Natural Disturbances Affecting Riparian Vegetation in Forested Landscapes

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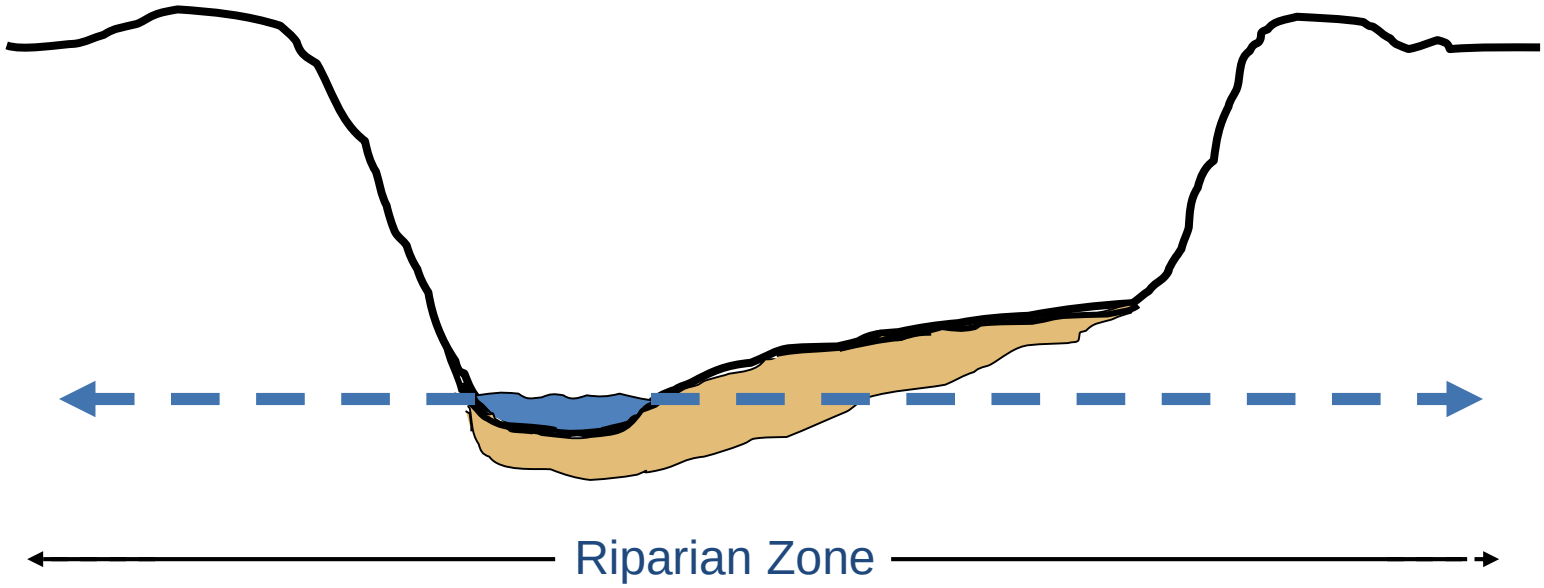
Presentation Outline

- Definition of terms
- Characteristics of streams and the riparian environment
- Riparian communities in forested landscapes
- Natural disturbances and vegetation responses to disturbances
- Human effects on natural disturbance regimes
- Implications for active management

Terms

- Riparian = area adjacent to a river or stream
- Riparian zone = area influenced by water moving into or out of the river or stream
- Riparian woodland/forest = woodland/forest growing in the riparian zone

Riparian Zone



Riparian Zones

Dry Creek, Sonoma County

Battle Creek, Tehama County

Riparian Zone in Conifer Forest

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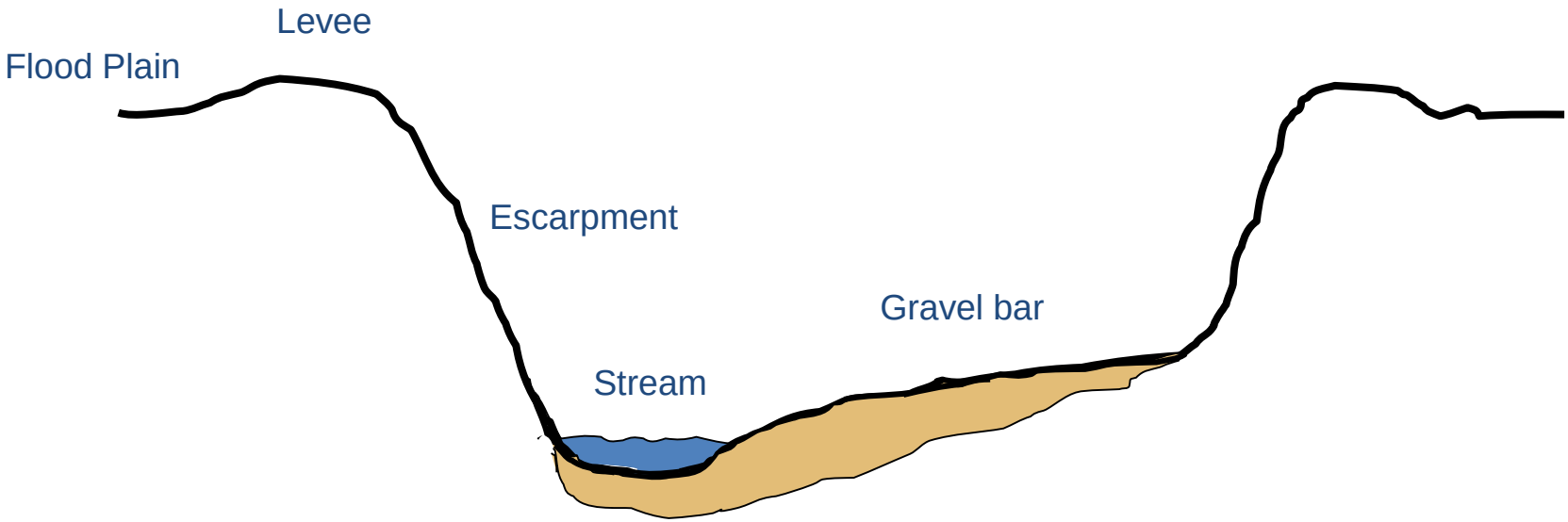
Characteristics of Streams

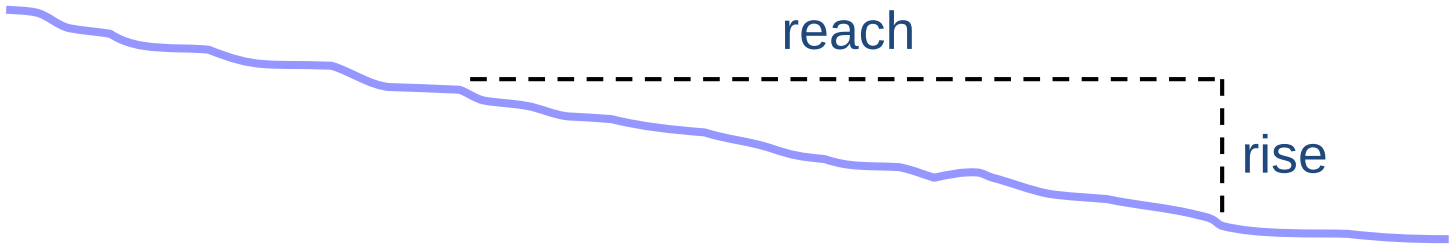
- Topography
- Channel Cross Section
- Stream Gradient
- Meander Patterns
- Riffle Pool Sequences

Terminology of the Cross Section



Stream Gradient

Steepness of the stream surface

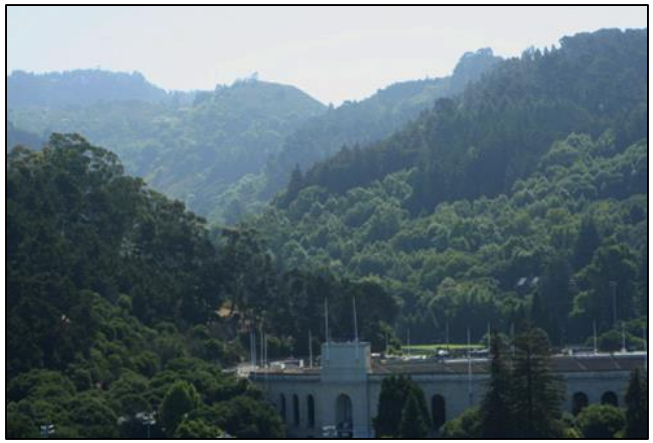


$$\% \text{ slope (gradient)} = \frac{\text{rise}}{\text{reach}}$$

Stream Gradient

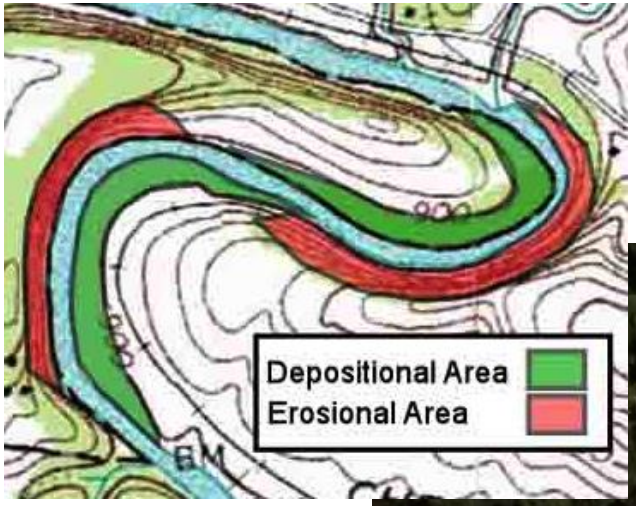
Strawberry Creek in:

Strawberry Canyon = 9%



Berkeley Campus = 3%

Meander Patterns



Riffle-Pool Sequence

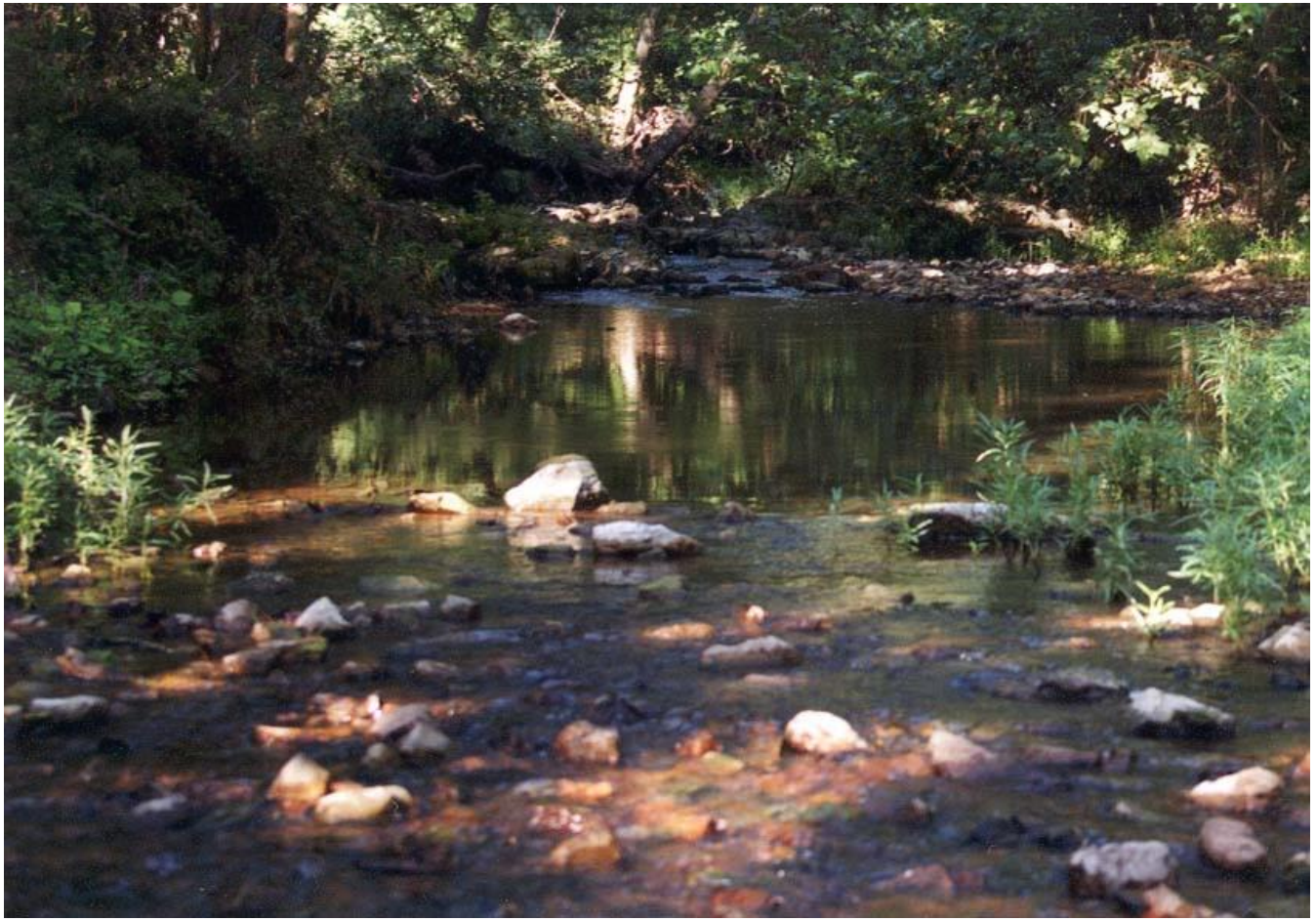
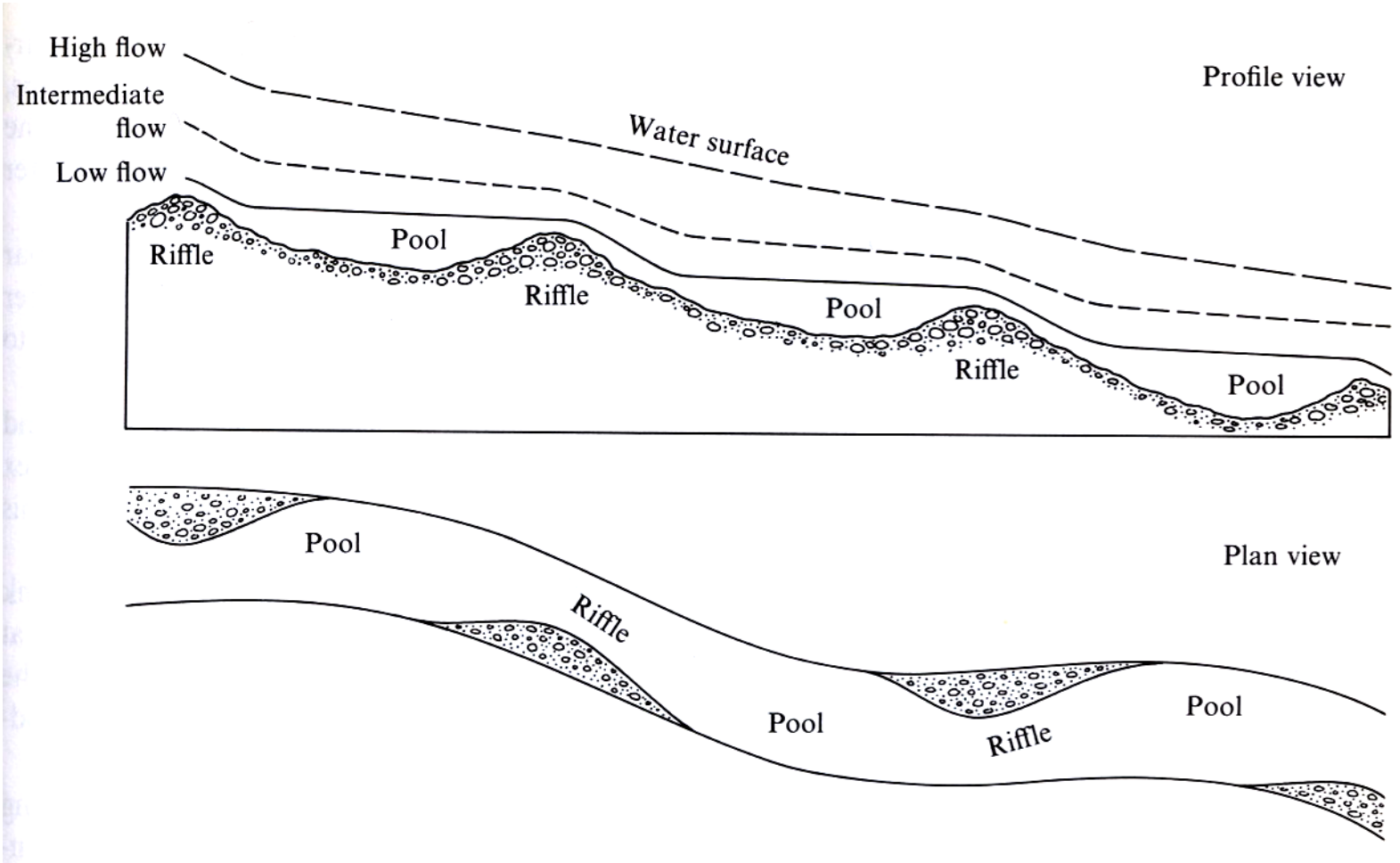
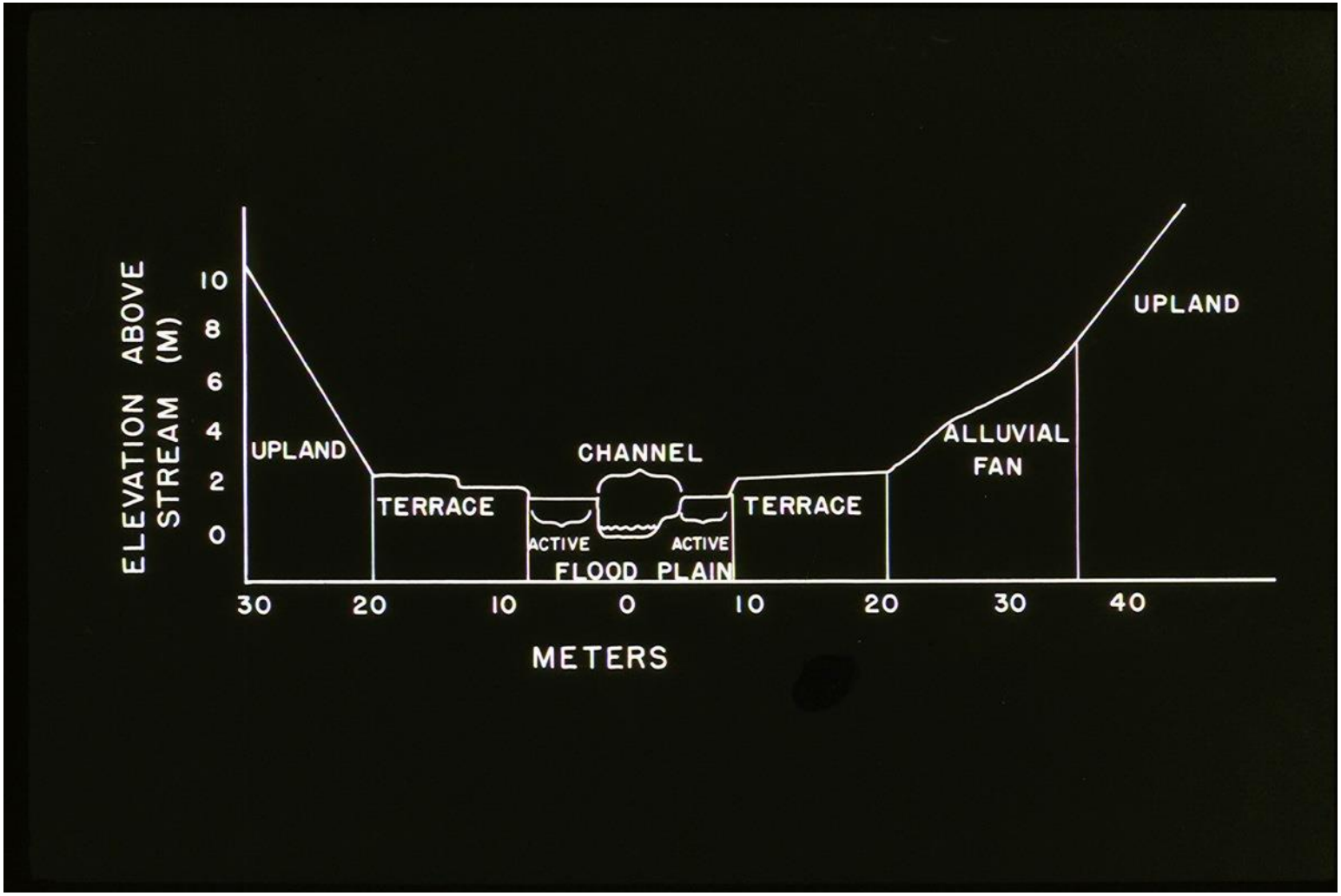


Photo: www.fisheries.org

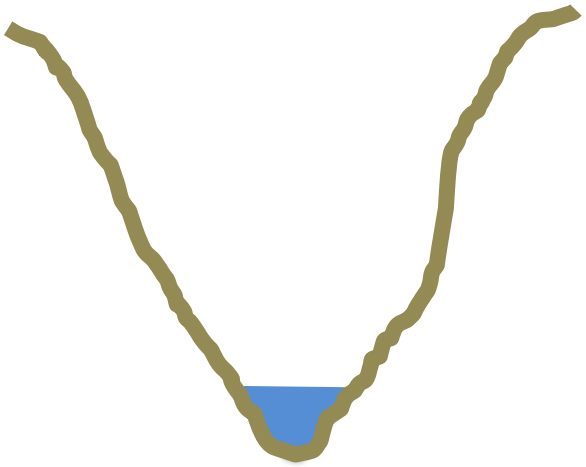
Riffle-Pool Sequence in Streams



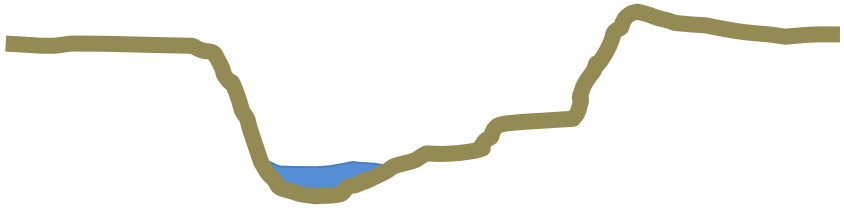
The Roles of Geomorphology and Hydrology in Structuring Riparian Communities



