

# The importance of habitat complexity & connectivity to river ecosystems



Photo courtesy of Lauren Rogers

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# Today's talk

- What is habitat complexity & connectivity?
- How does habitat complexity & connectivity help create & maintain river ecosystems?
  - Floodplains
  - Watershed-scale
- What happens to river ecosystems when habitats are simplified or disconnected?



Photo courtesy of Katy Doctor



Photo courtesy of John McMillan

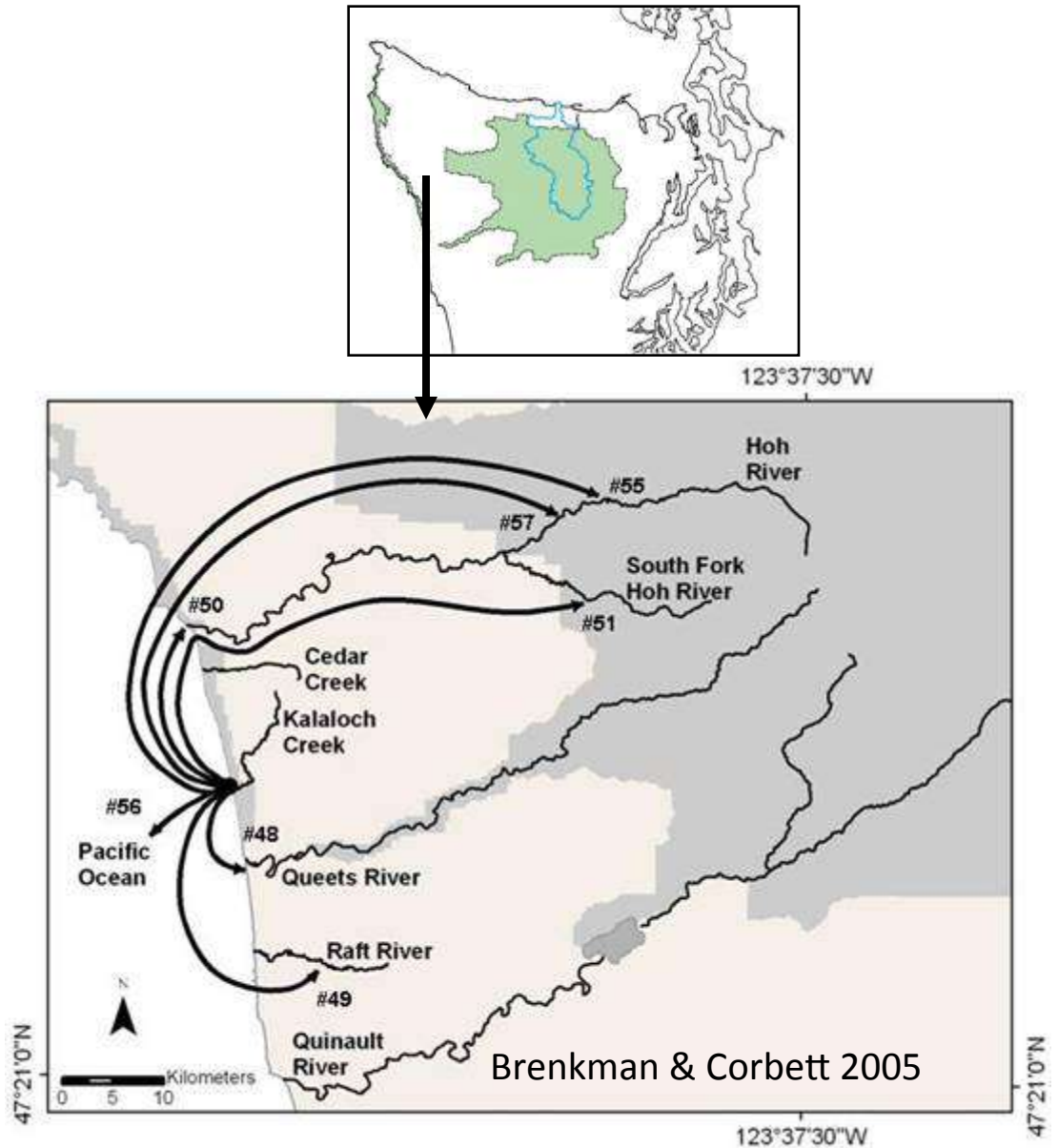
# What is habitat complexity?

- Physical, biological, & chemical attributes that determine stream productivity
  - Physical habitat structure
  - Species diversity
  - Nutrients



# What is habitat connectivity?

- The capacity of river systems to allow longitudinal & lateral dispersal of:
  - biological organisms,
  - chemical components,
  - and physical structures.



# How does **floodplain** habitat complexity & connectivity create & maintain river ecosystems?

- Define floodplain & identify important habitat features.
- Discuss the importance of high flows as a mechanism for habitat complexity & connectivity.
- Identify river ecosystem functions that result from floodplain habitat complexity & connectivity.

# What is a floodplain?

- Geomorphology
  - Flat, depositional feature of river valley
  - Adjoins river channel
  - Formed under current climate regime
- Hydrology
  - Land subject to 100 year flood event

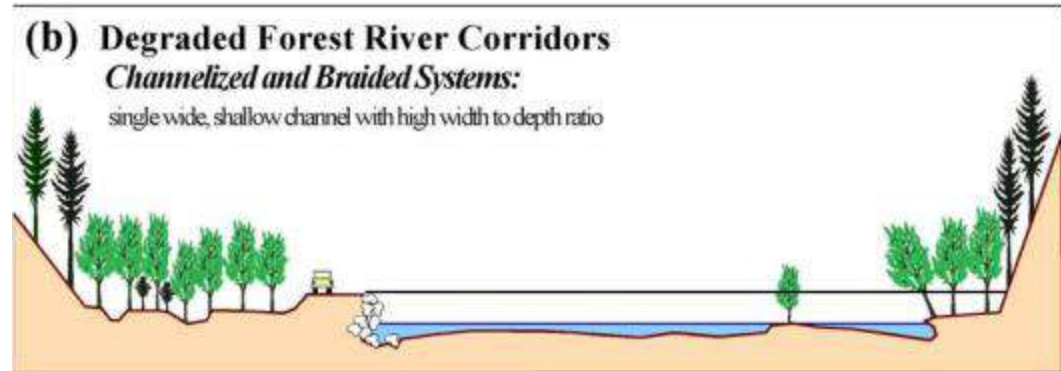
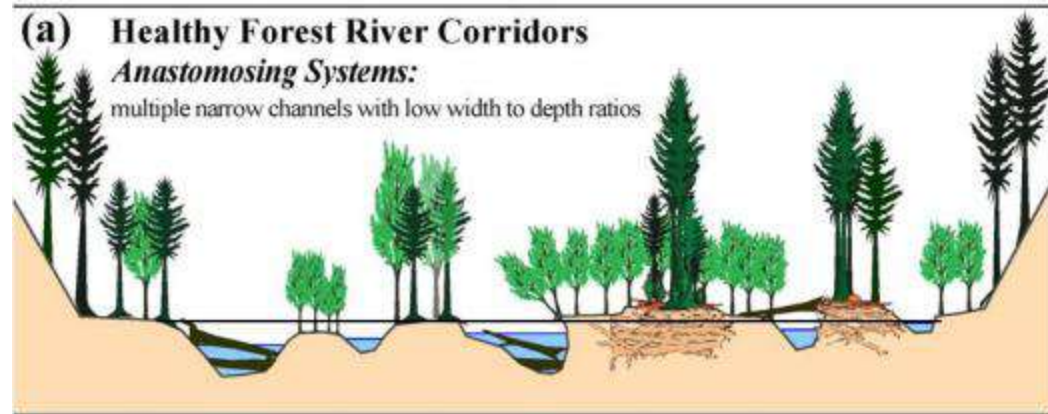
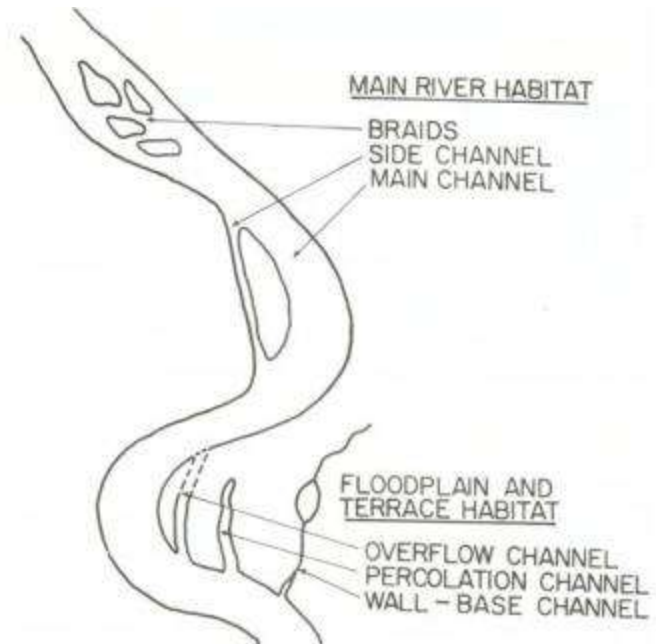
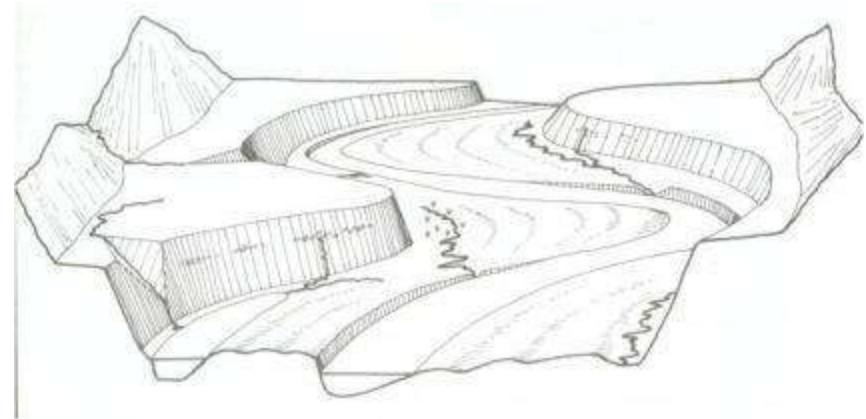


Photo and schematic courtesy of Tim Abbe

# What is a floodplain?

- Ecology
  - Areas periodically flooded by lateral overflow of river or lakes.
  - Biota respond to change in environment
    - Individual
    - Community



Schematic courtesy of Petersen and Reid 1984

# Habitats associated with floodplains

- Main channels
- Logjams
- Meander bends & scrolls
- Floodplain channels
- Beaver ponds
- Mid-channel islands





# High flows create & maintain floodplains

- Flows which inundate features that typically do not convey water on a regular basis.
- Flows that form channel conditions are not present throughout the majority of a flow year.



