Riparian Forest Ecology & Management

Derek Churchill,
Nov 8, 2014

Outline

1. Importance of Riparian Zones

2. Watersheds & Stream Type

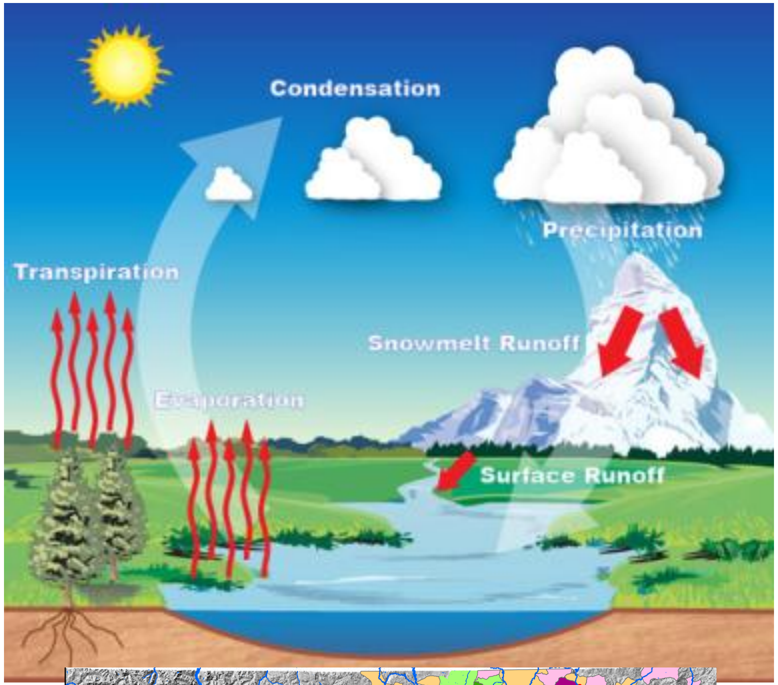
3. Forest – Stream Interactions

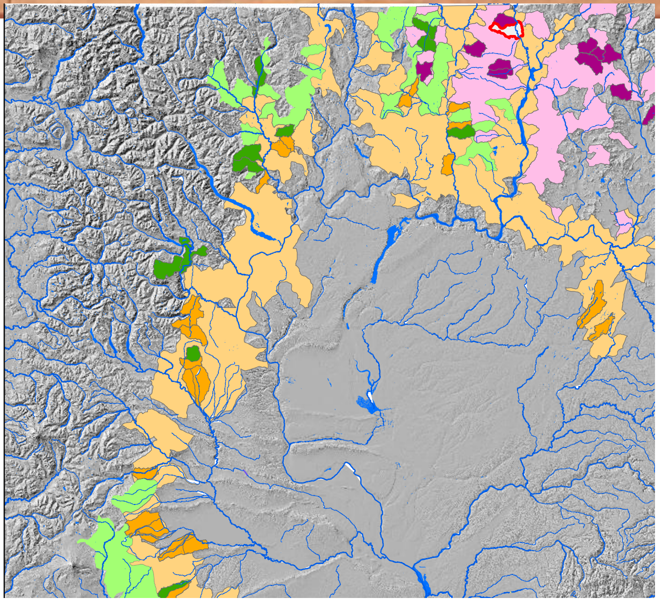
4. Riparian forest types & development

5. Ecological Forestry Options

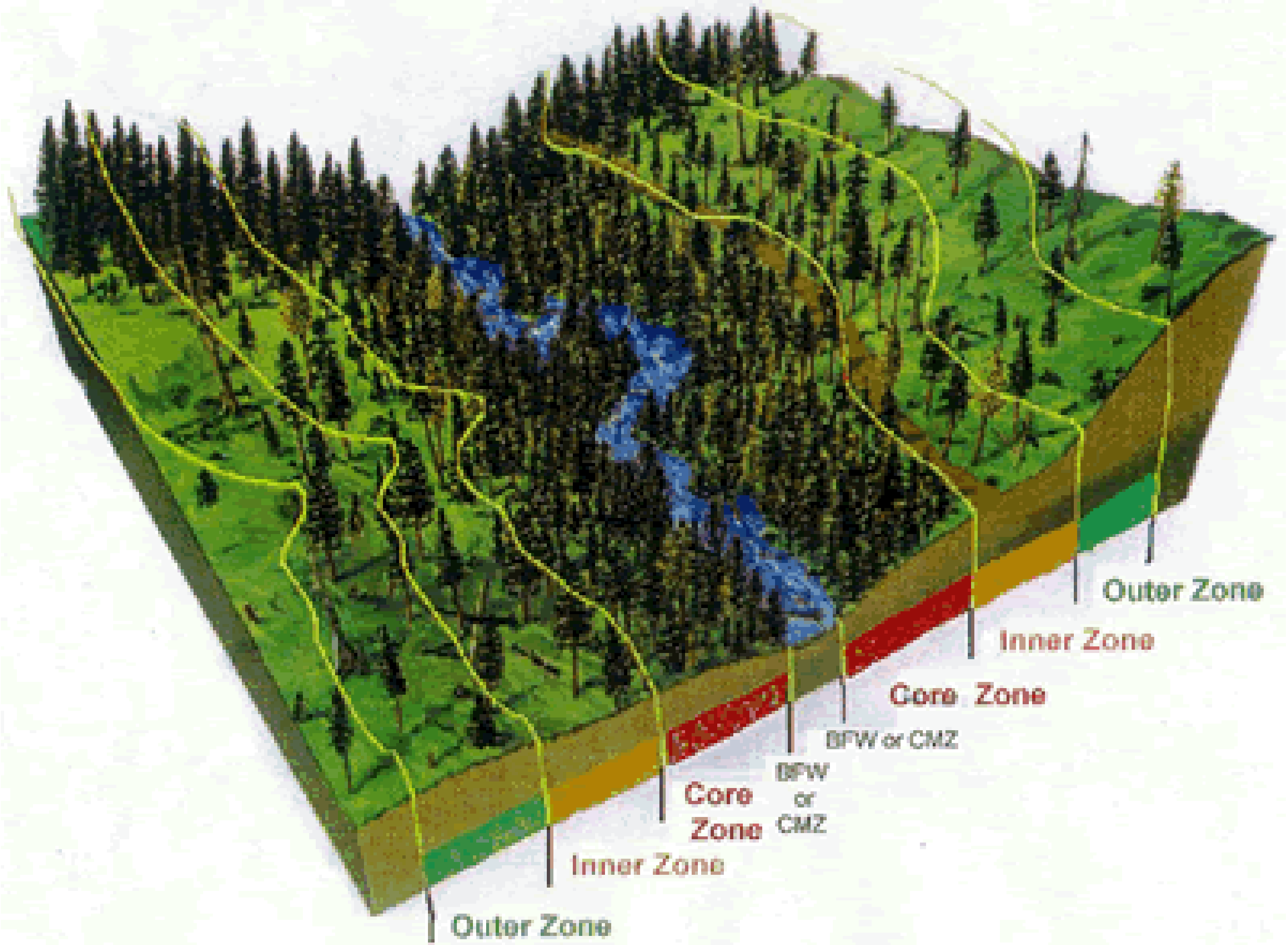
Riparian Zones

- Aquatic – Terrestrial Connection
- Critical to hydrological function
- Landscape diversity
- Biodiversity Hotpots: key habitats
- Ecosystem services



