A TRAIL FOR THE MASSES

Trails to Educate, Celebrate, and Inspire

University of Oregon
Department of Landscape Architecture
Cameron Coronado

Master's Project

2024



PROJECT OVERVIEW

Project Background
Goals and Objectives
Site Context
Site Analysis
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Trail Design
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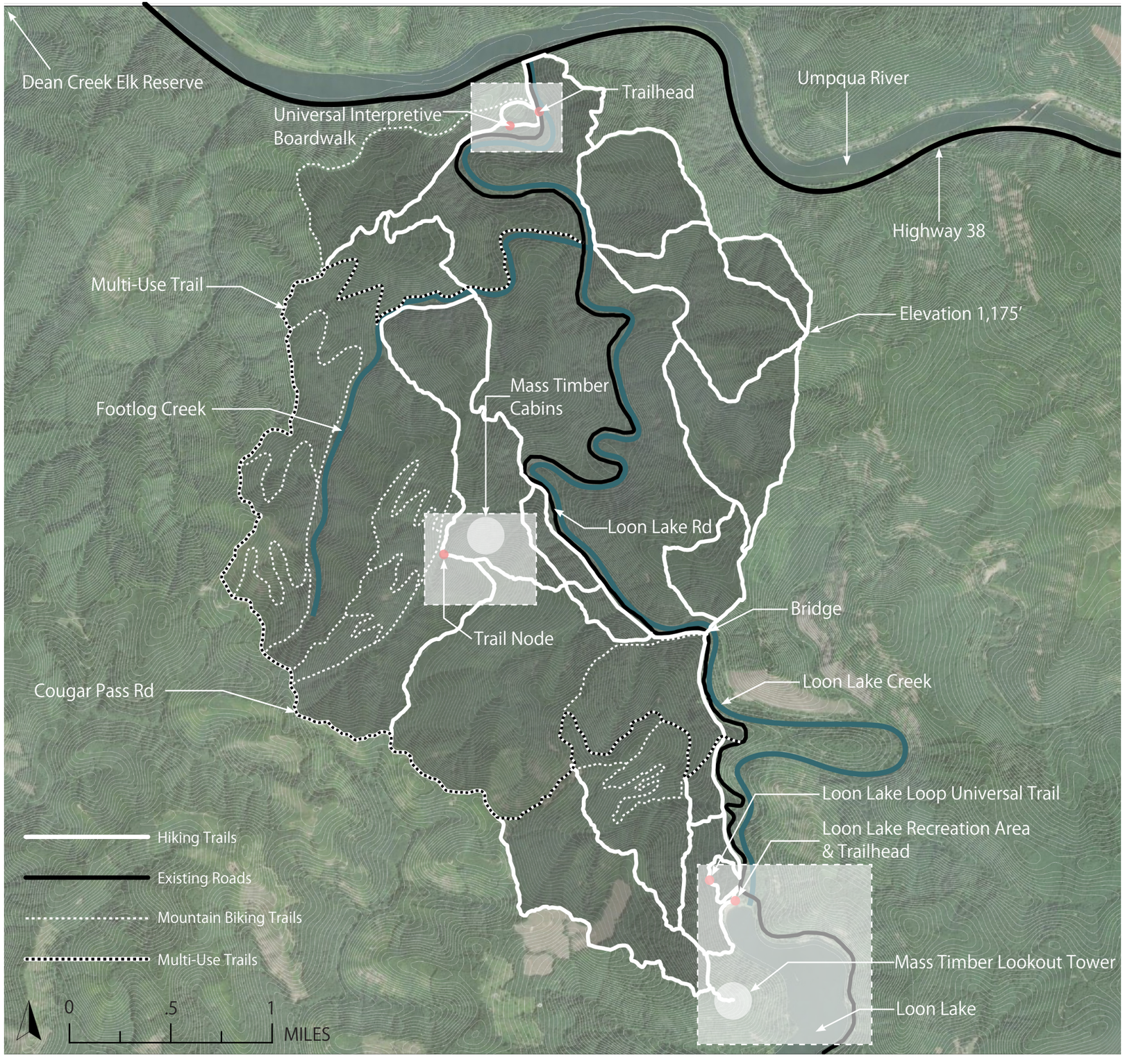
Takeaways & Future Research
Thank You



PROJECT BACKGROUND

A PATH TO A PROJECT

Exploring Interests

Dual Majors

Landscape Architecture
Community and Regional Planning

Graduate Research Assistant

School of Planning, Public Policy, and Management **(PPPM)**
Institute for Policy Research and Engagement **(IPRE)**
National Science Foundation **(NSF)**

As a dual major in landscape architecture and community and regional planning, I have been highly involved in both programs. Through the School of Planning, Public Policy, and Management (PPPM), in which my planning degree is housed, I became aware of the Institute for Policy Research and Engagement (IPRE). IPRE is an interdisciplinary institute that assists communities by providing planning and technical assistance to help solve local issues and improve the quality of life.

Through IPRE, I have been working as a graduate research assistant on a project funded by a $1 million grant from the National Science Foundation to advance the production and use of mass timber in the PNW.

A PATH TO A PROJECT

Mass Timber

Mass timber is an engineered wood product that combines multiple pieces of lumber into a robust composite material most often used in structural applications of buildings. Mass timber can be a viable alternative to steel and concrete in some building applications. Additionally, mass timber can convert low-value raw materials, such as small-diameter trees and less commonly used tree species, into durable construction materials.











Source: OPB



Cross-Laminated Timber (CLT)



Glulam



Dowel-Laminated Timber (DLT)



Nail-Laminated Timber (NLT)



Massiv-Holz-Mauer



Hollow Core Panels



Mass Plywood Panel

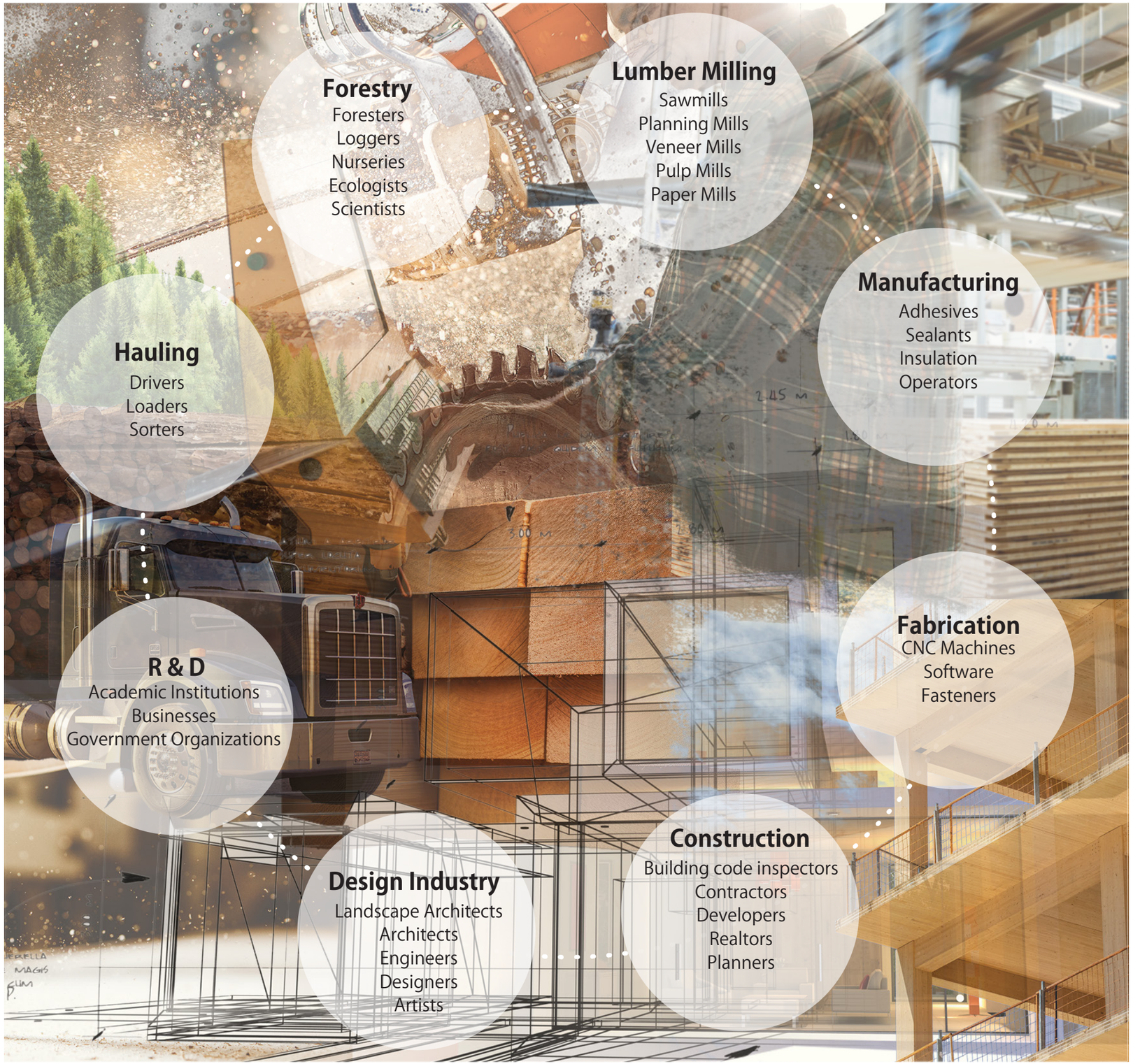
A PATH TO A PROJECT

Advancing Mass Timber in PNW

Our team, referred to as the NSF Mass Timber Engine, is an interdisciplinary multi-institutional team that spans across Oregon and Washington. We are focused on creating a strategic approach to a thriving economic ecosystem in the Pacific Northwest that will drive and coordinate research and education innovations in mass timber architecture, engineering, and construction, along with manufacturing and forest management, to address social and environmental challenges in housing, workforce development, and natural resource stewardship.

What this requires is an in-depth understanding of the entire mass timber ecosystem. When I refer to the mass timber ecosystem, it includes all of the players involved in creating and using mass timber products. The mass timber supply chain includes many components covering multiple sectors and large geographic areas. The mass timber supply chain starts with trees in the forest and flows all the way through occupants and maintenance workers of mass timber structures. A high-level view of sectors that make up the supply chain includes forestry management, logging, transportation and hauling, lumber milling, manufacturing, fabrication, and construction. Each component of the supply chain has its own set of sub-sectors and stakeholders. For example, the construction component of the supply chain includes contractors, developers, realtors, architects, engineers, designers, planners, and building code inspectors, amongst others. The process of creating a mass timber panel includes many related products and industries, such as adhesives, sealants, fasteners, acoustic isolation products, and software.

Mass timber has garnered significant attention from architects, engineers, developers, forest managers, and community leaders in recent years. As of September 2023, 59 mass timber projects are currently in the design phase in Washington and 43 in Oregon. Federal, state, and local agencies and organizations have begun funding projects to support research and innovation of mass timber in the PNW.



A PATH TO A PROJECT

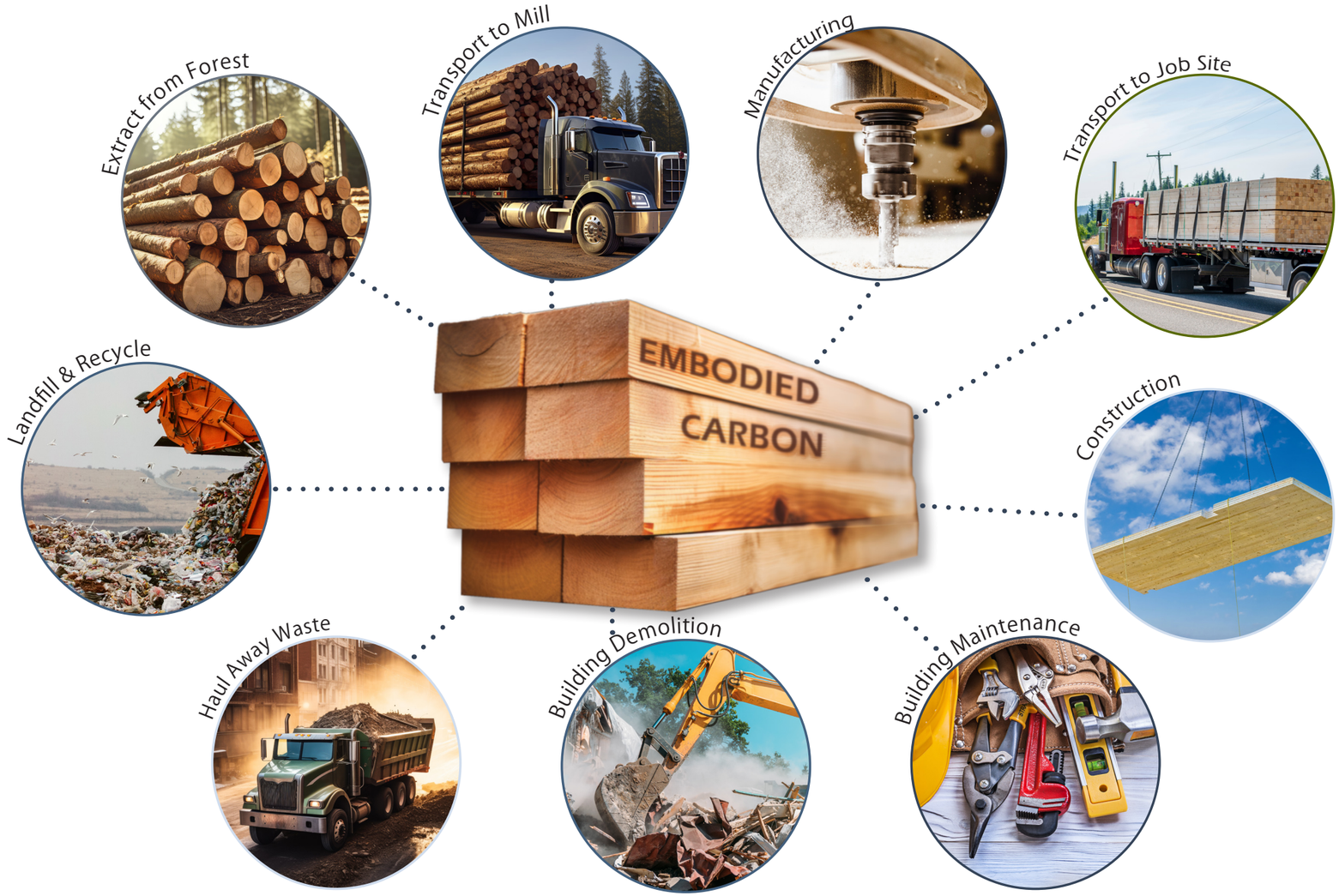
Mass Timber Benefits

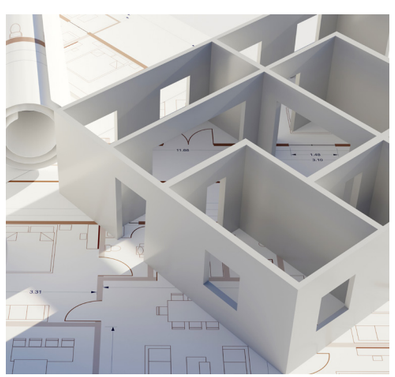
One of the most compelling attributes of mass timber lies in the sustainability of this product and its significantly low embodied carbon. Embodied carbon refers to the greenhouse gas (GHG) emissions generated during a particular product's extraction, transportation, manufacturing, construction, demolition, and disposal phases. Our built environment and the construction industry contribute more than any other single sector to global greenhouse gas emissions at a whopping (39%). Substituting steel and concrete with a renewable resource like mass timber can potentially curtail the US's carbon footprint. Studies have shown that mass timber buildings exhibited a reduction in embodied carbon, varying between 22% and 50%, compared to concrete buildings.

The benefits of mass timber are also noticed on the job site. The factory automation of mass timber products can lead to increased construction speeds and overall construction cost reductions.

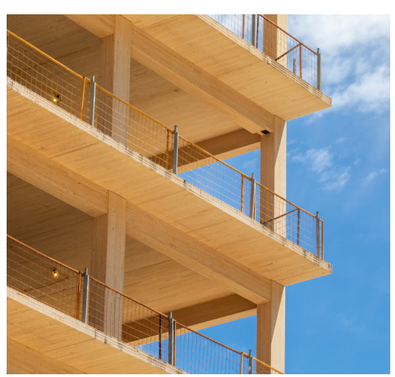
This modularity and speed of production have also led to arguments about mass timbers' ability to revolutionize our ability to produce affordable housing for the masses in less time. Buildings constructed with mass timber have demonstrated increased thermal comfort, improved air quality, and exceptional acoustic properties. Other basophilic benefits include stress reduction, increased visual comfort, and improved occupant health.

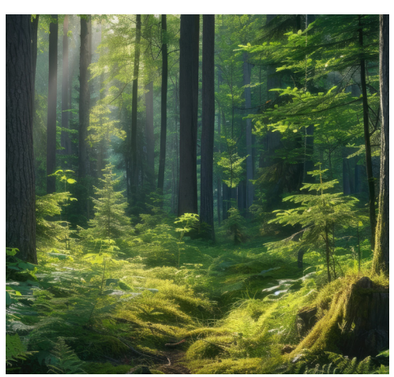
Lastly, mass timber also has the ability to bolster forest health. As an environmental science major and a lover of trees and forests, I was immediately drawn to mass timbers connection to forest health.











A PATH TO A PROJECT

Mass Timber and Forest Management

Mass timber can utilize smaller-diameter logs, offering an environmentally sound solution and presenting a novel market opportunity for previously unusable wood.

As climate change leads to more intense and frequent wildfires, managing our forests and reducing fuel loads are become increasingly important. Unfortunately, high costs associated with restoration activities have resulted in a large backlog of forests needing management. An estimated 9.5 million acres of forests in Washington and Oregon are in need of immediate thinning or burning.

Thinning forests for mass timber production could, in turn, improve forest health and reduce wildfire risk and intensity while generating revenues for mass timber producers. Mass timber could significantly incentive the escalation of restoration projects and lead to healthier and more climate-resilient forests.

By examining the mass timber ecosystem and learning about mass timber's connection to forest management, I began to see where I wanted to focus my attention for this project.



Managed Forest







Fire Suppressed Forest







A PATH TO A PROJECT

Finding My Place

I wanted to focus on the land that makes the entire mass timber ecosystem possible. When forests are simply seen as extraction points, we are disconnecting ourselves from the land. This ego-centric way of thinking places humans above nature and considers it something to be controlled and dominated. This way of thinking has led to many detrimental land use practices, including poor harvesting techniques that degrade our environment and hurt our species.



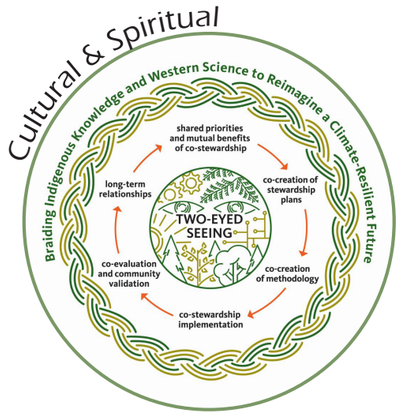
A PATH TO A PROJECT

Finding My Place

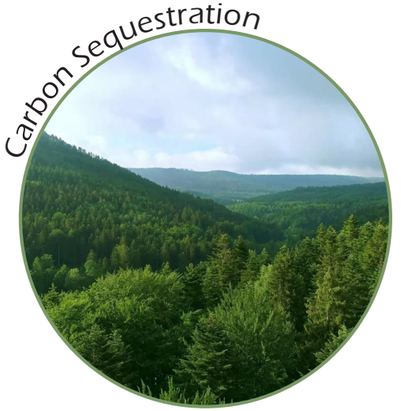
In my research, I quickly understood that forests are much more than extraction points. Forests carry cultural and spiritual meaning to Indigenous nations who have relied on and stewarded these lands for over 40,000 years. First Nations Peoples were so connected to these landscapes that forests actually evolved with their people and rely on disturbance regimes like fire to maintain a healthy forest structure.

I argue that we need to learn from Traditional Ecological Knowledge and view our forests more holistically. Healthy forests are homes to countless species and support biodiversity. They clean our water, purify our air, sequester carbon from the atmosphere, and provide jobs and regional economic prosperity.

Through my research, I began to learn about the complexity of forests and quickly realized that there are a lot of emotional responses and varying perceptions around what happens in our beautiful PNW forests. Forest fires and logging operations conjure up negative feelings for many people. These types of wicked problems are the ones landscape architects are drawn toward and motivated me to learn more.



















GOALS

&

OBJECTIVES

A PATH TO A PROJECT

Prosperity

At this point in my research, I saw many trails of thought come together. Just as a good view on a hike comes into focus as you crest the last hill, the goals and objectives of my project came into focus.

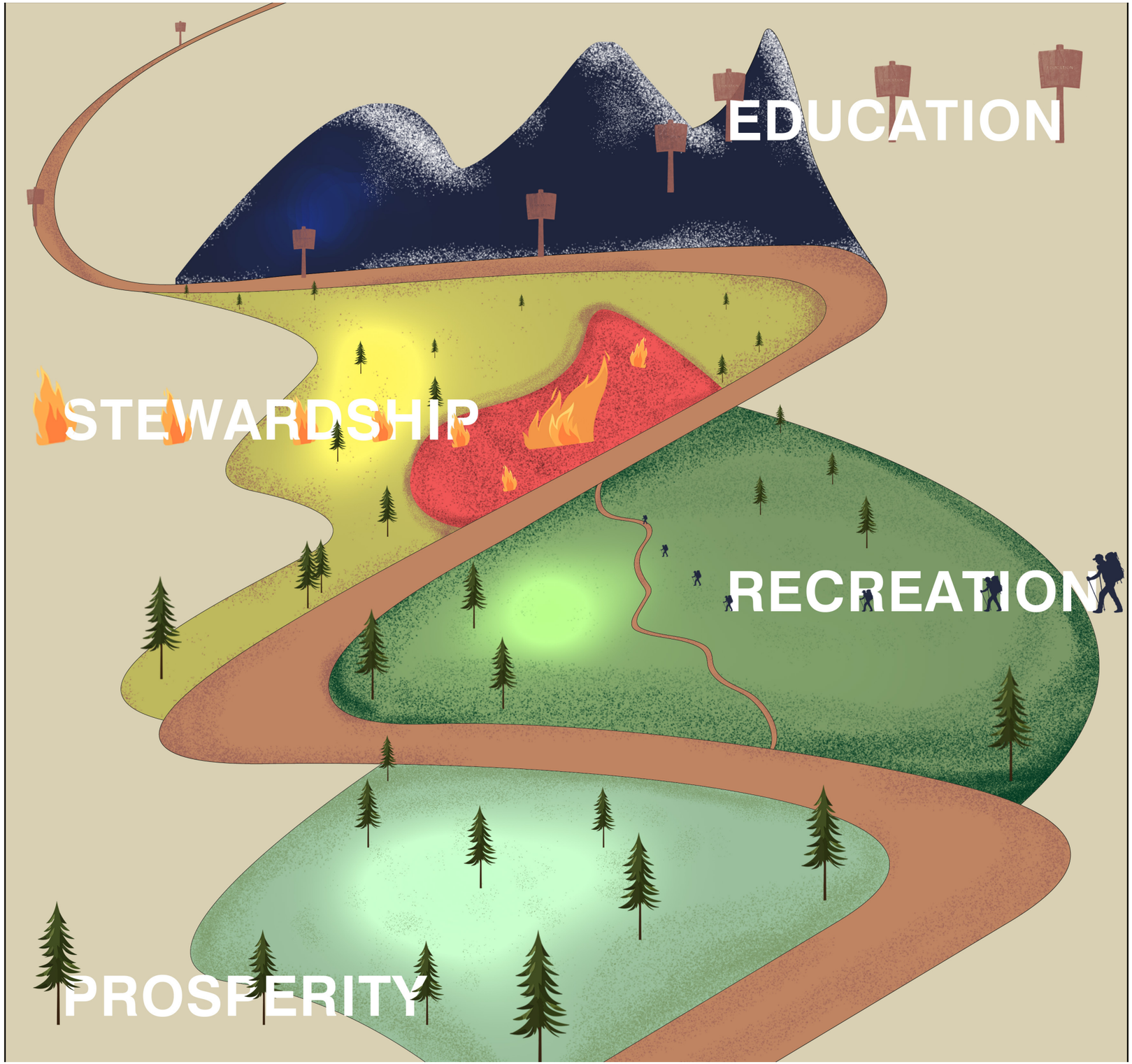
This project seeks to educate. Interpretive signage will inform visitors on forests' complex role in providing habitat, sequestering carbon, providing jobs, supplying building materials, and generating tax revenue that helps pay for our schools and public infrastructure. These trails will help us understand mass timber's connection to forest management and showcase its utility and creative design opportunities through demonstration projects.

This trail system will enable us to learn from the land and educate visitors on beneficial stewardship practices like fire and thinning.

These trails will, of course, provide ample opportunities for people to get out into nature and connect with the land through hiking, mountain biking, snowshoeing, and bird-watching.

Lastly, these trails will showcase how landscape architects can use their skills to create connections across disciplines, change perceptions, and help create a prosperous future that benefits our forest, people, and natural areas.

In addition to these goals, I approached this project as an opportunity to further develop my ability to use GIS. As a future planner and designer who wants to work on large scale projects, these skills are important to me.



LANDSCAPE ARCHITECTURE

Wearing Multiple Hats

This project will demonstrate that landscape architects must wear multiple hats to be good designers. I want to be very clear: although this project is focused on forest management, I am not a forester and do not claim to be making any ground-breaking discoveries of forestry management techniques or practices in this project. Forestry is a complex science on which I do not claim to be an expert.

Humility is a necessary trait for landscape architects. From this program, I have learned that we must know a little bit about everything. We don't need to be subject experts in every field to create beautiful, functional, and resilient landscapes. However, we must know enough to make informed design decisions that can be validated by real experts like my friends Brett and Woody up at OSU. Throughout this presentation, I will be swapping out hats that will help inform and guide my design decisions.



















SITE

CONTEXT

ELLIOT STATE FOREST

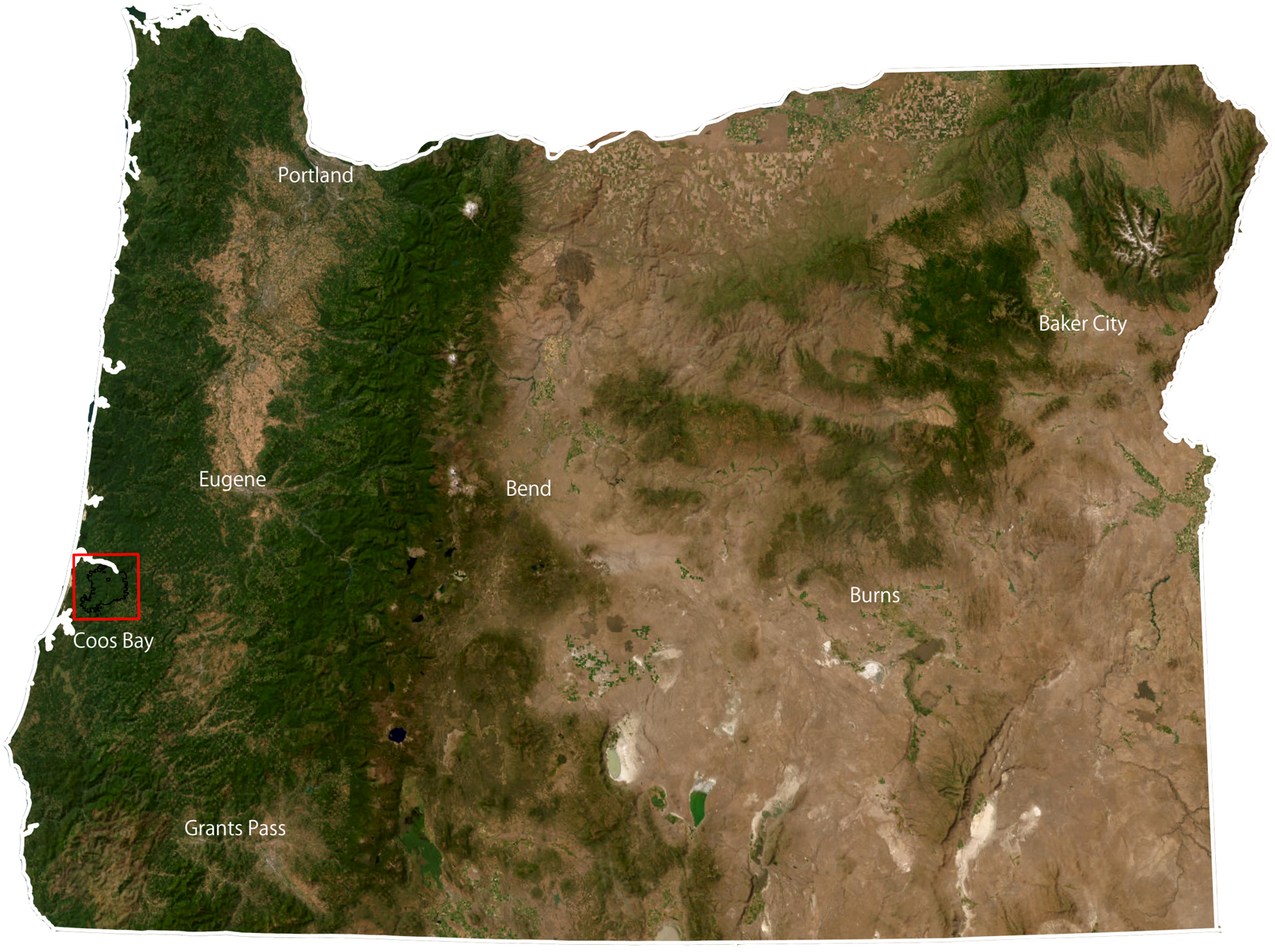
Data Rich

Some of the criteria I set for myself in choosing a site included:

- Proximity to Eugene for site visits
- Complex topography
- Diverse forest stands
- Availability of stand-level data

Utilizing my connections through the NSF Mass Timber Engine, I contacted our partners at OSU Department of Forestry and was introduced to the Elliot State Forest. In addition to meeting the criteria I just mentioned, OSU has been intimately involved with the Elliot for many years and had rich data to share with me.

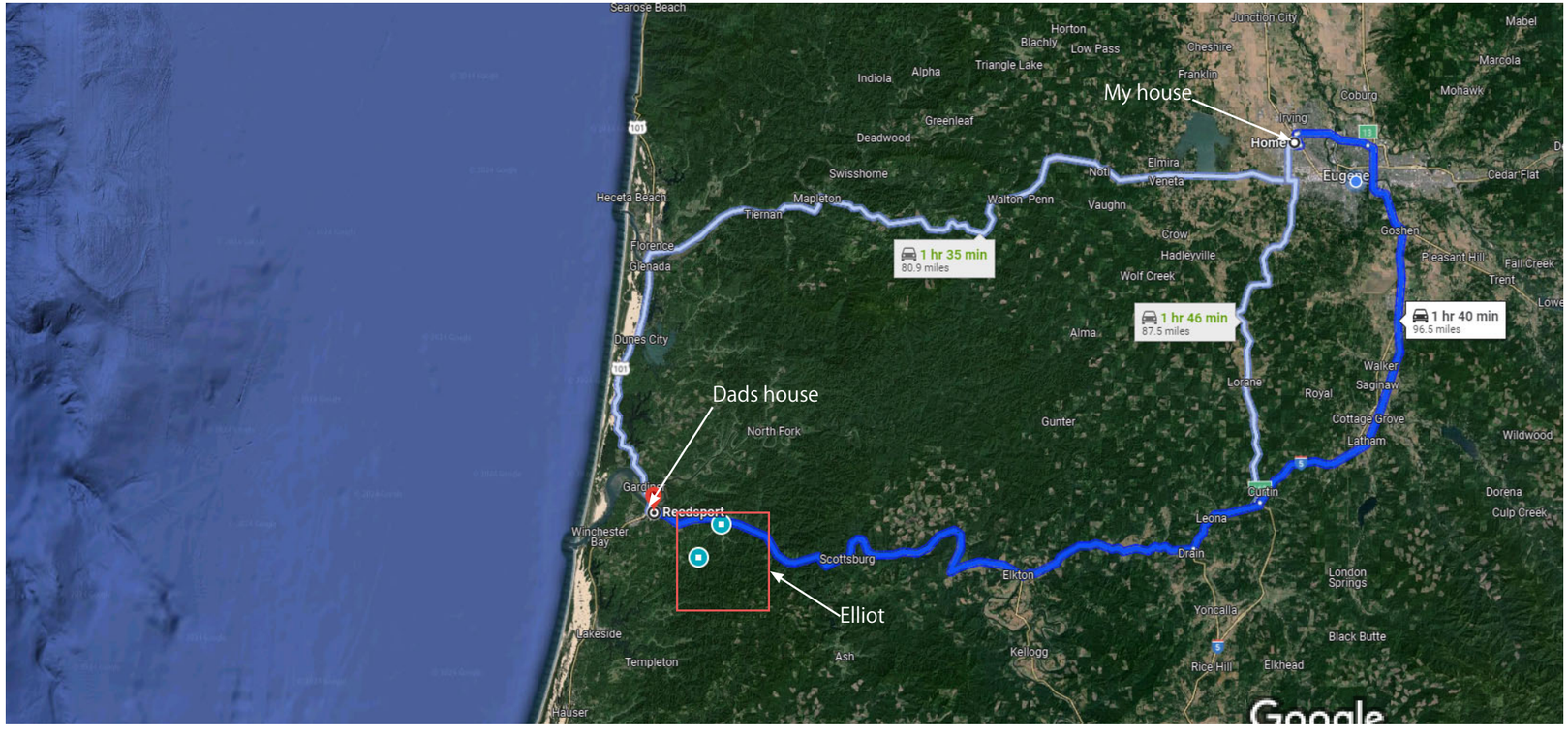
Oregon State University



ELLIOT STATE FOREST

Over the Mountains & Through the Woods

The Elliot lies between my house and my fathers house in Reedsport. This allowed me to visit the site multiple times throughout the last year and get a feel for the site.







