Climate Change Impacts to Coastal Habitat and Estuarine Ecology

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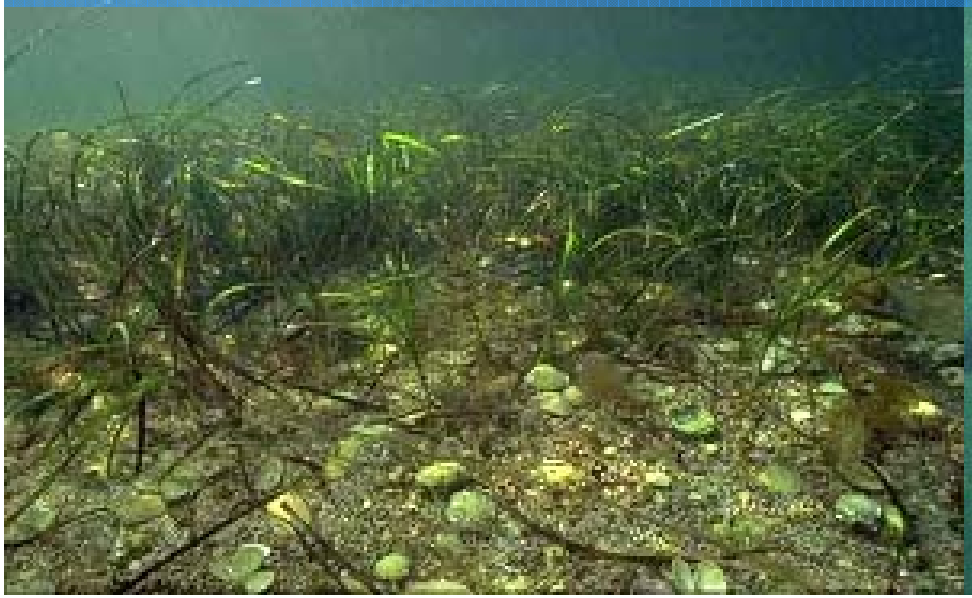

Talk Outline

Introduction
- Importance of coastal ecosystems
- Problems and issues

Predicted climate-driven changes

Likely impacts:
- Habitats
- Processes
- uncertainties/science needs

Conclusions

Acknowledgements:
Harriet Beale (Puget Sound Action Team), Margaret Dutch (WA ECY), Greg Hood and Eric Beamer (SRSC)

“Take home messages”

1) Climate change will impact coastal ecosystems that are already greatly modified by humans

2) Ecological interactions are highly dynamic: vary spatially/temporally within coastal zone

3) Wide range of adaptation outcomes; we need greater knowledge and predictive capacity

Interface between terrestrial, marine and atmospheric processes

- High productivity, biodiversity
- Foundation of estuarine foodweb
- Extensive area

