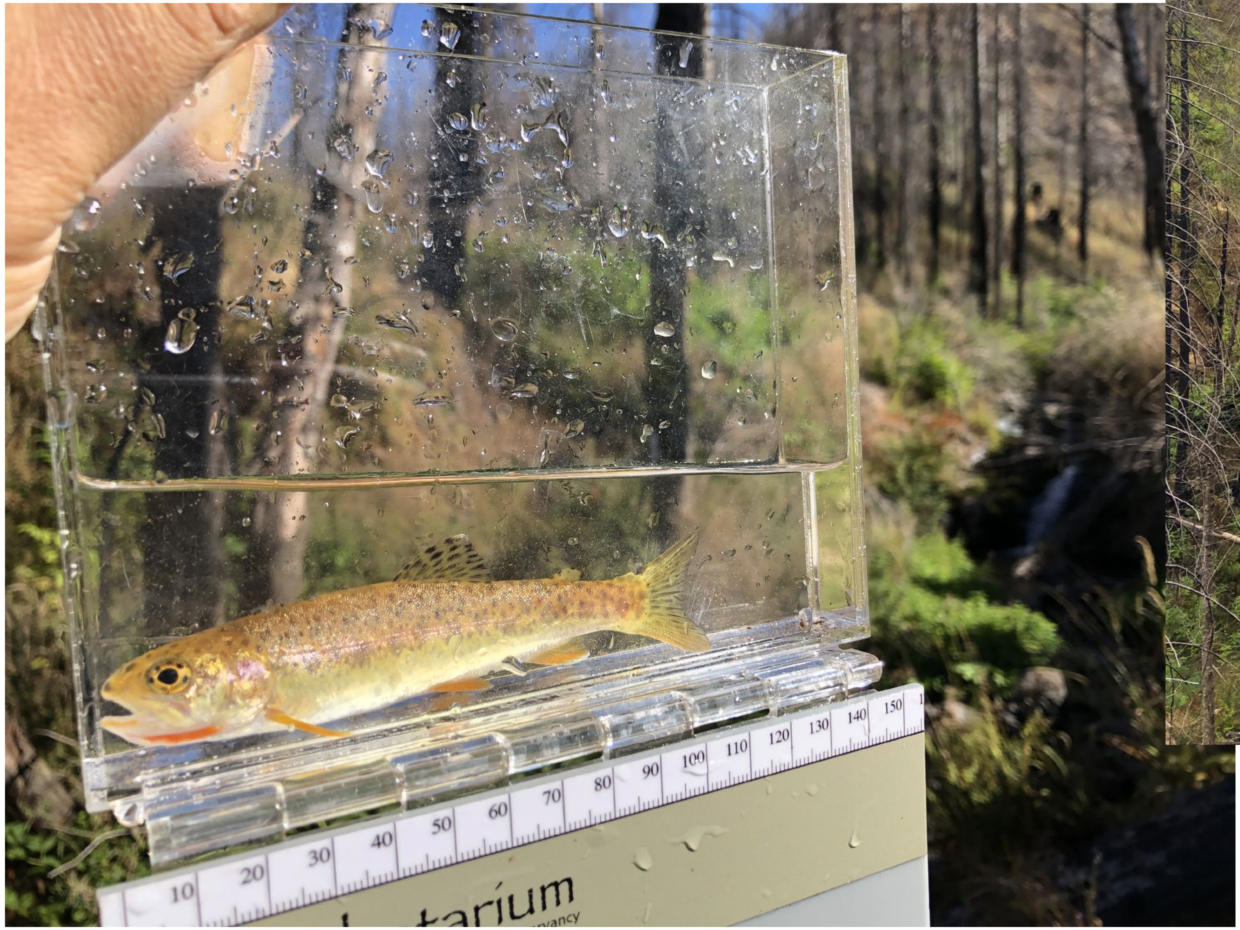
- Paired watershed experimental design
- Pre-harvest 2001-05, headwater harvest 2005-06, mainstem harvest 2008-09
- Parameters measured:
  - Physical habitat
    - streamflow
    - suspended sediment
    - stream temperature
    - water quality
  - invertebrates
  - fish and amphibians



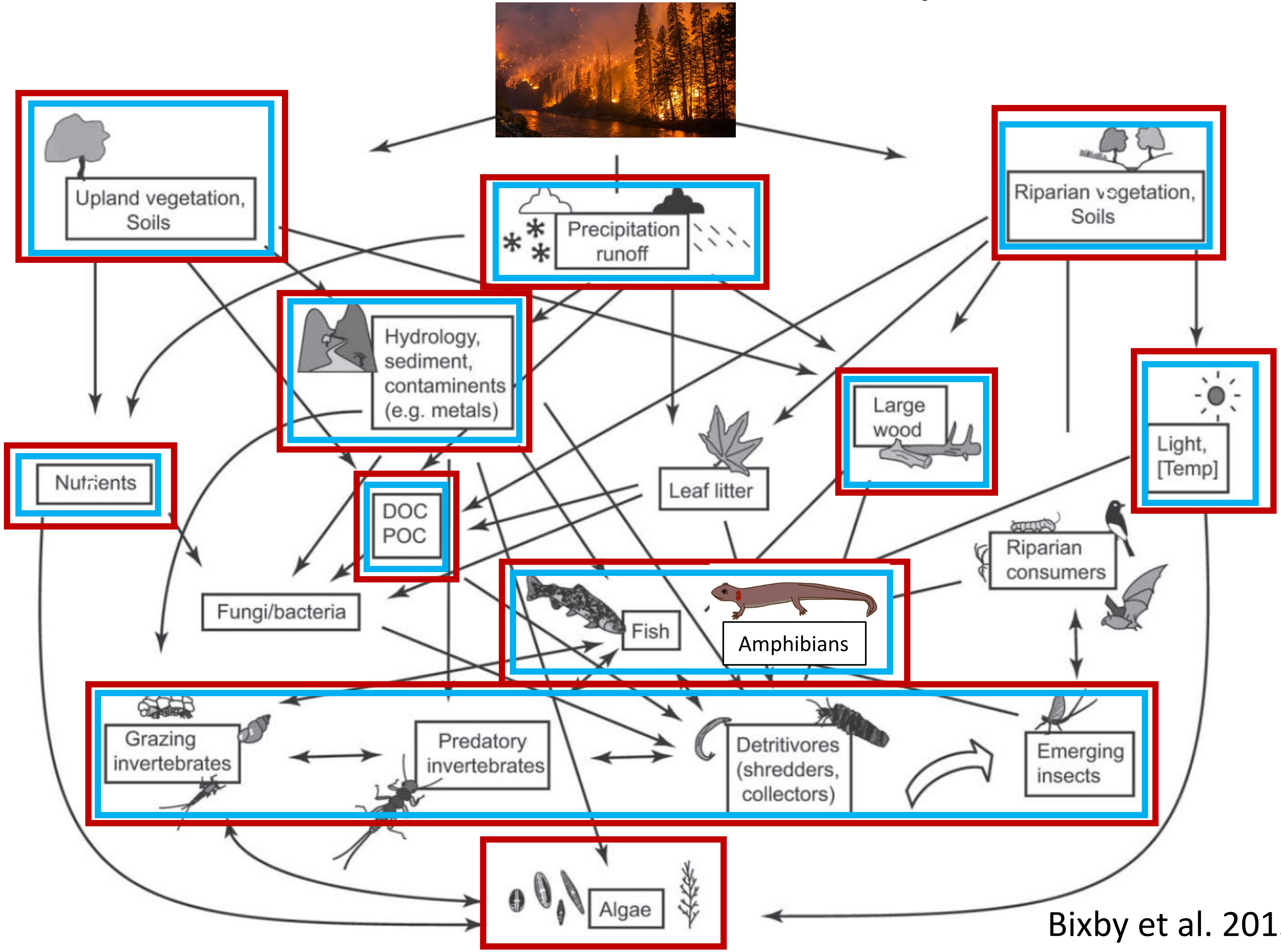
Dramatic shift in watershed conditions…

A. Skaugset 2013

So, how do wildfires affect fish and their habitats?



We are monitoring many of the same variables collected in the original Hinkle Watershed Study



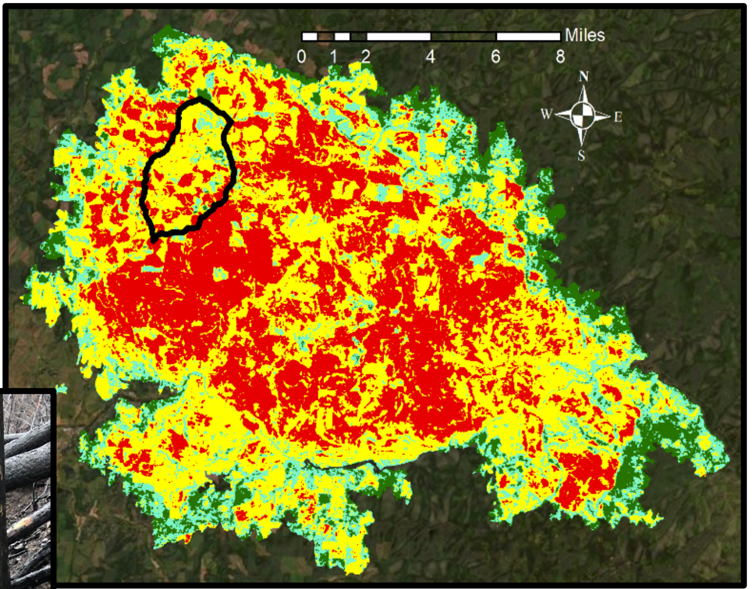
Original Hinkle Watershed Study

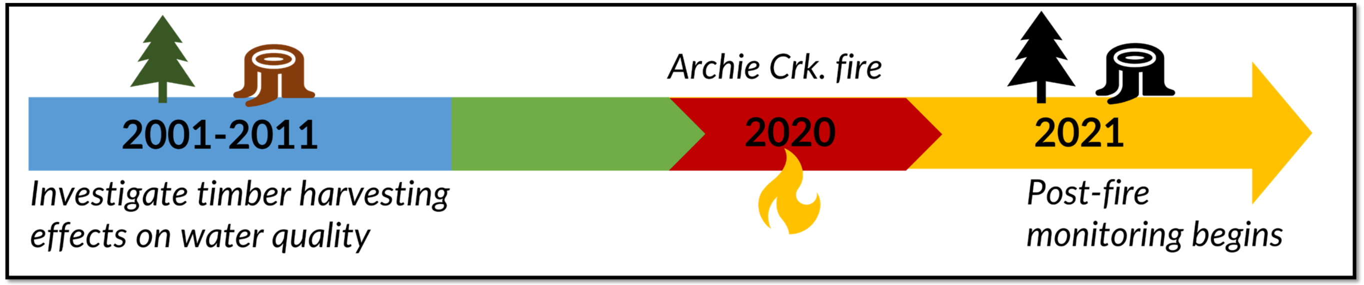
Currently monitoring

Bixby et al. 2015

Research Objectives

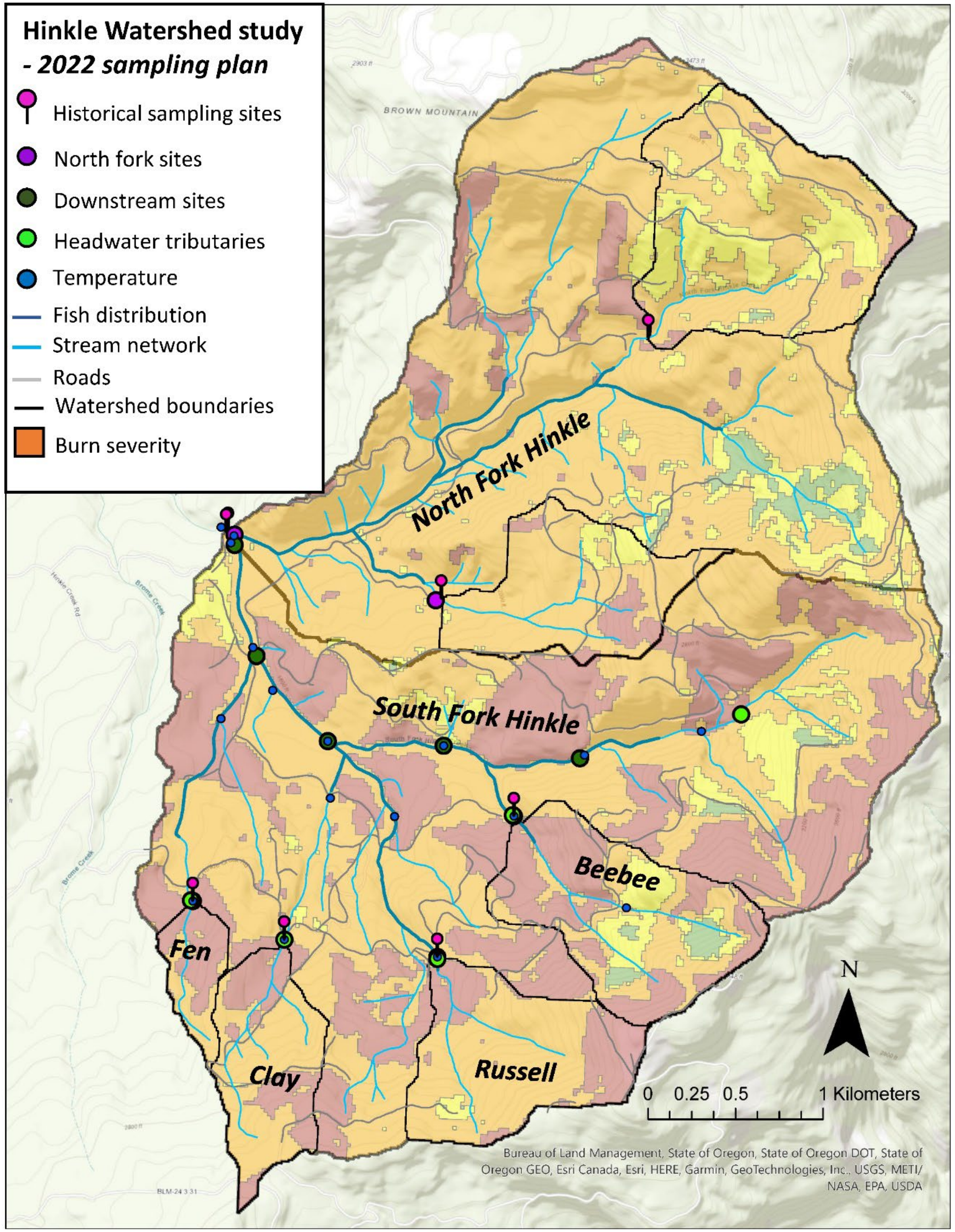
- 1) Quantify effects of fire on **water quality** (nutrient concentrations) and relate those to broader food web including fish and amphibians
- 2) Quantify effects of fire on **water quantity** (streamflow) to track nutrient yields, water supply, and fish and amphibian habitat quantity and quality
- 3) Relate water quantity and quality responses to **spatial data** to identify drivers of post-fire variability
- 4) Leverage data from **original Hinkle Creek Watershed study** to compare relative magnitude of disturbance types (fire and post-fire management vs. timber harvest)





Experimental design

- Post-fire monitoring focused on SF Hinkle and tributaries
  - Repeating locations from original study
- Measuring suite of parameters:
  - Water quality – nutrients (*Objective #1*)
  - Water quality – sediment (*Objective #1*)
  - Water quantity – streamflow (*Objective #2*)
  - Riparian canopy cover
  - Stream temperature
  - Aquatic ecology
  - Fish and amphibian communities



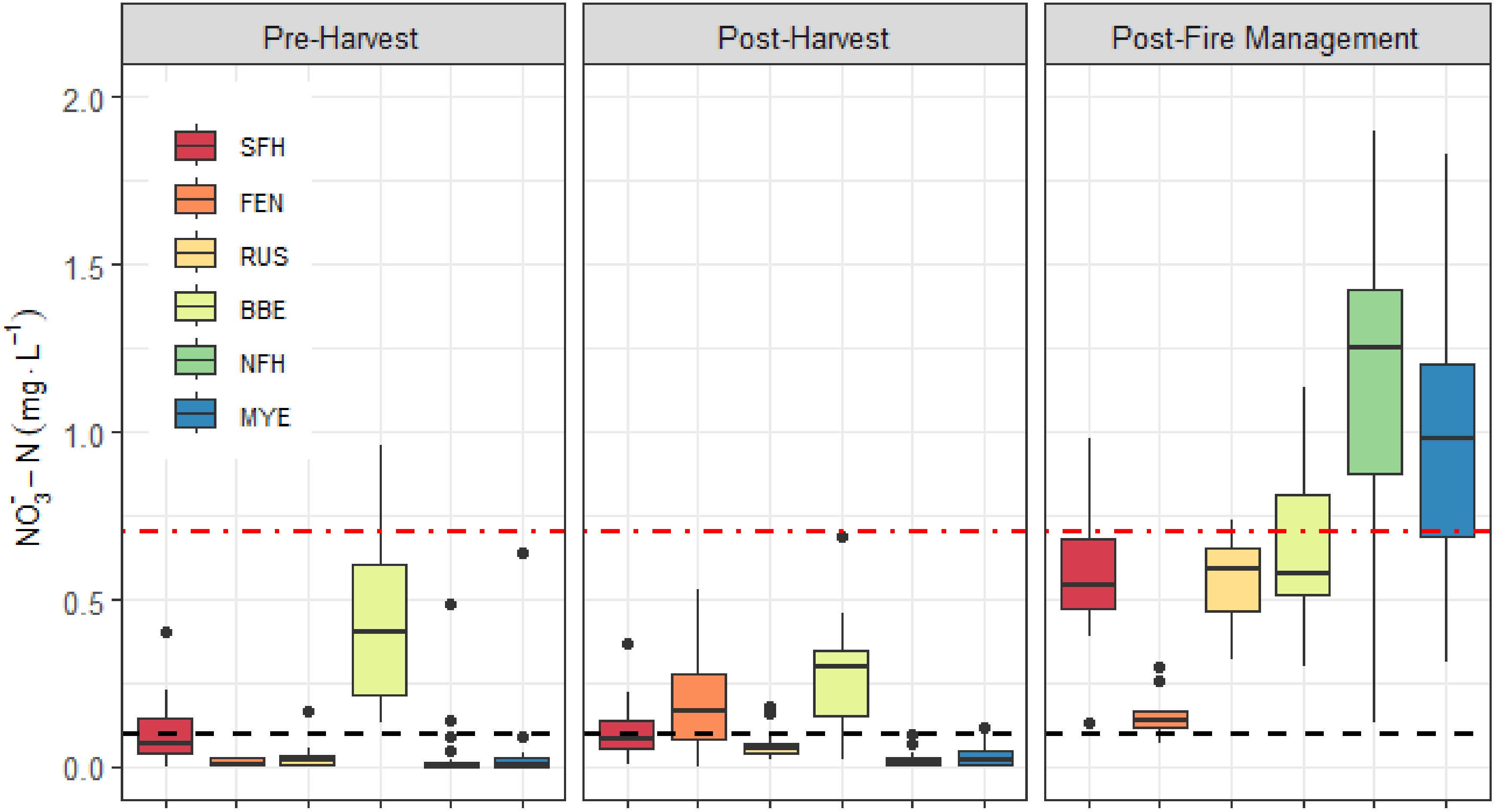
Fire effects on physical dimensions of aquatic habitats

- **Water quality – nutrients:** grab samples for N, P, and DOC
- **Water quality – sediment:** ISCO's (automated water samplers)
- **Streamflow:** flumes, physical discharge measurements, and pressure transducers
- **Riparian canopy cover:** hemispherical photography
- **Stream temperature:** digital temperature sensors

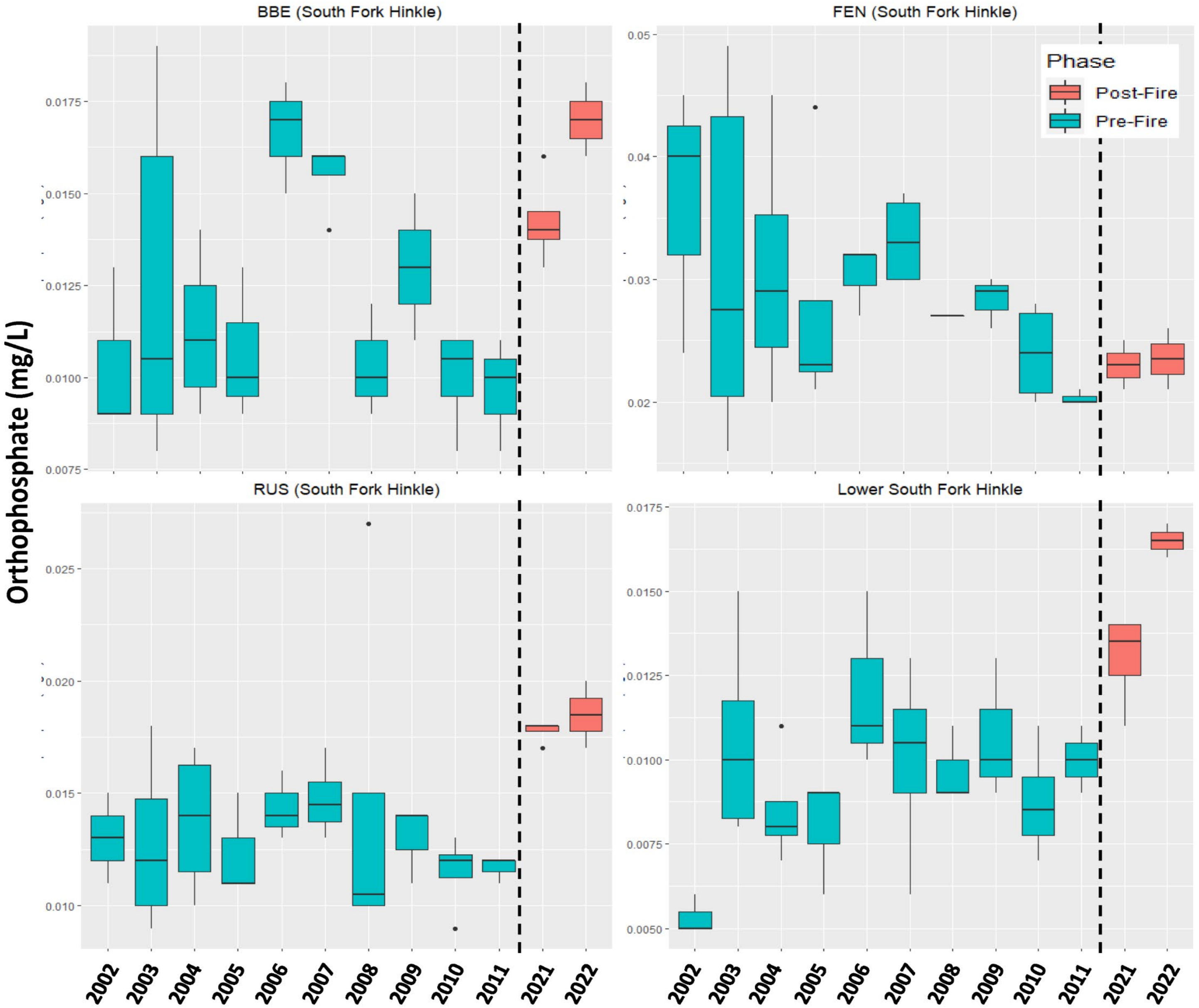




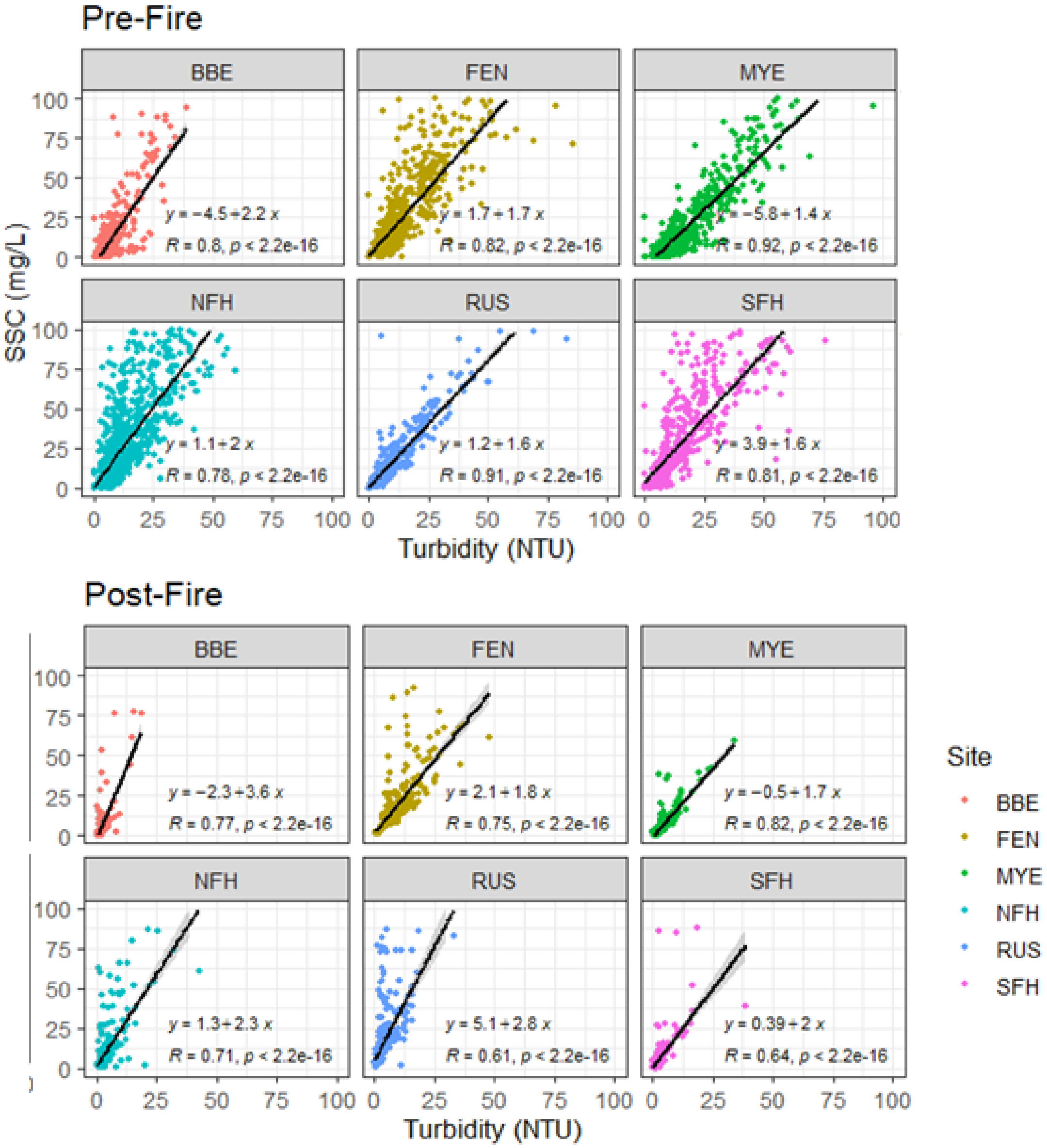

Evidence of substantial post-fire increases in **nitrate concentrations**



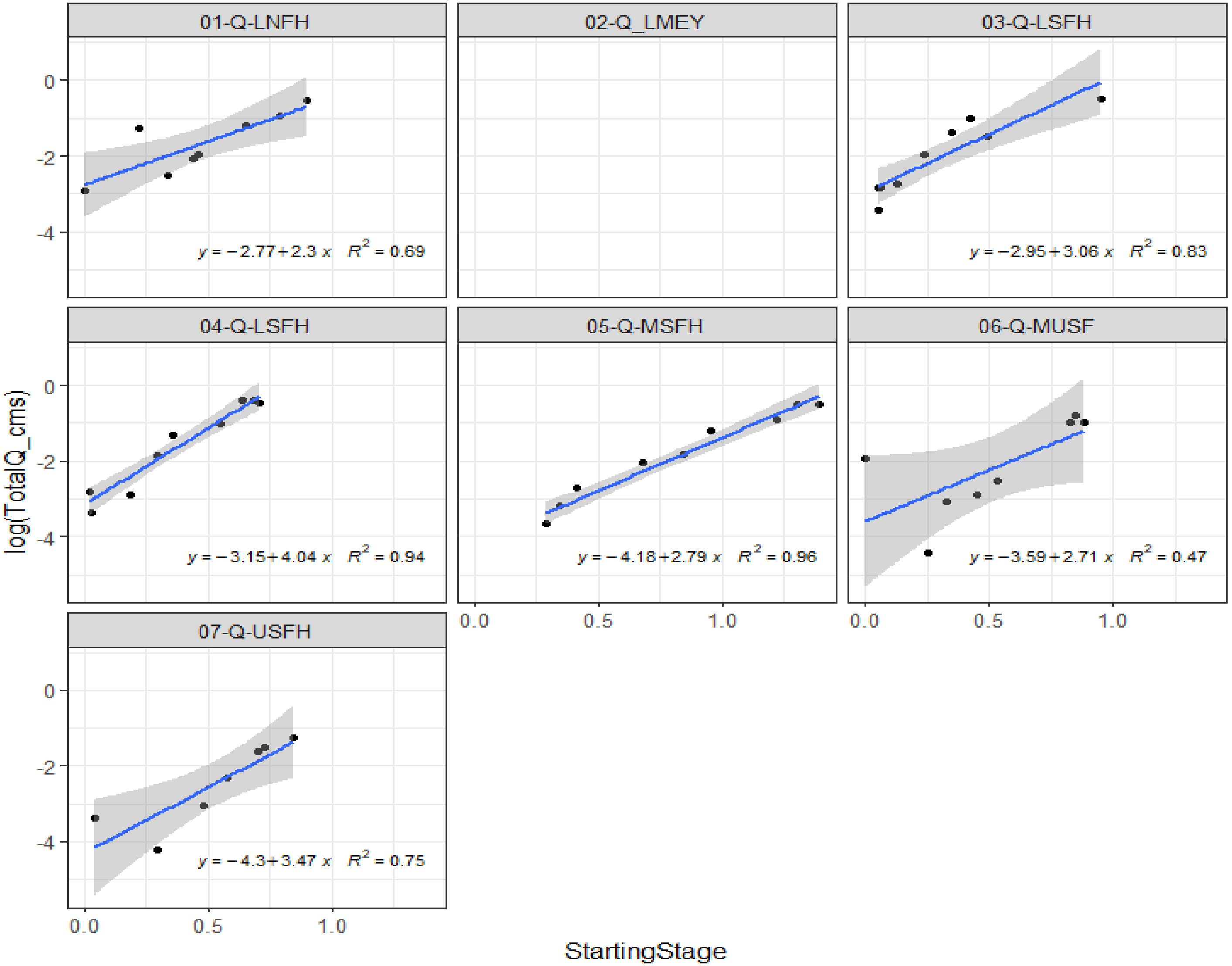
Post-fire **phosphorus concentrations** more variable so far



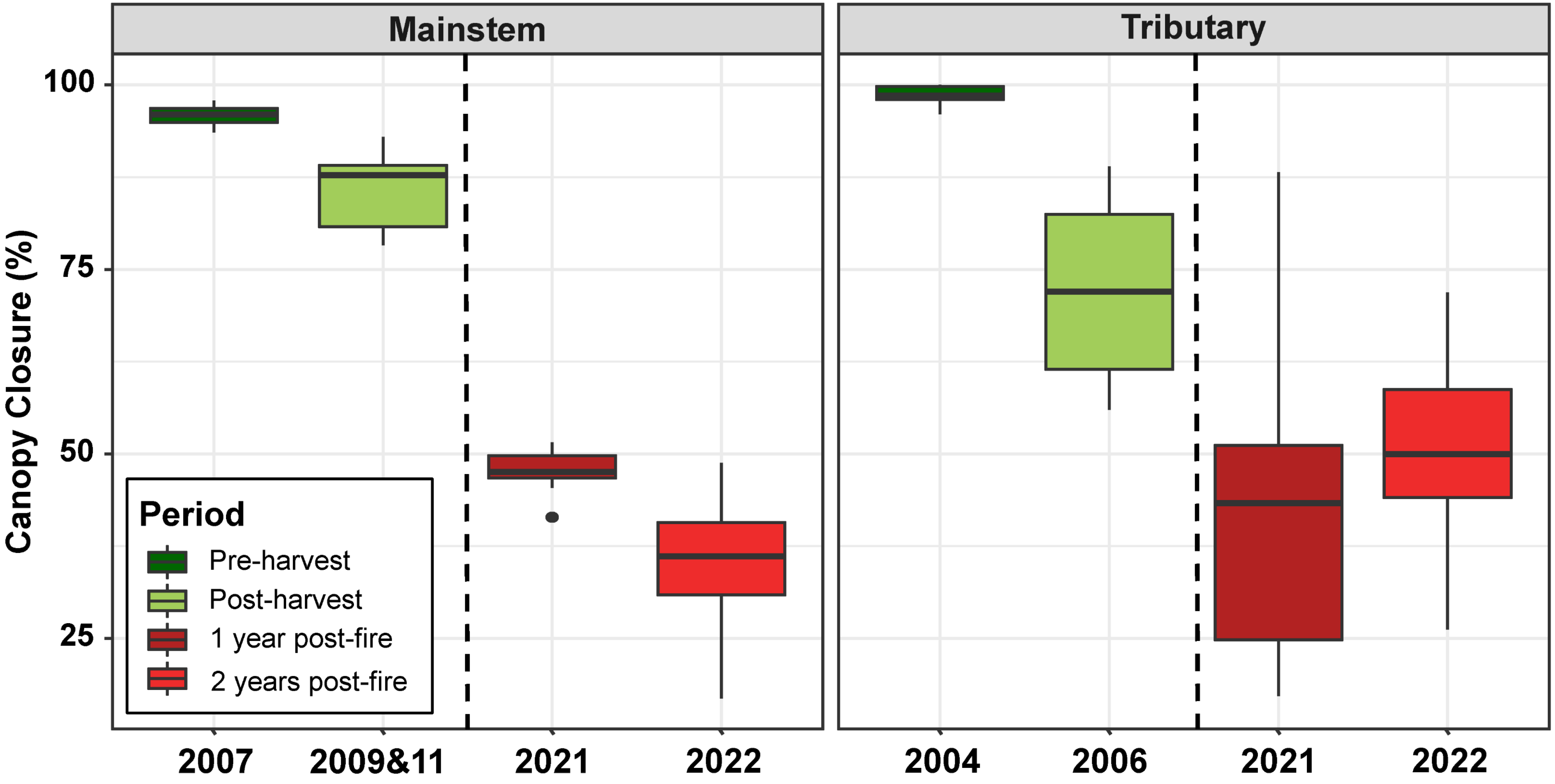
Post-fire **turbidity-sediment** concentrations muted so far