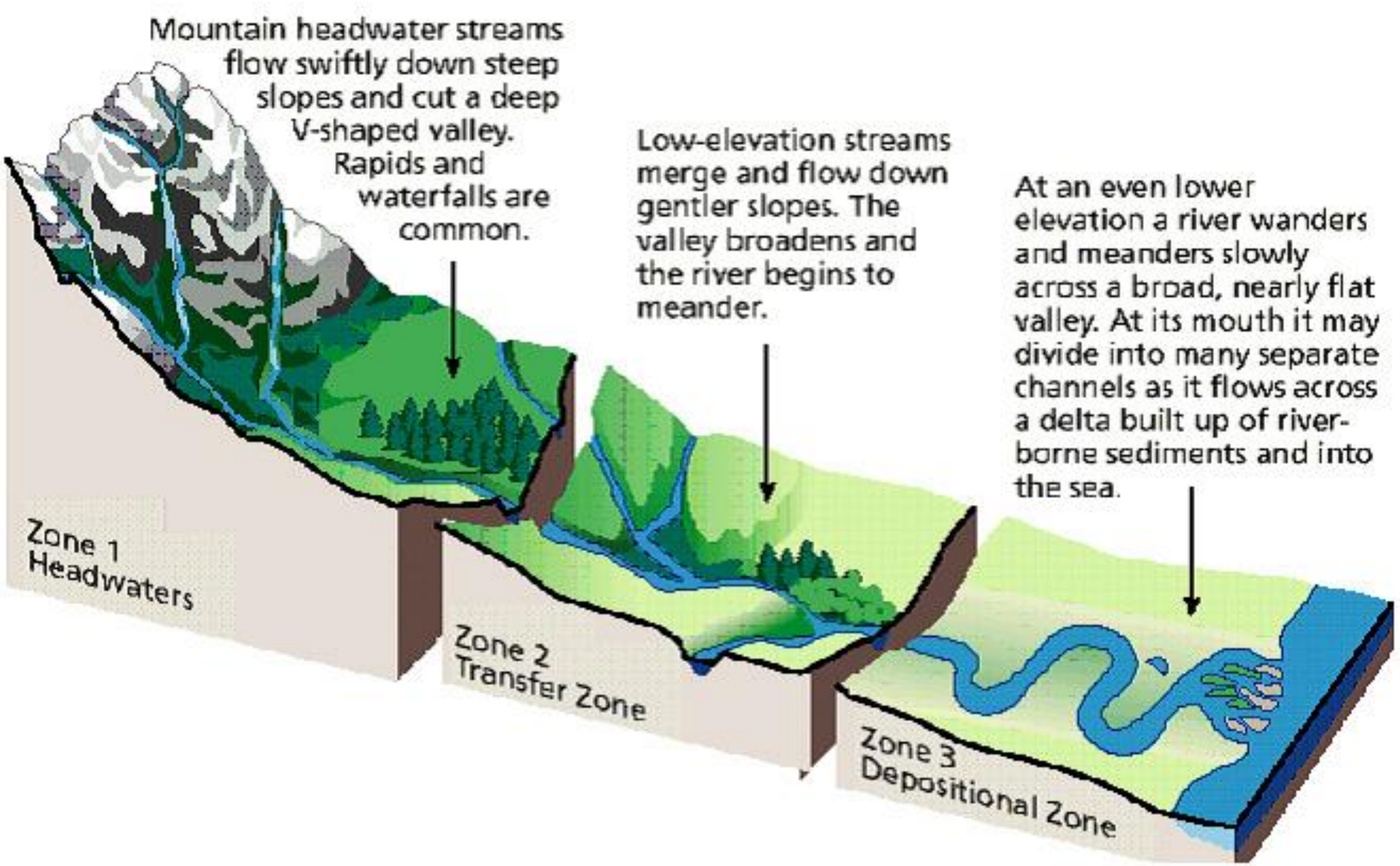


Riparian Zones



Watersheds & Stream Type

Upper Mid Lower



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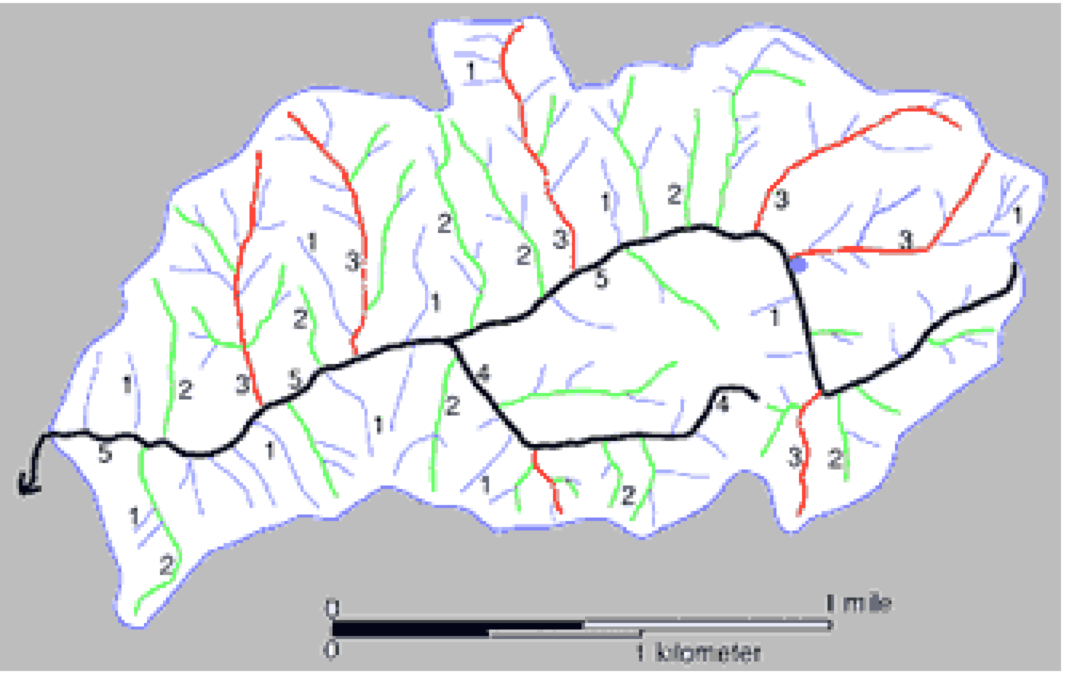
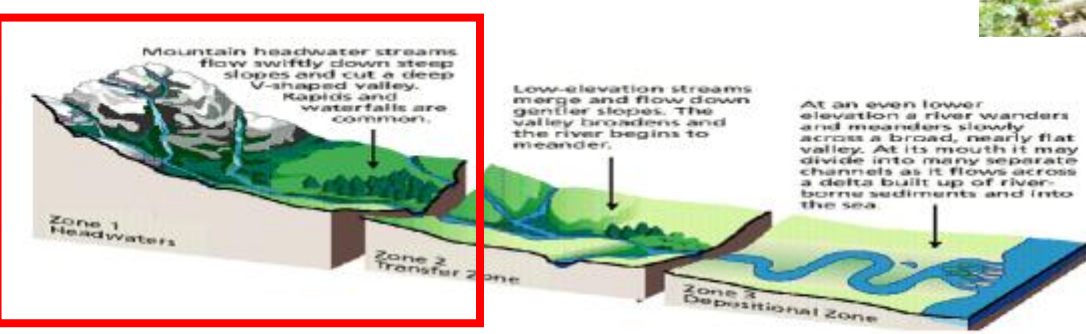


Forest → Stream Interactions

1. Shade & temperature regulation
2. Woody debris inputs: stream structure
3. Litter inputs: food chain
4. Nutrient inputs
5. Water storage & flow regulation
6. Regulation of sediment inputs

Upper Zone

Riparian Forest Function	Importance/ Mechanism
Temperature Regulation	High: shading
Woody Debris Inputs	High: debris flows
Litter & Nutrient Inputs	High: direct inputs
Water storage & flow regulation	Slow input & groundwater
Sediment regulation	Slope stability & landslides



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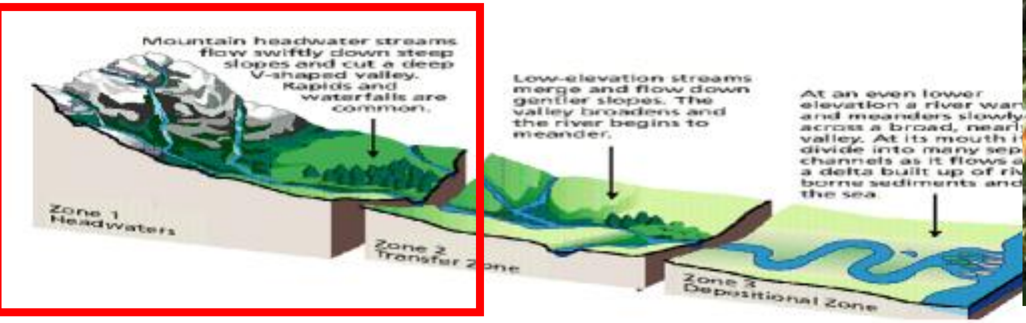
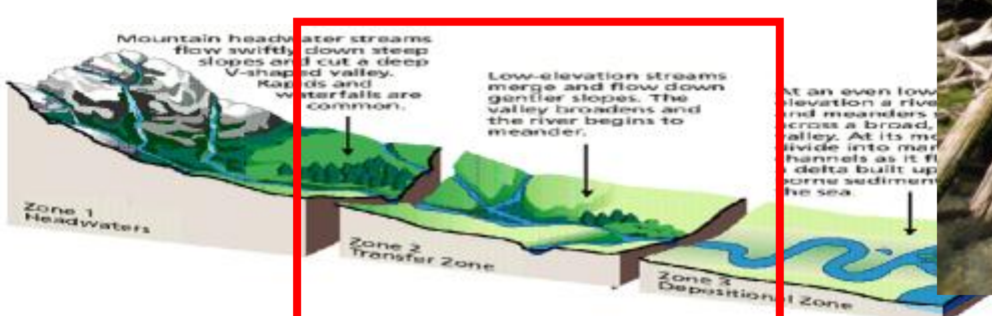


Middle Zone

Riparian Forest Function	Importance/ Mechanism
Temperature Regulation	Shading & microclimate
Woody Debris Inputs	High: streamside recruitment
Litter & Nutrient Inputs	Direct inputs
Water storage & flow regulation	Pooling
Sediment regulation	Bank stability & storage



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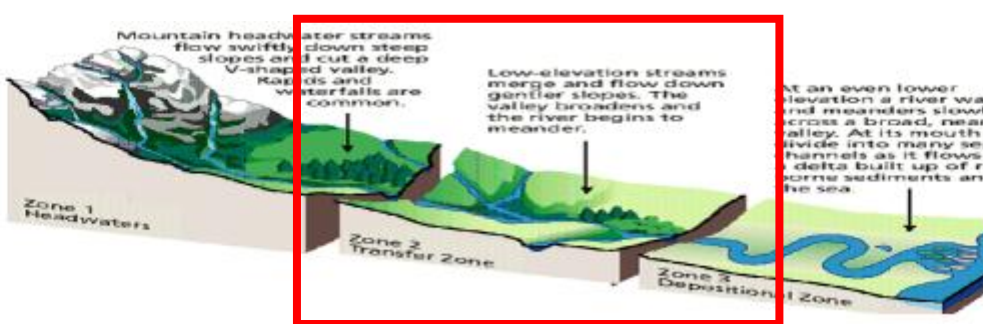
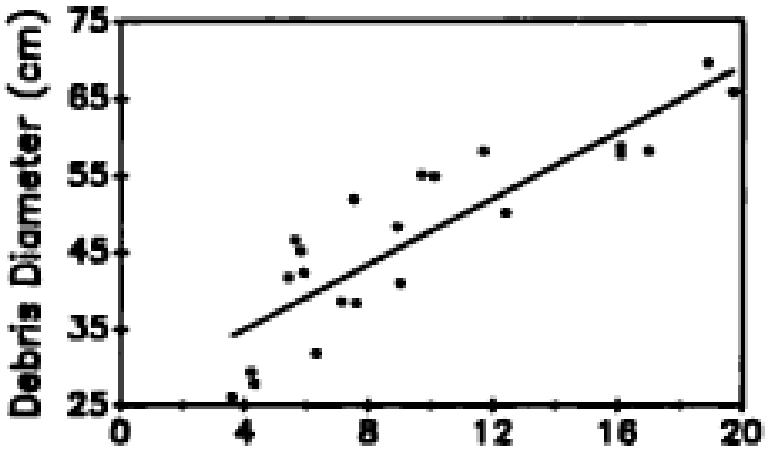
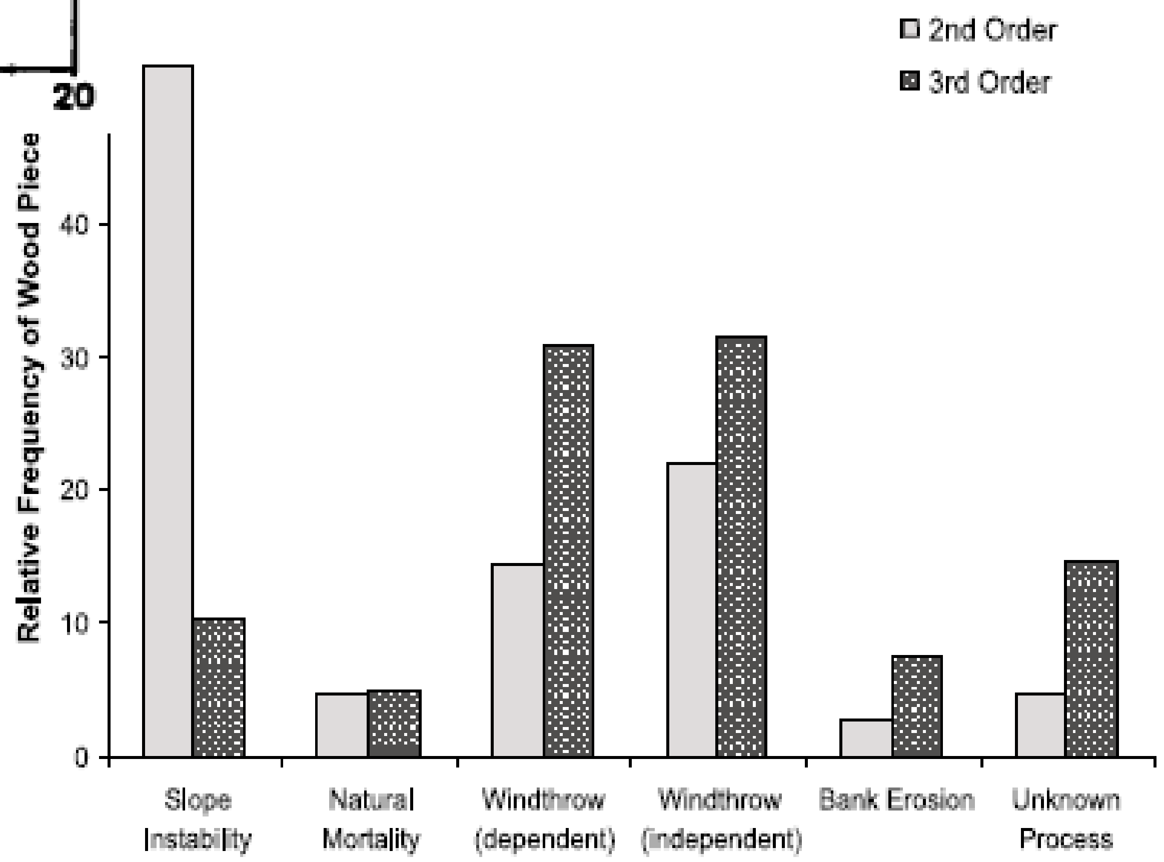