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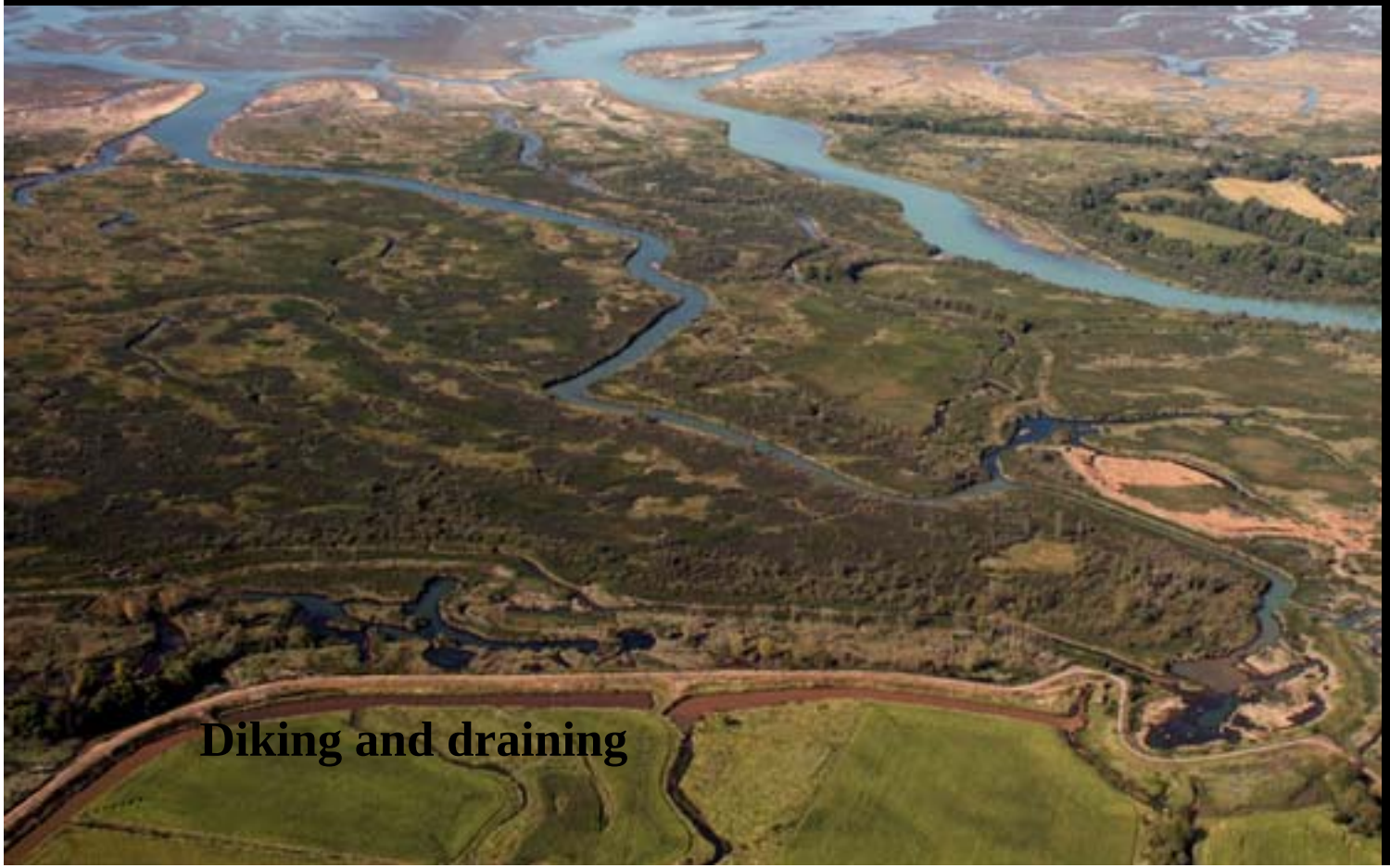
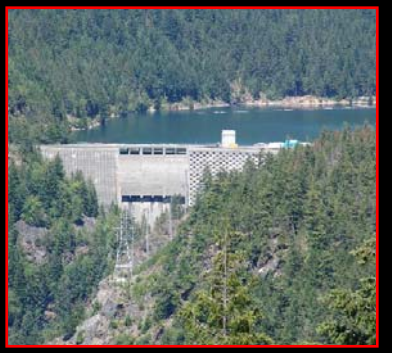
Human modifications to habitat and hydrodynamic/geochemical processes

- freshwater discharge and mixing
- sediment/contaminant/nutrient flux
- distribution and timing of usable habitats



Puget Sound Nearshore Restoration Program



PUGET SOUND RESTORATION PROGRAM

PSNERP

Consortium of scientists, federal and local governments, NGOs, and resource managers tasked with developing scientific data and tools to guide adaptive management of nearshore habitats