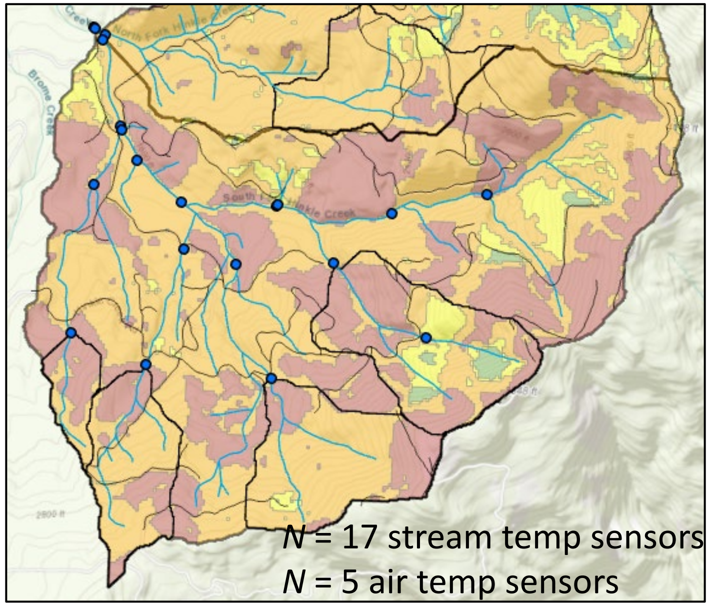
Post-fire **streamflow** analysis still in progress, rating curves combined with level loggers to estimate continuous discharge

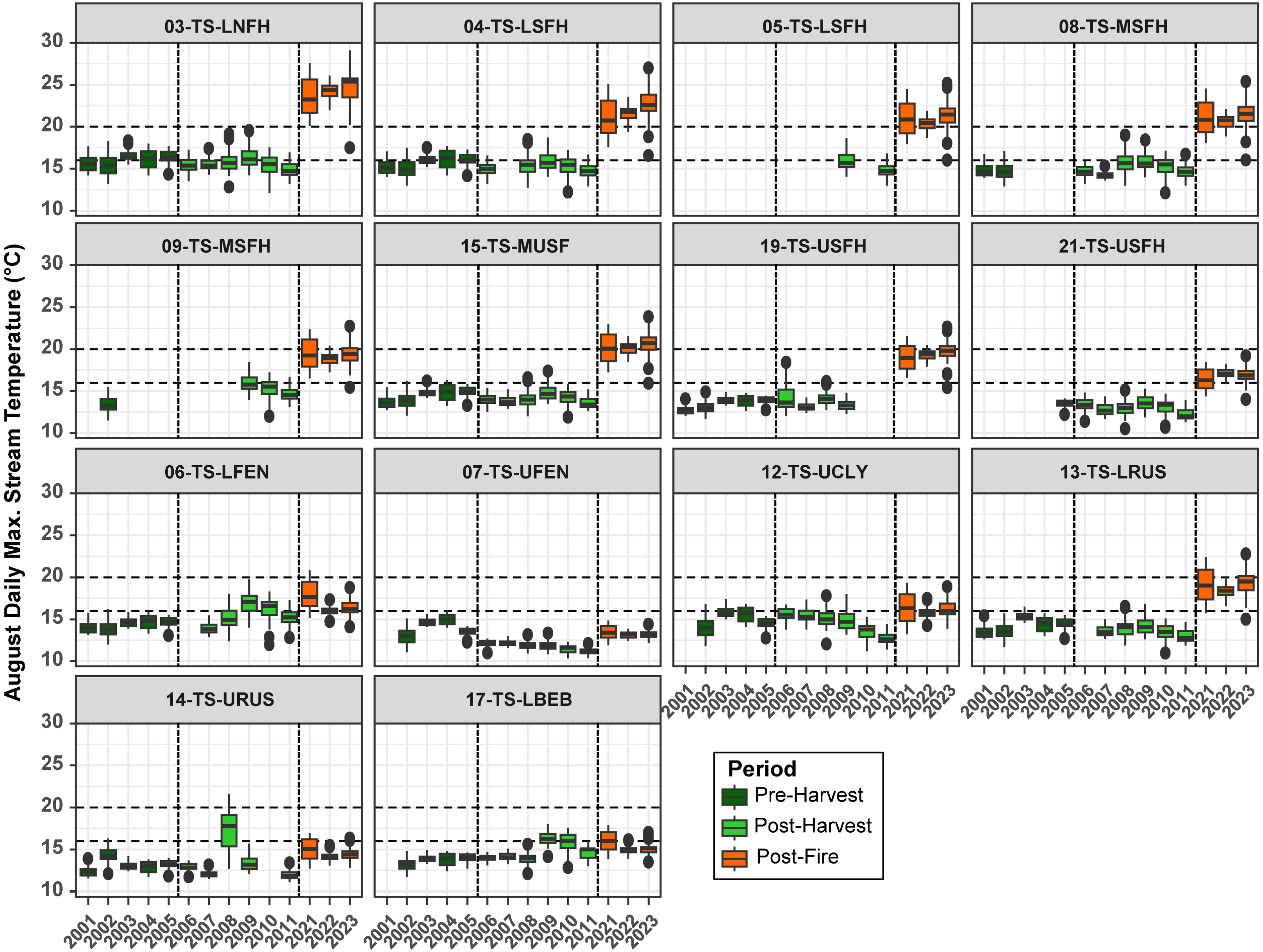


Substantial post-fire reductions in **riparian canopy cover**



Major post-fire increases in summer **stream temperature**

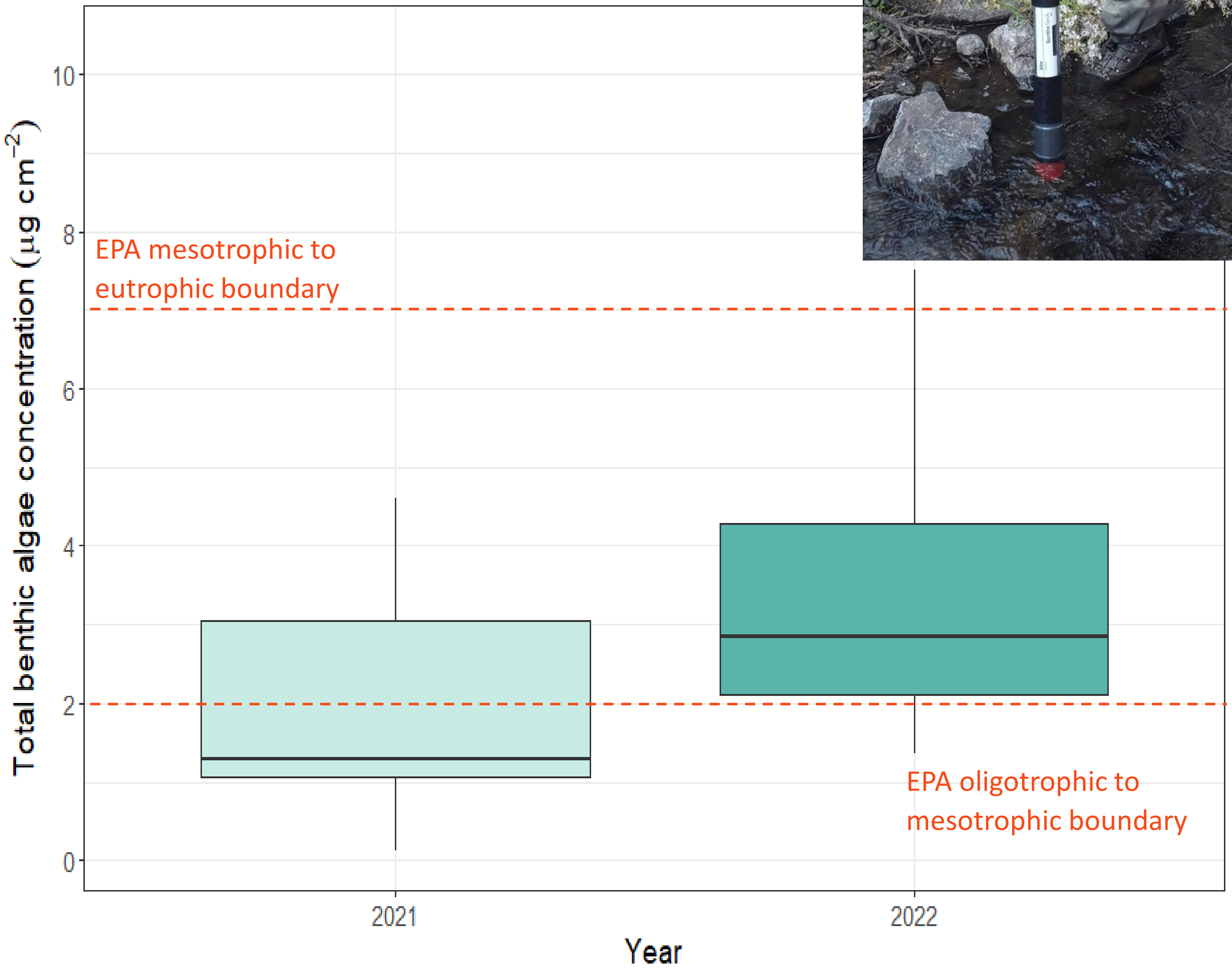




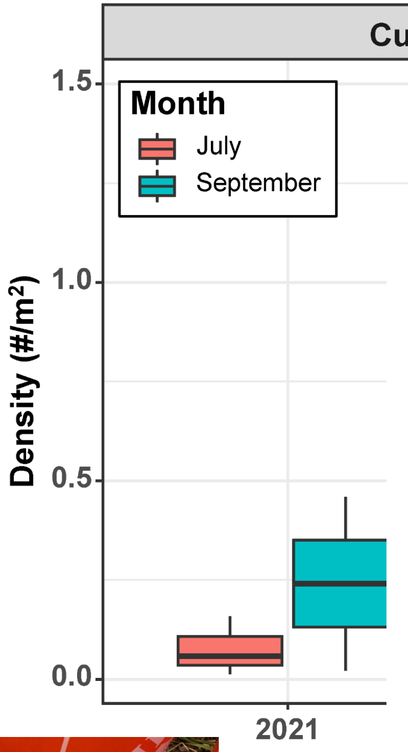
Fire effects on aquatic ecology, fish, and amphibians

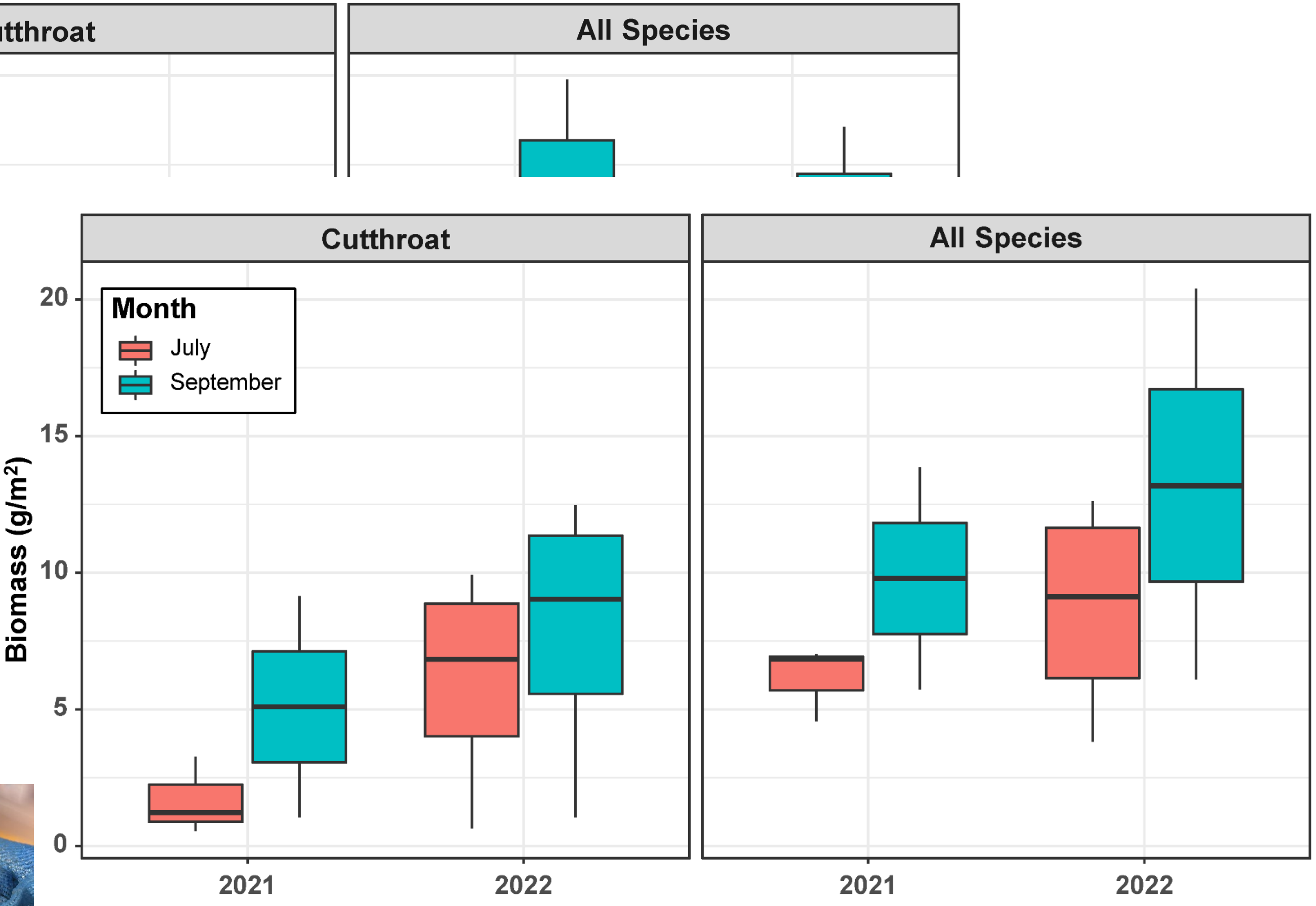
- **Stream periphyton/primary production:** benthotorch and measurement on natural and artificial substrates
- **Macroinvertebrates:** benthic communities and predator diets
- **Fish and amphibian communities:** backpack electrofishing at reach and watershed scales

Lab work still in progress, but preliminary results suggest post-fire increases in **stream periphyton**

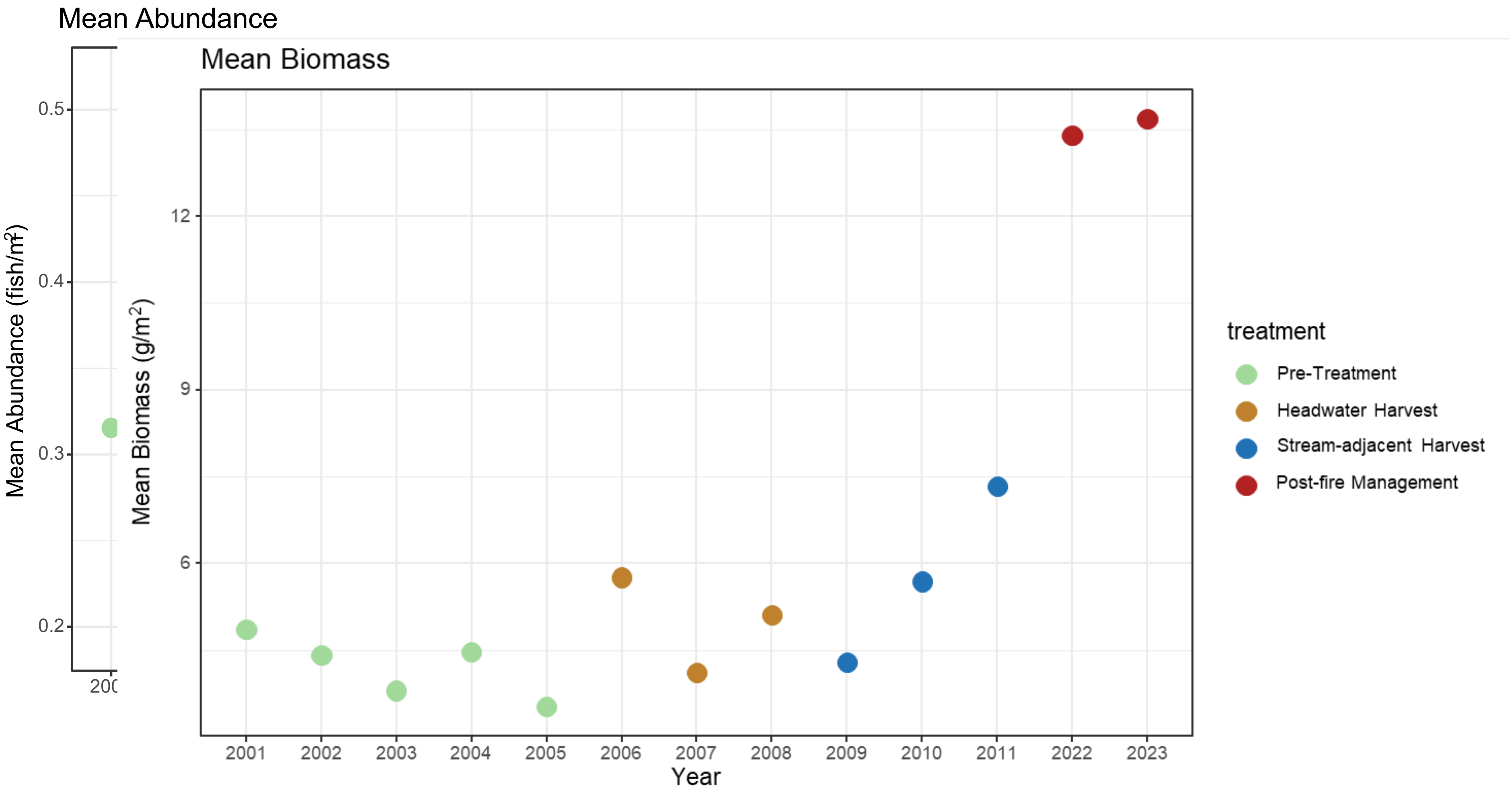


Reach-scale surveys suggest initial post-fire persistence for **cutthroat trout and other aquatic species**

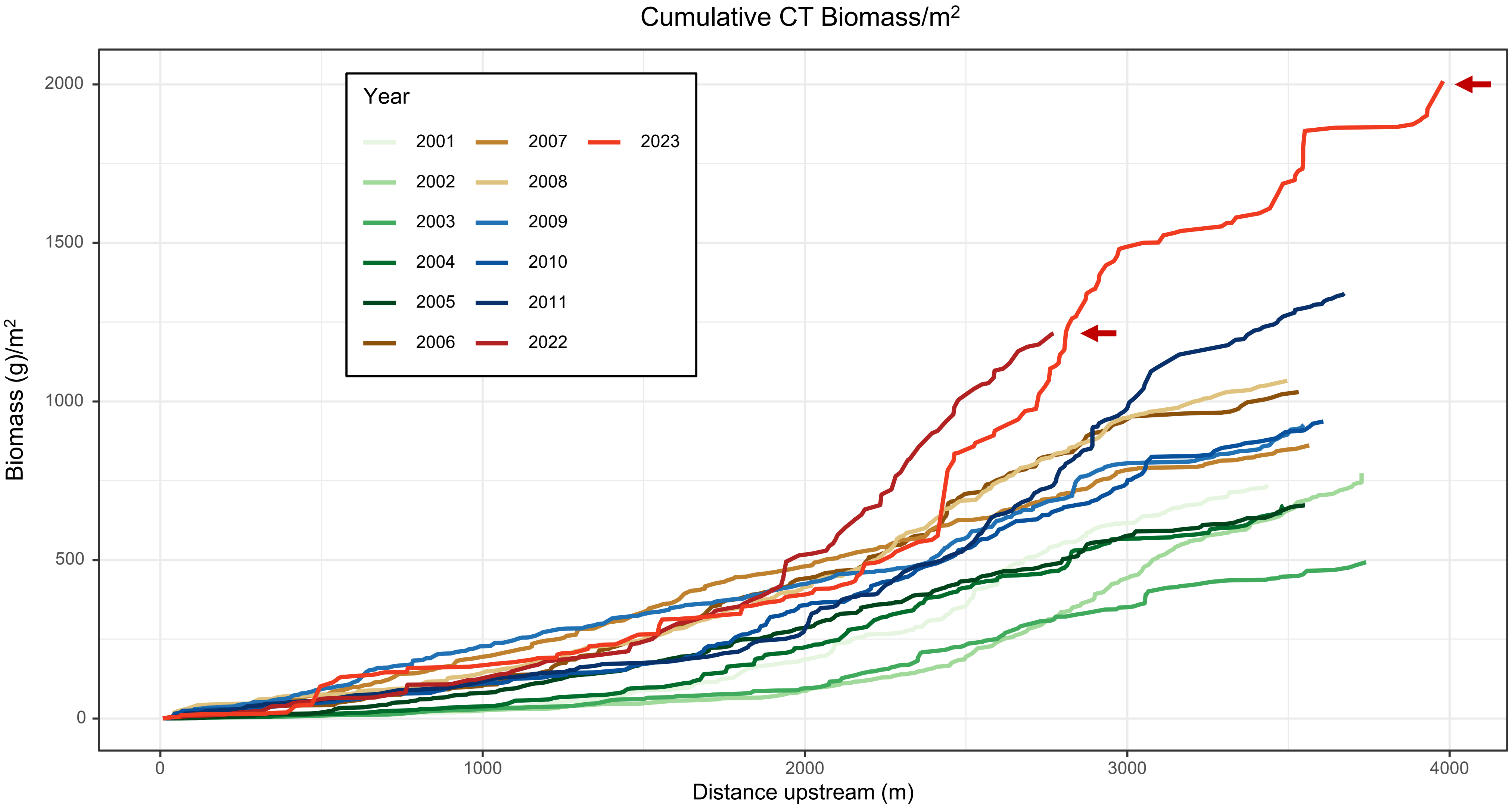




Watershed-scale pool surveys suggest post-fire increases in **cutthroat trout populations**

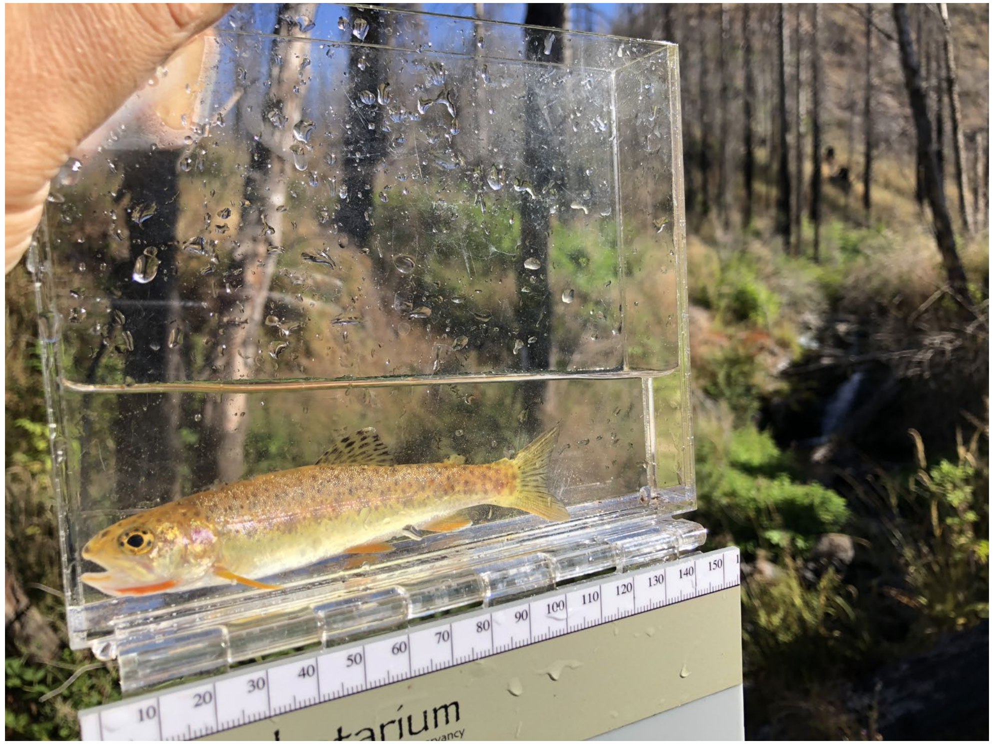


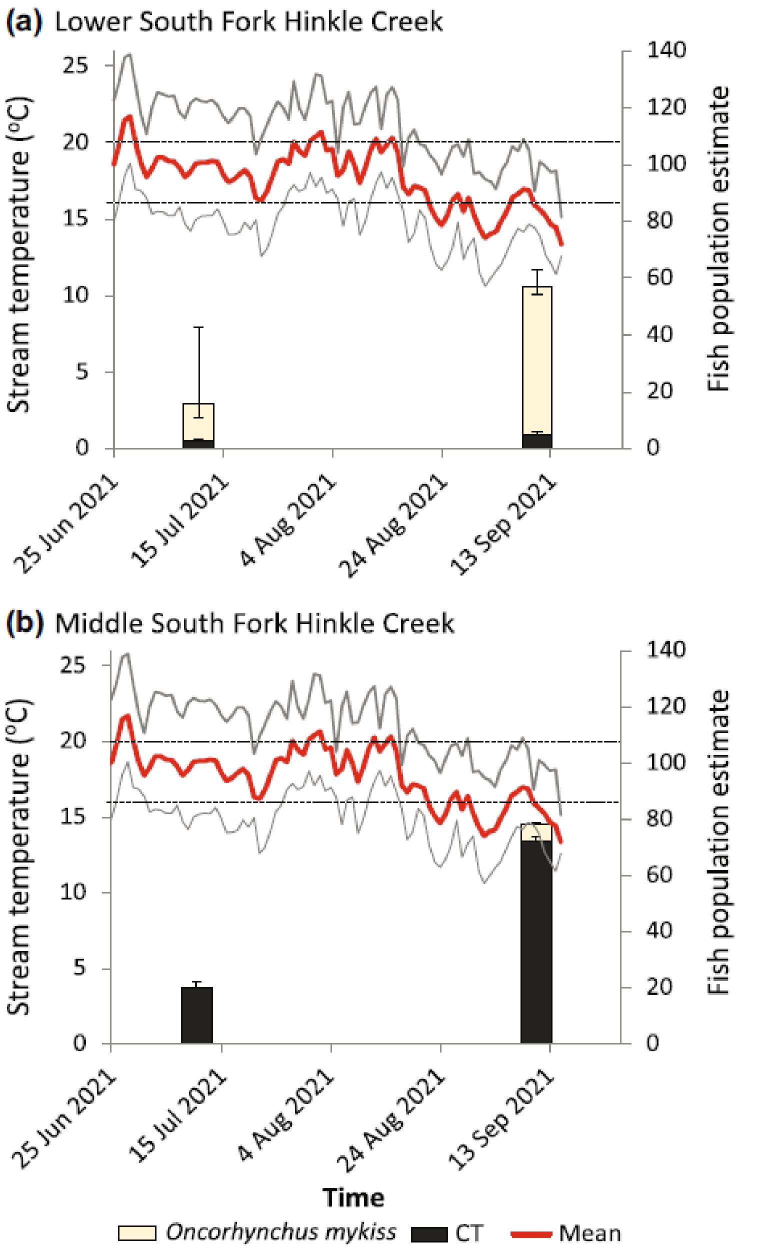
Watershed-scale pool surveys suggest post-fire increases in cutthroat trout biomass



Mechanisms driving post-fire fish resilience?

- Prey resources?
- Thermal refugia?
- Other ideas?





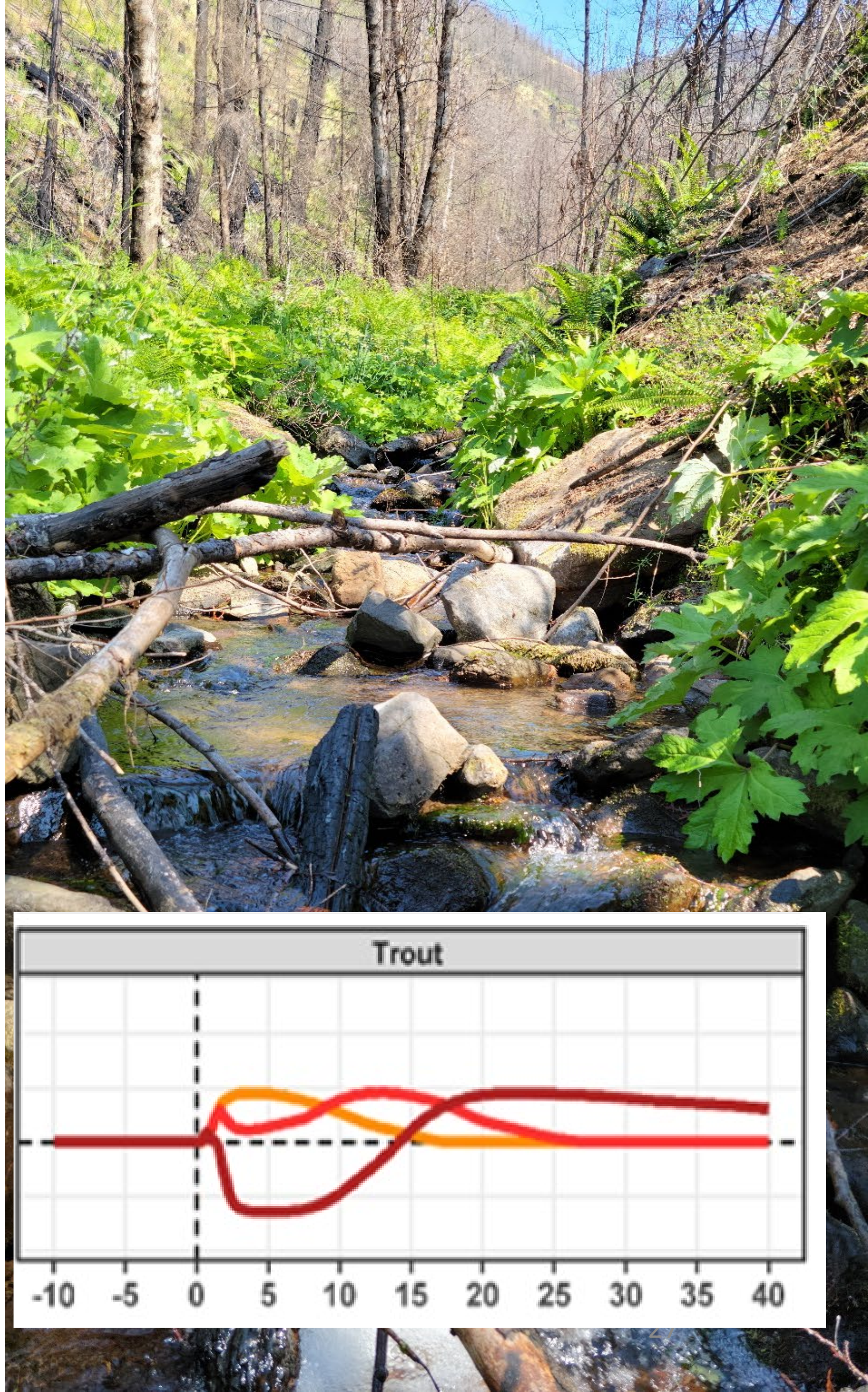
Warren et al. 2022 Ecosphere

Next steps

- Continue monitoring to track initial post-fire responses and recovery over time (*Objectives #1&2*)
- Relate responses to spatial data to identify drivers of post-fire variability (*Objective #3*)
- Leverage data from original Hinkle study to quantify pre- and post-fire changes (*Objective #4*)

Conclusions

- Adding **water quantity** and **water quality** provide essential contextual pieces to better understand **fish, amphibians, and aquatic habitats** responses to **fire** on working landscapes
- **Leverage data from original Hinkle Watershed study** to quantify effects of fire and post-fire management to other disturbance types (e.g. forest harvest)
- Whole-system understanding crucial to understand effects of **fire and post-fire management** in westside forests of Oregon
- Preliminary results suggest some interesting initial post-fire changes to aquatic habitats and fish, but **long-term monitoring needed**



Acknowledgements

- Funding sources (OFIC, NCASI, OSU College of Forestry FWHMF)
- Landowner (Roseburg Forest Products)
- Field technicians and graduate students
- FEWS and Warren labs
- Everyone involved with original Hinkle Watershed Study

Oregon State University

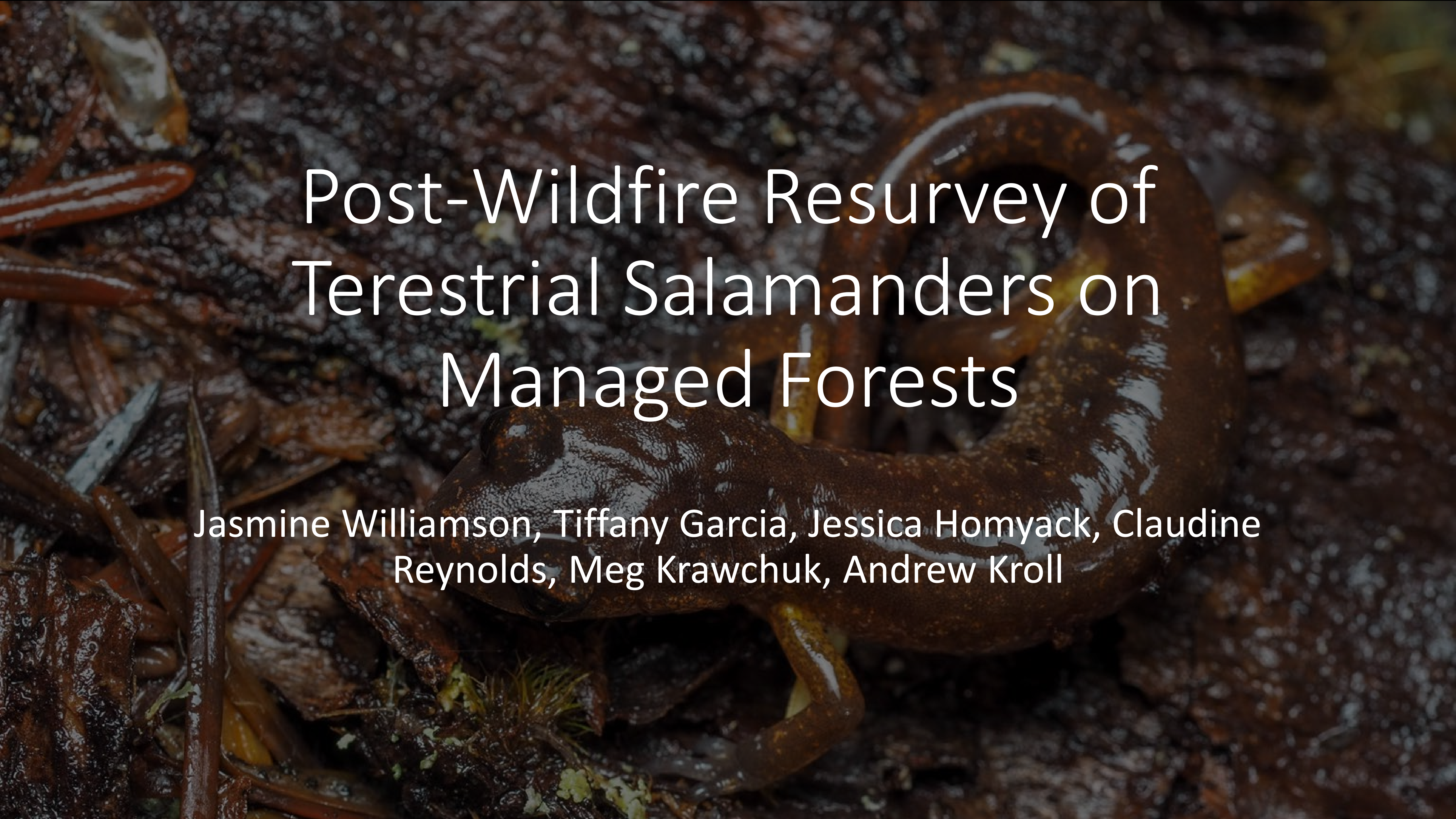
FOREST ECOHYDROLOGY AND WATERSHED SCIENCE LAB

OREGON FOREST & INDUSTRIES COUNCIL

Roseburg

NCASI
IMPACT. SCIENCE. SOLUTIONS.

