Building Functional Resilience for Ecological Restoration

Rodney Pond

Executive Director, Sound Salmon Solutions
Adjunct Faculty, Edmonds Community College

Rolf Gersonde

Senior Environmental Analyst, Seattle Public Utilities
President, Society for Ecological Restoration Northwest

Our 40 Minute Journey

A Review of Relevant Ecosystem Concepts

- ✓ Processes & Functions
- ✓ Disturbance
- ✓ Resistance & Resilience
- ✓ Functional Resilience & Redundancy
- ✓ Ecological Thresholds

Ecosystem Degradation

- ✓ Sagebrush steppe example

Ecosystem Repair

- ✓ Building Functional Redundancy
  - Plant Selection
  - Design Approaches
  - Site Preparation
  - North Creek Wetland example

Key Themes

Recommended Reading

Ecosystem Functions & Processes

Functions: The “services” or critical support elements of an ecosystem

Processes: The complex multidimensional interactions and flows involving organisms, nonliving elements, and the environment that realize those functions

FUNCTIONS	PROCESSES
Regulation	
Nutrient	Decomposition, denitrification, storage, disturbance, nutrient cycling
Climate	Shading, evapotranspiration
Water	Filtering, retention, storage
Energy	Primary production, decomposition, storage
Habitat	
Reproduction Forage Shelter	Niche availability, structural development, primary production, pollination, seed dispersal, disturbance
Production	
Energy Structure	Primary production (photosynthesis)
Information	
Resistance/resilience	interspecies interactions, evolutionary adaptations

Disturbance

Disturbance - Any disruption of ecosystem processes leading to the diminishment or loss of functions often through the mortality or loss of vigor of key organisms.

Natural: Organisms and the relationships between them and their environment become adapted to cyclical natural disturbances over evolutionary/ecological time developing the capacity for endurance (resistance) and self-repair (resilience).

Natural disturbances are critical processes supporting ecosystem functions that ultimately reinforce functional redundancy and therefore resilience.

Anthropogenic: Novel disturbances to which ecosystems are not adapted that differ in frequency, duration, and intensity which may overwhelm their resistance and resilience and shift the ecosystem over a threshold to another stable but lower functioning state.

Anthropogenic disturbances reduce functional redundancy and therefore resilience by exceeding the adapted tolerances for ecosystems.

Resistance & Resilience

Resistance – the ability of an ecosystem to endure disturbance without significant disruption/damage to species composition, structure, and functions.