Diking and draining

Survey methods - mapping

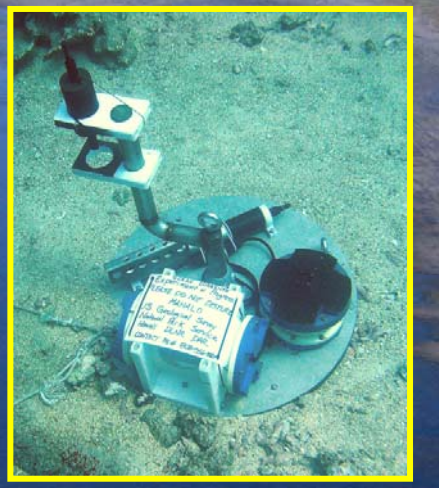
GPR

Coring

Grainsize mapping

Multibeam/seismic reflection/video

Physical Oceanographic Instrumentation



Climate Forcing

temperature

Climate Change

precipitation

- magnitude
- frequency
- timing

Predicted	Measured (1948 to 2003)
↑ air temperature	1.5° F
↑ water temperature	?
↑ winter rainfall	?
↑ flooding	yes
↓ snowpack	yes
Earlier snow melt (freshet)	12 days
↓ summer river flow	-18%
↑ peak/daily river flow	Increased
↓ Annual river flow	Decrease

