



What are **WETLANDS**?

Wetlands definitions from a LEGAL standpoint




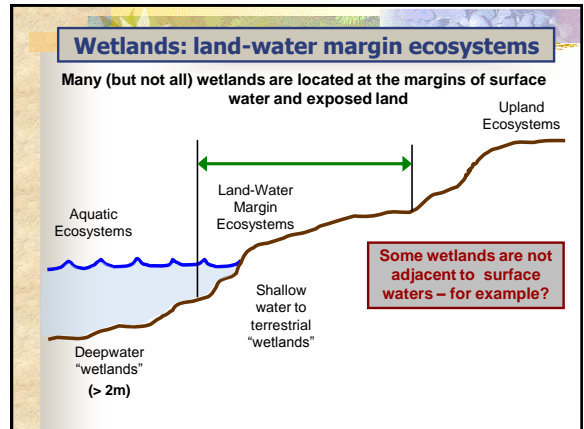
Those areas that are saturated or inundated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, & similar areas. (US Army Corps of Engineers 1987)

"Wetlands" or "wetland areas" means areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas. Wetlands do not include those artificial wetlands intentionally created from non-wetland sites, including, but not limited to, irrigation and drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of the construction of a road, street, or highway. Wetlands may include those artificial wetlands intentionally created from nonwetland areas to mitigate the conversion of wetlands. (Washington Administrative Code 173-22-030.)

What are **WETLANDS**?

Wetlands are distinguished by:

1. _____
2. _____
3. _____

Wetlands: classified by location / salinity

Wetlands: classified by water source & depth

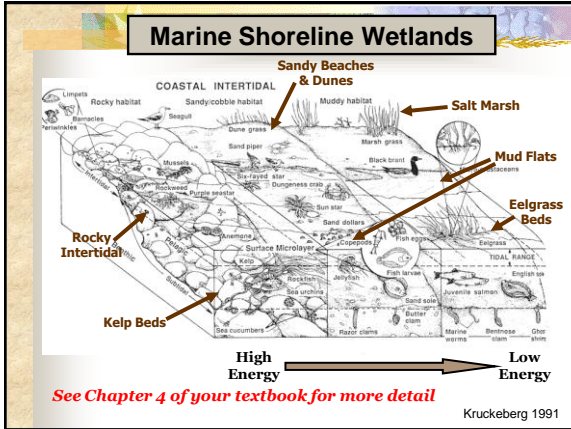
- I. Surface water wetlands
- II. Groundwater wetlands

Marine & Marine Shoreline Wetlands

Marine Shoreline Regions of WA

Outer Coast Islands & Straits Puget Sound

High Energy Low Energy



Freshwater Wetlands

- I. Freshwater Wetland Types**
 1. General wetland types & classification
- II. Freshwater Wetland Ecology**
 1. Wetland environments
 2. Ecological functions
- III. Freshwater Wetlands of the Puget Sound Region**
 1. Wetland Organisms
 2. Wetland Communities
- IV. Stream Ecology: Riverine and Riparian Wetlands**
- V. Lakes & Ponds**

Annual Net Primary Productivity of Ecosystems

Ecosystem Type	Mean NPP g C / m ² / yr	Range of NPP g C / m ² / yr
Terrestrial Uplands		
Tropical rain forest	2,200	1,000 - 3,500
Temperate evergreen forest	1,320	600 - 2,500
Temperate deciduous forest	1,200	600 - 2,500
Boreal forest	800	400 - 2,000
Woodland & shrubland	700	250 - 1,200
Temperate grassland	600	200 - 1,500
Tundra and alpine	140	10 - 400
Desert & semidesert scrub	90	10 - 250
Freshwater Wetlands		
Swamp & marsh	2,000	800 - 6,000
Lake and stream	250	100 - 1,500
Marine		
Algal beds and reefs	2,500	500 - 4,000
Estuaries	1,800	500 - 4,000
Open Ocean	125	2 - 400

Freshwater Wetland Types

- 1. Wetland Types & Classification**

Physiognomy

- 1.
- 2.
- 3.
- 4.

Freshwater Wetland Types

- 1. Wetland Types & Classification** Physiognomic classification

Forested wetlands: woody vegetation at least 6 m tall

Drawing from Yates (1993)

Freshwater Wetland Types

- 1. Wetland Types & Classification** Physiognomic classification

Scrub-Shrub wetlands: woody vegetation < 6 m tall

Drawing from Yates (1993)

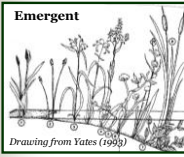
Freshwater Wetland Types

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1. Wetland Types & Classification


Physiognomic classification

Emergent wetlands:



Emergent


Drawing from Yates (1993)



Freshwater Wetland Types

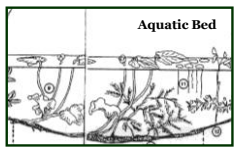
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1. Wetland Types & Classification



Nuphar luteum

Aquatic bed wetlands:



Aquatic Bed

Drawing from Yates (1993)


Freshwater Wetland Ecology

★


1. Wetland Types & Classification

<u>Physiognomy</u>	<u>Location</u>	<u>Hydrology</u>
1. Forested		
2. Scrub-shrub		
3. Emergent		
4. Aquatic bed		