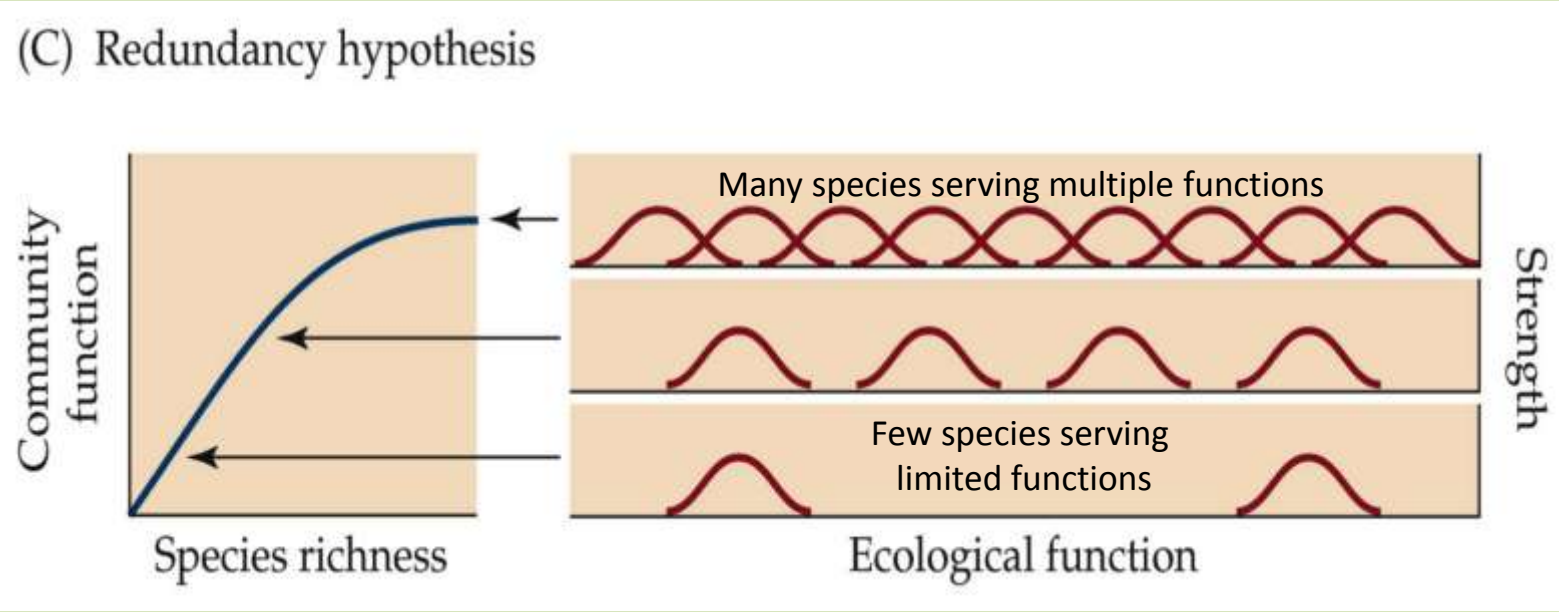
Resilience – the ability of an ecosystem to recover to its pre-disturbance species composition, structure, and functions after being significantly disrupted by a disturbance.

Resilience – severe windstorm

Functional Resilience & Redundancy

Functional Resilience - the ability of an ecosystem to regain essential functions after a disturbance. Directly related to the level of functional redundancy in the ecosystem.

Functional Redundancy – Having more than one species in an ecosystem that serves a particular function *as well as* having species that serve multiple functions. High redundancy supports resistance and resilience in ecosystems.



Ecological Thresholds

Biotic thresholds – Organism mediated limitations to ecosystem recovery to its previous state.

Ex. low primary productivity, invasive species, imbalanced predator/prey relationships, lack of decomposers, lack of pollinators, lack of seed dispersers