Climate Forcing - Process Responses

- river flows, floods
- estuarine mixing
- evapotranspiration
- groundwater flux

temperature

Climate Change

precipitation

Hydrodynamics

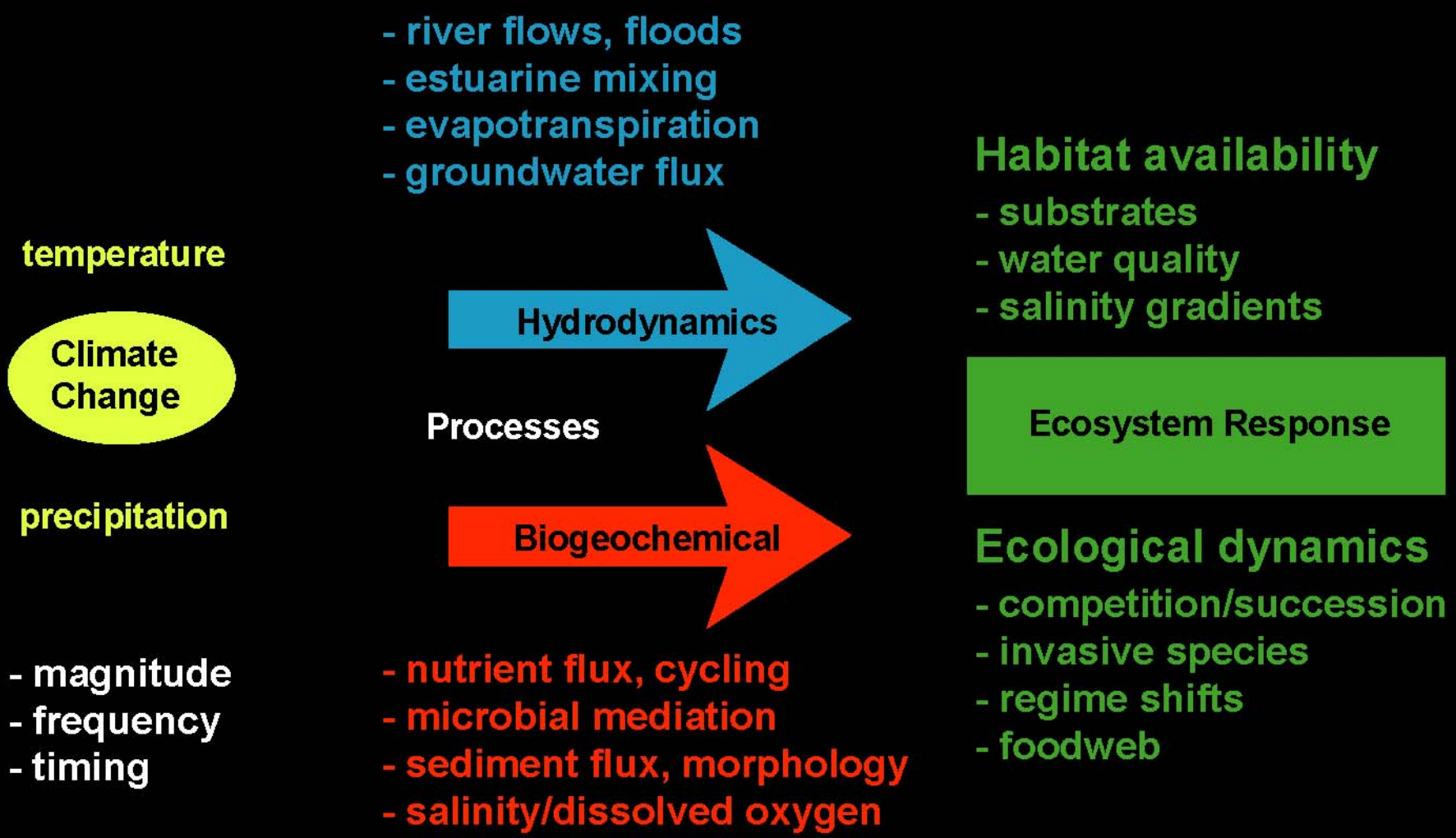