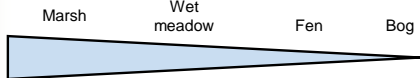
Wetlands characterized by hydrology



Surface flow in → Surface flow out



evaporation ↑
↓ drainage



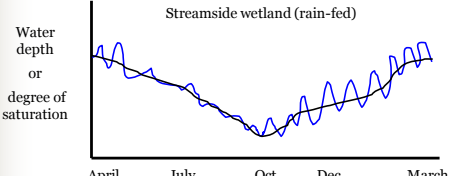
Marsh Wet meadow Fen Bog

Surface water flow dominant Vertical water flow dominant

Freshwater Wetland Environments

A) Water – the defining feature of wetlands

- 1) Abundant supply (exceptions?)
- 2) Variation in water availability (depth of inundation / degree of saturation: the “hydroperiod”)
 - a) Hydrographs show the hydroperiod



Streamside wetland (rain-fed)

Water depth or degree of saturation

April July Oct Dec March

A streamside wetland that is both rain-fed and snowmelt-fed will have a similar pattern but offset timing

Freshwater Wetland Environments

A) Water – the defining feature of wetlands

- 1) Abundant supply (exceptions?)
- 2) Variation in water availability (depth of inundation / degree of saturation: the “hydroperiod”)
 - a) Hydrographs show the hydroperiod
 - b) **Hydroperiod Classification (Cowardin et al. 1979)** ↖

How do we characterize (categorize) environments with different hydroperiods?

Freshwater Wetland Environments

Hydroperiod Classification (Cowardin et al. 1979)

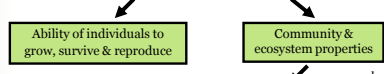
Hydroperiod Class	Description
Permanently flooded	Inundated throughout year
Intermittently exposed	Permanently flooded, except in years of extreme drought
Semi-permanently flooded	Flooded during growing season (GS) in most years
Seasonally flooded	Flooded for extended periods during GS (but no standing water at end)
Saturated	No standing water but saturated soils for extended periods during GS
Temporarily flooded	Flooded for brief periods during GS but otherwise water table well below surface
Intermittently flooded	Surface water present unpredictably (without seasonal pattern)

Freshwater Wetland Environments

A) Water – the defining feature of wetlands

- 1) Abundant supply (exceptions?)
- 2) Variation in water availability
(depth of inundation / degree of saturation: the “hydroperiod”)
 - a) Hydrographs show the hydroperiod
 - b) Hydroperiod Classification

What effects do these water level fluctuations have on ecological systems?



3) Water Level Fluctuations & Biodiversity

Freshwater Wetland Environments

Water Level Fluctuations & Plant Biodiversity (Cooke & Azous 2001)

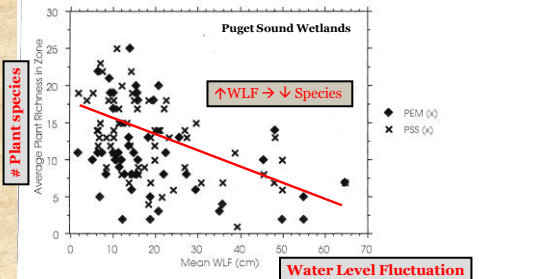


Figure 3-5. Plant richness in the emergent and scrub-shrub communities related to mean annual WLF.

Freshwater Wetland Environments

Water Level Fluctuations & Plant Biodiversity (Cooke & Azous 2001)

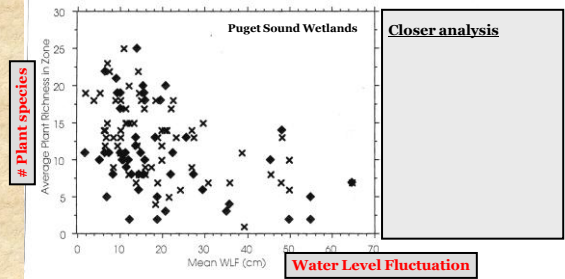


Figure 3-5. Plant richness in the emergent and scrub-shrub communities related to mean annual WLF.

Freshwater Wetland Environments

Water Level Fluctuations & Plant Biodiversity (Cooke & Azous 2001)

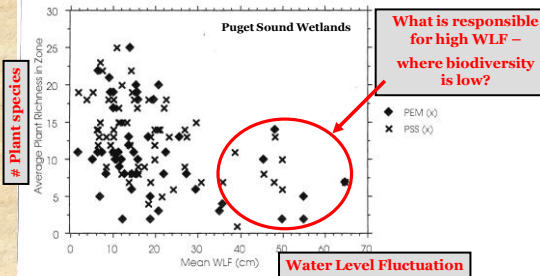


Figure 3-5. Plant richness in the emergent and scrub-shrub communities related to mean annual WLF.