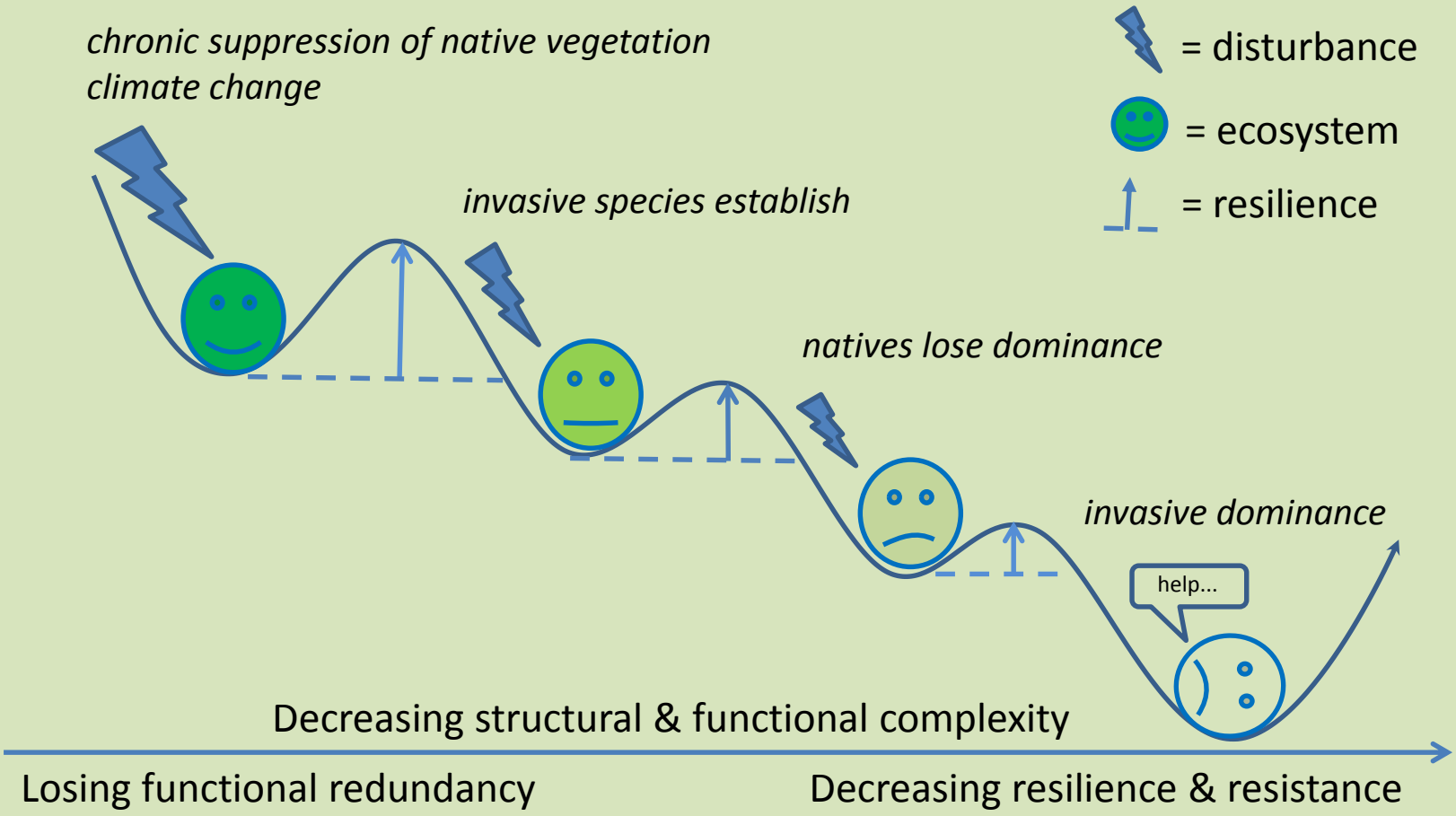
Abiotic thresholds – Chronic environmental stresses (disturbance) that pose limitations to ecosystem recovery to its previous state.

Ex. drought, flooding, diking, fire, soil compaction, isolation from donor sites (fragmentation)