Variation in Channel Cross Section

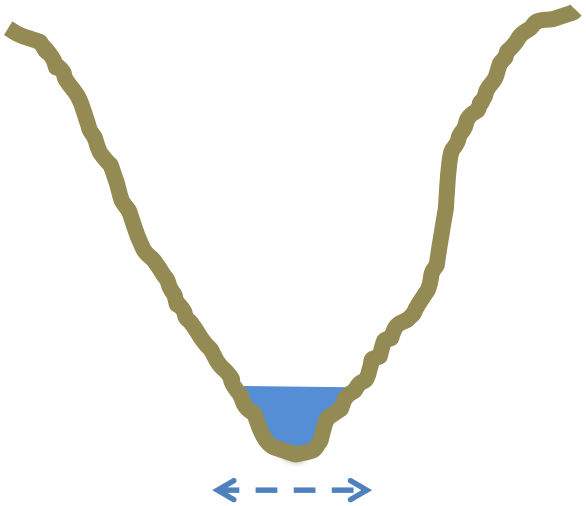


Headwaters



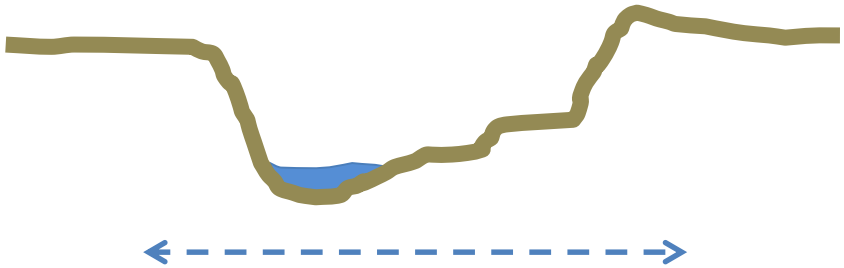
Lower Reach

Variation in Channel Cross Section



Riparian Zone

Headwaters



Riparian Zone

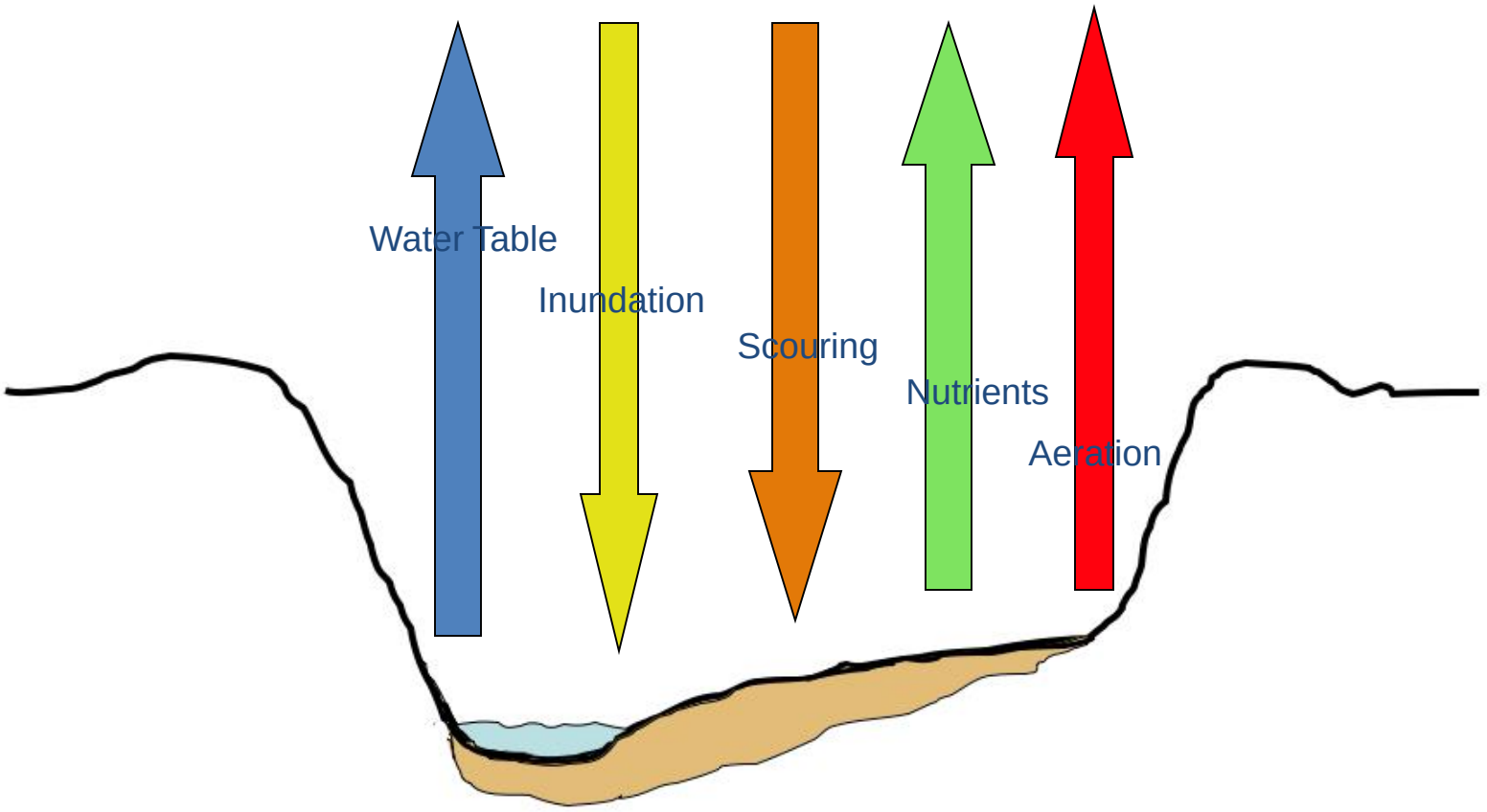
Lower Reach

Characteristics of the Riparian Environment*

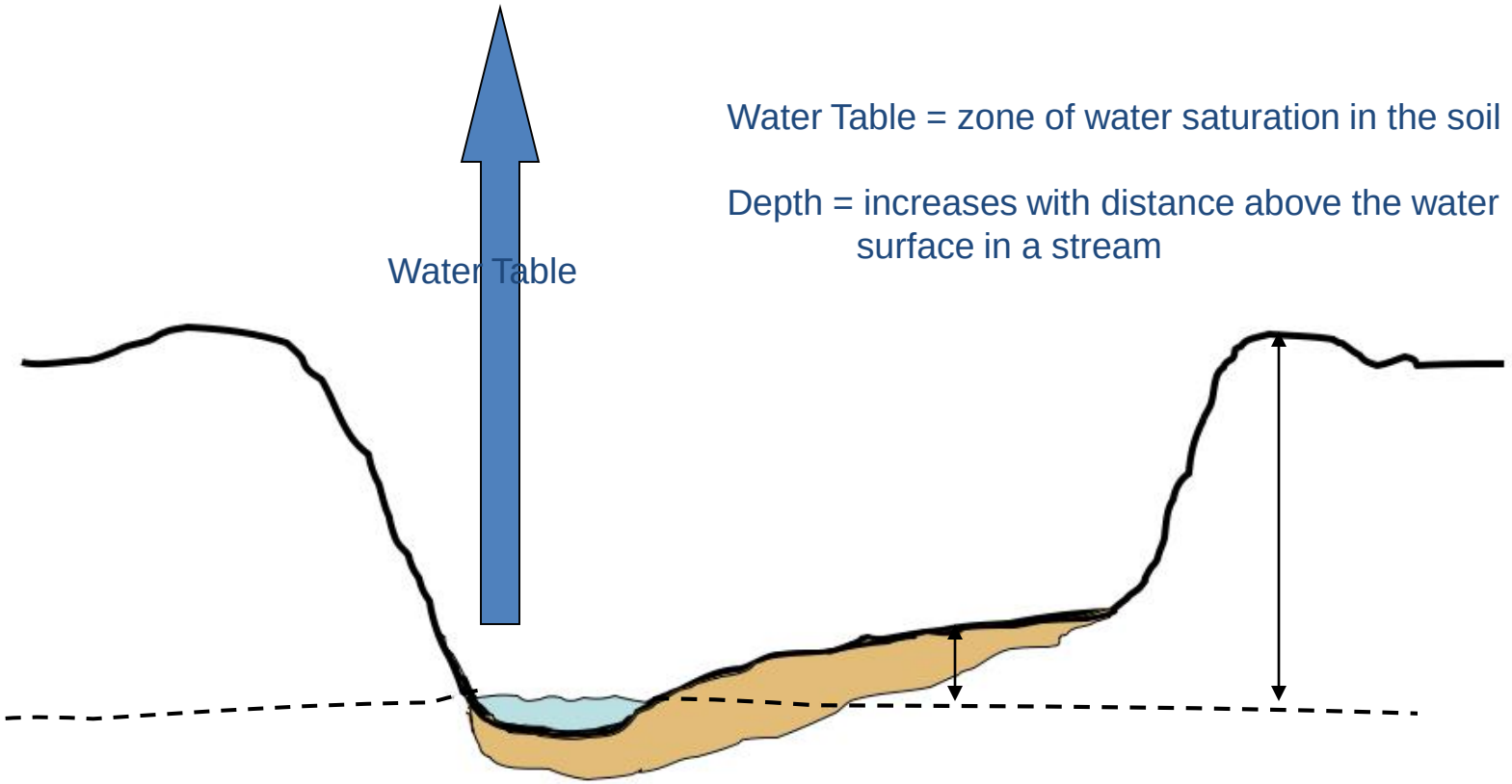
- Depth to water table
- Inundation
- Scouring
- Nutrient concentration
- Dissolved oxygen

**from a plants point of view*

Environmental Gradients



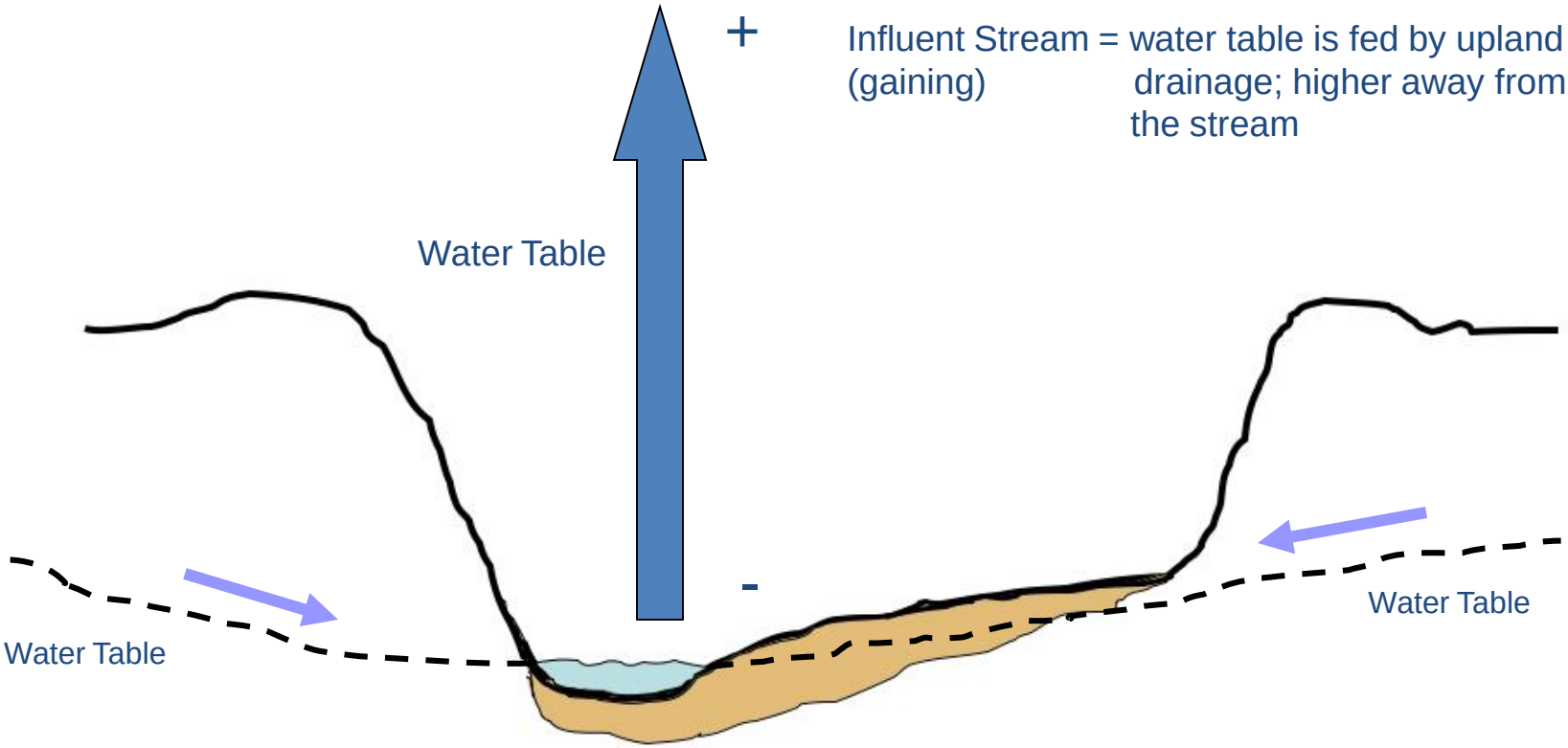
Depth to Water Table



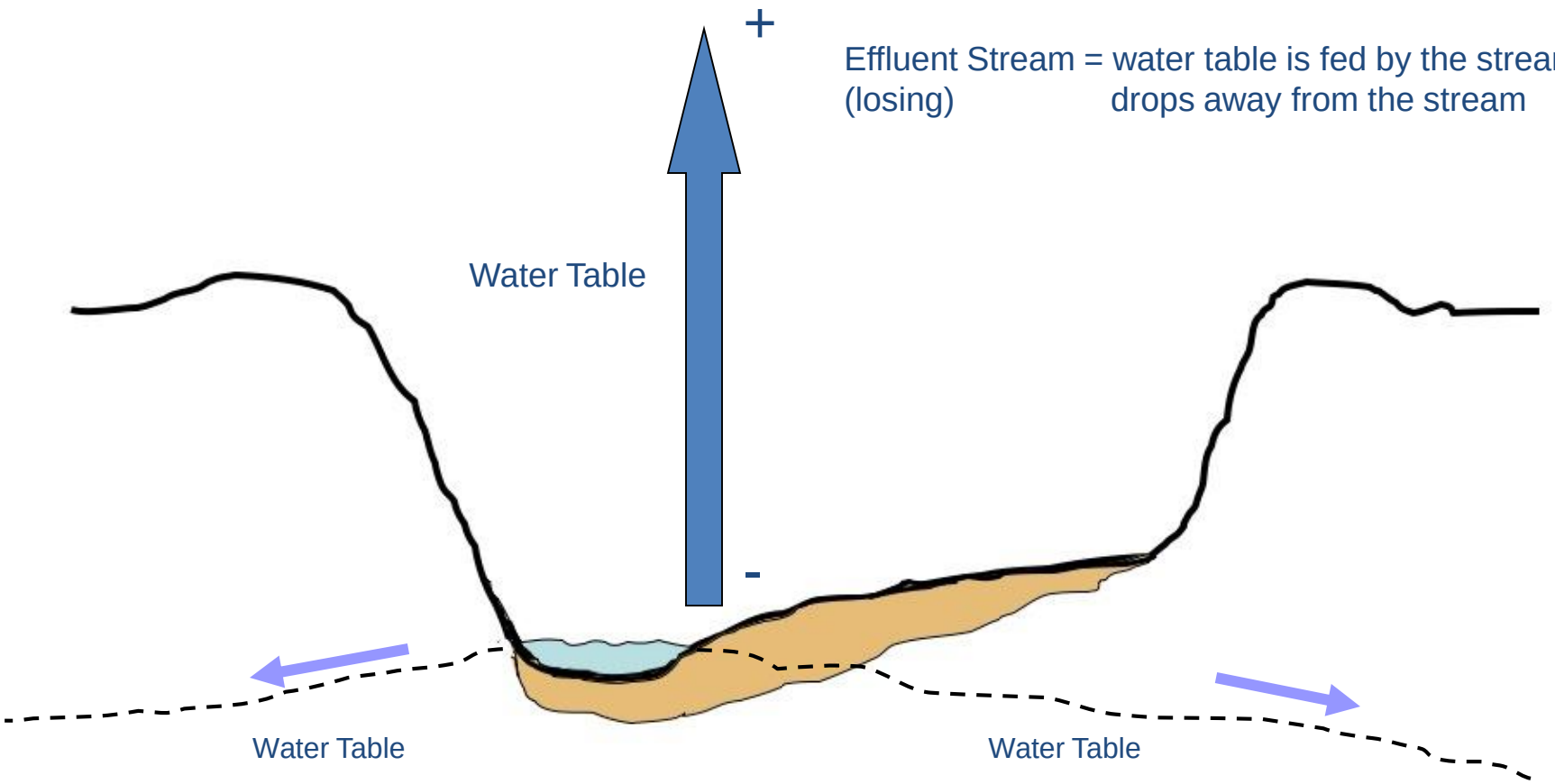
Water Table = zone of water saturation in the soil