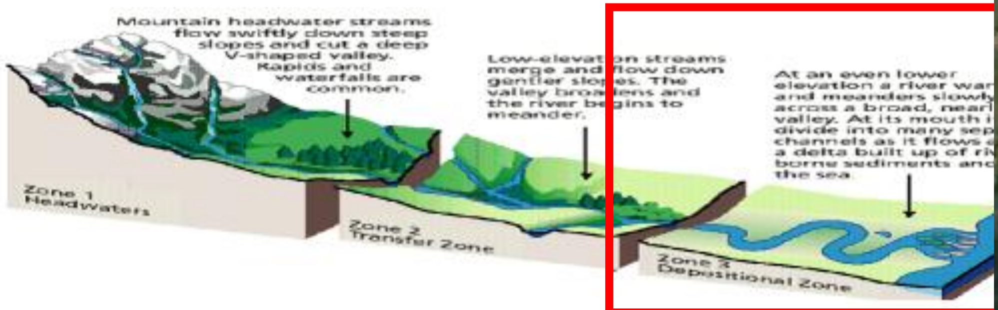
Wood Recruitment & Zone





Lower Zone

Riparian Forest Function	Importance/ Mechanism
Temperature Regulation	Low
Woody Debris Inputs	Bank erosion & downstream flow
Litter & Nutrient Inputs	Low: solar driven
Water storage & flow regulation	High: floodplain storage
Sediment regulation	High: floodplain dynamics



Riparian Forest Types & Development

- High productivity
- High diversity & structural complexity
- Disturbance prone

- Conifer dominated
- Mixed hardwood-conifer forests
- Hardwood dominated

Riparian Forest Types

Conifer dominated

- Similar stand development to upland forests

PNW Stand Development

Pre-Forest

1. Disturbance Event

2. Live and dead legacies creation

3. Early-seral plant colonization and establishment

4. Tree cohort initiation

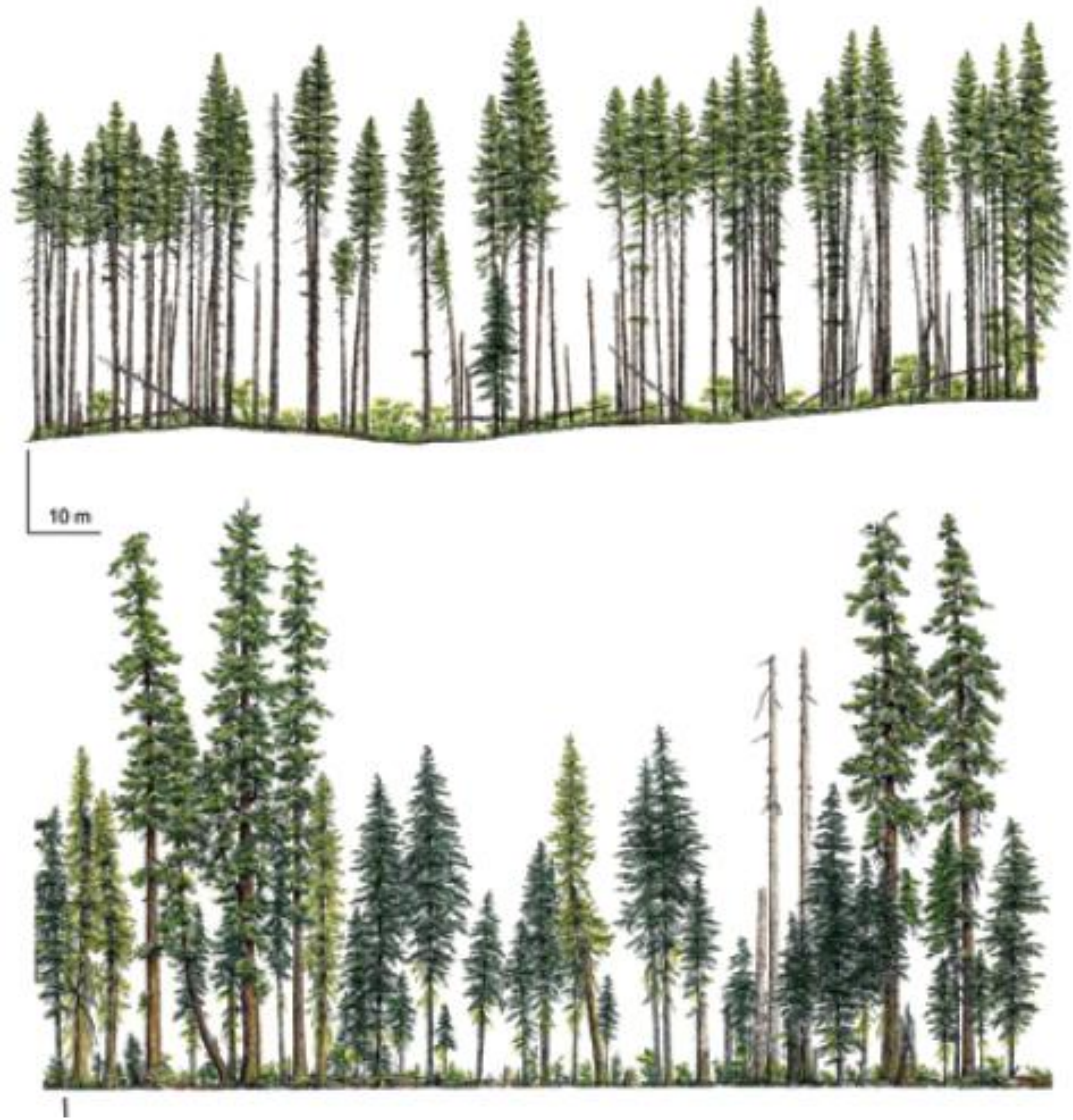
PNW Stand Development

Young Forest

1. Canopy Closure
2. Biomass Accumulation: Height & stem growth
3. Vertical crown development
4. Competition:
   - -Differentiation and stratification
   - -Crown recession
   - -Suppression mortality
   - -Understory exclusion

PNW Stand Development

Mature Forest
1. Height grow slows 2. Agent based, aggregated damage, mortality, and gap formation. 3.Understory re-initiation and development 4.Dead wood “trough”



Old Forest

1. Old tree canopy development: height growth stops, complex crowns, epicormic branching, epiphytes
2. Vertical canopy development: midstory recruitment; bottom loaded canopy
3. Horizontal complexity: Gaps, thickets, and intermediate densities
4. Decadence & dead wood accumulation