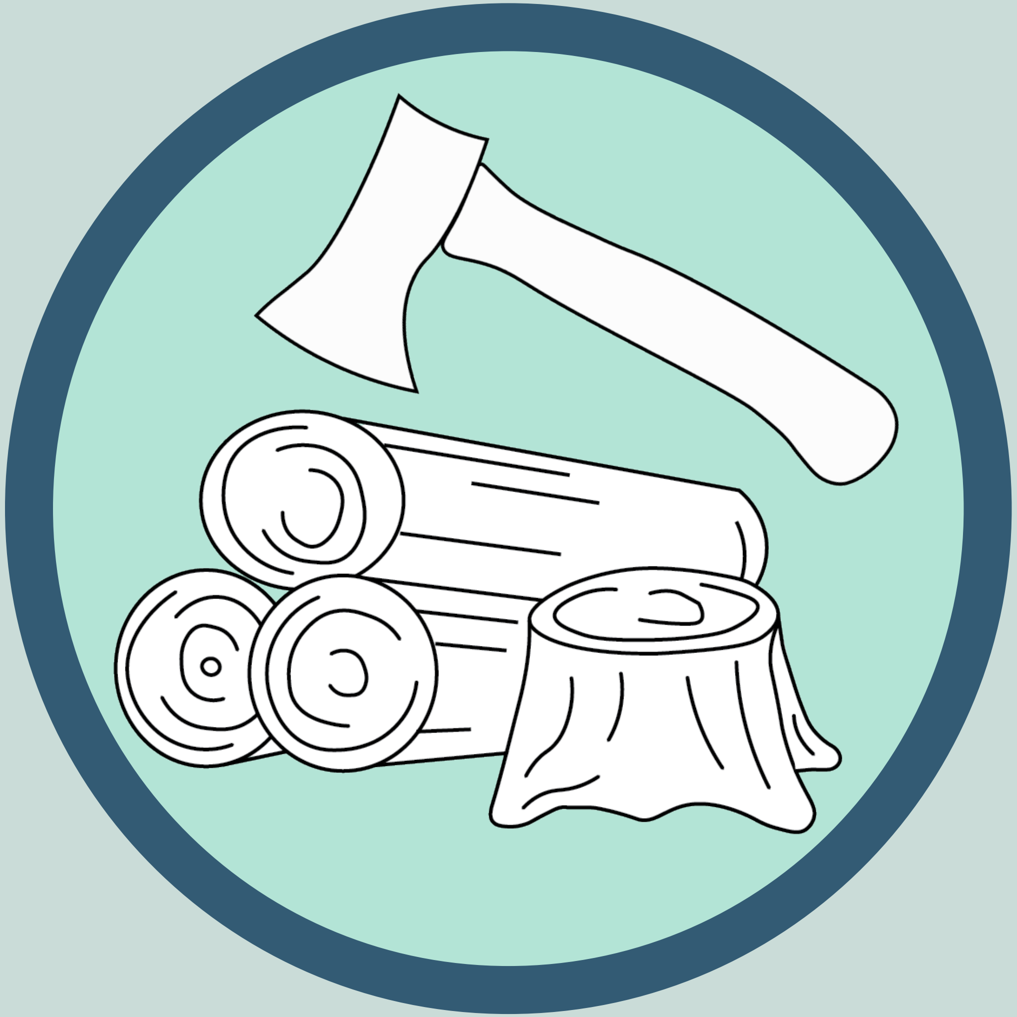
Questions?



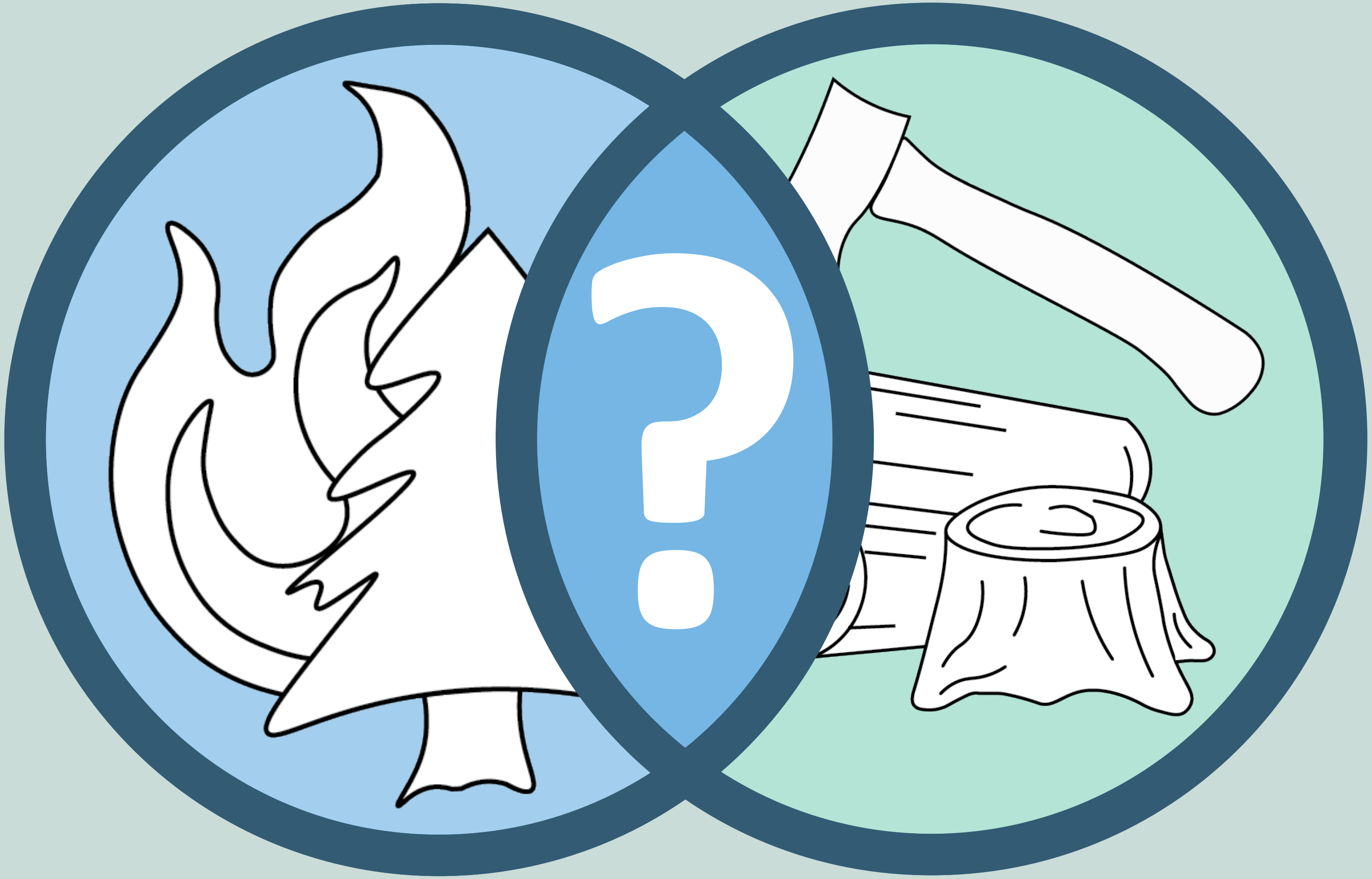
Post-Wildfire Resurvey of Terestrial Salamanders on Managed Forests

Jasmine Williamson, Tiffany Garcia, Jessica Homyack, Claudine Reynolds, Meg Krawchuk, Andrew Kroll

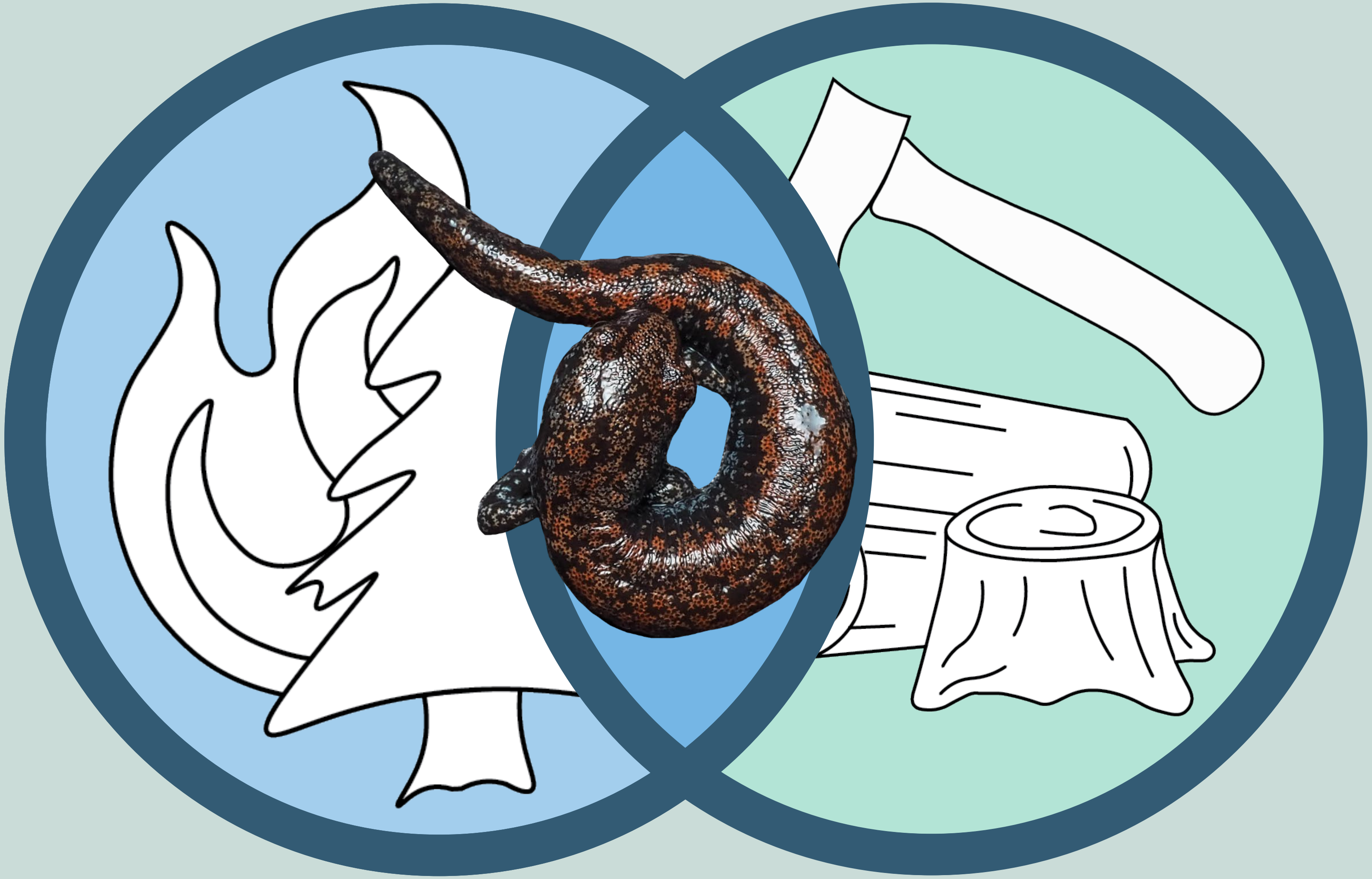
Background: Disturbance



Background: Disturbance



Background: Disturbance



Study Species

Oregon Slender, *Batrachoseps wrighti (BAWR)*

- Endemic to Oregon
- Mid-elevation old growth, OR Cascades
- Low dispersal, small home range
- Downed-wood associated
- Oregon priority species

Ensatina, *Ensatina eschscholtzii (ENES)*

- Common species in PNW forests
- Widespread generalist
- High dispersal, large home range
- Downed wood associated

Background: Timber Harvest

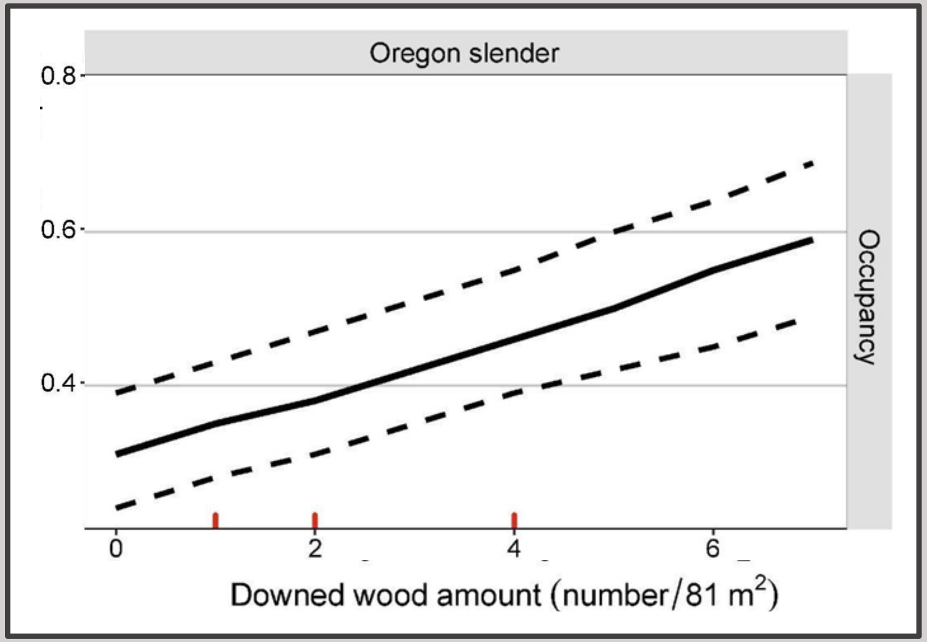
Control

Unharvested
Unburned

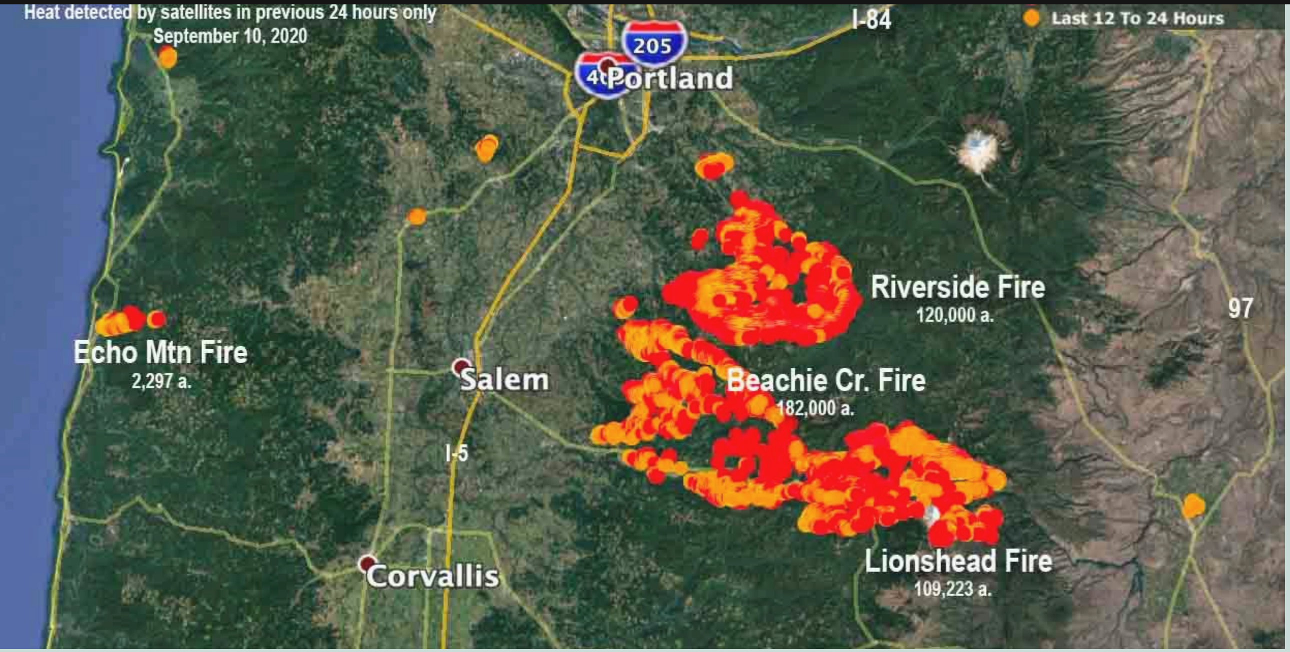
Treatment

Harvested

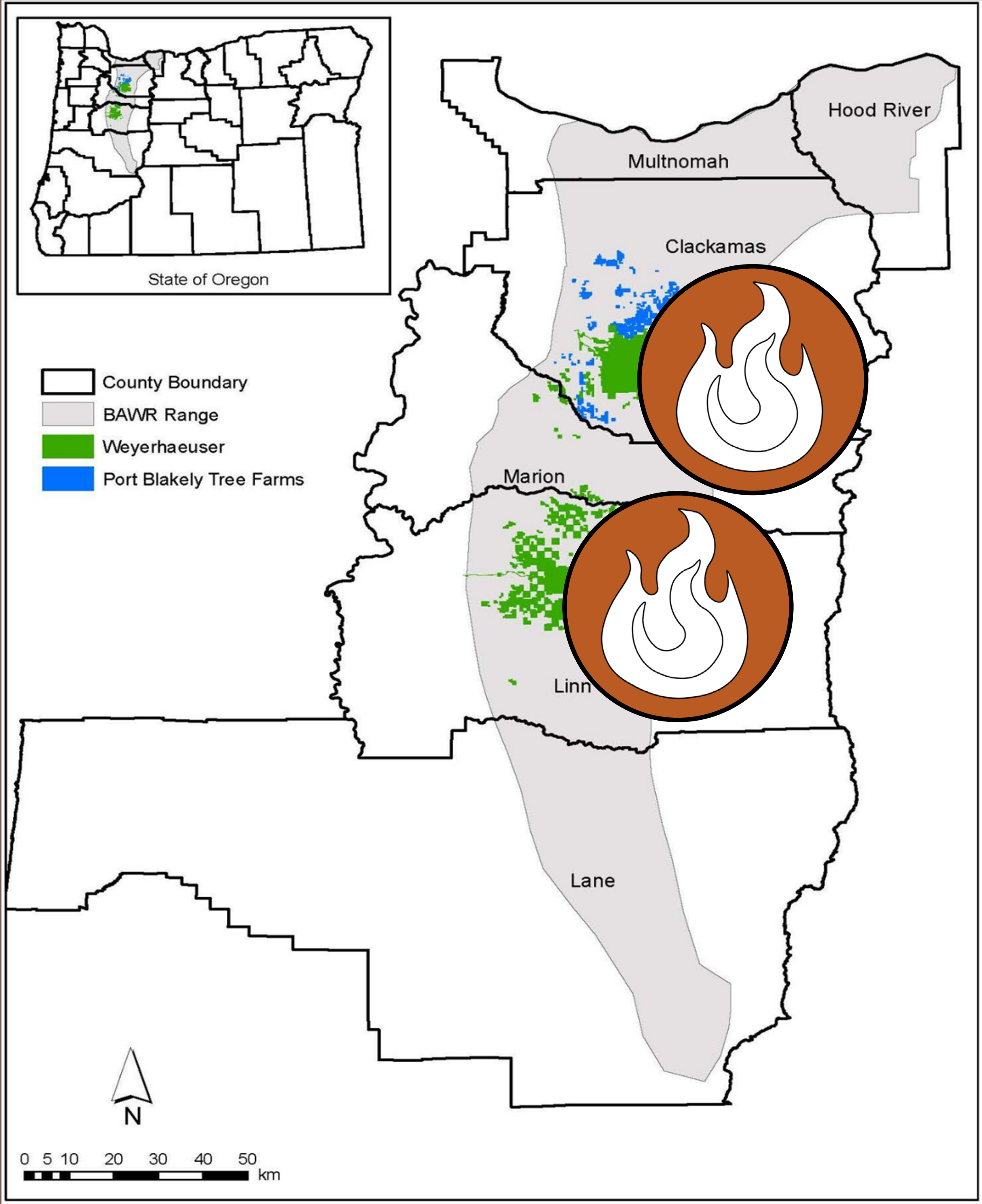
Occupancy tied to downed wood amount



Natural Experiment



Half of historical study sites burned!



Methods

Control

Harvest

Wildfire

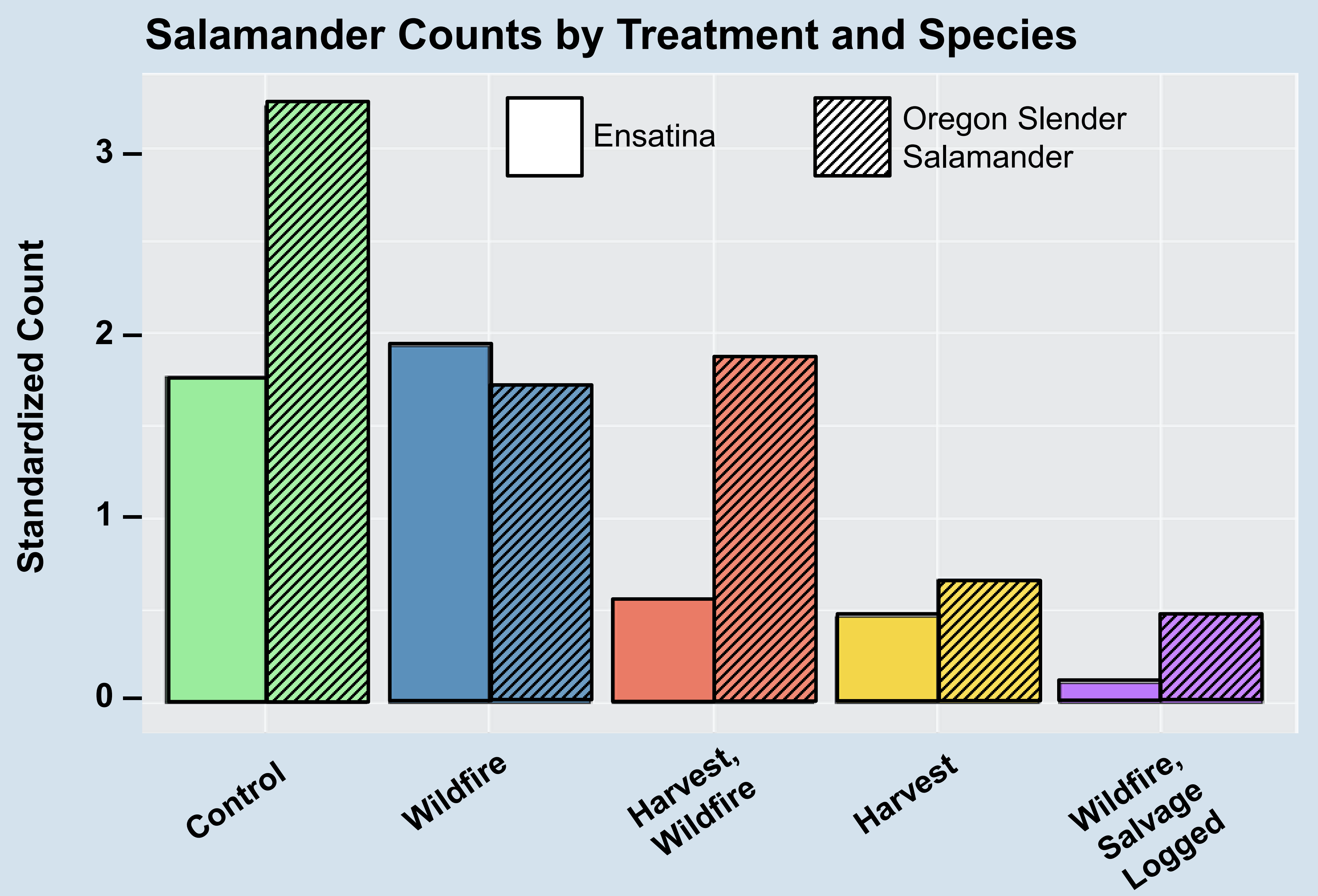
Harvest, Wildfire

Wildfire, Salvage Logged

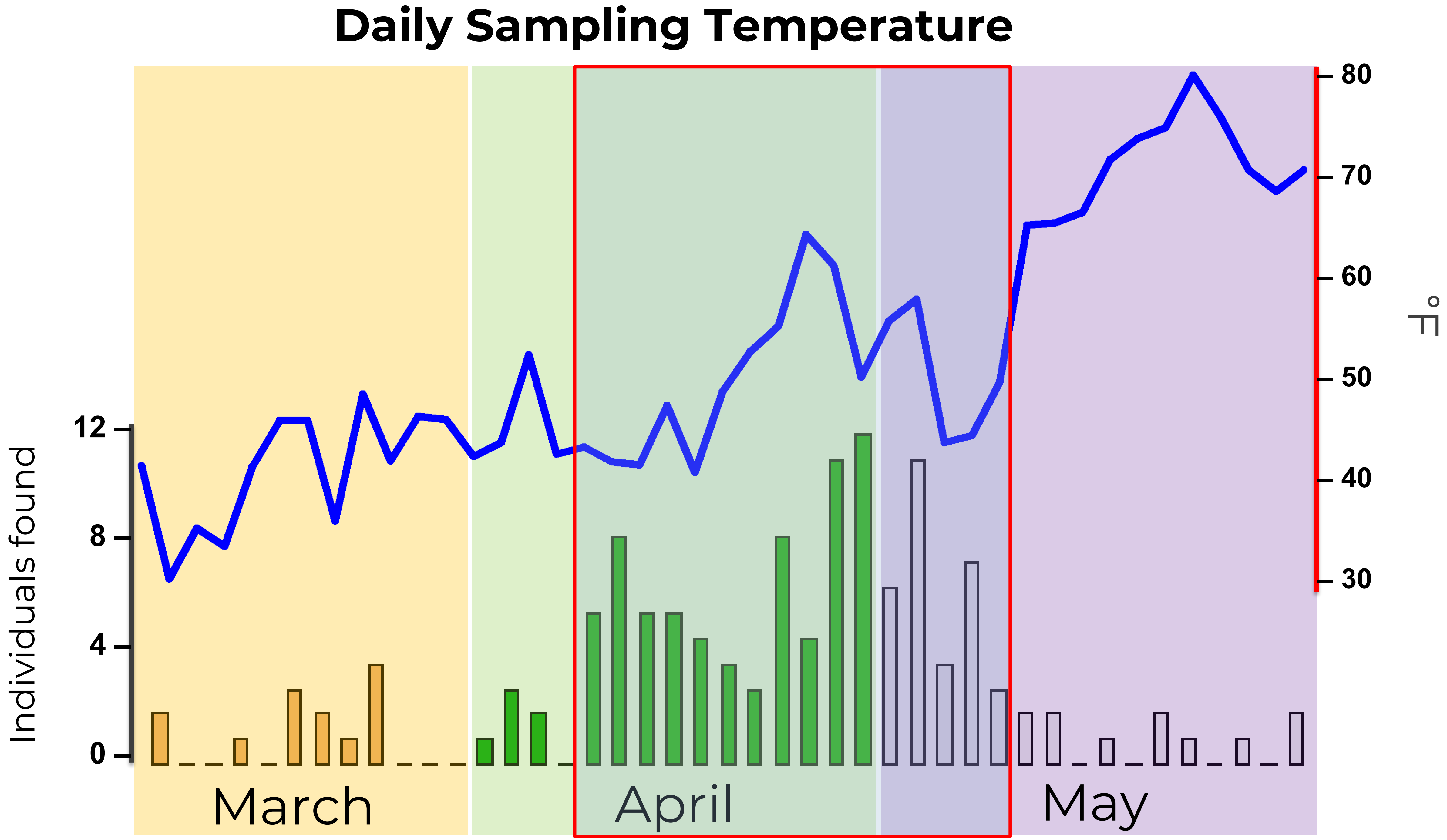
Methods

Replicated survey methods

- Seven 9x9m subplots
- Time-constrained, active search
- 67 stands 2023 (planning 2024 survey)
- 10-15 stands per treatment
- Salamander presence
- Habitat/climate variables



Salamander Counts by Treatment and Species
Ensatina
Oregon Slender Salamander
Standardized Count
0
1
2
3
Control
Wildfire
Harvest, Wildfire
Harvest
Wildfire, Salvage Logged



Daily Sampling Temperature
Individuals found
0
4
8
12
°F
30
40
50
60
70
80
March
April
May