Depth = increases with distance above the water surface in a stream

Depth to Water Table



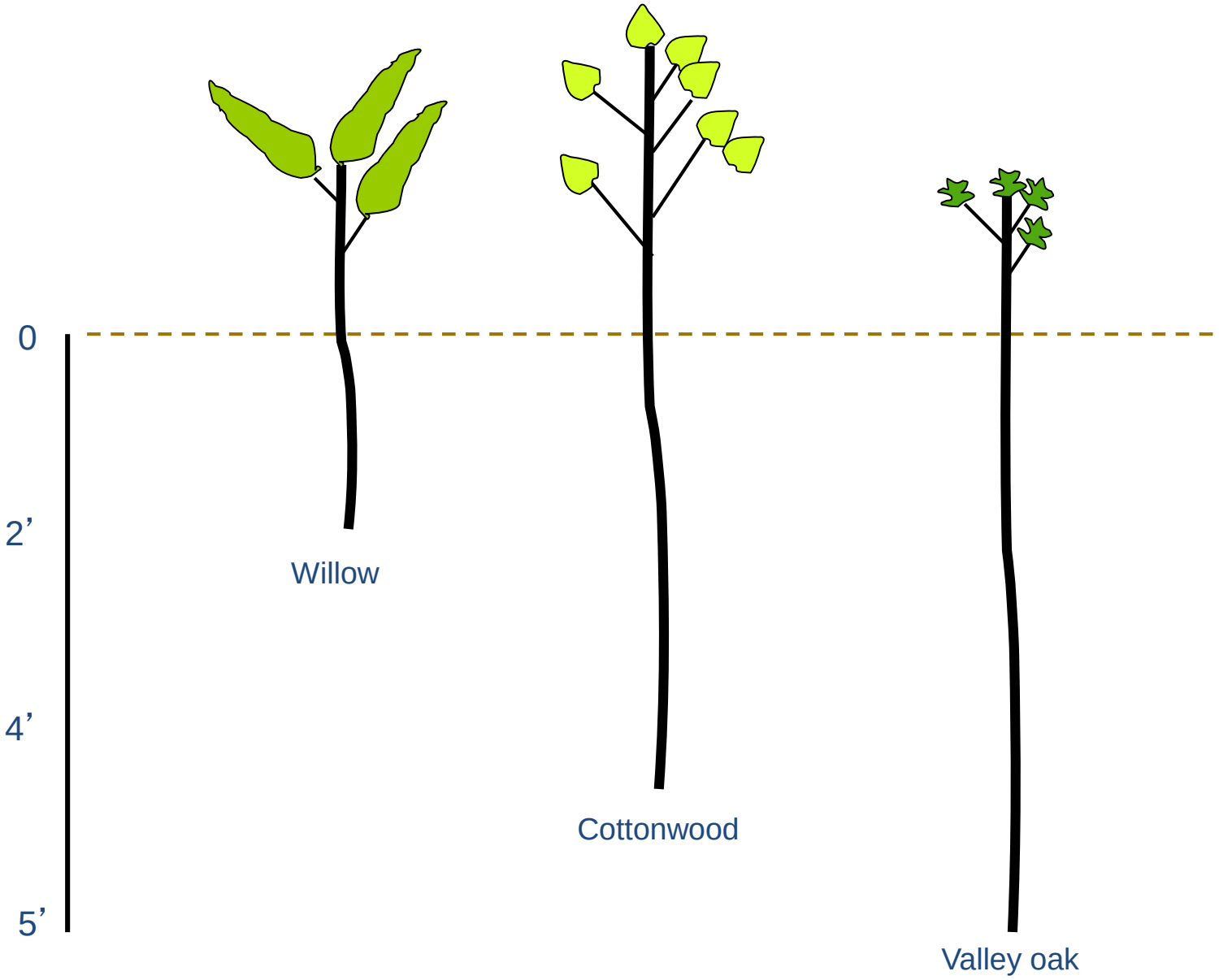
Depth to Water Table



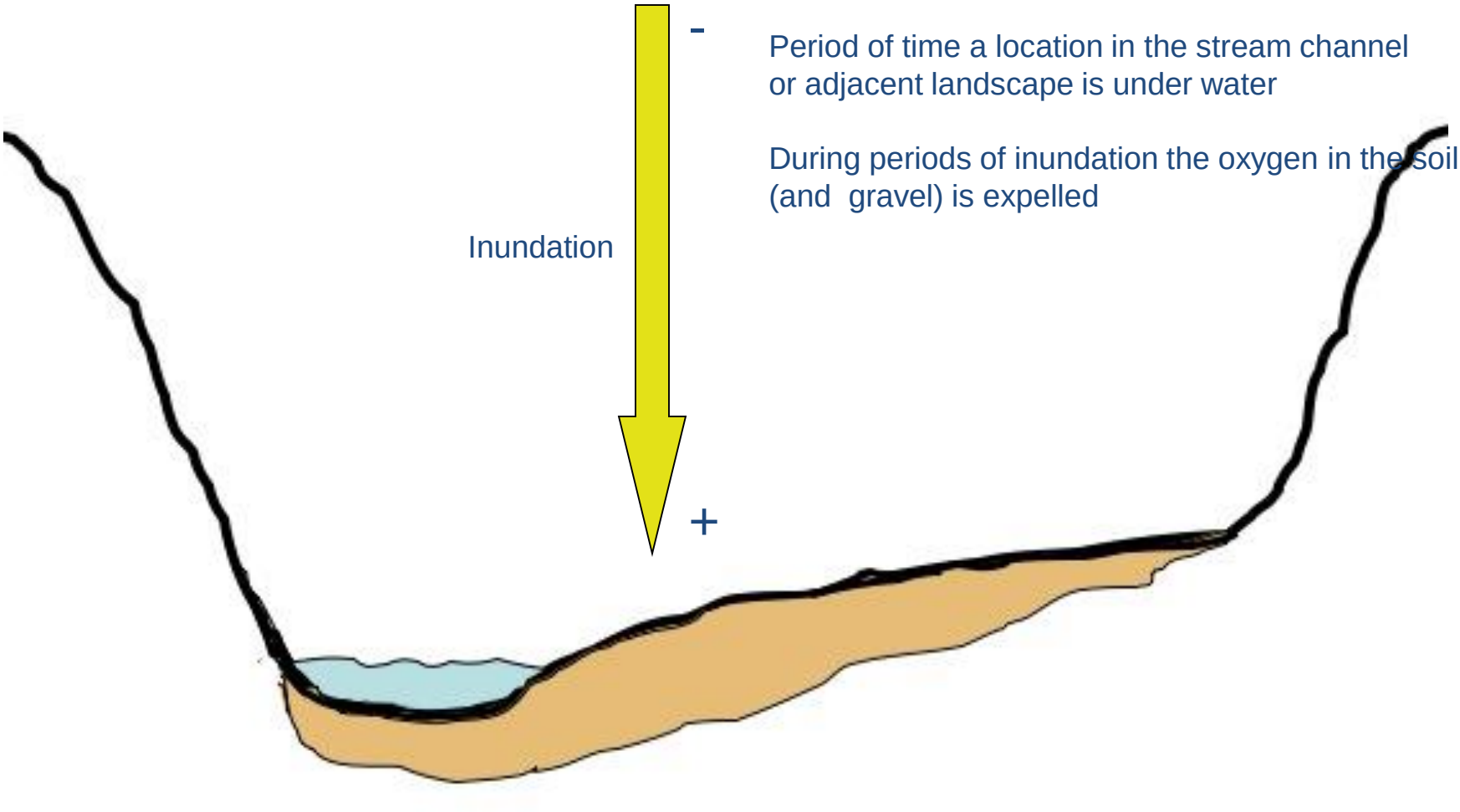
Effluent Stream = water table is fed by the stream;
(losing) drops away from the stream

Root Growth Potential Study

Variation in Root Growth



Duration of Inundation



Period of time a location in the stream channel or adjacent landscape is under water

During periods of inundation the oxygen in the soil (and gravel) is expelled

Seasonal Inundation

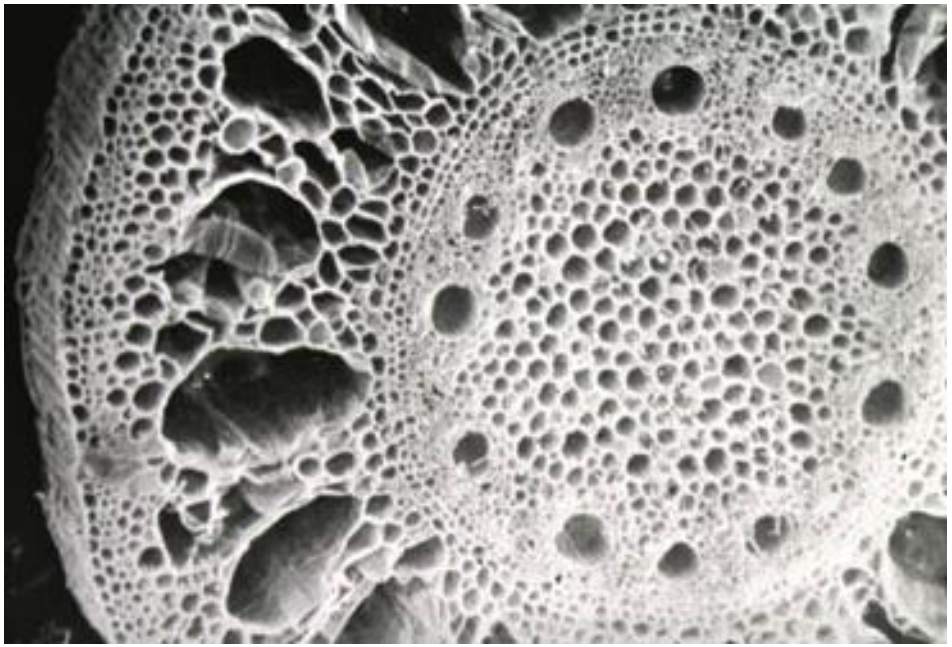
April

September

Dry Creek - Sonoma County

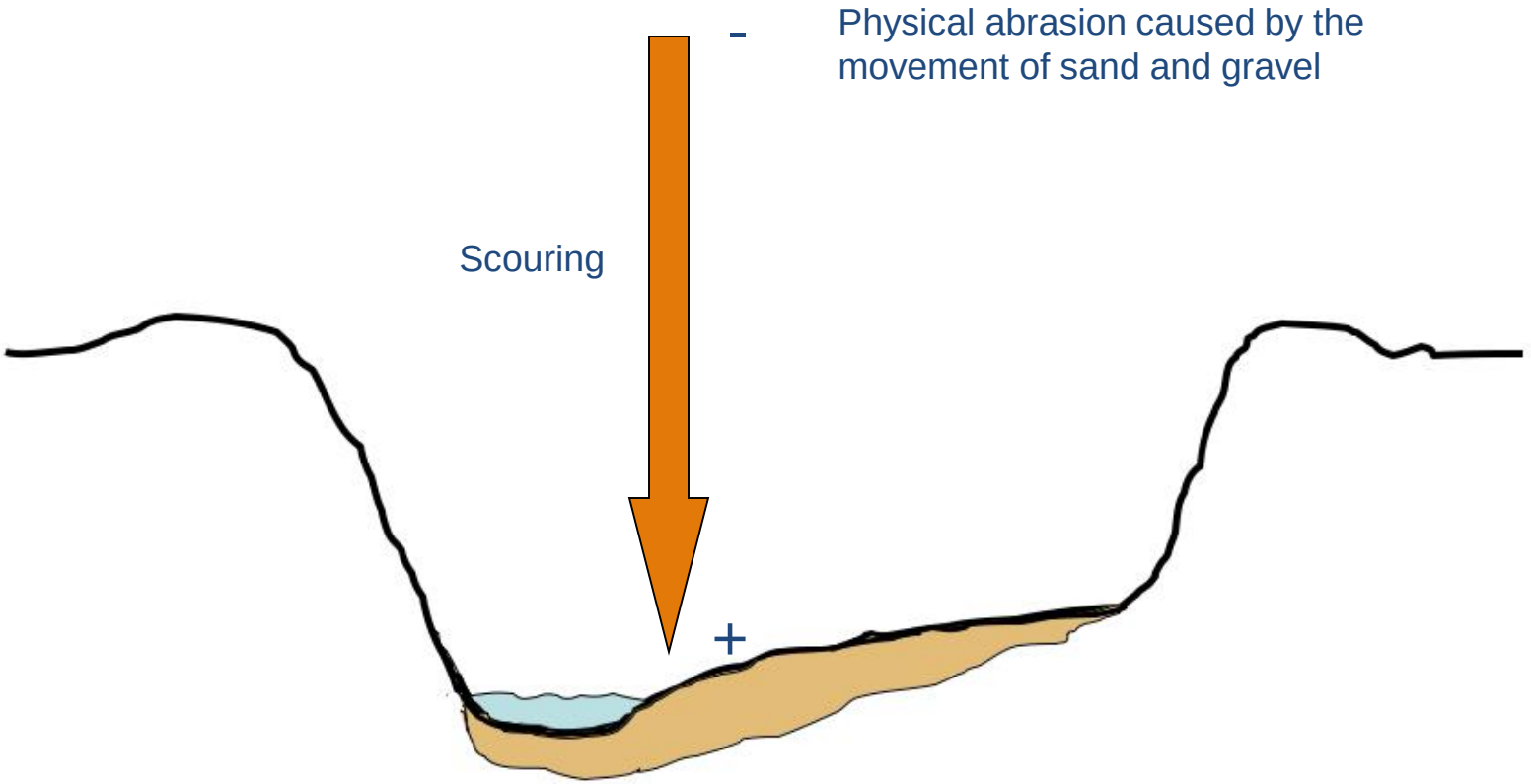
Willow

Partially Submerged Willow



Aerenchyma

Scouring


-
Physical abrasion caused by the movement of sand and gravel
Scouring
+

Scouring Stream

Photo: travelpanamablog.com

Scouring of Willows (“training”)

Wood Characteristics

Oak

Willow

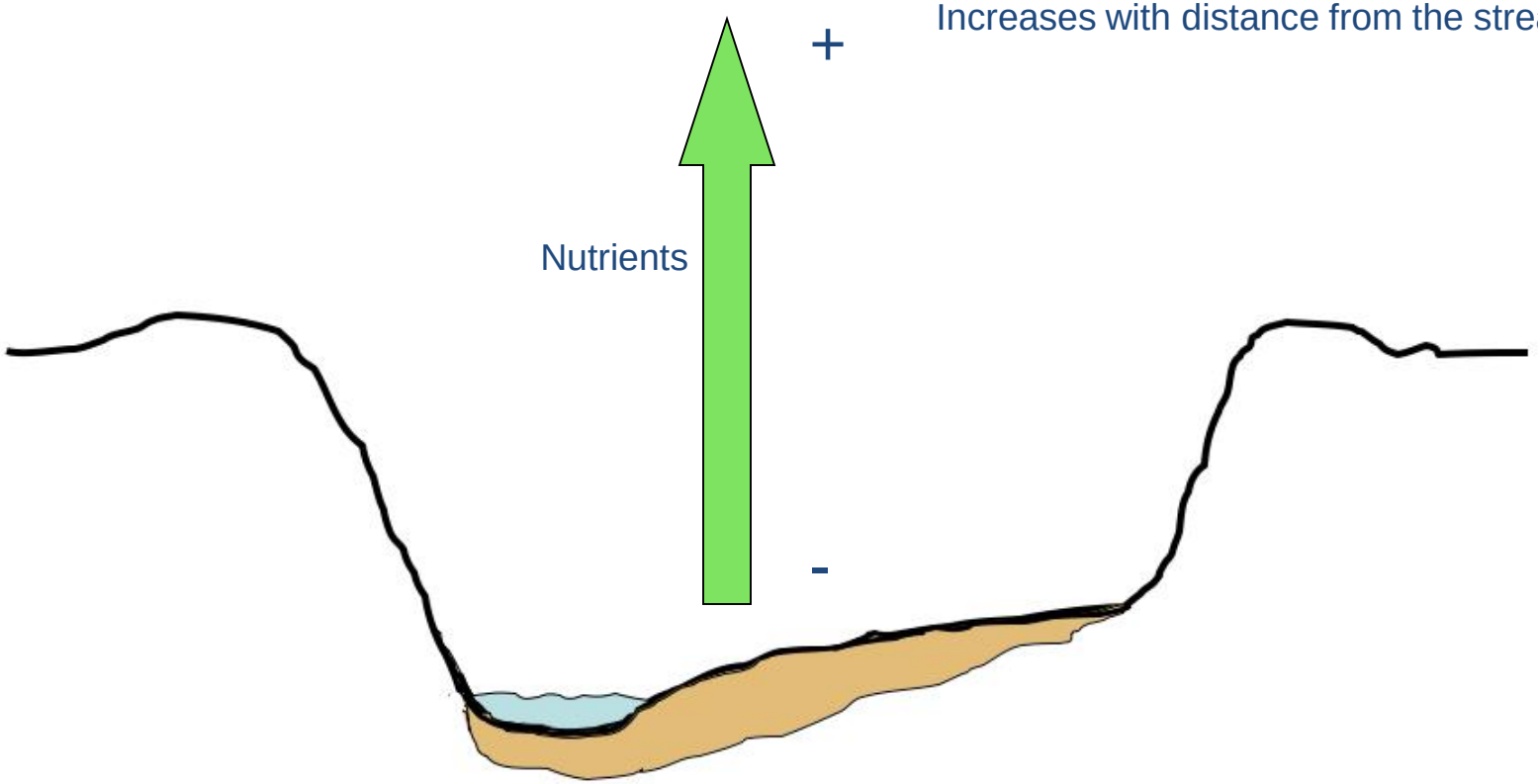
Willow Hoops

Tree Species	Specific Gravity*	Modulus of Elasticity**
Oak	0.68	17
Willow	0.39	10

(*gm/cm; **psi)

Nutrient Concentration

The concentration of available nutrients
Increases with distance from the stream



Variation in particle size

Raymondskill Creek - Pennsylvania

(photo from Ammodramus)