# High flows create & maintain floodplains

- Floodplain formation
- Wood, sediment, & nutrient recruitment
- Stream ecosystems & their biota have adapted & evolved to the natural hydrologic regime



# Floodplain habitat complexity & connectivity

Increases ability of inputs to become habitat



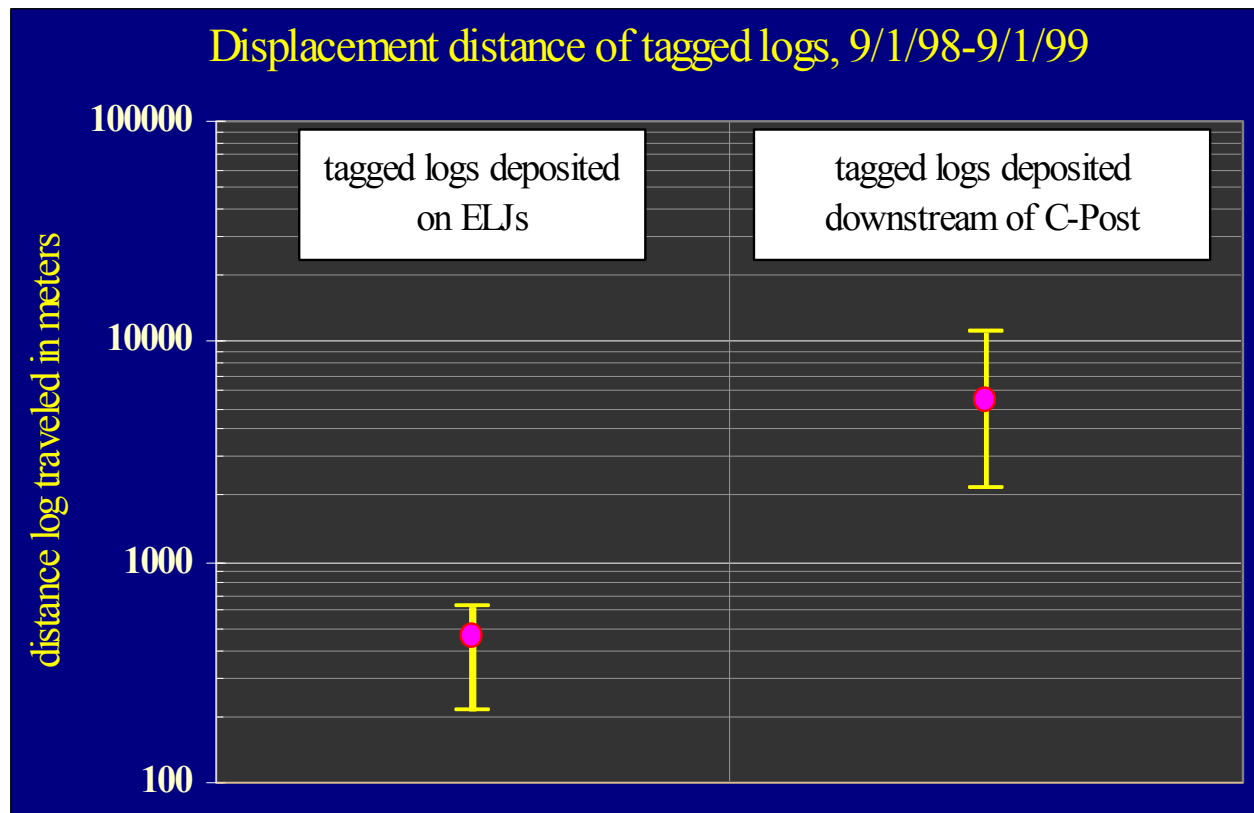
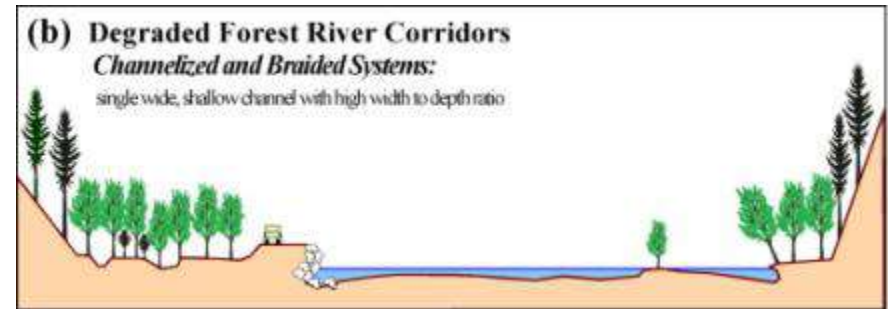
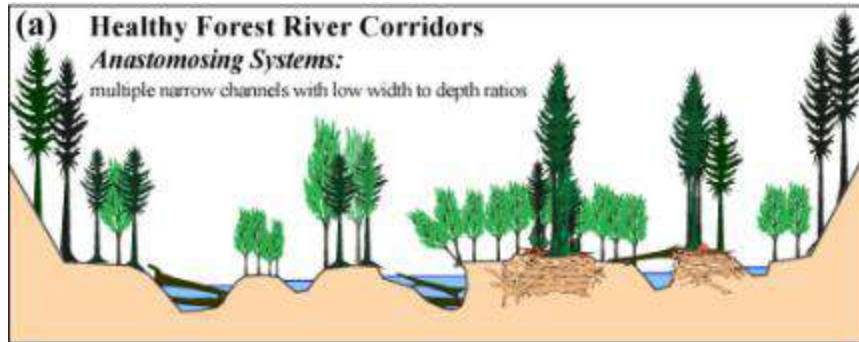
Photo courtesy of Dave Montgomery



Photo courtesy of Lauren Rogers

# Floodplain habitat complexity & connectivity

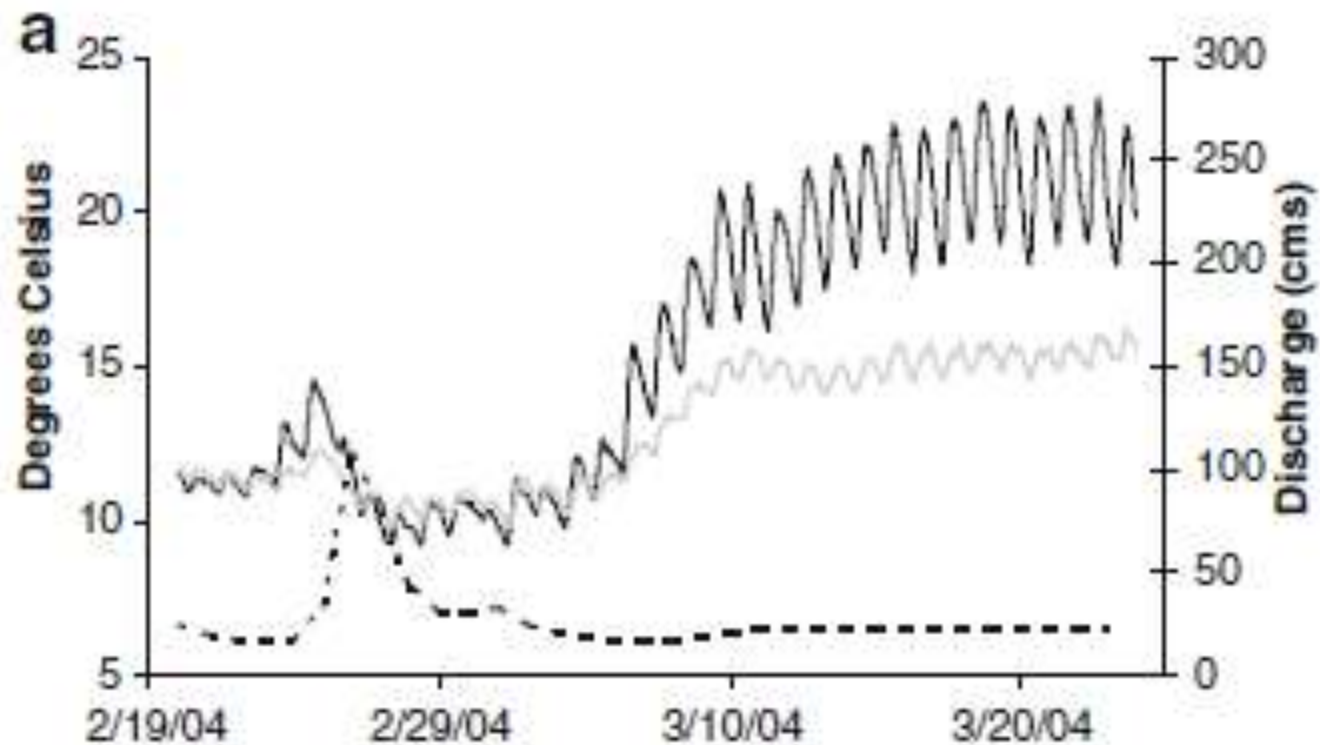
## Shorter travel distance for inputs



# Floodplain habitat complexity & connectivity

## Increased residence time of inputs

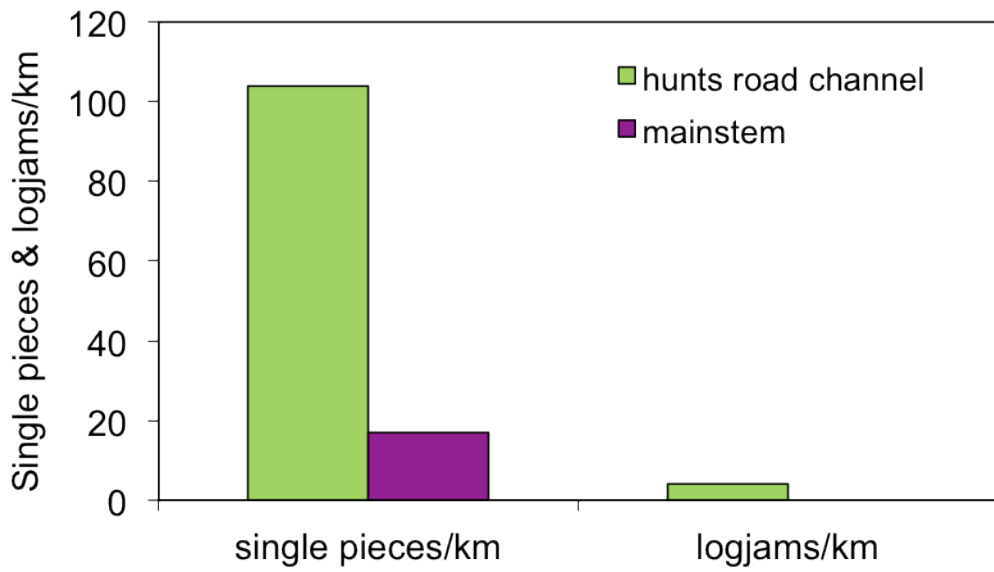
Dashed line – discharge, light grey – river, solid black - floodplain



Jeffres et al. 2008.