Preliminary Results

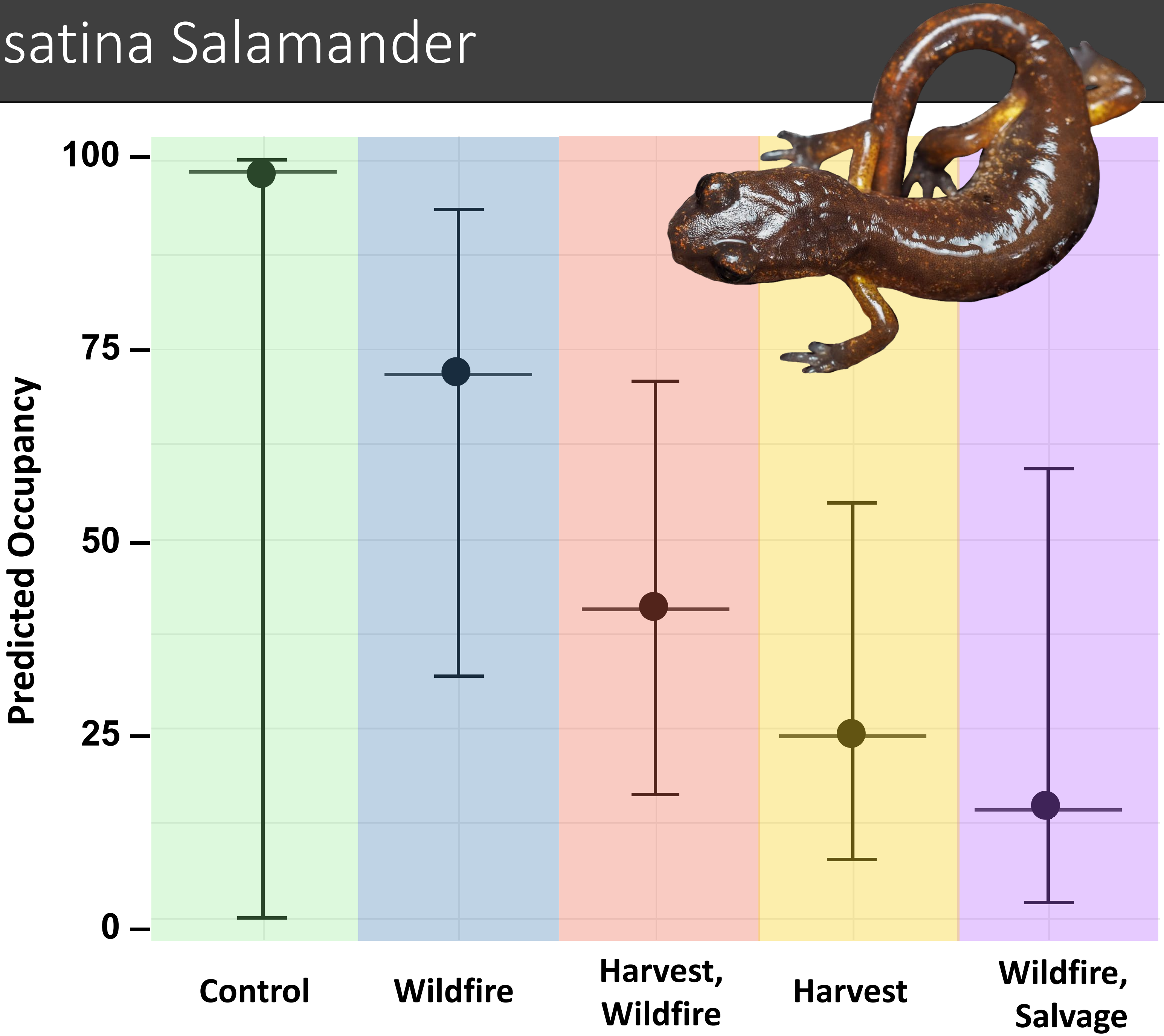
Model Comparisons

1	psi(.) p(.)
* 2	psi(treatment) p(.)
3	psi(.) p(temp)
* 4	psi(treatment) p(temp)

Slender

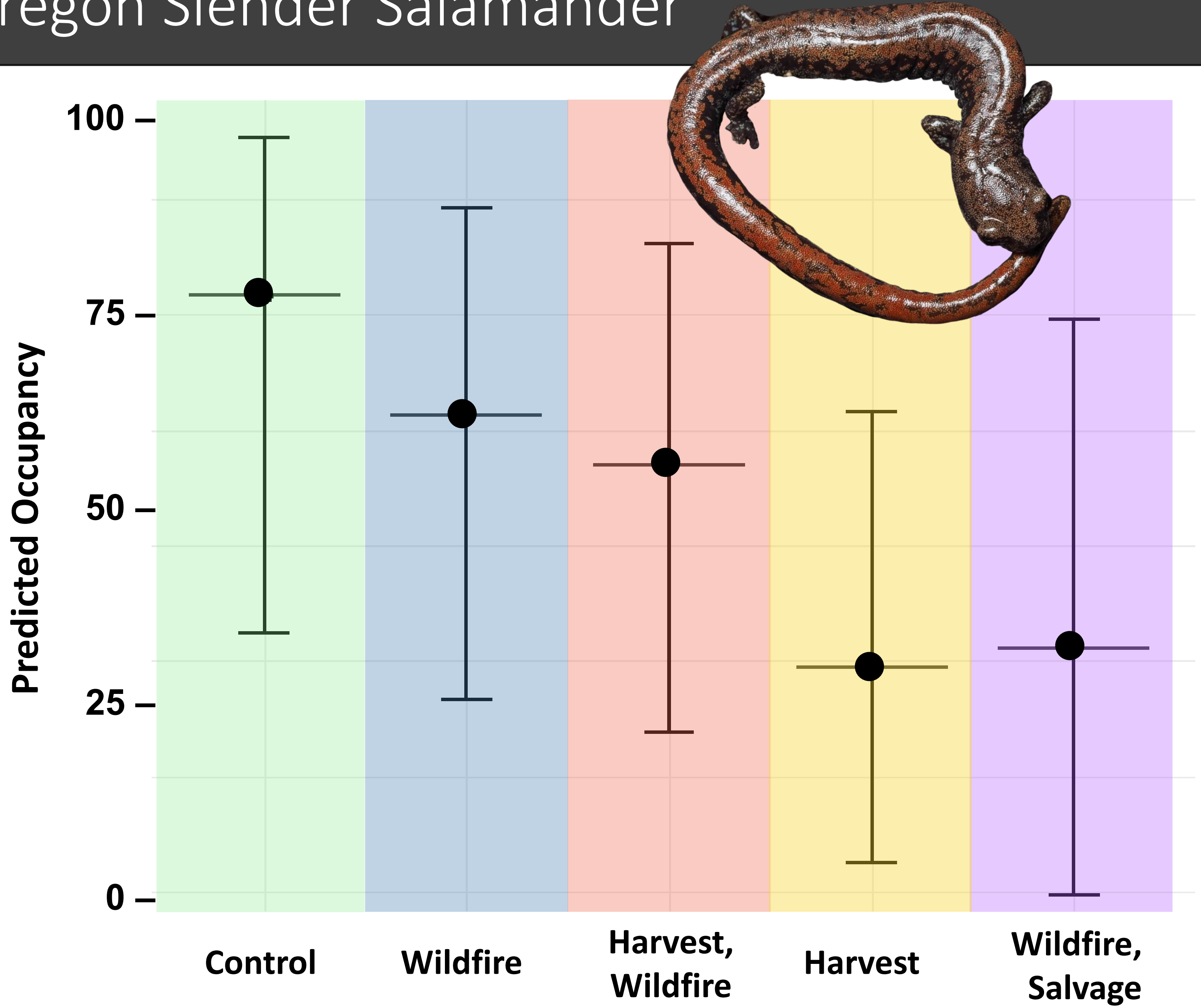
Ensatina

Preliminary Occupancy: Ensatina Salamander



Preliminary Occupancy: Oregon Slender Salamander

- Similar point estimate trend
- Less variable by treatment
- No "significant" treatment differences



Moving forward

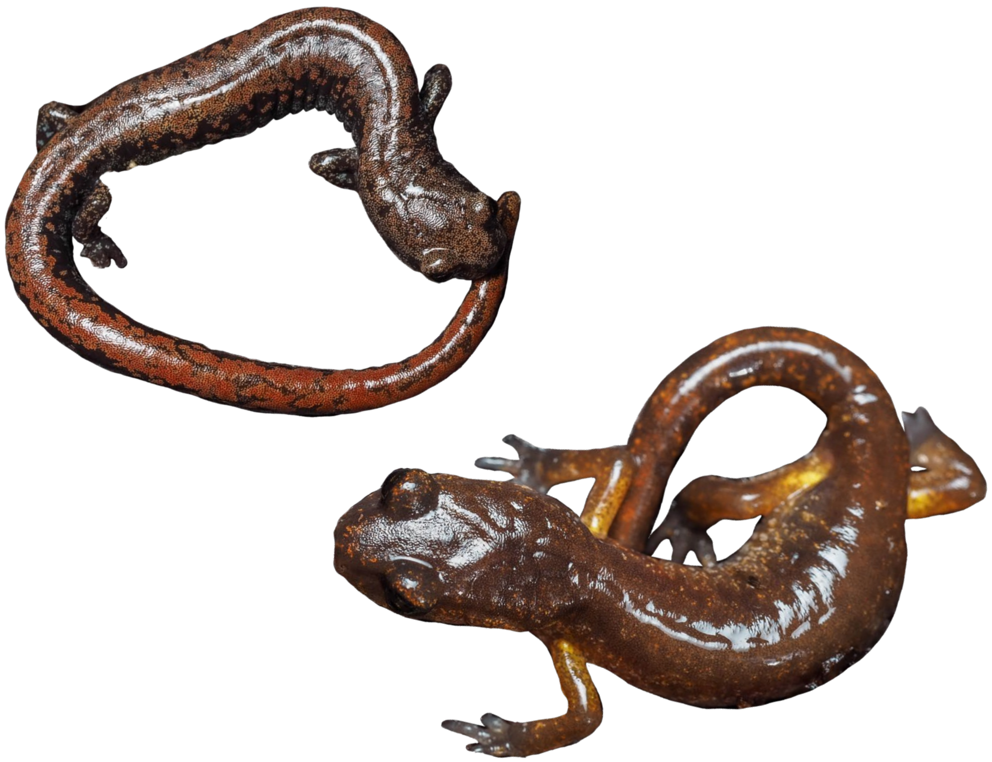
- Small sample size
  - 5 treatments
  - Inclement weather
- Second field season 2024
- Bayesian occupancy
- Temporal differences using pre-fire data

Implications

- Good model for environmental change
- Important role in forest communities
- Species Specific responses to disturbance
- OSS are an understudied species

Communication and Timeline

- Williamson et al. 2022. The Wildlife Society, Oregon Chapter. Bend, Oregon. Oral Presentation.
- Williamson et al. 2023. Plethodontid Conference, Hammond, Louisiana. Oral Presentation.
- Williamson et al. 2023. The Wildlife Society, Annual Meeting. Louisville, Kentucky. Oral Presentation.



Site Selection
Housing and Permits
Survey Season
Data Analysis and Comm.

Acknowledgements

GARCIA LAB
AQUATIC ECOLOGY

Oregon State University

Oregon State University
College of Forestry

NSF

Weyerhaeuser

All salamander photo credit:
@christopher.cousins.wildlife

Responses of Fish to Forest Management: Evaluating How Different Riparian Reserve Configurations Affect Fish and Food Webs in Headwater Streams – YEAR 2 REPORT

Dana Warren - Oregon State University

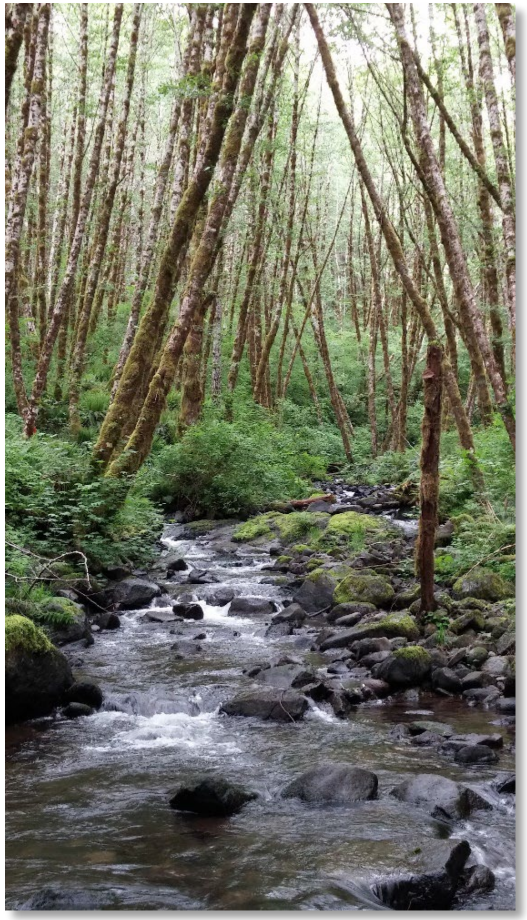
Ashley Coble - NCASI

Ashley Sanders - Oregon State University

Landowner collaborators

Study Motivation:

- There is uncertainty (and therefore controversy) over the best ways to protect aquatic biota on managed forest landscapes.



Study Motivation:

- There is uncertainty (and therefore controversy) over the best ways to protect aquatic biota on managed forest landscapes.

- Much of this uncertainty focuses on the function of streamside (riparian) forests, and how regulations around buffer size, configuration and location can protect stream aquatic habitat while allowing for active management.

> In an increasingly complicated management arena, the challenge will be to find alternatives to fixed-width buffers that meet the multiple objectives of providing clean water (minimizing nutrient and sediment inputs), aquatic habitat, habitat for riparian species, connectivity across landscapes, and related responses.

Richardson et al. 2012 – *Freshwater Science*

Study Motivation:

- There is uncertainty (and therefore controversy) over the best ways to protect aquatic biota on managed forest landscapes.

- Much of this uncertainty focuses on the function of streamside (riparian) forests, and how regulations around buffer size, configuration and location can protect stream aquatic habitat while allowing for active management.

- This an issue that is relevant now - and it will be relevant again. . .

  - Regulation decisions are made on the best available science, which can - *and should* - change as we learn.

“Alternative” riparian buffers

Modify fixed width standard to actively manage for specific ecological outcomes

- Promote “desired future conditions” in riparian zone
- Emulate natural disturbance
- Cultivate riparian vegetation diversity
- Protect sensitive habitats
- Mimic late-succession light environment

“Alternative” riparian buffers

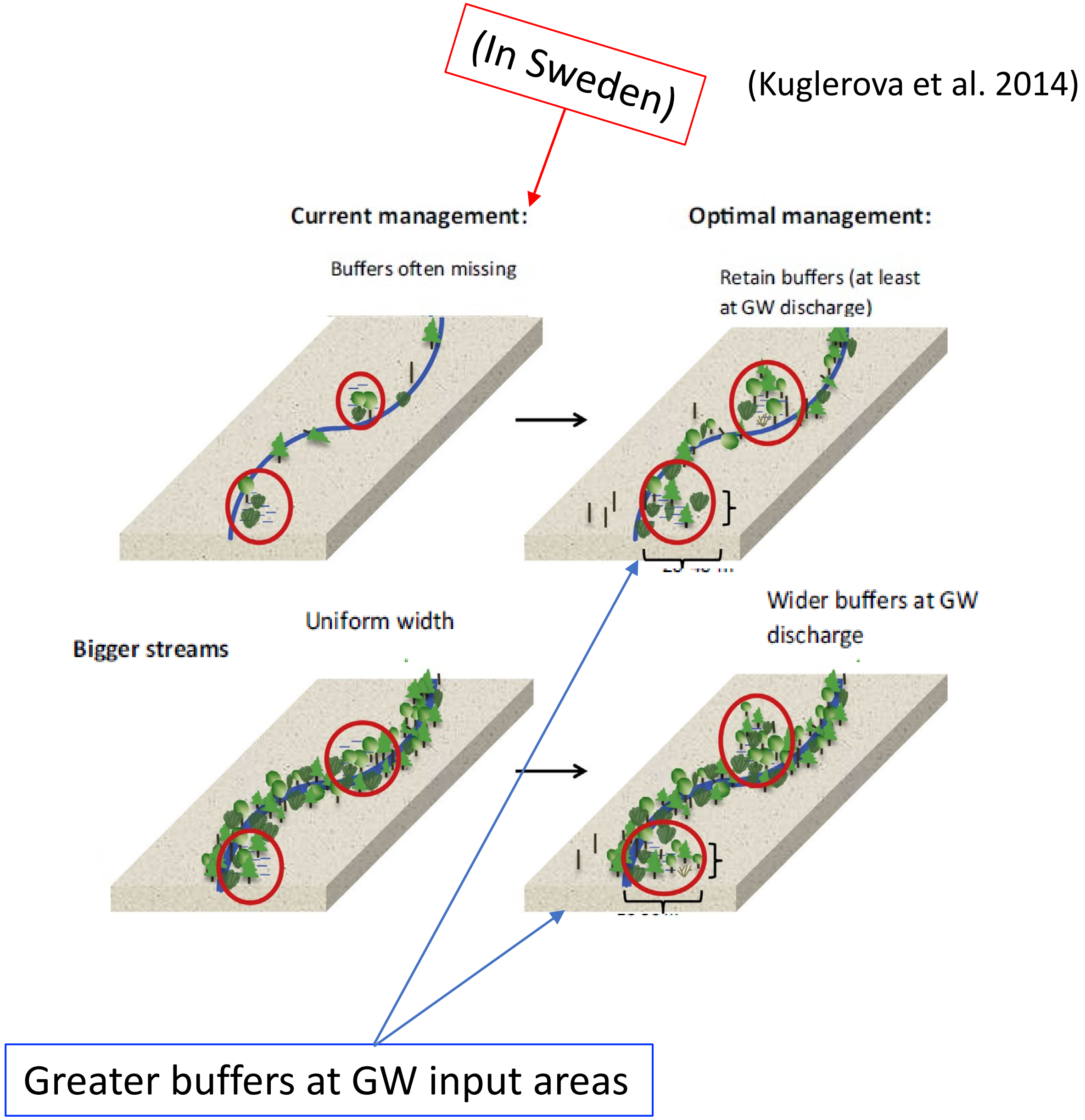
Alternative buffers - focus areas

- Groundwater discharge areas
- High-risk landslide locations
- Legacy wood
- Creating variable light

“Alternative” riparian buffers

Alternative buffers - focus areas

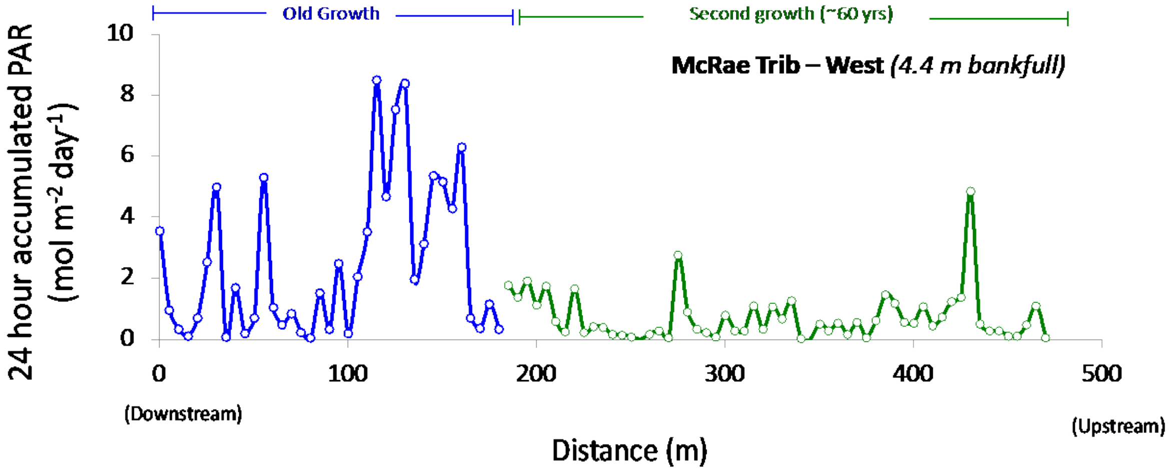
- **Groundwater discharge areas**
- High-risk landslide locations
- Legacy wood
- Creating variable light



“Alternative” riparian buffers

Alternative buffers - focus areas

- **Groundwater discharge areas**
- High-risk landslide locations
- Legacy wood
- **Creating variable light**



“Alternative” riparian buffers

Alternative buffers - focus areas

- **Groundwater discharge areas**
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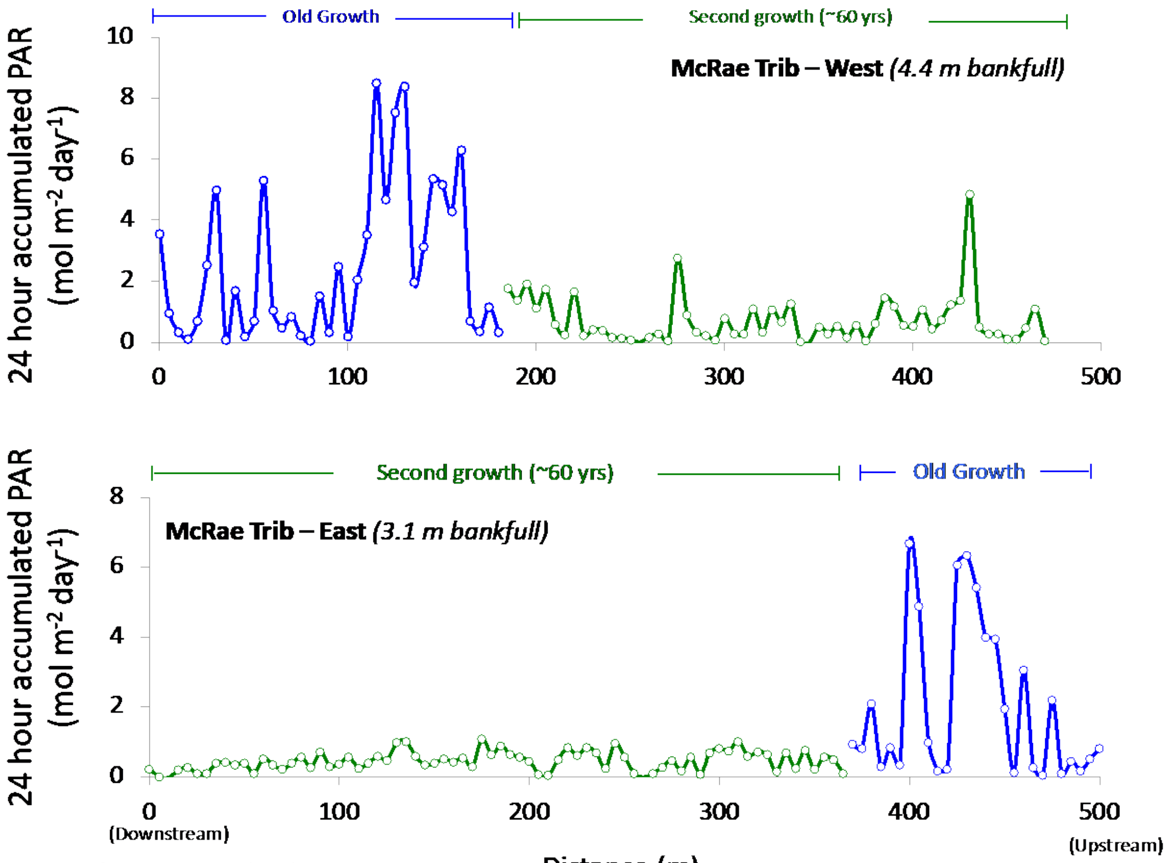


Warren et al. 2013 – Aquatic Sciences

Expected responses to alternative buffer configurations

Hypothesis 1: Alternative buffers that create greater increases in ligt result in greater biomass of fish and other apex predators

Hypothesis 5: no change

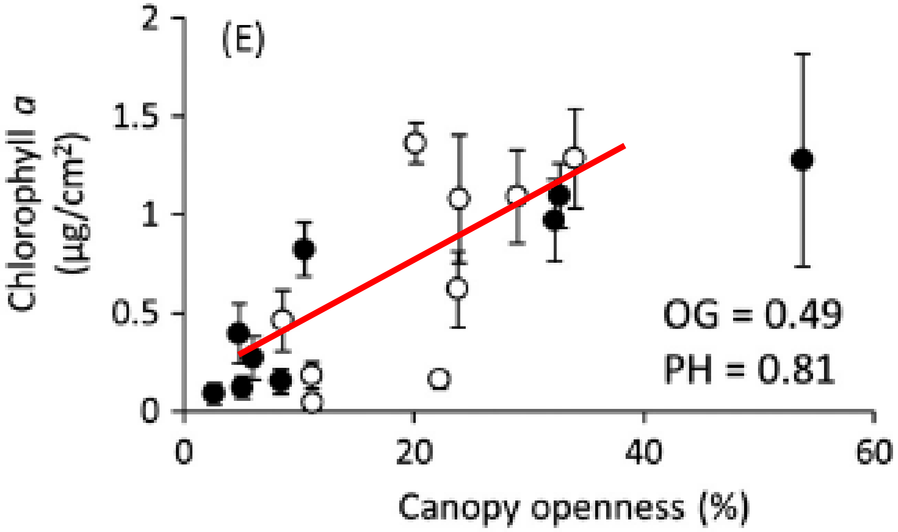
Hypothesis 2: Alternative buffers that create greater increases in light result in increases in temperature that negatively affect fish and other apex predators

Hypothesis 3: Fish and apex predators increase due to changes in habitat and food associated with litter and wood input after management

Hypothesis 4: Fish and apex predators decline due to negative impacts of management (e.g. sediment input)

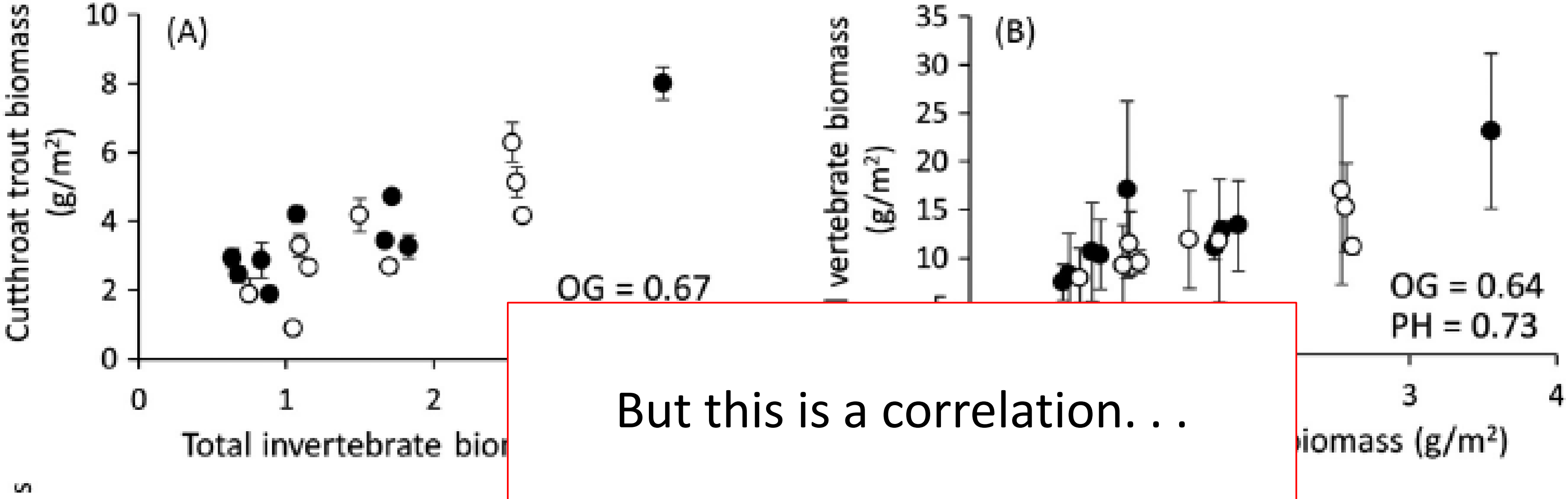
(Kaylor and Warren 2018)

More light - *Stream food web linkages associated with greater light*



(Kaylor and Warren 2018)

<u>More light</u> - *Stream food web linkages associated with greater light*



But this is a correlation. . .

In western OR streams, sites with more light generally have more biofilm, more bugs and more fish and salamanders

(Kaylor and Warren 2018)

We need **experiments** to understand mechanism or link pattern to process

Assessing the response of aquatic biota to alternative riparian management practices

Moving from Theory to Practice

BACI study design

- 2 years Pre-treatment sampling
- 2 years Post-treatment sampling
- Staggered start/finish

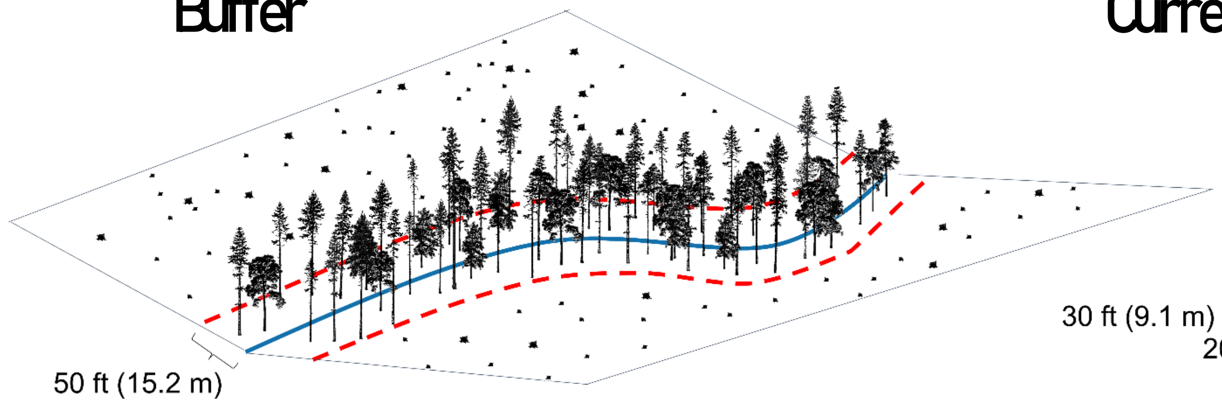
Study goal

Determine how stream biota respond to five alternative riparian management options that provide varying degrees of increased light:

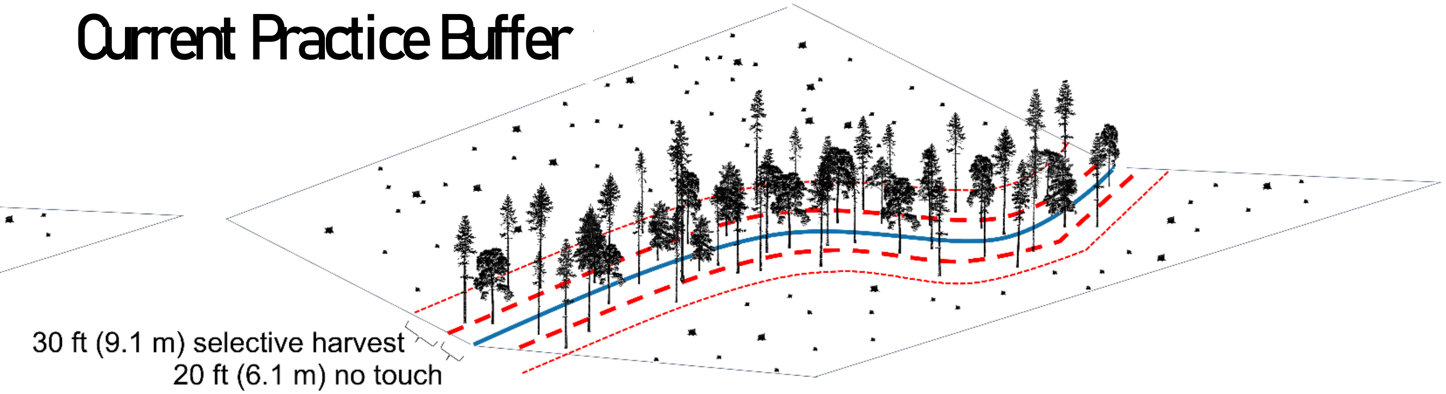
- Buffers with gaps,
- Current practice (mostly fixed but flexible with BA minimum)
- Variable retention
- Fully fixed-width (no BA min.)
- Unharvested (~30-60 yr stand)