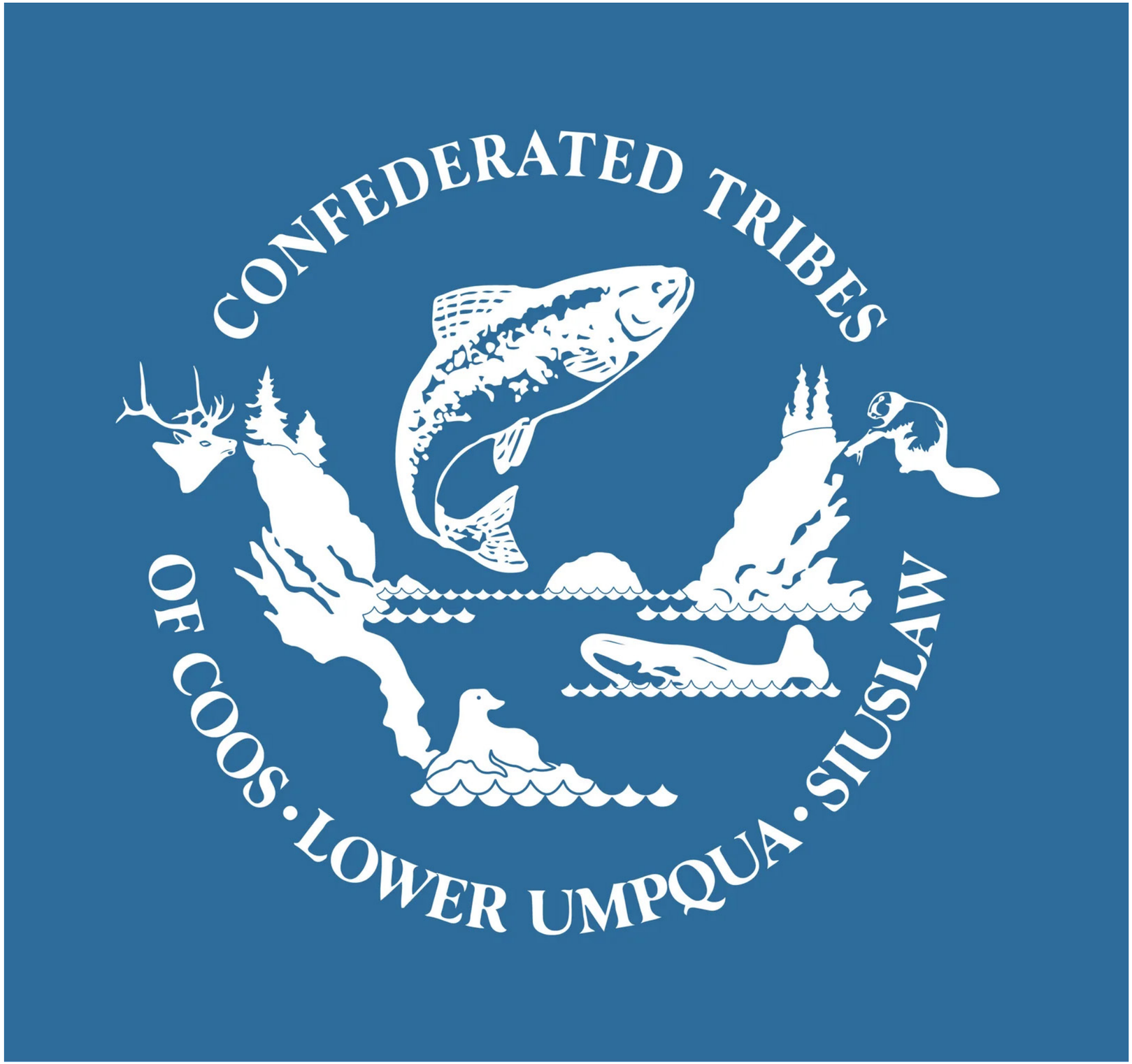





ELLIOT STATE FOREST

Traditional Homelands

The forested landscape we now refer to as the Elliot lies in the traditional lands of the Hanis and Quuiich (Lower Umpqua) Peoples, descendants of whom today are enrolled in the Confederated Tribes of the Coos, Lower Umpqua, and Siuslaw Indians, Confederated Tribes of Siltez, and the Coquille Tribe. This land remains, as it has been since time immemorial, a place where their youth first learn to steward, hunt, and gather, and it is here where their Elders go to rest. This place has shaped their languages, defined their culture, and nurtured their spirits.



ELLIOT STATE FOREST

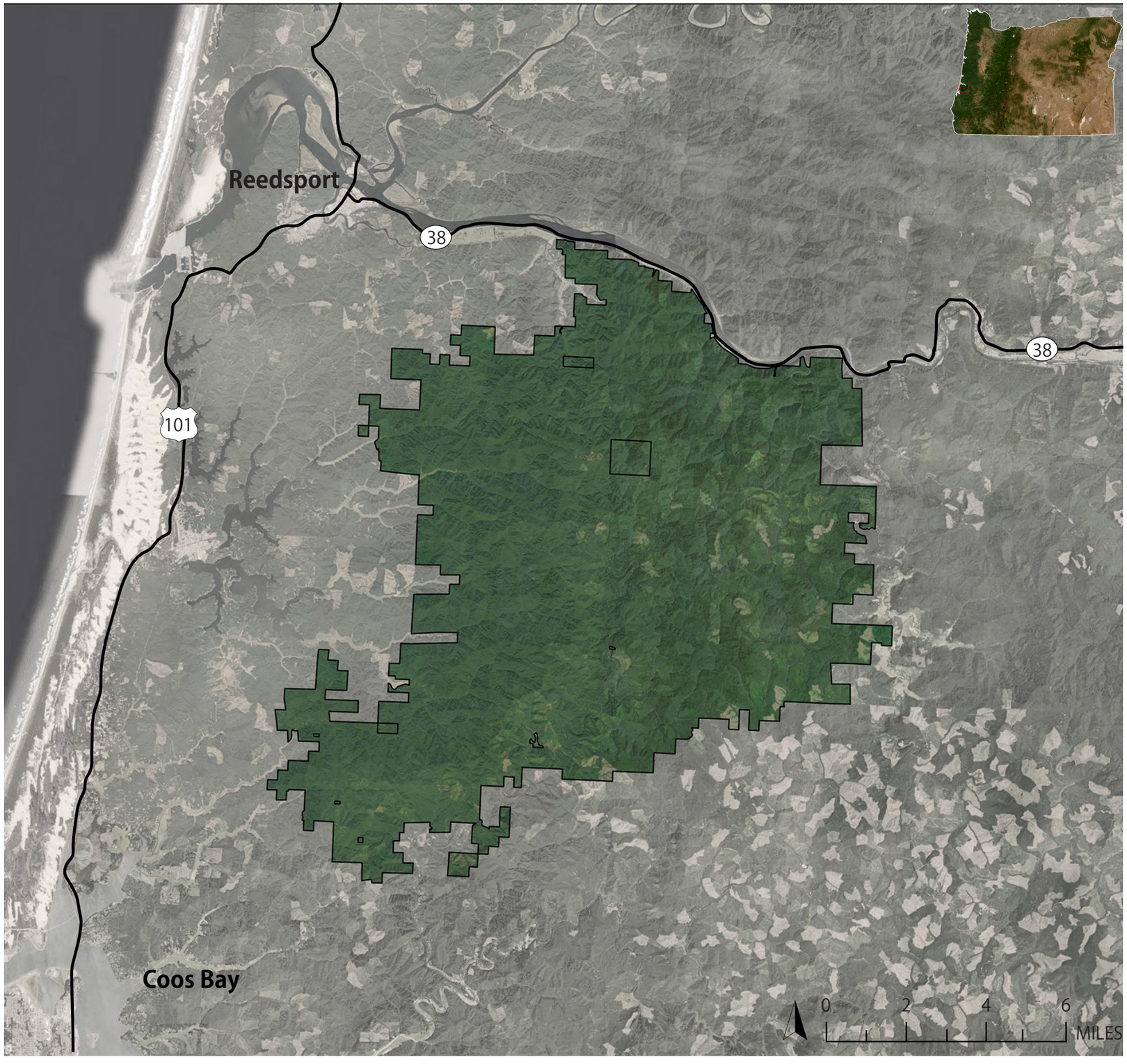
Context

Characteristics

- 83,000 Acres
- Moderate climate
- Annual precipitation is 70-90 inches
- Fog is common
- Level IV Mid-Coastal Sedimentary Eco-region
- Dominated by Douglas-fir
- 3 main watersheds
- Publicly Owned
- Shallow soils on slopes, deeper soils in hollows, terraces, and valley bottoms
- Historically logged- Provided funding for Oregon's Common School Fund
- Today the forest is overseen by the State Land Board and managed by the Department of State Lands (DSL)

History

Time Immemorial: The Coos and Lower Umpqua People are the original stewards of the lands
1859: Oregon statehood. 3.4 million acres of land for the use of schools
1927: Bill authorizes the exchange of Common School Fund lands
1930: Elliot established as Oregon's first state forest
2012: Lawsuit over endangered species affects harvest levels and significantly reduces revenue
2017: Potential sale to private timber company. Backlash from public blocked the sale and Elliot remained publicly owned
2018: DSL and OSU begin to explore the Elliot State Research Forest concept
2020: Approximately 50% of Elliot had been clear cut and replanted
2022: State Land Board decoupled the Elliot from the Common School Fund
2023: OSU drops out of plans to manage Elliot State Research Forest



SITE ANALYSIS

ELLIOT STATE FOREST

Regional Analysis

Using GIS, site analysis began at a regional scale by looking at wildlife species that live in and around the Elliot. Understanding the species that inhabit this area and their habitat needs, can help guide land decisions.

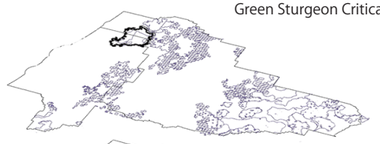
Three species that are common to the Elliot are listed as threatened or endangered under the Federal Endangered Species Act, including the Northern Spotted Owl, the Marlbed Murrelet, and the Coho Salmon.



Coho Salmon Critical Habitat



Green Sturgeon Critical Habitat



Northern Spotted Owl Critical Habitat



Marbled Murrelet Critical Habitat



Endangered Species Critical Habitat

Coos & Douglas County



Garter Snake
Thamnophis ordinoides



Song Sparrow
Melospiza melodia



Northern Spotted Owl
Strix occidentalis caurina



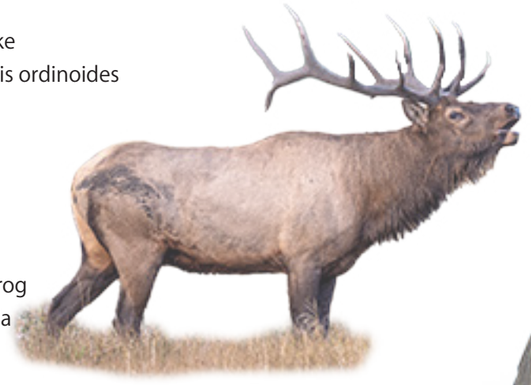
Bald Eagle
Haliaeetus leucocephalus



Black-tailed Bumble Bee
Bombus melanopygus



N. Pacific Tree Frog
Psuedacris regilla



Elk
Cervus canadensis



Great Blue Heron
Ardea herodias



Marbled Murrelet
Brachyramphus marmoratus



Anise Swallowtail
Papilio zelicaon



Lorquin's Admiral
Limenitis lorquini



Green Sturgeon
Acipenser medirostris



Coho Salmon
Oncorhynchus kisutch

Forest

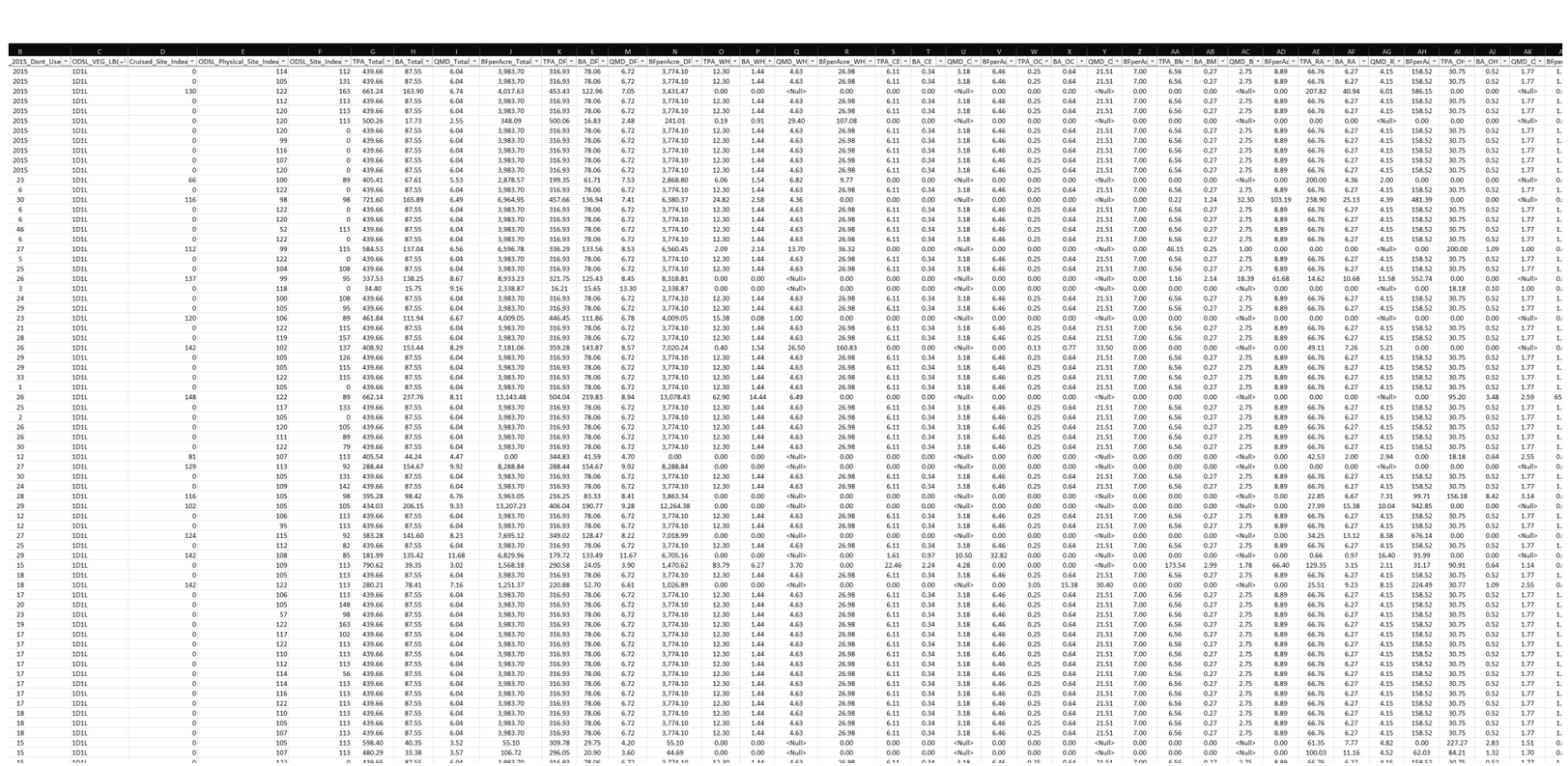
Meadow

Aquatic

ELLIOT STATE FOREST

High Quality Data

At this point in the project, the time had come to start digging into the data from my friends at OSU. I want to examine individual tree data to understand the forest better. I wanted this trail to take visitors through a variety of forest stands so they can experience what forest stewardship looks and feels like at different stages and under different stewardship goals. It was a bit overwhelming opening up the spreadsheets and looking at the data for the first time. However, over the course of a couple of months, using GIS and my masters project advisor Ignacio's help, I was able to make sense of the data in a way that suited the needs of this project.



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Oregon State University
College of Forestry

ELLIOT STATE FOREST

OSU Vegetation Labels

Using GIS, I can turn the spreadsheets you saw on the previous slide into maps like the one you see here.

This particular map visualizes a classification system OSU has created to explain species, size, and density of trees in particular forest stands.

A forest stand is defined as a contiguous group of trees relatively uniform in age-class distribution, composition and structure, and growing on a site of sufficiently uniform quality, that is a distinguishable unit from adjoining areas or stands (Helms 1989).

- 1D1L
- 1D2H
- 1D2L
- 1D3H
- 1D3L
- 1D4H
- 1D4L
- 1D5H
- 1H1L
- 1H2H
- 1H2L
- 1H3H
- 1H3L
- 1H4H
- 1W1L
- 1W4H
- DX1L
- DX2H
- DX2L
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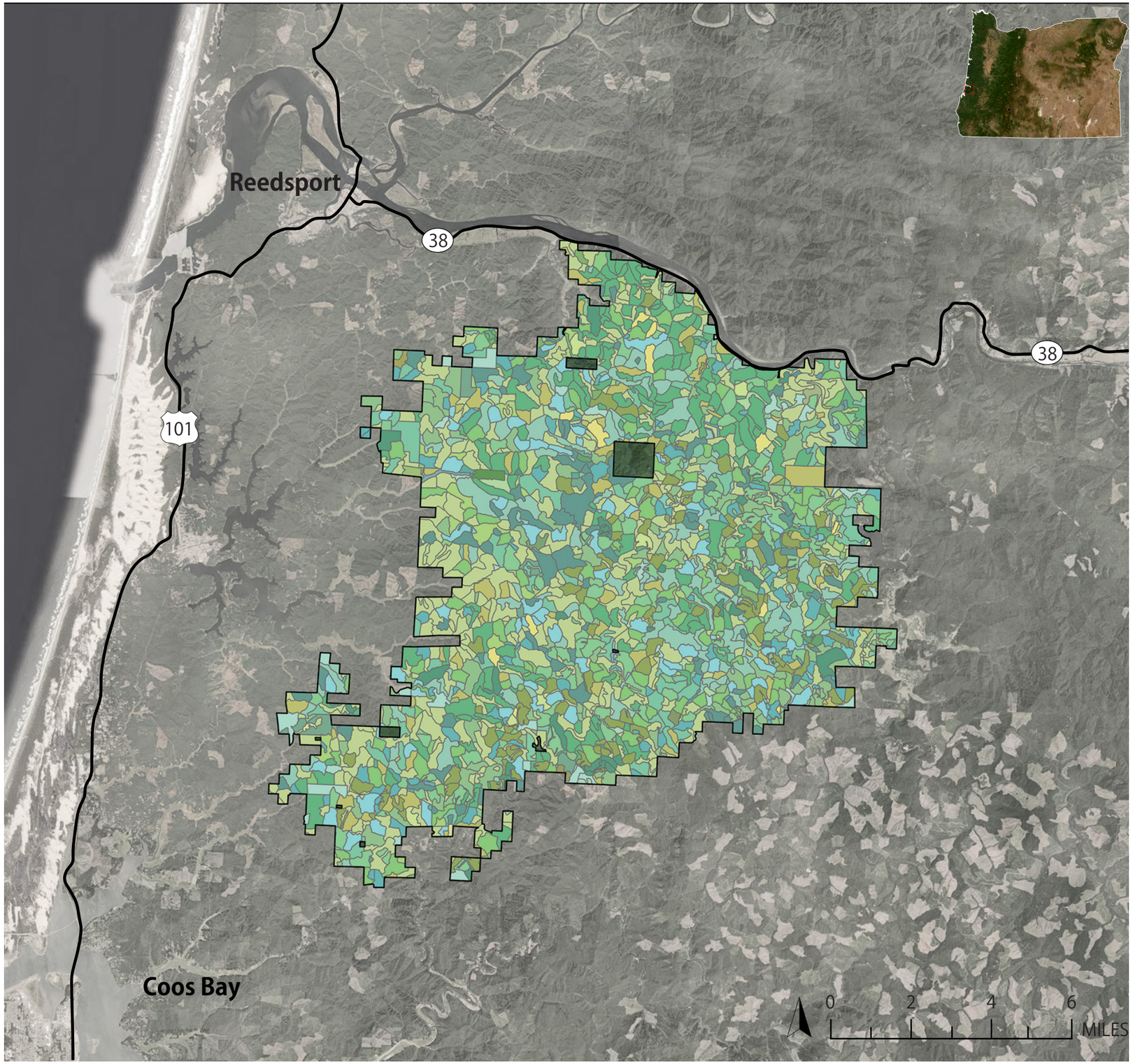


ELLIOT STATE FOREST

Forest Stands

Forest stands can be noticeable even to the untrained eye, like my sweet dog Jenny. As she looks out onto the Elliot, it's pretty clear that there are differences in composition and structure.



ELLIOT STATE FOREST

Forest Stands

Using our new terminology, we can look at this landscape and identify three separate forest stands.



ELLIOT STATE FOREST

OSU Vegetation Labels

Tree Species

Douglas-fir only- 1D
Hemlock only- 1W
Hardwood- 1H
Douglas-fir majority mixtures- DX
Hemlock majority mixtures- WX
Hardwood majority mixtures- HX
Other species- OT

Tree Size

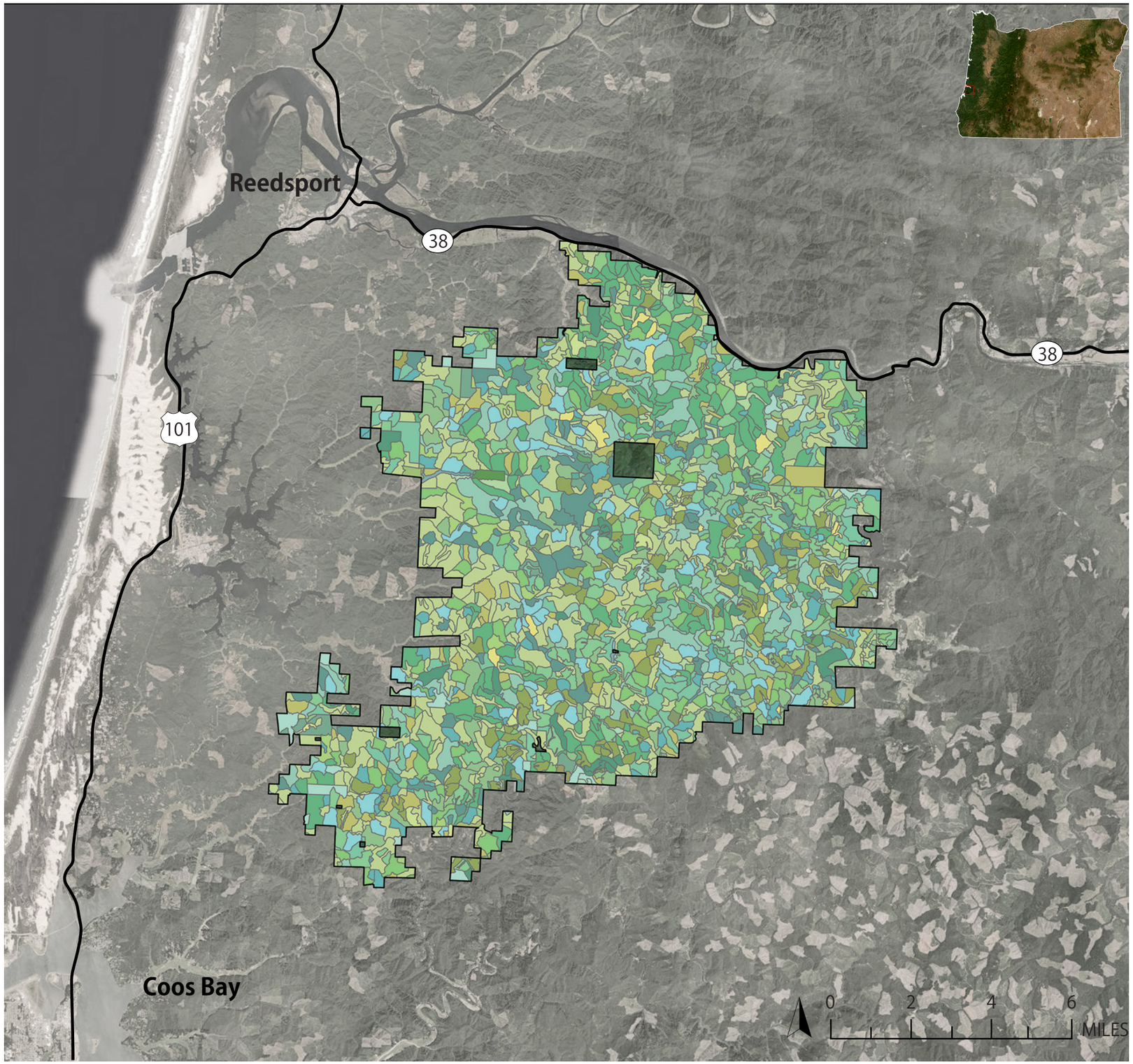
Early and Mid-Seral- 1
Small- 2
Medium- 3
Large- 4
OFS Candidate(+) - 5

Stand Density

Low density and or patchy stocking- L
Higher density and or homogeneous stocking- H

Other Labels

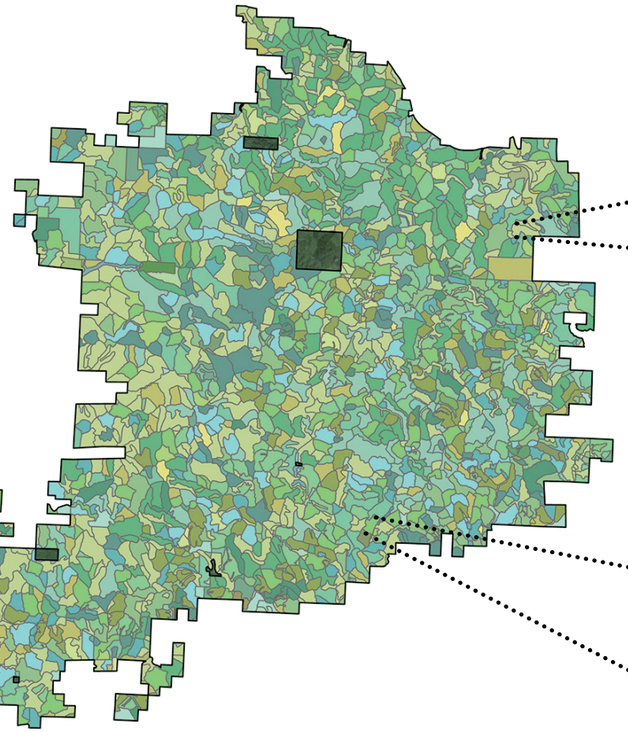
XA - Administrative Sites (Lookouts, Rock Pits)
XC - Regeneration Harvest / Open, Ready for Planting
XB - Brush
XG - Grass / Meadow
XS - Soil, exposed / Rock / Desert
XH - Open water / Lakes / Rivers / Bays
XW - Wetlands / swamps
XR - Right of Way / Powerlines / Railroads / Roads
XX - Unspecified

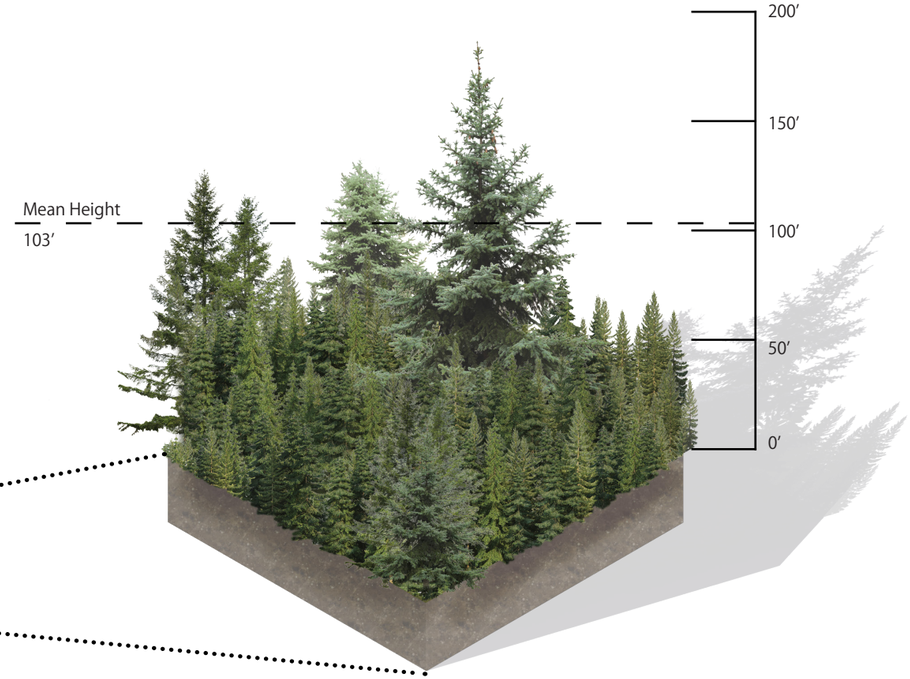


ELLIOT STATE FOREST

OSU Forest Stand ID

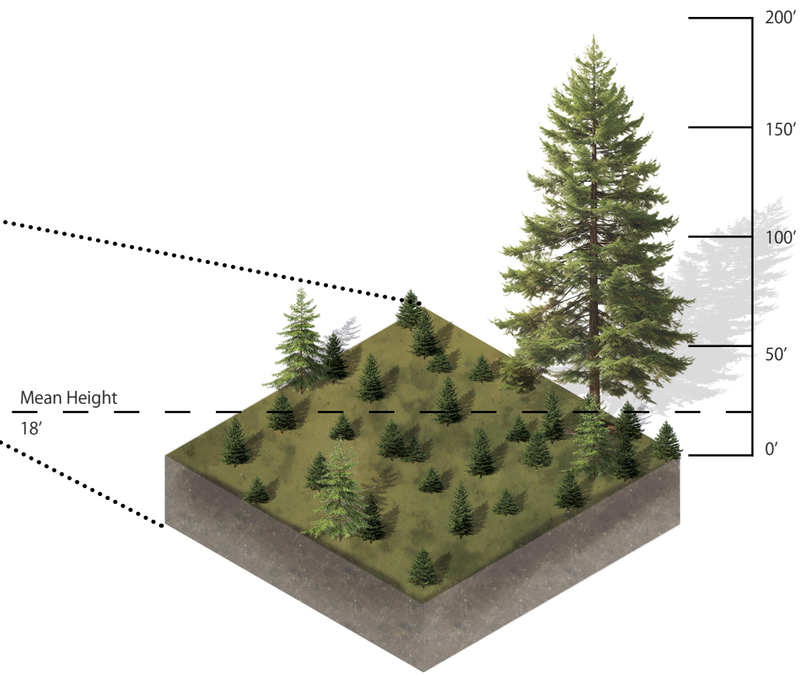
A stand that is labeled 1D4H, tells you that the stand is comprised of a high density of large Douglas-fir trees between 20-30" in diameter In comparison, a stand that is labeled 1D1L, tells you that the stand has a low density of small Douglas-fir trees that are between 8-14" in diameter.