# Floodplain habitat complexity & connectivity

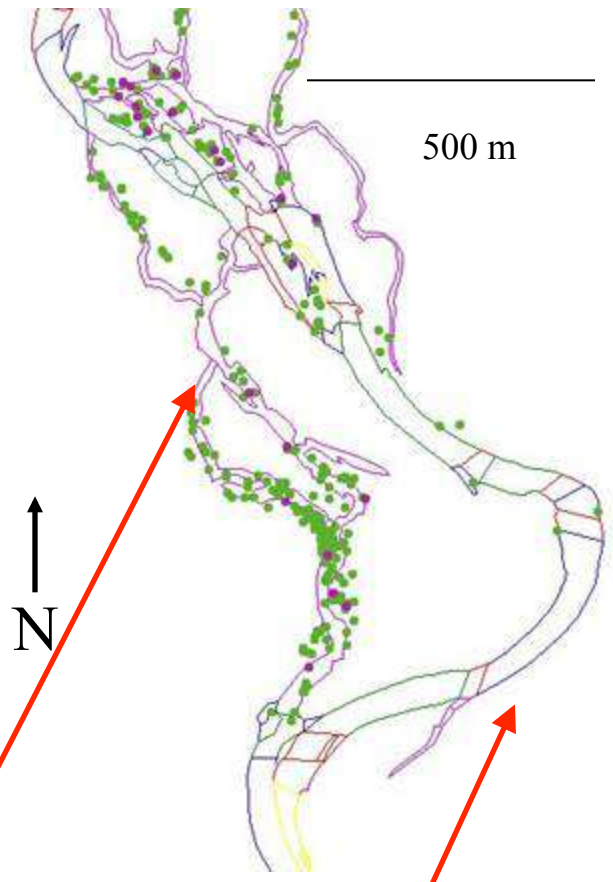
## Greater accumulation of inputs



Pess et al. 2008

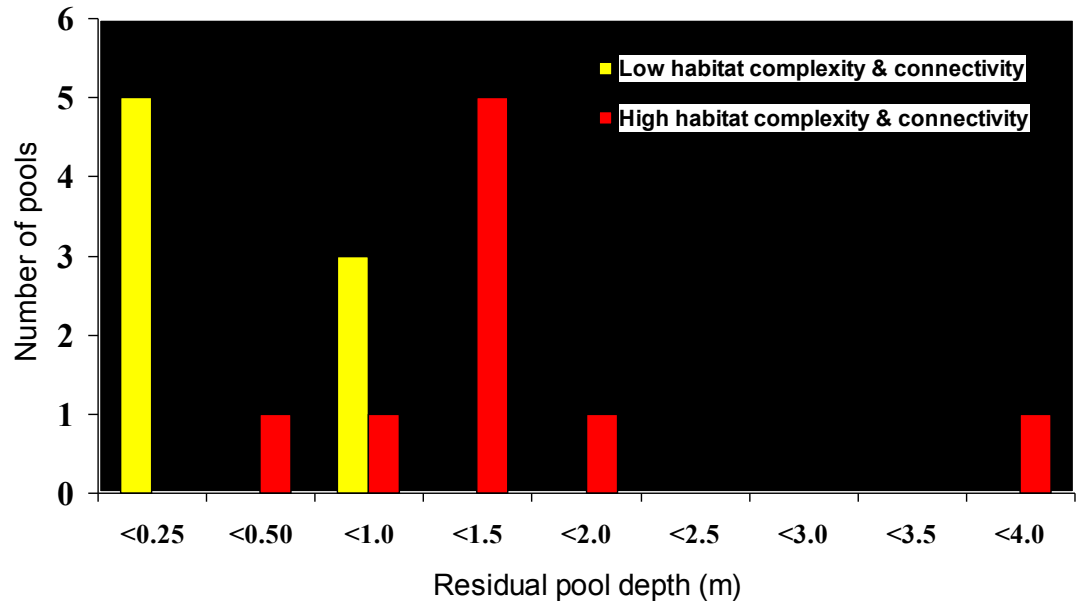
Hunts road channel

Mainstem Elwha

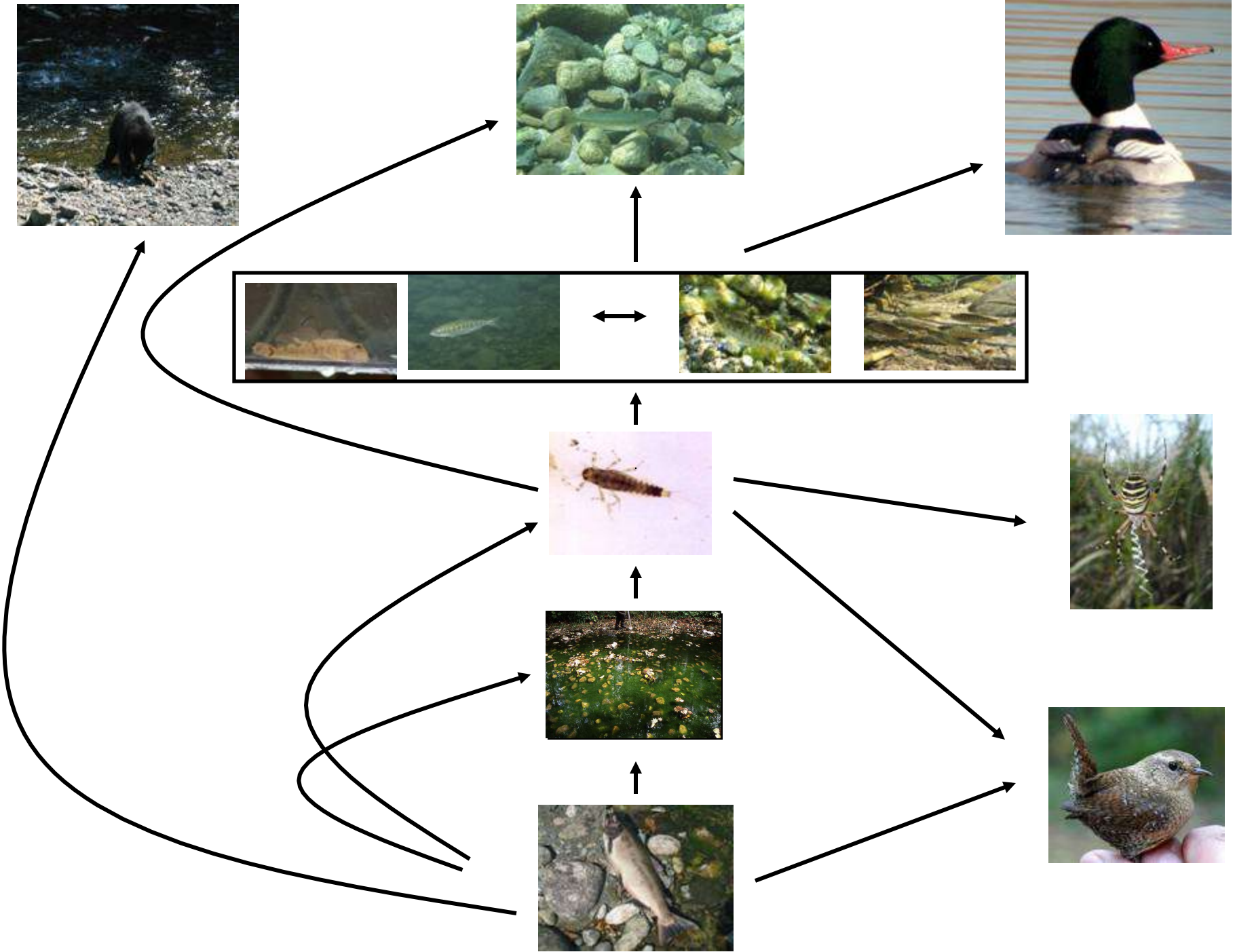
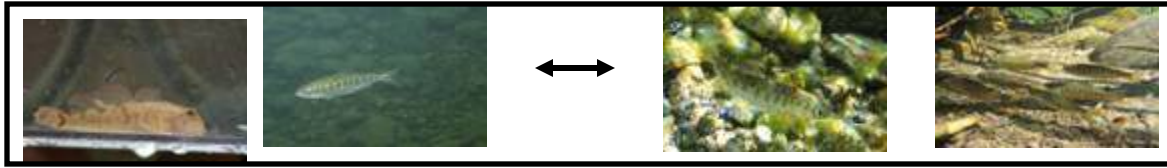