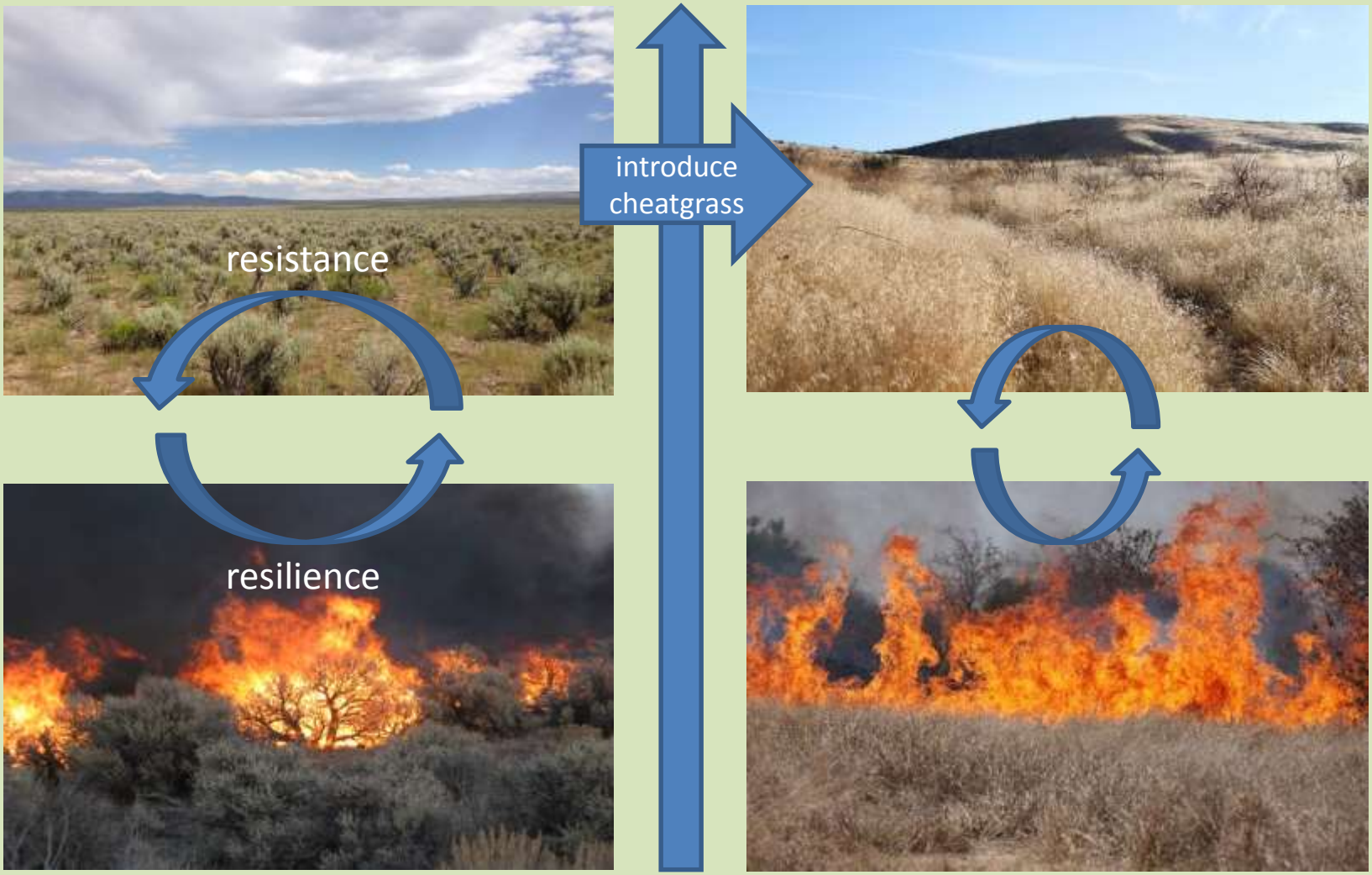
Ecosystems adapted to natural disturbance have the resilience to overcome thresholds and regain lost or diminished functions without human intervention.

Anthropogenic disturbances necessitate intervention - overcoming and/or lowering thresholds to move an ecosystem on a trajectory towards greater resistance, resilience, and functioning.