Carbon Storage

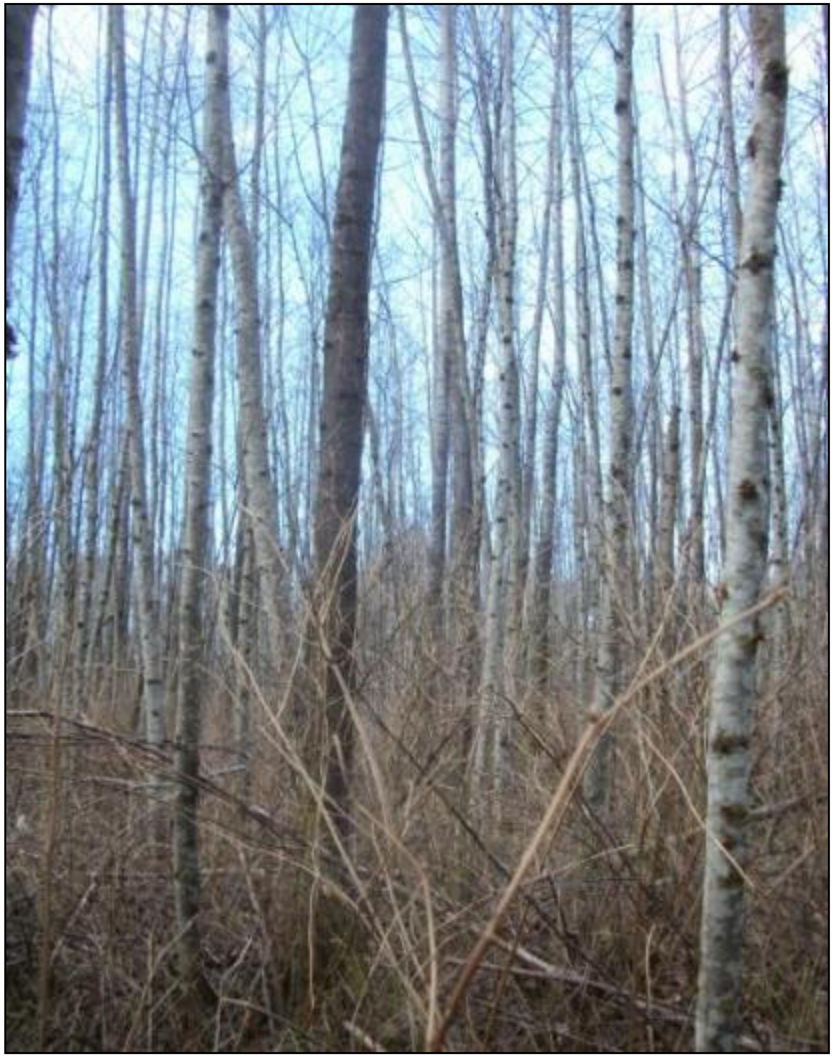
Disturbance

Riparian Forest Types

Hardwood Forests

Riparian Forest Types

Hardwood development



Riparian Forest Types

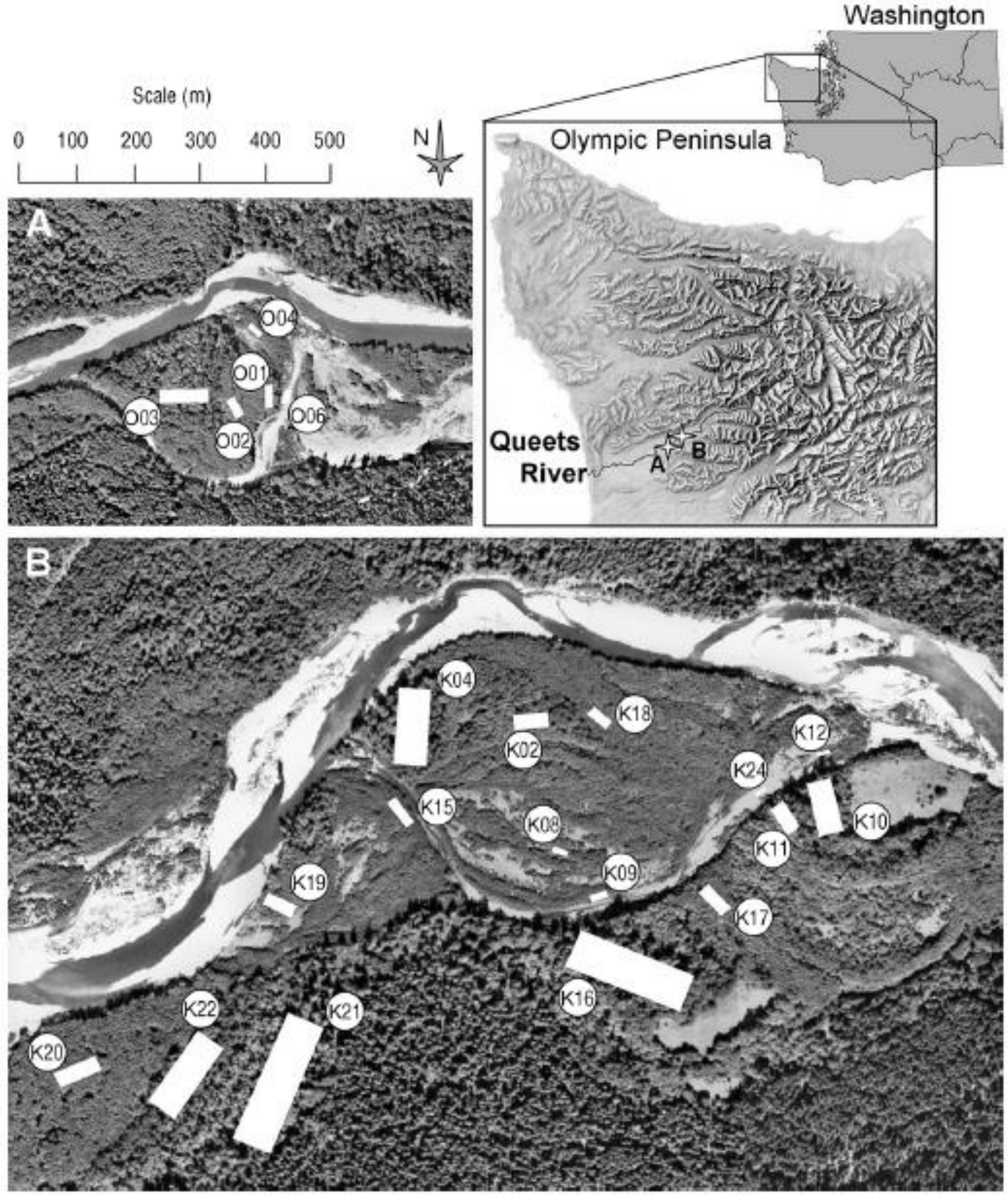
Hardwood development

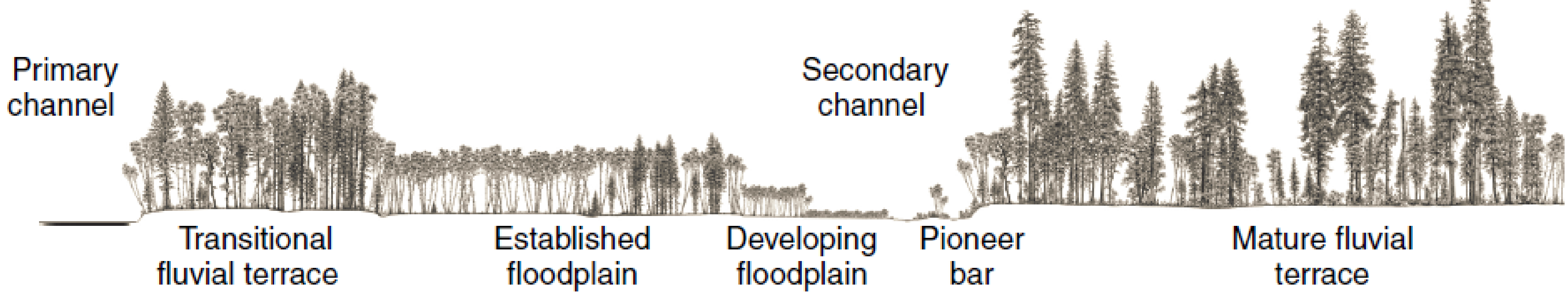
Riparian Forest Types

Hardwood development

Riparian Forest Types

Floodplain Development




Primary channel
Secondary channel
Transitional fluvial terrace
Established floodplain
Developing floodplain
Pioneer bar
Mature fluvial terrace

Riparian Forest Types

Mixed Conifer-Hardwood

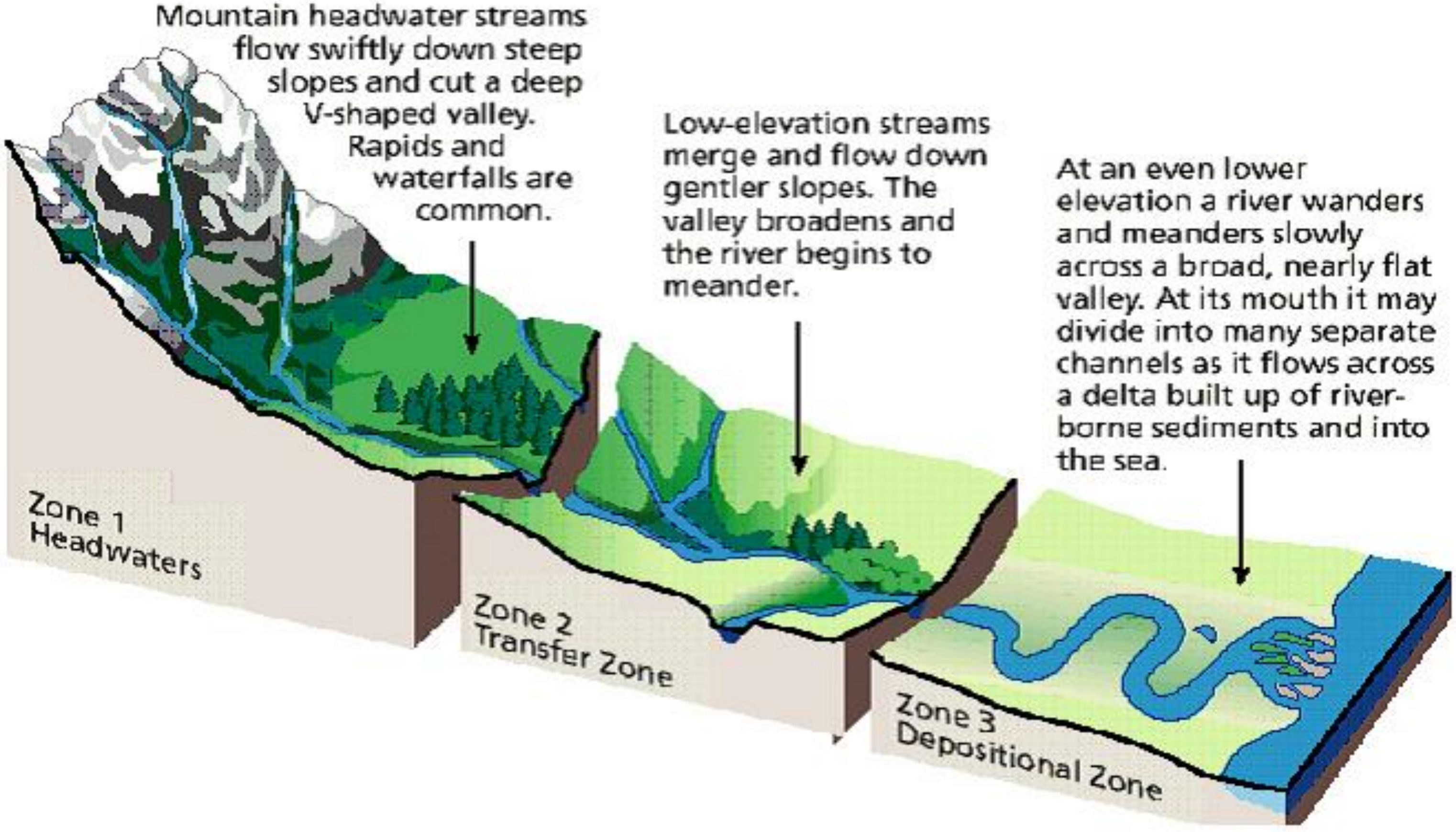
Multiple Development Pathways

Forest & Stream Type

Conifer > Hardwood

All of above

Hardwood >> Conifer



Riparian Forest Types

Riparian Forest Function	Conifer	Hard-wood
Temperature Regulation: Shade	++	~
Woody Debris Inputs	++	–
Litter & Nutrient Inputs	~	+
Water storage & flow regulation	+	+
Sediment regulation	+	~
Habitat	~	+++