Processes

Biogeochemical

- magnitude
- frequency
- timing

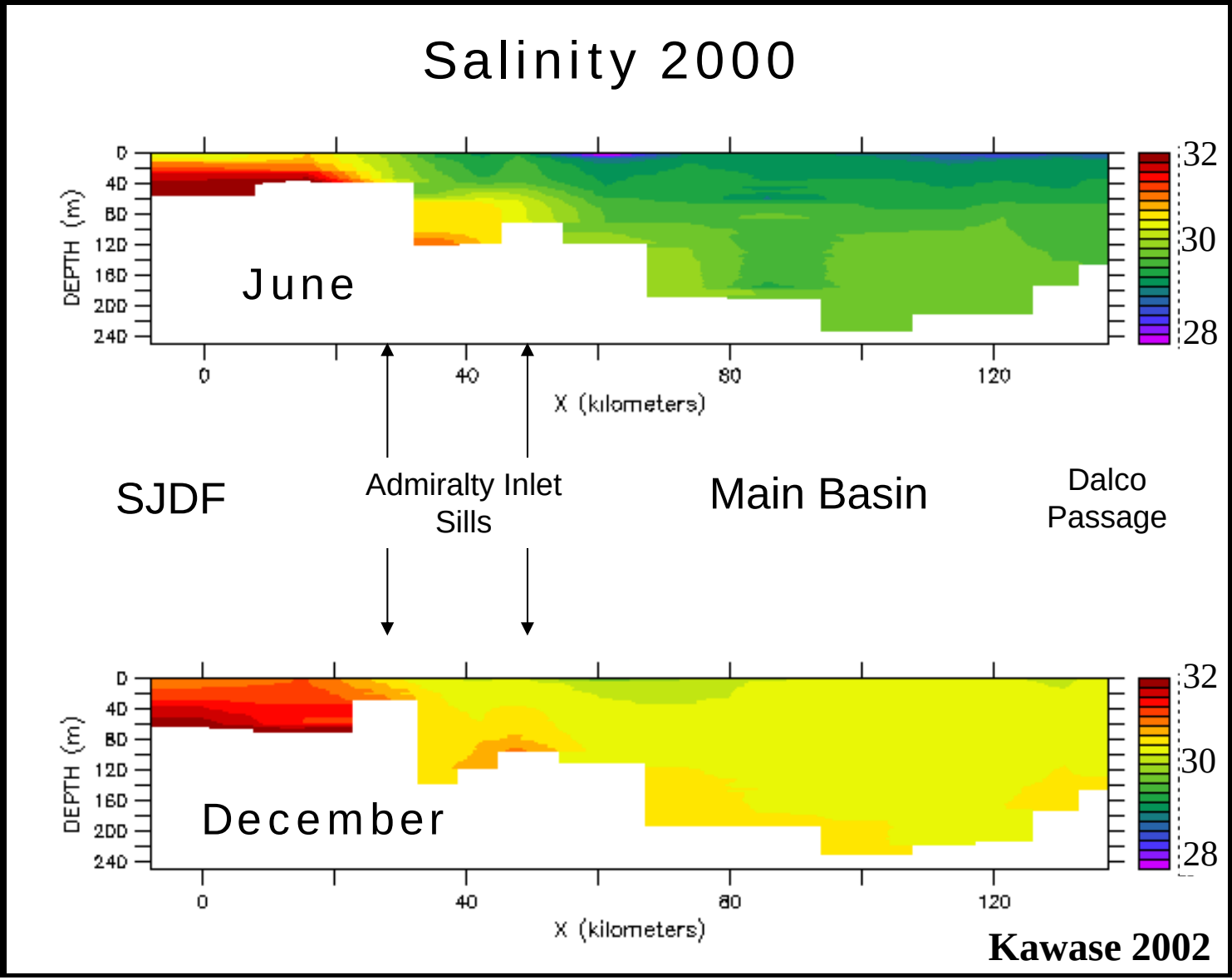
- nutrient flux, cycling
- microbial mediation
- sediment flux, morphology
- salinity/dissolved oxygen