Freshwater Wetland Environments

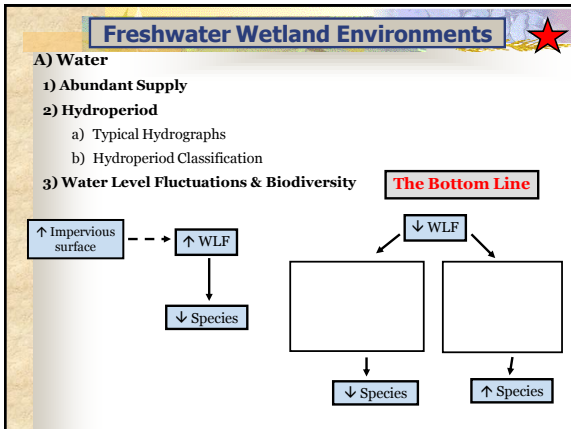
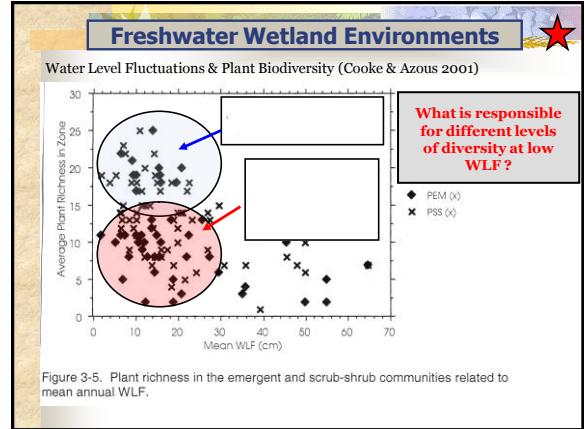
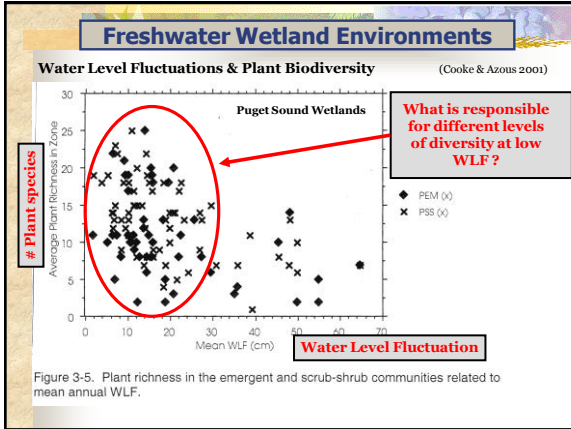
Water Level Fluctuation

What is responsible for high WLF – where biodiversity is low?

In much of the Puget Sound lowlands,

are the reason for high WLFs in streams.

The hydrology of many of our freshwater wetlands are dominated by these surface flows.



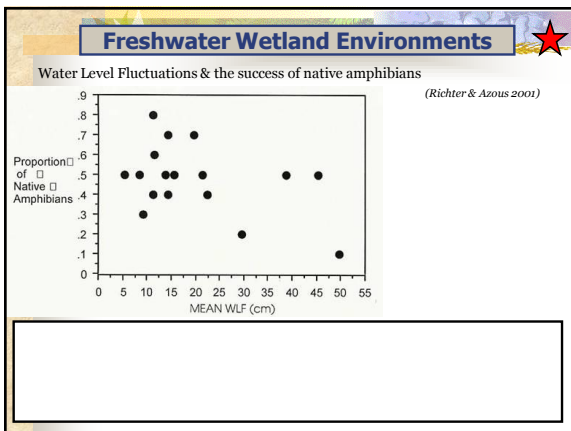
Freshwater Wetland Ecology

2. Wetland Environments

A) Water

- 1) Abundant Supply (exceptions?)
- 2) Depth / Hydroperiod
 - a) Typical Hydrographs
 - b) Hydroperiod Classification (Cowardin et al. 1979)
- 3) Water Level Fluctuations & Biodiversity

Fluctuating water levels also have effects on wetland **animals**
Example: amphibians



Freshwater Wetland Environments

A) Water

- 1) Abundant Supply
- 2) Depth / Hydroperiod
- 3) Water Level Fluctuations & Biodiversity
- 4) Water Source & hydrodynamics
 - Balance of water input sources is a strong ecological control on wetlands
(precipitation, groundwater, stream flow, surface flow)
 - Speed of flow through a wetland also has a strong ecological control
(disturbance, chemistry)

Freshwater Wetland Environments

B) Temperatures

- Moderate & stable

C) Nutrients

- Large organic supply
- Inorganic availability variable (sometimes very limited)
 - Limited availability: Slow nutrient cycling slows replenishment
 - Limited availability: Reduced root function slows soil exploration

D) Acidity

- pH variable in space & time – can be quite low (bogs)

E) Light

- Often high (varies) but considerable seasonal competition

F) Gases

- No aerial limitation on CO₂ or O₂
- Limited O₂ in soils can limit plant function & productivity

Freshwater Wetland Ecological Functions

(mostly from a human perspective)

III. Freshwater Wetlands of the Puget Sound Region

TWO References for Washington Wetland Science:

1. Freshwater Wetlands in Washington State

Volume 1: A Synthesis of the Science

Washington State Dept. of Ecology

Publication #03-06-016 (2003)

<http://www.ecy.wa.gov/pubs/0306016.pdf>

2. Wetlands and Urbanization: Implications for the Future

by A. Azous & R. Horner (CRC Press 2001)

UWB Library (on reserve): QH105.W2 W38 2001

III. Freshwater Wetlands of the Puget Sound Region

1. Wetland organisms

2. Wetland communities

Puget Sound Freshwater Wetlands

1. Wetland Organisms

A) King County Wetland Inventory Species List (on e-reserve)

- Appendix 1: Full species list
- Appendix 2: Priority species & habitats

B) Plants

1) Wetland Indicator Lists

Wetland plant guides

AVAILABLE IN THE LIBRARY

Cooke, S. (ed.) 1997. A Field Guide to the Common Wetland Plants of Western Washington & Northwestern Oregon