Ecosystem Degradation



Sagebrush Steppe: Species Invasion



Biotic threshold

Photos: USGS & USFWS

Sagebrush Steppe: Climate Change

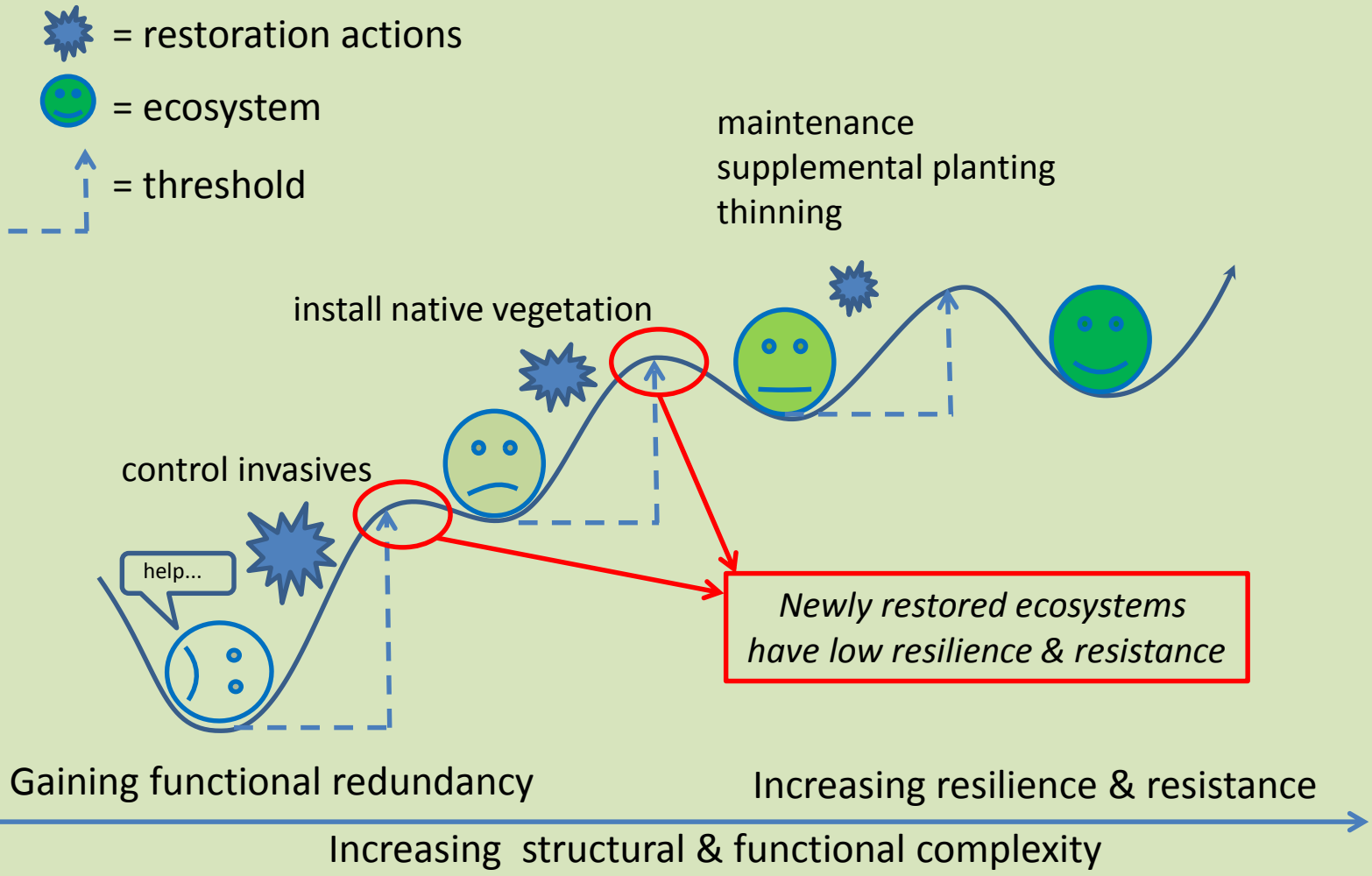
Increased fire frequency
prolonged drought

desertification?

abiotic threshold

Photos: USGS & USFWS

Ecosystem Repair



Species Selection
Building Functional Redundancy

Dominant lowland Puget Sound native riparian species

- Bird forage
- Shade forming canopy species
- High primary productivity
- Fast growing substrate stabilizers