Study Design

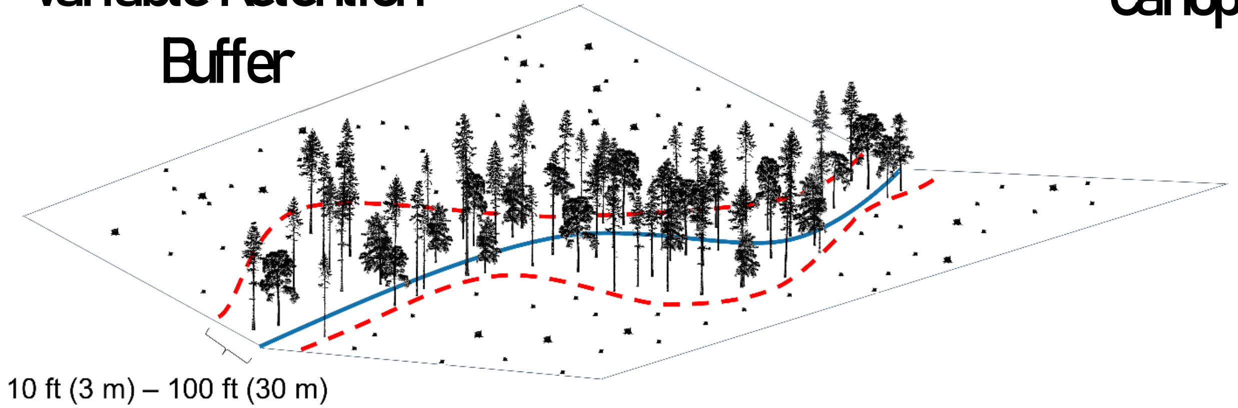
Fixed-Width Buffer



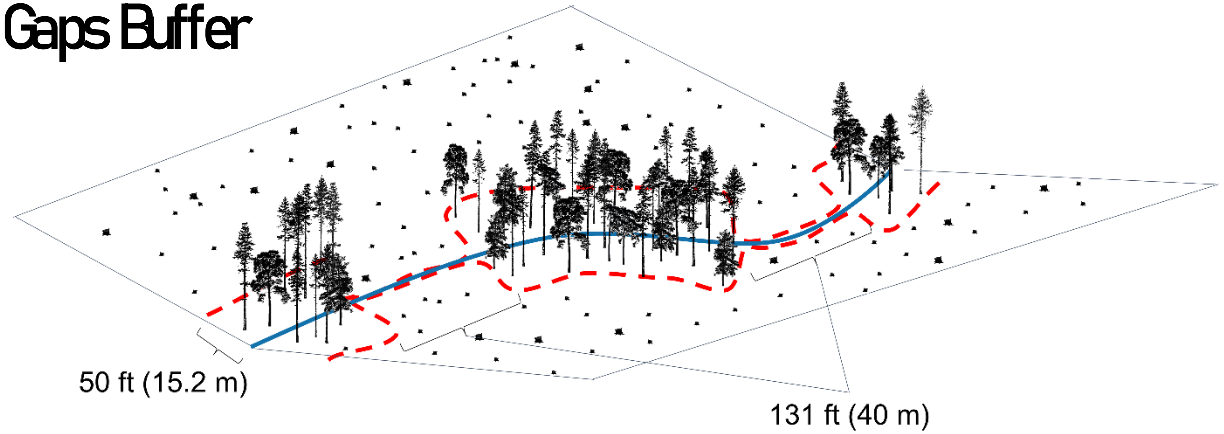
Current Practice Buffer



Variable Retention Buffer

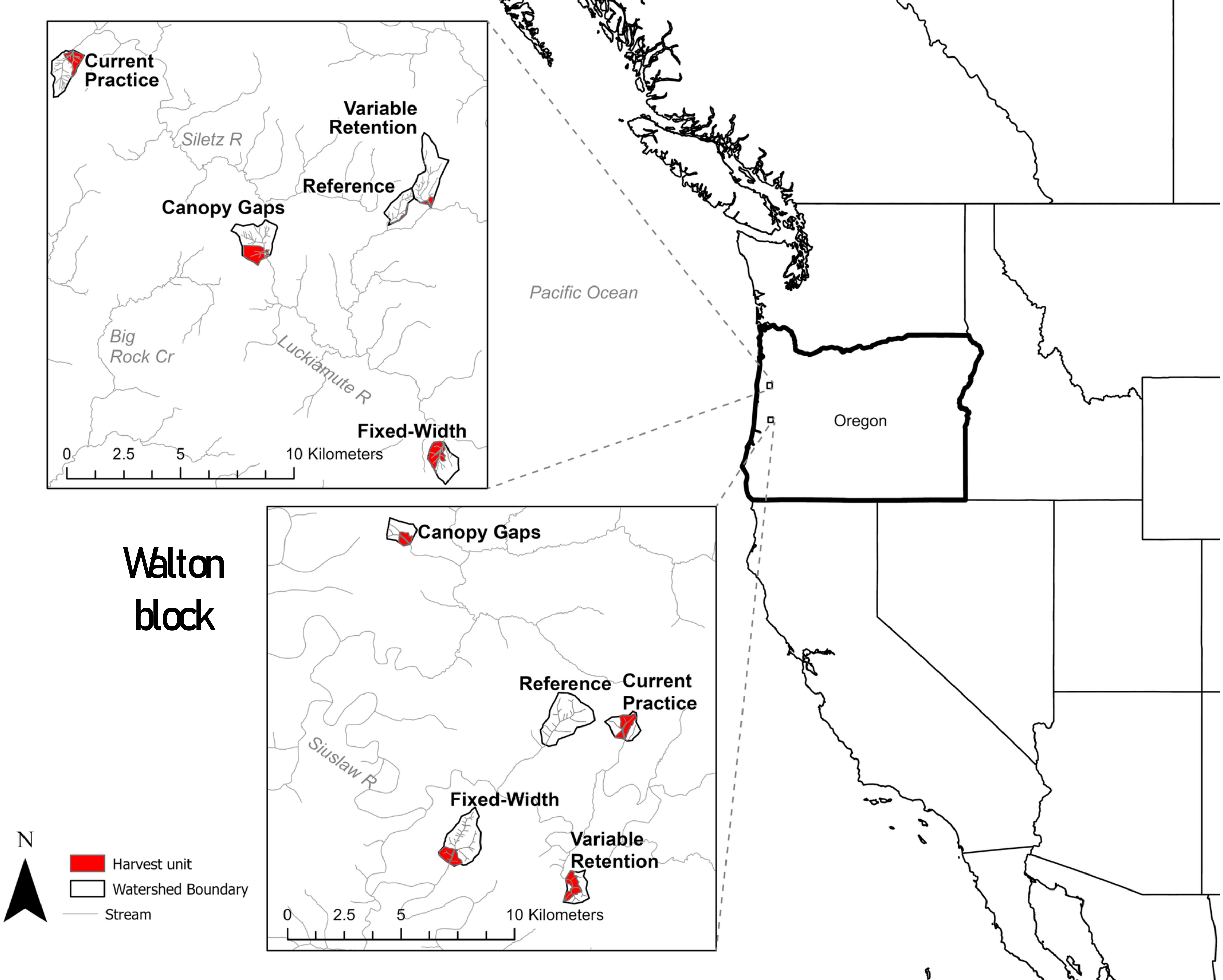


Canopy Gaps Buffer

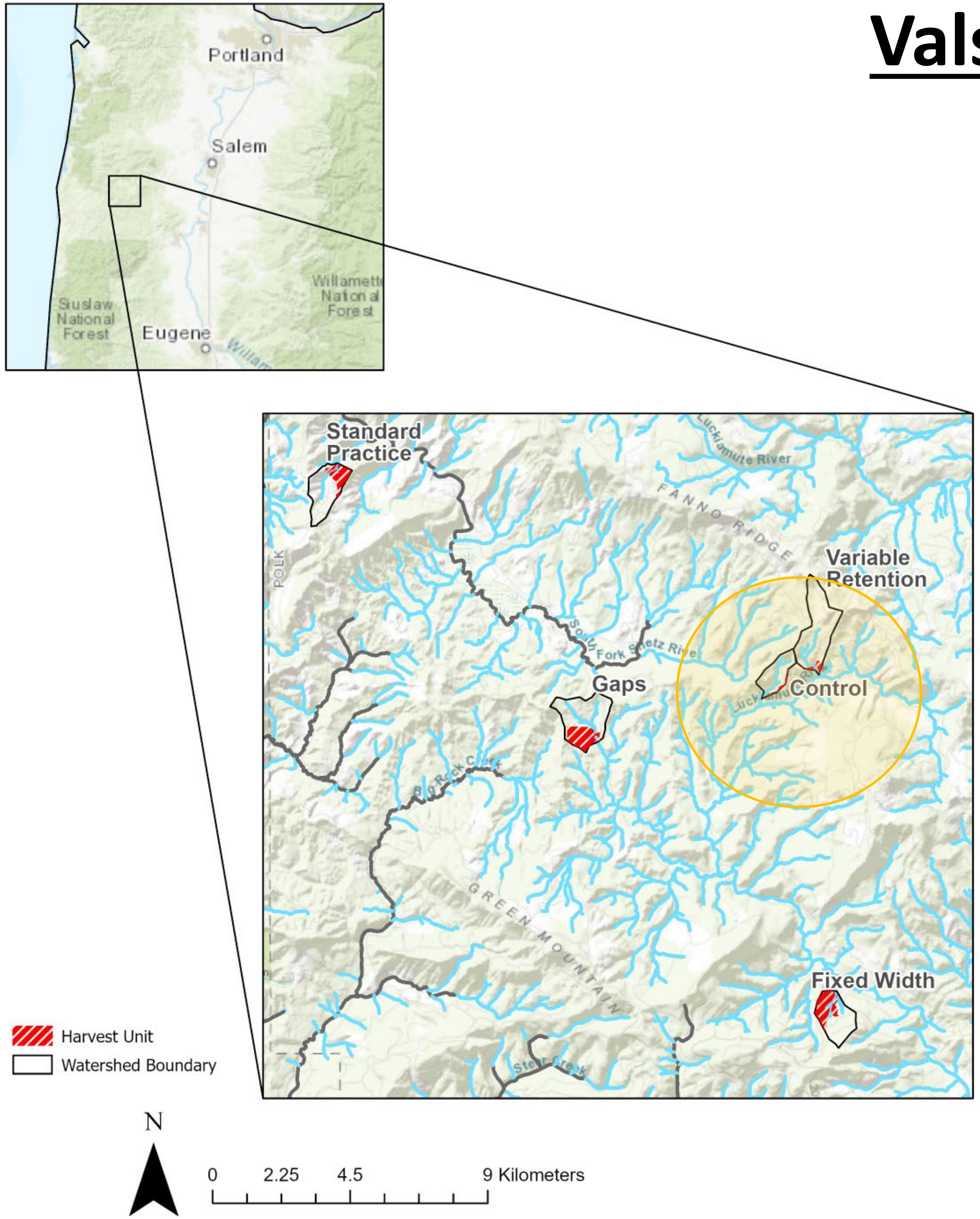


Valsetz block

Walton block

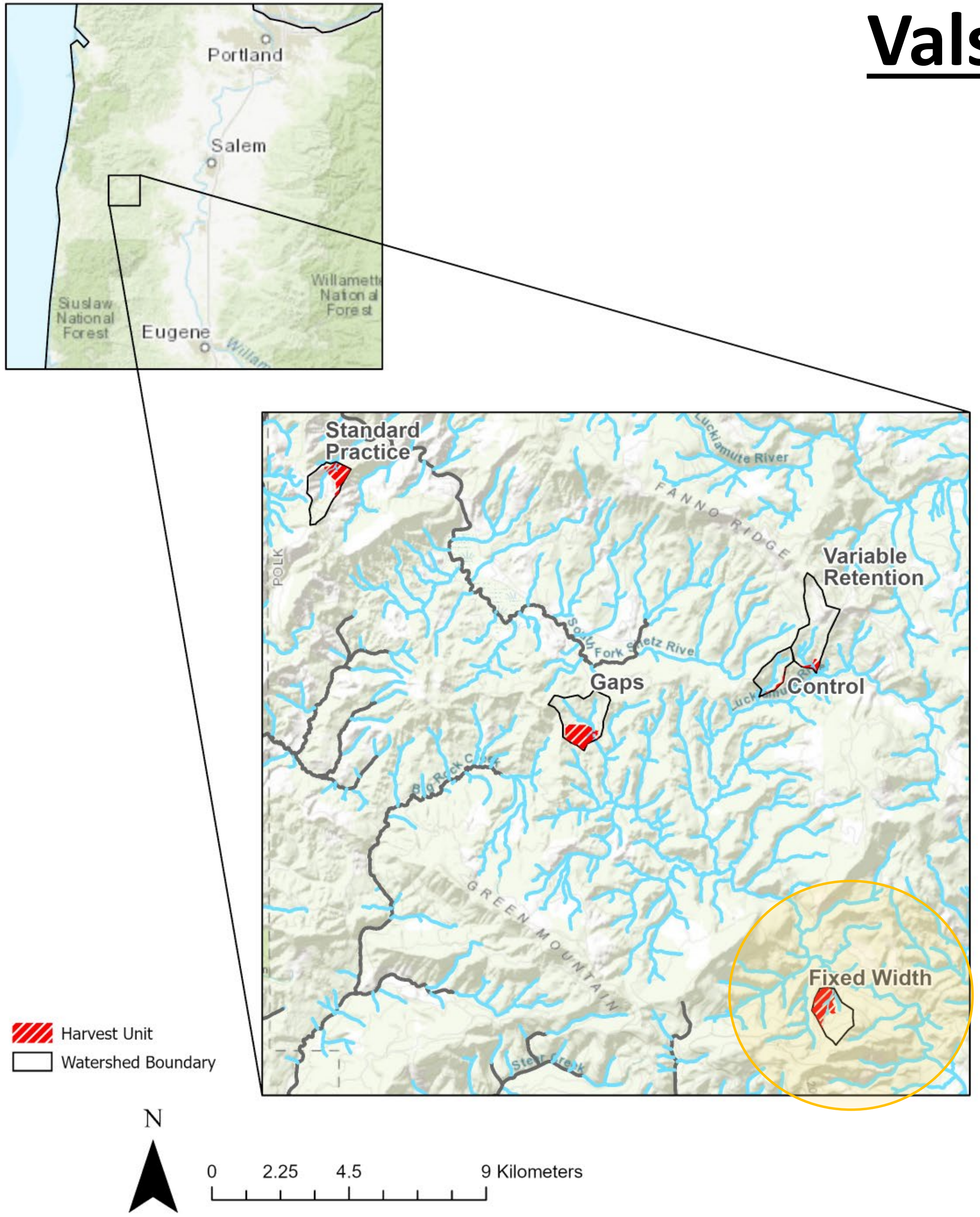


Valsetz



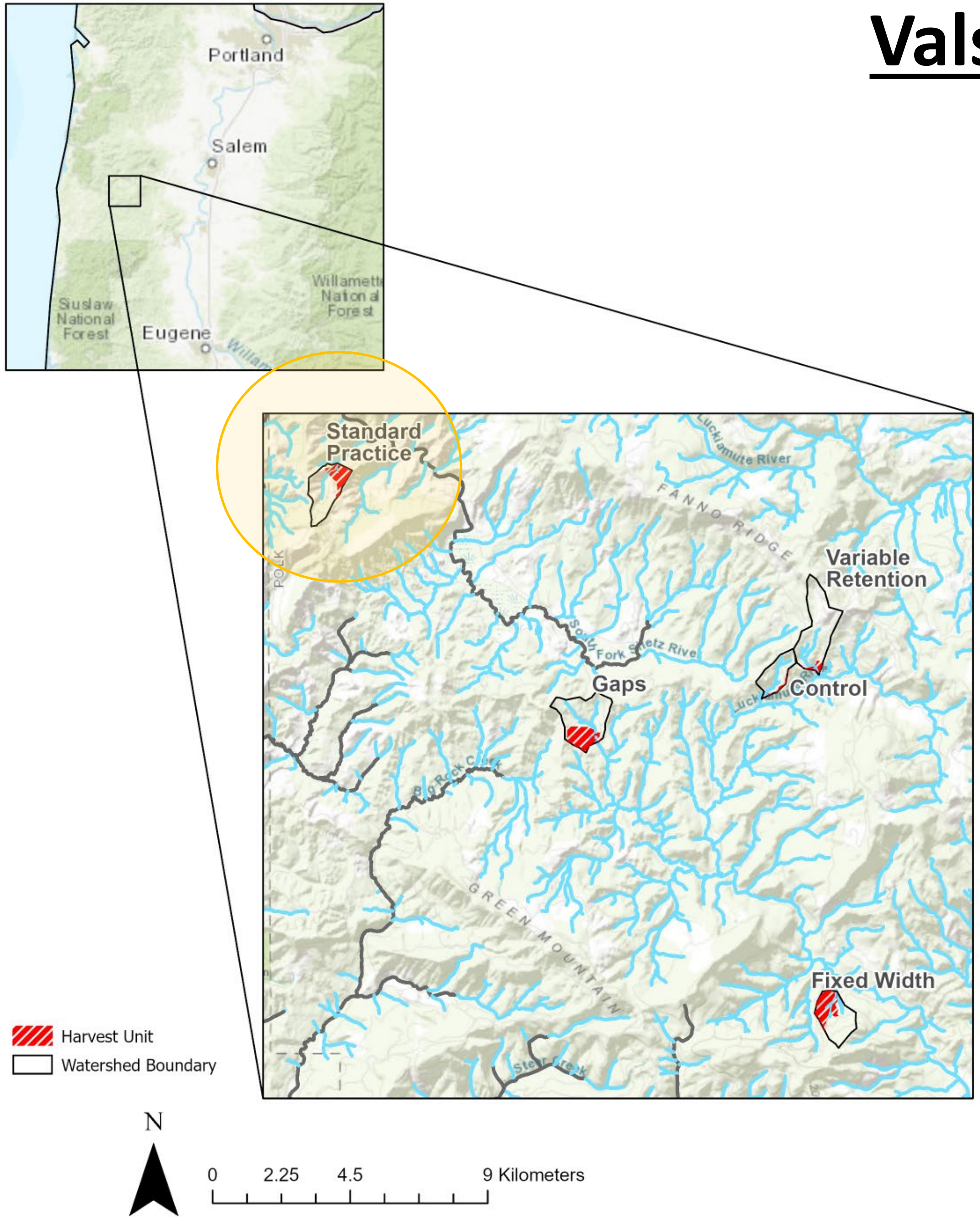
Control (unharvested)

Valsetz



Fixed Width (50 ft)

Valsetz



Current Practice (>20 ft)

*affected by 2021 ice storm

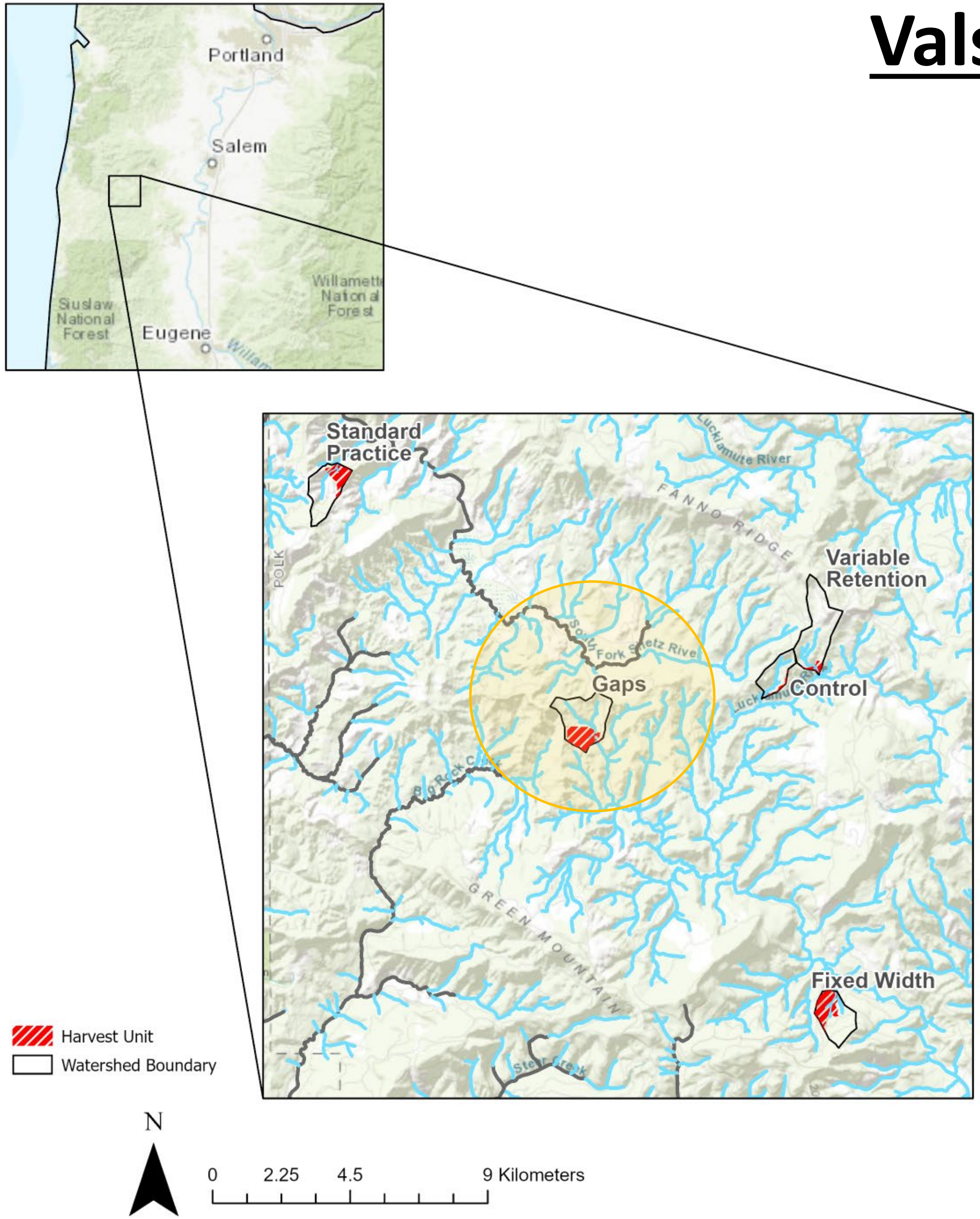
Harvest U

Watershe

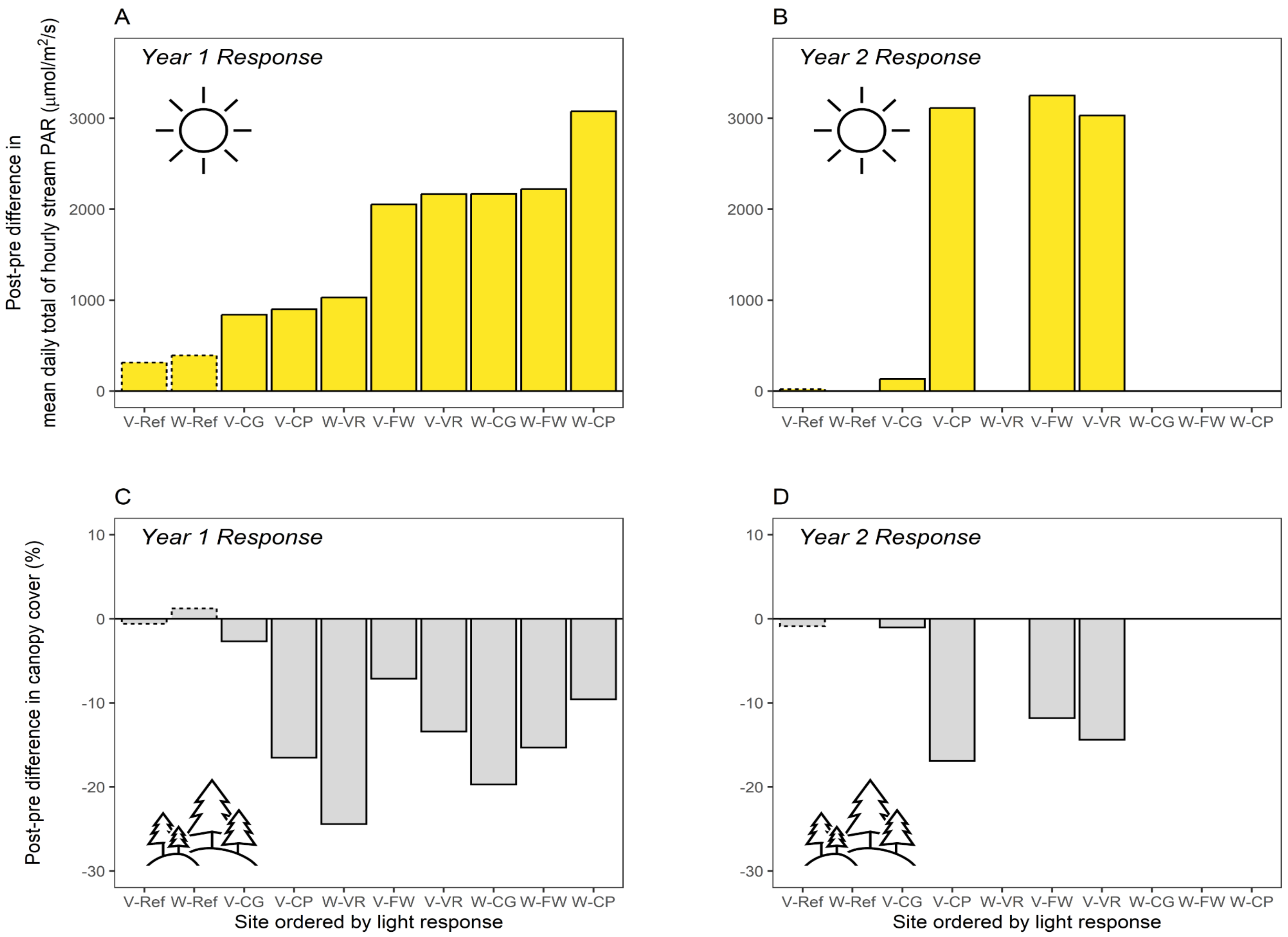
m

Valsetz

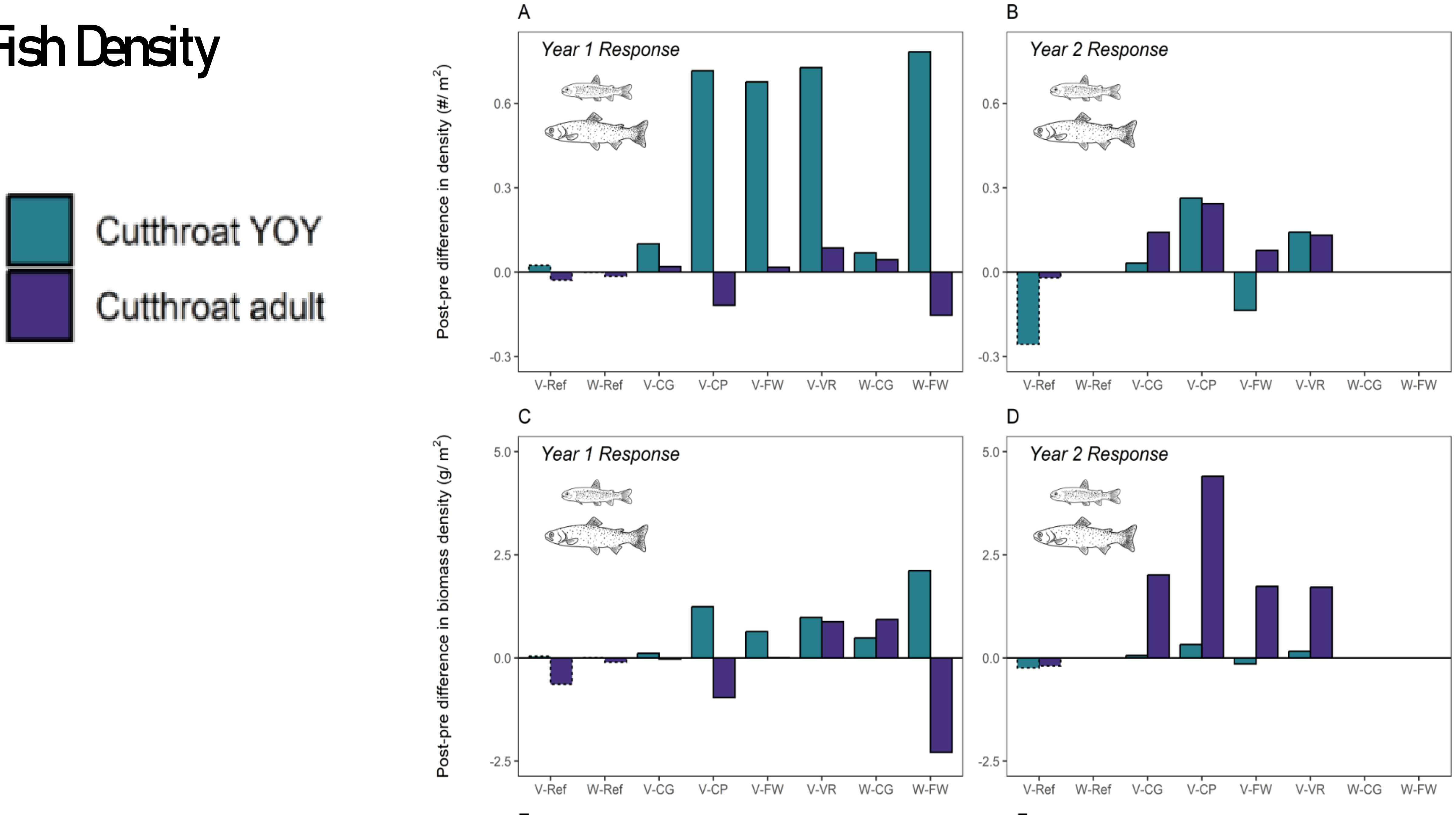
Gaps (40 m gaps in 50 ft buffer)



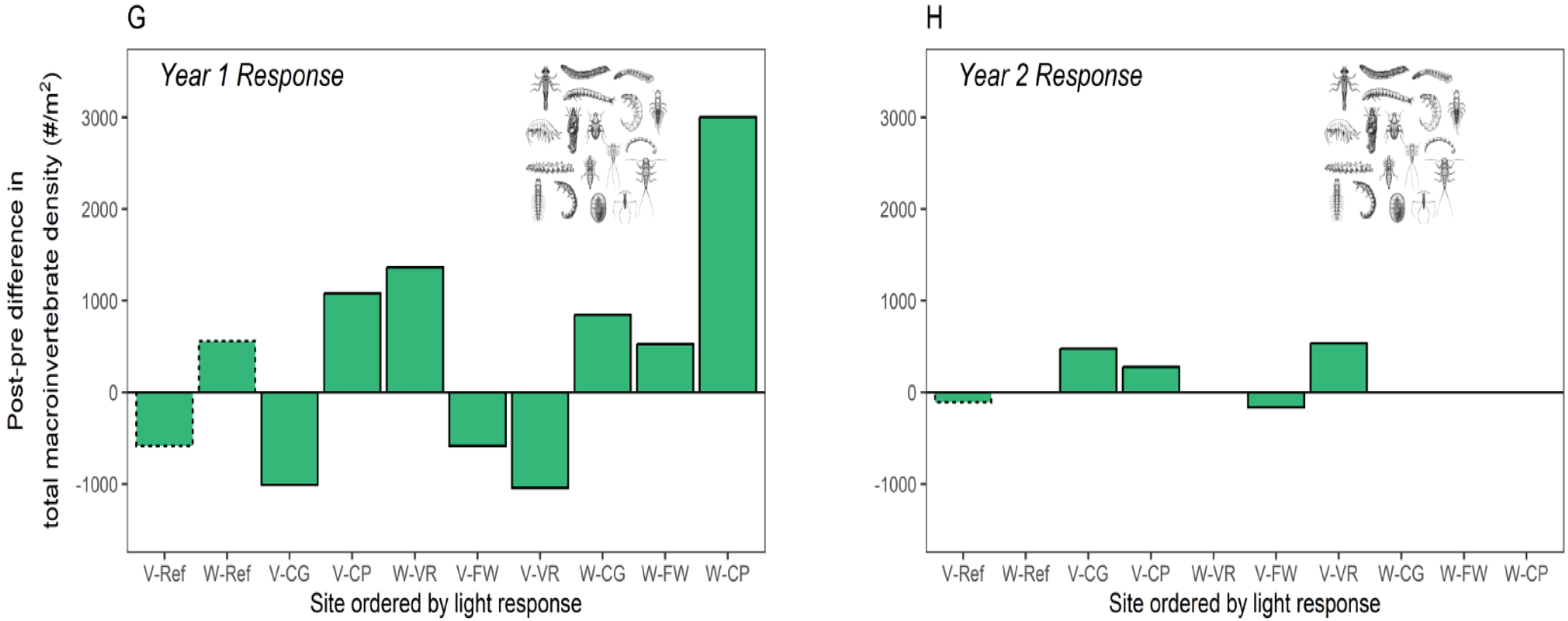
Light


A
Year 1 Response
Post-pre difference in
mean daily total of hourly stream PAR (μmol/m²/s)
3000
2000
1000
0
V-Ref W-Ref V-CG V-CP W-VR V-FW V-VR W-CG W-FW W-CP
B
Year 2 Response
3000
2000
1000
0
V-Ref W-Ref V-CG V-CP W-VR V-FW V-VR W-CG W-FW W-CP
C
Year 1 Response
Post-pre difference in canopy cover (%)
10
0
-10
-20
-30
V-Ref W-Ref V-CG V-CP W-VR V-FW V-VR W-CG W-FW W-CP
Site ordered by light response
D
Year 2 Response
10
0
-10
-20
-30
V-Ref W-Ref V-CG V-CP W-VR V-FW V-VR W-CG W-FW W-CP
Site ordered by light response