# Floodplain habitat complexity & connectivity

Greater chance for inputs to create & maintain favorable habitats



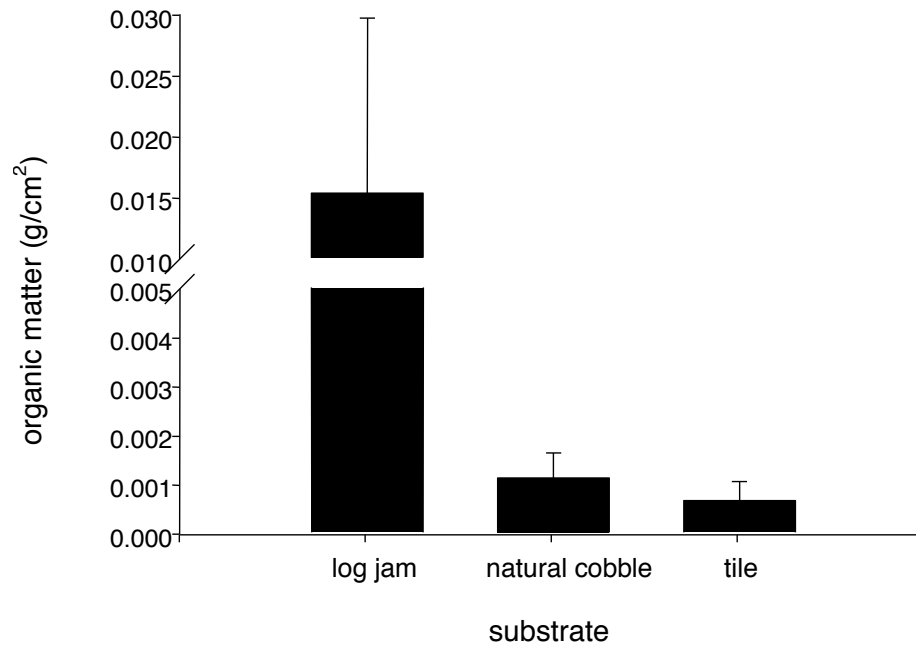
Abbe et al. 2003





# Floodplain habitat complexity & connectivity

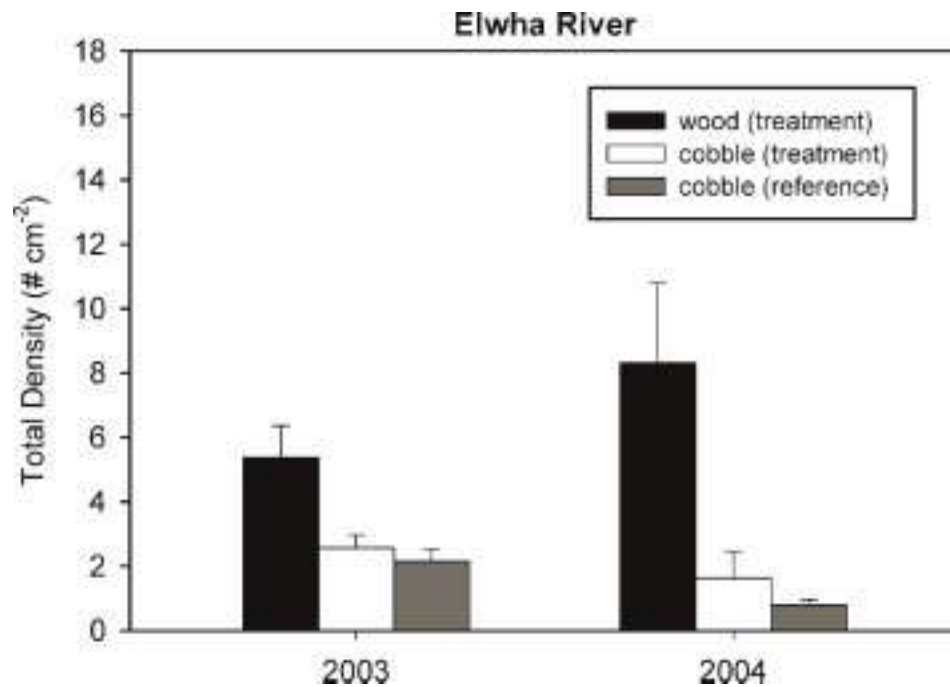
## Greater density of periphyton



Coe et al. 2006, 2009

# Floodplain habitat complexity & connectivity

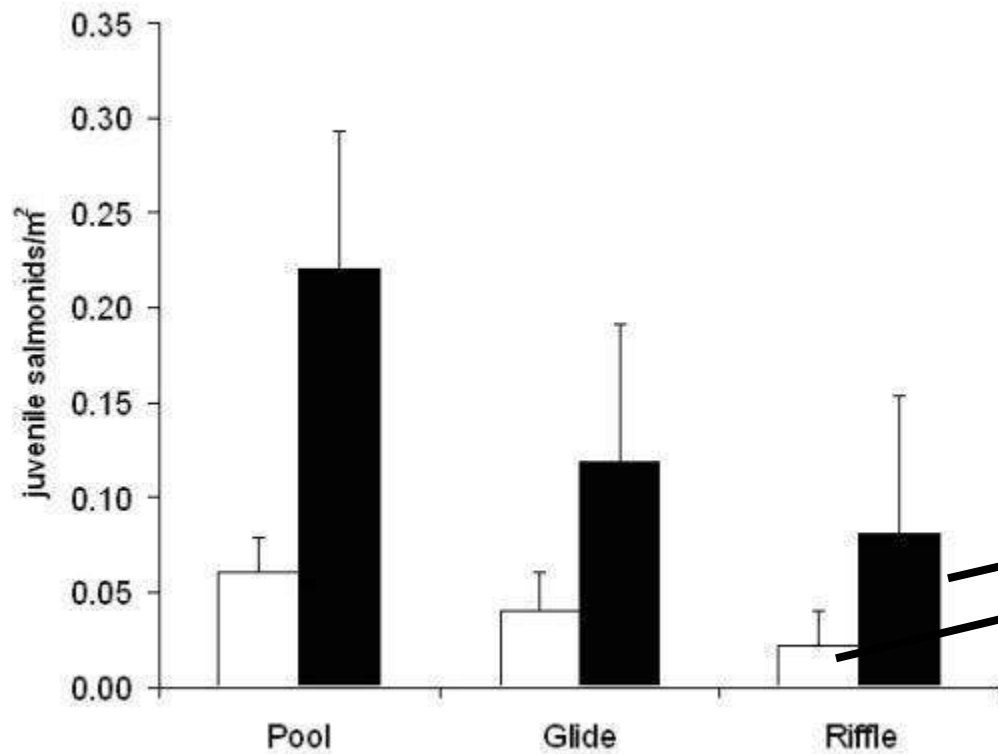
## Greater density of aquatic invertebrates



Coe et al. 2009

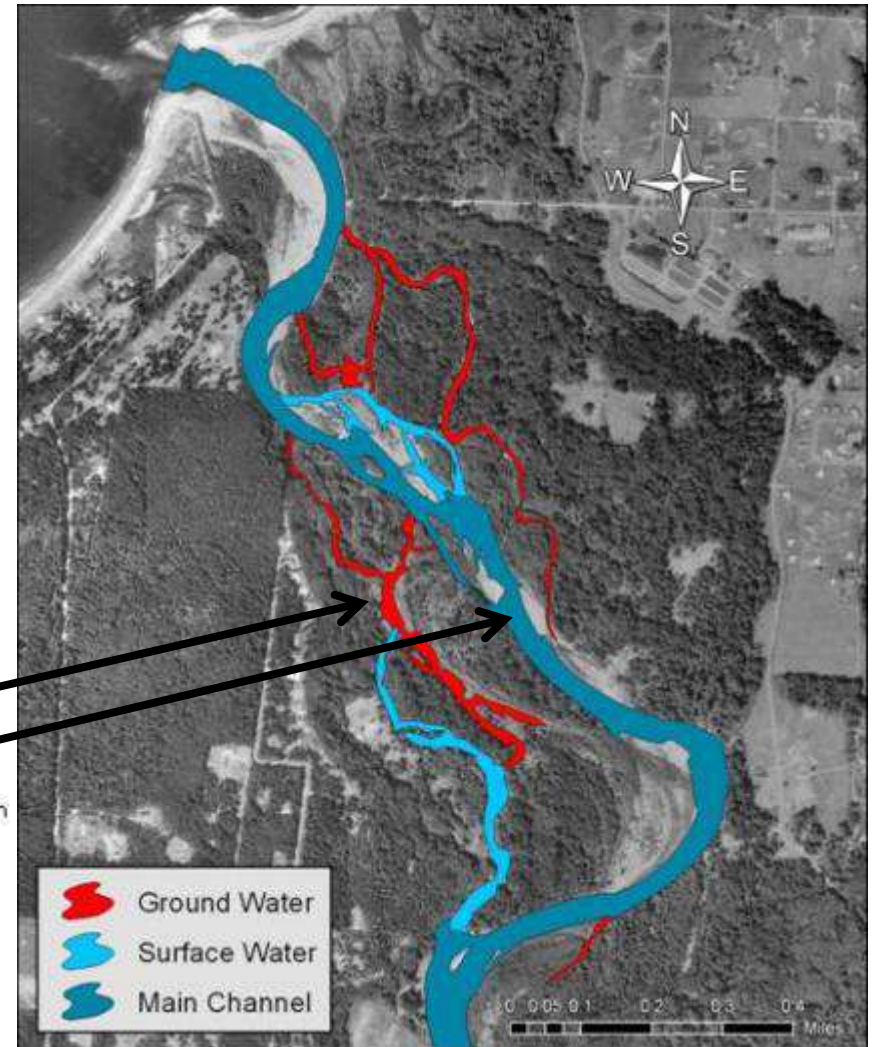
# Floodplain habitat complexity & connectivity

Greater density of salmonids



Clear = main stem

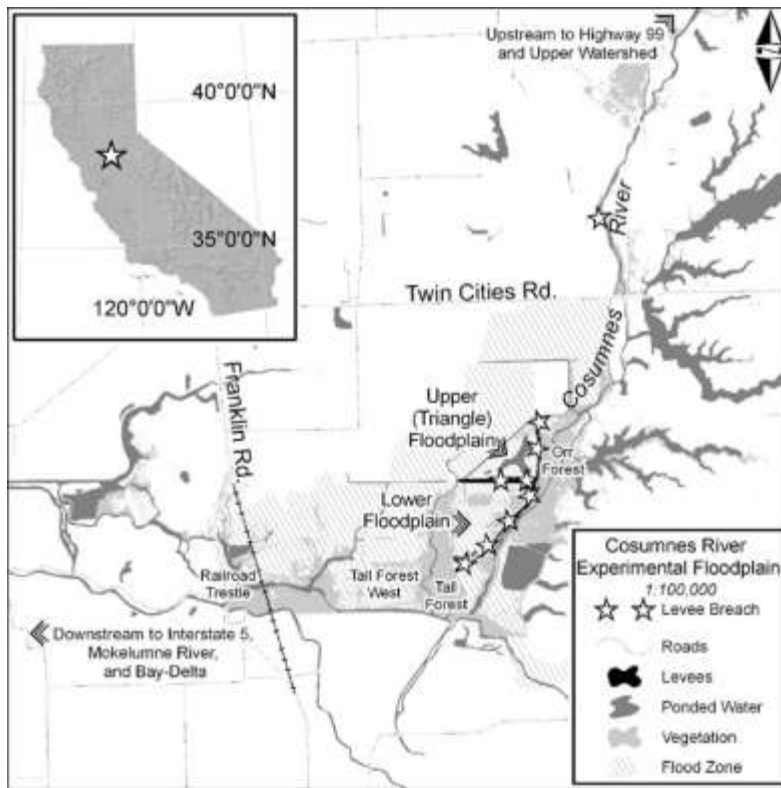
Black filled = floodplain



Pess et al. 2008

# Floodplain habitat complexity & connectivity

Greater condition factor for salmonids



Below floodplain

Floodplain

Jeffres et al. 2008

Enclosed experiment, same age Chinook

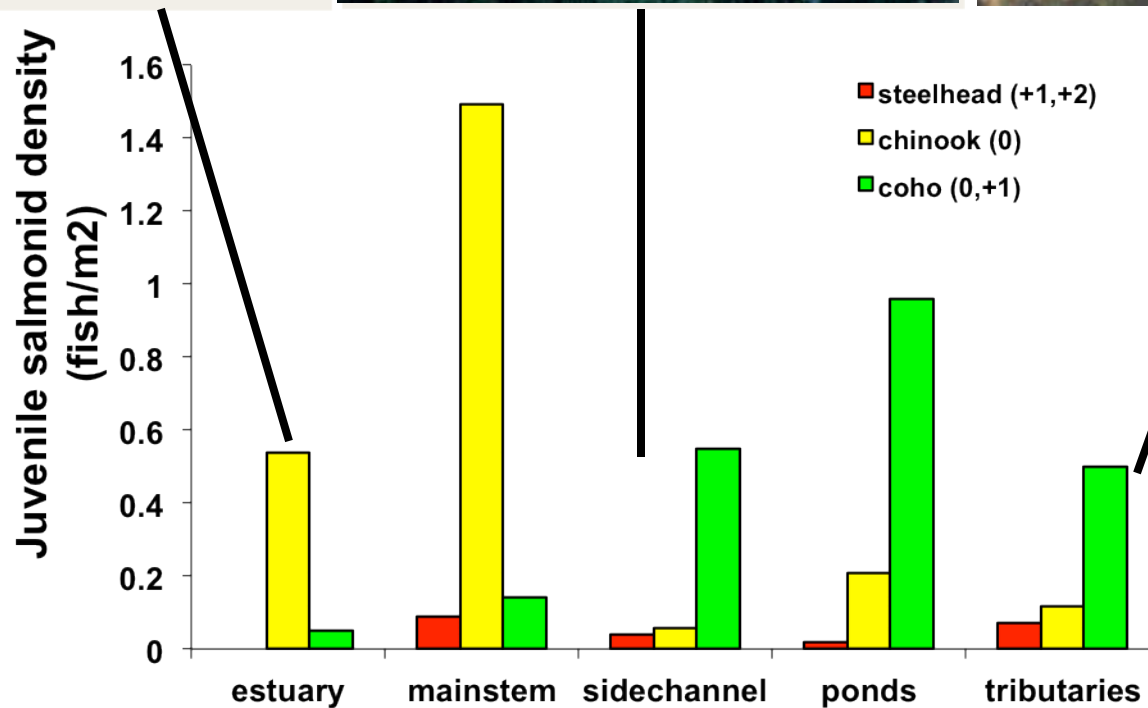
# Watershed habitat complexity & connectivity