Amelanchier alnifolia

Prunus emarginata

Malus fusca

Sambucus racemosa

Rubus spectabilis

Flood tolerance

Species Selection
Building Functional Redundancy

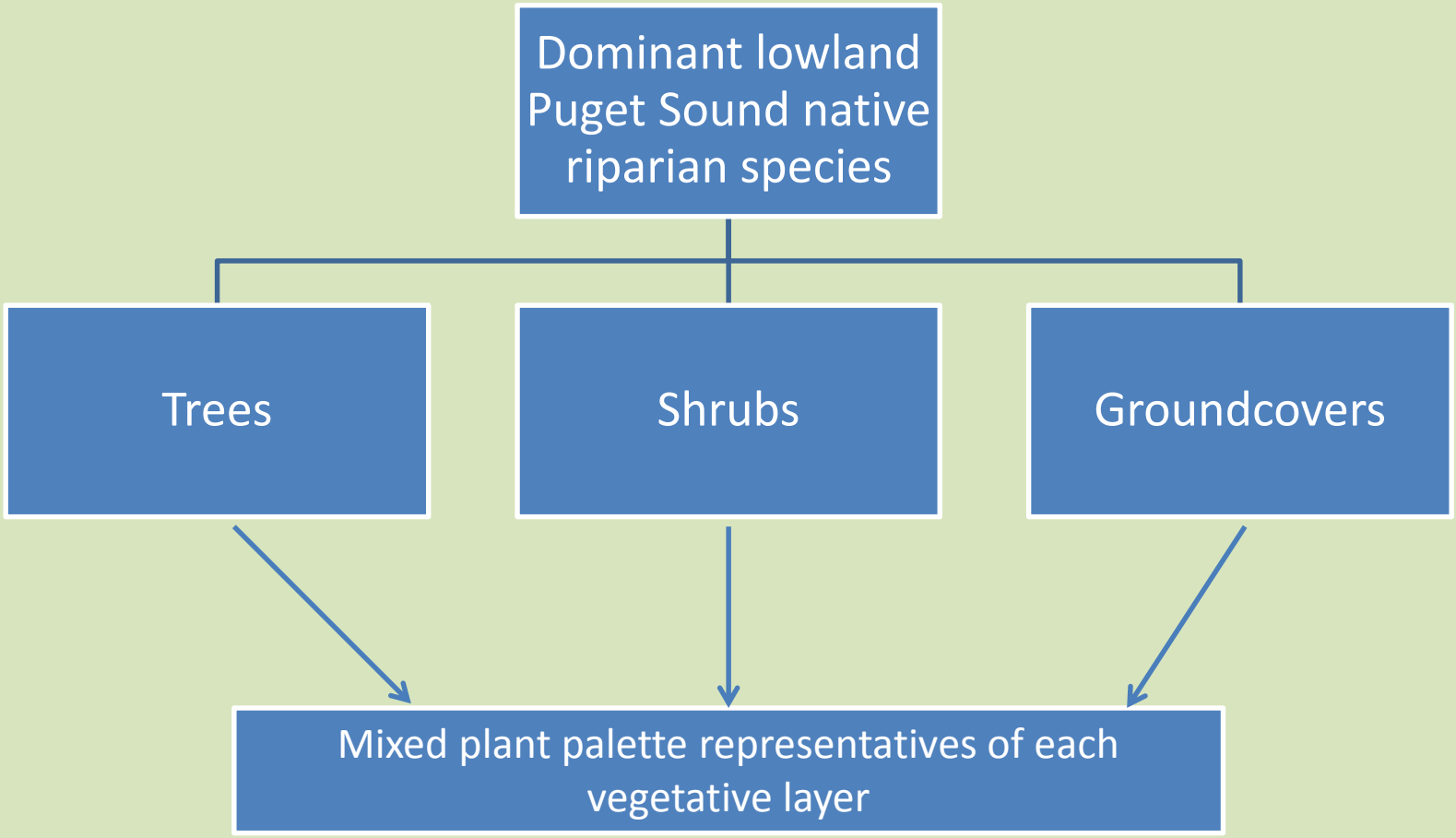
Amelanchier alnifolia

Striped hairstreak

Cedar waxwing

Sweat bee

Species Selection
Vegetative Structure Approach



Project Design
Supporting Functional Resilience

Riparian species providing bird forage


Amelanchier alnifolia


Prunus emarginata


Malus fusca


Sambucus racemosa


Rubus spectabilis

Increasing shade & flood tolerance

Design Approaches

✓ Target species for installation at optimal points along existing gradients

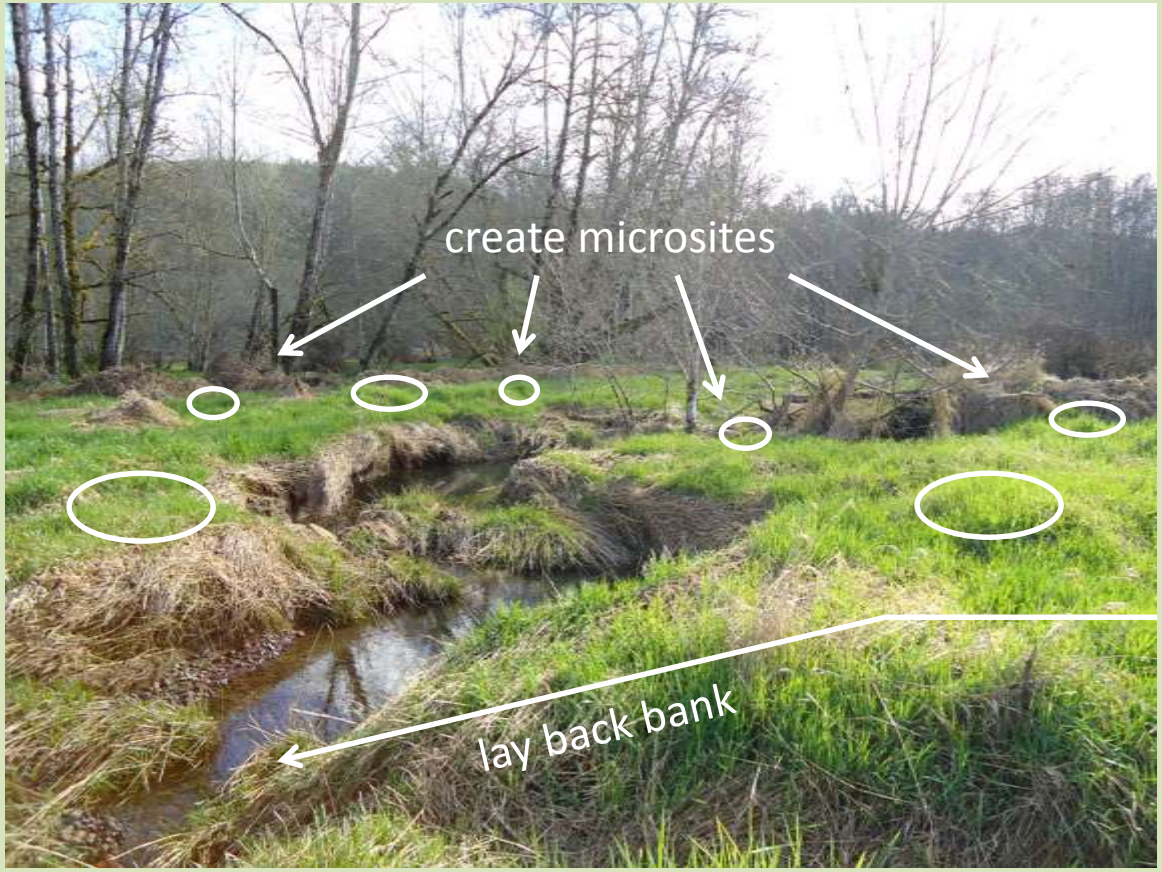
✓ Identify elevational microsites (pits & mounds) for targeted planting

"right plant, right place"

✓ Create gradients and elevational microsites to support desired species selected for functional redundancy

"right place, right plant"

Site Preparation
Supporting Functional Resilience



- ✓ Define site boundaries
- ✓ Survey topography
- ✓ Consider ability of topography to support desired functional redundancy
- ✓ Compensate as possible with altered topography
- ✓ Manage invasives, competition, and herbivory

UW Bothell North Creek Wetlands

Key Themes

Ecological restoration (ER) design and implementation requires more of an engineering and construction rather than a plant palette and landscaping approach.

ER practice essentially lies in manipulating site conditions and introducing species to repair ecosystem processes and support resistant and resilient ecosystem functions.

ER projects inherently have low resistance & resilience and can easily regress without maintenance and adaptive management in early development. High resistance & resilience are properties of maturing/mature ecosystems

Building functional resilience means (1) making species selection based on creating redundancy for ecosystem functions being targeted and (2) ensuring the site conditions through site preparation and maintenance to support that redundancy .

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