Guard, B.J. 1995. Wetland Plants of Oregon and Washington

US Fish & Wildlife Service Branch of Habitat Assessment

<http://www.nwi.fws.gov/bha/>

USDA "PLANTS" Database: <http://plants.usda.gov/wetland.html>

State and local government lists

Puget Sound Freshwater Wetlands

1. Wetland Organisms

A) King County Wetland Inventory Species List

- Appendix 1: Full species list
- Appendix 2: Priority species & habitats

B) Plants

1) Wetland Indicator Lists

2) Common Puget Lowland Wetland Plants

Puget Sound Freshwater Wetlands

1. Wetland Organisms

Common Puget Sound Lowland Wetland Plants




2 most common:

Table 3-2. Species occurrence for different categories

Cover Dominance Category	High Occurrence (>50% wetlands)	Low Occurrence (<10% wetlands)
Usually dominant. Greater than 64% coverage in more than 19 percent of observations.	Phalaris arundinaceae Spirea douglasii	Junco supracinctus Menyanthes trifoliata
Dominance in plots varies	Ailurus rubra Athyrium filix-femina Kalmia microphylla Lonocera involucreta Polyschum munilum Pteridium aquilinum Ranunculus repens Rhamnus purshiana Rubus laciniatus Rubus spectabilis Rubus ursinus Salix pedicellaris Salix scouleriana Salix sitchensis Vaccinium parvifolium	Azola mexicana Brasenia schrebneri Eriophorum chamissonis Hippurus vulgaris Hydrocotyl ranunculoides Hydrophyllum tenuipes Nymphaea odorata Polygonum amphibium Potentilla gramineus Rhynchospora alba Sparganium eurycarpum Sagittaria latifolia Scirpus acutus Veronica americana
Always less than 1% coverage	no species	Mimulus guttatus Myosotis laxa Potamogeton diversifolius Ranunculus acris Rorippa curvisiliqua Rumex obtusifolius Trillium ovatum Vaccinium ovatum Vaccinium uliginosum Viola sativa

Cooke & Azous (2001)

Puget Sound Freshwater Wetlands

Puget Sound Freshwater Wetland Plants

TREES

Red alder
Cascara (Pacific willow)
(Oregon ash)
(Cottonwood)

SHRUBS

Hardhack
Twinberry
Salmonberry
Blackberries
Red huckleberry
Willows

HERBACEOUS

Reed
Canarygrass
Lady, sword, bracken ferns
Creeping buttercup (sedges & rushes)
(many herbs)

Table 3-2. Species occurrence for different categories of plant type and cover dominance.

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Cooke & Azous (2001)

Puget Sound Freshwater Wetlands

1. Wetland Organisms

A) King County Wetland Inventory Species List

- Appendix 1: Full species list
- Appendix 2: Priority species & habitats

B) Plants

- Wetland Indicator Lists
- Common Puget Lowland Wetland Plants
- Nature of Wetland Vegetation Structure

Puget Sound Freshwater Wetlands

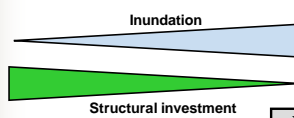
Vegetation Structure & the wetland environment

	Transition to Uplands	Emergent Plant Zone	Open Water
Hydrology	Periodically flooded	Waterlogged or shallow water	Shallow and continuously wet Continuous standing water > 30 cm
Plants	lowland grasses; woody plants, e.g., cottonwood Populus, arrowhead willow Salix	sedges Carex spp. butrush Sagittaria spp.	cattail Typha spp. Nymphaea spp. pondweeds Potamogeton spp. bladderwort Utricularia spp.

Mitsch & Gosselink (2001)

Puget Sound Freshwater Wetlands

Vegetation Structure & the wetland environment



environmental gradient

adaptational response

What is responsible for this pattern of adaptation?

Mitsch & Gosselink (2001)

Puget Sound Freshwater Wetlands

1. Wetland Organisms

C) Consumers

1) Herbivores

Invertebrates:

- Insects (caddis flies, midges, beetles, etc.) *many omnivorous*
- Crustaceans (crayfish, fairy shrimp) *often indiscriminate filter feeders*
- Mollusks (freshwater snails & clams)

Vertebrates:

- Birds
- Mammals (rodents, beaver, muskrat)
- Amphibians
- Fish

2) Carnivores

- Birds, mammals, fish, insects, amphibians, etc.

3) Detritivores

- Insects, annelid worms, crustaceans, microbes, etc.

Puget Sound Freshwater Wetlands

1. Wetland Organisms

D) Protected / Declining Species

King County 1991 Wetland Inventory Priority Species & Habitats (handout)

Priority species: species of concern due to population status and/or sensitivity to habitat manipulation

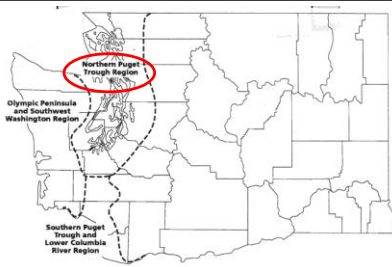
Includes federal & state listed species as well as species of special concern and game species

- 29 birds
- 6 plants
- 6 fish
- 3 insects
- 2 amphibians
- 1 reptile

Puget Sound Freshwater Wetlands

2. Wetland Communities

Kunze, L.M. 1994. Preliminary classification of native, low-elevation freshwater wetland vegetation in western Washington. Washington State Dept. of Natural Resources