Allows for increased species diversity



# Watershed habitat complexity & connectivity

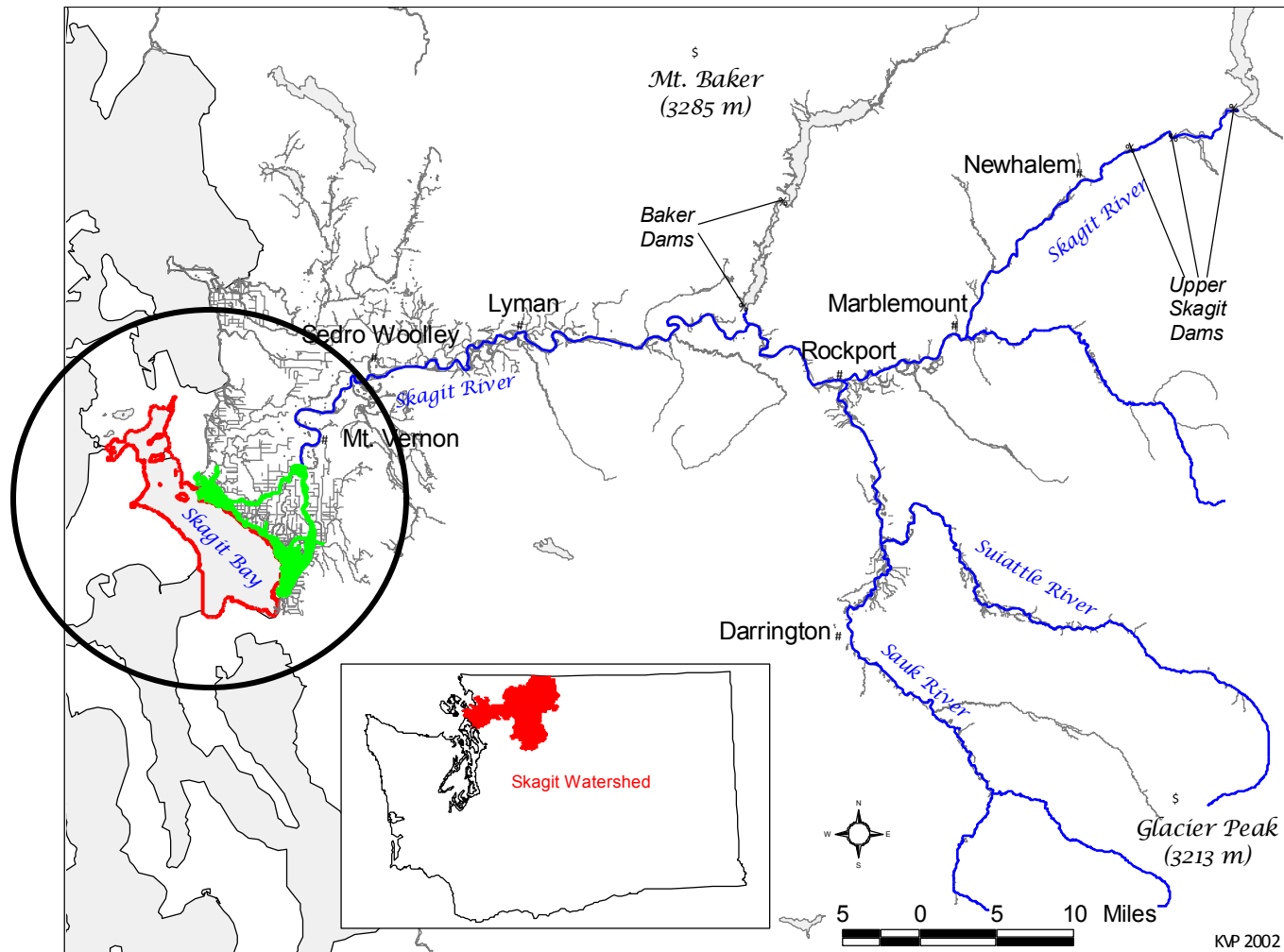
## Allows for increased species diversity



Pess et al. 2003

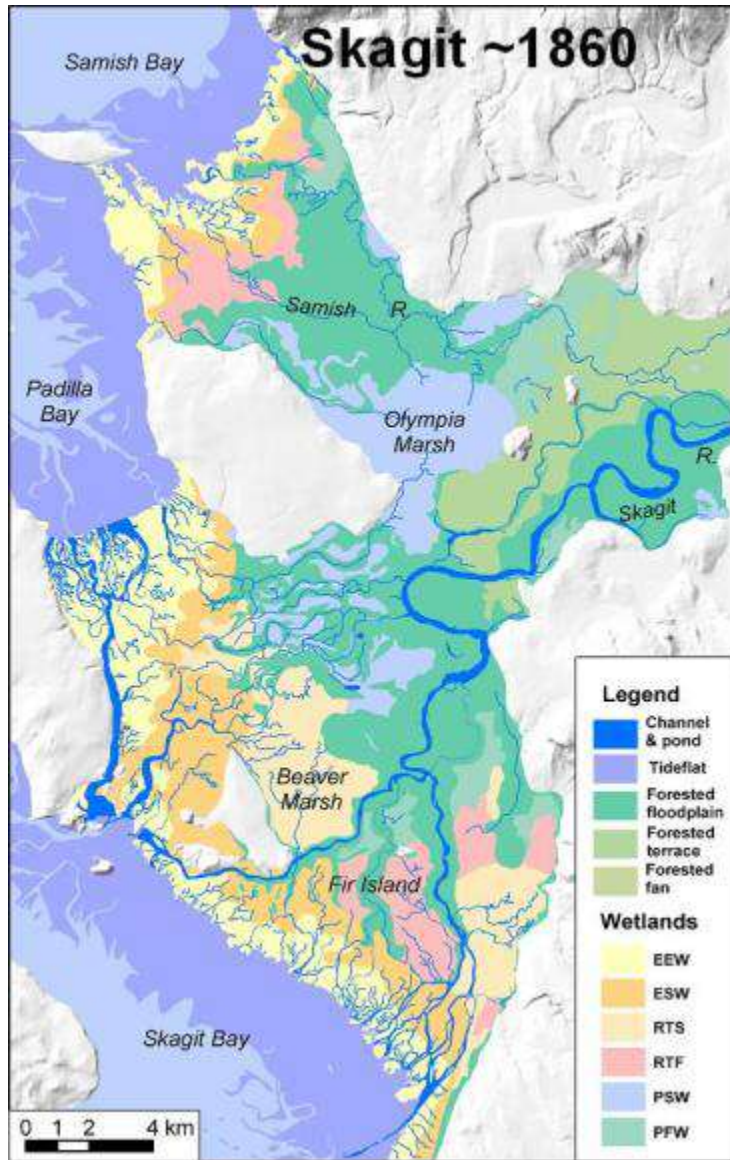
# Watershed habitat complexity & connectivity

## Increased life history diversity



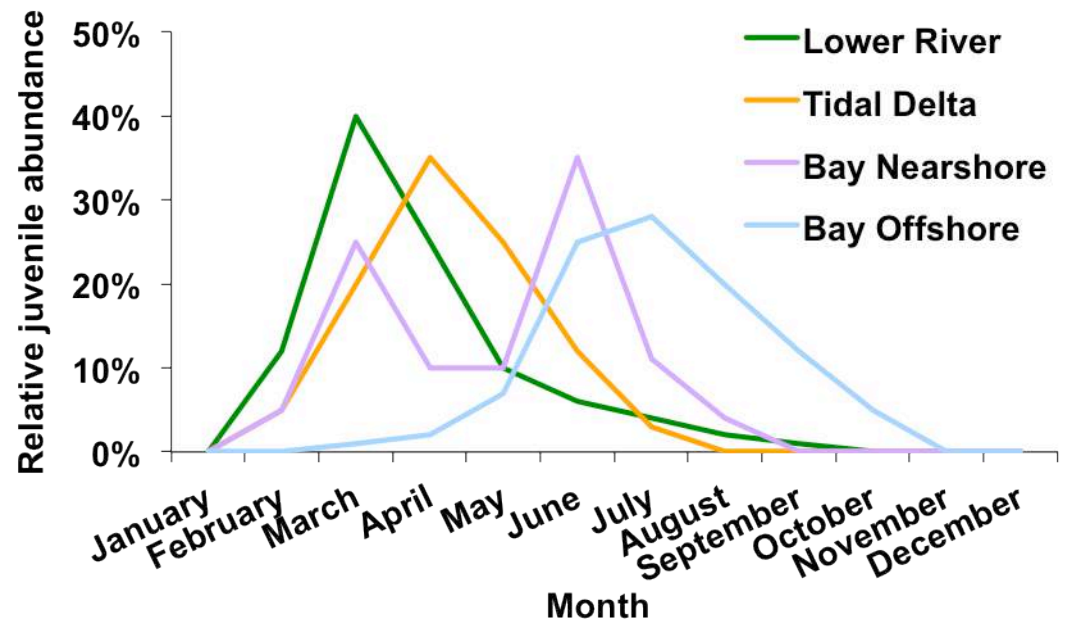
# Watershed habitat complexity & connectivity

## Increased life history diversity



Collins et al. 2003

### Ocean-type Chinook salmon



<http://www.skagitcoop.org/index.php/welcome/>



# What happens to river ecosystems when habitats are simplified or disconnected?

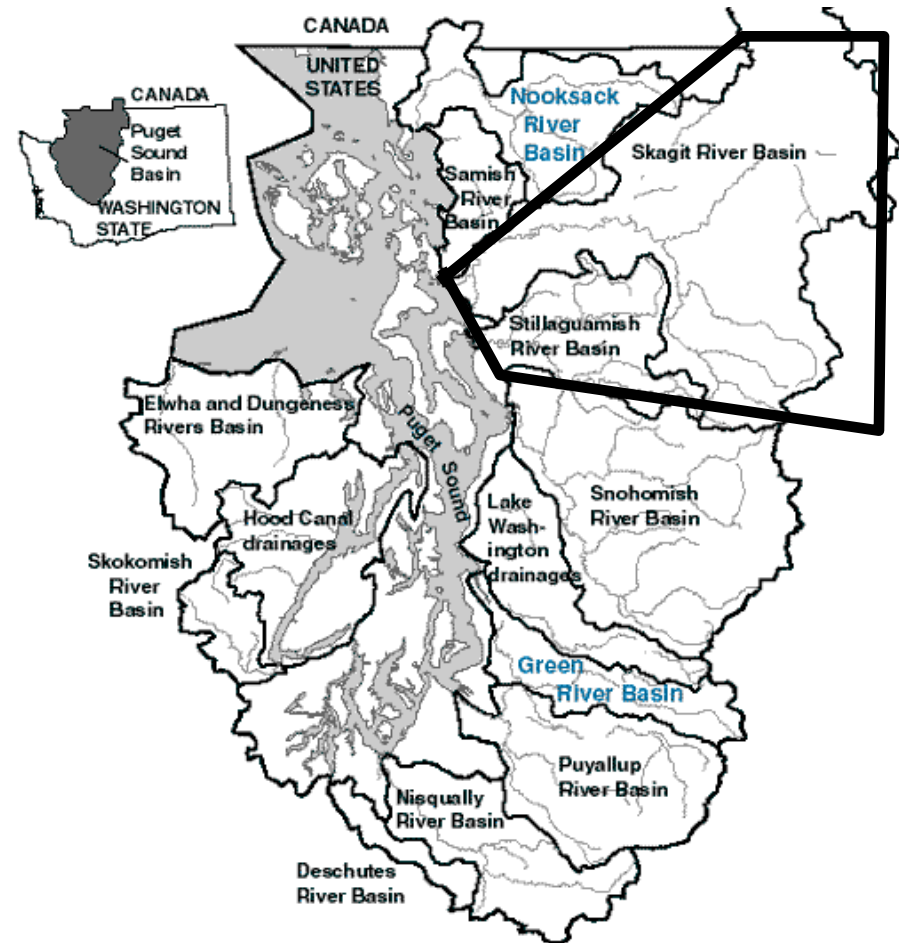
- Increase or decrease the amount & frequency of inputs
  - Water, sediment, nutrients, wood, & energy
- Simplify existing habitats
- Habitat removal
- Decrease salmonid survival at a particular life stage.
- Alters species distribution, increases competition, and can decrease overall salmonid survival at a particular life stage.