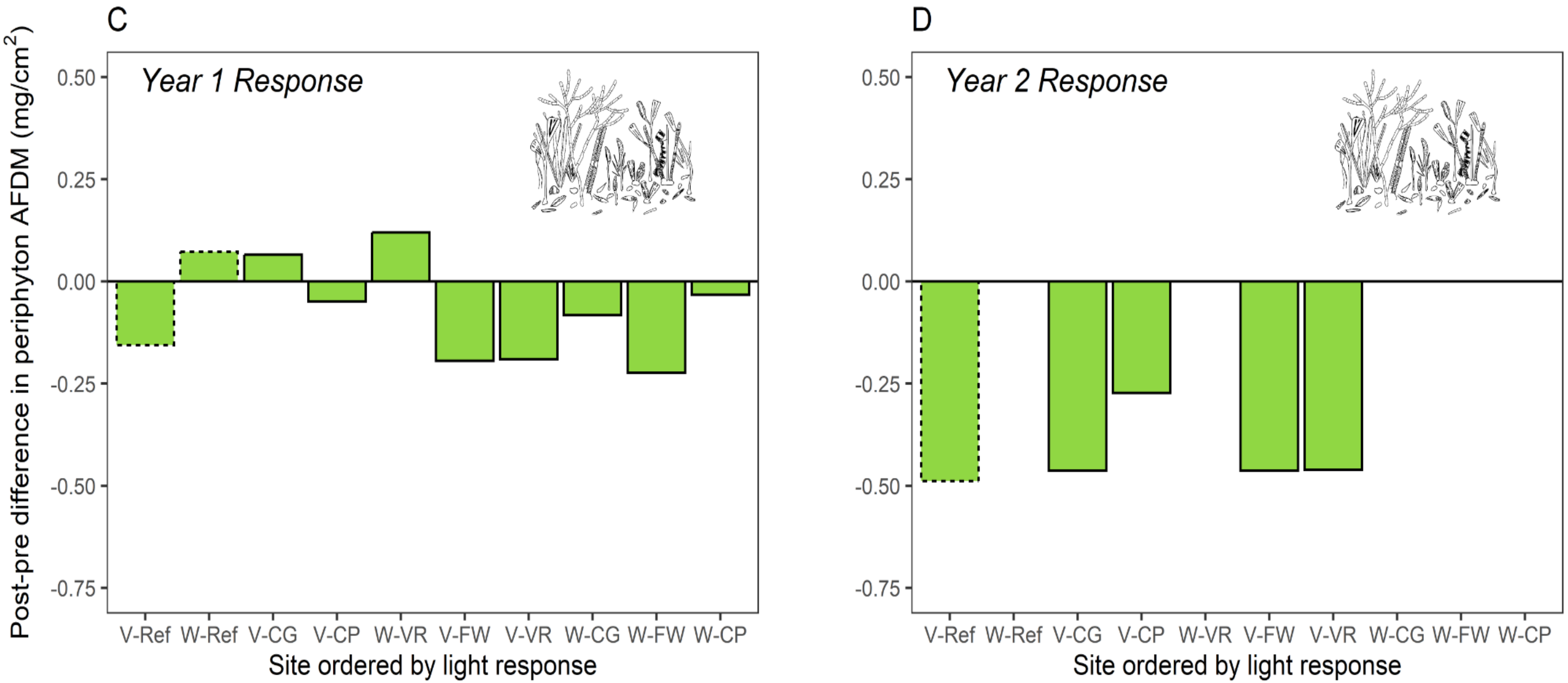
Fish Density



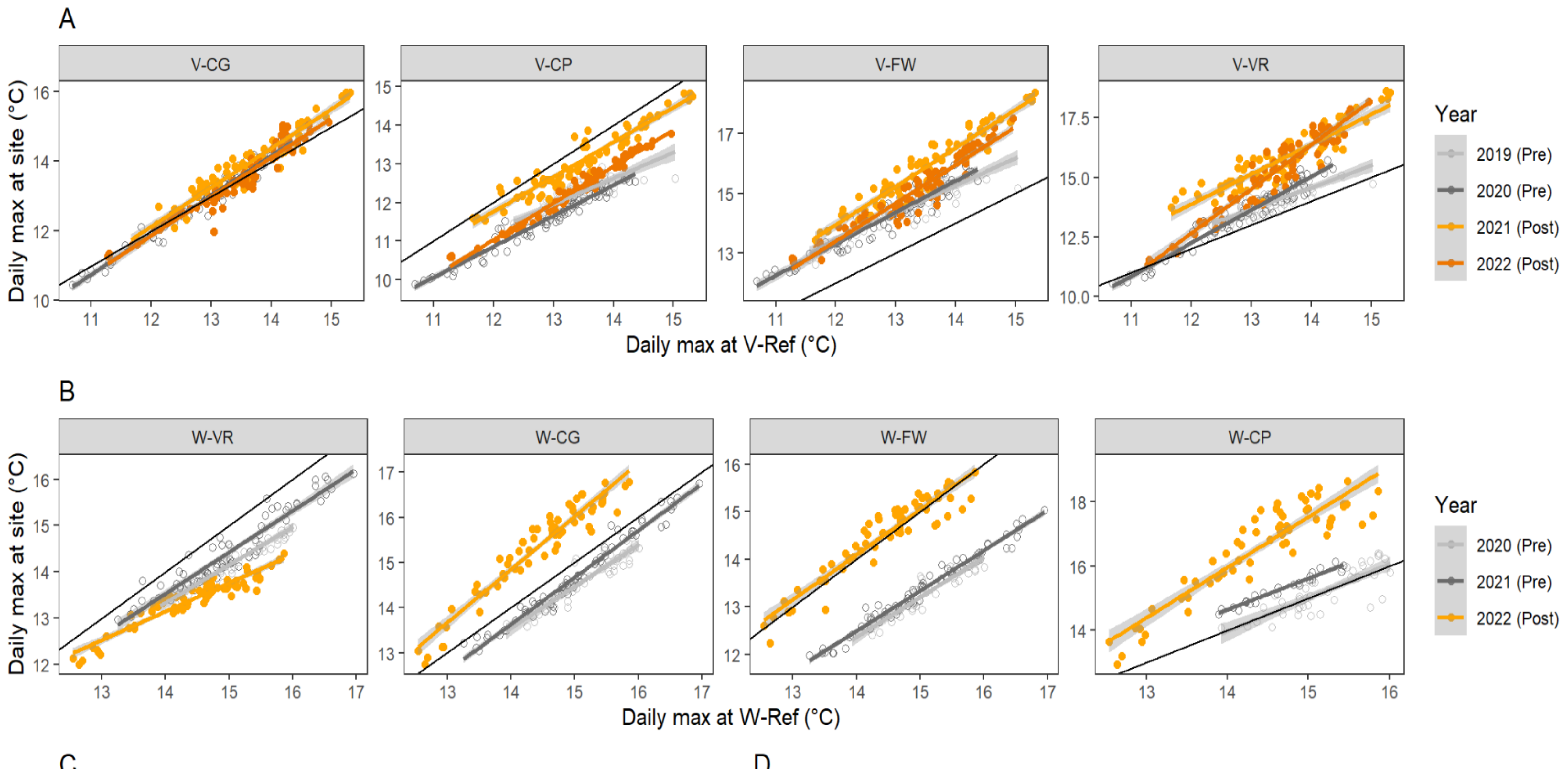
Macroinvertebrate Density



Biofilm Biomass

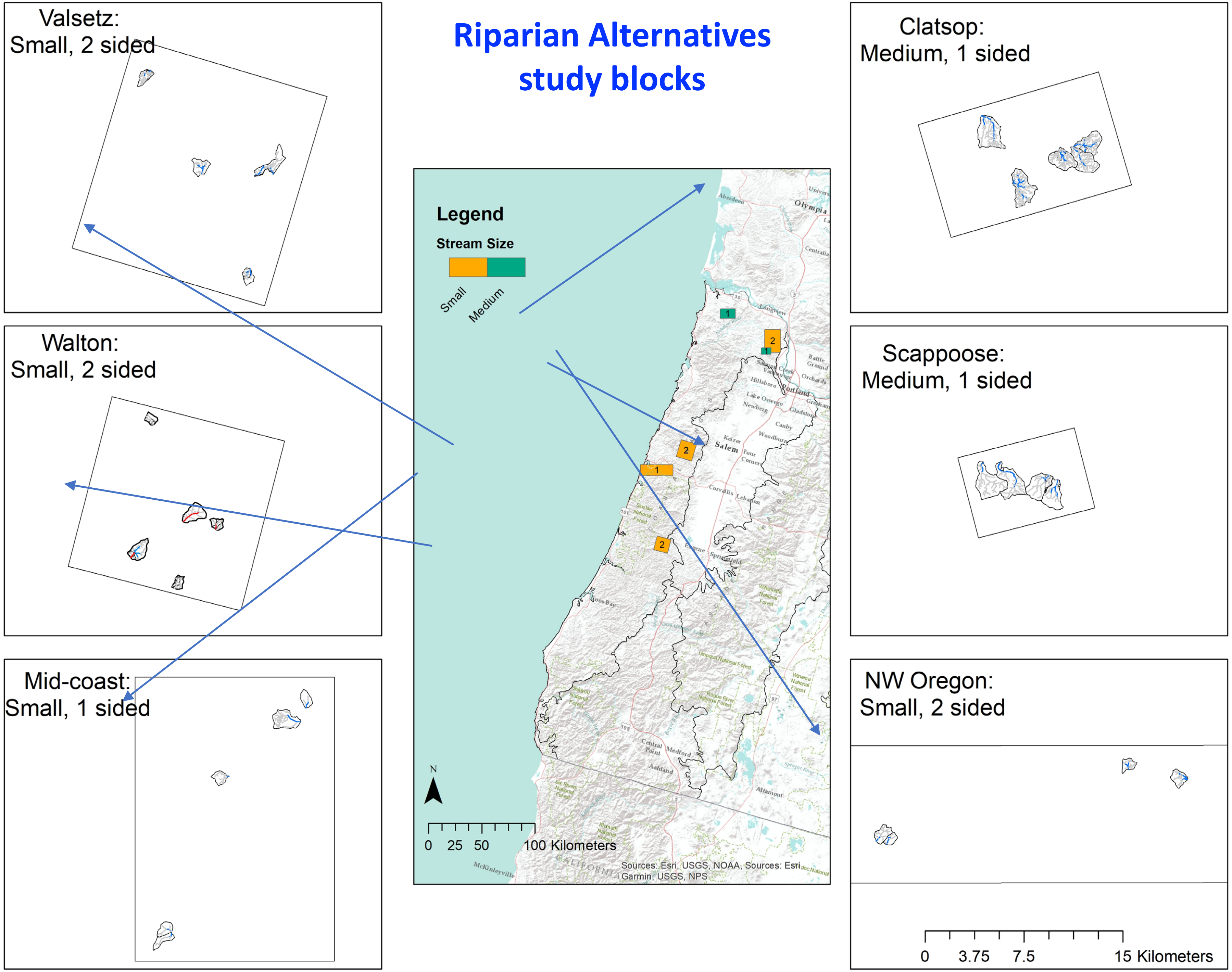


Temperature

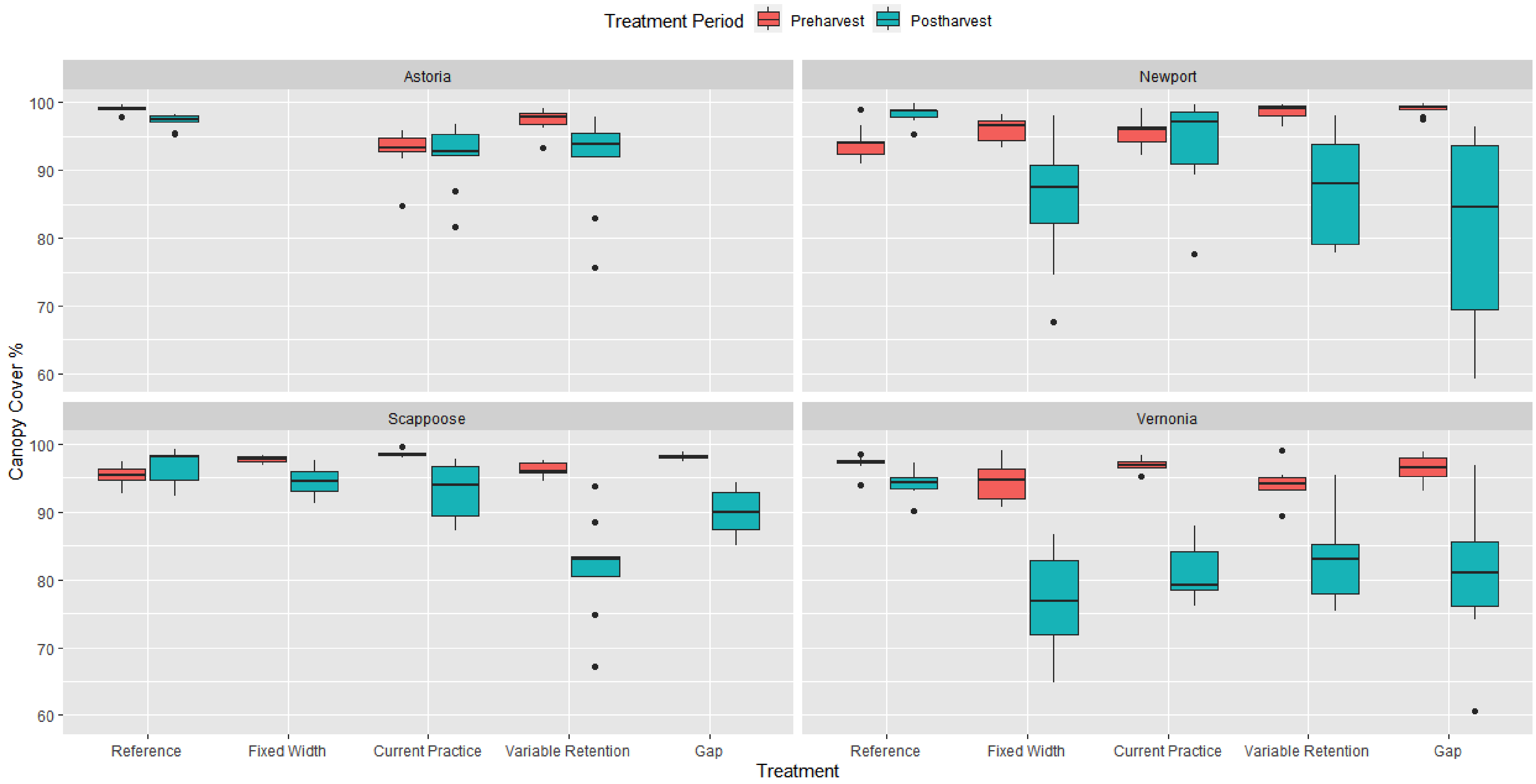


2023 Sampling

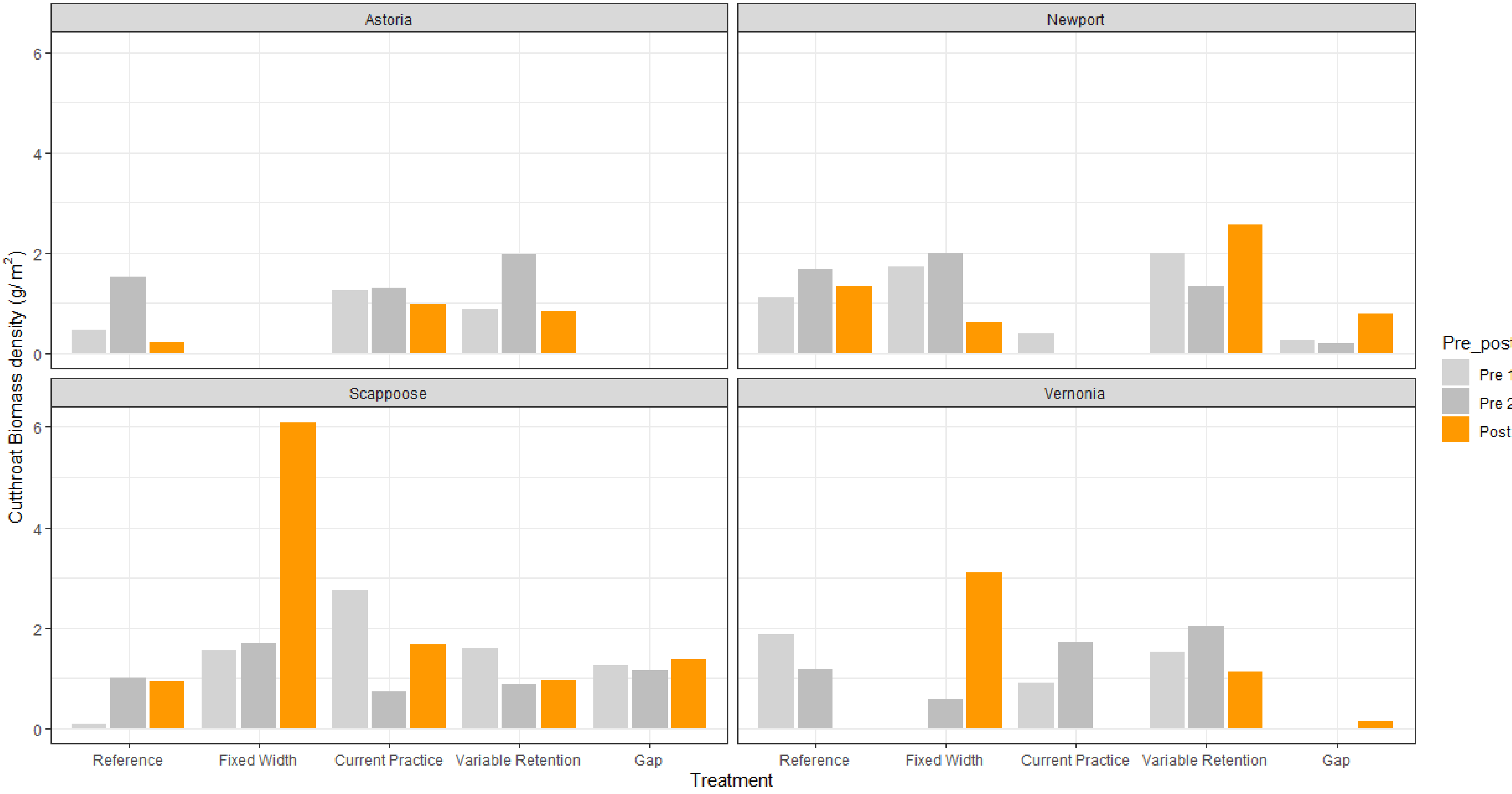
Riparian Alternatives study blocks

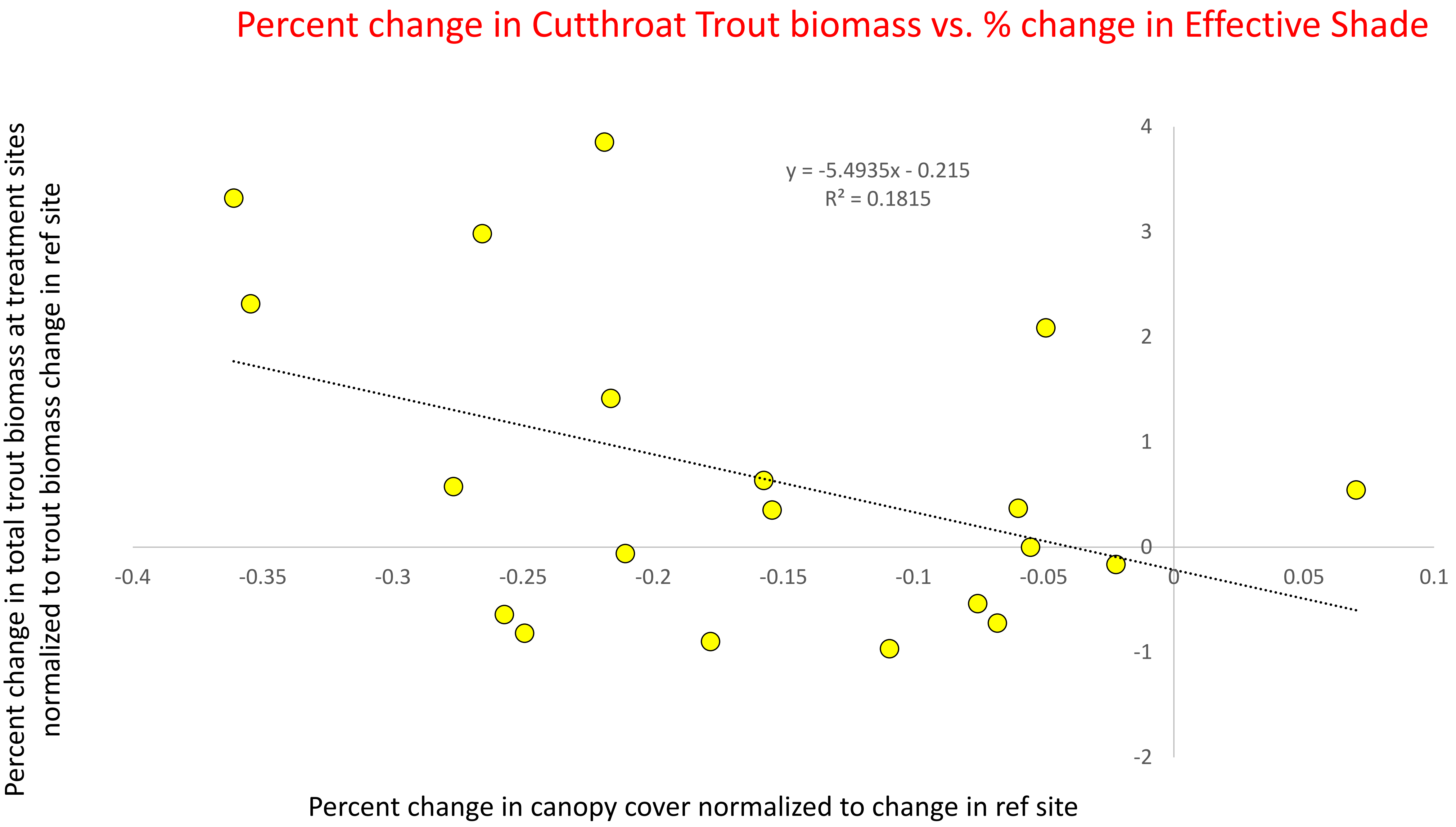


Canopy cover



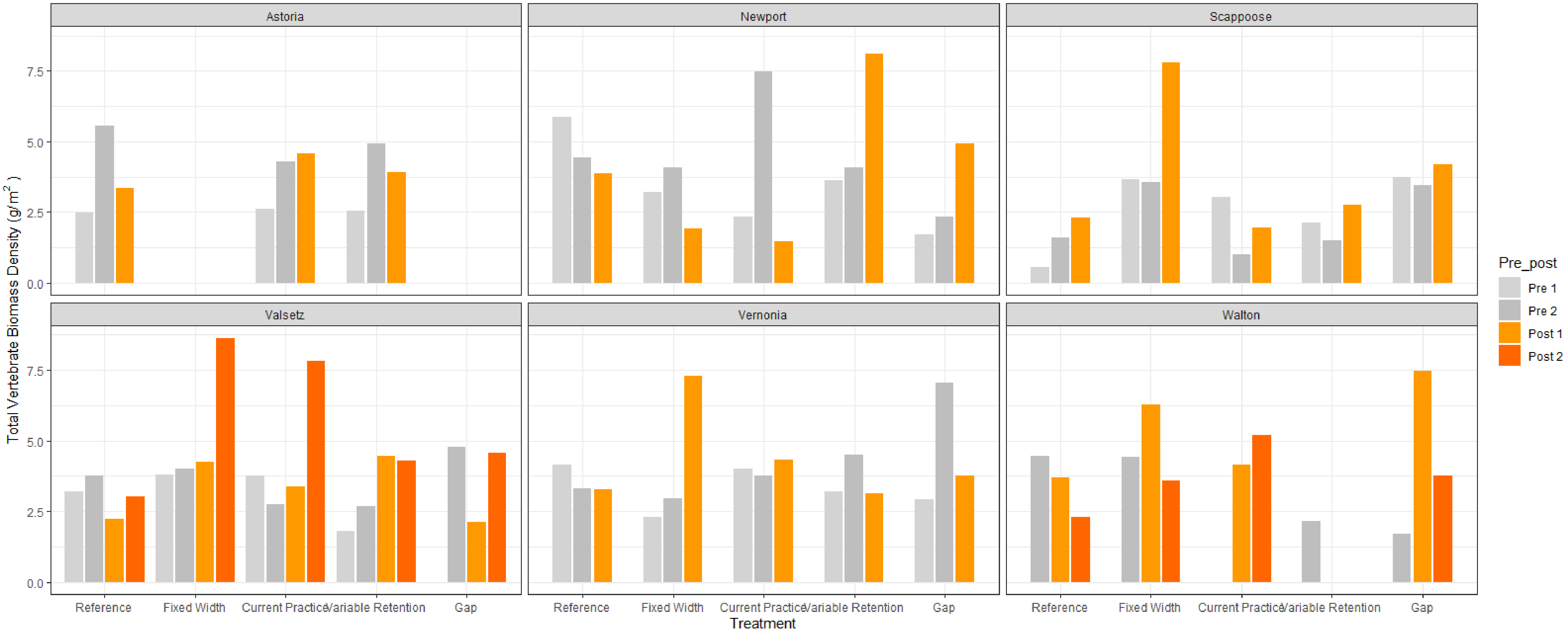
Trout Biomass Y1 response



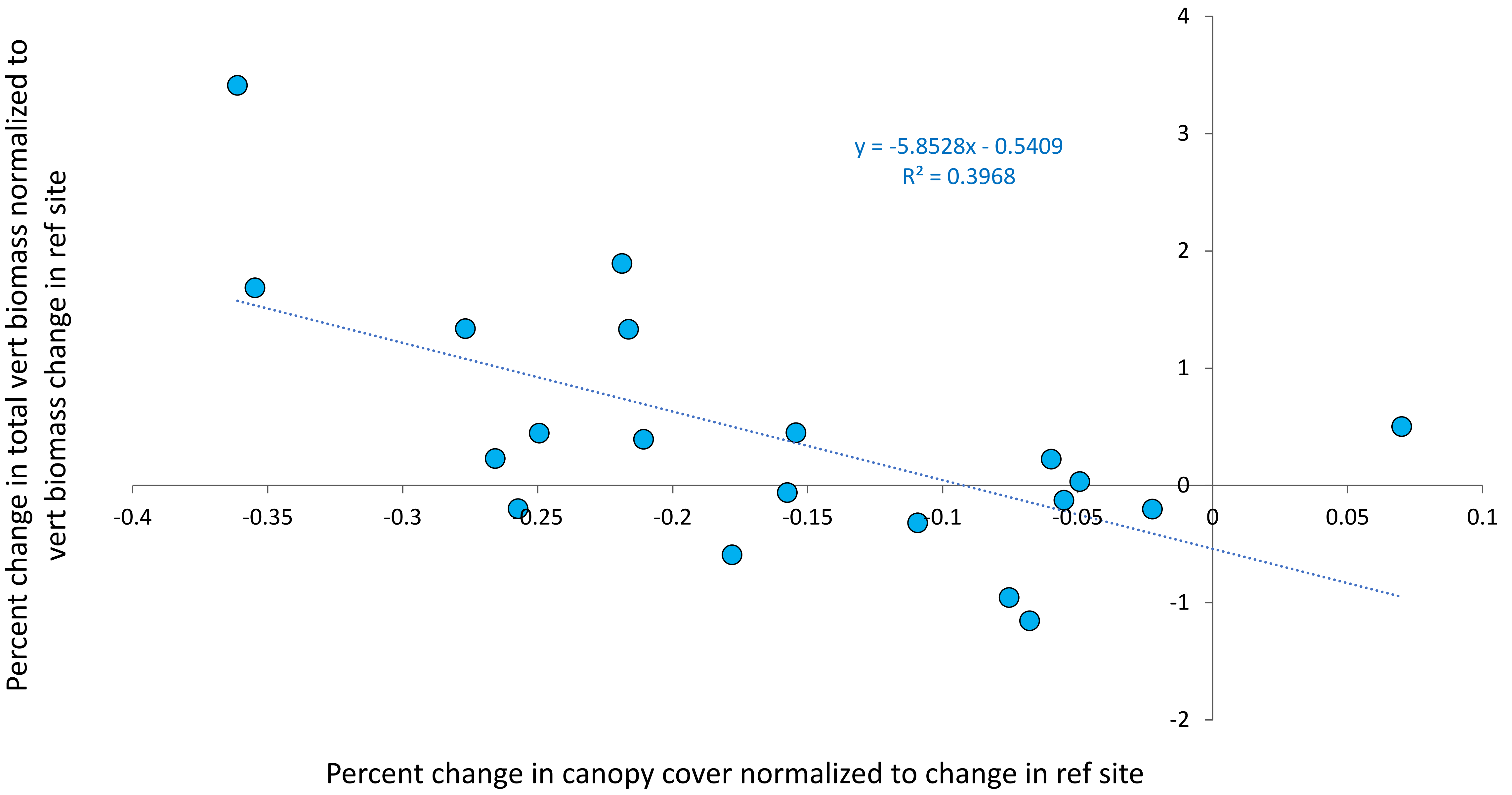


Percent change in Cutthroat Trout biomass vs. % change in Effective Shade
y = -5.4935x - 0.215
R² = 0.1815
Percent change in total trout biomass at treatment sites normalized to trout biomass change in ref site
Percent change in canopy cover normalized to change in ref site
4
3
2
1
0
-1
-2
-0.4
-0.35
-0.3
-0.25
-0.2
-0.15
-0.1
-0.05
0
0.05
0.1

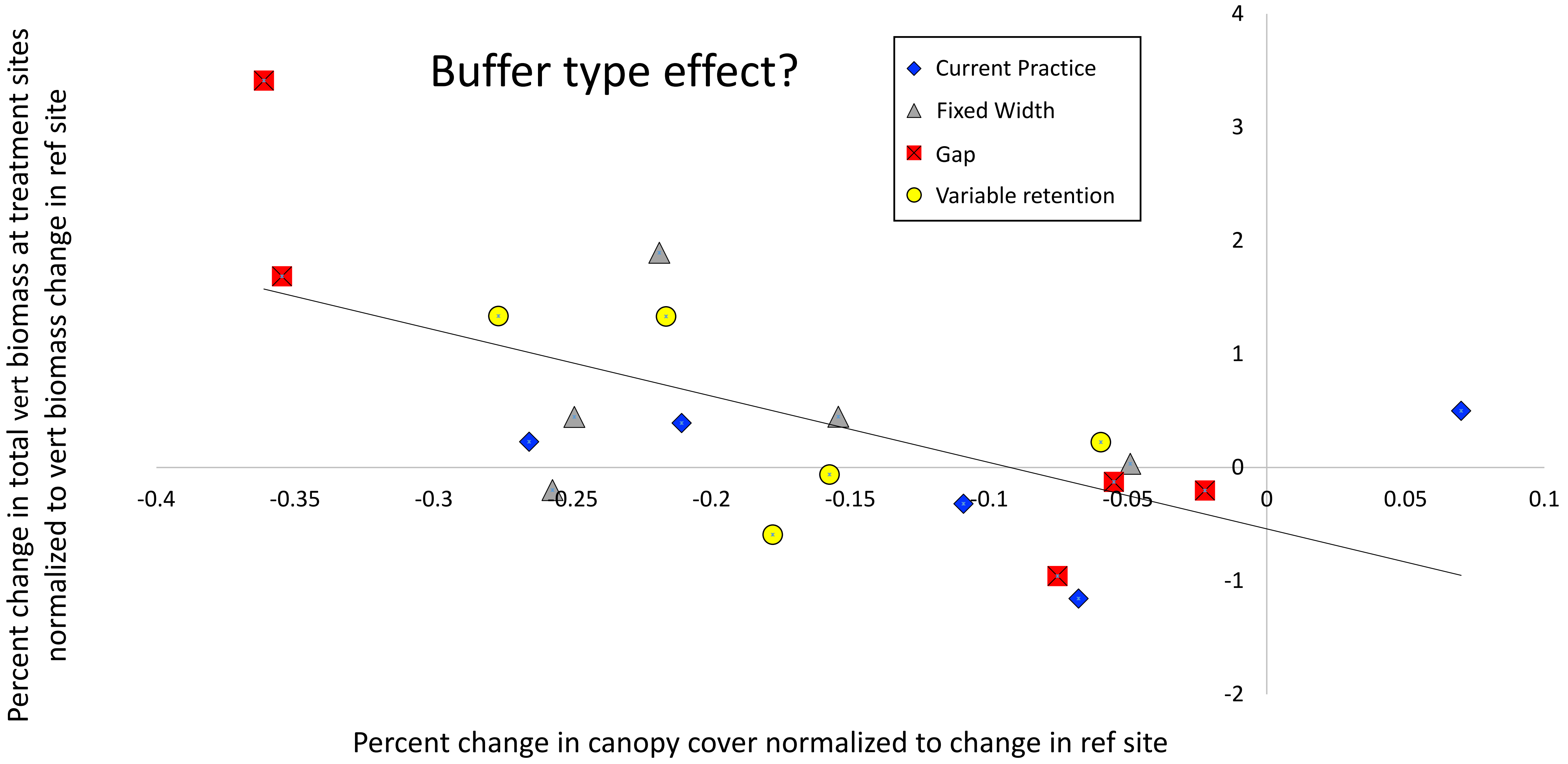
Total Vertebrate Biomass Y1 response



Percent change in Total Vertebrate biomass vs. % change in Effective Shade



Percent change in Total Vertebrate biomass vs. % change in Effective Shade



Questions?

Acknowledgements:

Ashley Sanders and Alex Foote

Landowners and partners

Field crews 2019-2023: Alex Boe, Molly Hamilton, Zowie DeLeon, Rylee Rawson, Annika Carlson, Nathan Maisonville, Rory Corrigan, Nate Neal, Maya Greydanus, Jacqui James, Tyler Parr, Nicole Miller, Brenna Cody, Alex Foote, and Ciana Carr, Lou Glowacki, Emma Legualt, Andrew Cropsey, and Lauren Ringrose

Funding:
NCASI, Inc. and OSU FWHMF Program

CampbellGlobal FOREST & NATURAL RESOURCE INVESTMENTS

Rayonier

Weyerhaeuser

GreenWood Resources

NCASI IMPACT. SCIENCE. SOLUTIONS.