Variation in Phosphorus Concentration

Total Phosphorus

32 mg/kg

0.12mg/kg

Raymondskill Creek - Pennsylvania

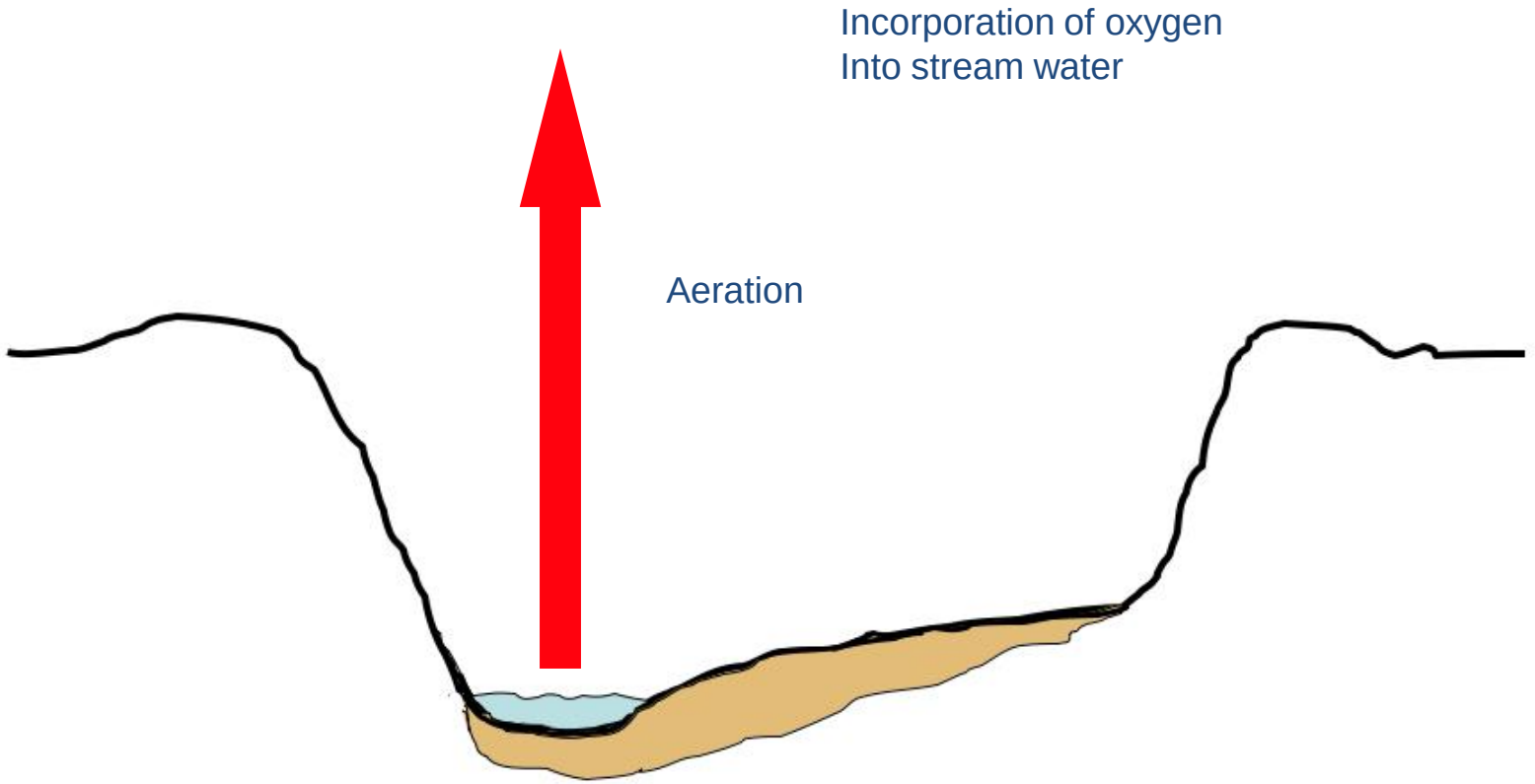
(photo from Ammodramus)

Transpiration Rates

Species	Transpiration (gal/day)
Cottonwood	25
Willow	13
Valley Oak	4

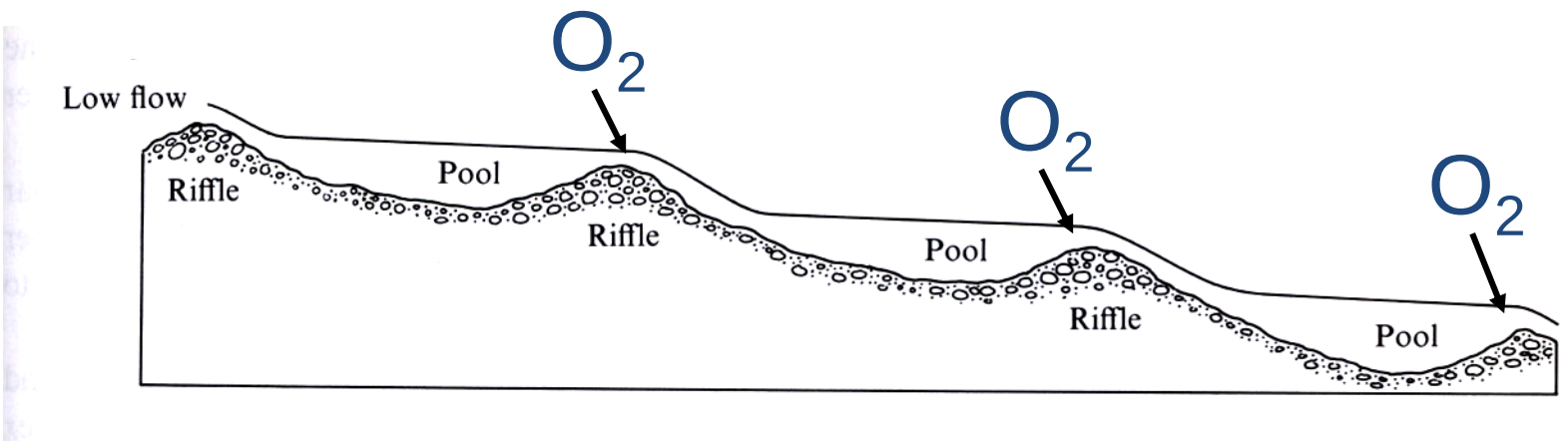
Based heat flux measurements in10” dbh trees

Aeration



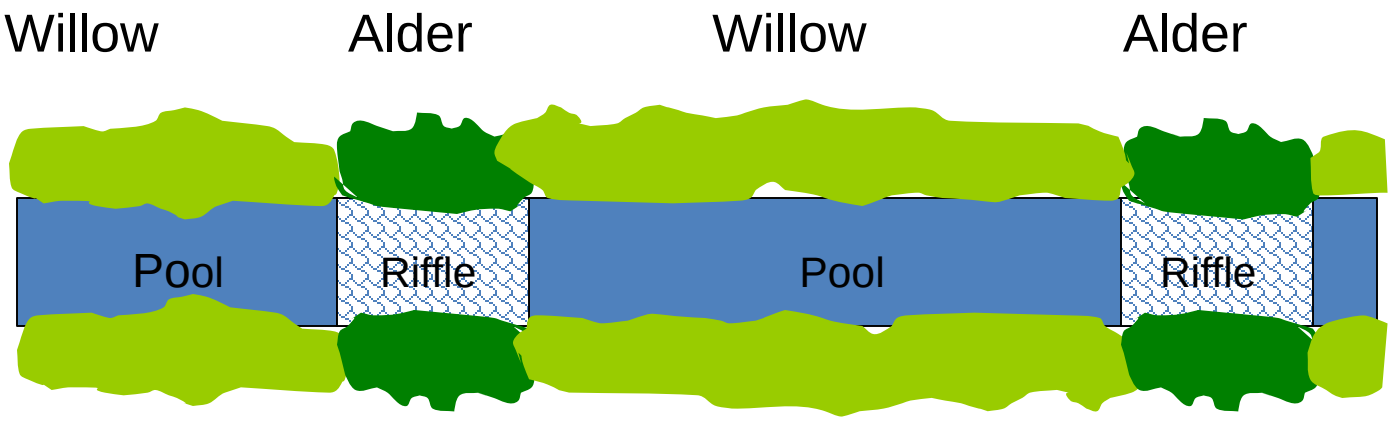
Stream Aeration

Dissolved Oxygen



Riffle-Pool Sequence in Streams

Pattern of Willows and Alders along Dry Creek, Sonoma County



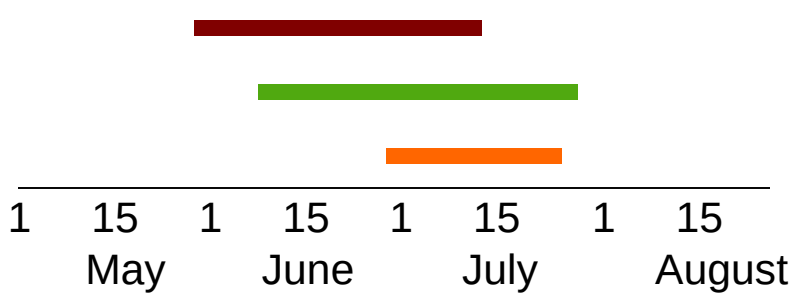
Factors Controlling Seedling Establishment in the Riparian Zone

- Seed supply
- Seed bed condition
  - Moisture
  - Oxygen

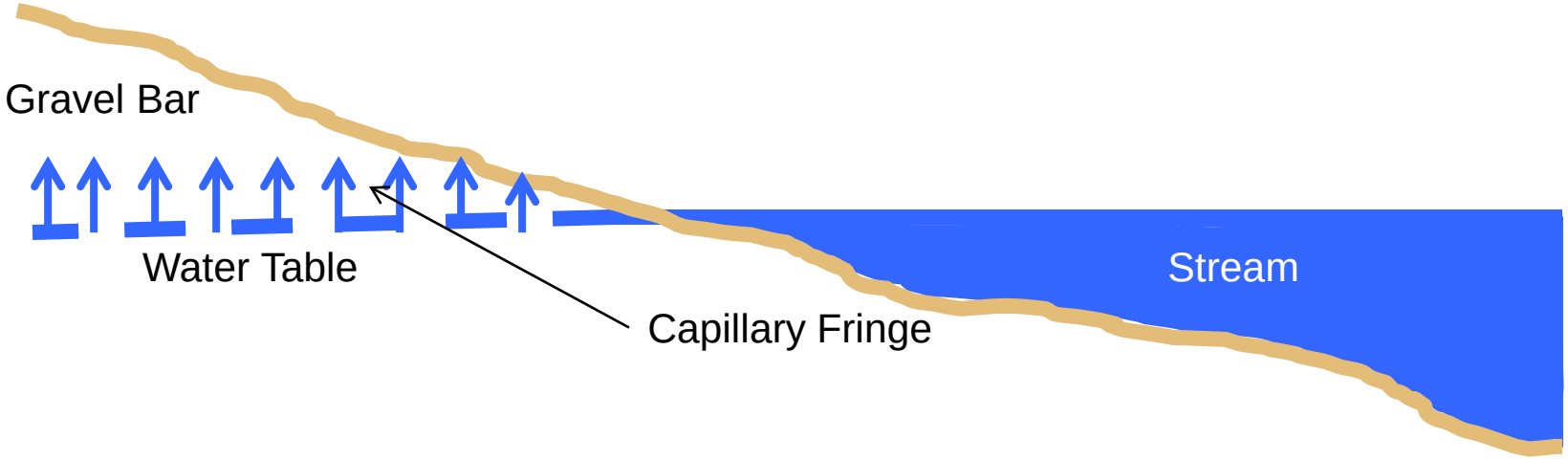
Seasonal pattern of Seed Production

(Stella *et al*, 2006)

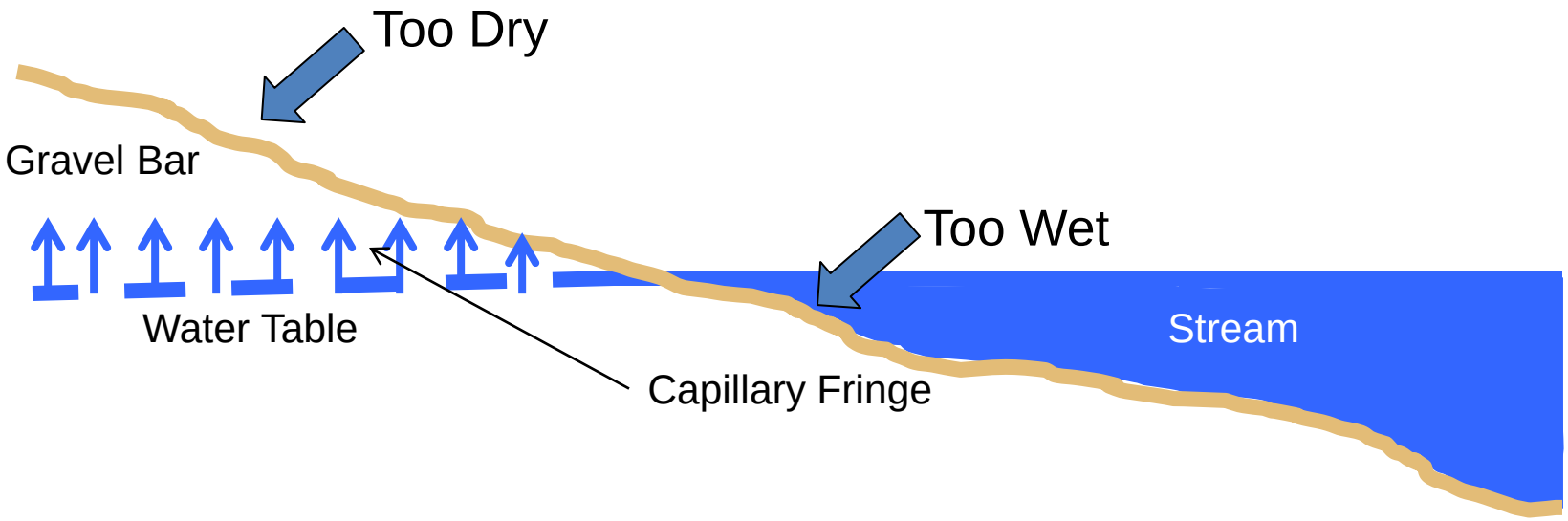
Species	Peak Seed Release Period
Fremont Cottonwood	
Gooding's Willow	
Sandbar Willow	