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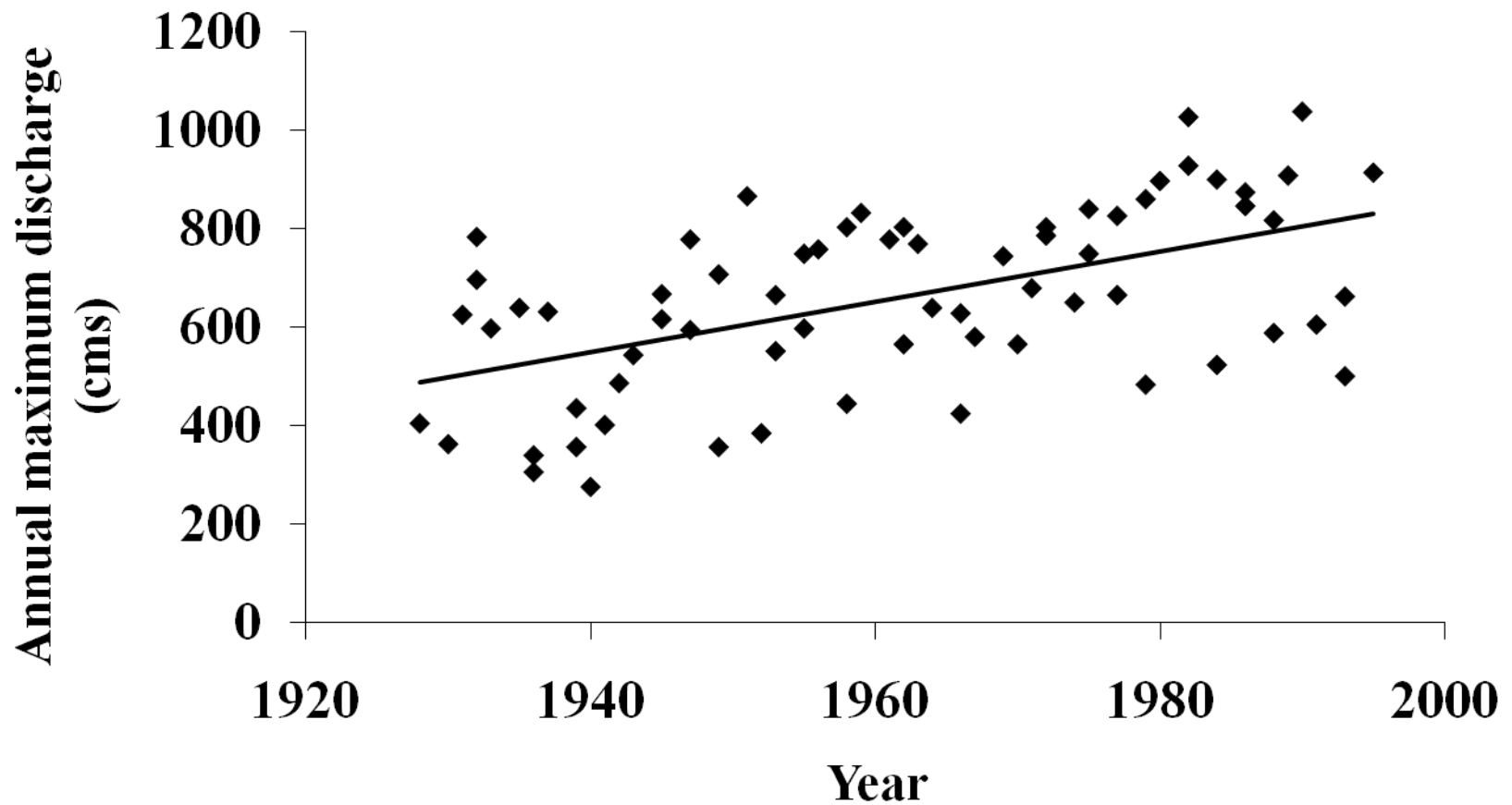
# Increase in the frequency & magnitude of water

- 50% of Skagit identified as hydrologically or sediment impaired
- Stillaguamish in similar situation
- Why?
  - Increased precipitation
  - Reduced hydrologic maturity
  - Increased road density
  - Disconnected floodplain habitats
- Potentially reduces salmonid egg to fry survival



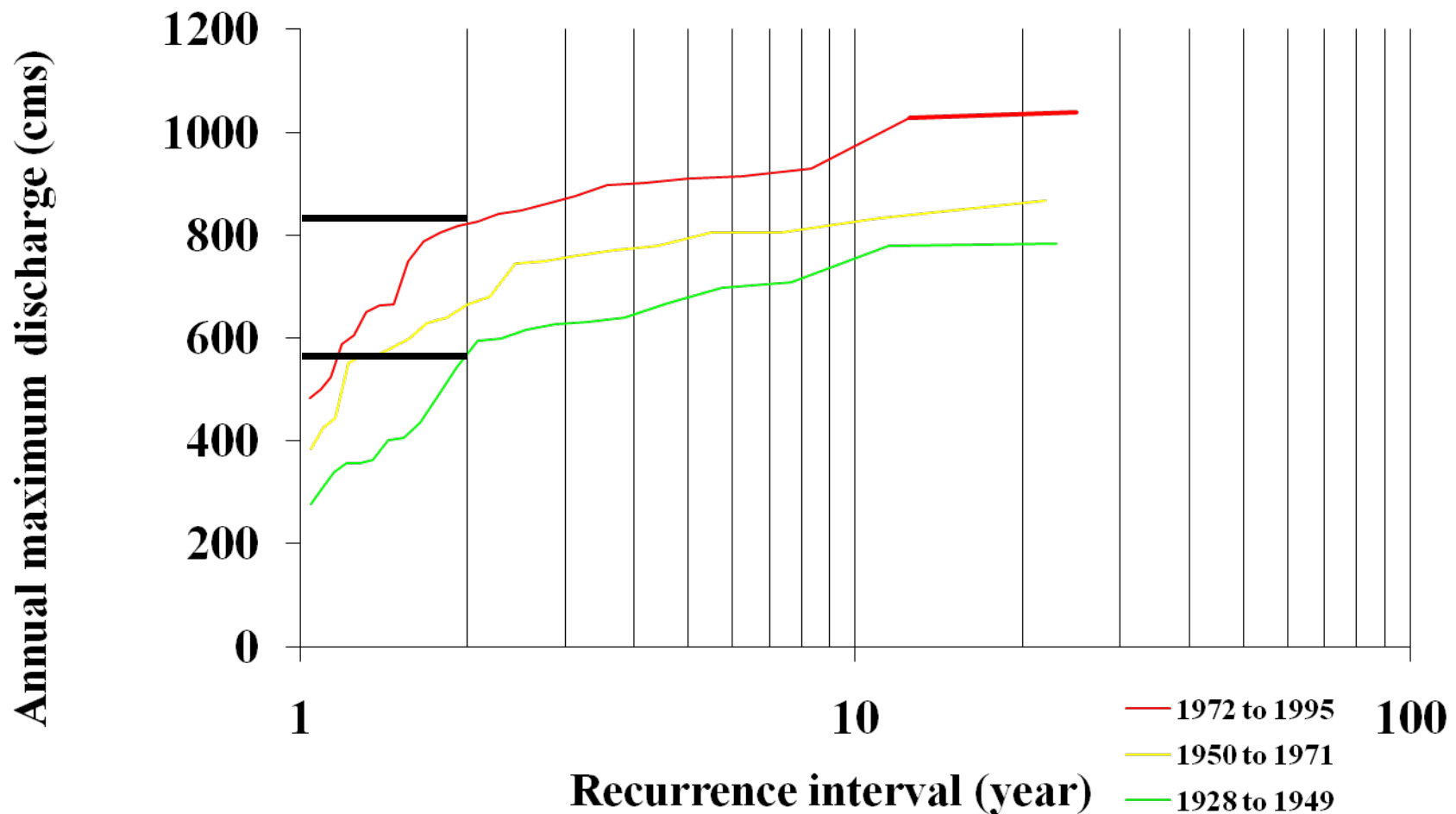
# Increase in the frequency & magnitude of water