Puget Sound Freshwater Wetlands

2. Wetland Communities

Generalized Wetland Plant Community Types of the Puget Trough Lowlands

I. Low Elevation Sphagnum Bogs

A. Herb Dominated

1. Sedge / Sphagnum spp. communities

B. Shrub Dominated

1. Western Bog Laurel - Labrador Tea / Sphagnum spp. community
2. Hardhack / Sphagnum spp. community

C. Tree Dominated

1. Pine or Western Hemlock (+ Labrador Tea) / Sphagnum spp. communities

II. Low Elevation Minerotrophic Wetlands

A. Permanently Flooded

1. Floating-leaved aquatic communities
2. Mar² = Tail community
3. Rush community
4. Bulrush communities
5. Cattail community

B. Saturated Soils or Seasonally Flooded

1. Herb Dominated
 - a. Sedge community
2. Shrub Dominated
 - a. Myrica sibirica community
 - b. Redstart dogwood - willow - hardhack community
 - c. Sweet gale community
 - d. Willow community
 - e. Hardhack community
3. Tree Dominated
 - a. Skunk Cabbage communities (with red alder, western red cedar or western hemlock)
 - b. Red alder / salmonberry community
 - c. Oregon ash communities (with sedge or snowberry)
 - d. Pacific crab apple community

Optional handout available on class web site

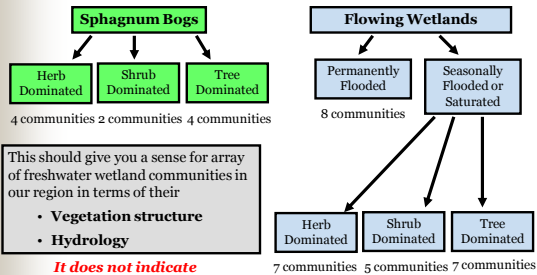
Summarized from Kunze's 37 Plant Community Types of the Puget Trough Lowland (Kunze 1994)

It is not necessary to "know" these specific communities.

Puget Sound Freshwater Wetlands

2. Wetland Communities

What I would like you to "know" is the basis for classifying our wetlands



This scheme was created from the 37 communities in Kunze (1994).

Puget Sound Freshwater Wetlands

2. Wetland Communities

A) Sphagnum Bogs



Lodgepole pine (*Pinus contorta*) growing on floating mat of *Sphagnum* moss (Anacortes City Forest)

Puget Sound Freshwater Wetlands


2. Wetland Communities

A) Sphagnum Bogs

1) Locations

- **Depressions** (glacial scours, isolated oxbows, old lake beds)
- **Tops of drainages** (little inflow, usually a slow outflow)
- **Backwater pockets within flowing wetlands**

2) Environmental Characteristics



Puget Sound Freshwater Wetlands


2. Wetland Communities

A) Sphagnum Bogs

3) Plants

Characterized by

- **Predominance of *Sphagnum* moss**
- **stress tolerant species** (with inherently slow growth) **adapted to low nutrient conditions**
 - Lodgepole & western white pines (also in dry, nutrient-poor sites)
 - Evergreen-leaved shrubs: an important strategy for nutrient conservation
 - Carnivorous plants (sundew, pitcher plant): nutrient acquisition



Puget Sound Freshwater Wetlands

2. Wetland Communities **A) Sphagnum Bogs**



Evergreen shrubs: evergreen leaves an important strategy for nutrient conservation

Ledum groenlandicum
Labrador tea

Kalmia polifolia
Bog laurel

Carnivorous plants (e.g., sundew):
nutrient acquisition

Drosera rotundifolia

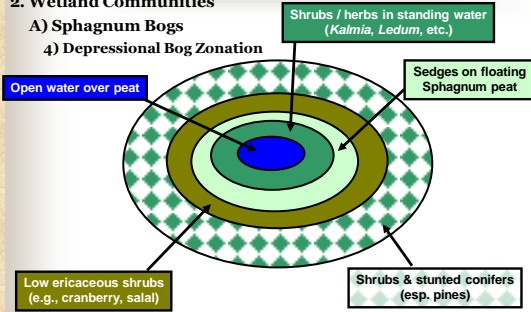




Puget Sound Freshwater Wetlands

2. Wetland Communities

A) Sphagnum Bogs

4) Depressional Bog Zonation



Puget Sound Freshwater Wetlands

2. Wetland Communities

B) Flowing (Minerotrophic) Wetlands

1) Locations

Surface Water impounded by topography or beavers
Varies from highly impounded sites (fens) to strongly flowing river systems

All parts of drainages (both inflow & outflow)


Degree of water-flow-through highly variable across types
Results in varying soils from peat to muck to mineral soil

2) Environmental Characteristics

Mosaics of varying environmental gradients
(often resulting in many communities within one wetland site)

Secondary substrates form crucial microenvironmental heterogeneity (e.g., wind throw depressions, root wads & other woody debris, standing snags, etc.)