Climate Forcing - Ecosystem Responses



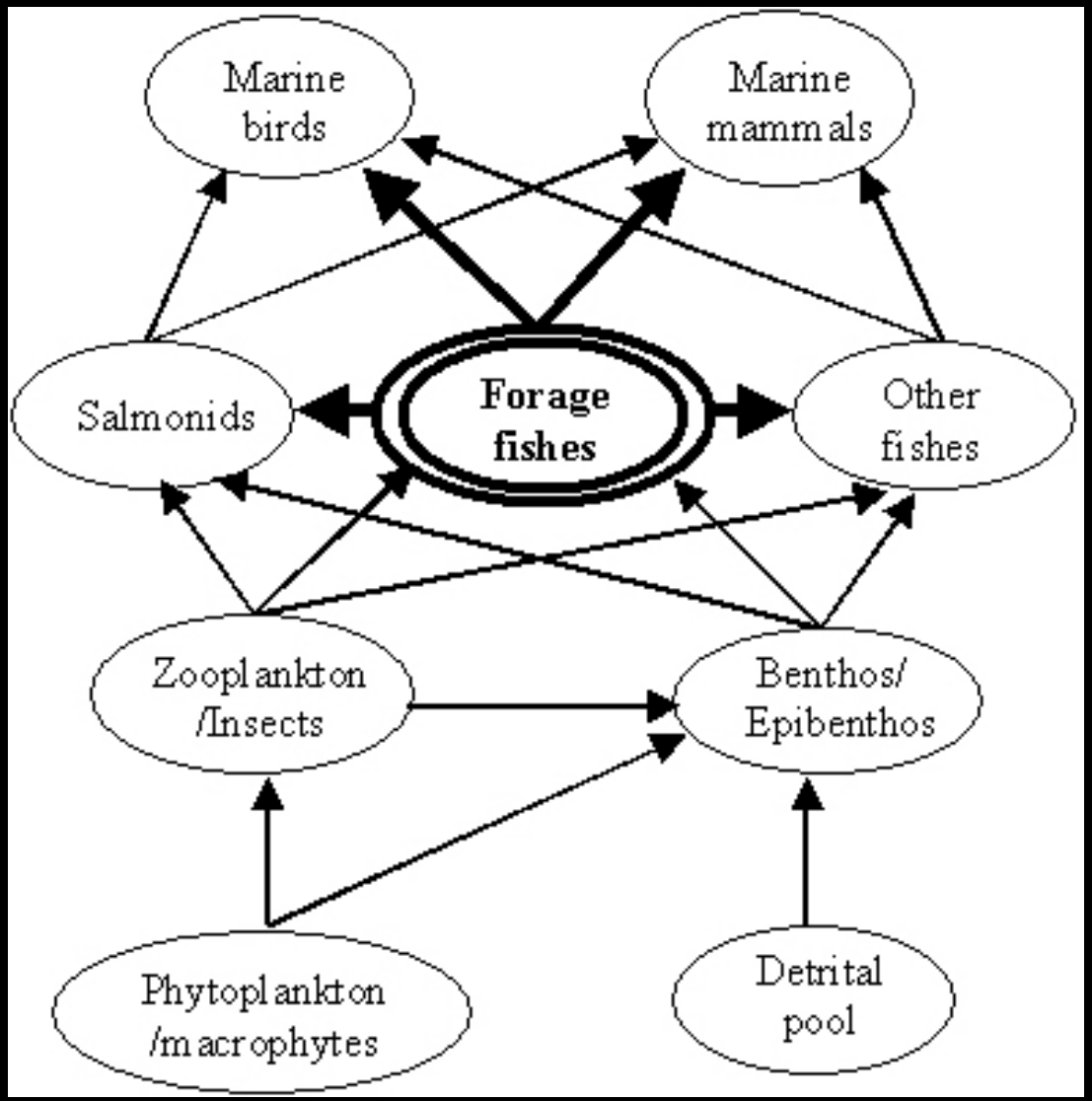
Large-scale circulation in Puget Sound

driven by marine and fresh-water mixing



Estuarine Food Web

Impacts may occur at any and all levels of foodweb and cascade through



Just a few examples:

Change in:
- **flow velocities**
- **sediment type/input**
- **nutrients**
- **salinity**
- **temperature**

Impacts:
Substrate change
- **erosion/siltation**

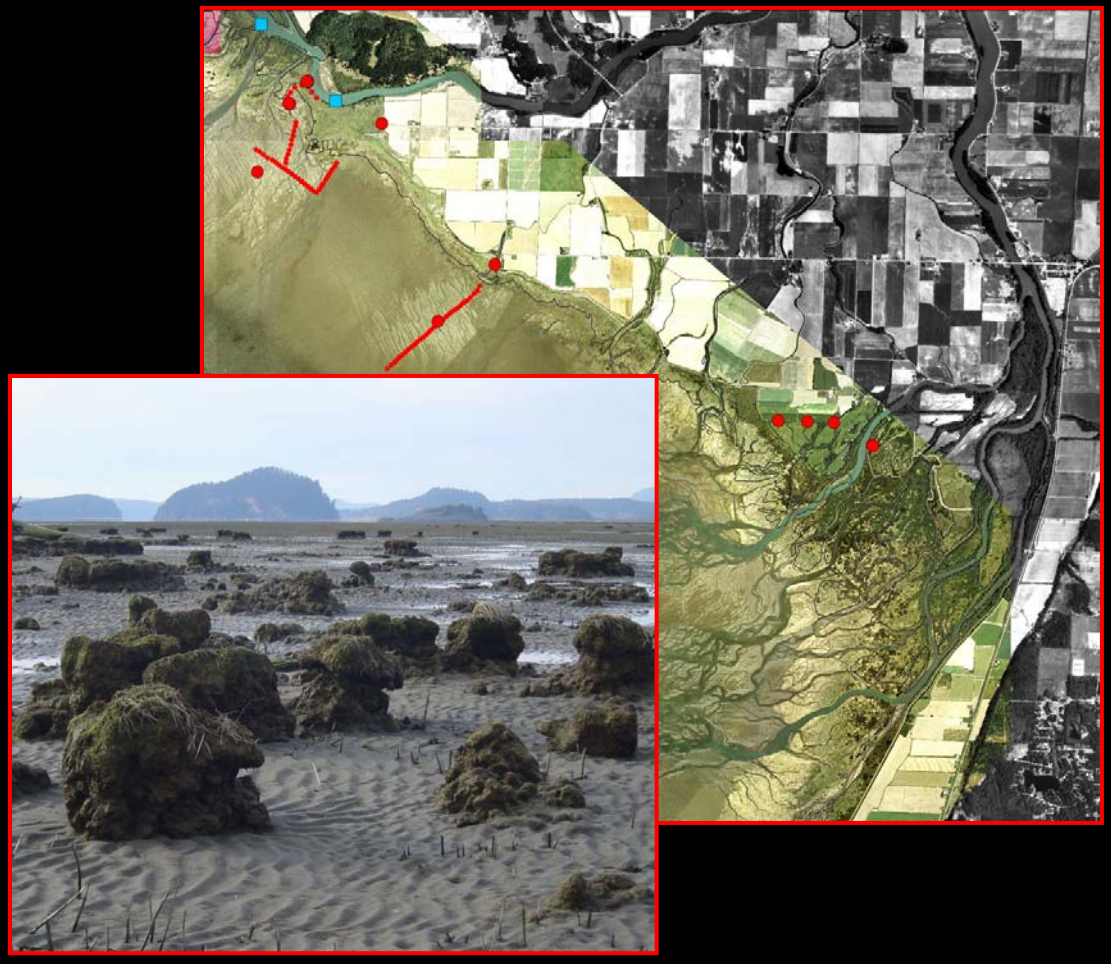
Eutrophication
Turbidity (↓ light)
Water quality
Nutrient cycling