1D4H

1D- Douglas Fir
4- Large- DBH >=20" and <30"
H- Higher density and or homogeneous stocking



1D1L

1D- Douglas Fir
1- Small- DBH >=8" and <14"
L- Low density and or patchy stocking

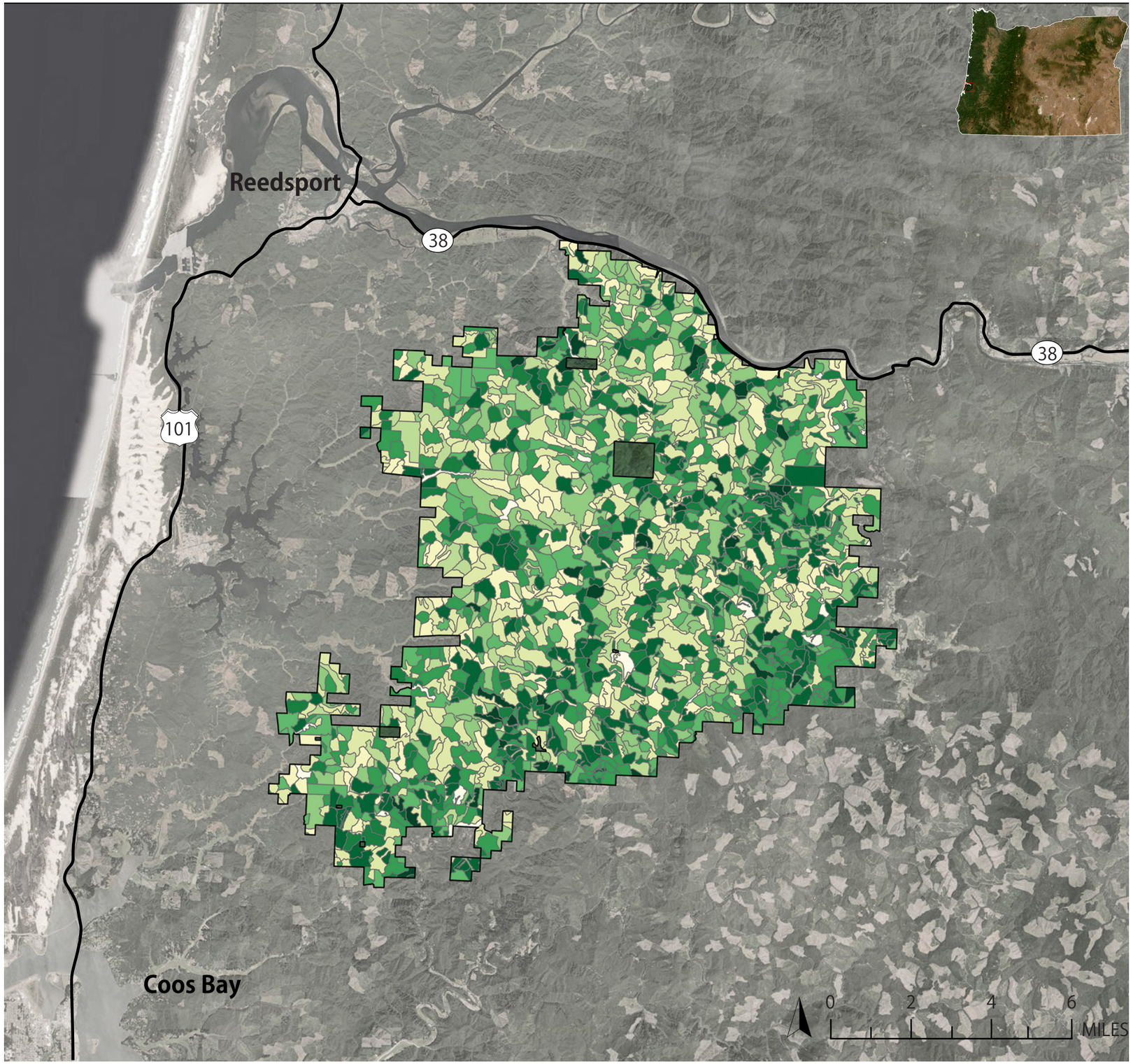
These images help you imagine what these stands might look like based on the assigned label. In addition to the vegetation labels, there was much more stand-level data to interpret.



ELLIOT STATE FOREST

Trees/Acre

Trees per acre serves as the basis for many other calculations in measuring forest stands.



TPA_Total

- 0-50
- 50-100
- 100-150
- 150-250
- 250-350
- 350-450
- 450-550
- 550-650
- 650+



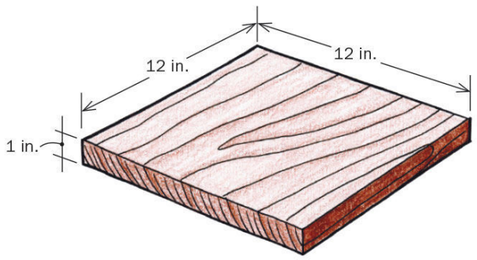




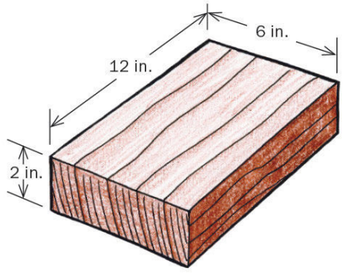
ELLIOT STATE FOREST

Board Feet

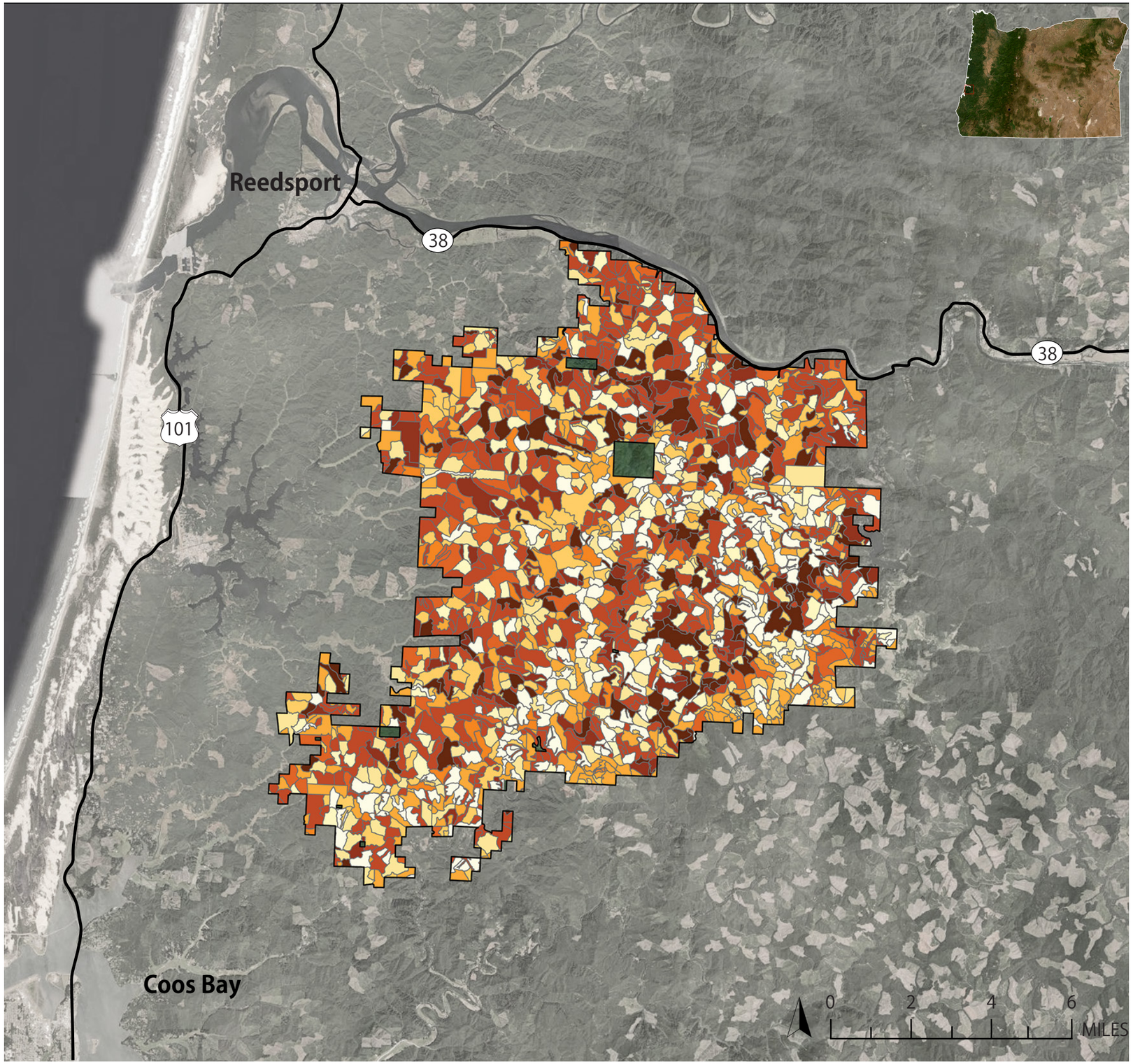
This number is of great interest in timber sales since most timber is sold at a price per 1,000 board feet (MBF). There are several methods of scaling or measuring board feet.



12″ x 12″ x 1″= 1 board feet



12″ x 6″ x 2″= 1 board feet



Board Feet/Acre

- 0.000000 - 6156.851360
- 6156.851361 - 10359.352131
- 10359.352132 - 13310.414375
- 13310.414376 - 17061.017052
- 17061.017053 - 22159.197052
- 22159.197053 - 28340.773041
- 28340.773042 - 36841.956566
- 36841.956567 - 48139.032211
- 48139.032212 - 58903.885040
- 58903.885041 - 98739.609543



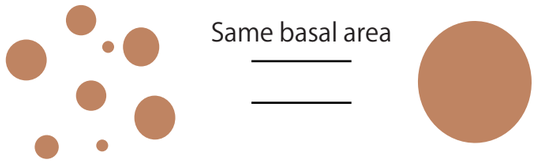




ELLIOT STATE FOREST

Basal Area

Cross-sectional (circular) area of a tree. It is measured at breast height (4.5 feet above the ground) and taken on the uphill side of the tree. The sum of the basal area for all trees in the stand is the total stand basal area, a common measure of stand density and tree size and a very important piece of information for making stand-management decisions (OSU, 2021).



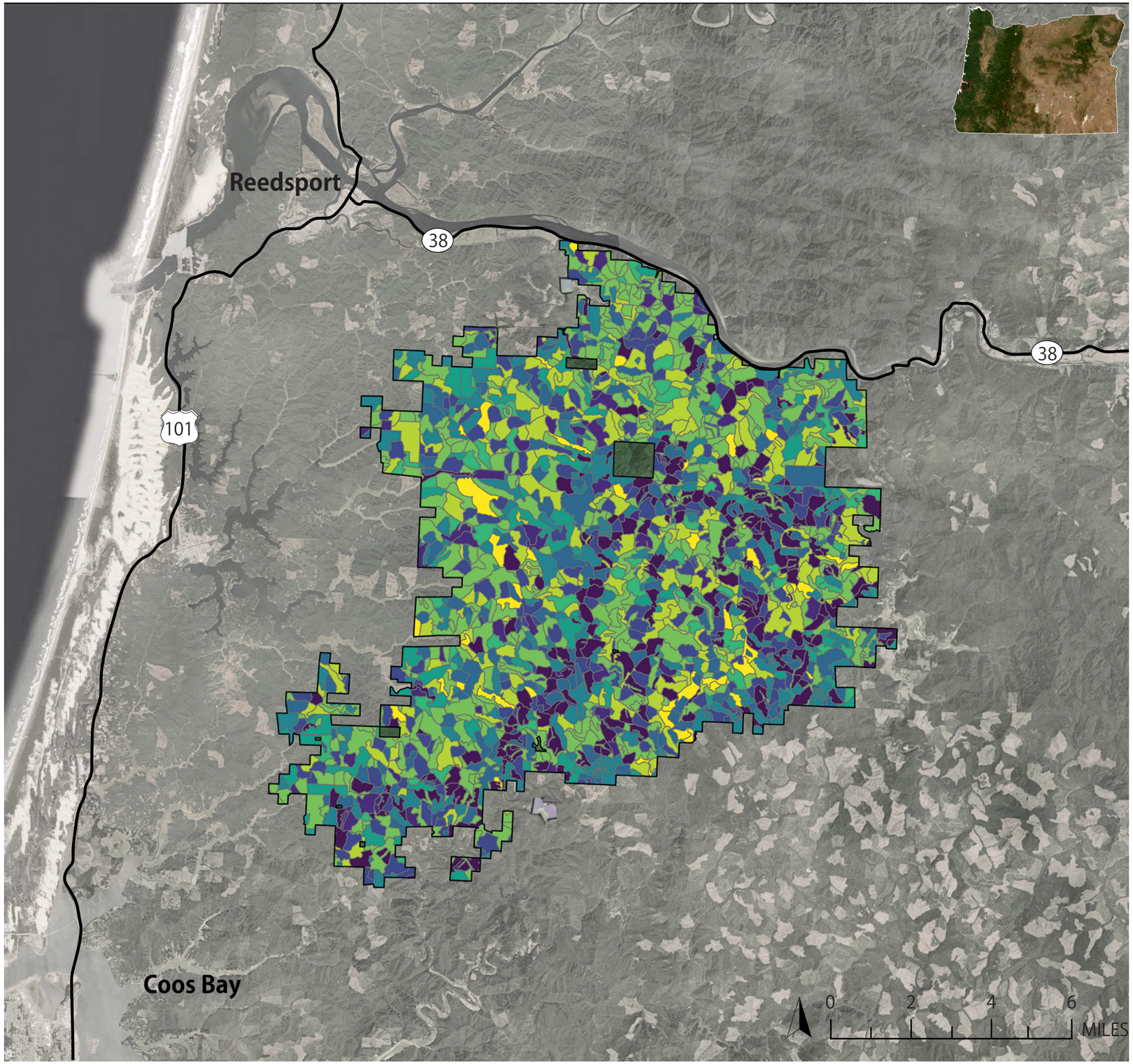
Many small trees

Few big trees

Basal Area

- 0.000000 - 46.153865
- 46.153866 - 92.602075
- 92.602076 - 123.023506
- 123.023507 - 146.153906
- 146.153907 - 163.461606
- 163.461607 - 184.615447
- 184.615448 - 209.592523
- 209.592524 - 236.604687
- 236.604688 - 274.293937
- 274.293938 - 405.000091



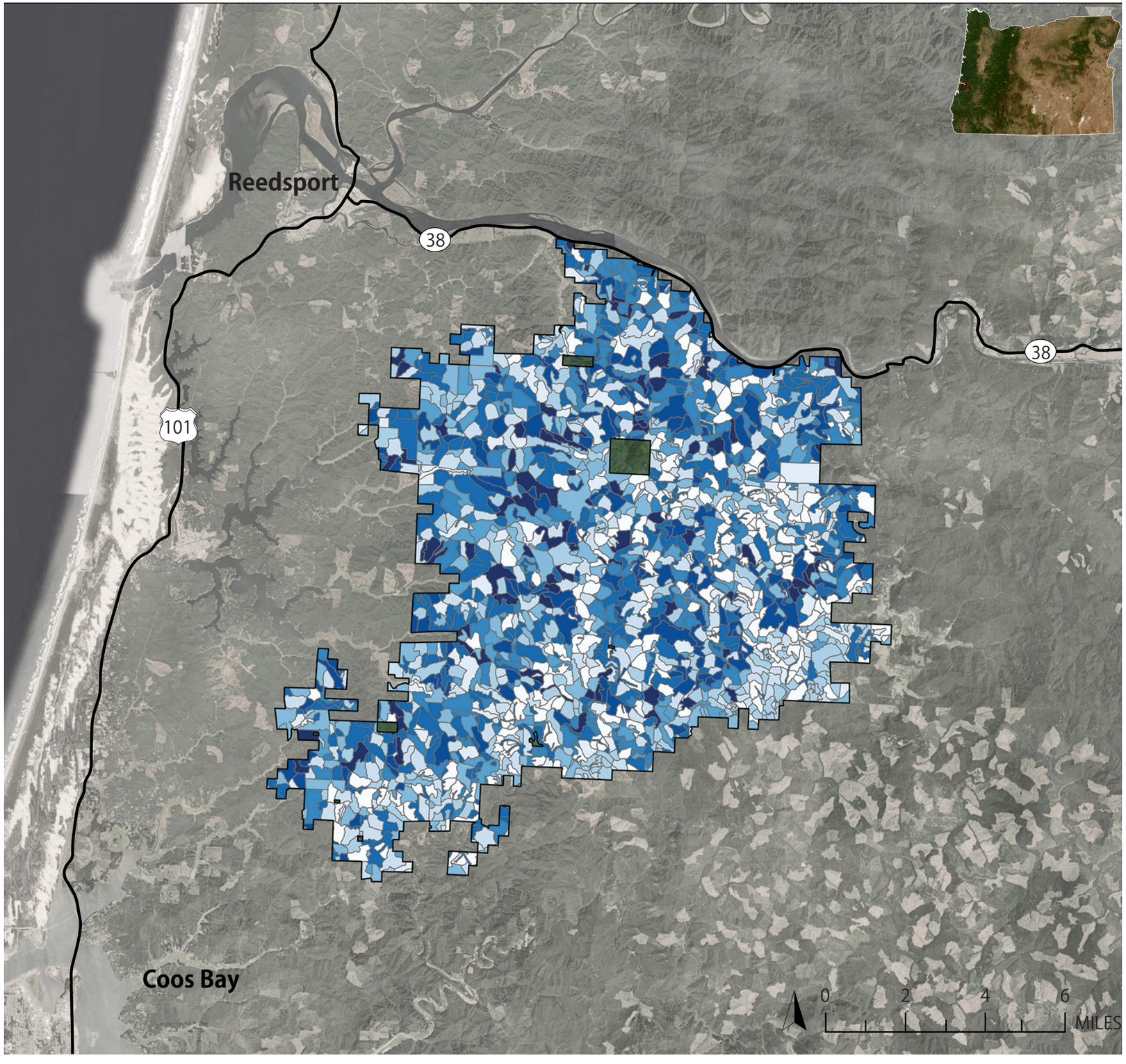


ELLIOT STATE FOREST

Quadratic Mean Diameter (QMD)

The QMD is used for calculating stand density because it accounts for variability in a stand better than the average DBH does, and it is readily converted into stand basal area. This is important because there is sometimes a great deal of variation in the size of individual trees within a stand. A simple average tends to underestimate the effect of the larger trees in those situations.

After many weeks of analyzing and understanding the data, I began to make connections on how this data could be used to meet my project goals and objectives of providing a recreational experience that taught visitors about mass timbers' connection to forest stewardship and ecology.



Quadratic Mean Diameter

- 0.000000 - 7.708800
- 7.708801 - 10.445279
- 10.445280 - 11.858573
- 11.858574 - 13.062592
- 13.062593 - 15.433803
- 15.433804 - 20.090243
- 20.090244 - 24.860654
- 24.860655 - 28.434970
- 28.434971 - 33.043435
- 33.043436 - 45.174307



ELLIOT STATE FOREST

Relative Density

OSU created an extremely helpful guide on competition and density in woodland stands that helps to develop management plans. Using stand-level data, including QMD and trees per acre, we can determine the relative density of a forest stand. The relative density of a stand tells us how crowded the trees are on a site and how intense the competition is between trees. Relative density helps us determine how many trees should be added or removed from a stand to reach your management goals.

No Thinning RD 0-35

Young trees. Not yet competing with each other and have lots of room and resources to grow. As trees grow, lower branches decline and die as they become shaded "self-pruning". Understory plants shift to shade tolerant as crown closes.

Light Thinning RD 35-45

Optimal growth zone. Repeated thinning promotes robust growth. Stands are vigorous and resilient to stress and pests. Stands are spaced widely enough to allow light penetration supporting understory growth providing habitat for many species. To meet certain habitat, it may be desirable to reduce competition.

Periodic Thinning RD 45-55

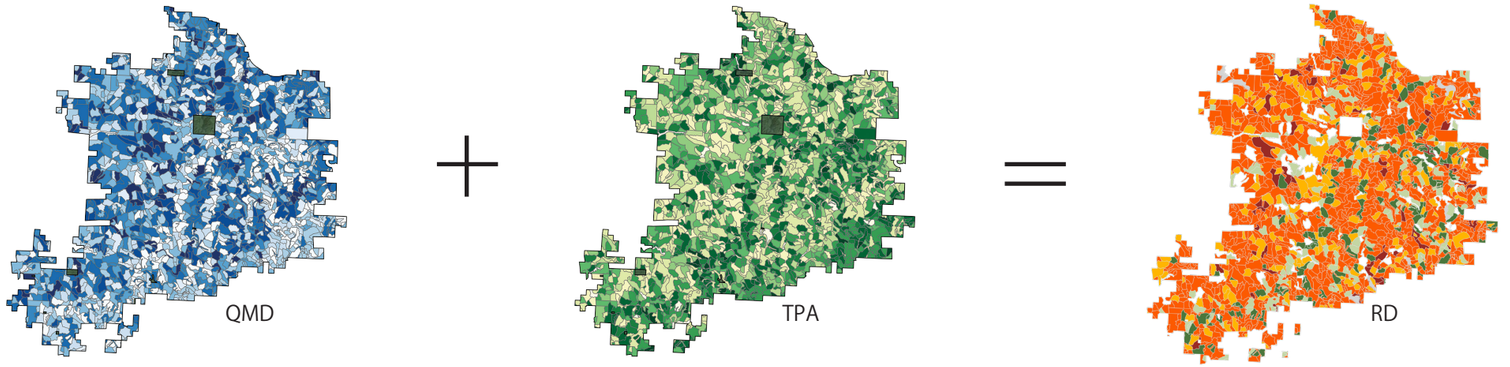
Competition is intense and individual tree growth is strong. Dense shade limits the density and diversity of understory vegetation. This zone is seen as "just right" when it comes to optimizing timber quality and quantity. To meet certain habitat, it may be desirable to reduce competition.

Heavy Thinning Now RD 55-75

Trees compete intensely for resources and some trees die due to competition. There is a rapid loss of treatment options if a stand is left in this condition. The window for thinning the stand narrows. The understory is sparse.

Zone of No Return RD 75+

Trees are small, skinny, and stressed. For most stands in this stage, it is too late to thin. The best option is to clear cut and start a new stand.



Appendix A. Douglas-fir stand density table

Approximate tree size in inches DBH at different absolute densities (trees per acre, or by approximate spacing [in feet]) and competition level (RD). Based on stand quadratic mean diameter and a maximum stand density index of 520.

Zones and thresholds	Relative density	Trees per acre ▶	50	75	100	125	150	175	200	225	250	275	300	360	435	680
		Spacing ▶	30'	24'	21'	19'	17'	16'	15'	14'	13'	12.5'	12'	11'	10'	8'
Maximum Stocking	100	▼ Average diameter at breast height (DBH) ▶	43"	33"	28"	24"	22"	20"	18"	17"	16"	15"	14"	13"	11"	8"
Zone of No Return	75		39	30	25	22	20	18	16	15	14	13	13	11	10	8
	70		36	28	23	20	18	16	15	14	13	12	12	11	9	7
Danger Zone	65		33	26	21	19	17	15	14	13	12	11	11	10	9	6
	60		31	24	20	18	16	14	13	12	11	11	10	9	8	6
	55		30	23	19	17	15	14	12	12	11	10	10	9	8	6
Upper Goldilocks Zone	50		28	22	18	16	14	13	12	11	10	10	9	8	7	5
	45		26	20	17	15	13	12	11	10	10	9	9	8	7	5
Lower Goldilocks Zone	40		24	19	16	14	12	11	10	10	9	8	8	7	6	5
	35		22	17	15	13	11	10	9	9	8	8	7	7	6	4
Enthusiastic Growth Zone	30		20	16	13	11	10	9	9	8	7	7	7	6	5	4
	25		18	14	12	10	9	8	8	7	7	6	6	5	5	4
	20		16	12	10	9	8	7	7	6	6	5	5	5	4	3
Crown Closure	15		13	10	9	7	7	6	6	5	5	5	4	4	3	3

Table: Withrow-Robinson and Maguire, © Oregon State University

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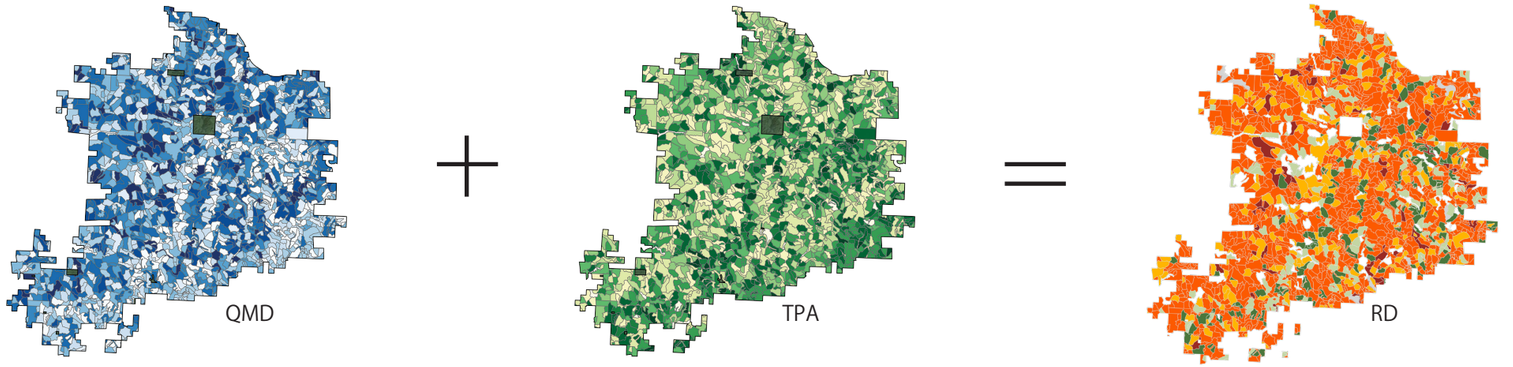
EM 9206
June 2018

ELLIOT STATE FOREST

Relative Density

The table can be used to plan a thinning operation which helps determine how many trees should be removed from a stand to reach your particular objective.



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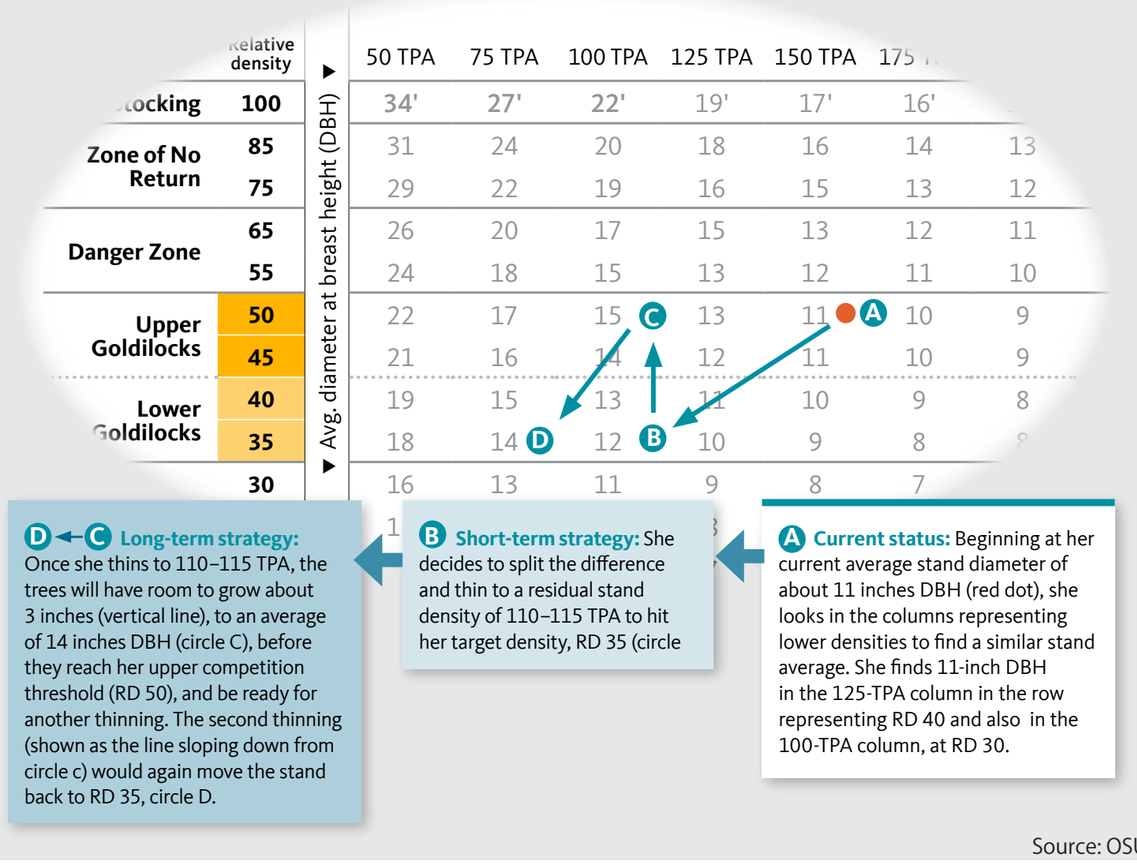
Zone of No Return RD 75+

Trees are small, skinny, and stressed. For most stands in this stage, it is too late to thin. The best option is to clear cut and start a new stand.

Figure 5. Planning a thinning operation to reach objectives

A landowner wants to keep her ponderosa pine stands' relative density between RD 35 and RD 50. She will do a "proportional thinning," which will not significantly affect the stands' average diameter.



Source: OSU

From Appendix C, Ponderosa pine stand density table

ELLIOT STATE FOREST

Thinning Treatment Classification

For this project, I have used this table to give each stand in the Elliot a thinning treatment classification, which you can see on the left. Some stands are young and require no thinning. Other stands have too much competition and require heavy thinning, and some stands have been neglected for so long that they are the "point of no return". Once a stand reaches this stage, it is too late to thin. The best option is to actually clear-cut the stand and start anew.

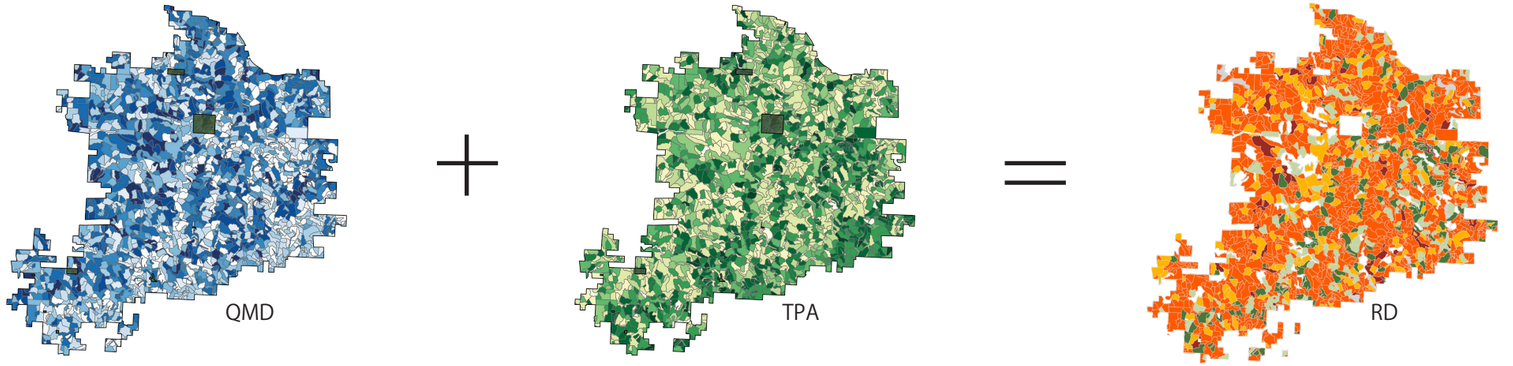


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Table: Withrow-Robinson and Maguire, © Oregon State University

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EM 9206
June 2018

ELLIOT STATE FOREST

Thinning Treatments

Using more GIS techniques each stand in the Elliot was given a thinning treatment classification. As you can see, a large amount of the Elliot is in need of immediate thinning, as you can see in the orange. As I mentioned at the beginning of the presentation, this circumstance is not unique to the Elliot. Research has calculated a 9.5 million acre backlog of Washington and Oregon forests requiring thinning or burning. So, by looking at this map, it is apparent that there is a high need for large-scale treatment. What this treatment looks like will depend upon the stewardship goals and objectives.

No Thinning RD 0-35

Young trees. Not yet competing with each other and have lots of room and resources to grow. As trees grow, lower branches decline and die as they become shaded "self-pruning". Understory plants shift to shade tolerant as crown closes.