Secondary substrates form crucial microenvironmental heterogeneity



Puget Sound Freshwater Wetlands

2. Wetland Communities B) Flowing Wetlands

1) Locations

Impounded by topography or beavers
All parts of drainages (both inflow & outflow)
Degree of water flow through highly variable across types

2) Environmental Characteristics

Mosaics of varying environmental gradients
Secondary substrates form crucial microenvironmental heterogeneity

Water input dominated by both precipitation and inflow
Natural disturbances from physical (flooding) and biological (beavers) environments have important influences (*diversity*)

Puget Sound Freshwater Wetlands

2. Wetland Communities B) Flowing Wetlands

3) Plants

• Vegetation correlated with:

• Riverside wetlands: dynamic vegetation with high diversity



Red alder floodplain forest



Black cottonwood floodplain forest

Flowing Wetlands

AQUATIC HERBS (Aquatic bed vegetation)



Nuphar polysepalum



Potamogeton natans



Lemna minor



Polygonum hydropiperoides

Flowing Wetlands

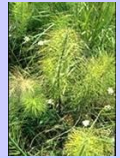
HERBS



Veronica americana



Oenanthe sarmentosa



Equisetum arvense



Sparganium emersum



Lysichiton americanum



Flowing Wetlands

GRASSES, SEDGES & RUSHES



Carex obnupta



Typha latifolia



Juncus effusus



Carex comosa



Carex utriculata



Alopecurus pratensis



Scirpus microcarpus

Flowing Wetlands

SHRUBS



Spirea douglasii



Cornus sericea



Rubus spectabilis



Lonicera involucrata



Salix species



Some Evil Doers: exotic species



Creeping buttercup



Purple loosestrife



Reed canarygrass



IV. Stream Ecology: Riverine and Riparian Wetlands

- 1) Streams in a Landscape
- 2) Structure of Stream Habitats
- 3) Salmon & Streams
- 4) Stream Environments
- 5) Stream Organisms

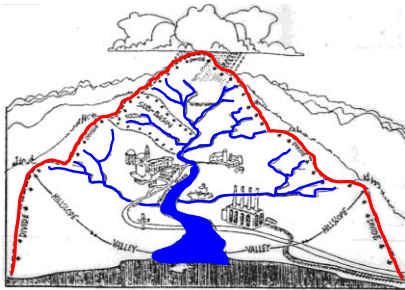


Streams in a Landscape



Streams in a Landscape: Streams exist within a _____

A)



Murdoch & Cho. (1999)

Streams in a Landscape

Streams in a Landscape

B) Streams as Ecological Corridors

- 1) Conduits of movement
- 2) Sites of ecological complexity

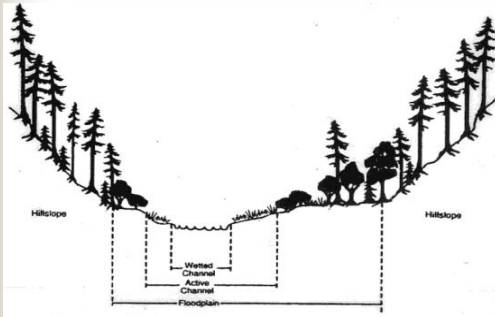
- Rapid lateral habitat transitions
- Atypical habitat attributes
 - ✓ High light
 - ✓ Summer water availability



Structure of Stream Habitats



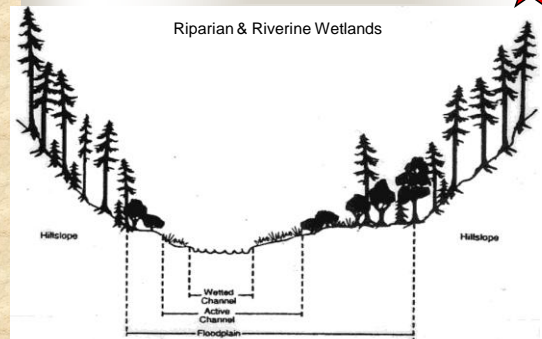
The Riparian Zone: what is it?

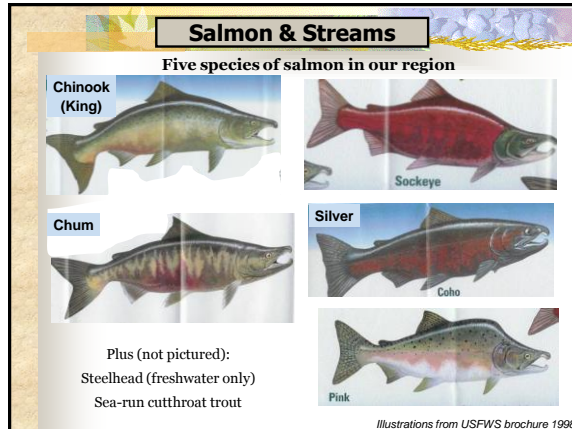
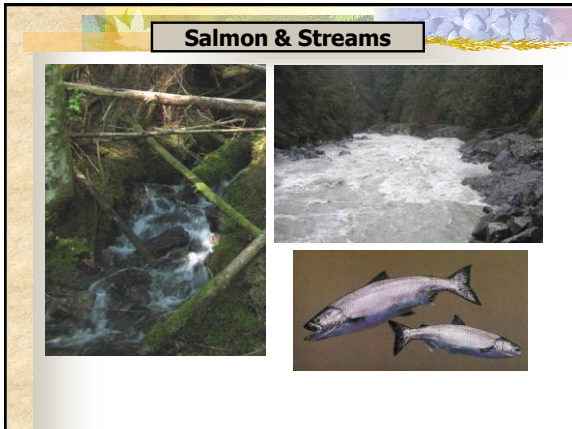