Riparian Forest Types

Mixed Conifer-Hardwood

Ecological Forestry

Principles

- Use natural disturbances as a guide

- Work with natural disturbances and stand development processes to achieve multiple objectives

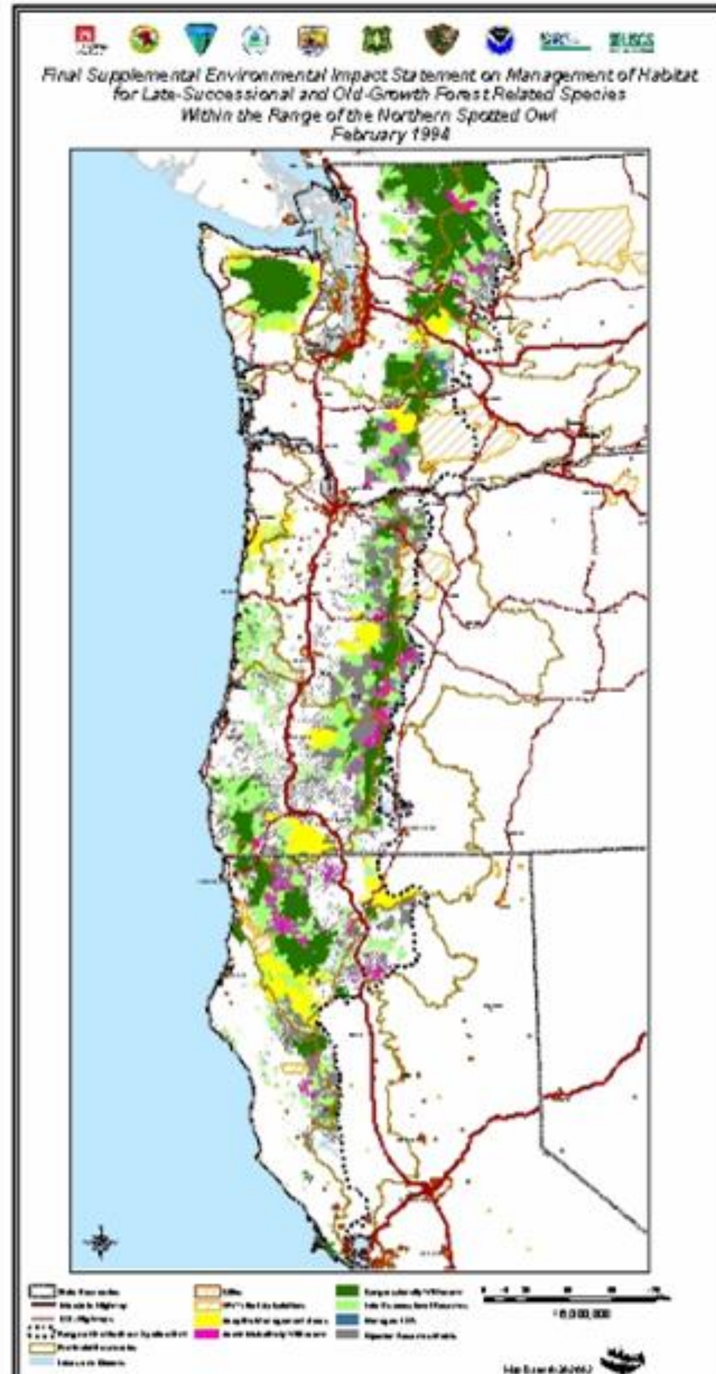
- Maintain key biological components
    - Long rotations or continuous cover
    - Maintain and increase structural complexity and species diversity throughout stand development
    - Retention

- Multi-scale thinking and approach

Mt Saint Helens

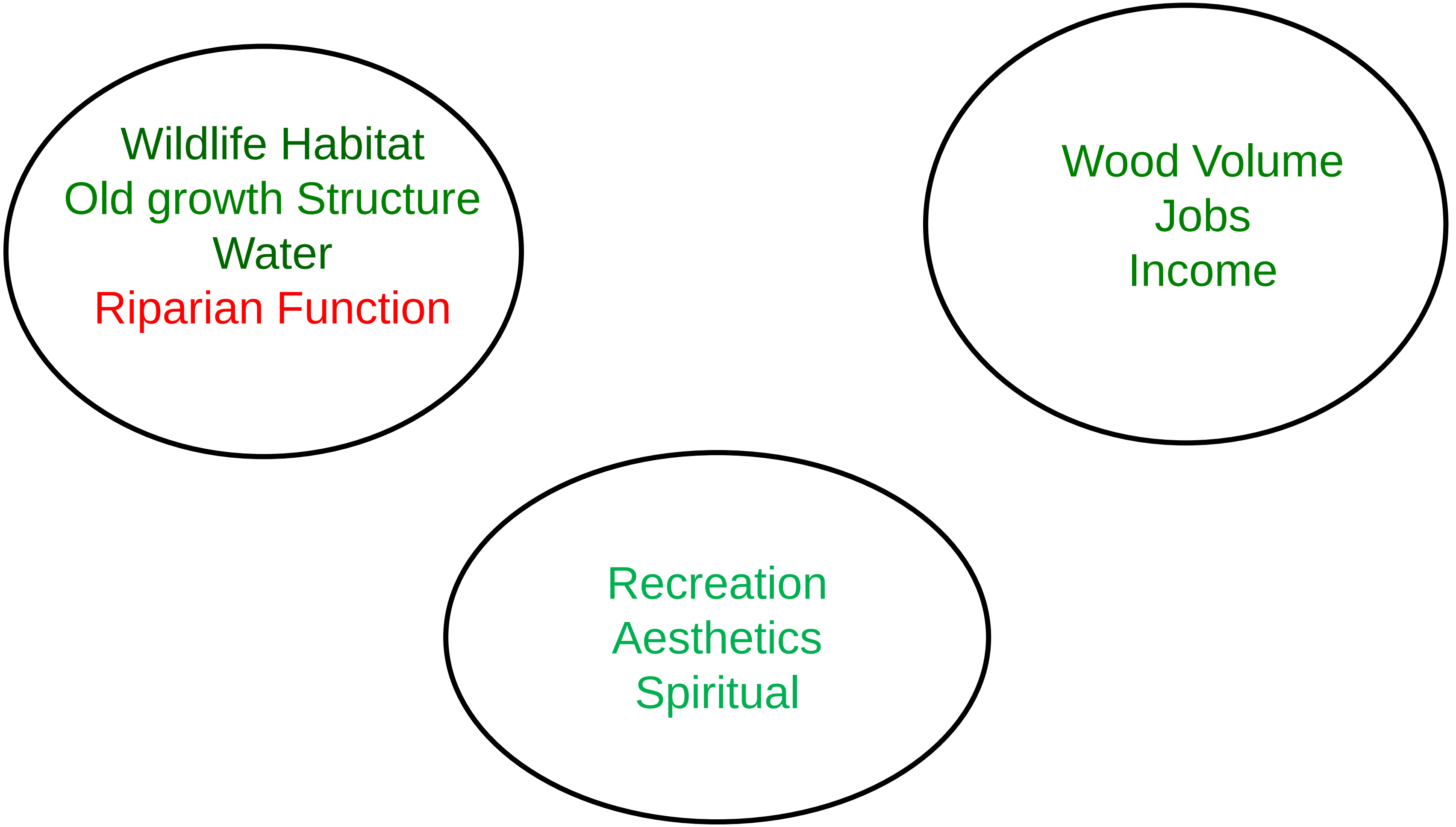
NW Forest Plan

- **Major change in management objectives**



Multiple Objectives

Ecosystem Services



Silvicultural Approaches

Production Forestry

- Harvest Overstory
  - Clear cut
  - Seed Tree
  - Shelterwood
- Regeneration
  - Planting
  - Natural
- Tending
  - Veg control
  - PCT
- Thinning from below

Ecological Forestry

- Variable Retention Harvest
  - Dispersed
  - Clumped
- Regeneration
  - Planting and/or natural
- Tending
  - Veg control
  - PCT
- Variable Density Thinning
  - Old growth structure
  - Long rotation & harvest

Uneven-aged

- Individual Tree Selection
- Group Selection

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Ecological Forestry

Maintaining Biological Elements

Thinning

Reduce density of a cohort to maintain or improve growth and crown development

Remove Overstory

Harvest trees for wood & revenue; and open growing space space for lower cohorts

Regeneration

Establish a new cohort

Approaches

- Individual Tree Selection
- Group Selection
- Thin from below
- Free thinning
- **Variable density thinning**
- Variable retention
- Planting & tending

Key Biological Elements

1. Large Trees with complex crowns

2. Multi-layered canopy

3. Decadence: snags, logs, and live trees

4. Diverse plant community: Hardwoods, understory, epiphytes, etc.

5. Horizontal Heterogeneity: “Patchiness”

6. Soil
7. Fungi
8. Invertebrates, vertebrates

Prescription Elements

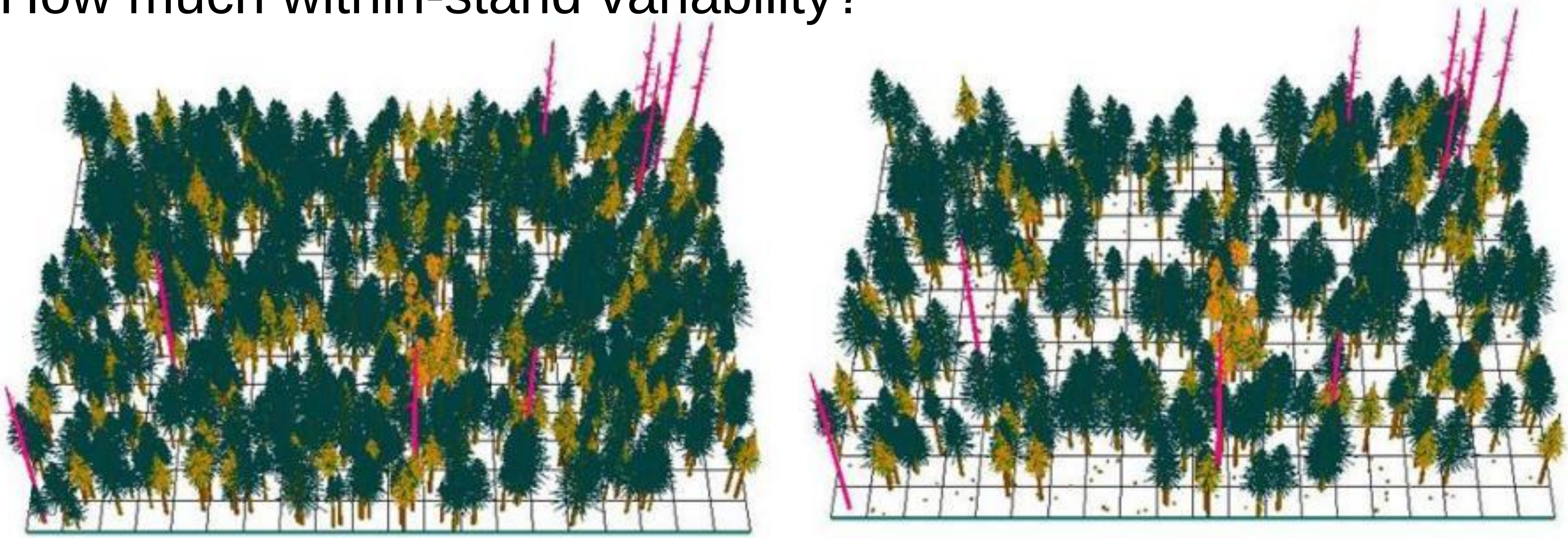
1. Focus on biodiversity hotspots: protect or release

Prescription Elements

2. What to leave and remove
   - Species selection
   - Thin from middle, and above to release key features
   - Snags, downed logs, and wildlife trees
   - Heavy thin (~50 tpa) vs. moderate thin (~35 Curtis RD)
   - Plant?