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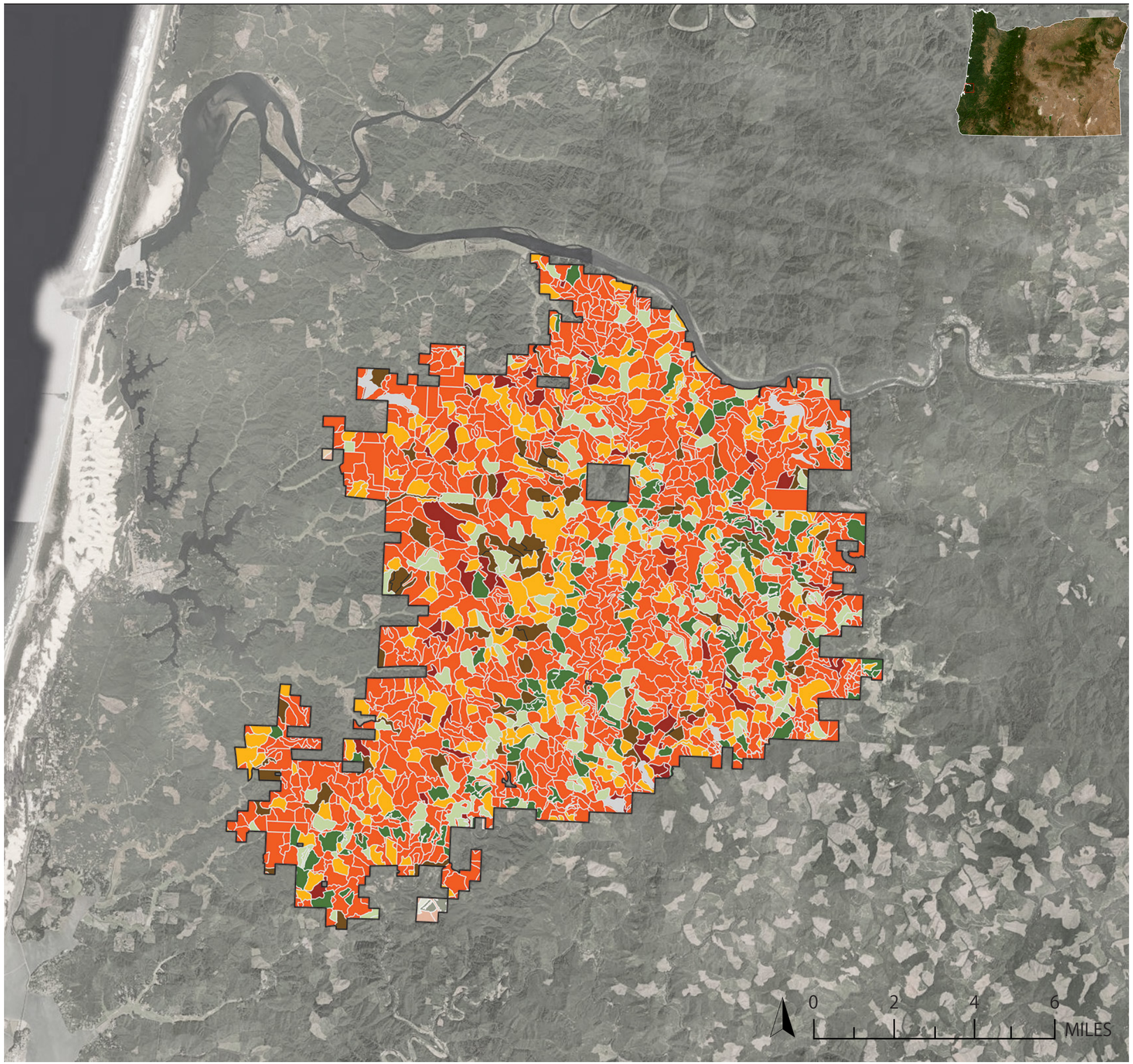
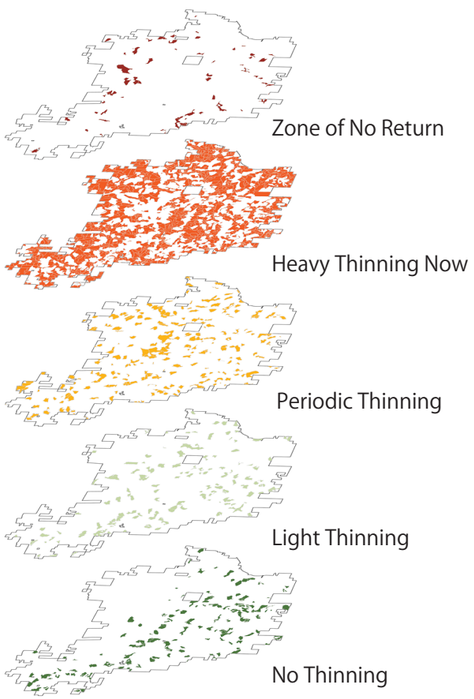


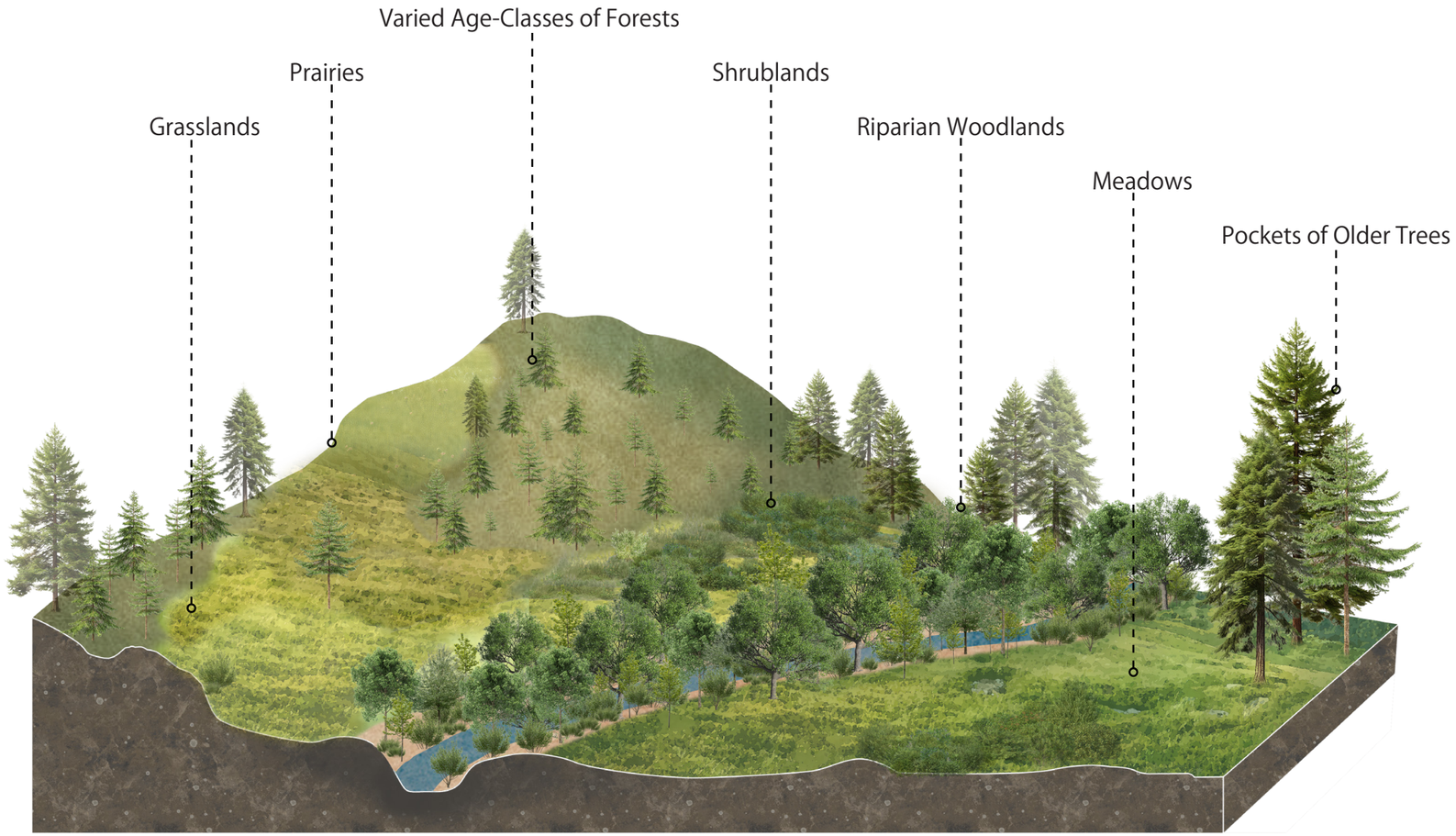
Large Scale Treatment

Habitat Mosaic

Aside from managing lands for timber production, there are many stewardship techniques to utilize that can create a rich habitat mosaic. Historically, when the Indigenous Peoples of this area stewarded these lands, there would have been a mix of non-forest, including meadows, grasslands, balds, and shrublands, and forests of various age classes with scattered older trees and pockets of older trees in areas of fire refugia like flat areas and riparian areas.
Figuring out the proper management plan for this forest is far beyond this project's scope. I will leave that part to my friends and forestry experts at OSU.

Either way, the treatment options in stands classified as "Heavy thinning now" will look much different than the treatment options in stands classified as "zones of no return" or "Light thinning". This trail system will weave visitors through the various stands to see what these different management options look and feel like. Through this journey, visitors will learn about the benefits of forest stewardship practices like thinning and burning and how mass timber could accelerate these restoration efforts.





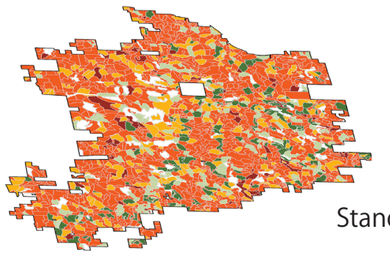
Historical Oregon Coast Range Landscape Mosaic



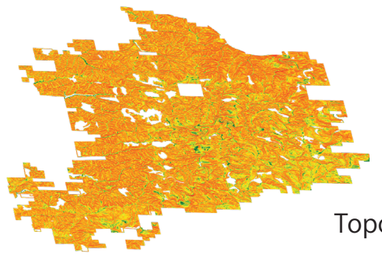
TRAIL LAYOUT

Trail for the Masses
Locating the Trail

Trail Criteria



Stand Complexity

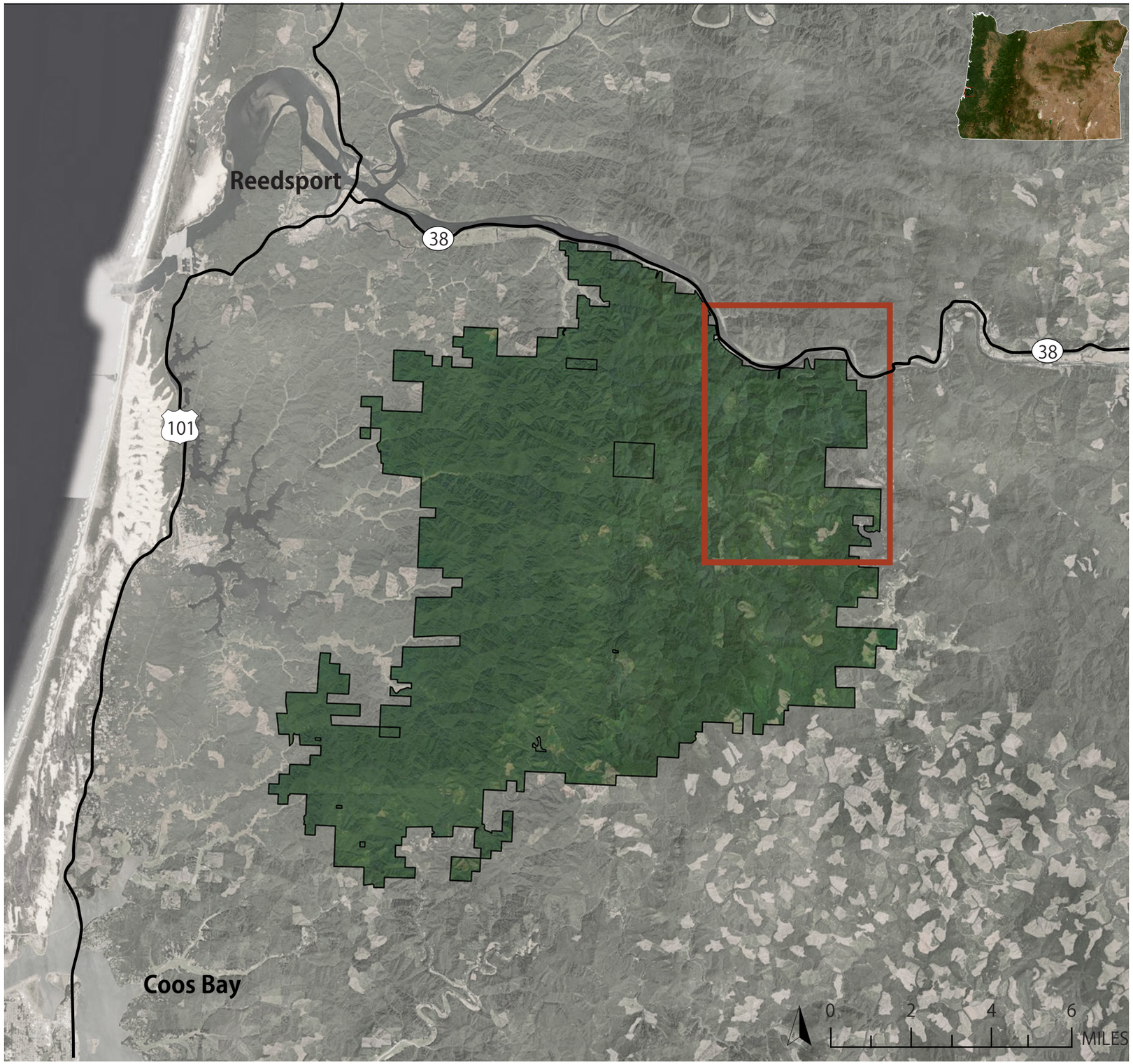


Topography



Access





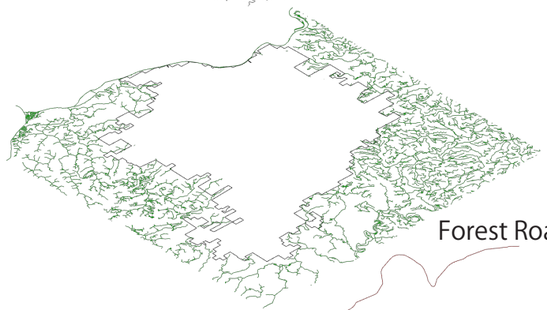
TRAIL FOR THE MASSES

Access

There is good access to the site off of Highway 38. Loon Lake road runs alongside the east side of the Elliot to Loon Lake resort and there is a complex network of forest service roads throughout the Elliot. Cougar Pass road in particular offers some good access throughout a interesting portion of the site.



ESF Roads

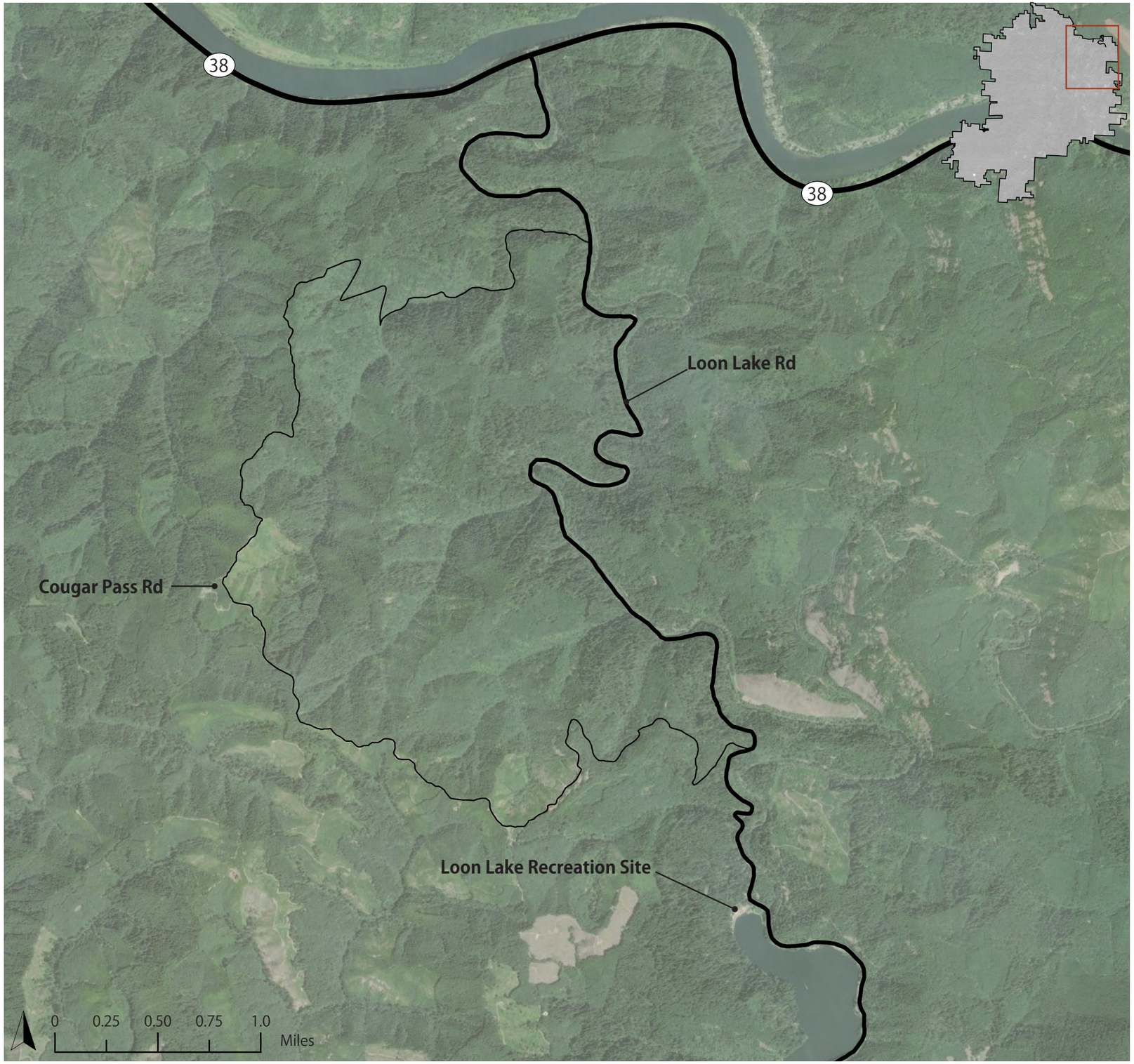


Forest Roads



Highways & Major Roads

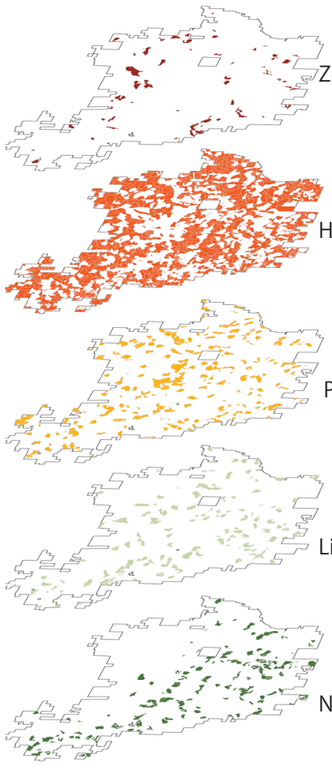




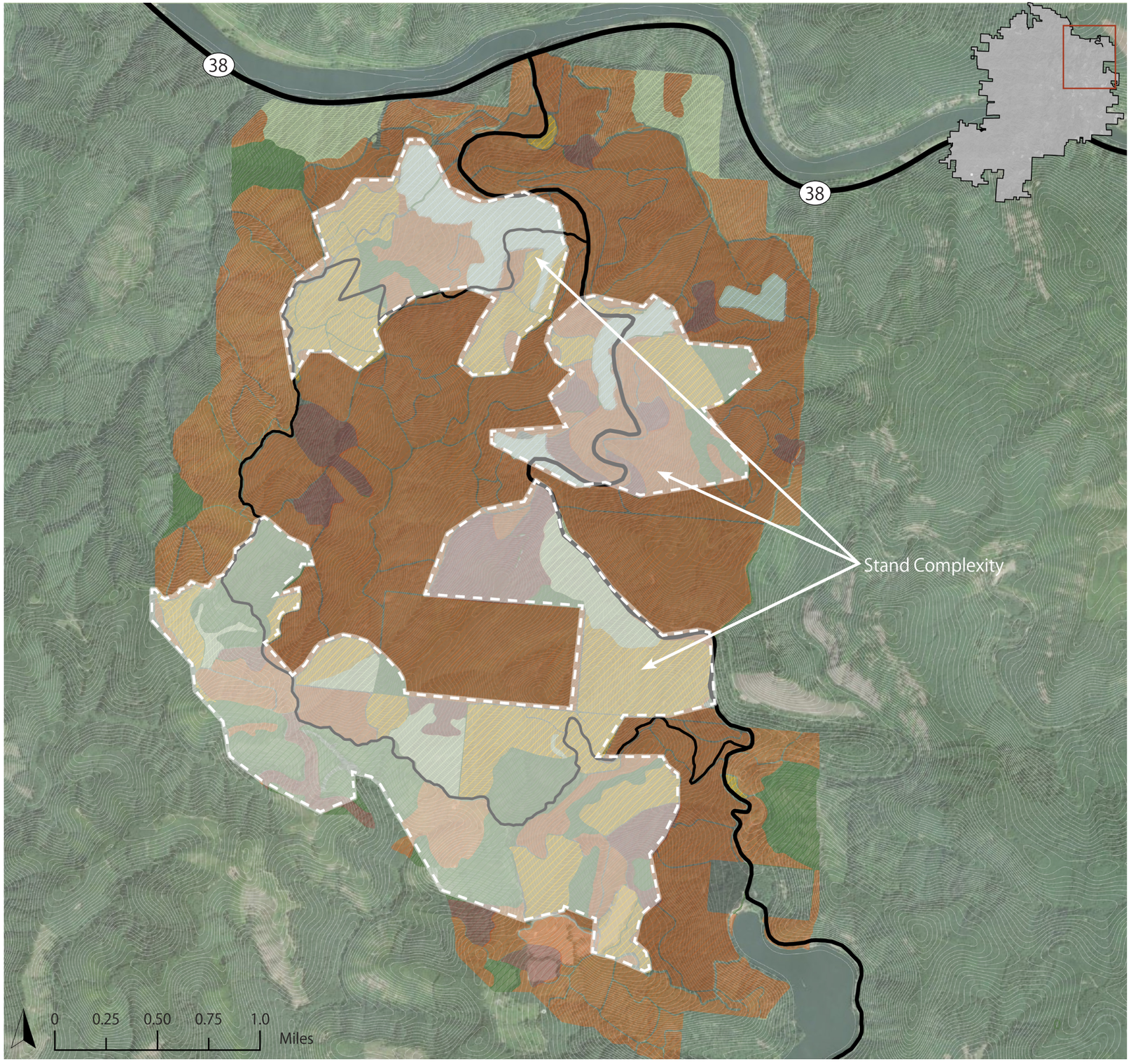
TRAIL FOR THE MASSES

Stand Diversity

This portion of the Elliot has a good diversity of forest stands. A variety of stewardship treatments will take place in this area, offering a valuable educational experience.







TRAIL FOR THE MASSES

Old Growth Stands

The Elliot contains some of the last remaining old growth stands in this region. There are trees in this these stands that date back to the 1500's! Old growth forests can be a large draw to the wider public.



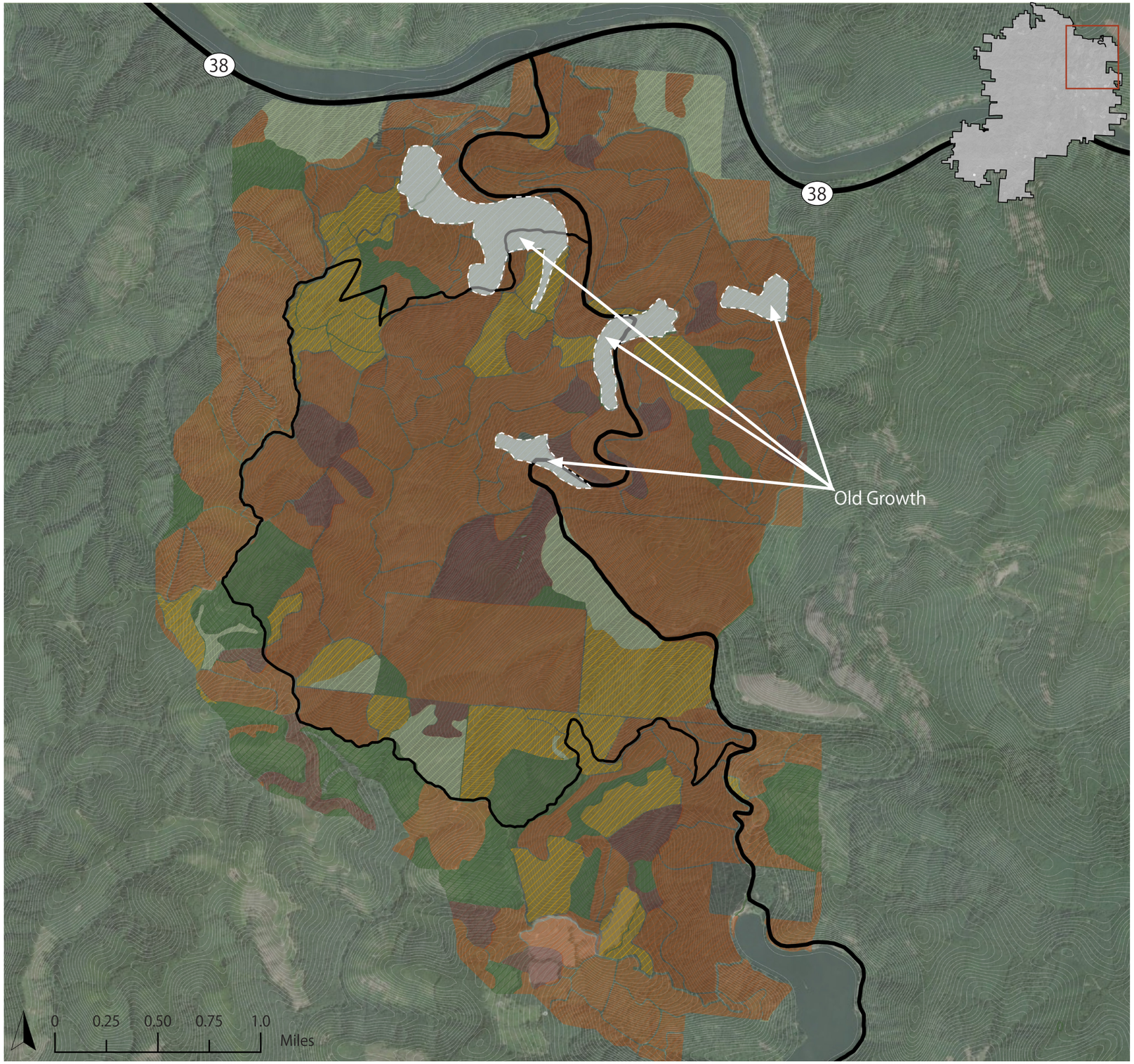
Northern California



Northern California



Rockaway Beach, OR



TRAIL FOR THE MASSES

Locating the Trail

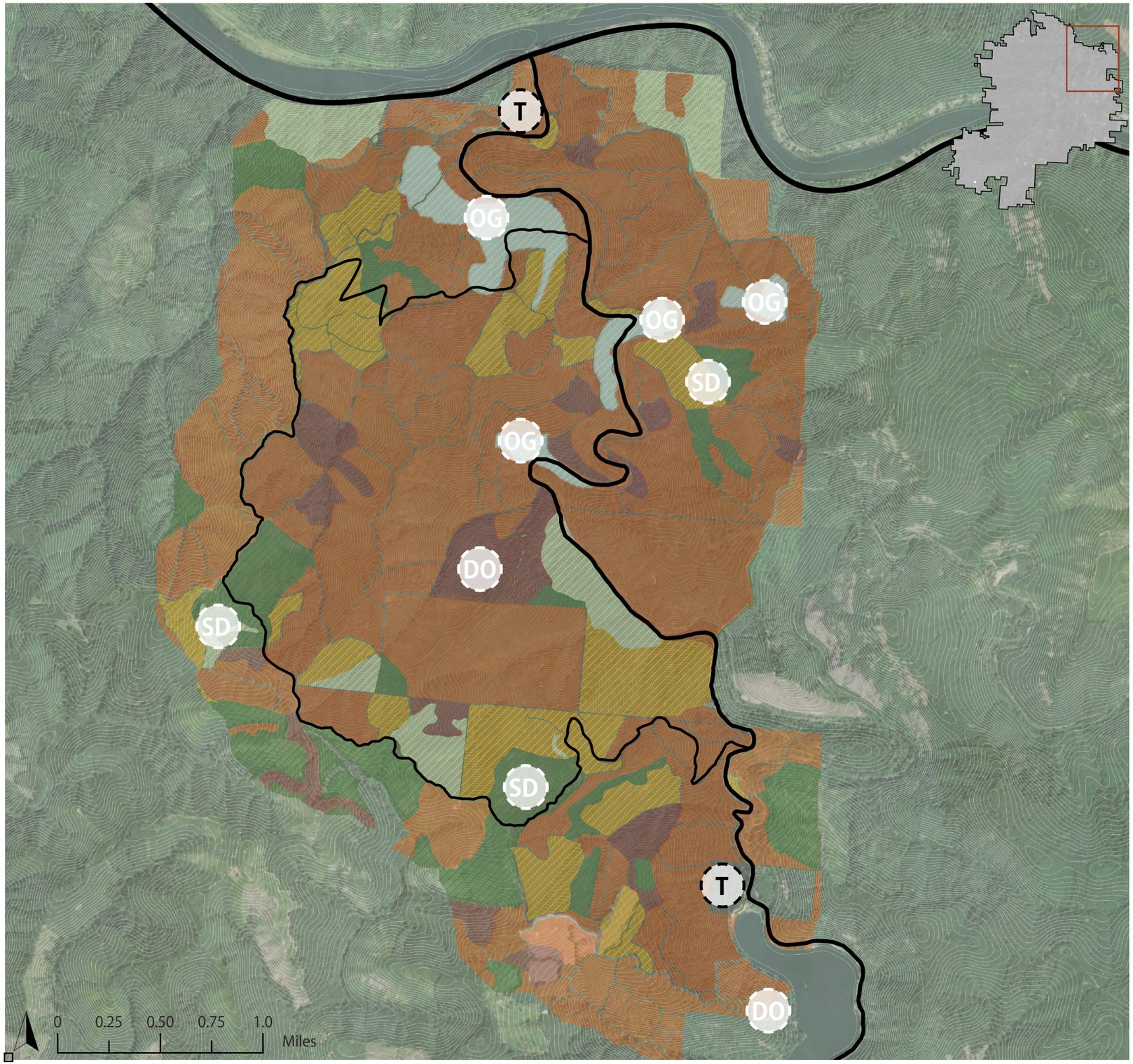
To start laying out the trail, I began setting anchor points for the trail beginning with easily accessible trailheads. Some of the other anchor points included areas with diverse forest stands, old growth stands, and areas that offer some exciting design opportunities.

OG Old Growth

SD Stand Diversity

DO Design Opportunities

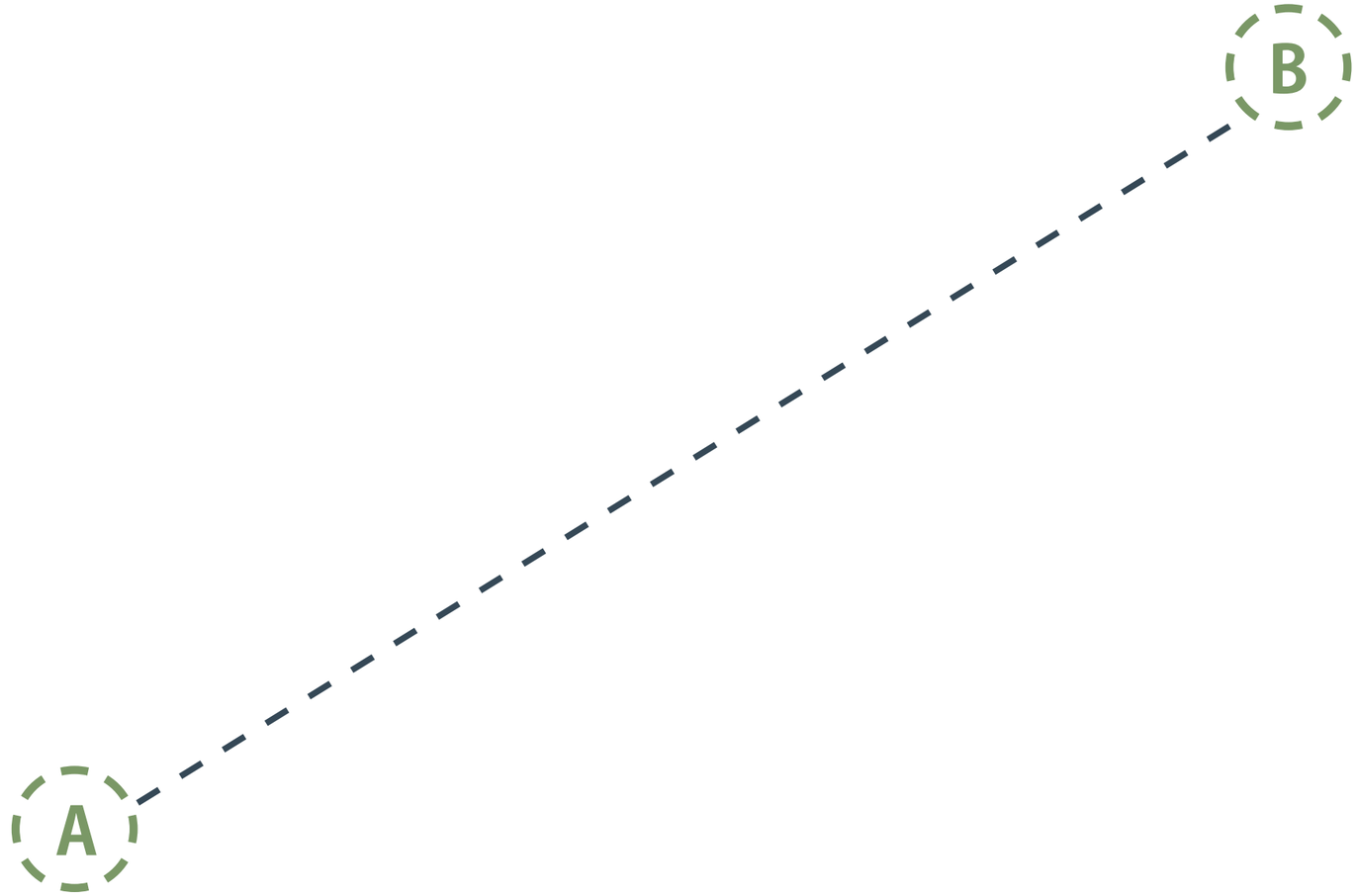
T Trailhead



WHERE TO PLACE TRAIL?

Least Cost Path

Continuing to use GIS, I used a tool called the least cost path for laying out the trail. This tool figures out the most efficient way to get from point A to point B.