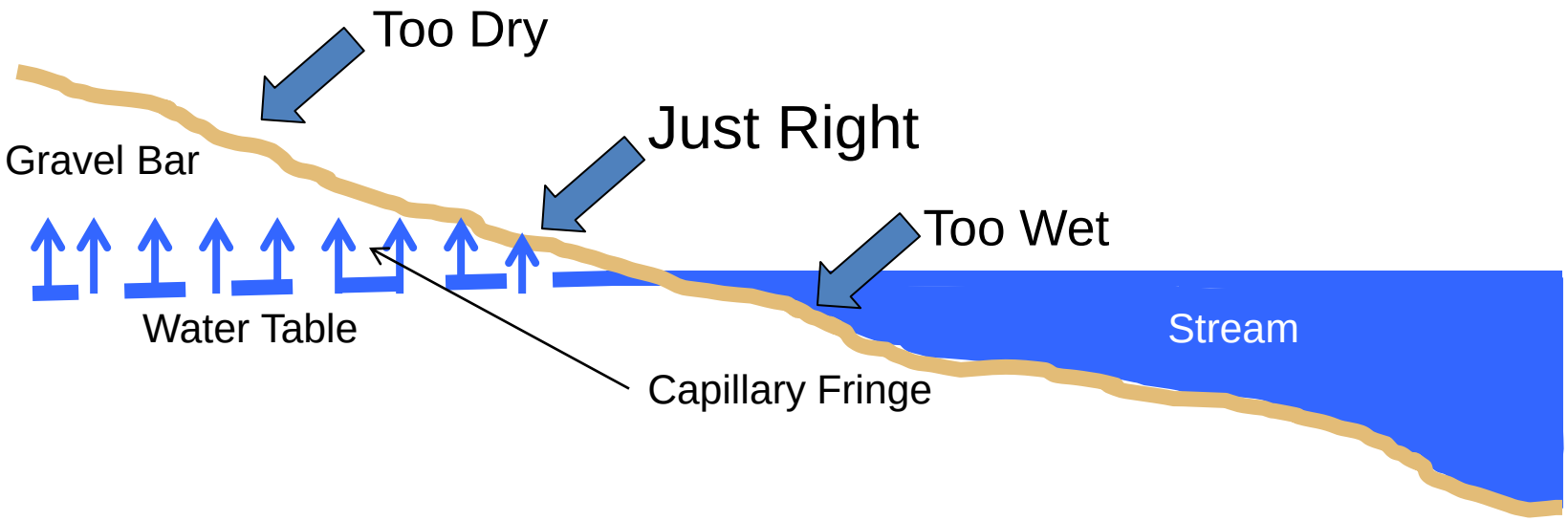
Seed Bed Condition



Seed Bed Condition

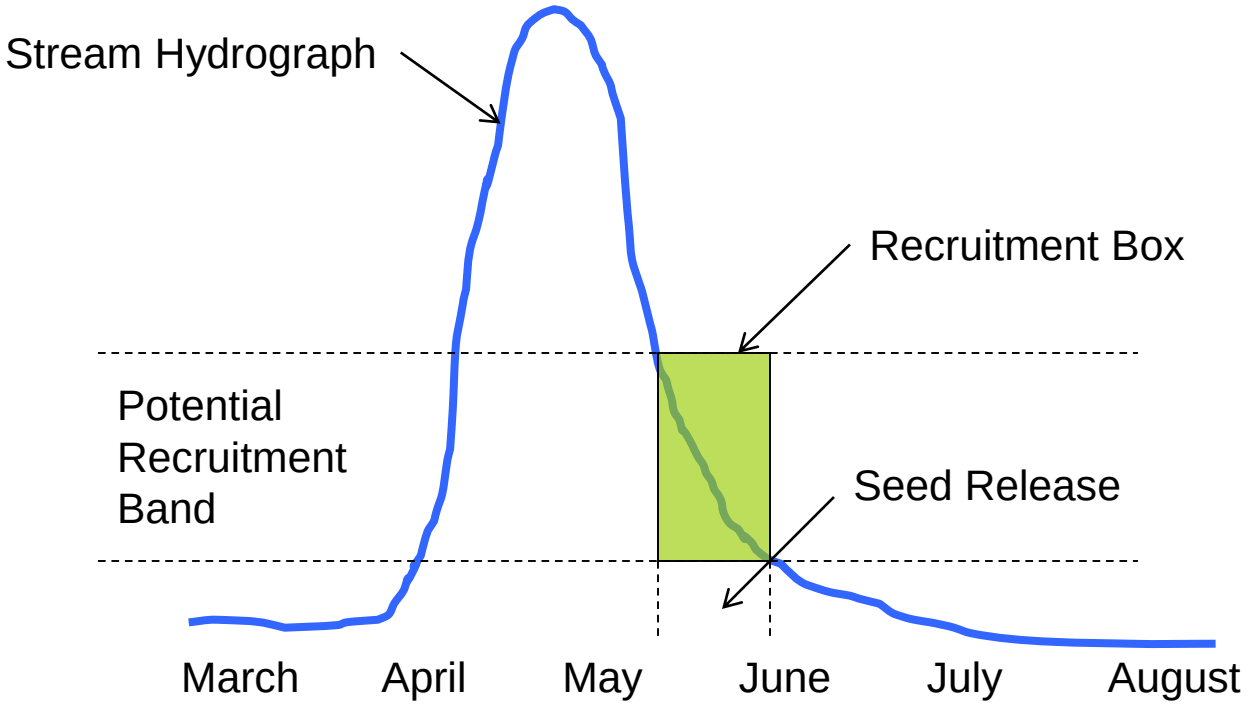


Seed Bed Condition

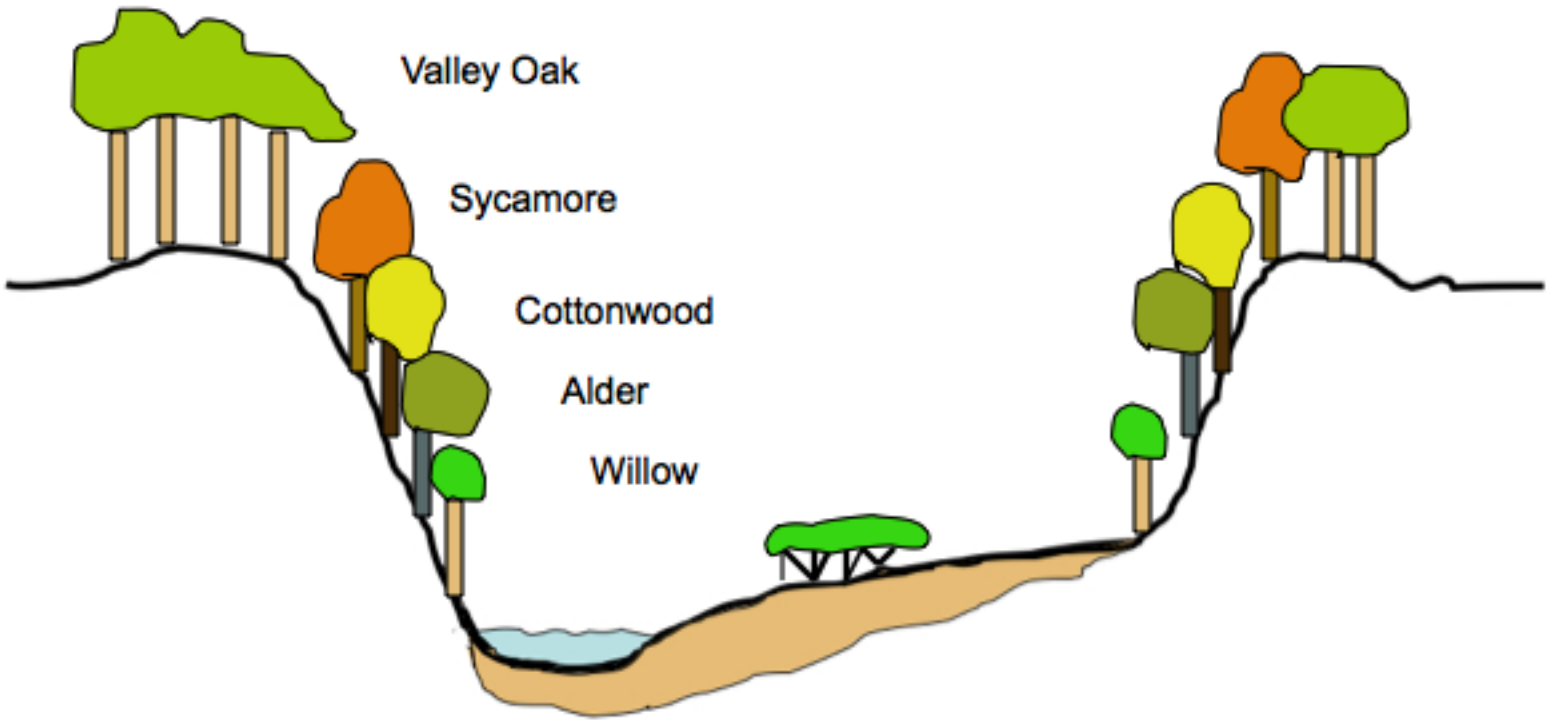


Recruitment Box Model

(Mahoney and Rood, 1998)



Toposequence



Questions?

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Riparian Communities in California

- Coastal Riparian Forests
- Intermountain Riparian Forests
- Southern California Riparian Forests
- Sierra Nevada forests
  - East side
  - West side

Coastal Riparian Forests

Common Species

Red alder

Redwood

California bay

Environmental Factors

High annual precipitation

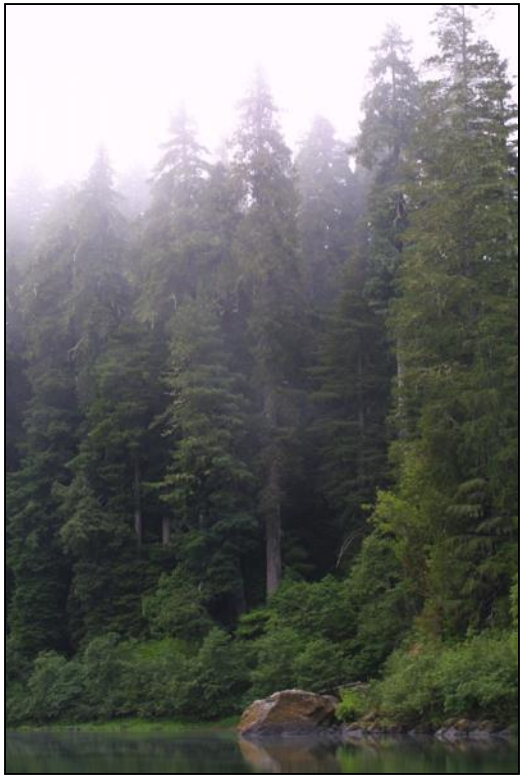
Mild temperatures

Summer fog

Sedimentary rock

Example Stream

Casper Creek (Mendocino County)



Intermountain Riparian Forests

Common Species

Fremont cottonwood

Red Osier dogwood

Sitka willow

Environmental Factors

High annual precipitation

Warm summers; cold winters

Igneous/metamorphic rock

Example Stream

Salmon River (Siskiyou County)

Sierra Nevada Riparian Forests

West Side

Common Species

Fremont cottonwood
Mountain alder
Pacific dogwood
Incense cedar
Red willow

Environmental Factors

Moderate annual precipitation
Snow melt runoff
Hot summer; cold winters
Granitic rock

Example Stream

Middle Fork Feather River (Plumas County)

Sierra Nevada Riparian Forest

East Side

Common Species

Western black cottonwood
Aspen
Water birch
Yellow willow

Environmental Factors

Moderate annual precipitation
Snow melt runoff
Hot summer; very cold winters
Granitic rock

Example Stream

Middle Fork Feather River (Plumas County)

Southern California Riparian Forest

Common Species

Western black cottonwood
Western sycamore
White alder
Willows

Environmental Factors

Low annual precipitation
Hot summer; mild winters
Sedimentary/granitic rock

Example Stream

Santa Ana River

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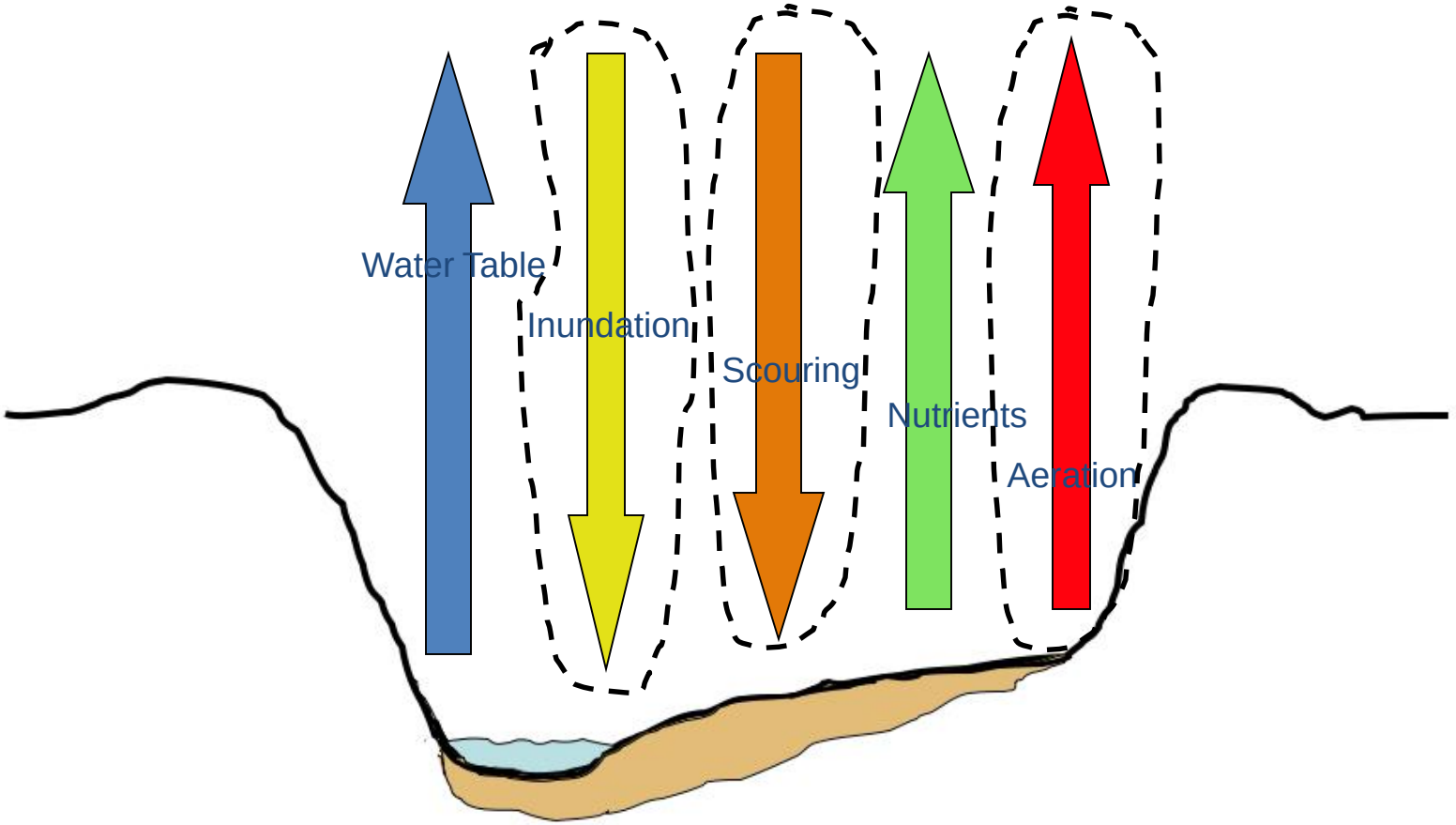
Natural Disturbances

- Flooding
- Land sliding/debris flows
- Wild fire
- Wind throw

Flooding

Impact of Flooding on Environmental Gradients



Inundation/Aeration

Mud lines – Navarro River

Silt Deposits - Bull Creek Flat

Scouring

Redwoods fallen into stream

Scouring/Stream Meandering

Bull Creek - Humboldt Redwood State Park

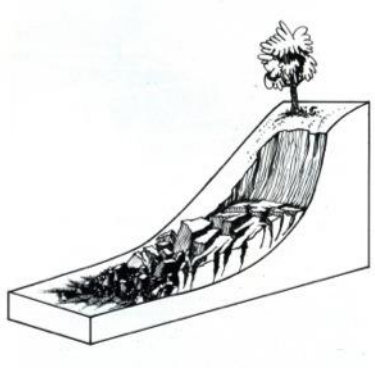
Human Effects on Flooding

Flood Reduction	Flood Increase
Dam Construction	Logging
Storm water retention projects	Agriculture
	Urbanization