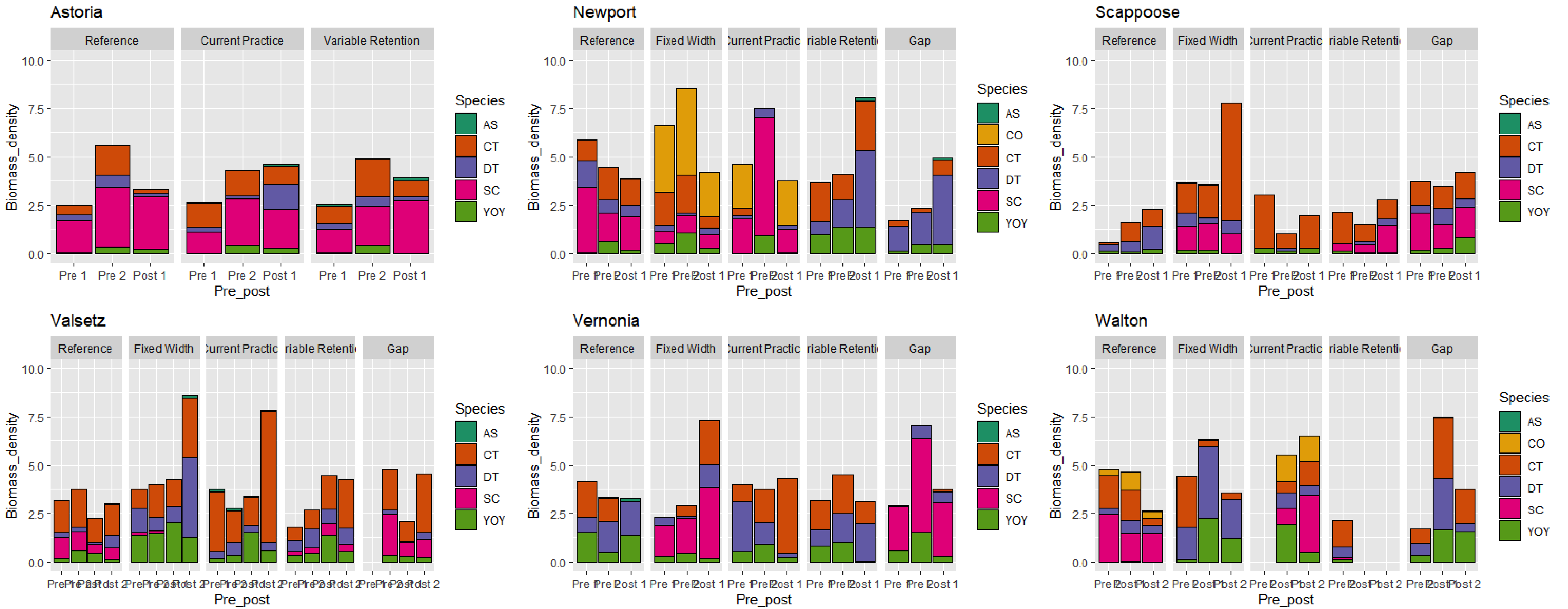
Oregon State University College of Forestry

Manulife Investment Management

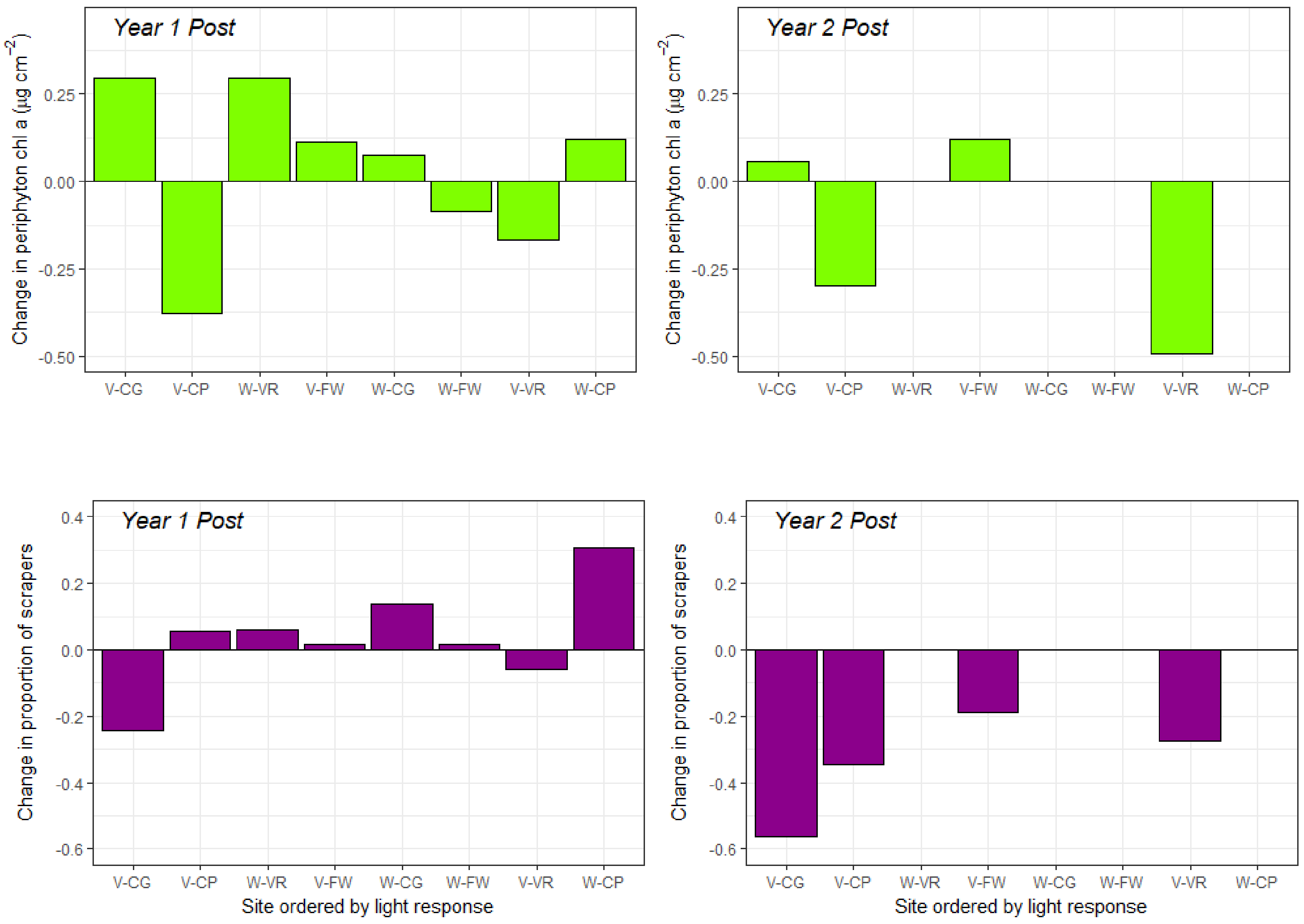
Roseburg A Forest Products Company

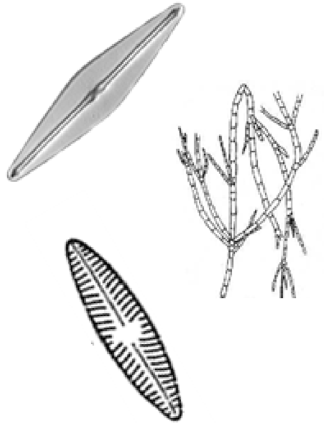
Giustina Land & Timber Co.

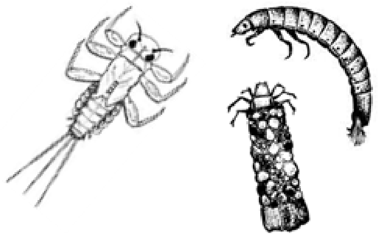
EXTRA SLIDES

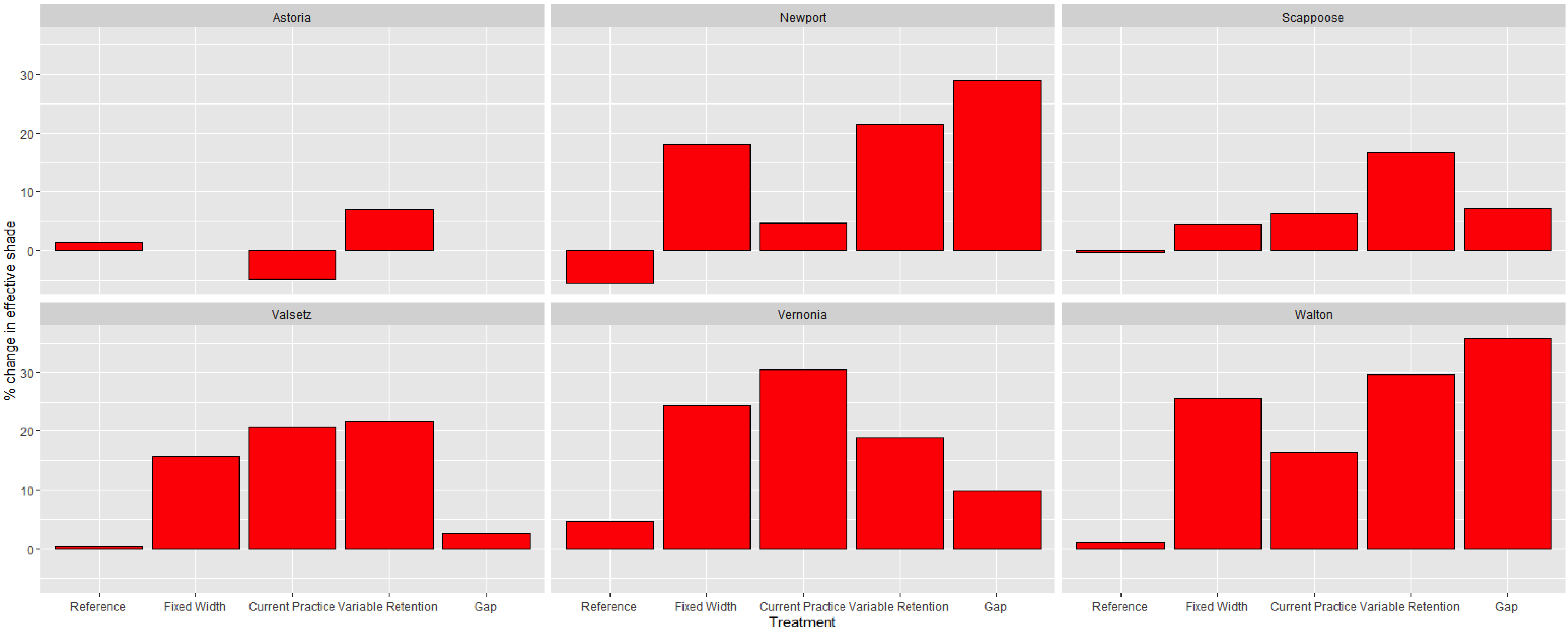

Astoria
Newport
Scappoose
Valsetz
Vernonia
Walton
Reference
Fixed Width
Current Practice
Variable Retention
Gap
Biomass_density
Pre_post
Pre 1
Pre 2
Post 1
Post 2
Species
AS
CO
CT
DT
SC
YOY

Basal Resources and Macros



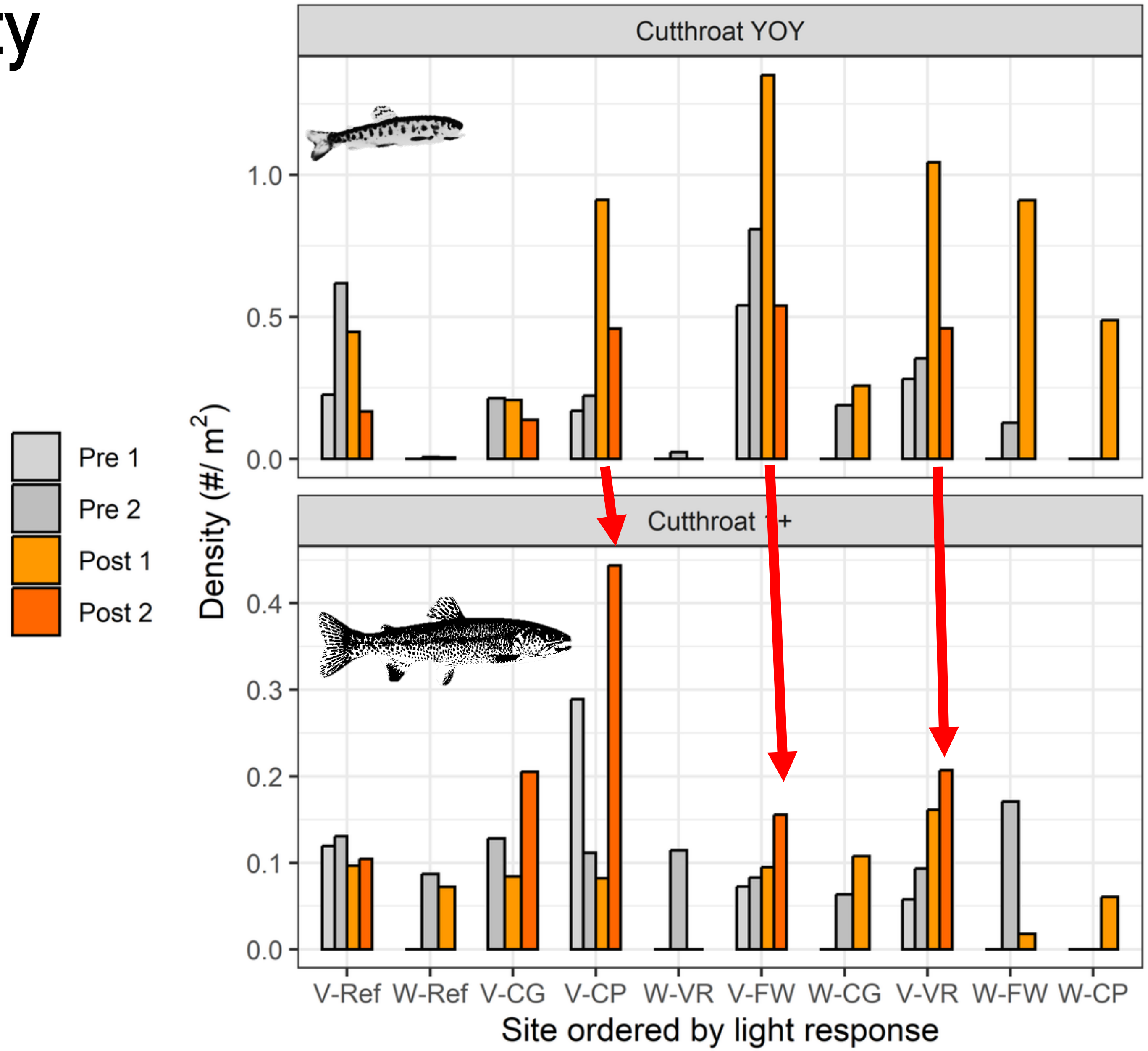






Astoria
Newport
Scappoose
Valsetz
Vernonia
Walton
% change in effective shade
30
20
10
0
Reference
Fixed Width
Current Practice
Variable Retention
Gap
Treatment

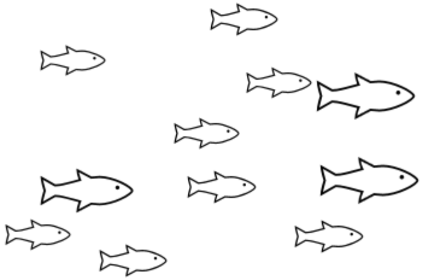
Fish Density

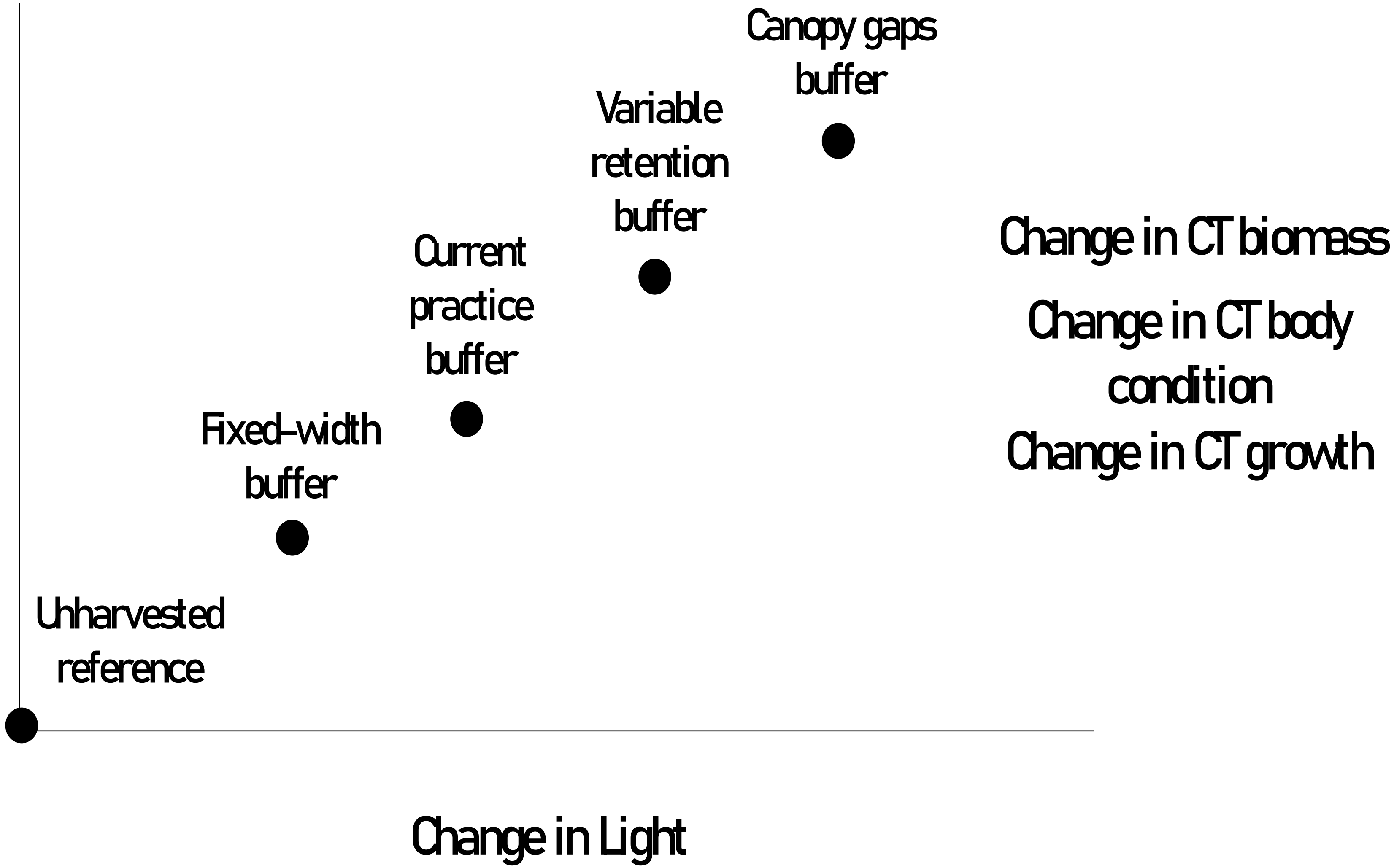


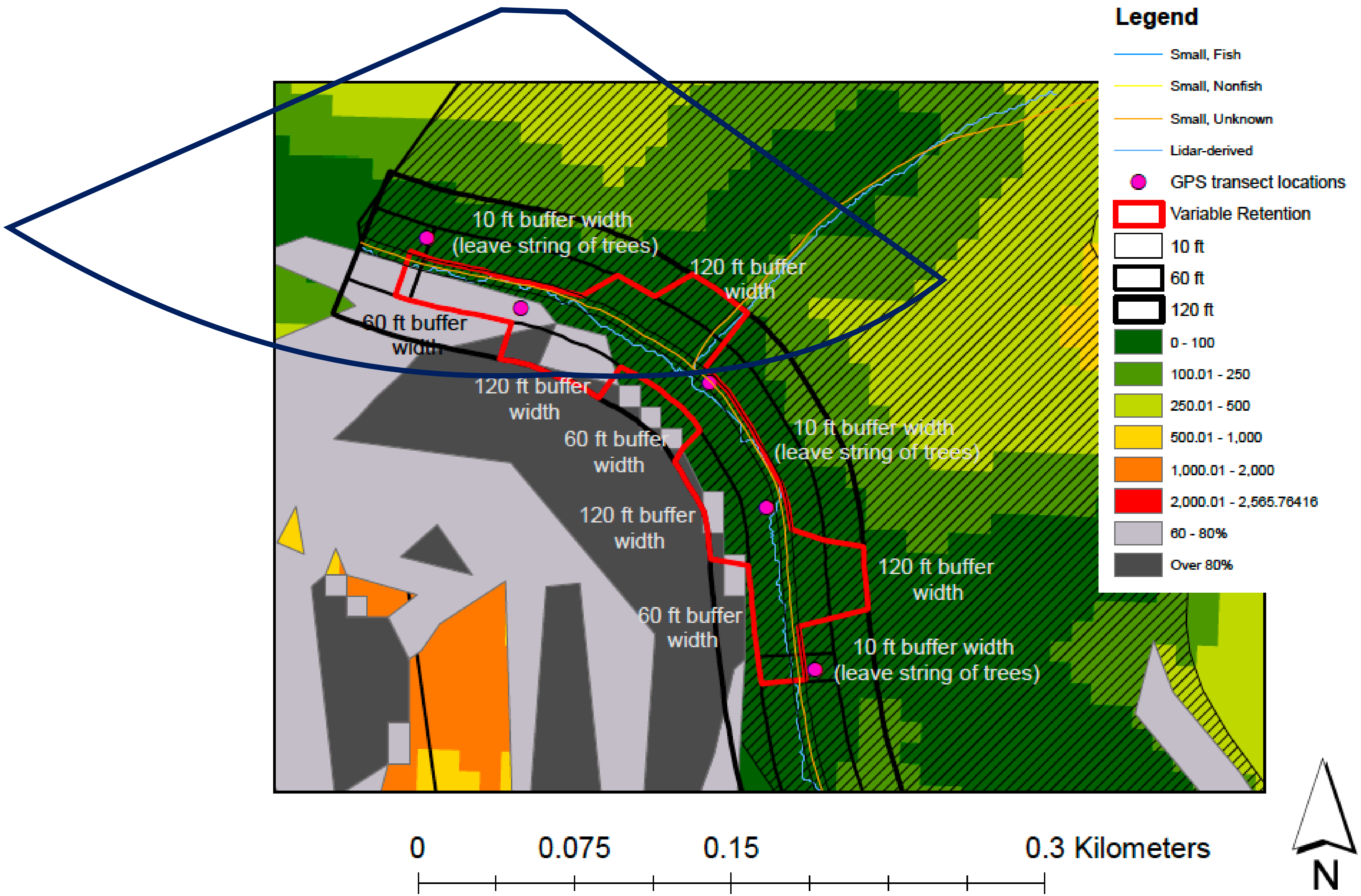
Predictions

P2.3 Carrying capacity at streams with greater streamlight increases because of increased food availability

“A rising tide...”






Legend
Small, Fish
Small, Nonfish
Small, Unknown
Lidar-derived
GPS transect locations
Variable Retention
10 ft
60 ft
120 ft
0 - 100
100.01 - 250
250.01 - 500
500.01 - 1,000
1,000.01 - 2,000
2,000.01 - 2,565.76416
60 - 80%
Over 80%
10 ft buffer width (leave string of trees)
120 ft buffer width
60 ft buffer width
120 ft buffer width
60 ft buffer width
10 ft buffer width (leave string of trees)
120 ft buffer width
120 ft buffer width
60 ft buffer width
10 ft buffer width (leave string of trees)
0
0.075
0.15
0.3 Kilometers
N


120 ft buffer width;
60 ft opposite side
0 m
Bottom of reach
current
practice
buffer
below our
reach

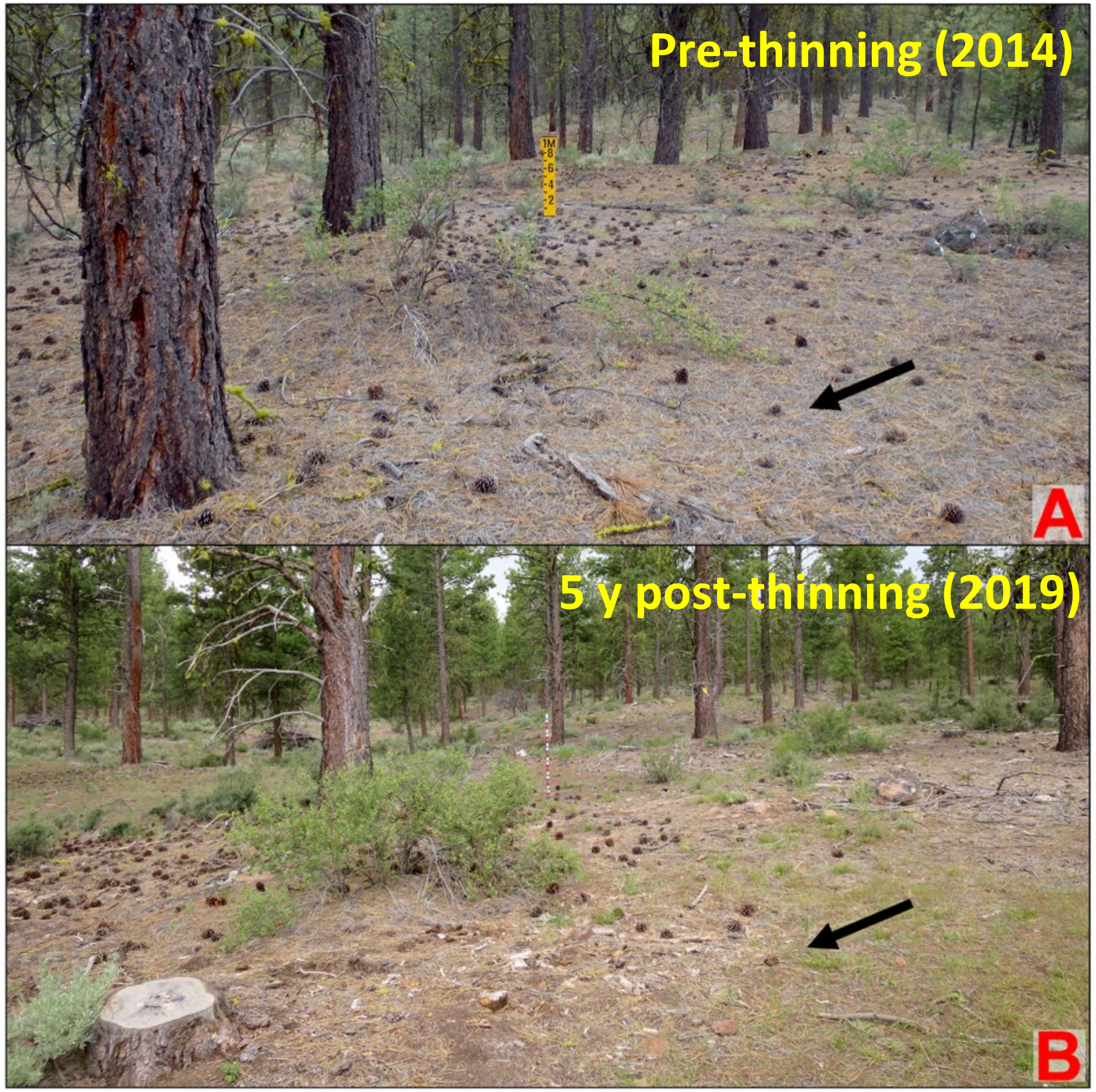
Evaluating insect pollinator response to dry forest fuels treatments

Jim Rivers[1] and James Johnston[2]

[1]Dept. Forest Engineering, Resources, and Management

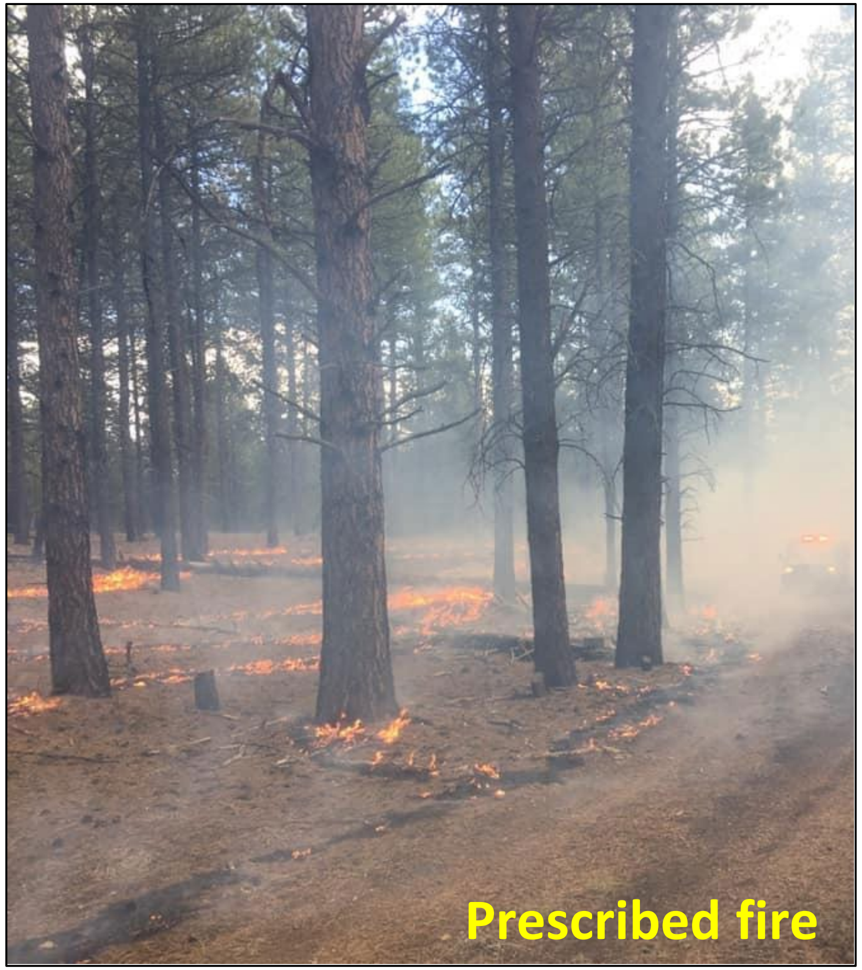
[2]Dept. Forest Ecosystems and Society

Fuels treatments are a management priority in dry forests of the western U.S.



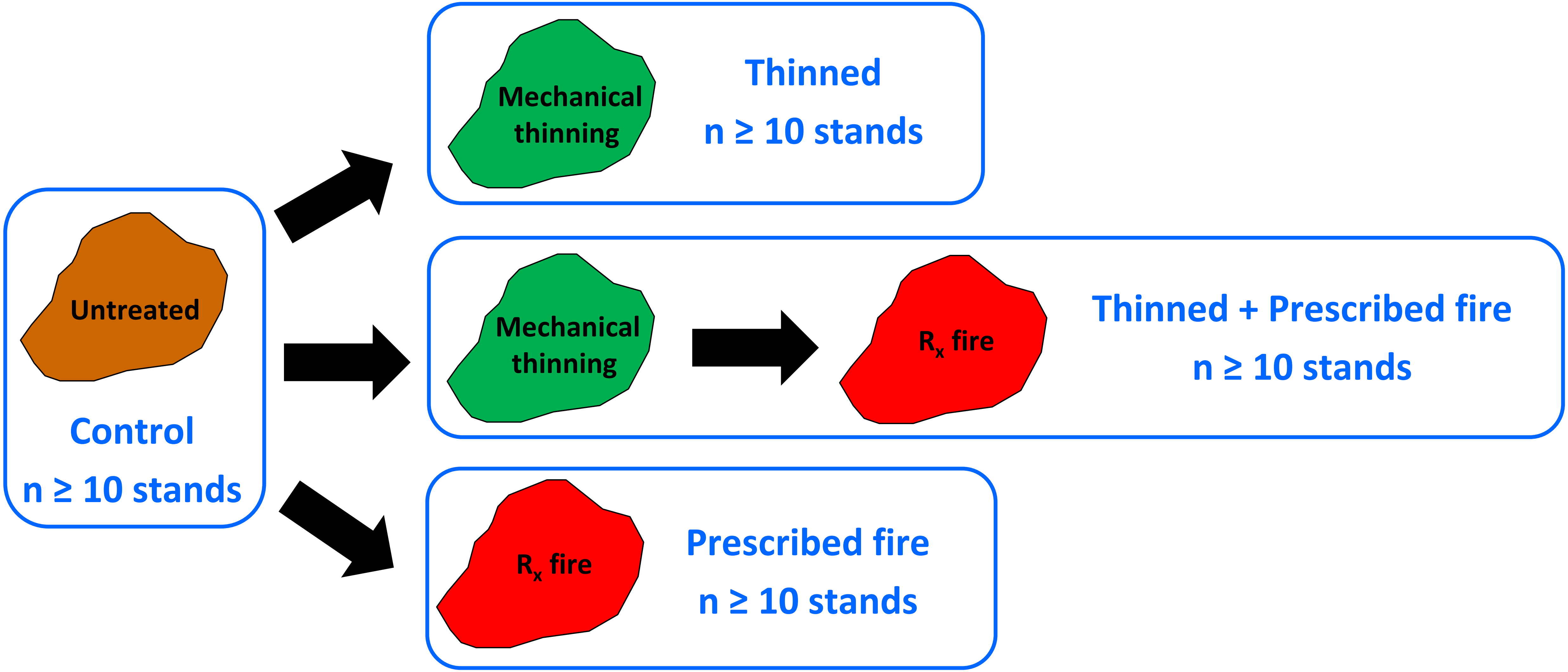
Johnston et al. 2021

The Collaborative Forest Landscape Restoration Program (CFLRP) supports thinning to reduce fuels and restore forest resilience

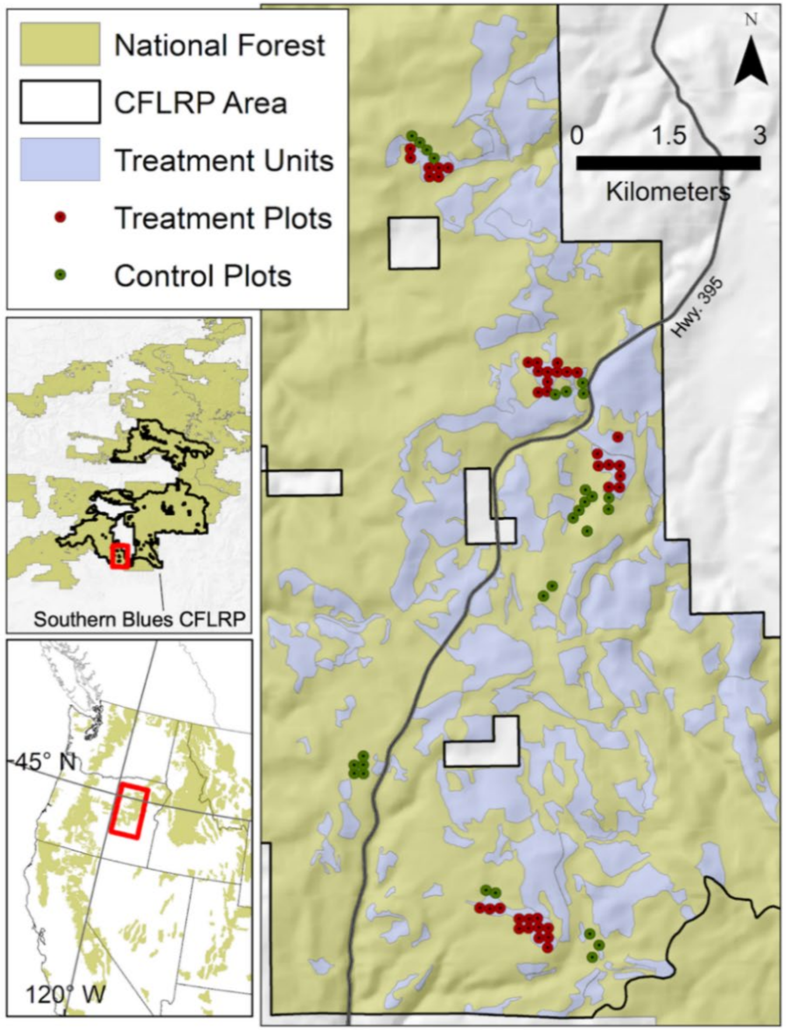


Johnston et al. 2021

We will assess bee response to the treatments currently being implemented to reduce fuel loads



Data collection will take place within established plots on the Malheur National Forest



Johnston et al. 2021

A general timeline for the next year

Interviews and select finalist for M.S. position (>40 applicants!): December 2023

Procure additional funding for field technicians: January to March 2024

Finalize study field site selection: January to March 2024

Interview and select field technicians: January to February 2024

Purchase field gear: February to March 2024

Undertake field season #1: May to August 2024

M.S. student matriculates into CoF: September 2024

Multi-scale Habitat Value of Slash Piles for Conserving Rare Carnivores

Jordan Ellison[1,2], Katie Moriarty[1], Angela Larsen-Gray[1], and John Bailey[2]

[1]National Council for Air and Stream Improvement, Inc.