North Fork Stillaguamish (NFS) annual flood events



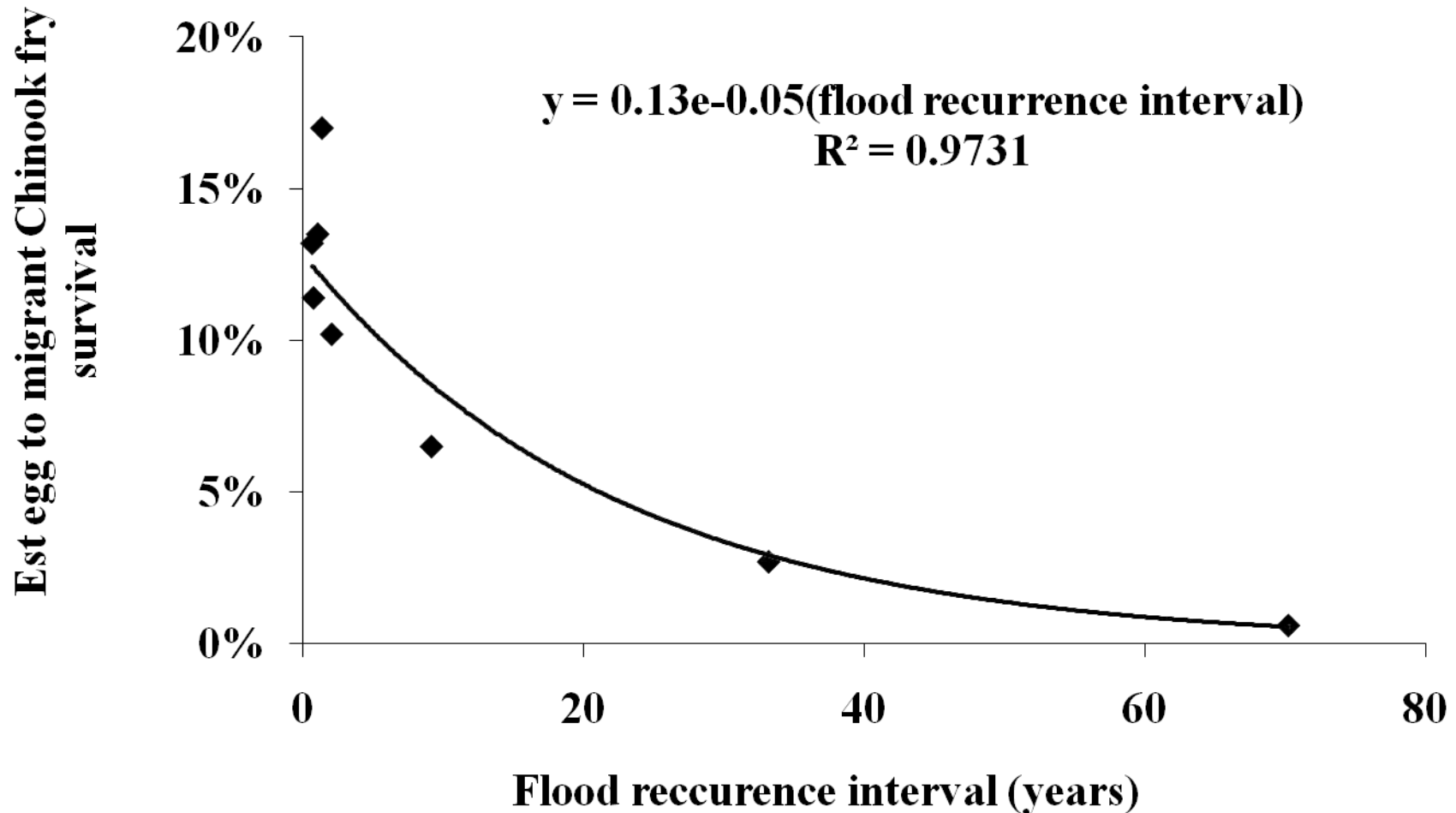
# Increase in the frequency & magnitude of water

North Fork Stillaguamish (NFS) annual flood events



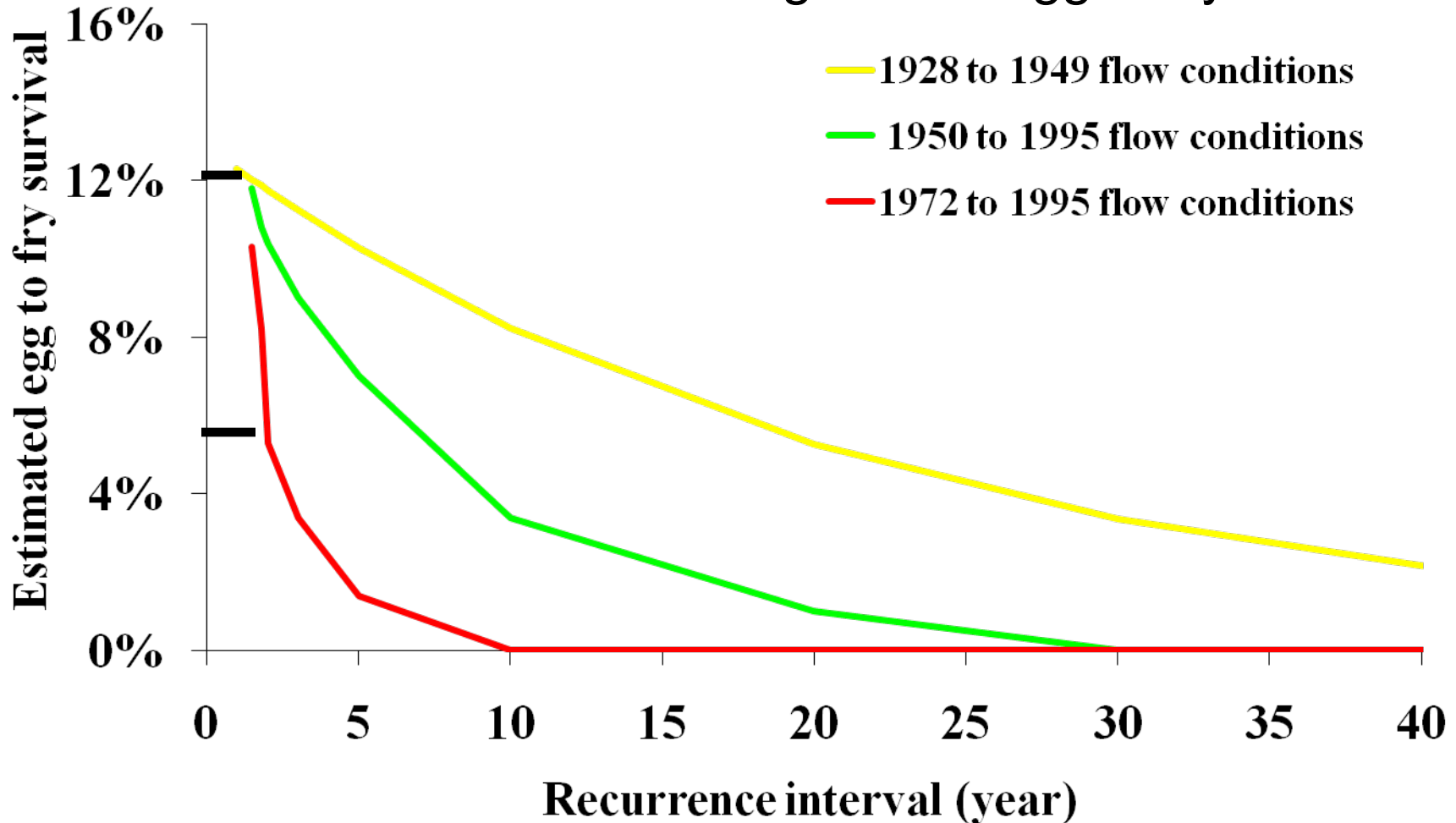
# Increase in the frequency & magnitude of water

High flows and estimated Skagit River egg to fry survival

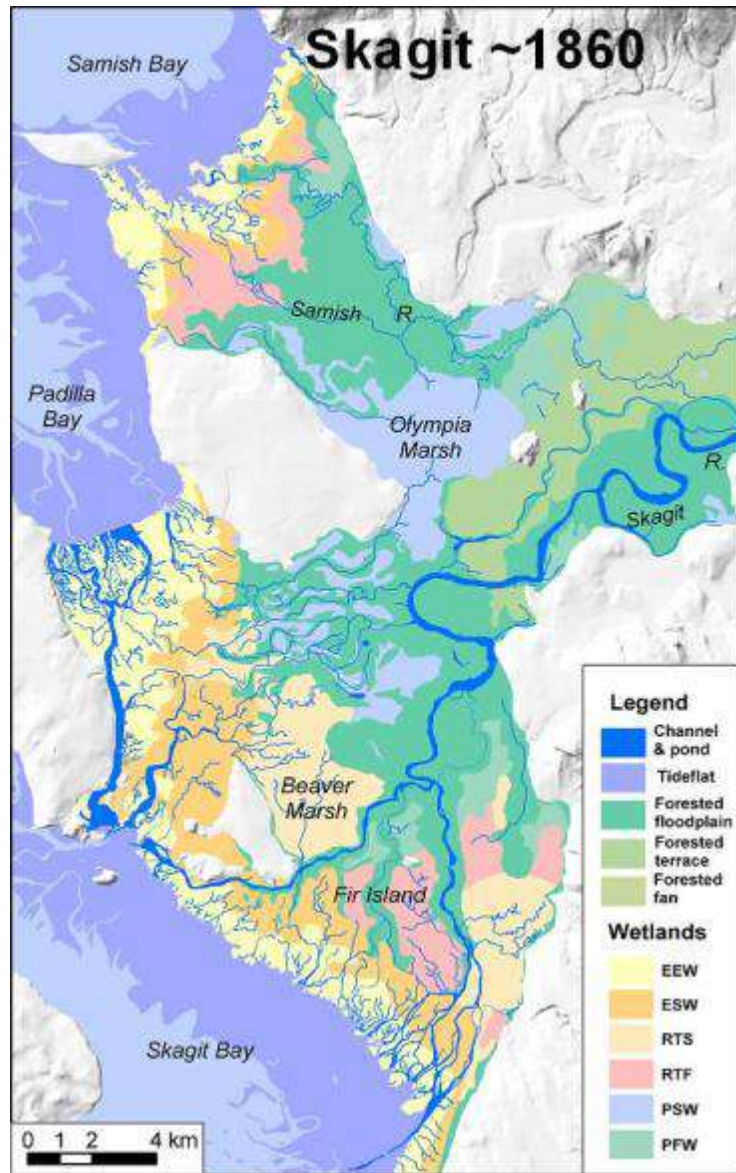


# Increase in the frequency & magnitude of water

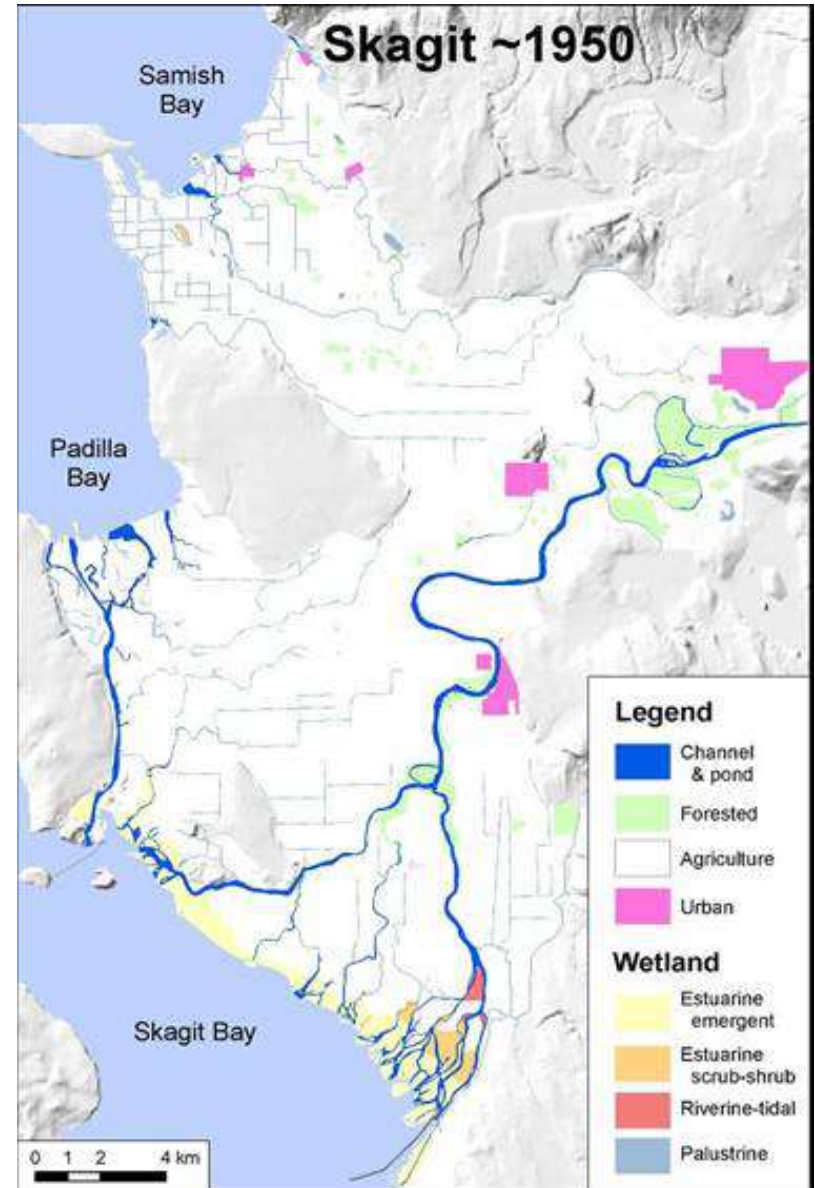
Estimated decreased Stillaguamish egg to fry survival