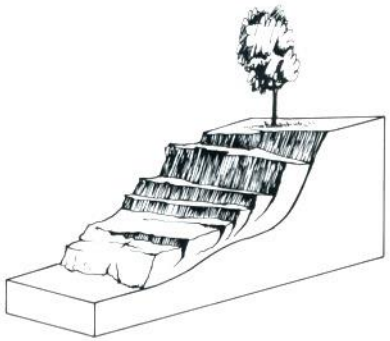
Landslides/Debris flows

Types of Landslides/Debris Flows

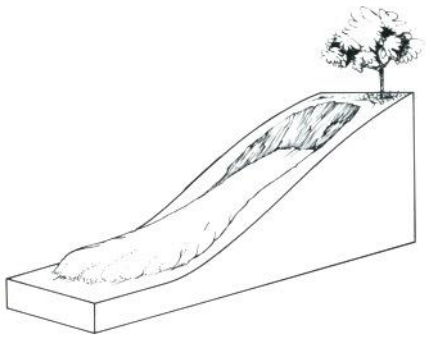
Rock Fall



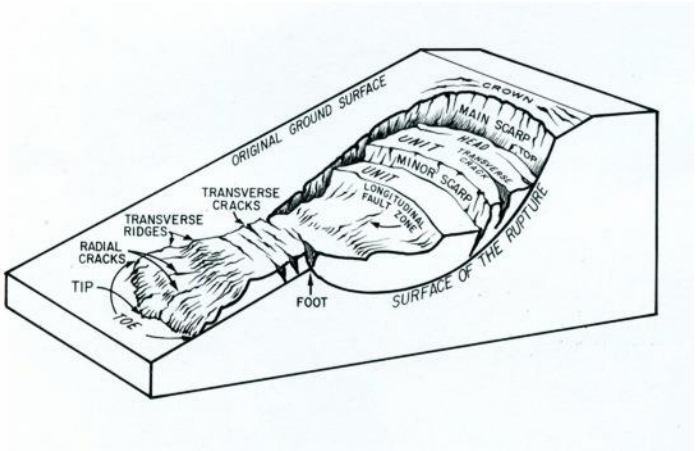
Rock Slide



Slump

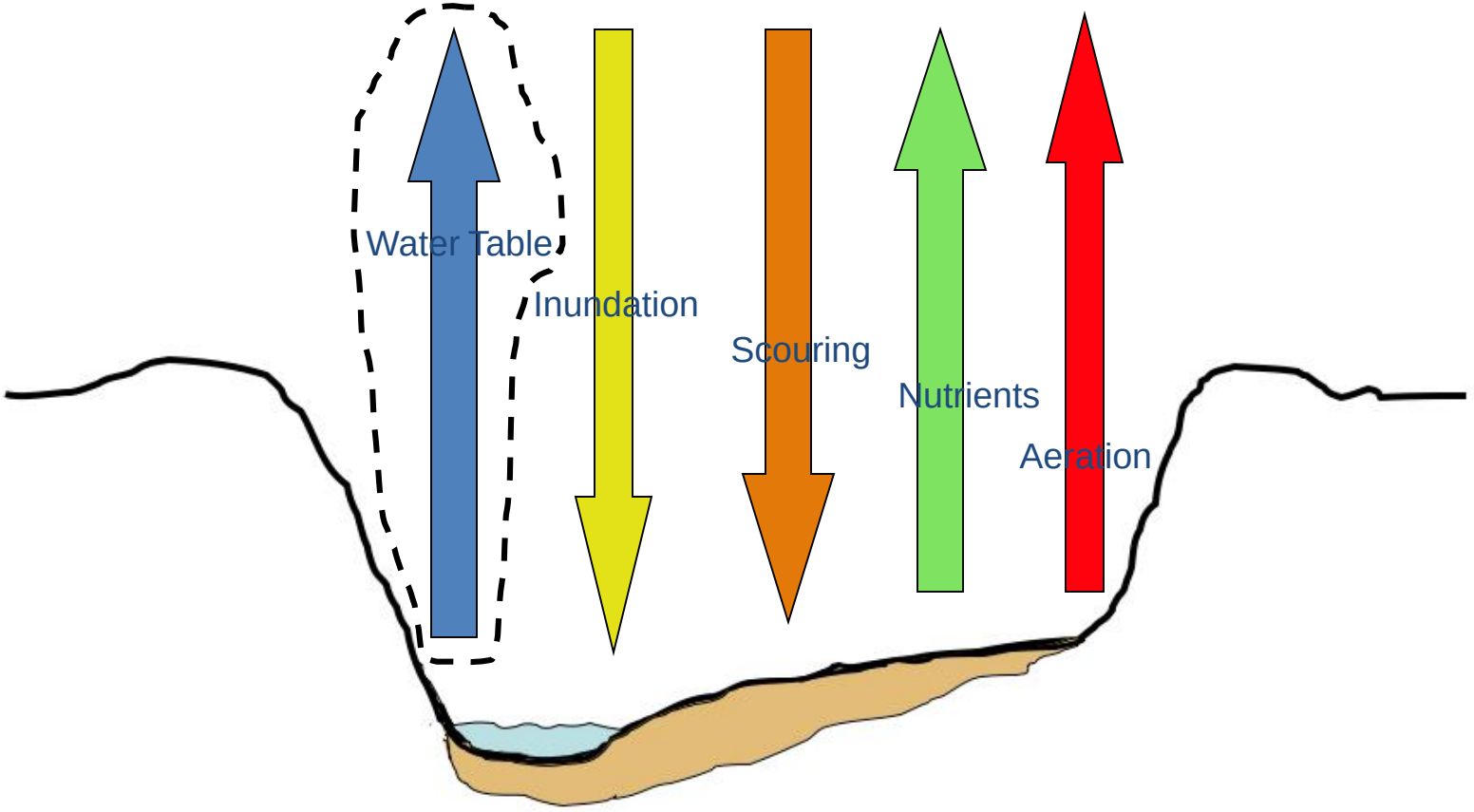


Flow



Complex

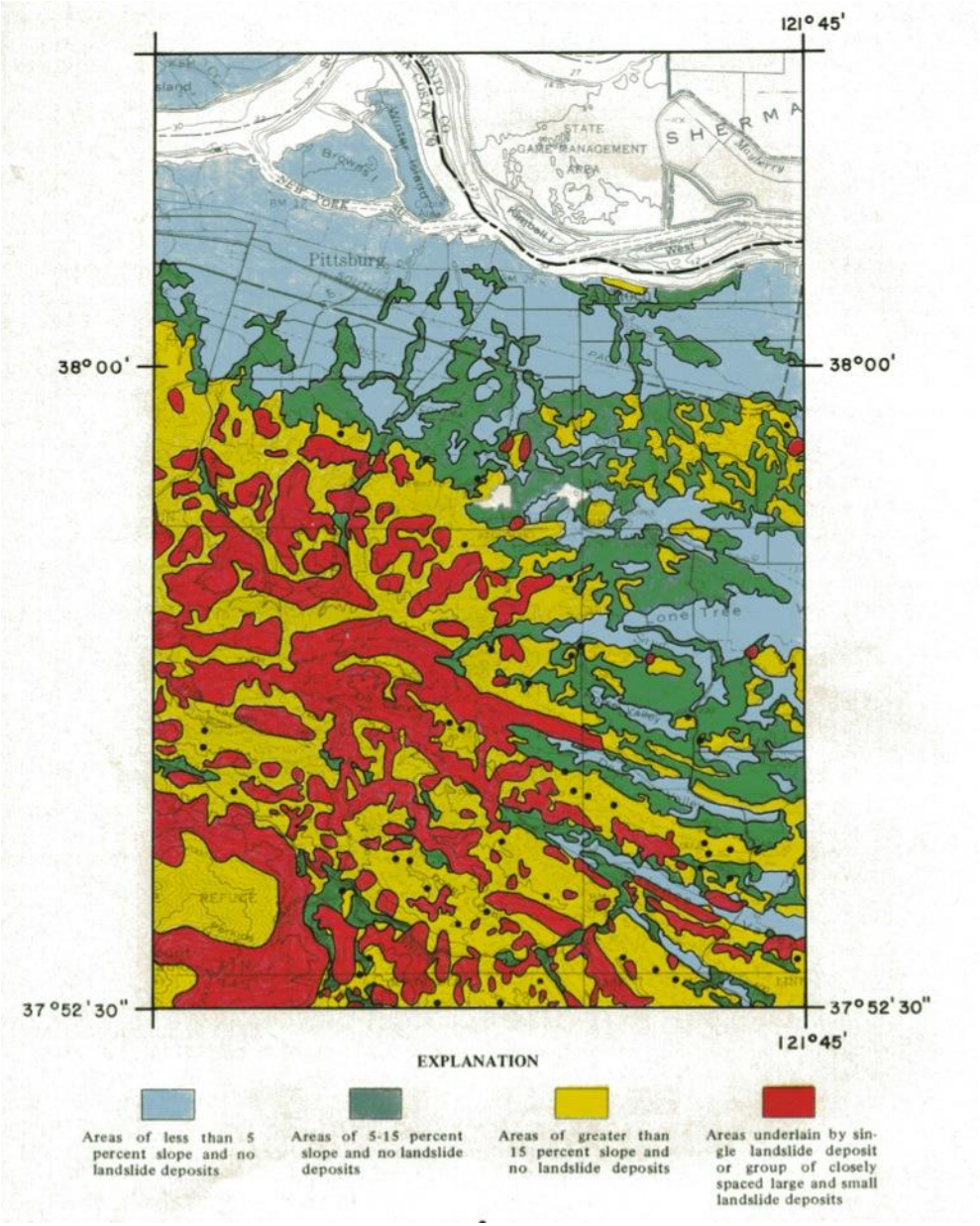
Impact of Landslide/Debris Flows on Environmental Gradients



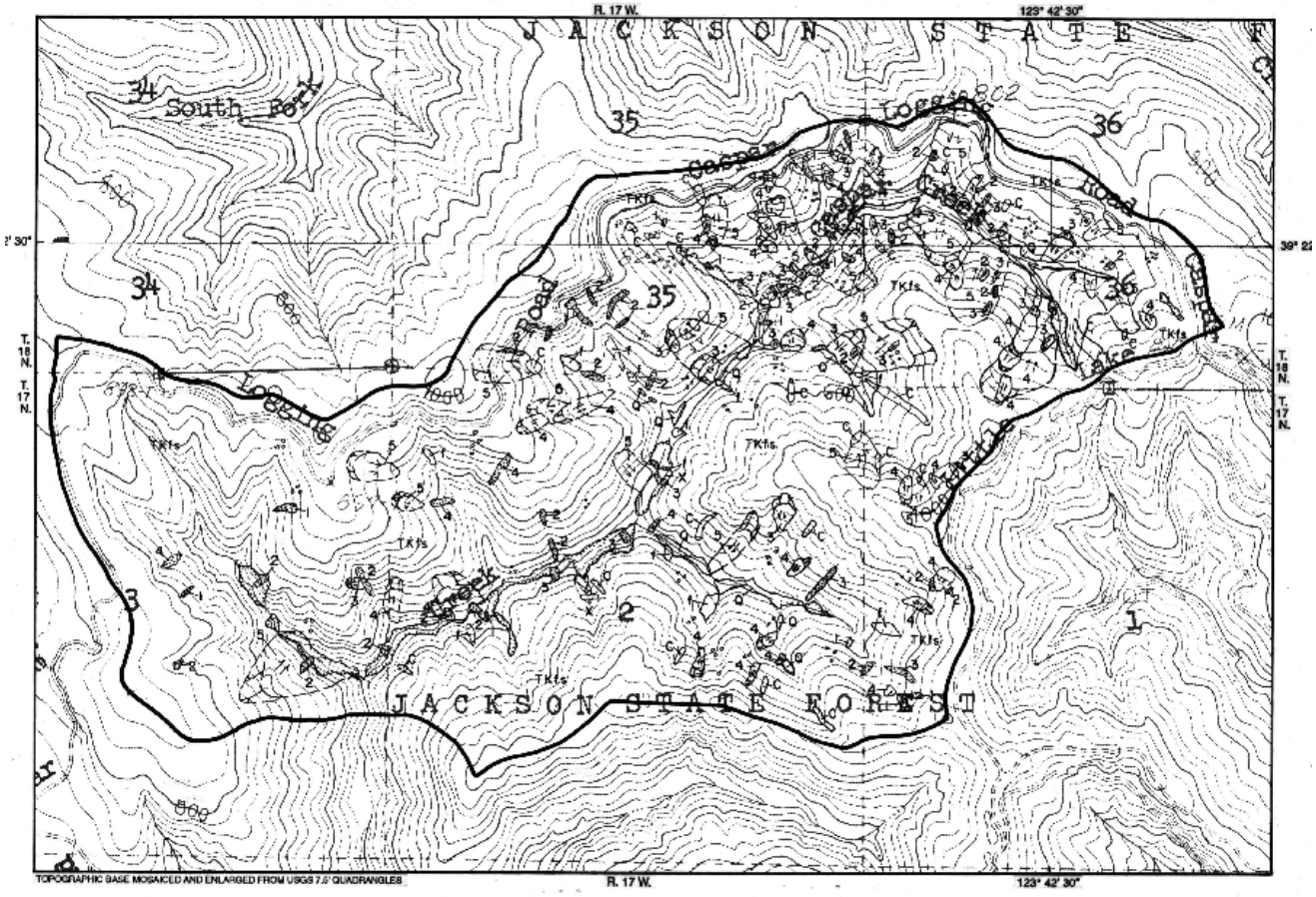
Effects of Landslides/Debris Flows on Riparian Vegetation

Cascades Range, Oregon
(photo by Gordon Grant)

U.S.G.S. Map of Landslide Potential



Historic Landslides



Jackson Demonstration State Forest

Human Effects on Land Sliding/Debris Flows

Reduce occurrence	Increase occurrence
Dewatering slopes	Logging
Retaining walls	Road building
Armoring stream banks	

Logging

Cascade Range, Oregon

Road Building

Willamette National Forest – Oregon

Lolo National Forest - Montana

Effects of Slope and Channel Instability on Riparian Vegetation

Alder stands on 1964 age debris flow deposits, French Pete Creek, Oregon (photo by Gordon Grant)