Marsh/Wetlands

Productive avian/mammal habitat, migration corridors, nutrient/water cycling, agricultural centers

Marsh/Wetlands

Productive avian/mammal habitat, migration corridors, nutrient/water cycling, agricultural centers



Lower river flow
Decrease sediment
Higher salinity
Increase floods
Siltation
Change in nutrient

Coastal erosion
Loss of marsh
Peat decay
Change in vegetation
Eutrophication

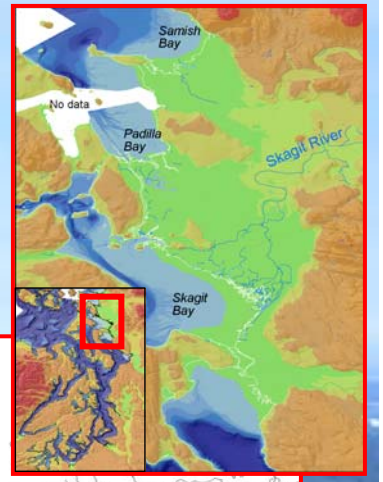
Marsh/Tidal Channel Habitat

Spawn/nursery habitat, migration corridor, nutrient/water pathway

Increase temperature, salinity
Decrease dissolved oxygen
Lower flow velocities
Siltation
Increase/decrease nutrient?

Decrease habitat, connectivity
Physiologic “salinity” barriers
Anoxia, stagnation
Loss of substrate/benthic community
Eutrophication, regime change