Prescription Elements

3. Pattern of retention and removal.
How much within-stand variability?



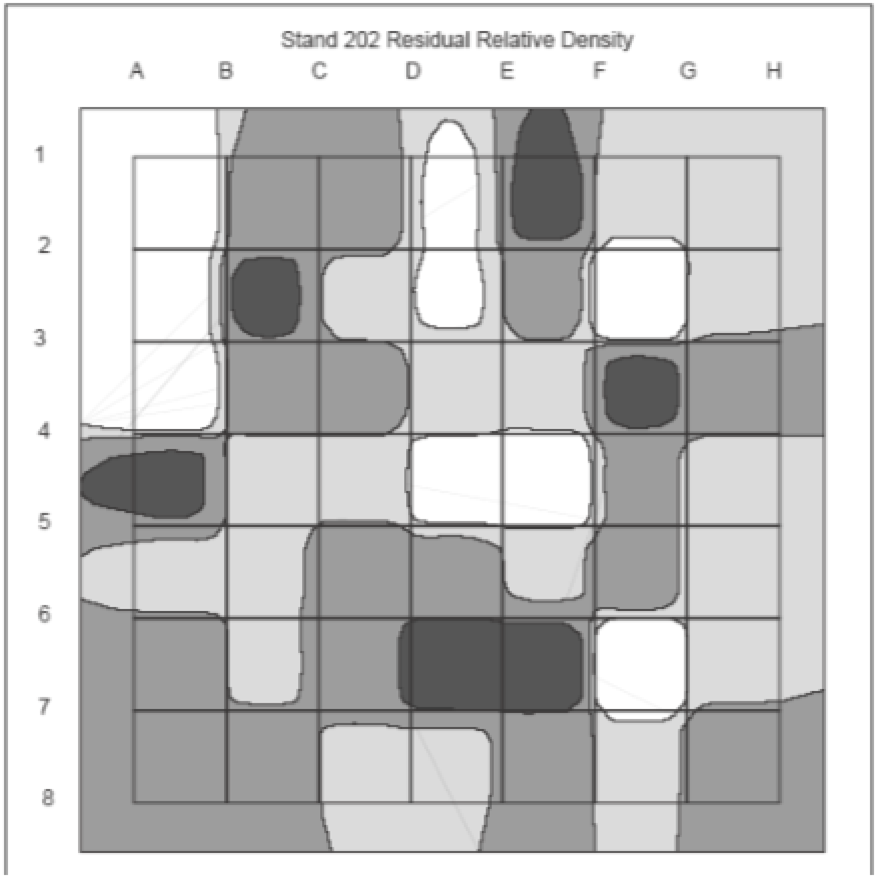
http://www.fs.fed.us/pnw/olympia/silv/selected-studies/variable/index.shtml

-Spatial Scale: size and configuration

- Temporal scale: impose now, via multiple entries, or develop naturally?

Forest Ecosystem Study

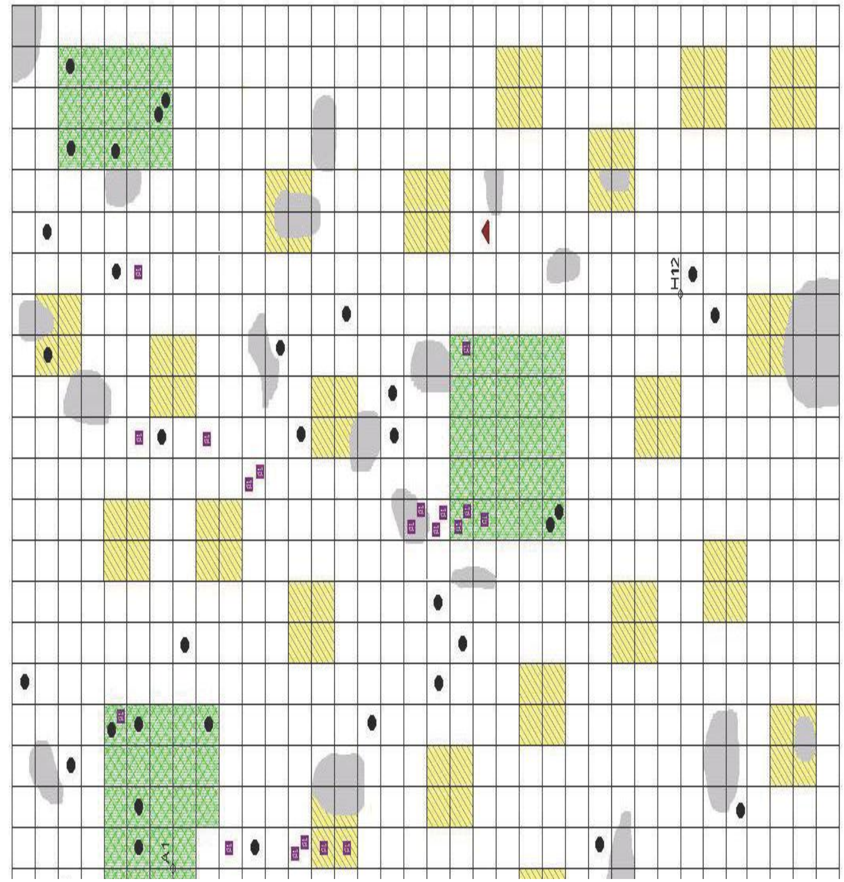
Andy Carey



- ¼ - 2 acre scale
- 2:1 light to heavy thin
- 5-10% in No-entry Skips
- 5-10% in Gaps

Habitat Development Study

Connie Harrington



- 10% in skips: 0.25-0.75 ac
- 15% in gaps: 0.10 ha
- Matrix: 25% BA removal; spacing based thin from below

Canopy Patch Types

Patch Type	Function	Size Range/Density
No-thin skips	- Protect hotspots - Competitive mortality - Dark, moist habitats	- Large: 1+acres - Small: 0.3 - 0.5 ac
Heavy Thin	- Grow big trees w/large crowns - Stimulate epicormics. - Develop understory-midstory	- Single tree or cluster release - Patch: 0.5 – 5+ acres - 10-20 Curtis RD
Gaps	- Develop understory-midstory - Regenerate or plant new species - Contain root rots	- 0.1 to 0.3 acre - Larger for shade intolerant species - 0-5 trees per acre

General Thin Area	- Bigger trees faster - Stimulate understory	- Majority of stand - 25-45 Curtis RD

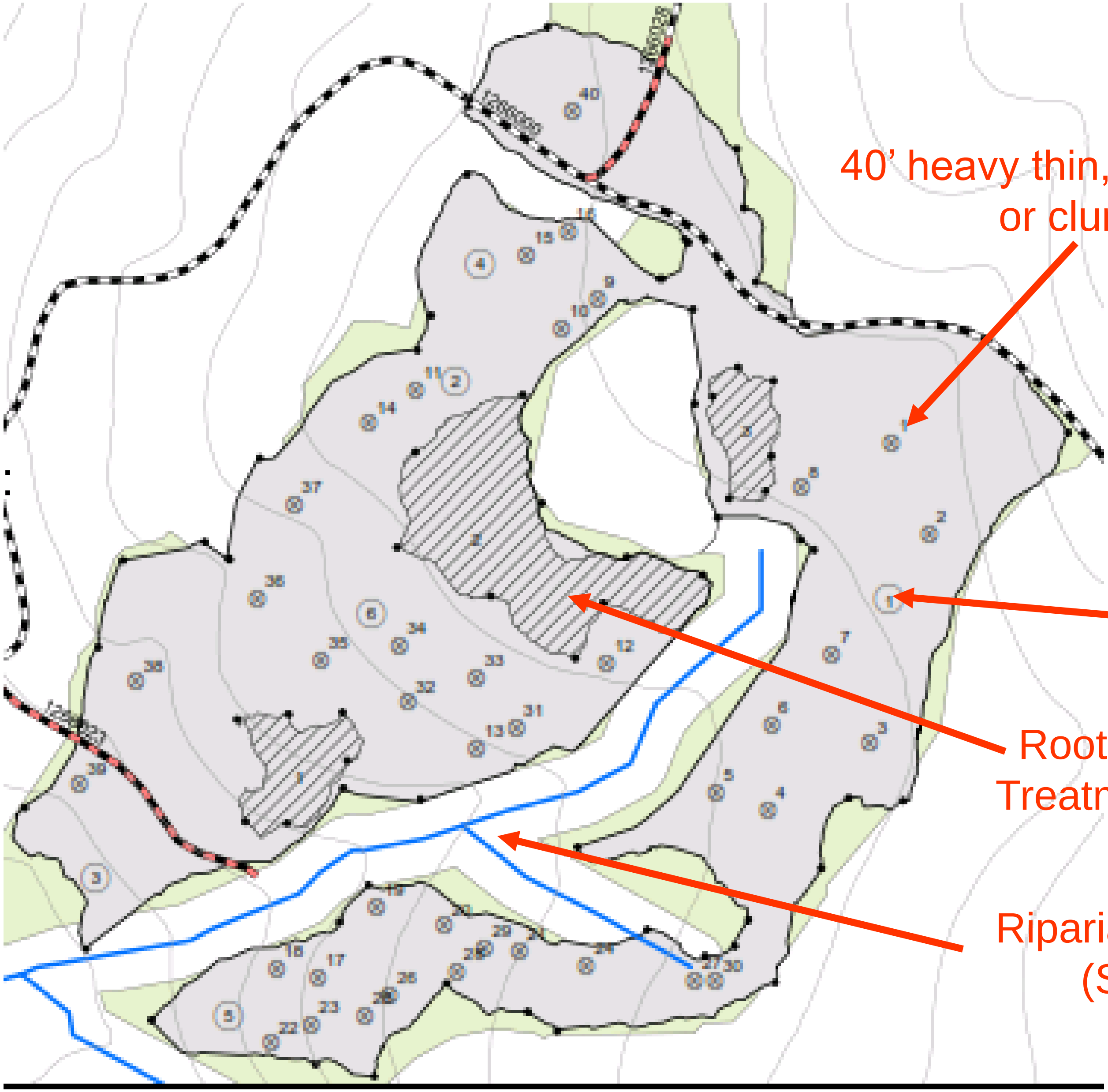
Canopy Patch Level Heterogeneity

~30% Skips:

~20% Openings:

~5% Heavy thin

~ 45% Thin rest



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Variable Retention

Ecological Forestry:

Application to Riparian Forests

<u>Landscape Context</u>
Position in watershed

Landscape conditions

<u>Objectives:</u>
Species Composition
- Conifers or mixed
- Native Species

Structural ,
- Accelerate
- Aforestation

Economic

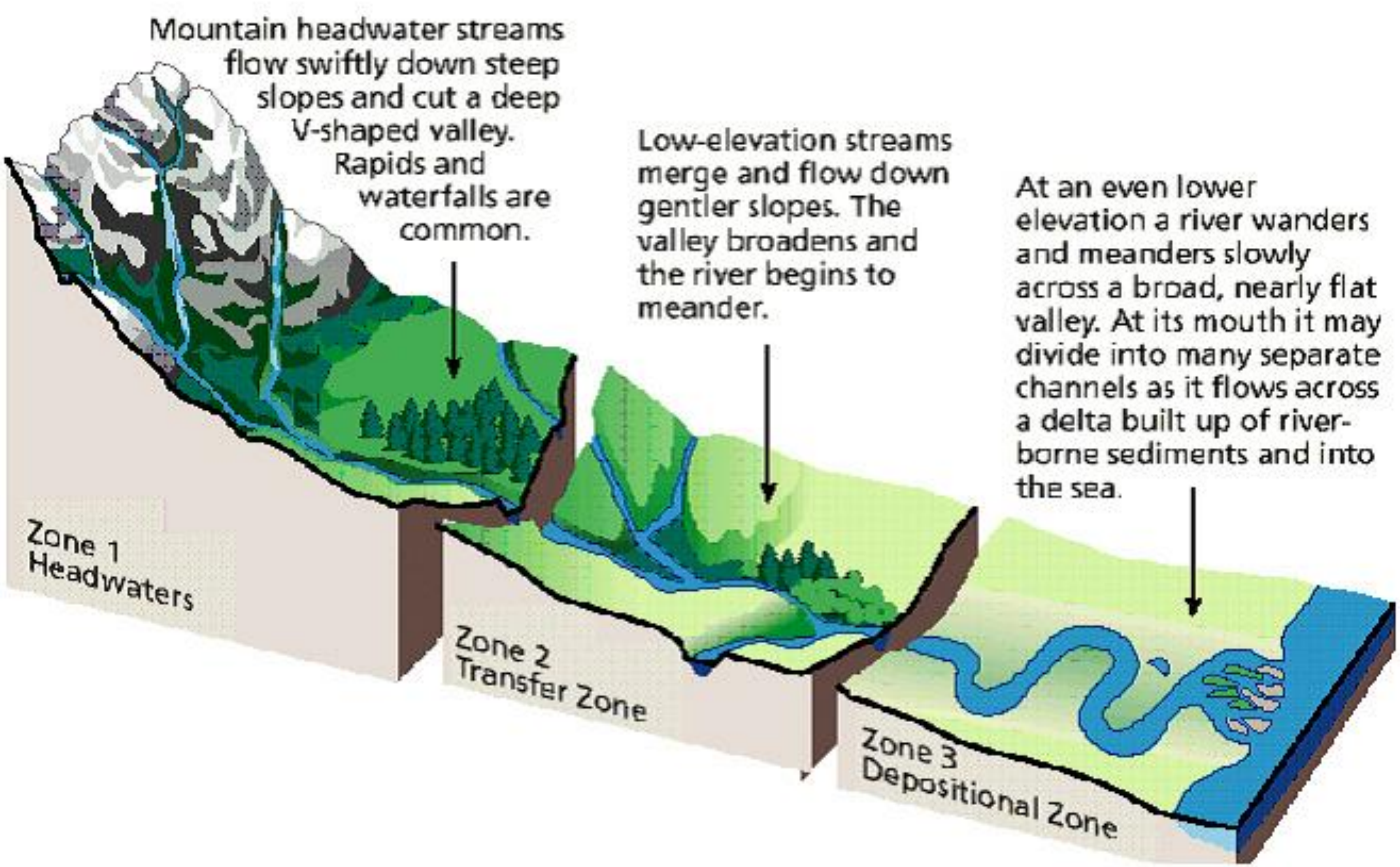
<u>Stream Type</u>
Regulations

<u>Current Conditions</u>
Species
Age
Structure

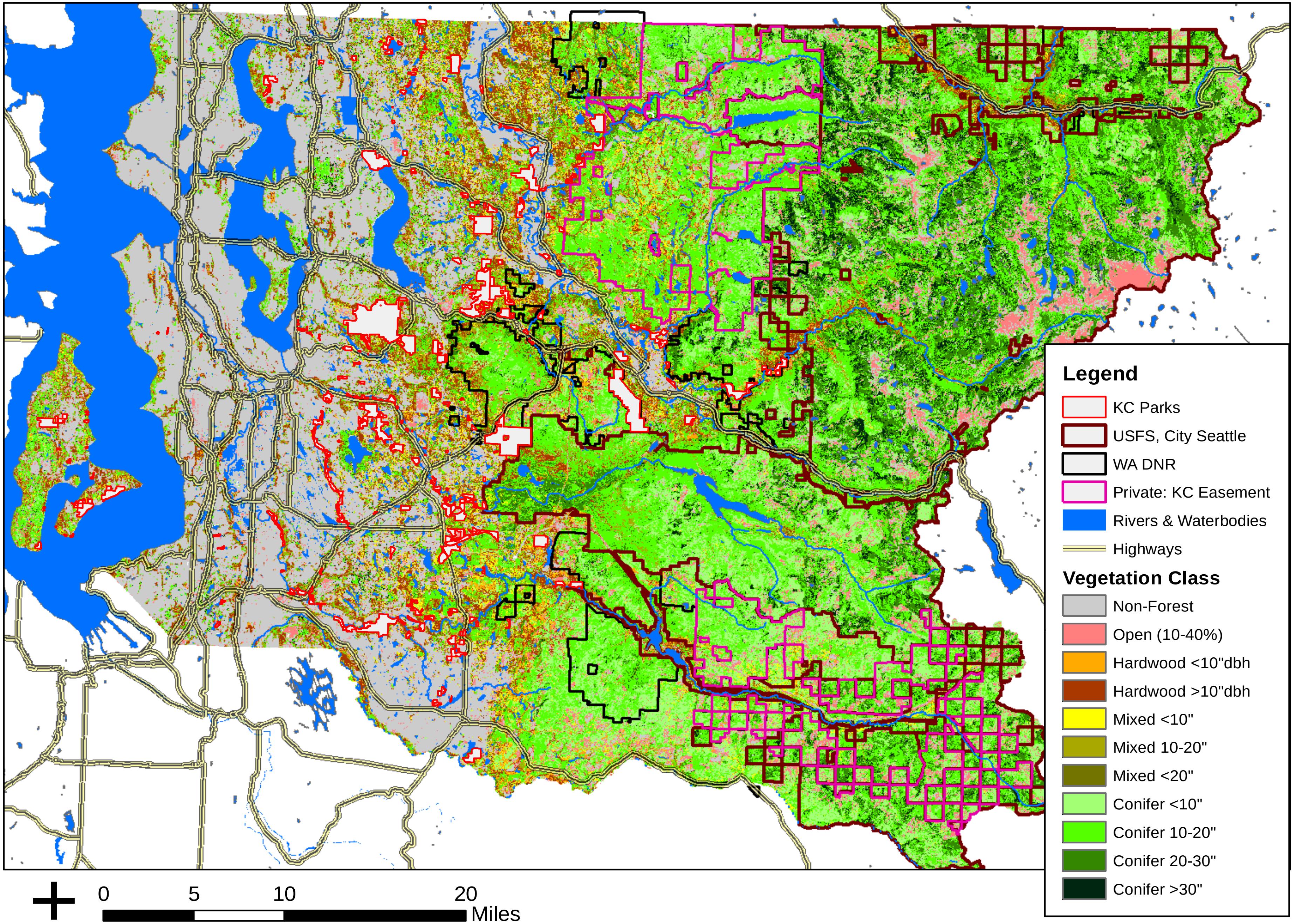
<u>Treatment</u>
Thin
Regenerate
Remove wood
Leave wood
Plant