TRAIL RATINGS

Setting the Cost

However, what this path looks like will depend on site constraints and the user group. Using the least cost path tool, you are able to set “costs” to certain features under consideration, like slopes. The higher the slope percentage, the higher the “cost”. When GIS runs the least cost path to get from point A to B, it does so in a way that avoids steep slopes. So, when designing for different user groups, you can use different costs that produce paths with different slopes depending on your goals. Pay attention to these user groups popping up in the rest of the presentation to give you an idea of who I am thinking about for particular design decisions.

	Easy	Moderate	Difficult
Hiking Trails	20%	30%	>30%
Mountain Biking Trails	10%	30%	<30%
Universal Trails	1-3%	3-6%	6-8%

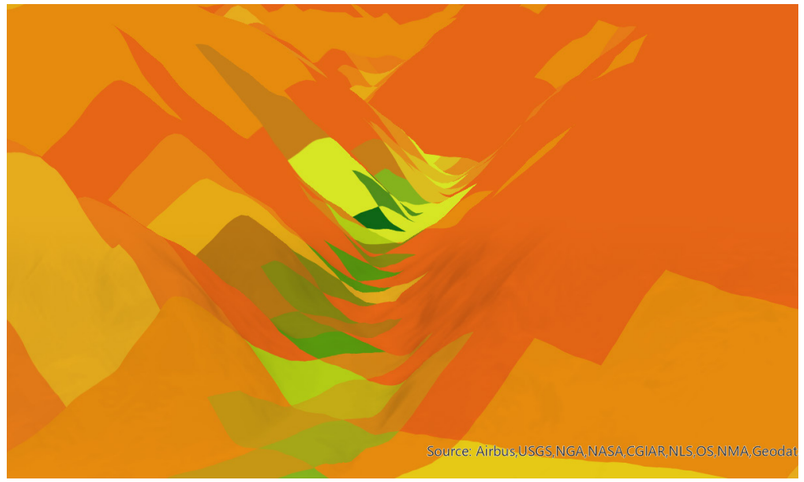
Source: US National Forest

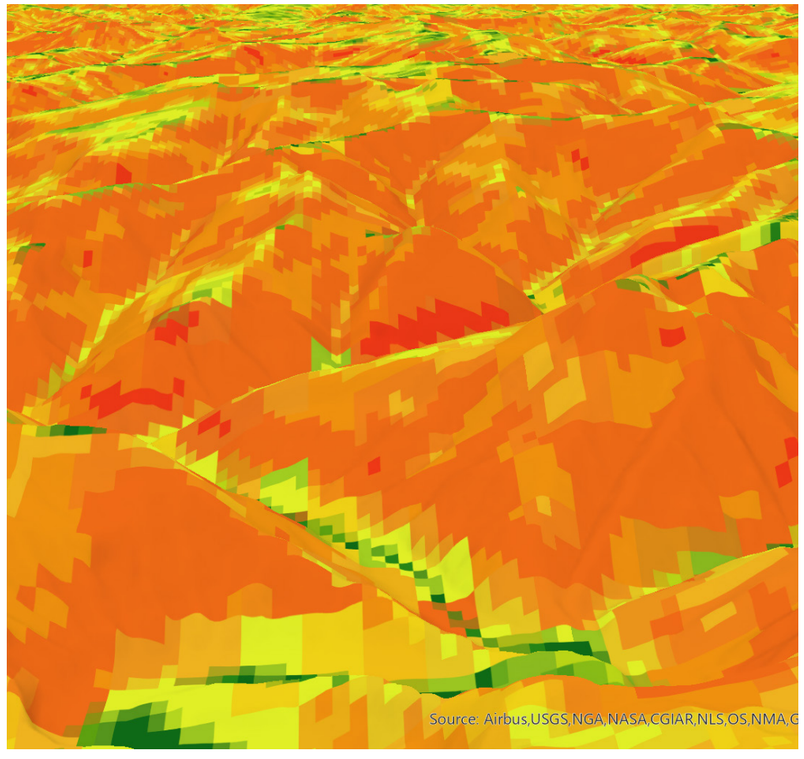


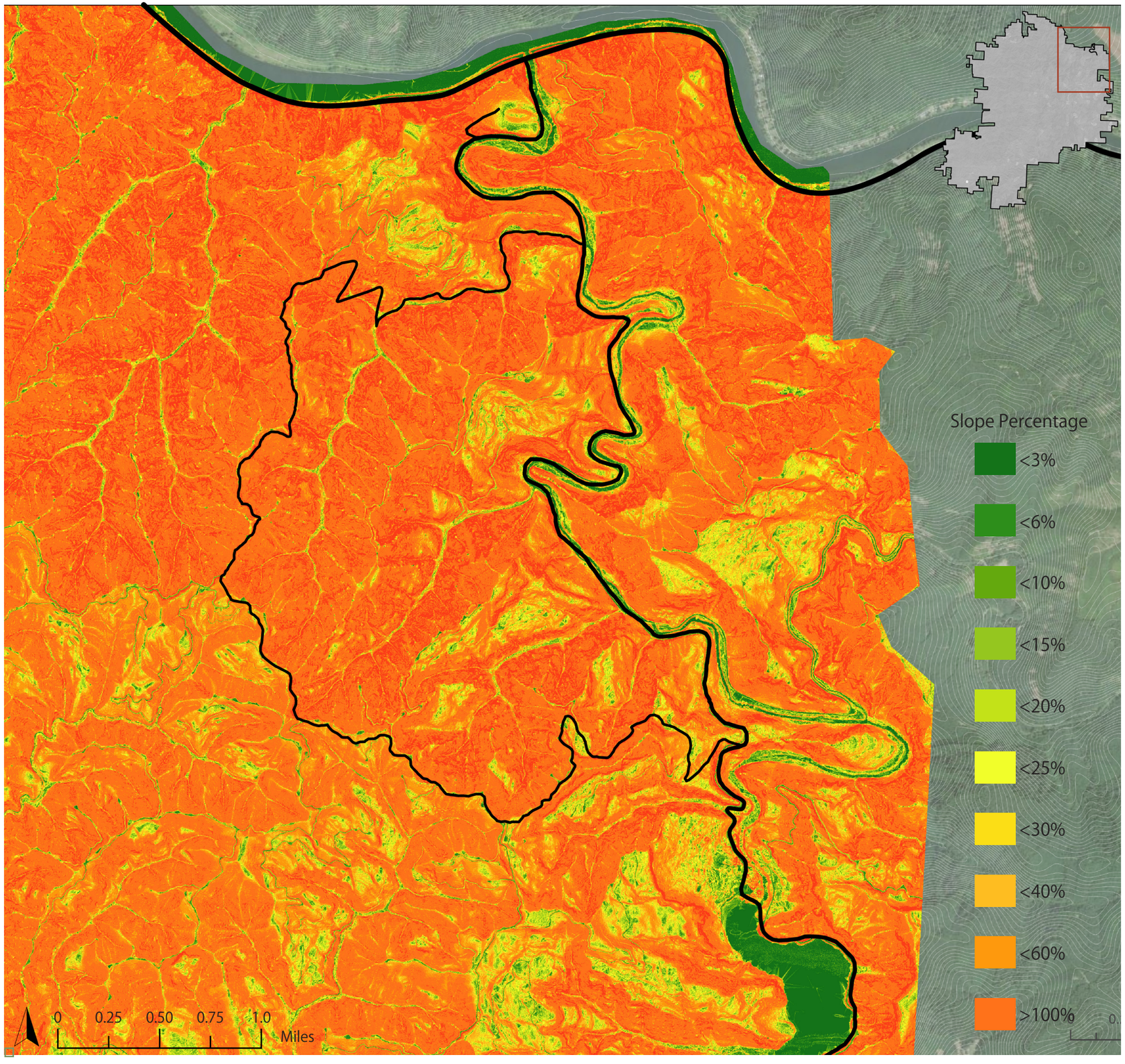
TOPOGRAPHY

Steep Slopes

The Elliot is very steep. Figuring how to get from point A to point B was no easy task.



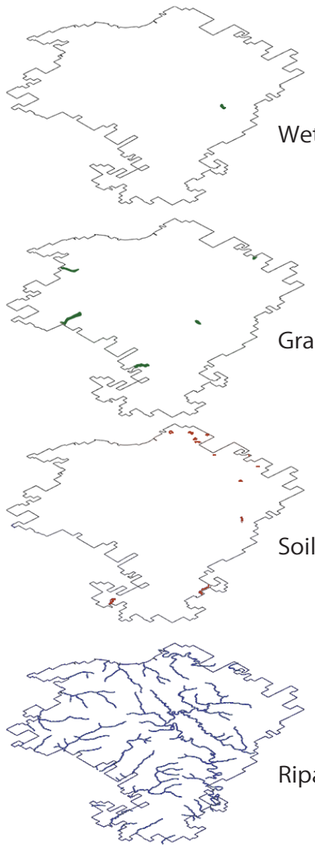




WHERE TO PLACE TRAIL?

Least Cost Path

In addition, there were other site constraints to avoid including rivers and streams. When I first began running this analysis, GIS kept putting the trail directly in the streams because they have the lowest slope and thus the least cost. Since you can't hike thorough streams, waterbodies were also added as a cost to this analysis.



Wetlands/Swamps

Grasslands/Meadows

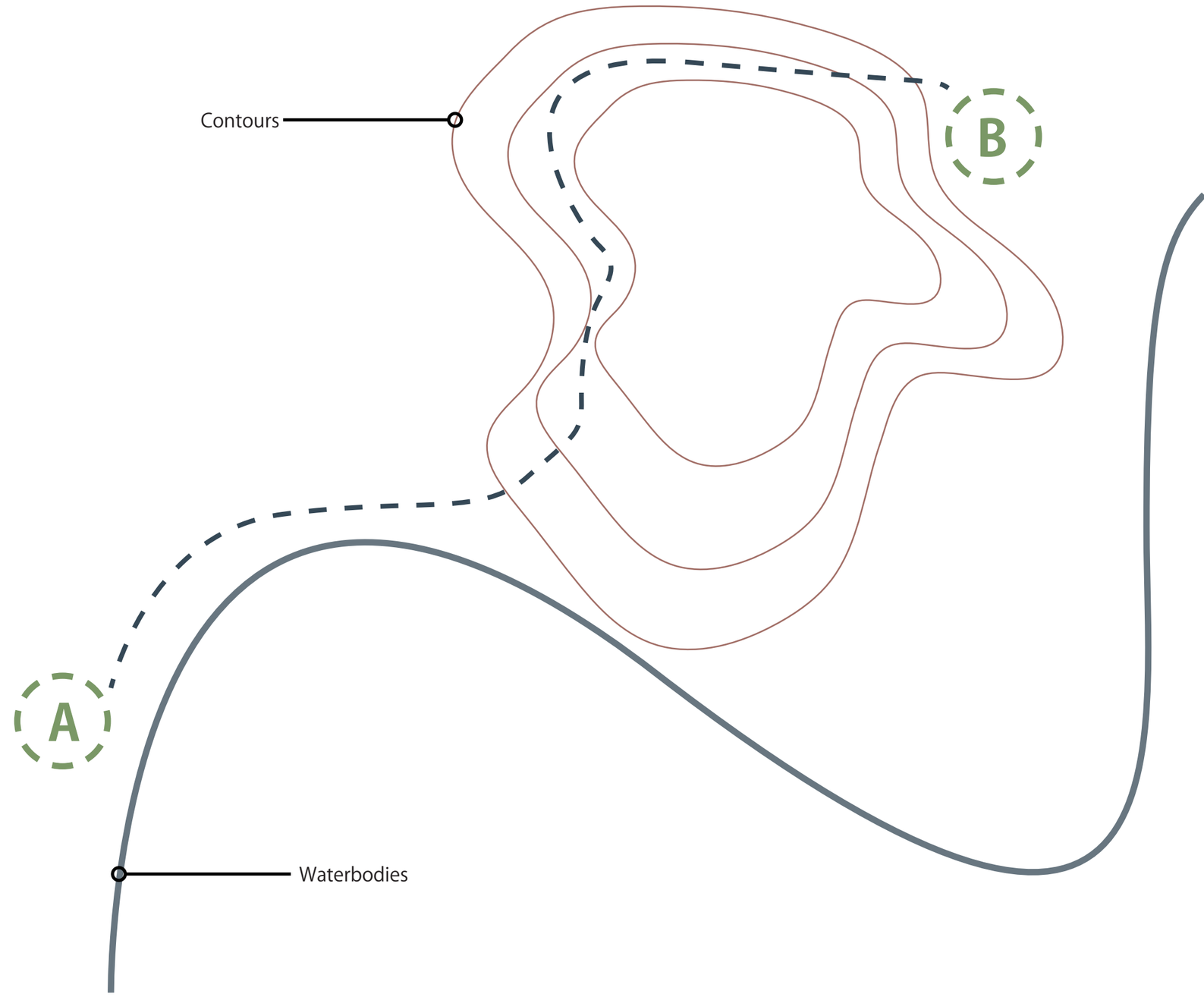
Soil/Exposed

Riparian Management Zones









TRAIL FOR THE MASSES

Locating the Trail

Using these anchor points, I began running the least cost path to determine the layout of the trail network.

OG Old Growth

SD Stand Diversity

DO Design Opportunities

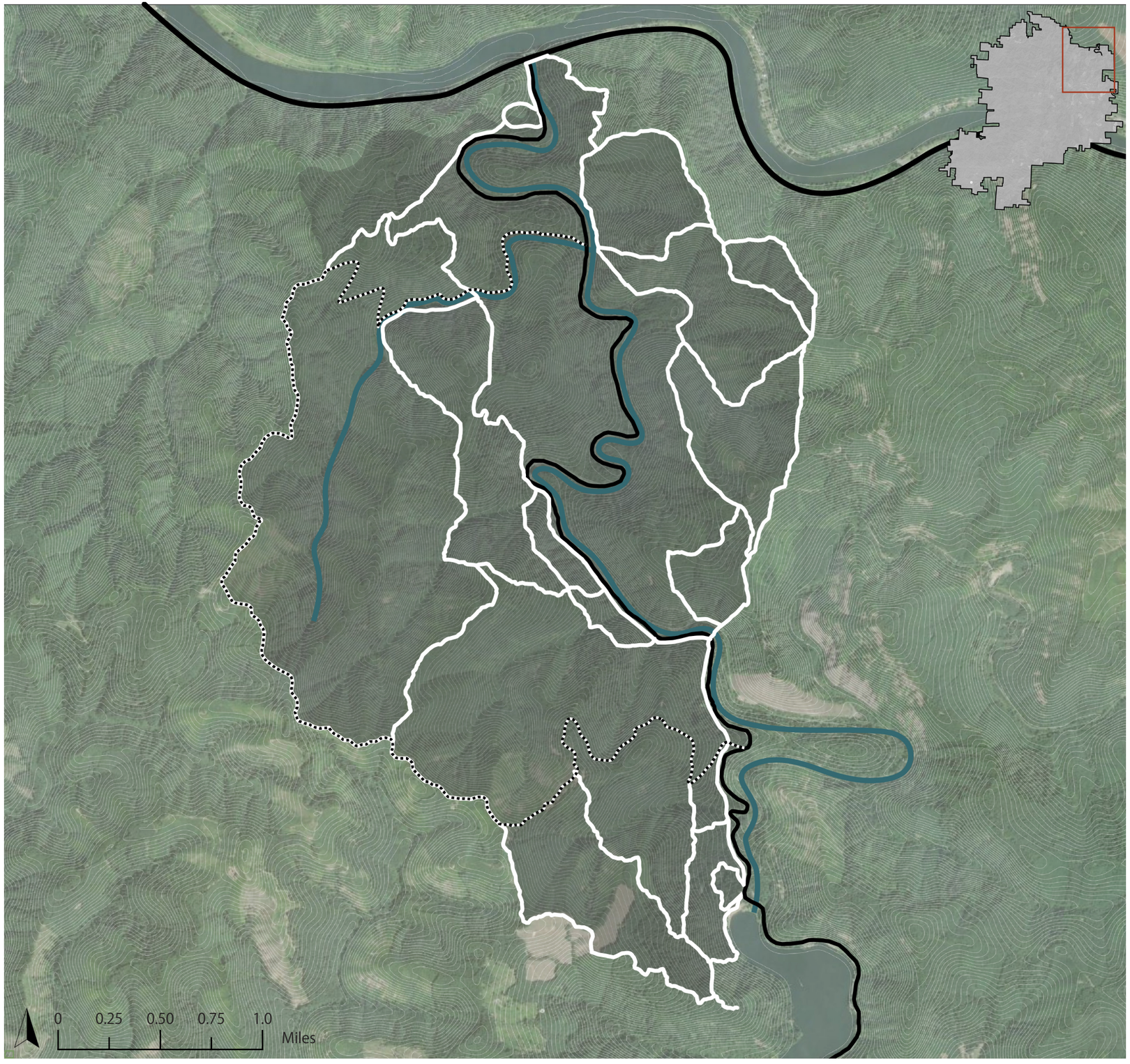
T Trailhead



HIKING TRAILS

Valleys, Ridges, Switchbacks

Through many iterations, the hiking trails were laid out. Since the Elliot is so steep, the trails are mostly along valleys and ridgelines, with switchbacks in between.





HIKING TRAILS

Valleys, Ridges, Switchbacks

This perspective gives you better insight into the type of hiking the Elliot would provide. These trails are not for the faint-hearted.

Hiking Characteristics

Big elevation gains
Viewsheds
River trails

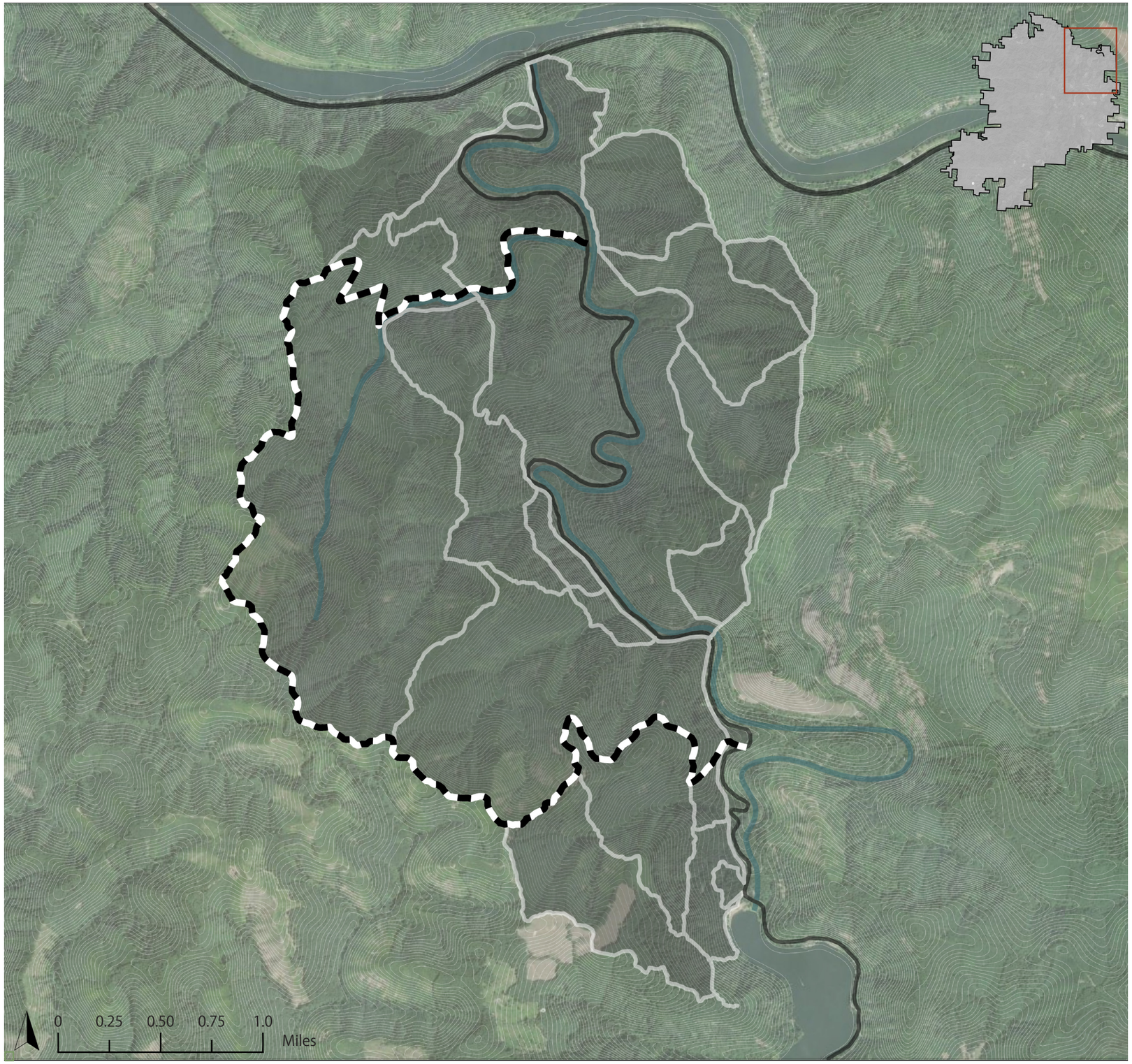




TRAILS MERGED

Vehicular Access/Hiking & Biking Trails

Since many of the trails will need to follow ridgelines, some portions of the trail will serve multiple user groups, including hikers, bikers, and forestry management personnel.

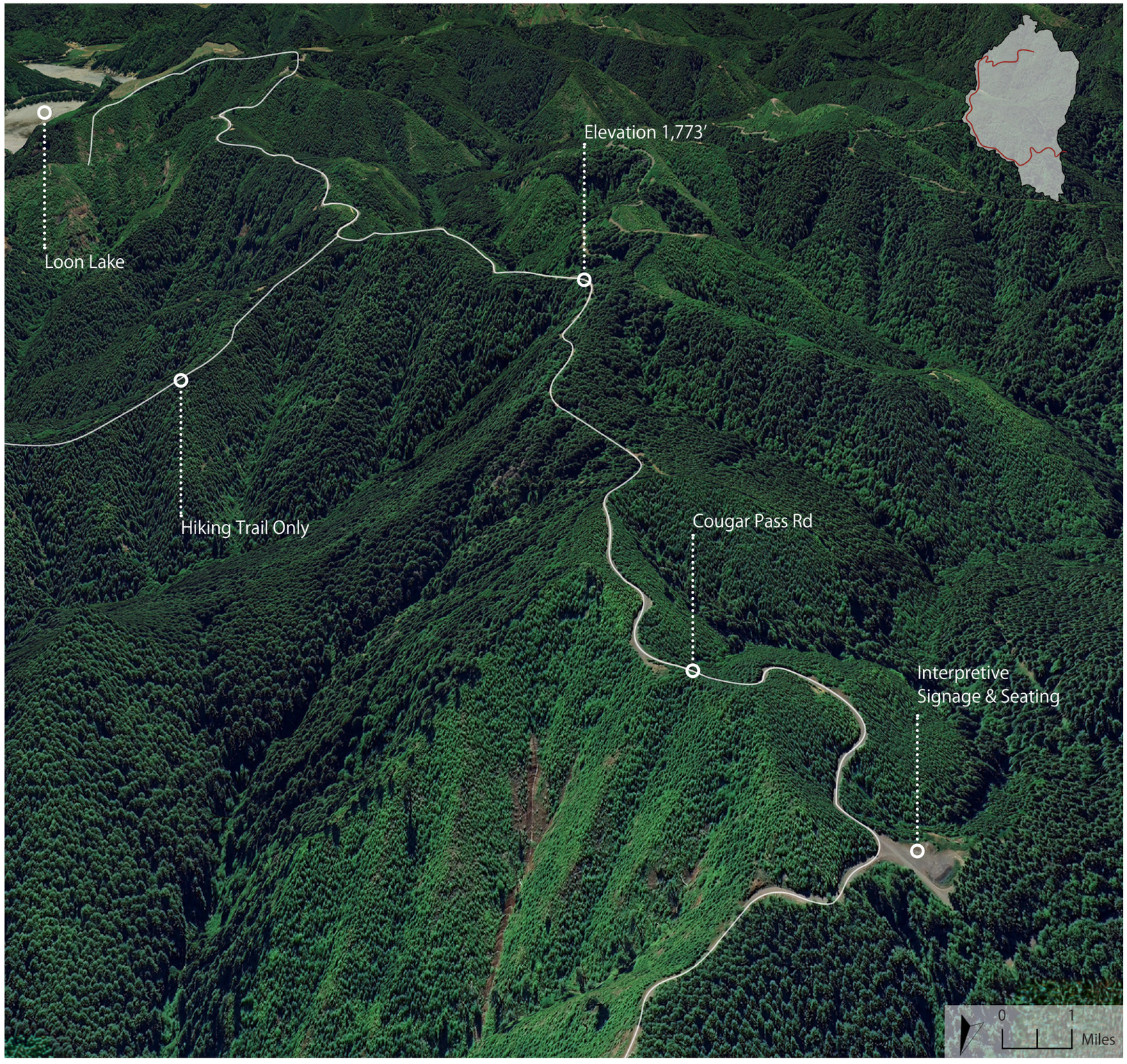




TRAILS MERGED

Vehicular Access/Hiking & Biking Trails

As you can see from this perspective, it would be difficult to place a hiking trail in any place other than the ridgeline.





MOUNTAIN BIKING

Steep Terrain & Endless Possibilities

However, this could be the perfect feeder trail for mountain biking enthusiasts. The Elliot is full of endless possibilities for thrill seekers looking to go “full send”.

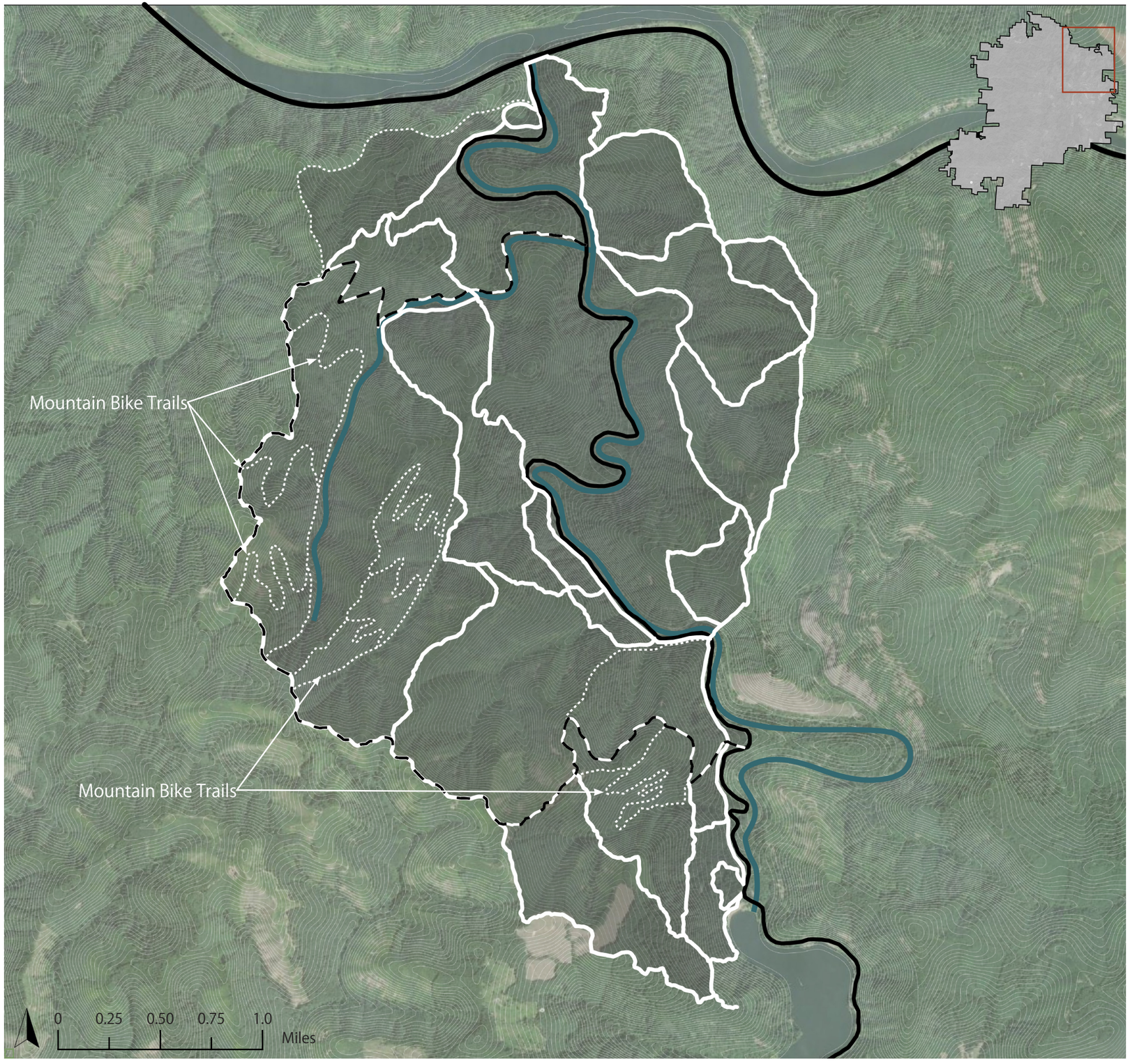




Mountain Biking

Steep Terrain & Endless Possibilities

A handful of mountain biking trails are proposed in this design. Knowing that mountain biking groups tend to site and build a lot of their own trails, this network is subject to grow!





UNIVERSAL ACCESS

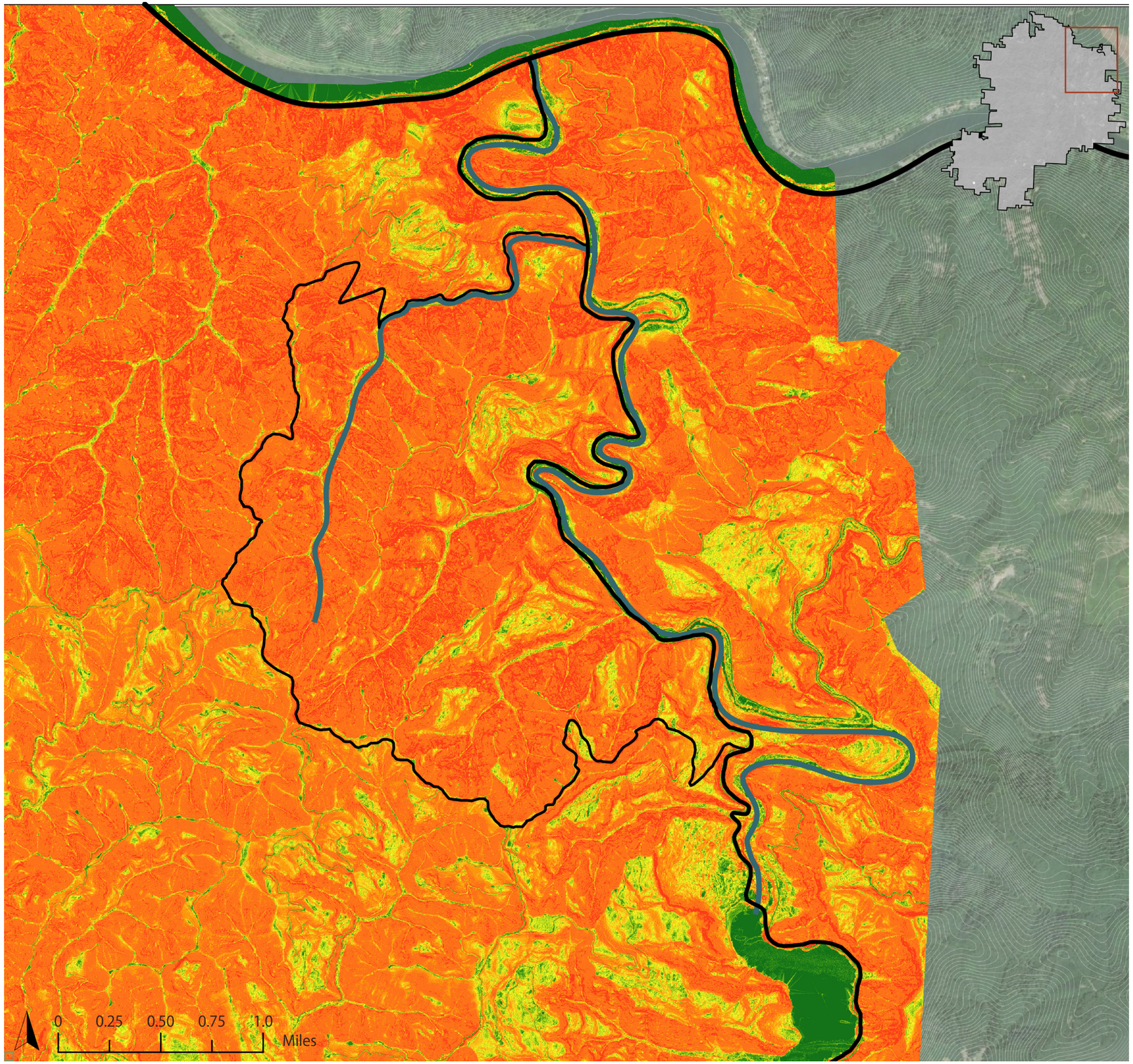
Is it Possible?

With a better understanding of the Elliot's topography, I began to wonder if universal access was even possible. The Elliot is steep!