[2]Oregon State University

Funding from **Fish and Wildlife Habitat in Managed Forests research program** and the **National Council for Air and Stream Improvement, Inc.**

November 2023

Pacific fisher (*Pekania pennanti)*

- Southern Sierra population State (2019) and Federally (2020) Endangered
- **New petition for listing entire west coast population filed Sept. 13, 2022**

Caylen Kelsey

Mark Linnell

Pacific marten (*Martes caurina)*

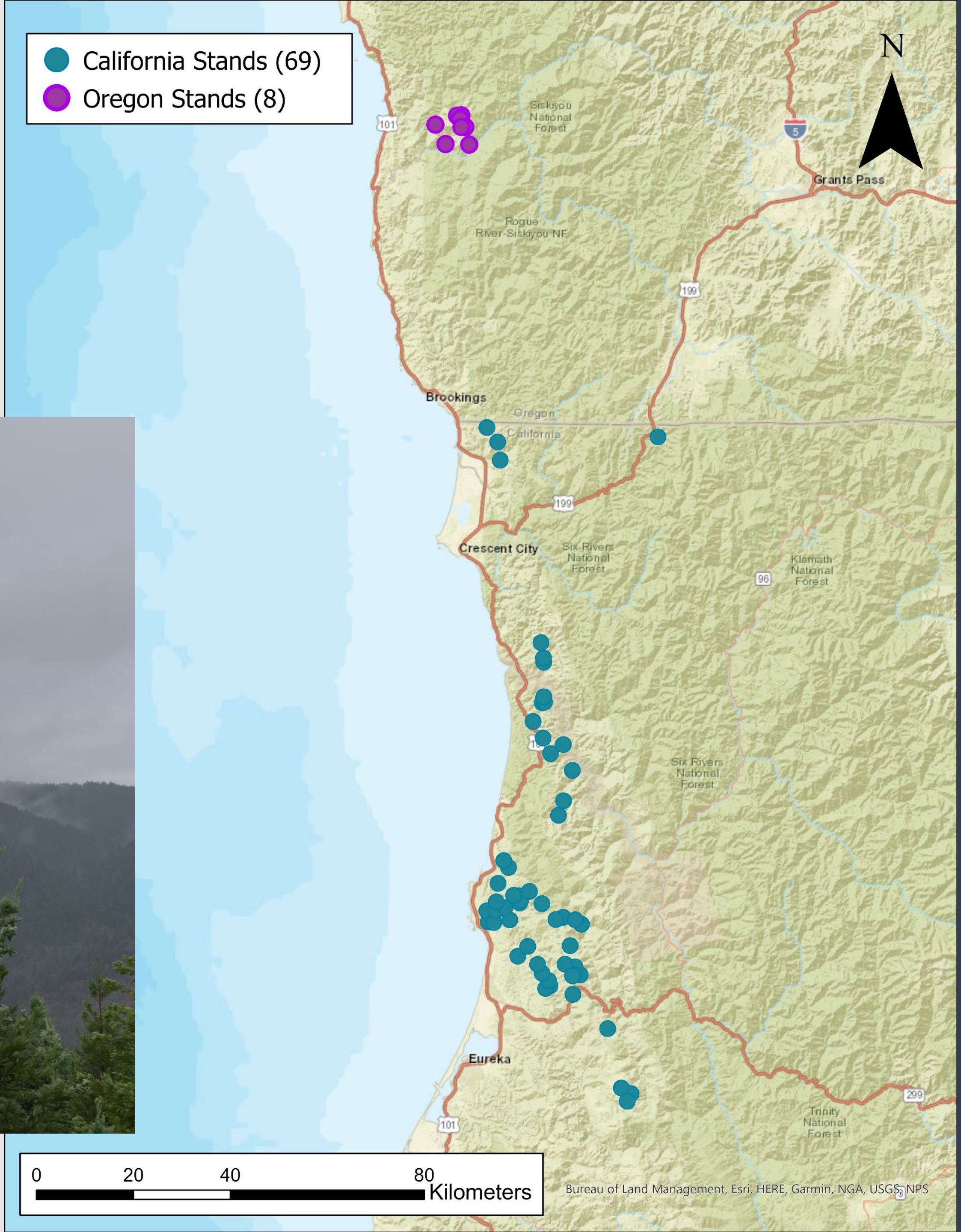
- Coastal Distinct Population Segment Federally Threatened (2020)
- State Endangered in California (2019)

Woody debris

Caylen Kelsey

Slash Piles

Study Area



California Stands (69)
Oregon Stands (8)
N
Siskiyou National Forest
Grants Pass
Rogue River-Siskiyou NF
Brookings
Oregon
California
Crescent City
Six Rivers National Forest
Klamath National Forest
Six Rivers National Forest
Eureka
Trinity National Forest
0
20
40
80
Kilometers
Bureau of Land Management, Esri, HERE, Garmin, NGA, USGS, NPS

Objective 1: Pile Visitation

Document pile visitation by martens and fishers

Quantify associations between pile visitation and stand/pile characteristics

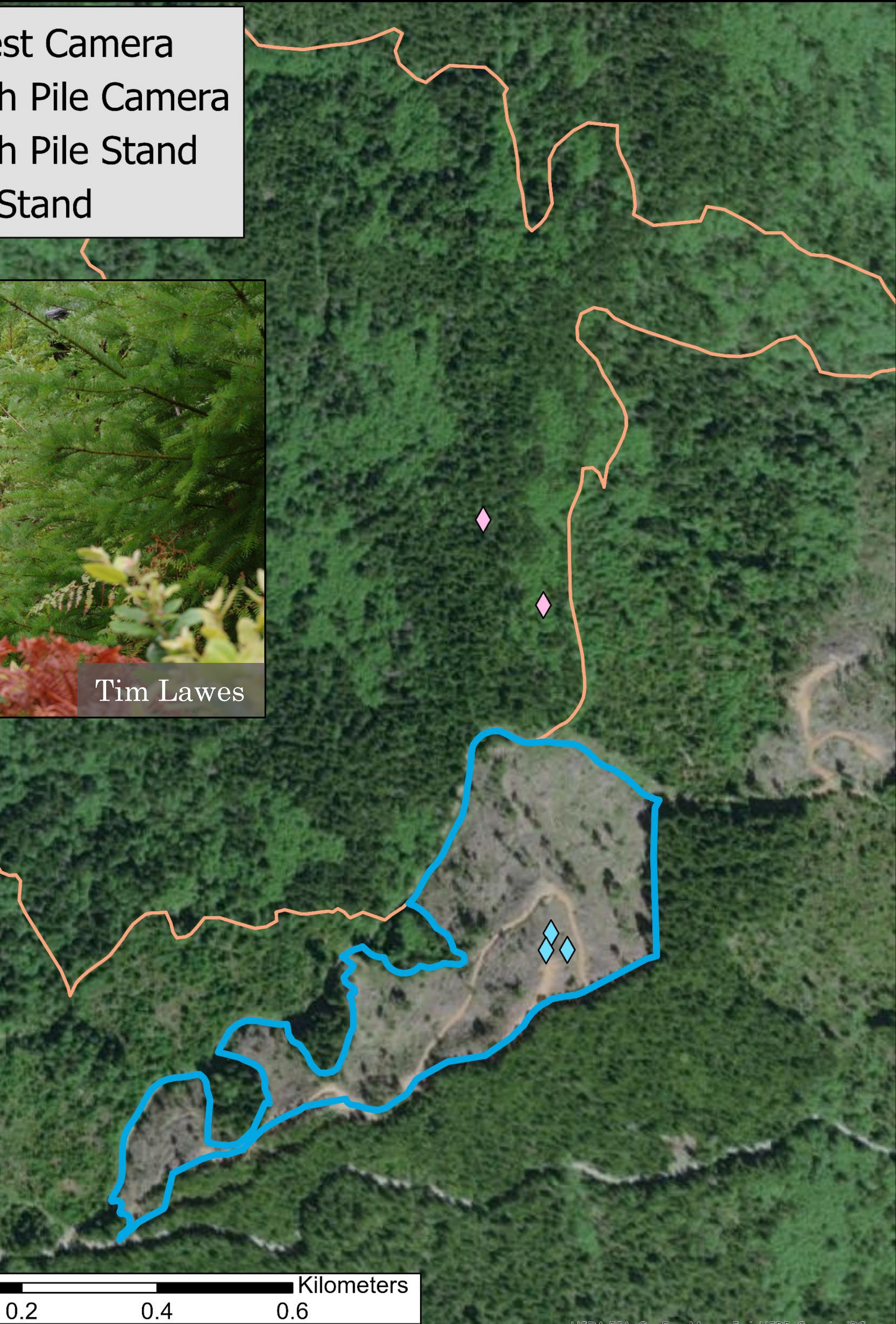
Objective 1: Pile Visits

Camera Surveys
(California only)

- 69 stand-pairs surveyed
- 354 cameras
- >1.6 million photos collected and tagged

Detection dog teams

- Used to survey stands in California (n = 45) and Oregon (n = 8)



Martens detected within **8** stand-pairs

Detected at **1** slash pile

Fishers detected within **59** stand-pairs

Detected at **36** slash piles

Final results anticipated December 2023

Stand and pile characteristics

	All (mean ± sd)	Non-Detections (mean ± sd)	Detections (mean ± sd)
Mean Shrub Cover (%)	55.77 ± 20.14	55.65 ± 20.16	62.80 ± 17.22
Pile Age (years)	3.96 ± 3.64	3.93 ± 3.63	5.73 ± 4.00
Approx Pile Volume (m^3)	367.33 ± 327.93	368.13 ± 328.18	318.38 ± 309.62
Distance to Forest Edge (m)	28.97 ± 17.42	28.89 ± 17.37	34.06 ± 19.34

Season

	Total survey days	Detections	Non-detections	Proportion (Detections/Total Days)
Summer May - Sept 20	2379	16	2363	0.007
Fall/Winter Sept 21 - March	3443	78	3365	0.02

Objective 2: Small mammal communities

Generate estimates of small mammal abundance, diversity, and energetic biomass at slash piles and in the surrounding landscape

18 stands, subset of N. California stands

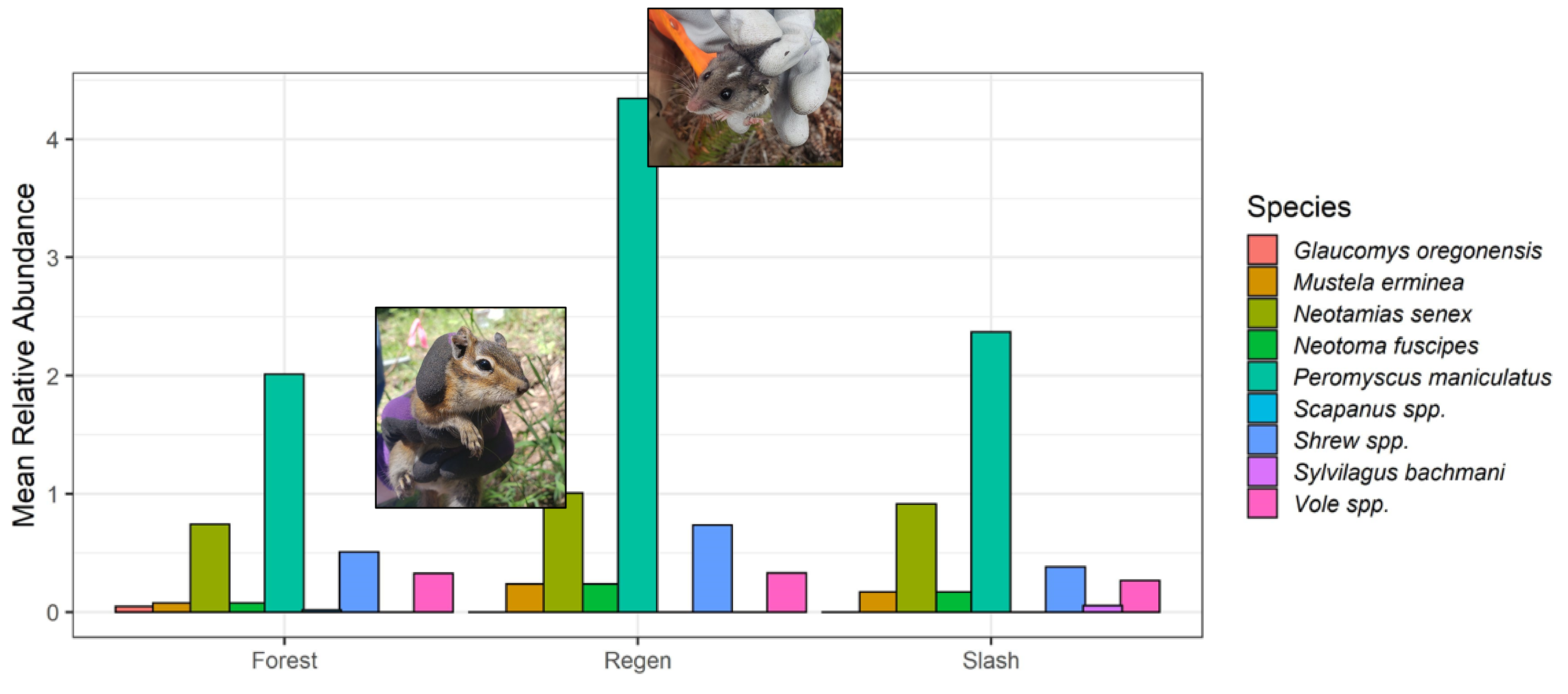
Final results anticipated early 2024

Objective 2: Small mammal trapping

Regen – no piles

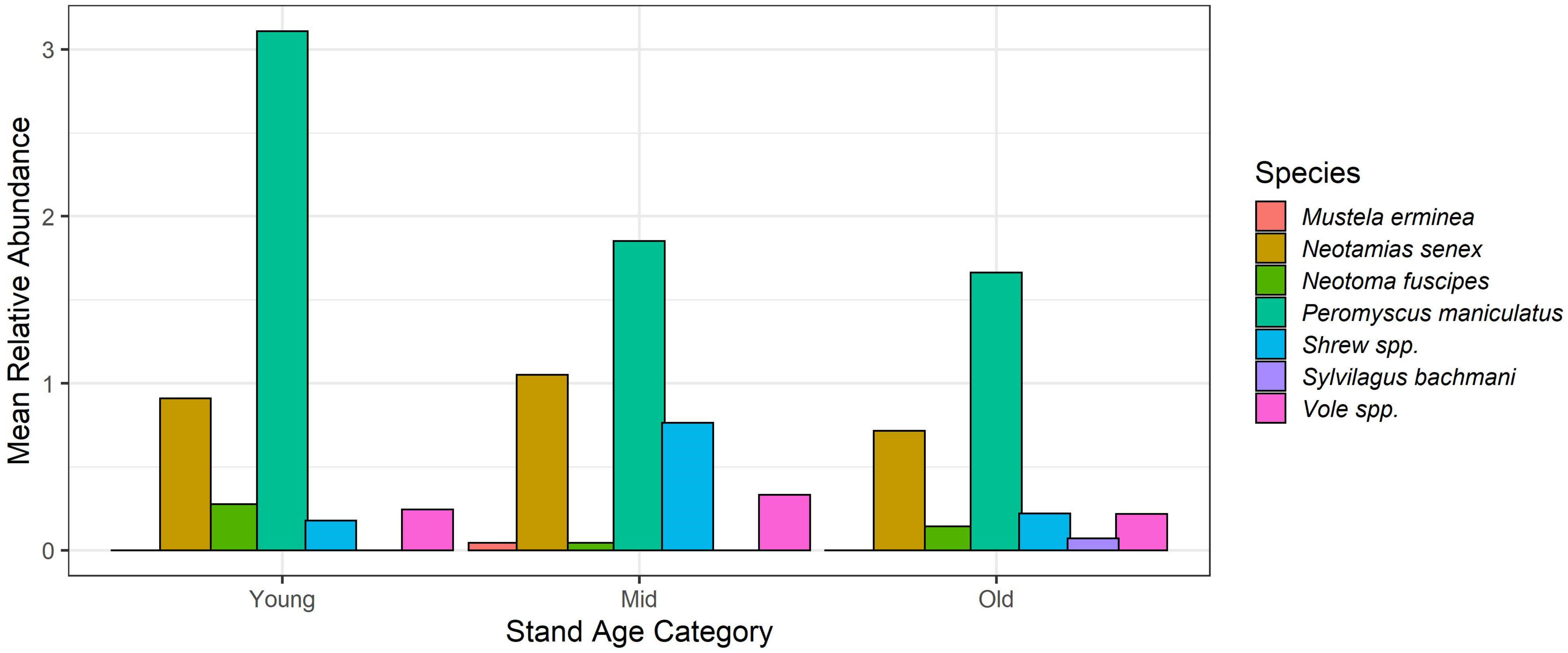
Adjacent forest

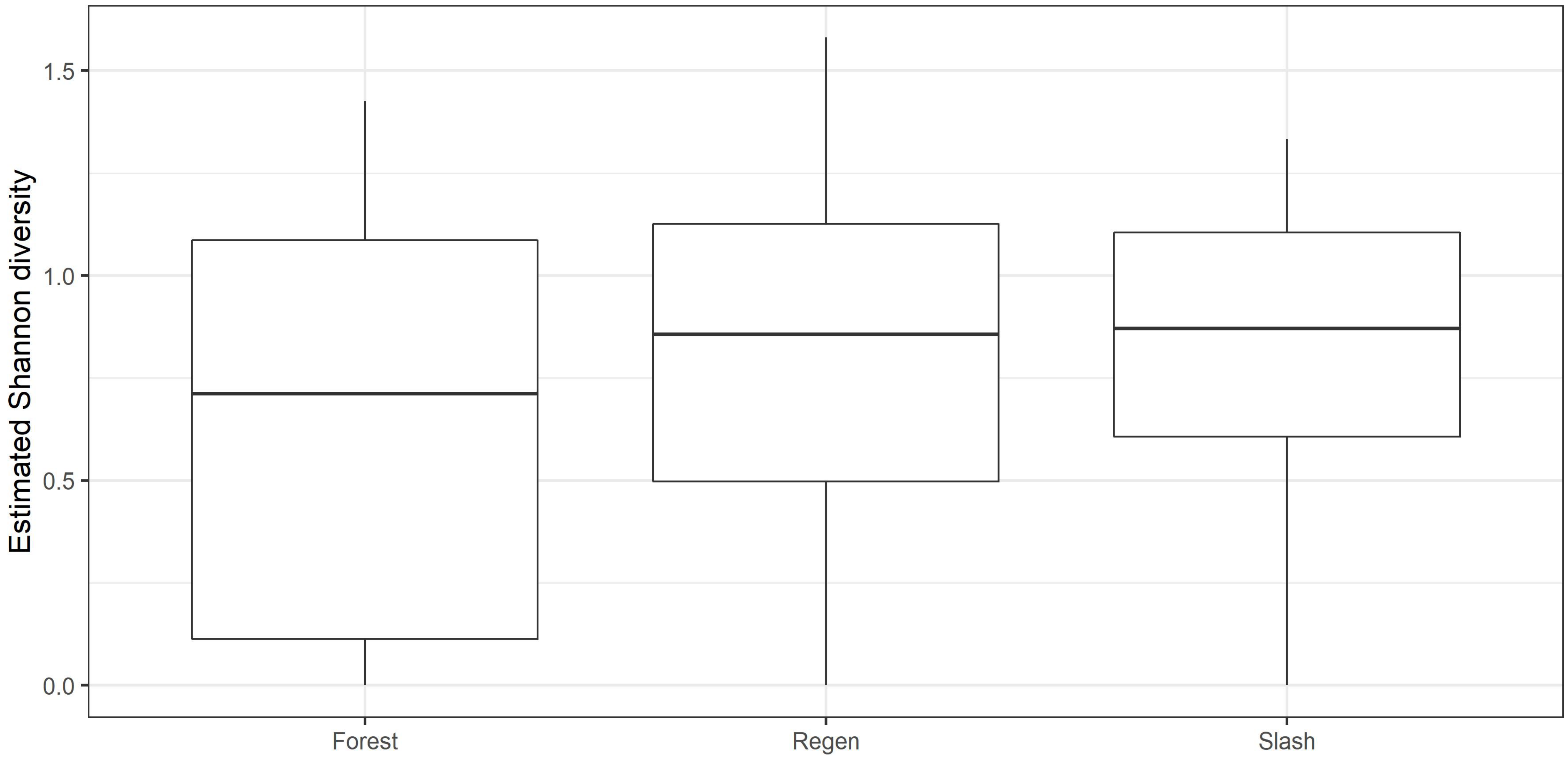
Slash pile

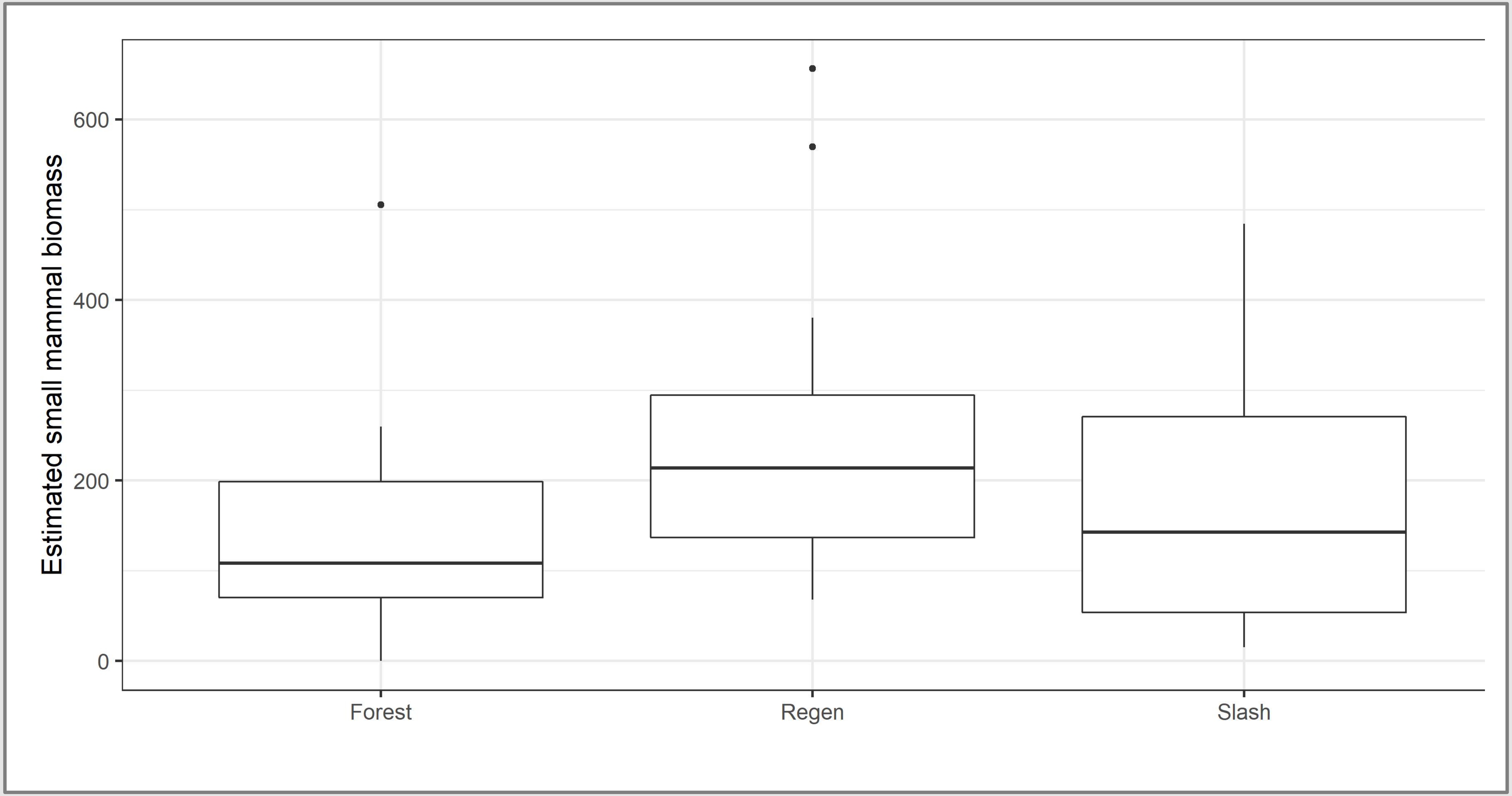


Mean Relative Abundance
0
1
2
3
4
Forest
Regen
Slash
Species
Glaucomys oregonensis
Mustela erminea
Neotamias senex
Neotoma fuscipes
Peromyscus maniculatus
Scapanus spp.
Shrew spp.
Sylvilagus bachmani
Vole spp.

*Slash piles only




Estimated Shannon diversity
1.5
1.0
0.5
0.0
Forest
Regen
Slash



Estimated small mammal biomass
600
400
200
0
Forest
Regen
Slash

Objective 3: Fire Behavior

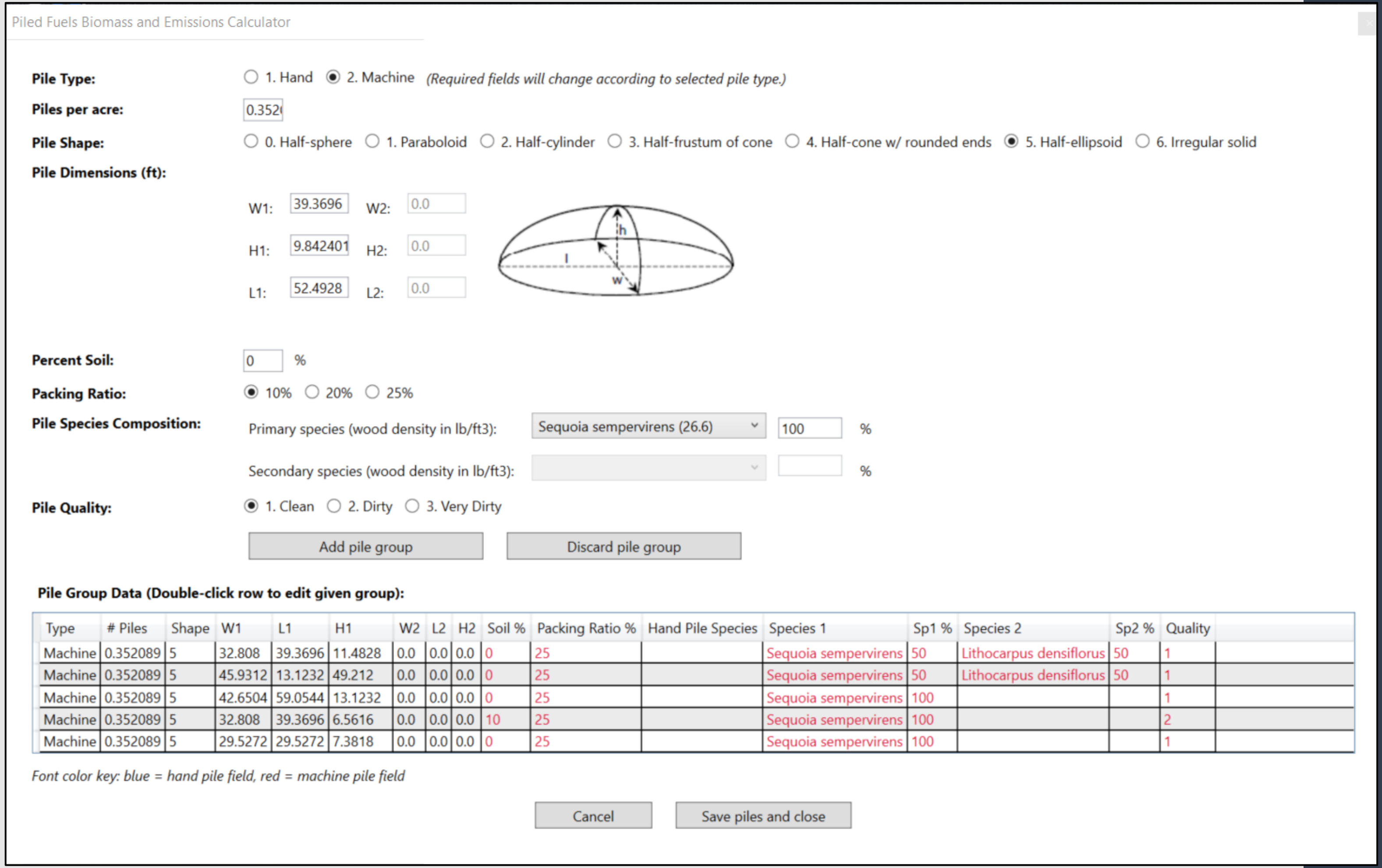
Model effects on surface fire behavior with occurrence of slash piles

19 stands between California (n = 10) and Oregon (n = 9)

- Ages 0-7 years
- 3-6 vegetation and woody debris plots
- Up to 10 piles sampled per stand

Fuel and Fire Tools

- “Pile Calculator” allows inclusion of slash piles in fuelbed

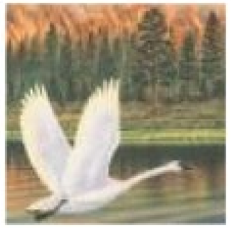


Fuel and Fire Tools

- “Pile Calculator” allows inclusion of slash piles in fuelbed

Behave

- Calculates spotting distance from a burning pile, based on flame height



Spotting Distance from a Burning Pile

Spotting distance from a burning pile is the *maximum* distance that one can expect potential spot fires resulting from firebrands from the burning pile. Flame height from a burning pile is an input used to calculate the lofting strength of embers from the burning pile.

I/O	Module	If	Notes
Input	None		
Output	SPOT		Can also be output as a map distance if *Display output distances in map units* is checked.

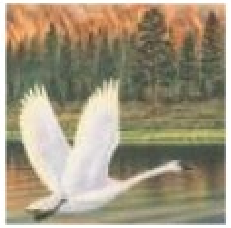
Fuel and Fire Tools

- “Pile Calculator” allows inclusion of slash piles in fuelbed

Behave

- Calculates spotting distance from a burning pile, based on flame height

Final results anticipated December 2023



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I/O	Module	If	Notes
Input	None		
Output	SPOT		Can also be output as a map distance if *Display output distances in map units* is checked.

Summary of accomplishments

78 stands surveyed between Oregon (n = 9) and California (n = 69)

- **>1.6** million remote camera images collected and photo-tagged
- **946** unique small mammal captures over **18** trapping replicates
- Measurements and composition estimates on **>275** slash piles

Presented at:

- 68th Annual Meeting of the Western Section of the Wildlife Society, 2021
- Western Forestry Graduate Research Symposium, 2021
- Annual Meeting of the Oregon Chapter of the Wildlife Society, 2022
- Annual Meeting of the Wildlife Society, 2022

Additional collaborations with Dr. Micaela Szykman-Gunther at Cal-Poly Humboldt

Next steps

Finalize fire behavior models at Model small mammal community metrics and energetic biomass at slash piles

Finalize GLMM describing associations between fisher detections at slash piles and stand and pile characteristics

Ellison MS Thesis, anticipated December 2023

Acknowledgements

Field crew: Shalom Fletcher, Dustin Marsh, James Mackenzie, Jordan McBain, Fiona McKibben, Jason Moriarty, Brandon Shea

Green Diamond field crew: Erika Anderson, Maddie Cameron, Drake Fehring, Theannah Hannon, Isley Jones, Jason Labrie, Jim Lucchesi, Ashley Morris, Kira Parker, John Roos

Additional support from Laurie Clark, Desiree Early, Keith Hamm, David Lamphear, Micaela Szykman Gunther, Alyssa Roddy, and Jake Verschuyl

Rogue Detection teams: Justin Broderick and Winnie, Will Chrisman and Hooper, Jenn Hartman and Filson

Photos from the field: Tim Lawes

Photo-taggers: Sandy Diaz, Alanna Garcia, Kelly Johnson, Sabrina Ott, Louis Salas, Anna Schwecke

Fish and Wildlife Habitat in Managed Forests Research Program

Questions?

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Oregon State University
College of Forestry

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GREEN DIAMOND
Resource Company

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

ROGUE DETECTION TEAMS

Rayonier