# Habitat removal & isolation



Collins et al. 2003

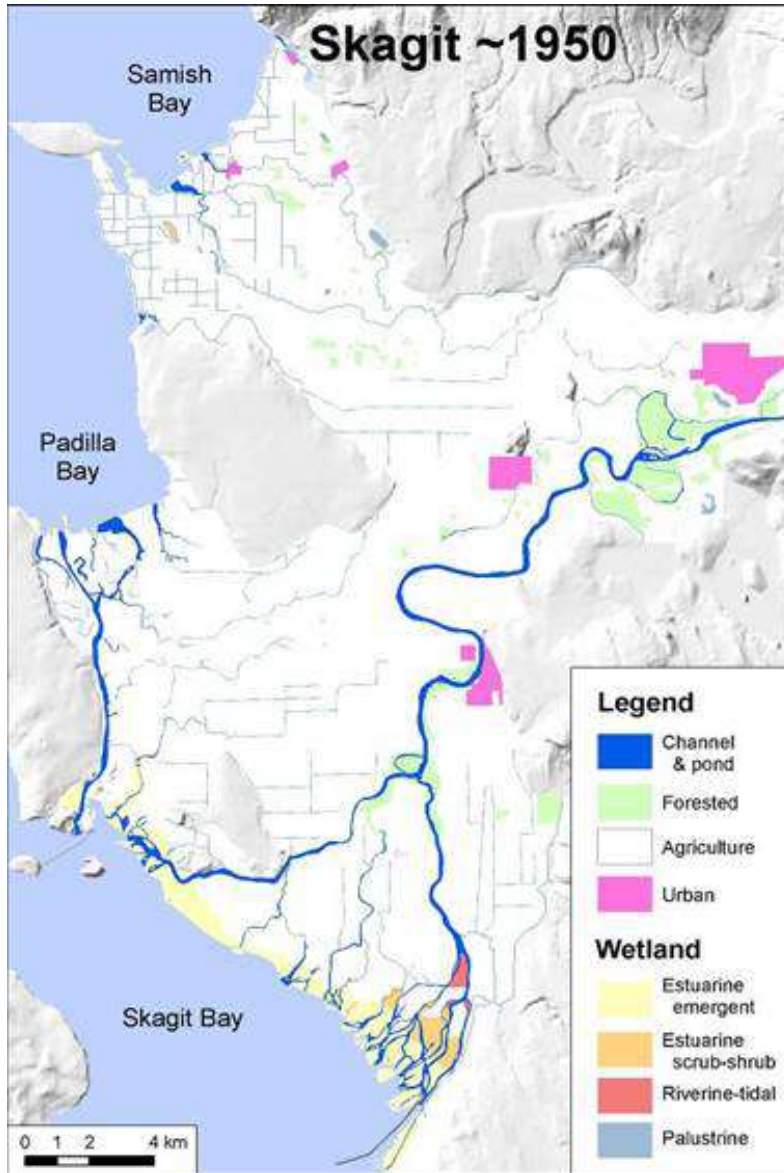


Collins et al. 2003



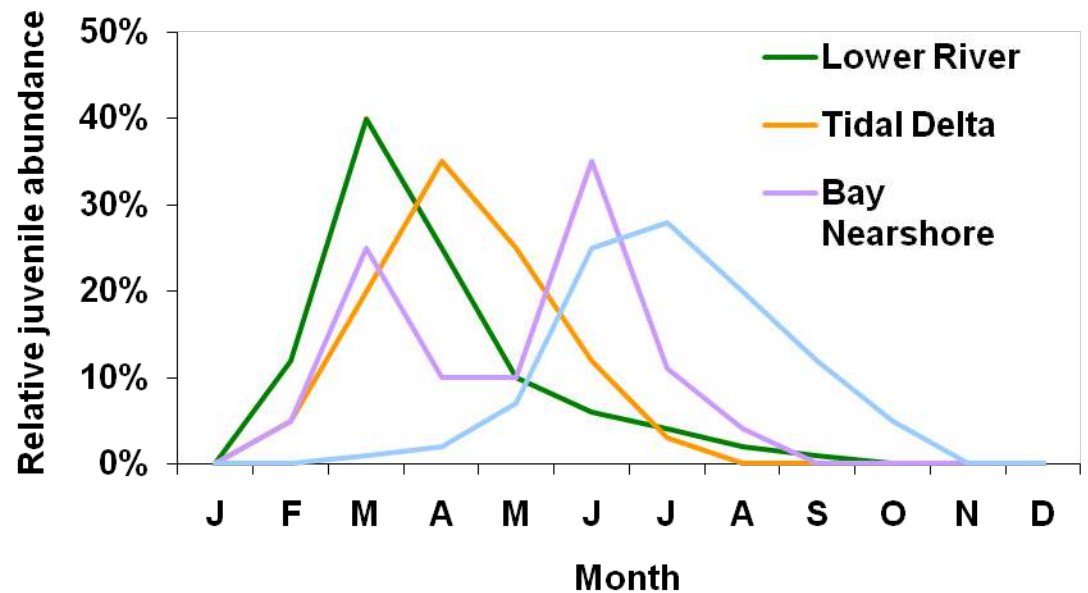
# Habitat removal & isolation

## Decreased life history diversity



Collins et al. 2003

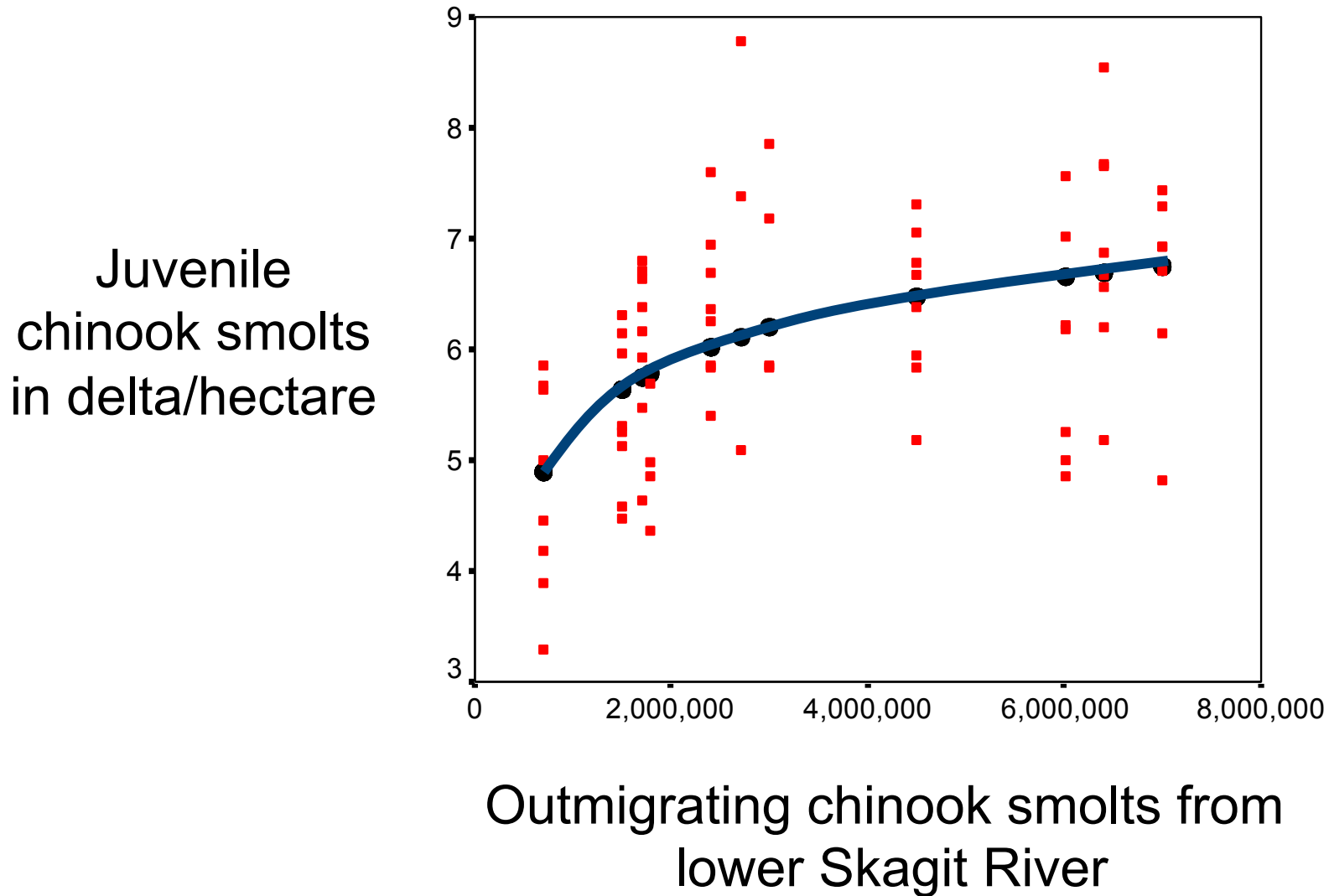
### Ocean-type Chinook salmon



Beamer, unpublished data.

# Habitat removal & isolation

Increased competition for remaining habitats



Beamer, unpublished data.

# What is habitat complexity & connectivity?

- Physical, biological, & chemical attributes that determine stream productivity
- The capacity of river systems to allow longitudinal & lateral dispersal of biological organisms, chemical components, and physical structures.



Photo courtesy of Lauren Rogers

# How does habitat complexity & connectivity help create & maintain river ecosystems?

- Habitat complexity & connectivity increase the ability of inputs (i.e., water, wood, sediment, & nutrients) to become habitat for a long enough time period to accumulate, be incorporated, and benefit aquatic organisms such as salmonids.
- Habitat complexity and connectivity can increase both species & life history diversity of aquatic organisms.



Photo courtesy of John McMillan

# What happens to river ecosystems when habitats are simplified or disconnected?

- A change in the magnitude & frequency of input rates such as flow can lead to decreased survivorship at particular salmonid life stages.
- Reduced habitat quality & quantity can alter species distribution, lead to increased competition, and create specific life stages that limit population size.



Photo courtesy of John McMillan

# Questions?



Photo courtesy of John McMillan