Slope Percentage

<3%	<25%
<6%	<30%
<10%	<40%
<15%	<60%
<20%	>100%

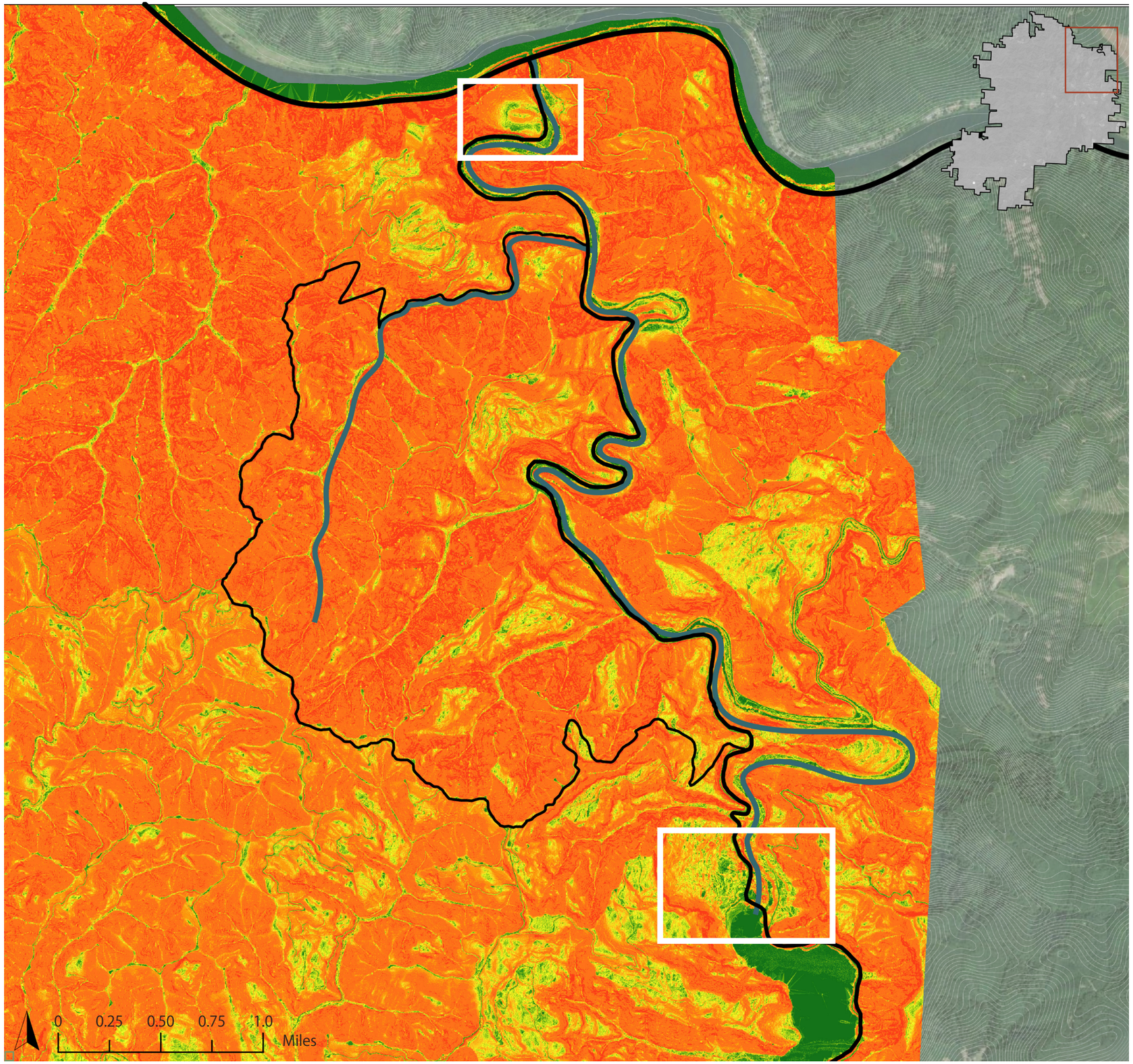




UNIVERSAL ACCESS

Yes! It is Possible!

Fortunately, there does seem to be a couple of flatter areas near both trailheads providing universal access.



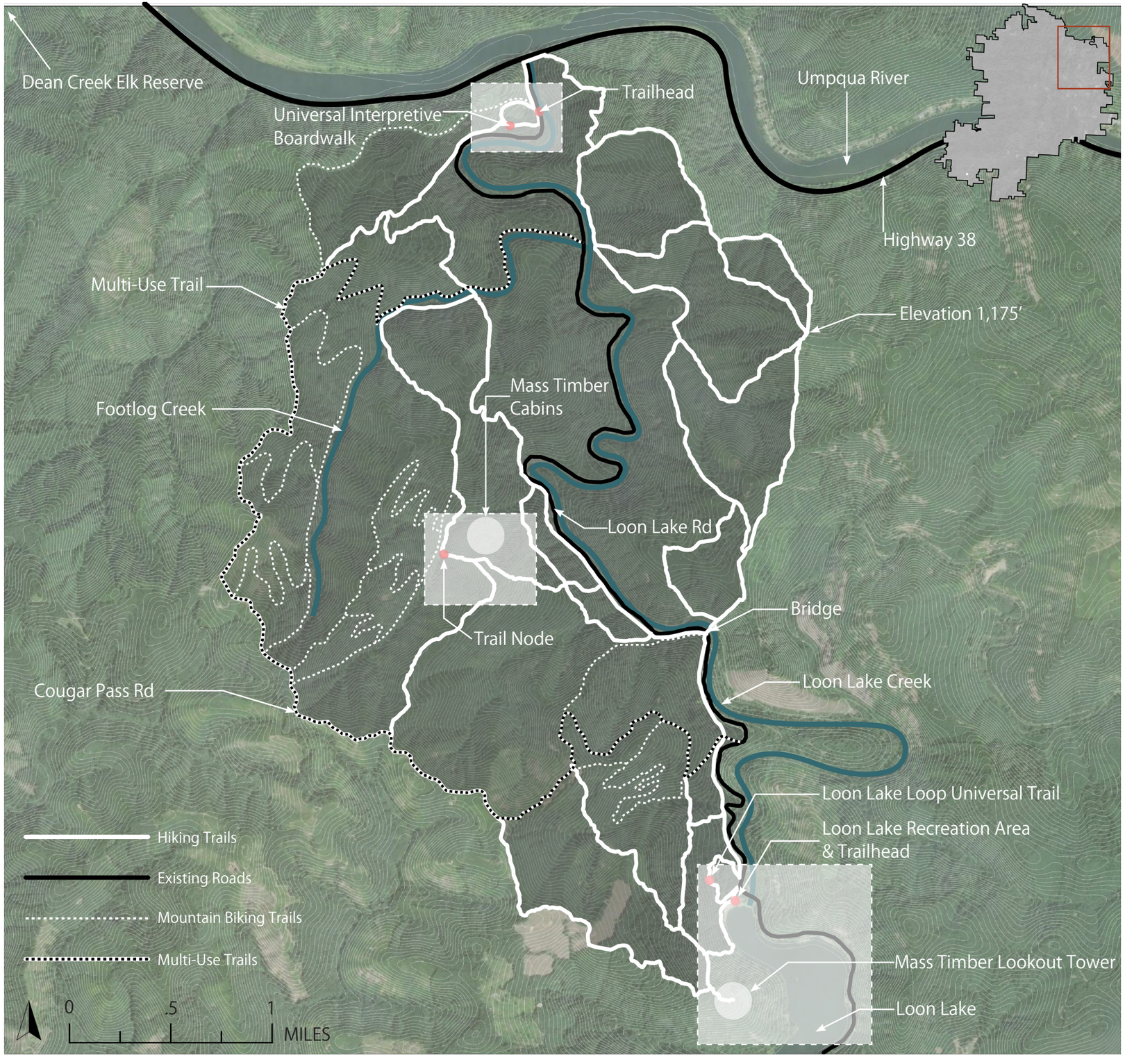
TRAIL FOR THE MASSES

Master Plan

Putting it all together, we arrive at the master plan for the trail for the masses.







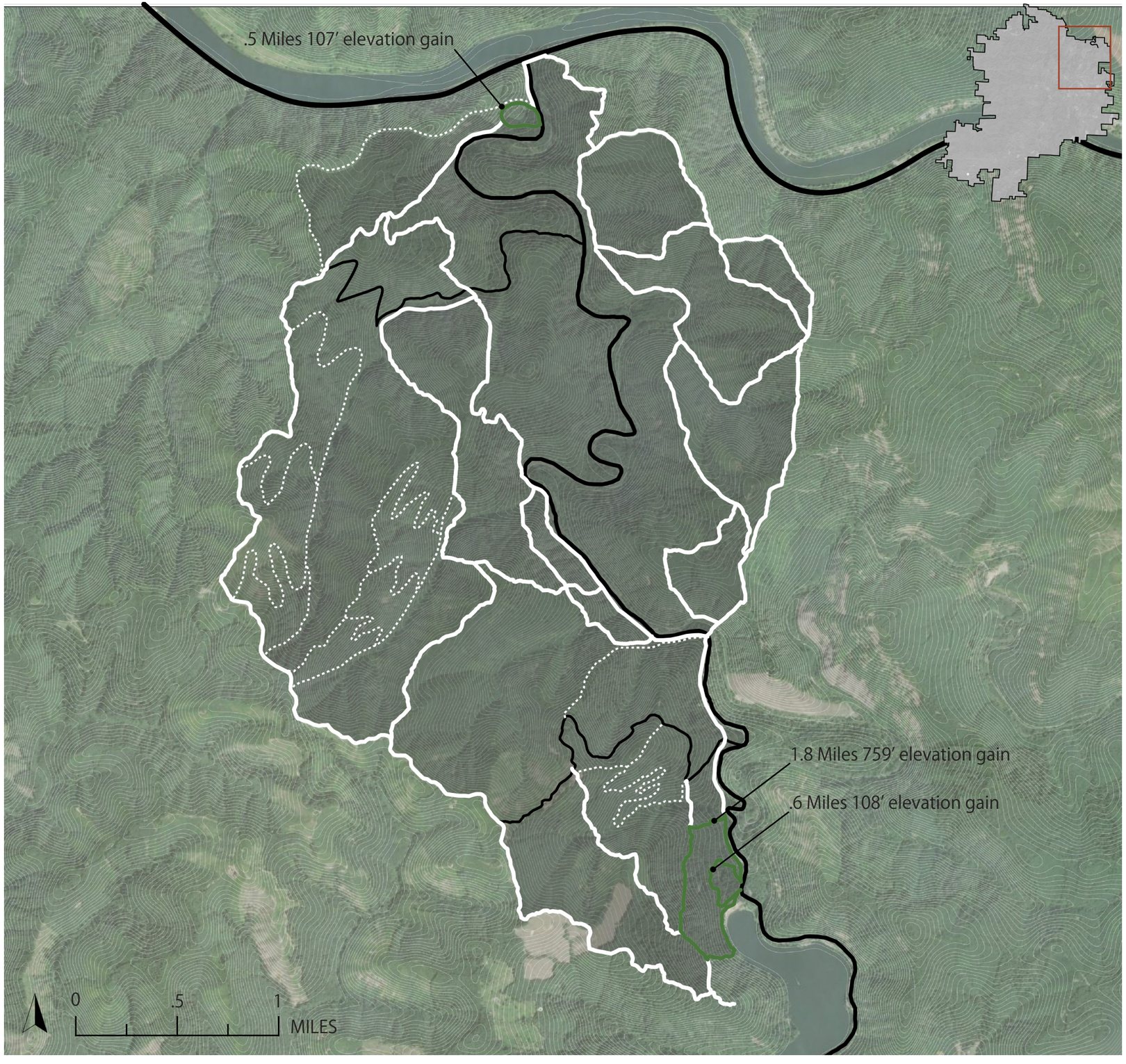
TRAIL FOR THE MASSES

Trail Rating- Easy

Sierra Club Hike Rating System

Easy- 6 miles or less with gentle elevation gains a losses of 1,000 to 2,500 feet. 30 minutes - 2 hours.





TRAIL FOR THE MASSES

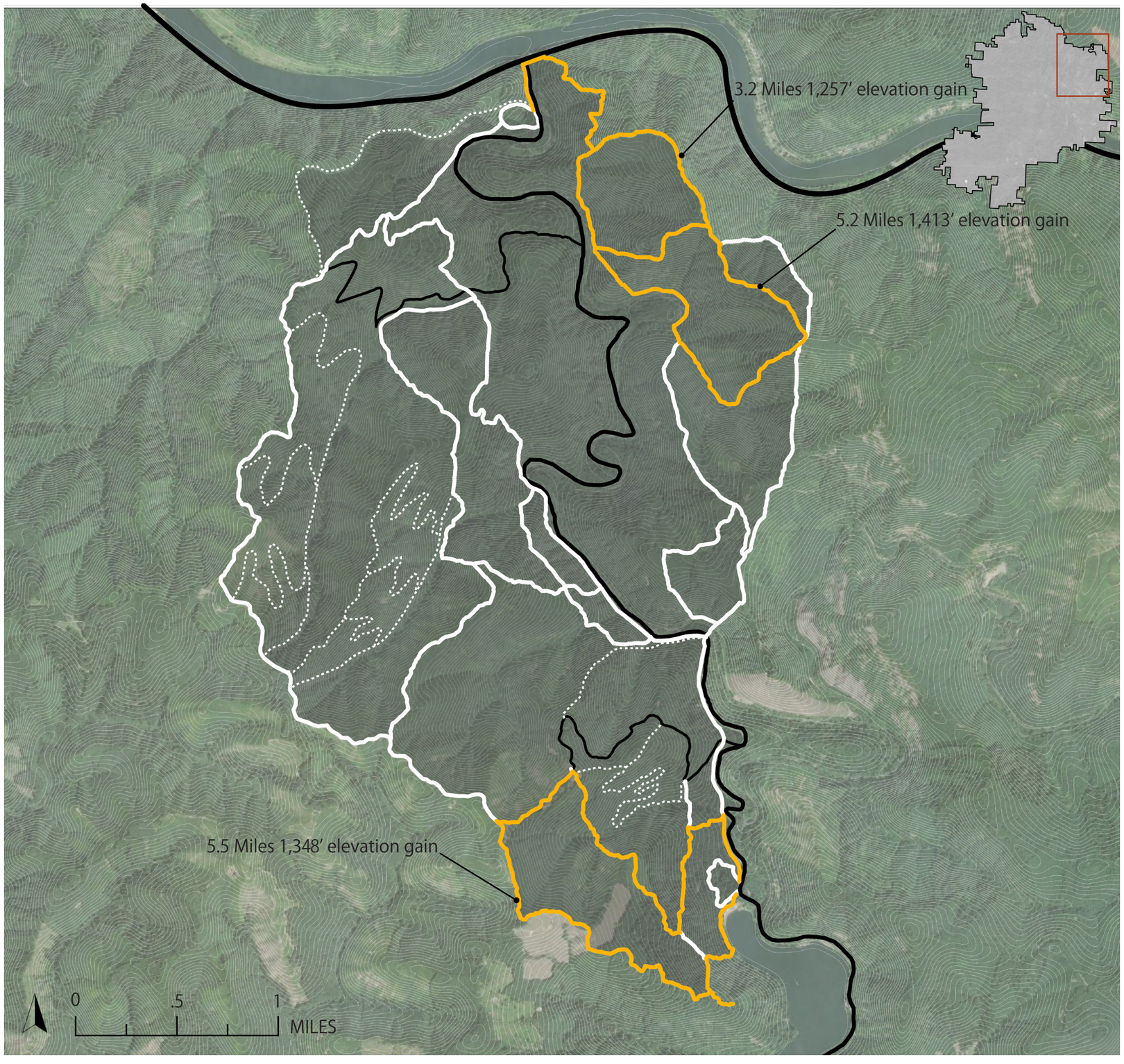
Trail Rating- Moderate

Sierra Club Hike Rating System

Easy- 6 miles or less with gentle elevation gains a losses of 1,000 to 2,500 feet. 30 minutes- 2 hours.

Moderate- 6 to 10 miles with varied terrain and gradual elevation gains and losses of 1,000 to 2,500 feet. 2-4 hours.





TRAIL FOR THE MASSES

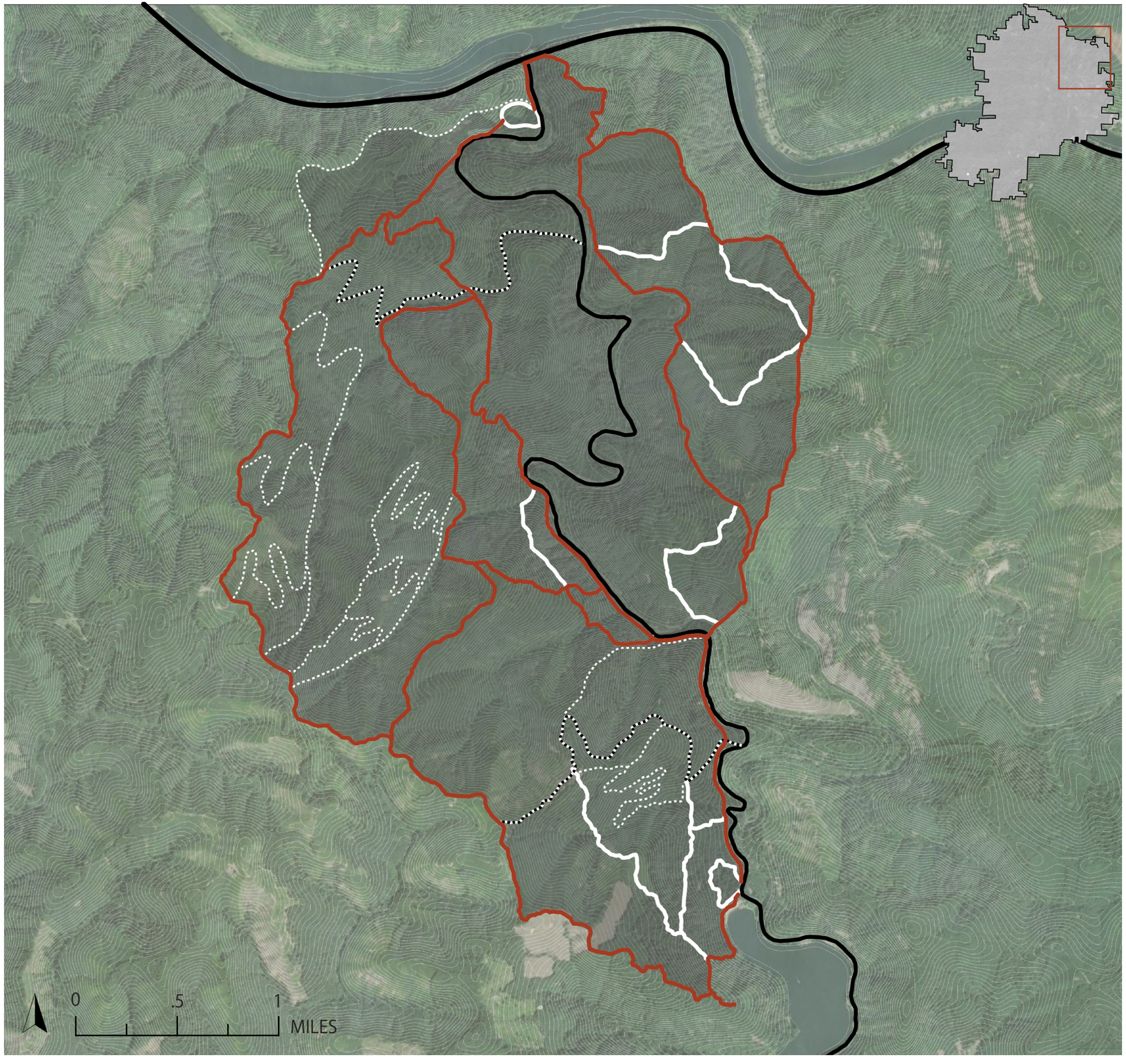
Trail Rating- Strenuous

Sierra Club Hike Rating System

Easy- 6 miles or less with gentle elevation gains a losses of 1,000 to 2,500 feet. 30 minutes - 2 hours.

Moderate- 6 to 10 miles with varied terrain and gradual elevation gains and losses of 1,000 to 2,500 feet. 2-4 hours.

Strenuous- 9 or more miles with significant elevation gains and losses greater than 2,500 feet. 4+ hours

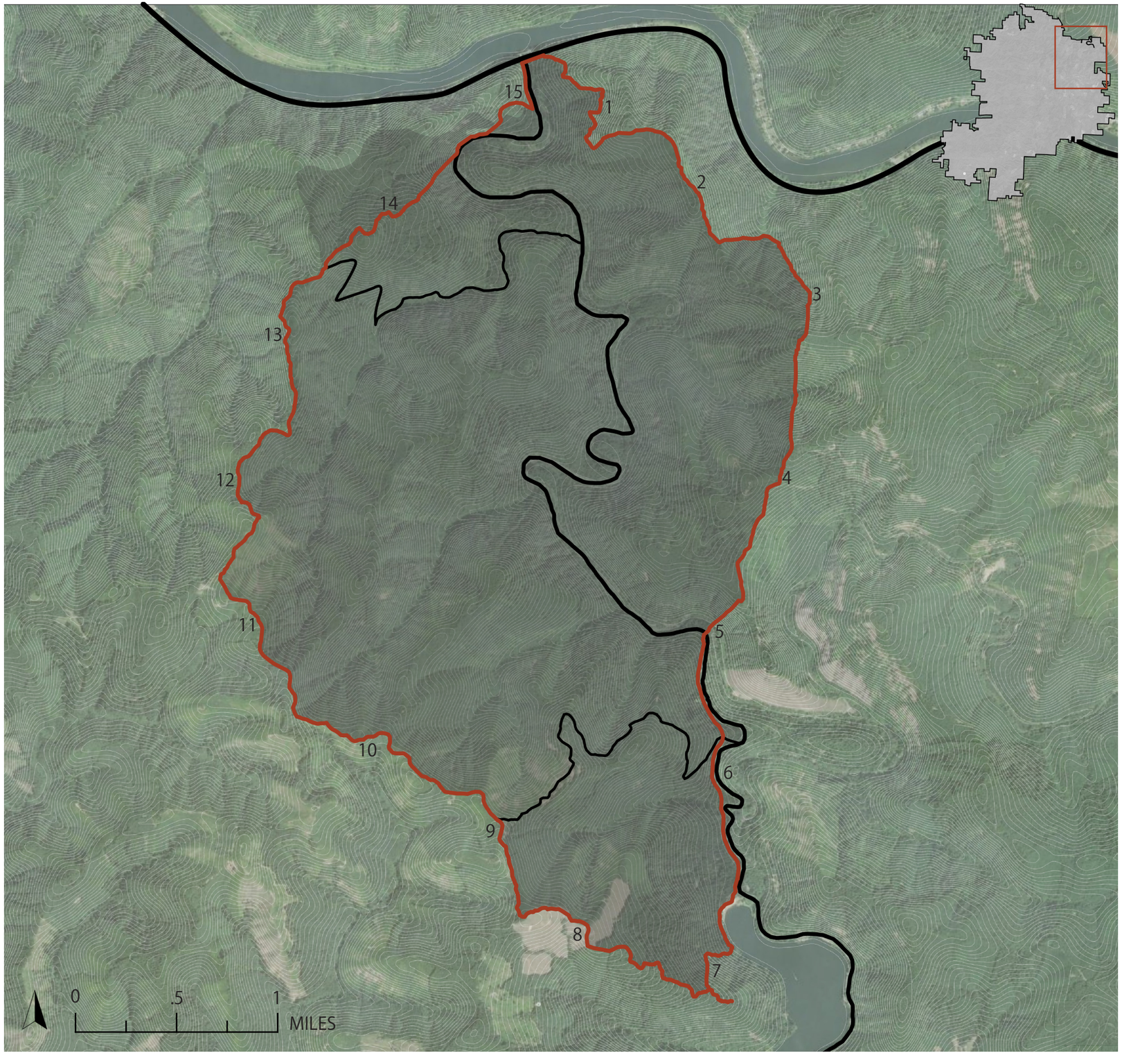




TRAIL FOR THE MASSES

One Massive Loop

This trail system could be utilized by day hikers and backpackers looking for overnight adventures—the full loop clocks in at just over 15 miles with almost 2,000 feet of elevation gain.



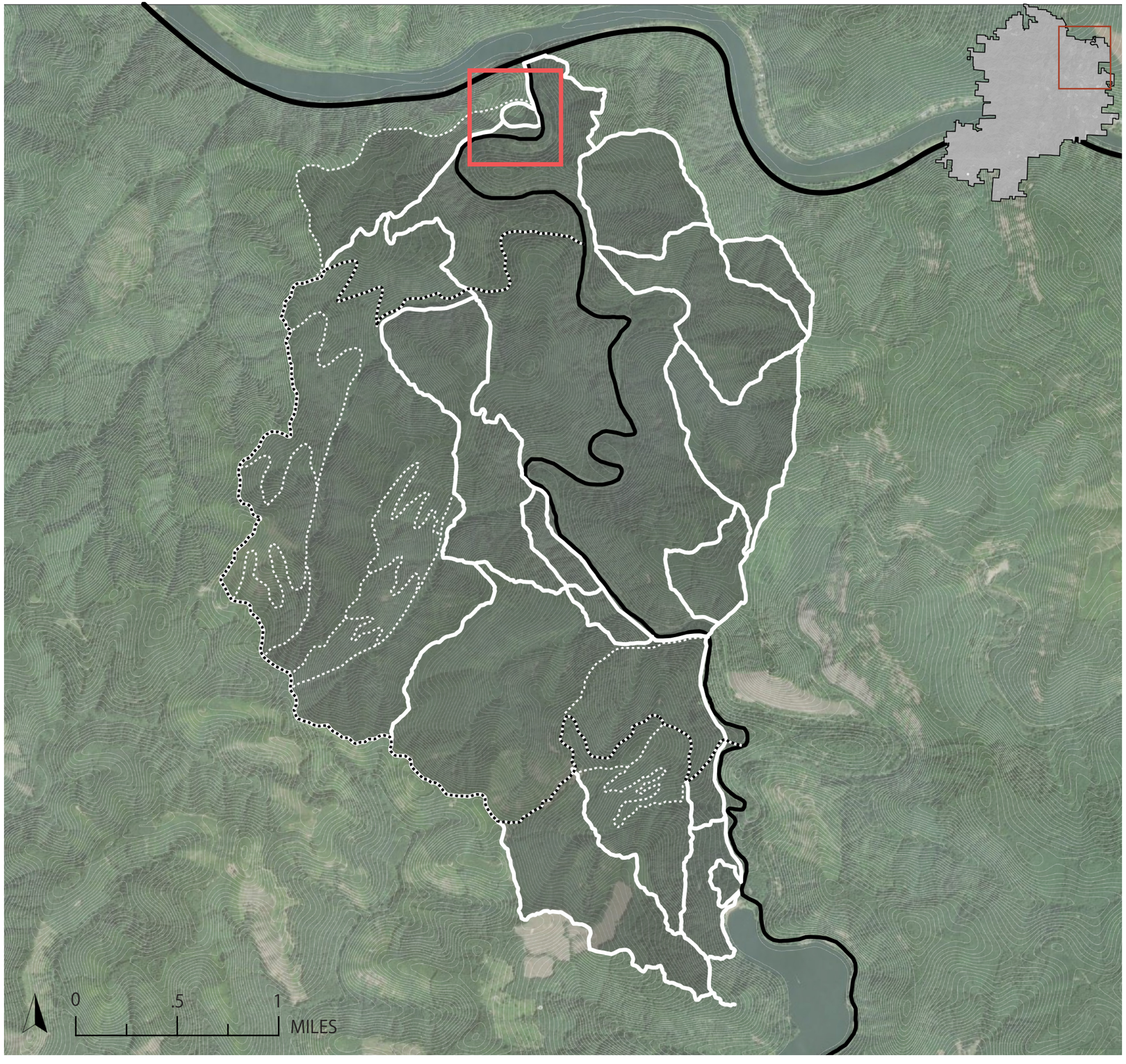


TRAIL DESIGN

TRAIL FOR THE MASSES

Trail Design

This project allowed me to really dig into GIS and understand its capabilities as well as its limitations. The techniques I utilized worked well at this master plan scale. However, when I zoomed into the site for trail design, I learned it was time to switch programs.

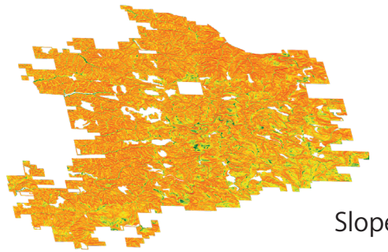




TRAIL FOR THE MASSES

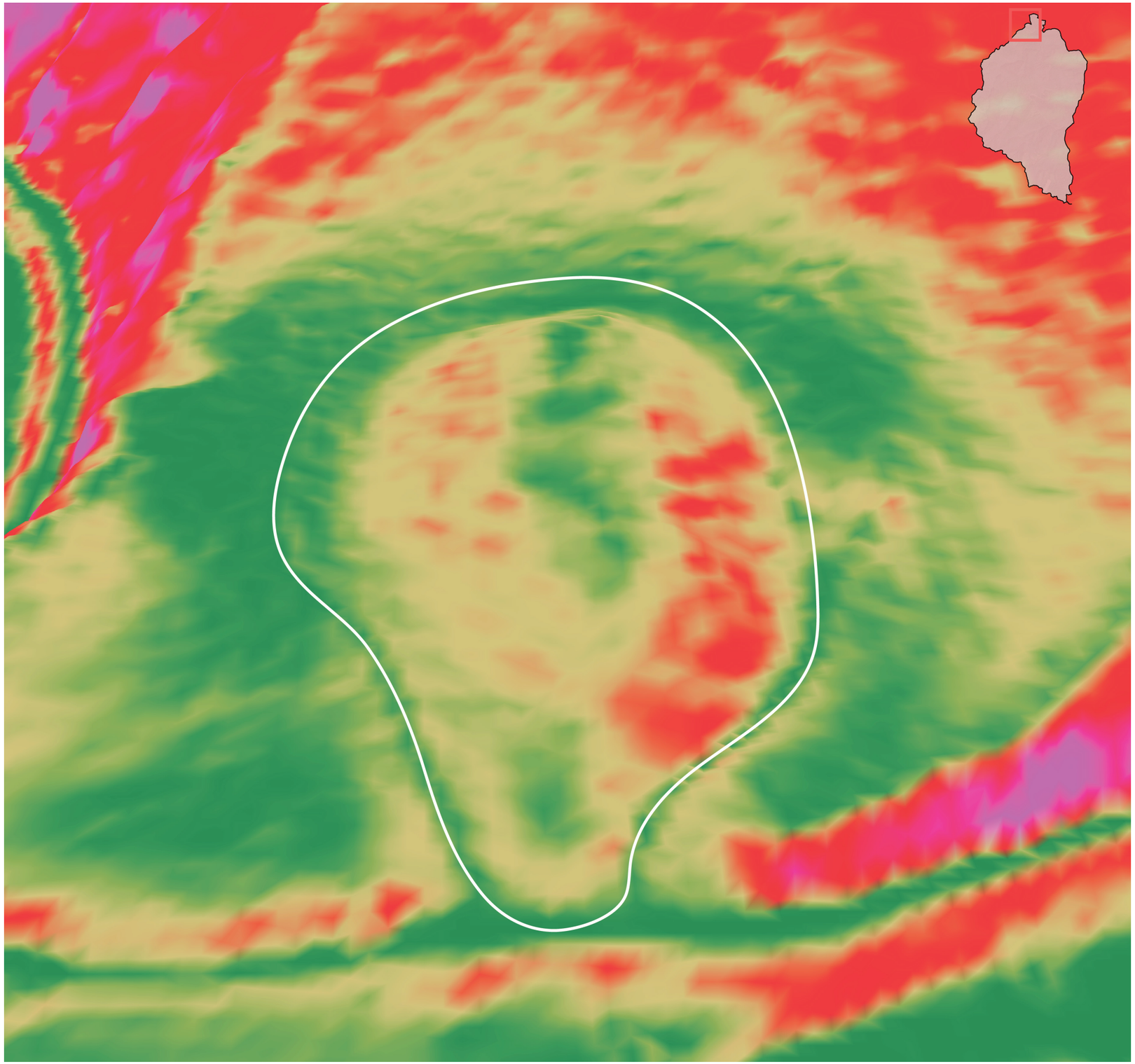
Universal Access

Looking at this slope map of the area in which I have proposed a universal access trail, it looks as though you could just throw in a trail like this.