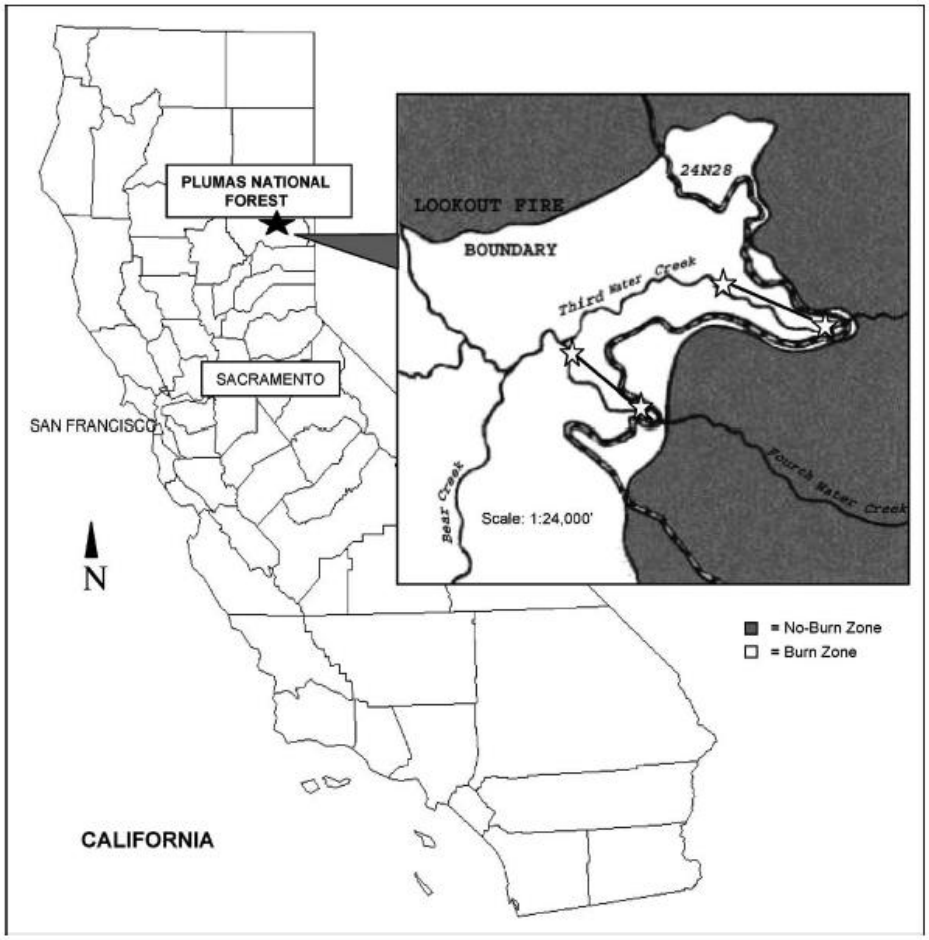
Wild Fire

Impacts and Responses of Riparian Vegetation to Wildfires

Impacts	Responses
Plant mortality	Seedling establishment
Loss of canopy	Sprouting
Shift in species composition	Recruitment of large woody debris

Independence Fire Study

(Kobziar and McBride, 2006)



Variation in Response to Burning

Independence Fire Study: Response to Burning

Species	Sprouting (%)
Arroyo willow	30
Bitter Cherry	50
Douglas spirea	100
Mountain alder	30
Pacific dogwood	30
Red osier dogwood	50
Thimbleberry	100
Twinberry	65
Incense cedar	0
White fir	0

Deer Creek Study

(Russell and McBride, 2001)

Fire Scar Dating

Deer Creek Study

(Russell and McBride, 2001)

Canopy Cover (%)

Conifers

Hardwoods

Basal area (ft^2/ac)

Seedlings (#/ac)

Saplings (#/ac)

Recovery of herbaceous, aspen and willow in the Angora Creek floodplain one month after the Angora fire.

Wind Throw

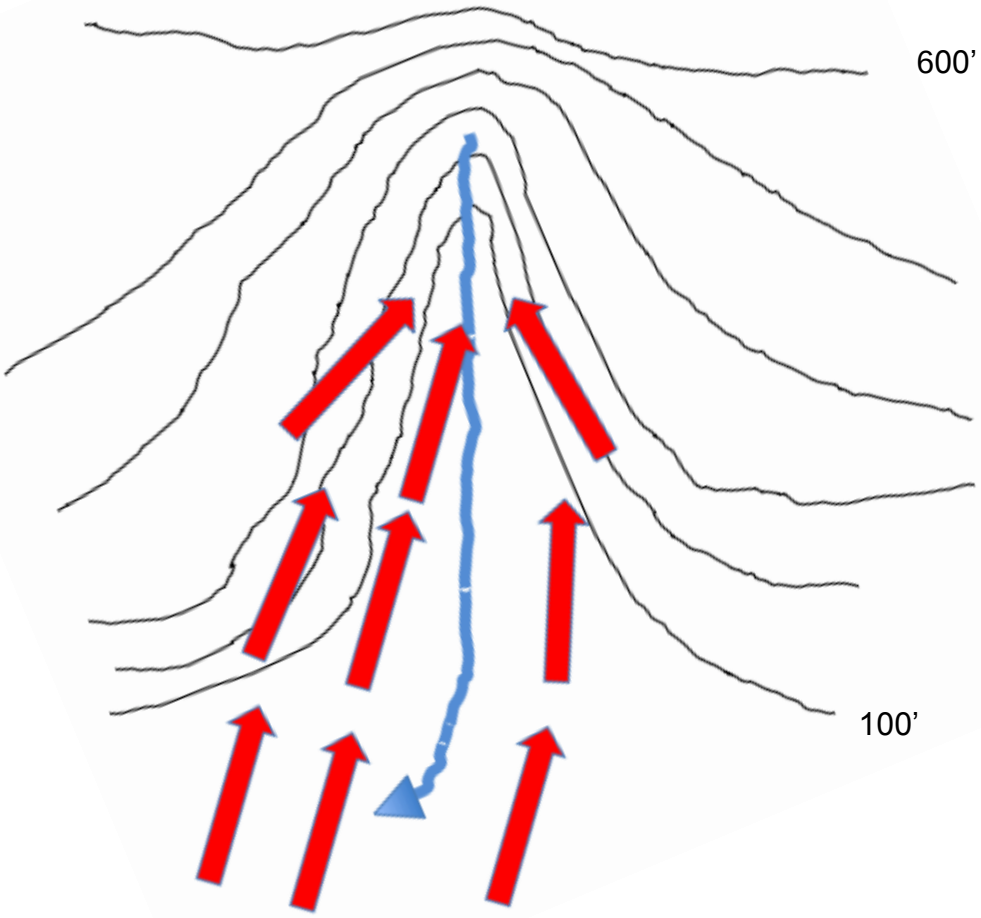
Natural wind throw, intermittent stream, Oregon Cascades

Factors Effecting Wind Throw in Riparian Forests

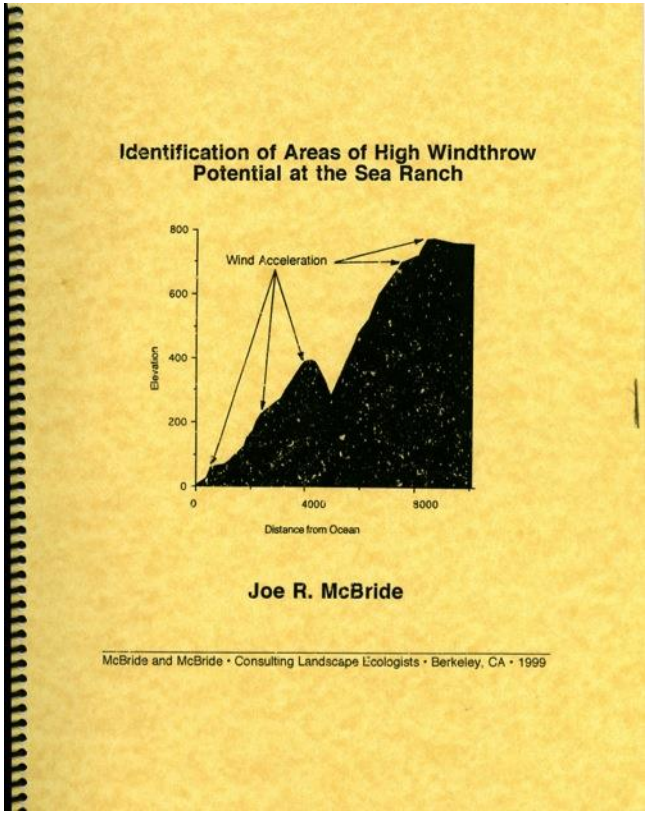
- Channel and floodplain width
- Wind funneling by topography
- Soil saturation
- Tree species

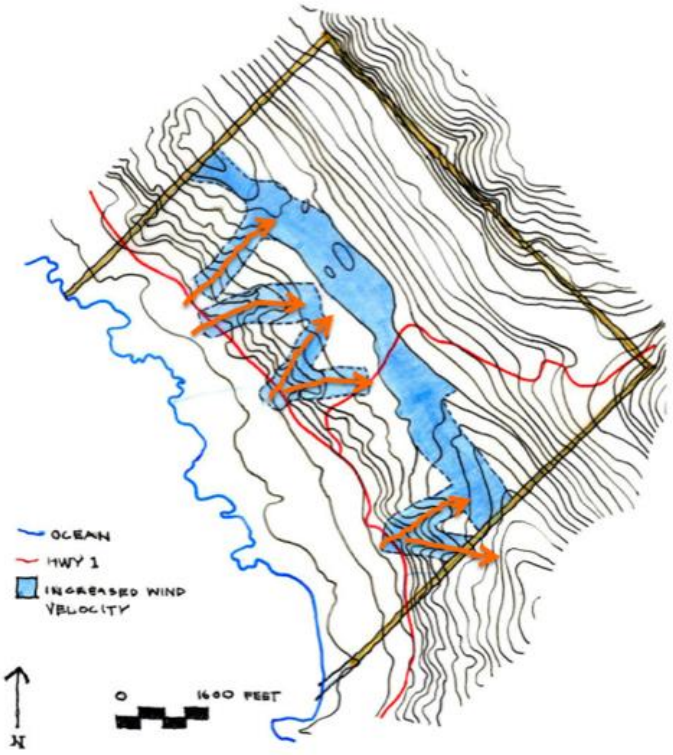
Channel and Floodplain Width

Wind Funneling by Topography

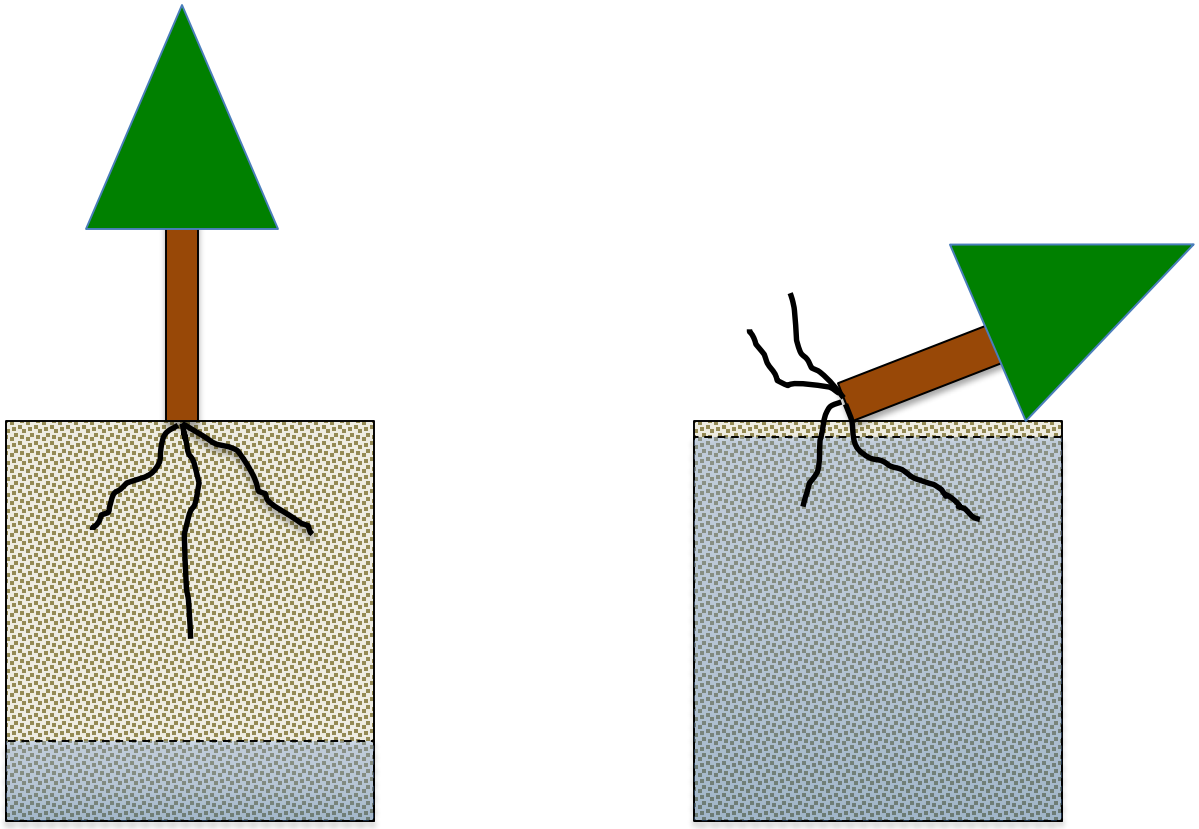


Wind Funneling by Topography at The Sea Ranch





Soil Saturation



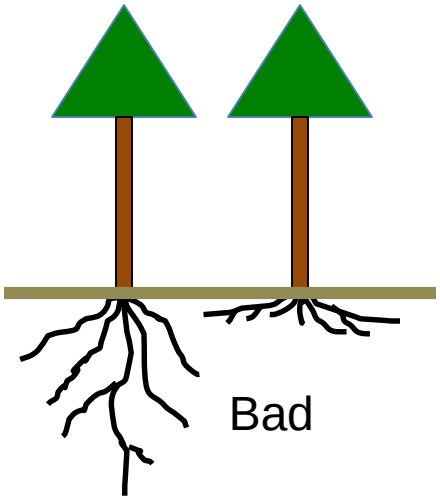
Dry

Wet

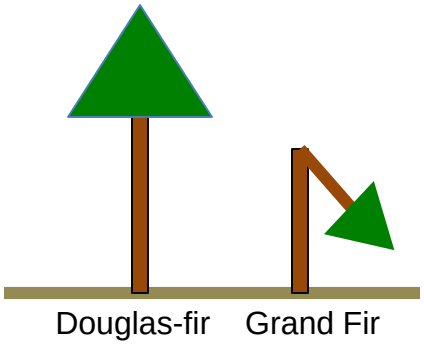
Tree Species

Tree Characteristics Associated with Wind Throw and Breakage

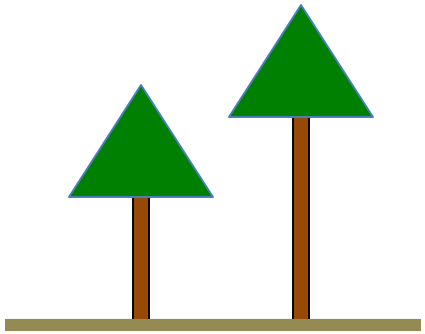
1. Root System Form



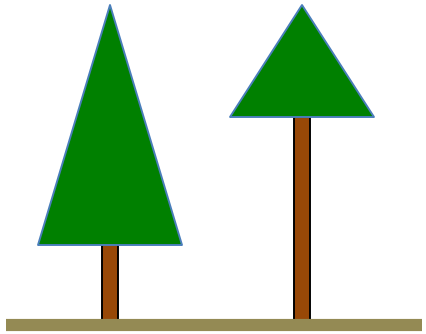
2. Weak wood



3. Height



4. Live crown ratio



Human Effects on Windthrow

Reduce Potential	Increase Potential
Road location	Logging
	Road building

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END