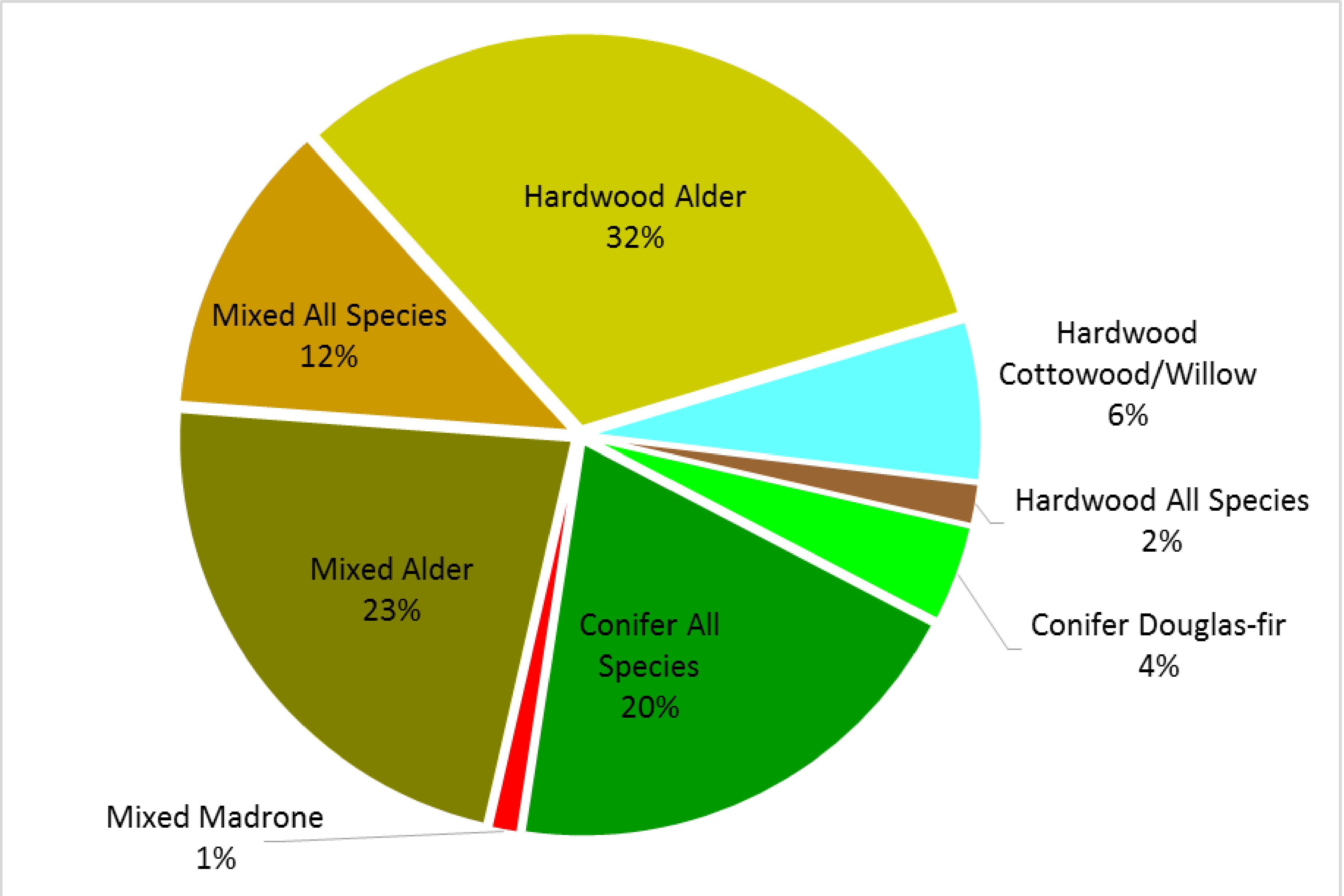
Landscape Context

Upper Mid Lower



King County Vegetation Classes

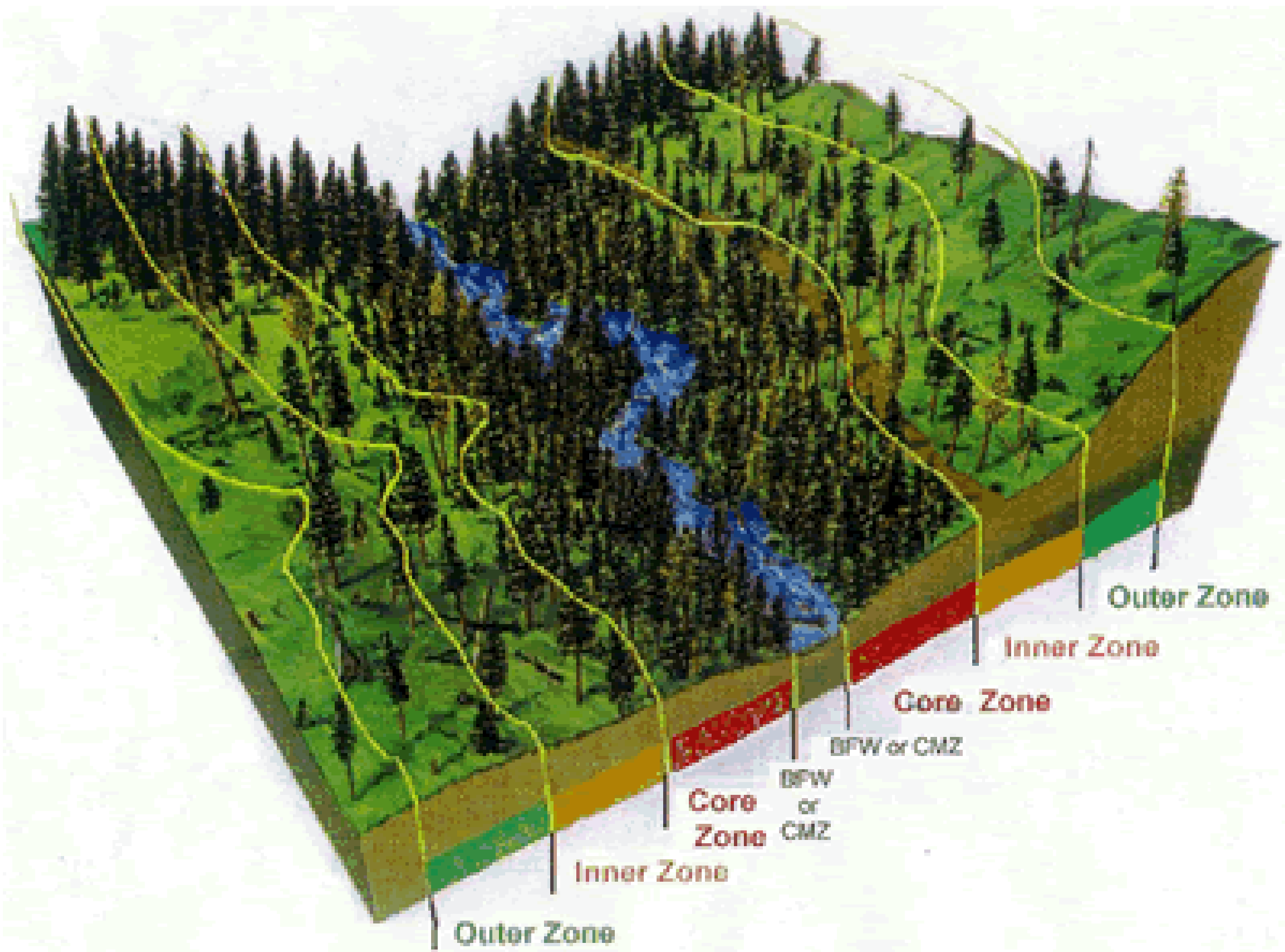



Hardwood Alder
32%
Mixed All Species
12%
Hardwood
Cottowood/Willow
6%
Hardwood All Species
2%
Mixed Alder
23%
Conifer All
Species
20%
Conifer Douglas-fir
4%
Mixed Madrone
1%

Current Conditions

Current Conditions

Stream Type & FPA Rules



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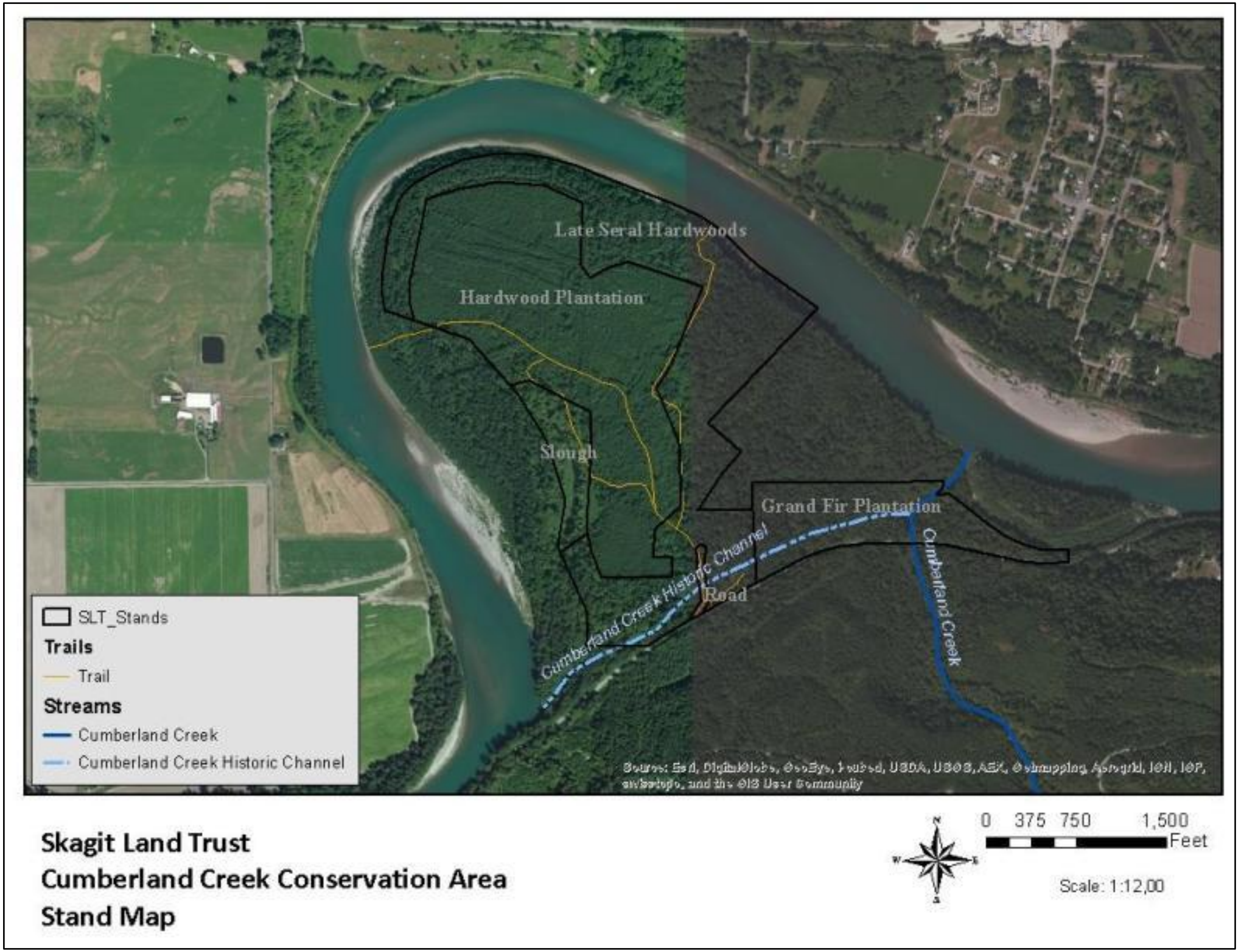
Skagit Land Trust



Skagit Land Trust

Floodplain hardwoods

- Variable density thin: hardwoods
- Gaps & plant conifers
- Invasive species

Conifer Upper Terrace

- Variable density thin: Conifer