Slope

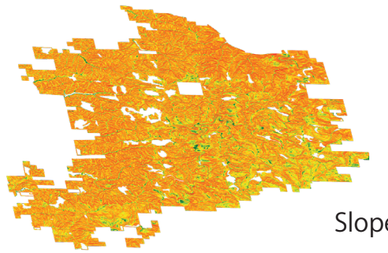




TRAIL FOR THE MASSES

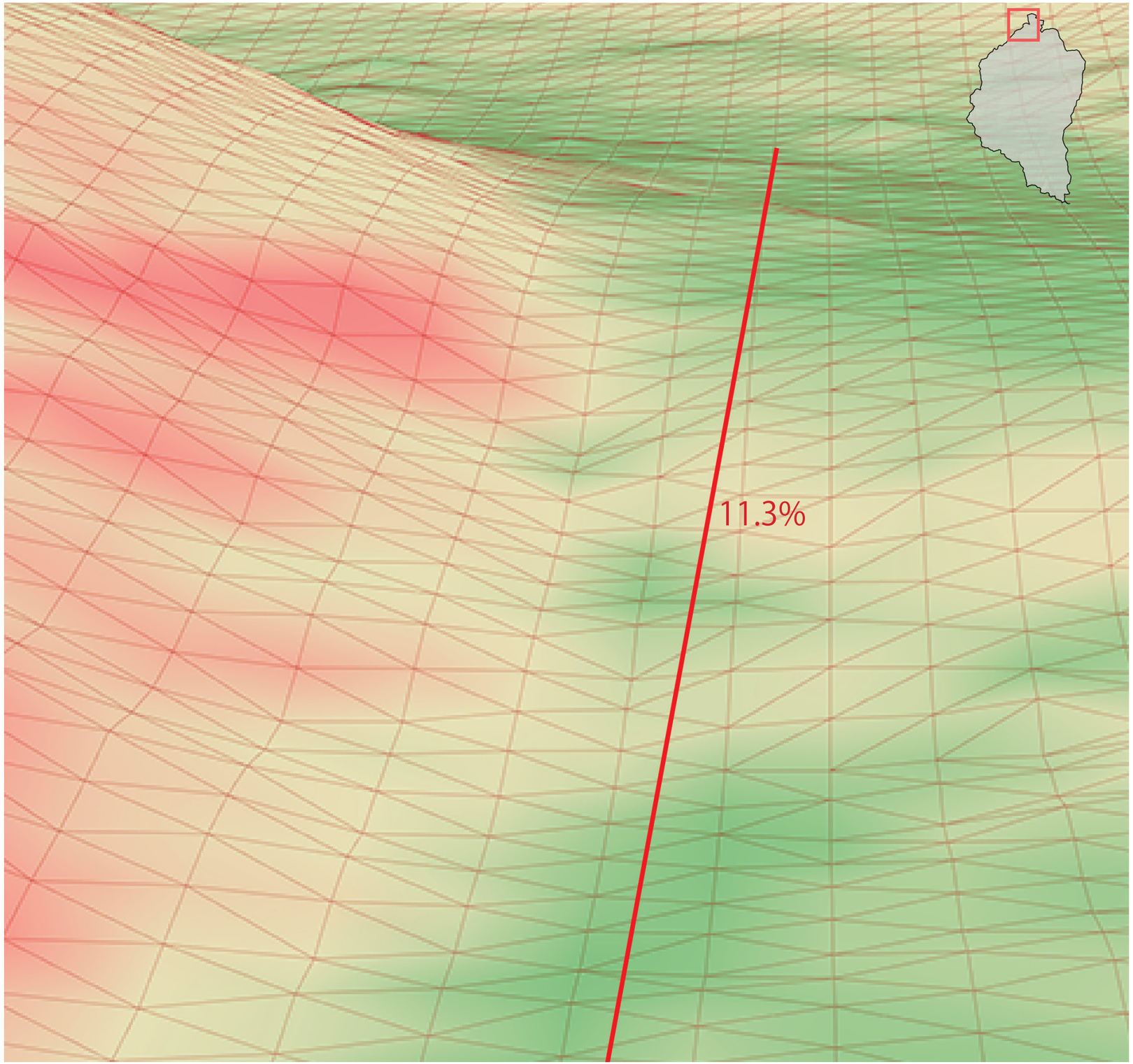
Universal Access

However, as you continue to zoom in and start laying out a trail, you can see that a straight line is too steep to provide universal access which requires slopes to be no greater than 5%.



Slope

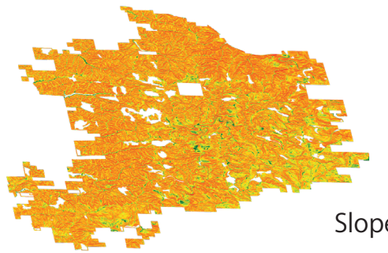




TRAIL FOR THE MASSES

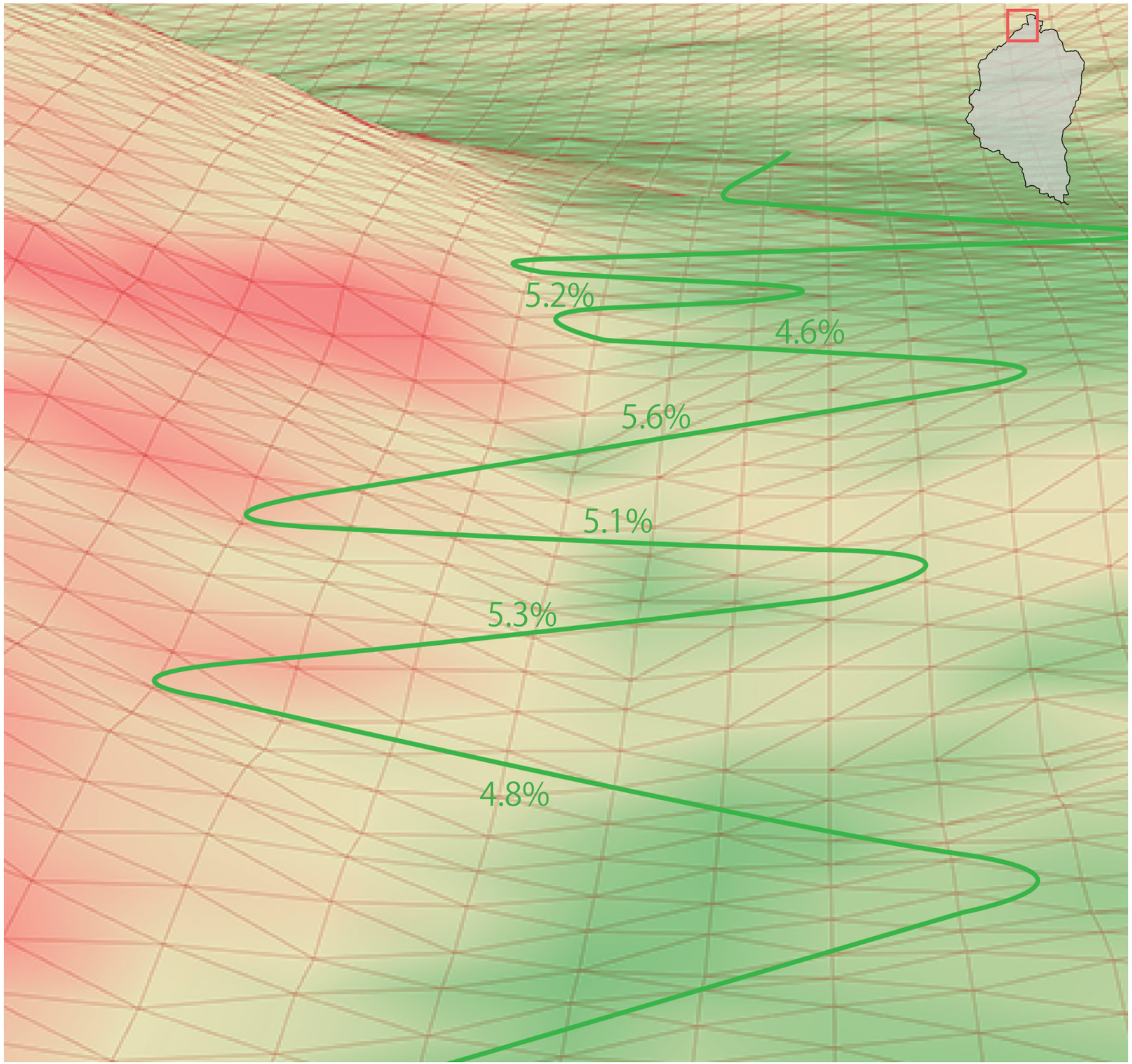
Universal Access

Using Rhino and a Grasshopper script, you can see that a universal trail would look much different than the one shown at the master plan level of detail.



Slope





TRAIL DESIGN

Coupling Stewardship & Design

And let's not forget that we are coupling this trail with stewardship treatments like thinning to improve forest health while also providing fiber for mass timber products.

Using individual tree-level data from OSU, including the specific location of trees and characteristics like height and width, we can use Grasshopper to select particular trees to be removed based on your management goals. These images here show trees to be removed based on their width. Smaller diameter trees shown in red are flagged for thinning removal.

Appendix A. Douglas-fir stand density table

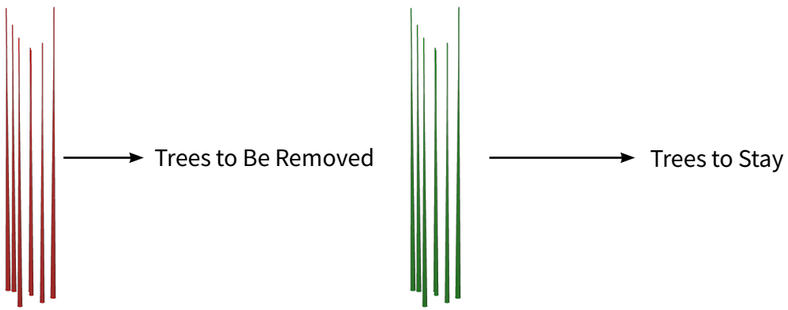
Approximate tree size in inches DBH at different absolute densities (trees per acre, or by approximate spacing [in feet]) and competition level (RD). Based on stand quadratic mean diameter and a maximum stand density index of 520.

Zones and thresholds ▼	Relative density ▼	Trees per acre ▶	50	75	100	125	150	175	200	225	250	275	300	360	435	680
		Spacing ▶	30'	24'	21'	19'	17'	16'	15'	14'	13'	12.5'	12'	11'	10'	8'
Maximum Stocking	100	▼ Average diameter at breast height (DBH) ▶	43"	33"	28"	24"	22"	20"	18"	17"	16"	15"	14"	13"	11"	8"
Zone of No Return	75		39	30	25	22	20	18	16	15	14	13	13	11	10	8
	70		36	28	23	20	18	16	15	14	13	12	12	11	9	7
Danger Zone	65		33	26	21	19	17	15	14	13	12	11	11	10	9	6
	60		31	24	20	18	16	14	13	12	11	11	10	9	8	6
	55		30	23	19	17	15	14	12	12	11	10	10	9	8	6
Upper Goldilocks Zone	50		28	22	18	16	14	13	12	11	10	10	9	8	7	5
	45		26	20	17	15	13	12	11	10	10	9	9	8	7	5
Lower Goldilocks Zone	40		24	19	16	14	12	11	10	10	9	8	8	7	6	5
	35		22	17	15	13	11	10	9	9	8	8	7	7	6	4
Enthusiastic Growth Zone	30		20	16	13	11	10	9	9	8	7	7	7	6	5	4
	25		18	14	12	10	9	8	8	7	7	6	6	5	5	4
	20		16	12	10	9	8	7	7	6	6	5	5	5	4	3
Crown Closure	15		13	10	9	7	7	6	6	5	5	5	4	4	3	3

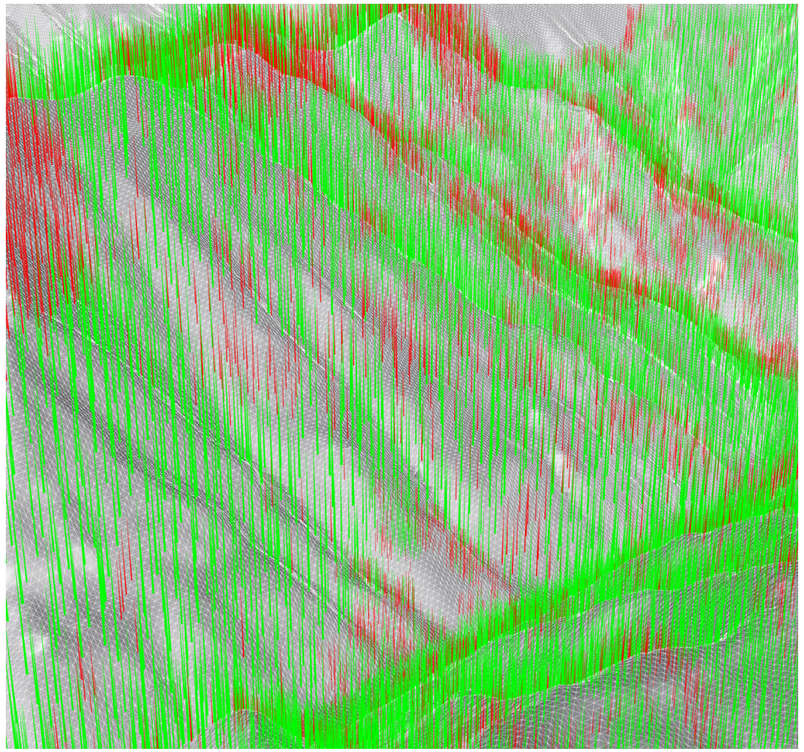
Table: Withrow-Robinson and Maguire, © Oregon State University

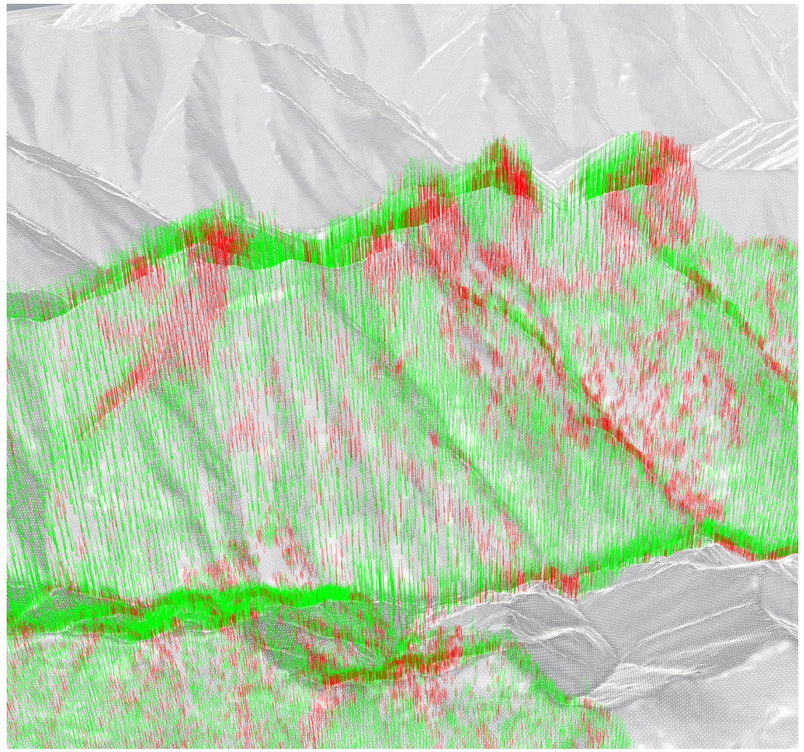
Oregon State University

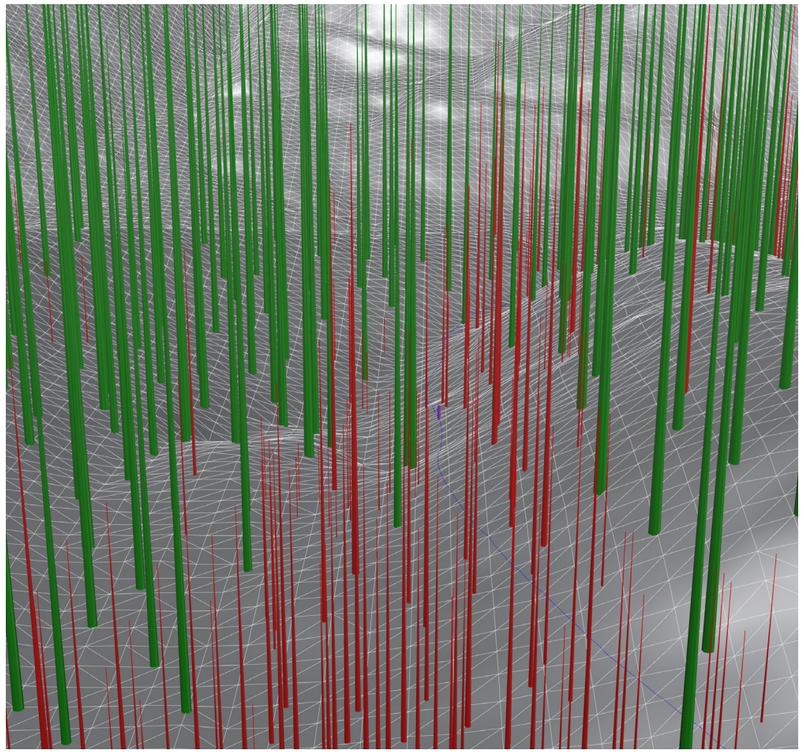
EM 9206
June 2018

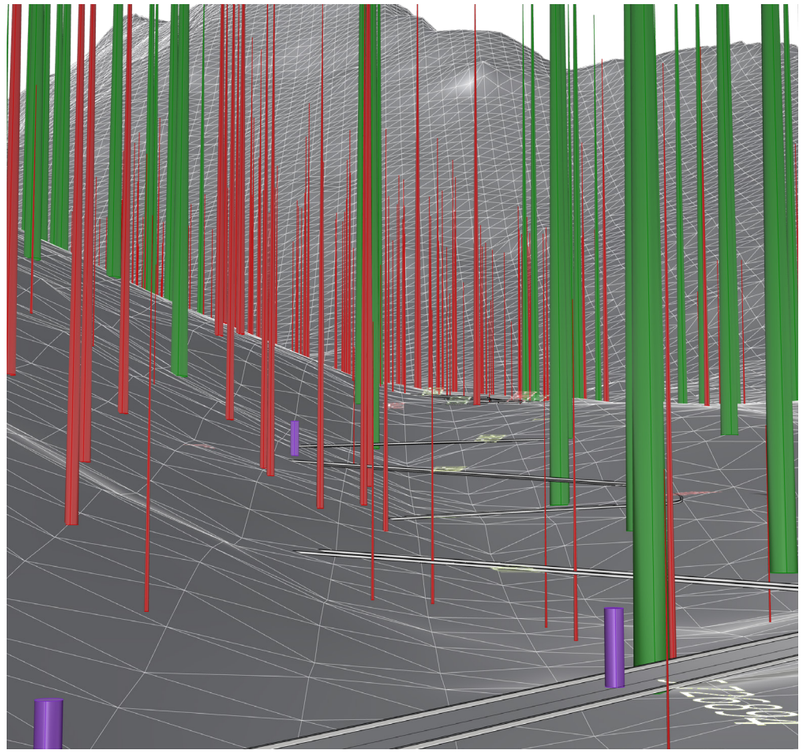










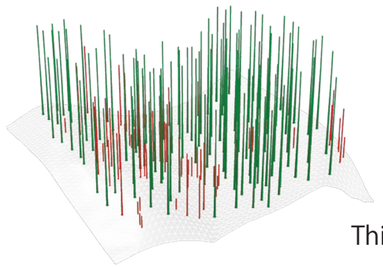


TRAIL DESIGN

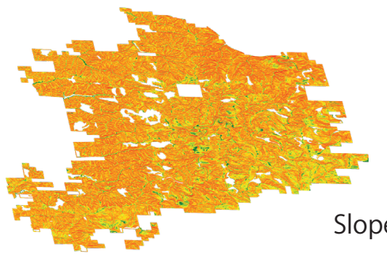
Coupling Stewardship & Design

Pre-Thinning

Zooming back into our universal access trail location, you can see what this would look like on the ground. This is a pre-thinning shot.



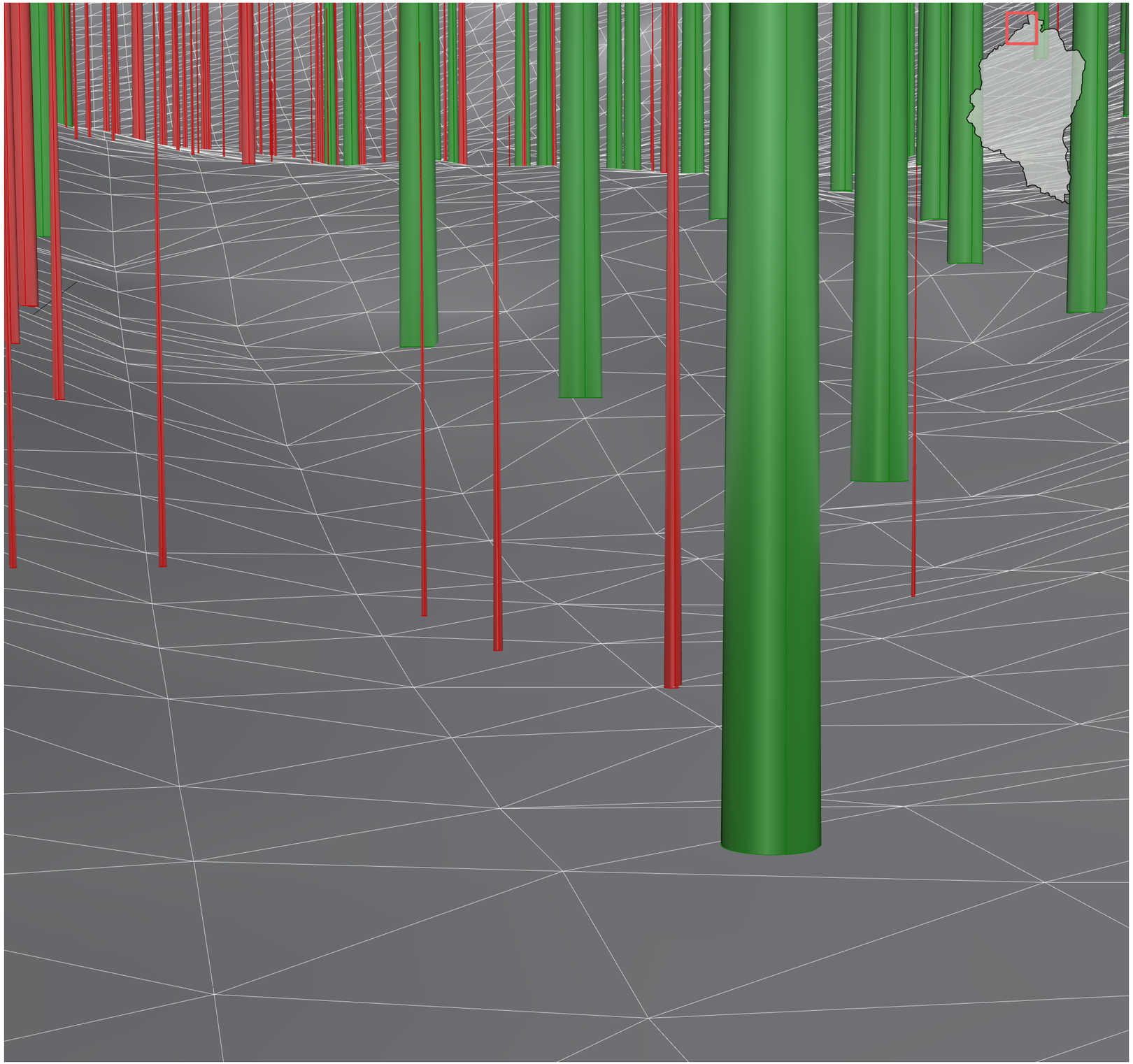
Thinning



Slope



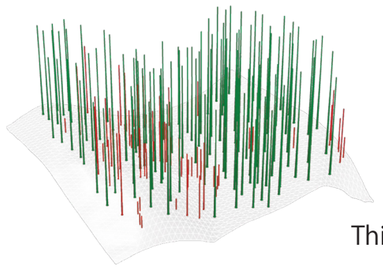




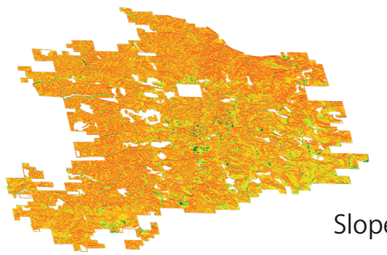
TRAIL DESIGN

Coupling Stewardship & Design

Post-Thinning



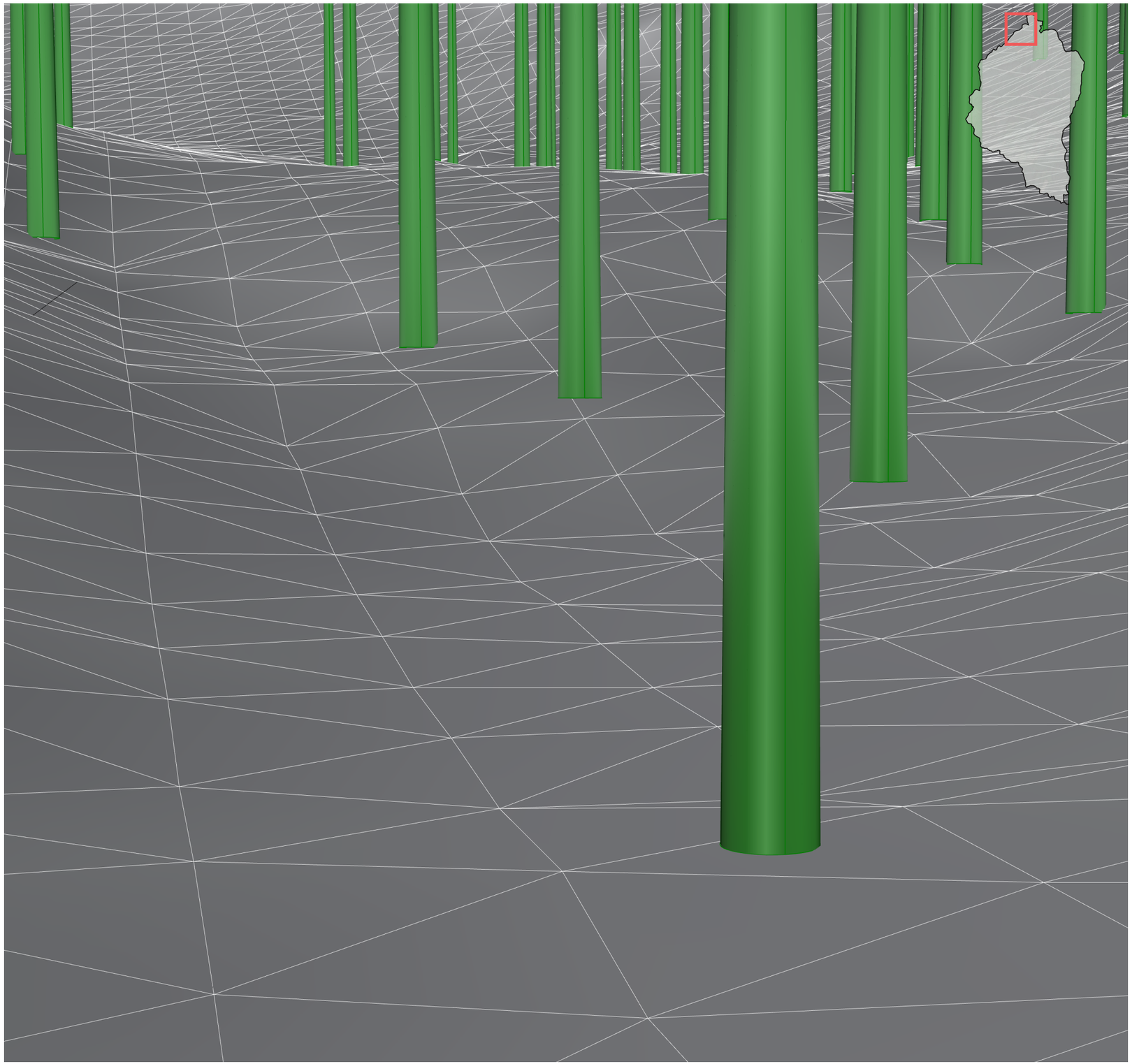
Thinning



Slope



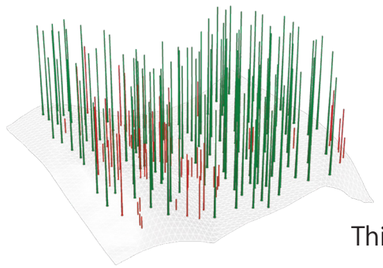




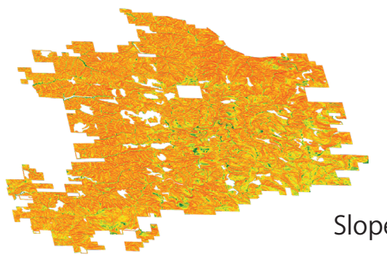
TRAIL DESIGN

Coupling Stewardship & Design

Putting together slope constraints with thinning operations, we now have a clearer idea of where to place a trail.



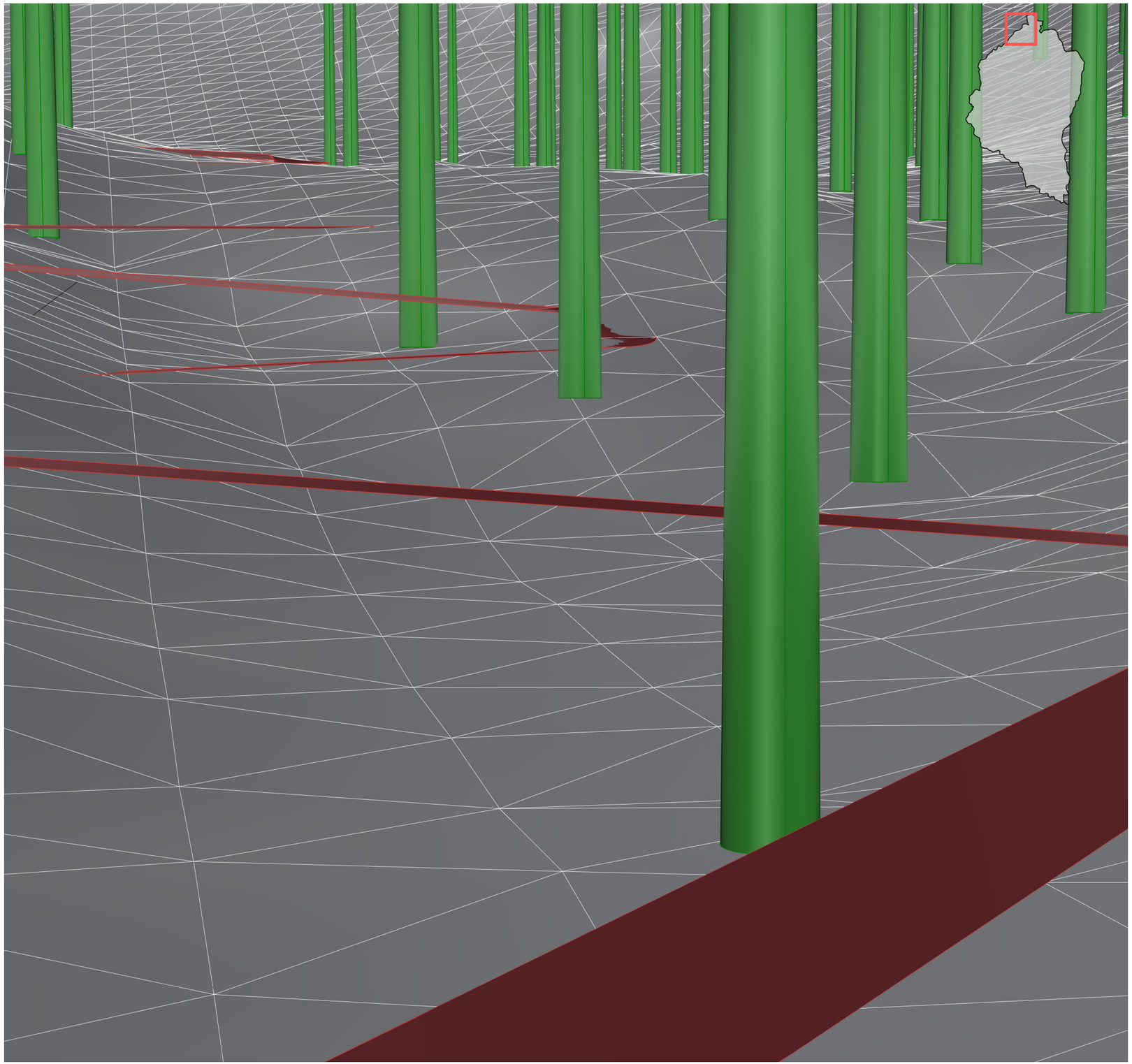
Thinning



Slope





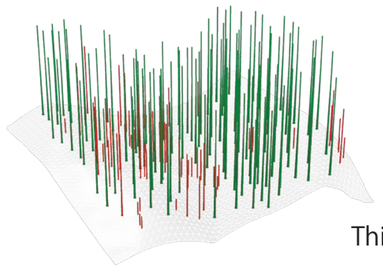


UNIVERSAL ACCESS

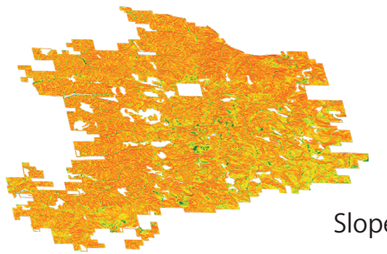
Pre-thinning

Pre-Thinning Forest Characteristics

Thick overcrowded forest
Intense competition from trees
Low understory biodiversity



Thinning



Slope







UNIVERSAL ACCESS
Post-thinning

Post-Thinning Forest Characteristics
Open forest floor allowing for more understory diversity
Optimal competition between trees
Creates space for demonstration projects

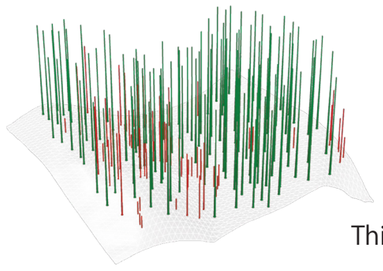




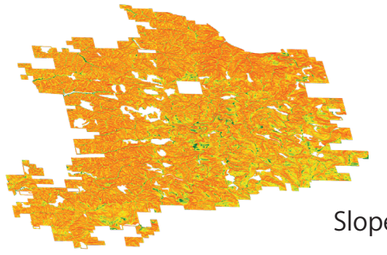
TRAIL FOR THE MASSES

Trail Design

The process of siting a mountain biking trail would look different as we are not as concerned about the slope. We want it steep!