Structure of Stream Habitats



Riparian & Riverine Wetlands

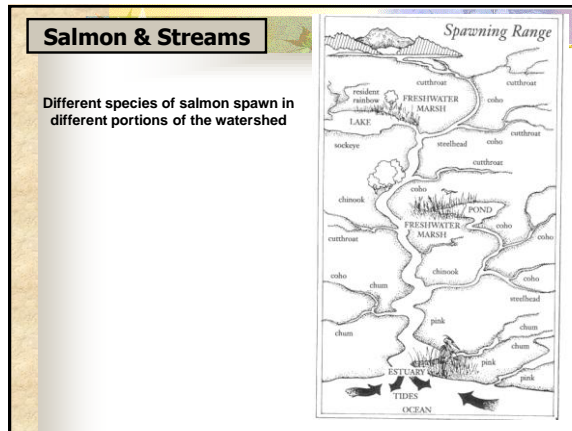
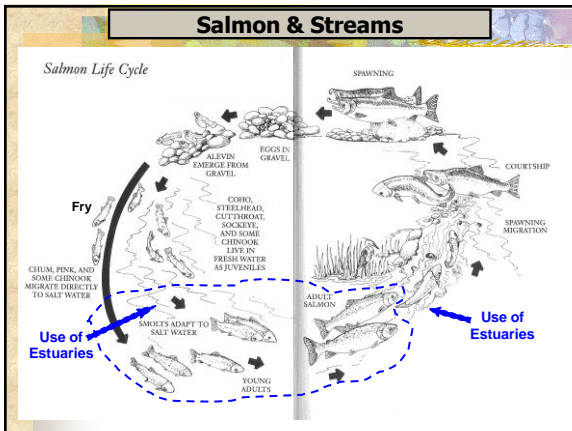
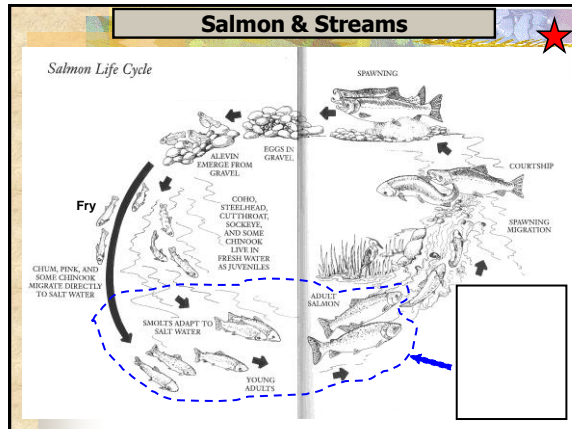




Salmon & Streams

Salmon are _____ fish

This means _____



Salmon : current status

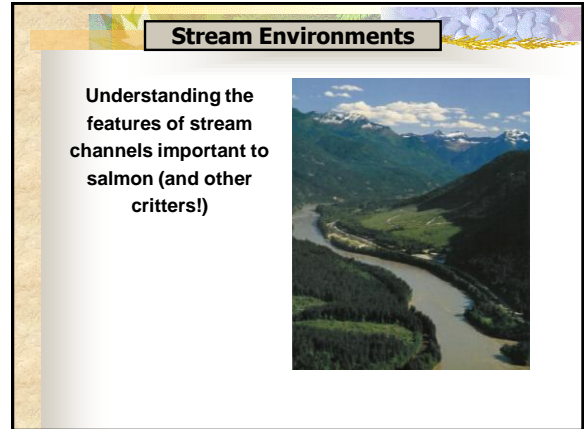
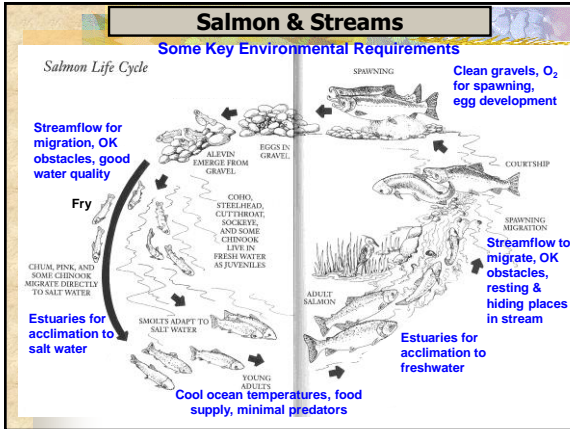
Endangered Species Act Status of West Coast Salmon & Steelhead
(Updated June 9, 2006)

Species ¹	Current Endangered Species Act Listing Status ²	ESA Listing Actions Under Review
Sockeye Salmon (Oncorhynchus nerka)	1 Snake River	Endangered
	2 Oyster Lake	Threatened
	3 Baker River	Not Warranted
	4 Okanogan River	Not Warranted
	5 Lake Wampanoac	Not Warranted
	6 Quinalt Lake	Not Warranted
	7 Lake Plummer	Not Warranted
Chinook Salmon (O. tshawytscha)	8 Sacramento River Winter run	Endangered
	9 Upper Columbia River Spring run	Endangered
	10 Snake River Spring/Summer run	Threatened
	11 Snake River Fall run	Threatened
	12 Puget Sound	Threatened
	13 Lower Columbia River	Threatened
	14 Upper Willamette River	Threatened
	15 Central Valley Spring run	Threatened
	16 California Coastal	Threatened
	17 Central Valley Fall and Late Fall run	Species of Concern
	18 Upper Columbia-Trinity Rivers	Not Warranted
	19 Oregon Coast	Not Warranted
	20 Washington Coast	Not Warranted
	21 Middle Columbia River spring run	Not Warranted
	22 Upper Columbia River summer/fall run	Not Warranted
	23 Southern Oregon and Northern California Coast	Not Warranted
	24 Duwamish River summer/fall run	Not Warranted