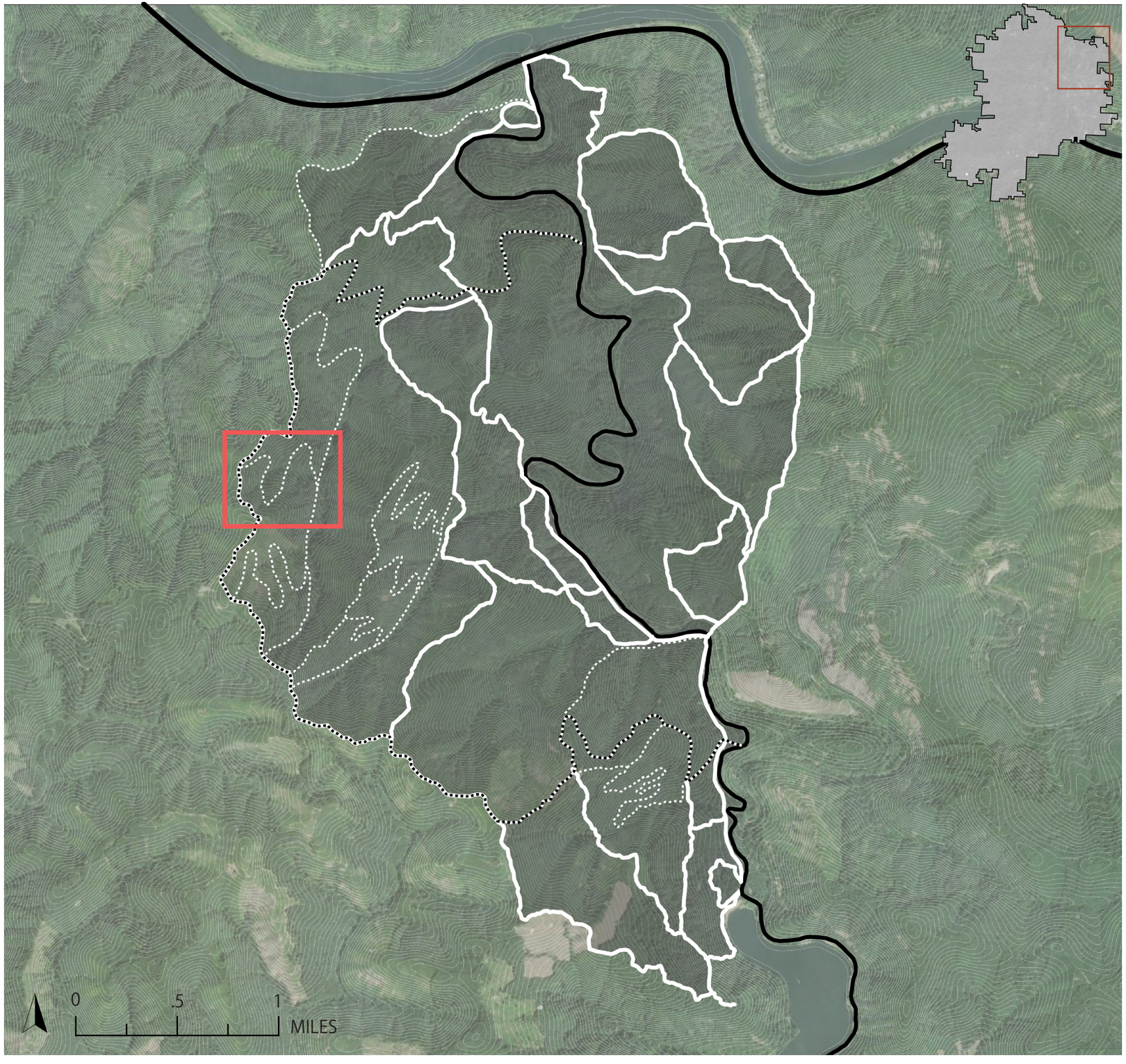
Thinning



Slope



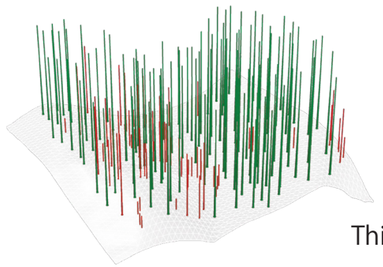




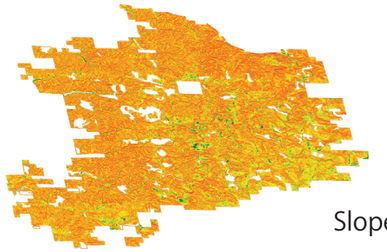
TRAIL DESIGN

Coupling Stewardship & Design

Instead, we are interested in where you could place a trail where a mountain biker won't smash into a tree.



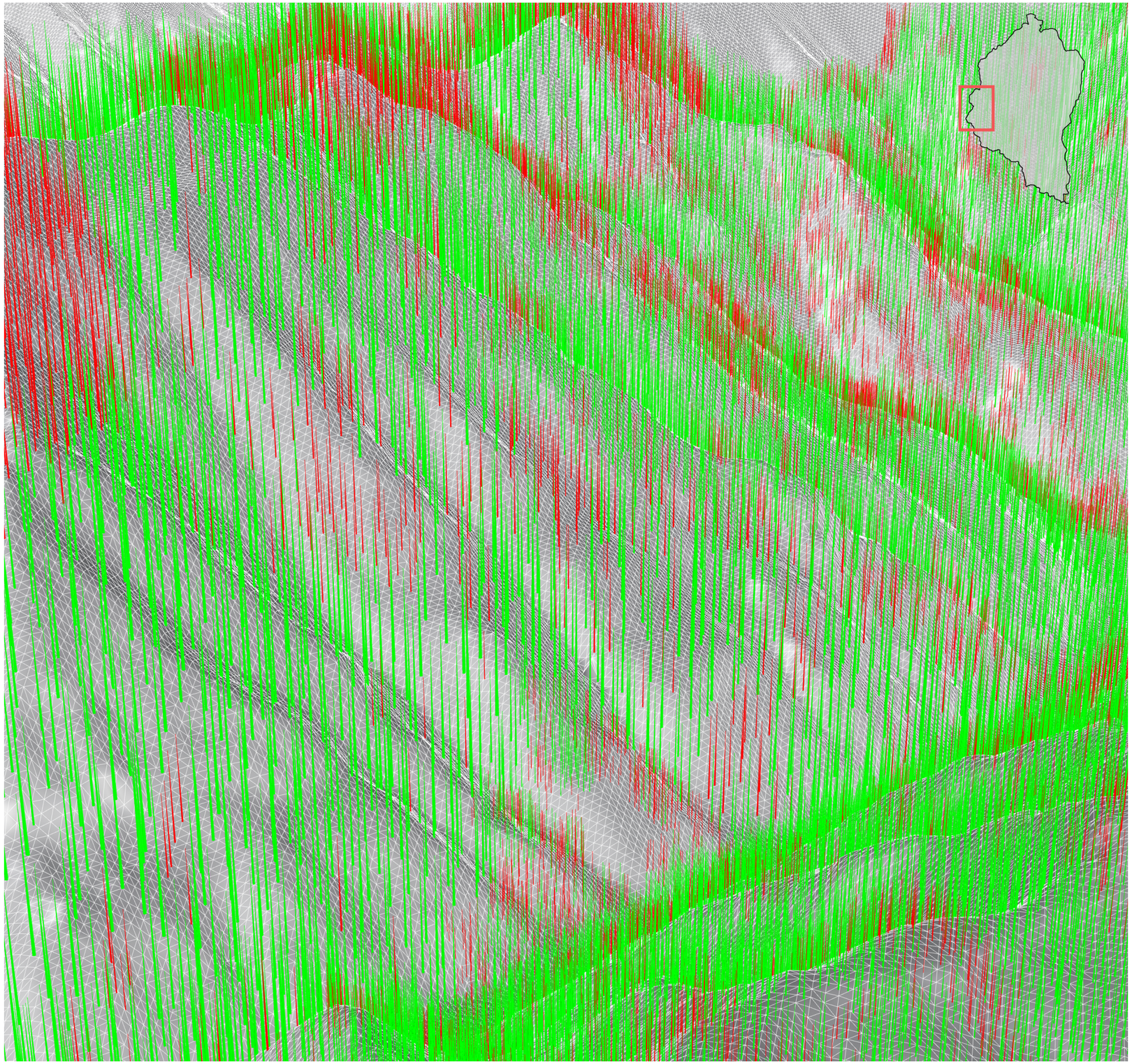
Thinning



Slope



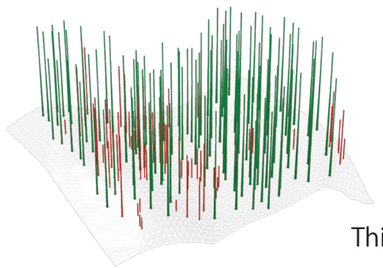




TRAIL DESIGN

Coupling Stewardship & Design

Looking downslope from the top of a ridgeline, you can see what the pre-thinning conditions would look like.



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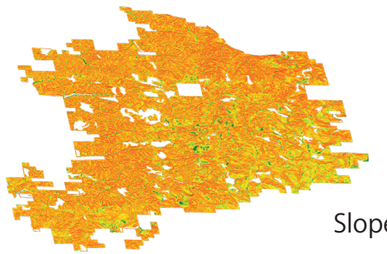

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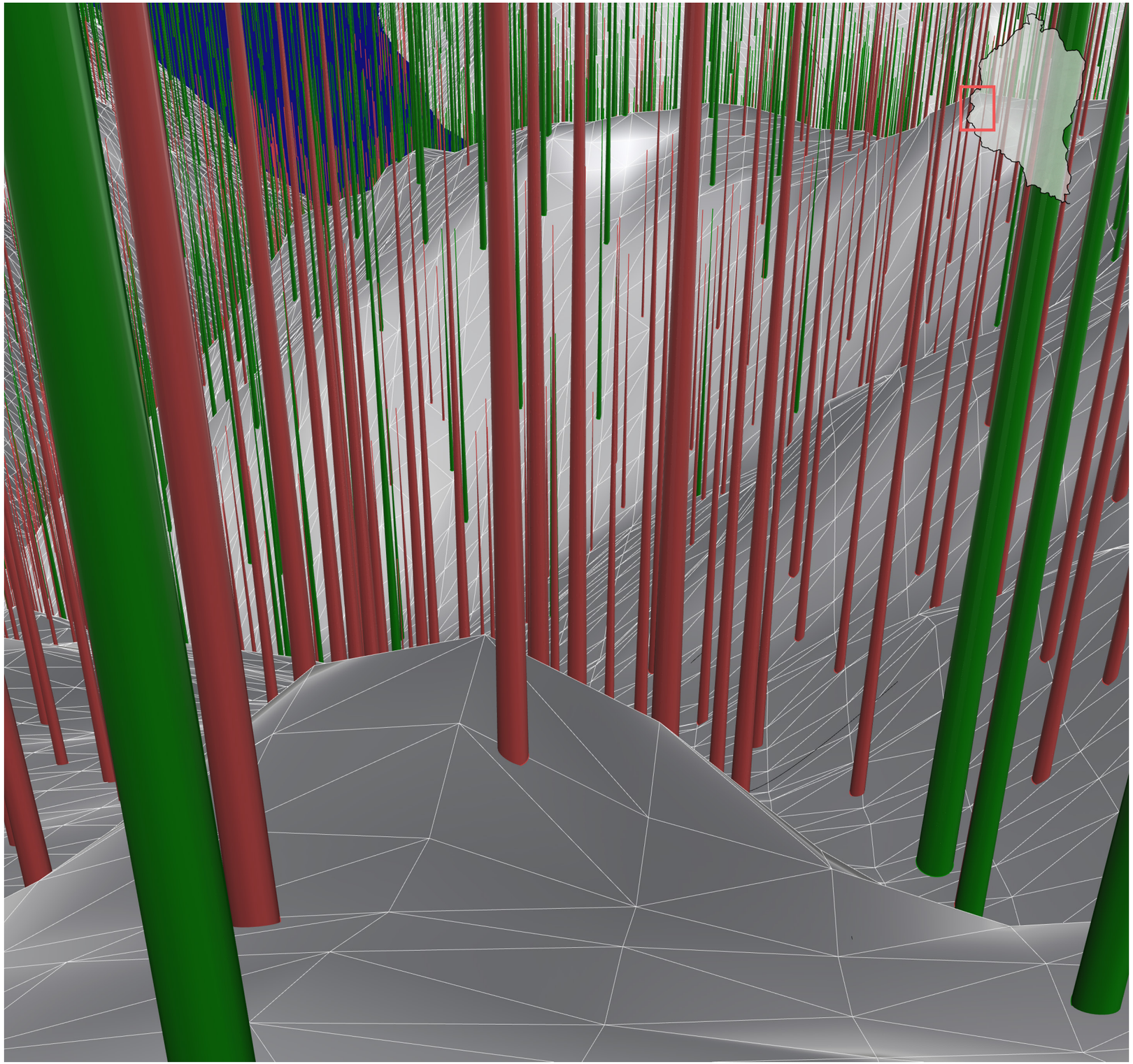
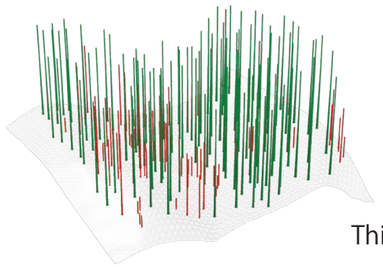


TRAIL DESIGN

Coupling Stewardship & Design

Following the thinning treatment, we have much more room to work with. This space allows us to create more mass timber demonstrations, like a mountain biking skills course, which could be a big regional draw.



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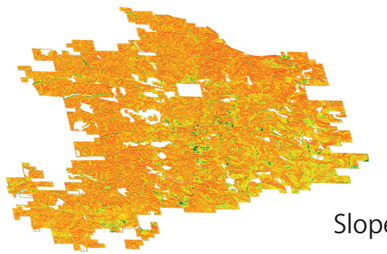

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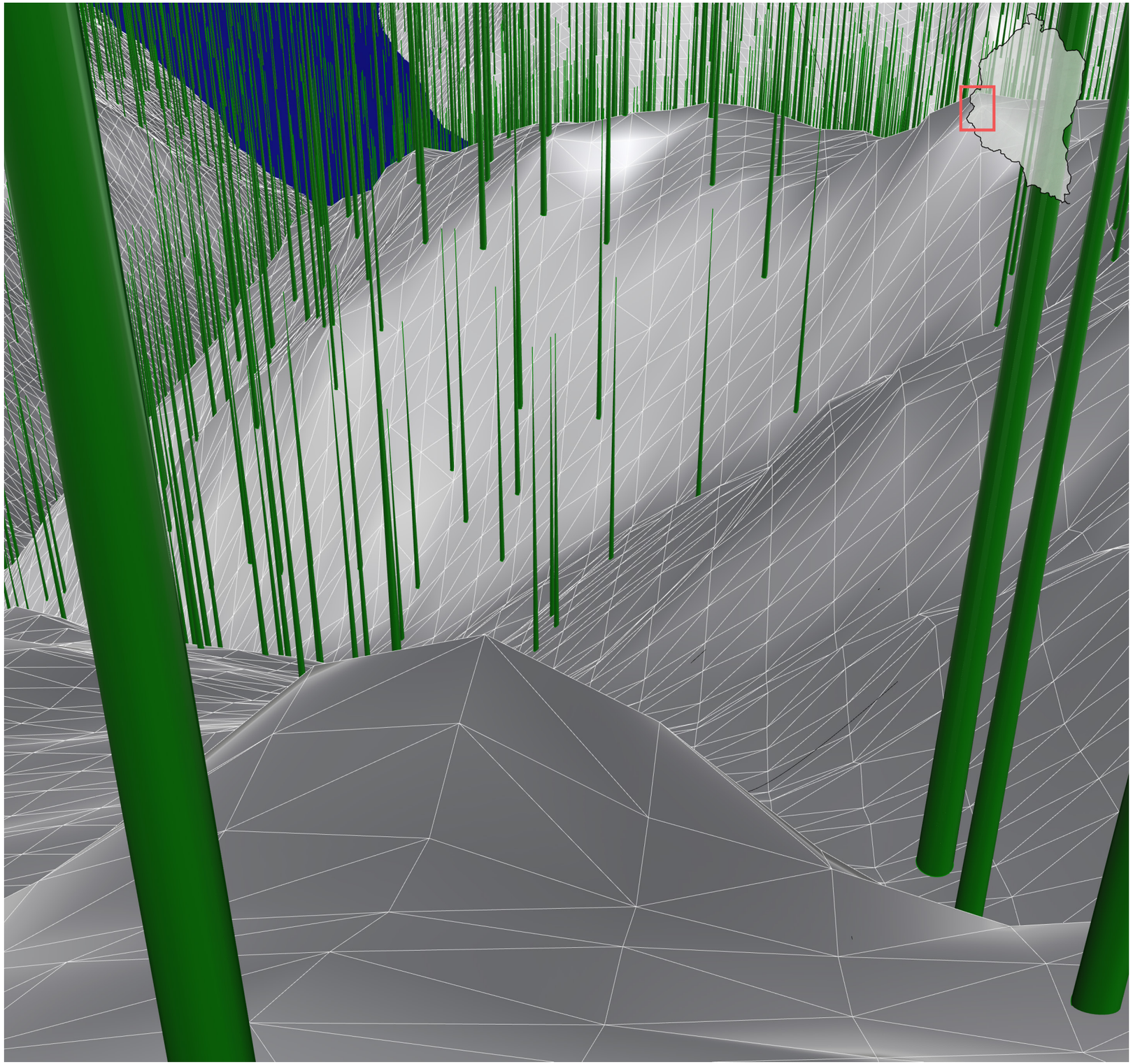


TRAIL DESIGN

Mountain Bike Skills Course



CAMERON CORONADO

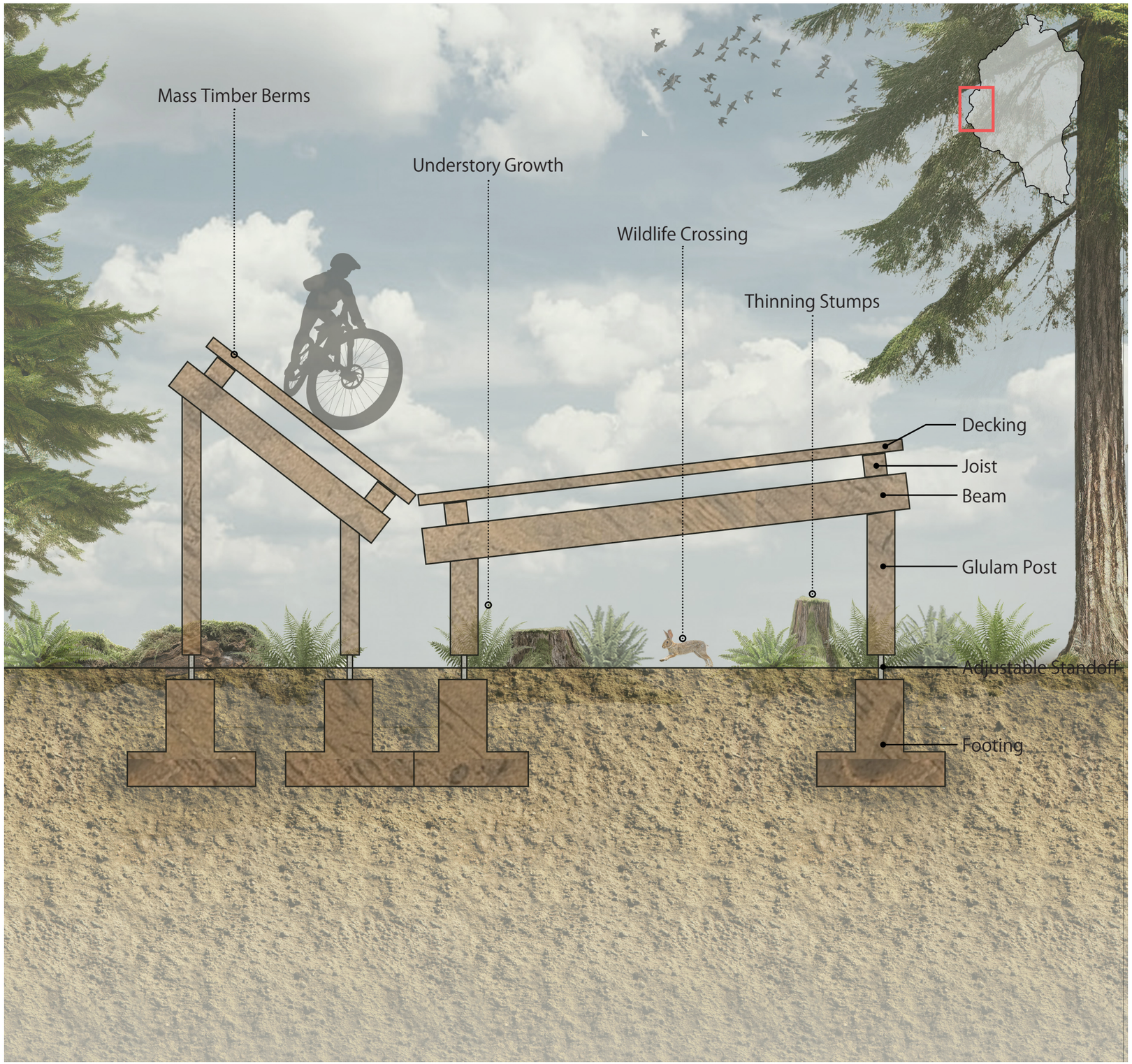
MASS TIMBER DEMONSTRATIONS

MASS DEMONSTRATIONS

Mountain Bike Skills Course

Using the timber from the thinning operation to create mass timber demonstrations will educate visitors on the product's ability to improve forest health and allow us to push new big design ideas. This section highlights some of the benefits a mass timber skills course could provide.

The skills course would need to be raised off the ground since there will be tree stumps left over from the thinning operation. Elevated structures like this would also benefit wildlife, allowing them to move under and avoiding habitat fragmentation.











MASS DEMONSTRATIONS

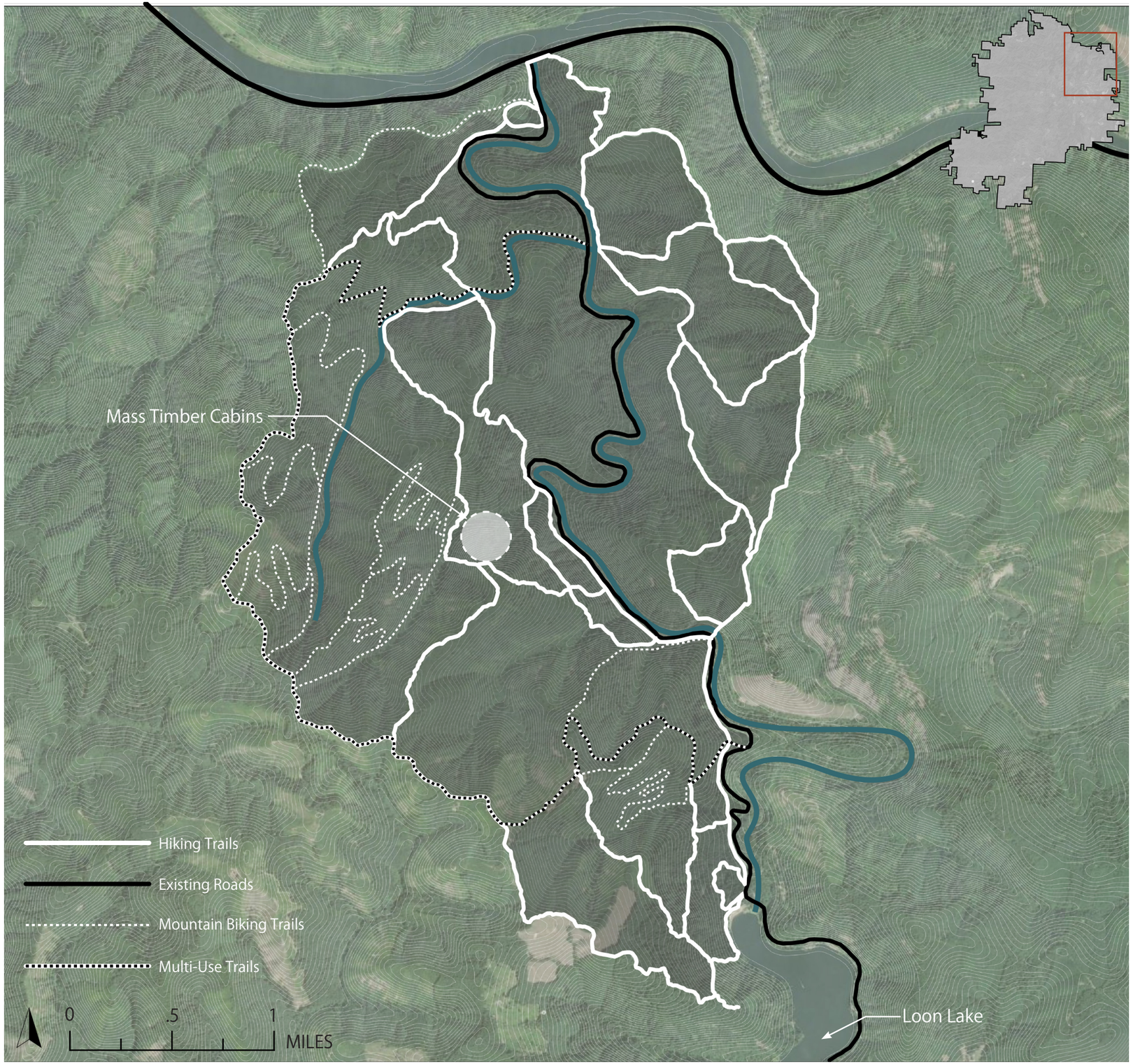
Mass Timber Cabins

As mentioned earlier, some stands are proposed to be clear-cut because they have passed the zone of no return. This blank slate creates an opportunity for another mass timber demonstration with a slightly heavier impact.



Zone of No Return= Design Opportunities





MASS DEMONSTRATIONS

Mass Timber Cabins

Mass timber cabins could be constructed to provide overnight destinations to hikers, bikers, and snowshoers. In addition to showcasing mass timber's ability to be used in remote locations, the landscaping around the cabins could provide examples of fire-wise design practices, defensible space, and home hardening techniques.



Zone of No Return= Design Opportunities







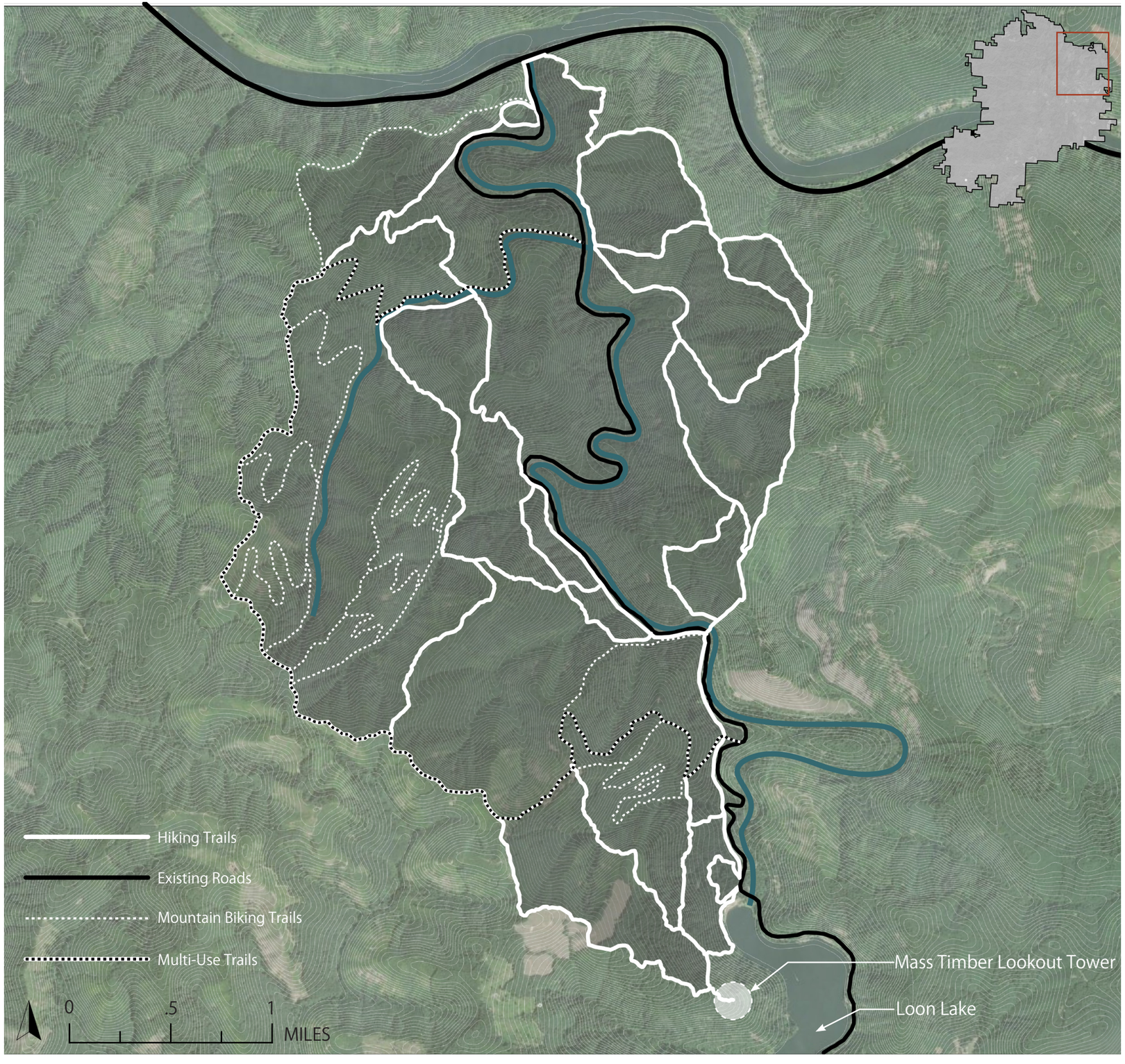


MASS DEMONSTRATIONS

Loon Lake Lookout Tower

The proximity of this trail system near Loon Lake provides us with another exciting opportunity to showcase mass timber and the heights it can reach.





MASS DEMONSTRATIONS

Loon Lake Lookout Tower

A mass timber lookout tower could provide another big draw to the area. Visitors would get expansive views of Look Lake, the surrounding mountain ranges, and likely ocean views on clear days.







TAKEAWAYS & FUTURE RESEARCH

TRAIL FOR THE MASSES

Project Takeaways

As this project has demonstrated, landscape architects wear multiple hats and can use landscape to make connections across disciplines, interests, and value systems. Whether connecting habitat preservation to Instagram, golf courses to biodiversity, or prisons to agrivoltaics, landscape architects are poised to tackle some of our world's most wicked problems.

Additionally, this project demonstrates how landscape architects can use their skills to work across various scales to drive research and innovation, from using CAD to design wood footings to using GIS and Rhino to run models on large-scale forest stewardship treatments.



TRAIL FOR THE MASSES

Future Research

Like most good projects, this work uncovered a whole new set of questions and ideas to test. The methods used for my research could be tailored and applied to different sites with different criteria, constraints, and goals.

Understanding that I needed to simplify some of the methods used for this project, exploring 3D modeling software to conduct more precise and data-driven models could prove helpful for forest managers and researchers intimately involved with the subject matter.

With new technologies and products being developed, exploring mass timber in non-traditional ways, such as outdoor uses and structure footings, could uncover a wide range of uses for mass timber.

Using 3D modeling software to couple the use of fire with thinning operations was another idea I would have liked to explore during this project. By visualizing the particular trees to be removed, we could potentially plan for fuel breaks to aid in cultural and prescribed burns.

My exploration of GIS in this project made me aware of its power and potential. I'm certain a more detailed and complex analysis could be done to help plan stewardship treatments across large areas of land to create context-specific rich habitat mosaics.

Lastly, the design of interpretive signage was another aspect of this project that I was not able to investigate and design.

This project showcases how a trail system can re-connect people with the land, appreciate the value of timber products, and better understand how sustainable sourcing can improve forest health, lower carbon emissions, and bring economic prosperity to local communities. Through mass timber demonstrations, hiking paths that weave through forest stands in different phases of treatment, and interpretive signage, these trails can educate, celebrate, and inspire the masses.









THANK YOU!

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The Best Cohort Around

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