National Marine Fisheries Service, NOAA, 2006

Salmon : current status

Coho Salmon (O. kisutch)	25 Central California Coast	Endangered
	26 Southern Oregon/Northern California	Threatened
	27 Lower Columbia River	Threatened
	28 Oregon Coast	Not Warranted
	29 Southwest Washington	Undetermined
	30 Puget Sound Strait of Georgia	Species of Concern
	31 Olympic Peninsula	Not Warranted
Chum Salmon (O. tshawytscha)	32 Hood Canal Summer run	Threatened
	33 Columbia River	Threatened
	34 Puget Sound Strait of Georgia	Not Warranted
	35 Pacific Coast	Not Warranted
	36 Southern California	Threatened
	37 Upper Columbia River	Threatened
Steelhead (O. mykiss)	38 Central California Coast	Threatened
	39 South Central California Coast	Threatened
	40 Snake River Basin	Threatened
	41 Lower Columbia River	Threatened
	42 California Central Valley	Threatened
	43 Upper Willamette River	Threatened
	44 Middle Columbia River	Threatened
	45 Northern California	Threatened
	46 Oregon Coast	Species of Concern
	47 Southwest Washington	Not Warranted
	48 Olympic Peninsula	Not Warranted
Pink Salmon (O. gorbuscha)	49 Puget Sound ¹	Threatened
	50 Klamath Mountains Province	Not Warranted
	51 Elwha river	Not Warranted
	52 Old man	Not Warranted



Stream Environments

What does a stream channel look like? ★

Stream Environments

What happens with a meandering stream channel? ★

Cut Banks & Point Bars

a side view

Cut Bank and **Point Bar** labels are present in both diagrams.

Pools are created in cut banks
What good are pools?
Other important features
• Woody debris

Drawings from Murdoch & Cheo (1999)

Stream Environments

Wood in streams is very important – WHY?

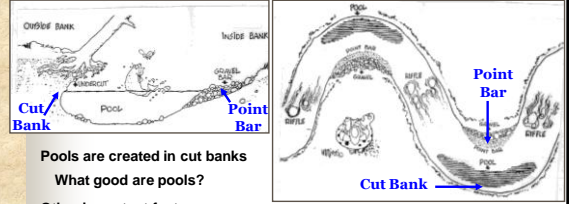


Stream Environments

What happens with a meandering stream channel?

Cut Banks & Point Bars

a side view



Pools are created in cut banks

What good are pools?

Other important features

- Woody debris
- Succession

Drawings from Murdoch & Cheo (1999)

Stream Environments

Point bar succession in action



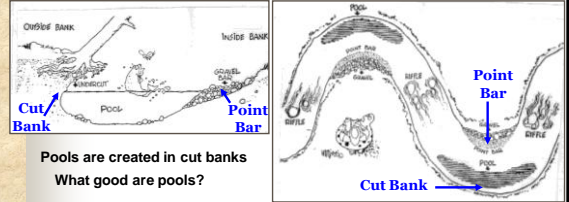
Point bar colonization by black cottonwood on the Elwha River

Stream Environments

What happens with a meandering stream channel?

Cut Banks & Point Bars

a side view



Pools are created in cut banks

What good are pools?

Other important features

- Woody debris
- Succession

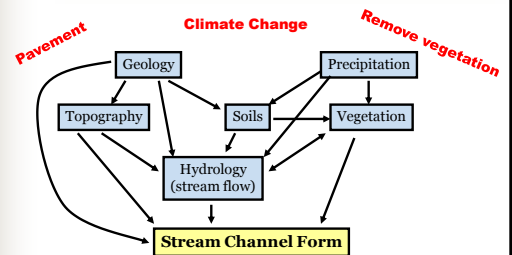
Drawings from Murdoch & Cheo (1999)

Stream Environments

What do we do to stream channels ?

Stream Environments

We can also alter how stream channels form and change without a backbone



Stream Environments

The Stream Bed is also important

silt sand gravel **cobble** **boulders**

Why is this important?

Stream Environments

Water Quality is Important

Stream Environments

Streams FLOOD

Precipitation / snowmelt

Topography
Wetlands (rentention ponds) vs. slopes

Surface runoff
Pavement vs. plants

↓

Flooding

Stream Environments

Marine-derived nutrients support forest ecosystems

Young salmon migrate out to ocean

Salmon feed in ocean, gathering nutrients from the marine environment and incorporating them into their bodies

After a few years they return to migrate upstream

Predators transport nutrients in salmon into forest ecosystem

After spawning the salmon die (if not taken by predators earlier)

Photos from Lewis (1994)

Stream Organisms

A) Primary Producers

- Algae
- Obligate wetland plants
- Facultative wetland plants
- Plants tolerant of saturated soils & flooding

B) Herbivores

- Aquatic: Various invertebrates
- Terrestrial: Mammals (e.g., beavers)

C) Carnivores

- Aquatic: Various invertebrates; Fish (e.g., salmon)
- Terrestrial: Mammals (e.g., river otters)

D) Detritivores

- Aquatic insects
- Fungi
- Bacteria

V. Lakes & Ponds

Lacustrine ecosystems described on pp. 247 – 270 in textbook