Skagit Delta Habitat Loss



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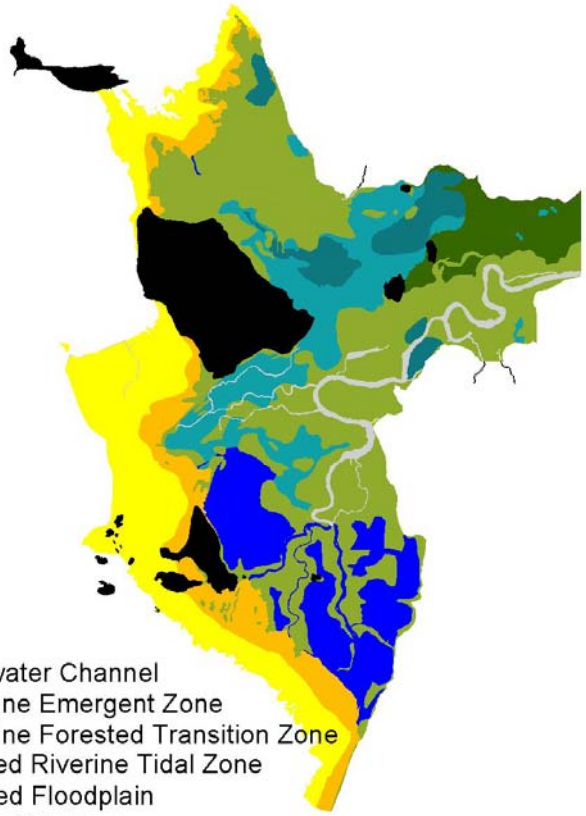
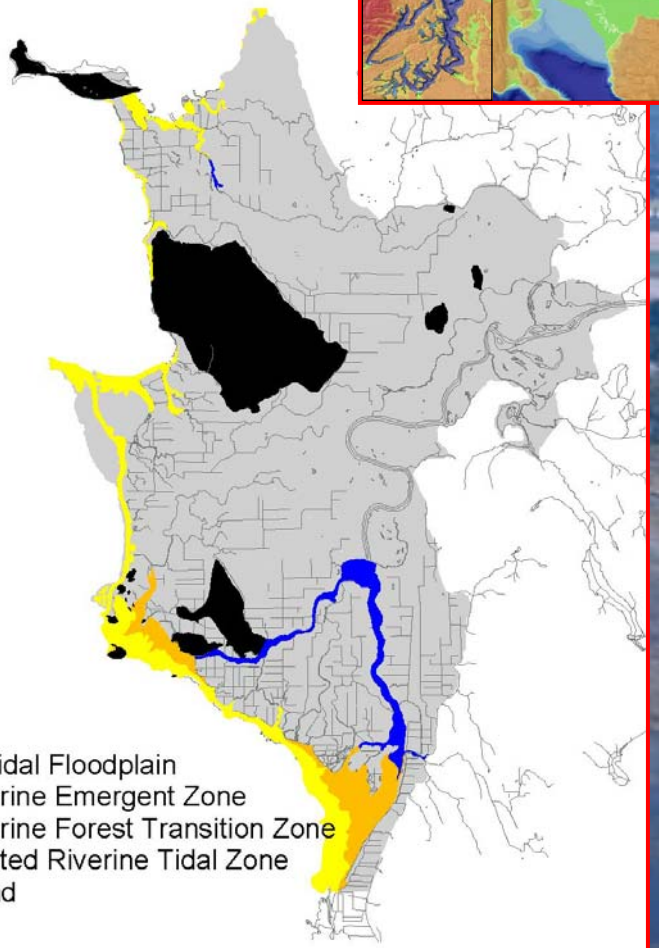


- Freshwater Channel
- Estuarine Emergent Zone
- Estuarine Forested Transition Zone
- Forested Riverine Tidal Zone
- Forested Floodplain
- Forested Terrace
- Palustrine Forested Wetland
- Palustrine Scrub-Shrub Wetland
- Upland

Collins (2000)

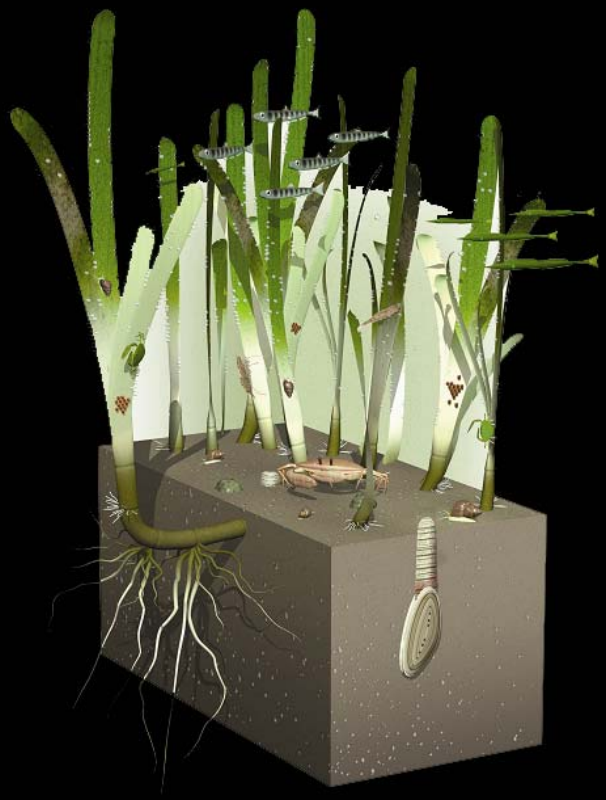
Today



- Non-tidal Floodplain
- Estuarine Emergent Zone
- Estuarine Forest Transition Zone
- Forested Riverine Tidal Zone
- Upland

Eelgrass meadows

Food, productivity, habitat structure, shelter/nursery, sediment stabilization

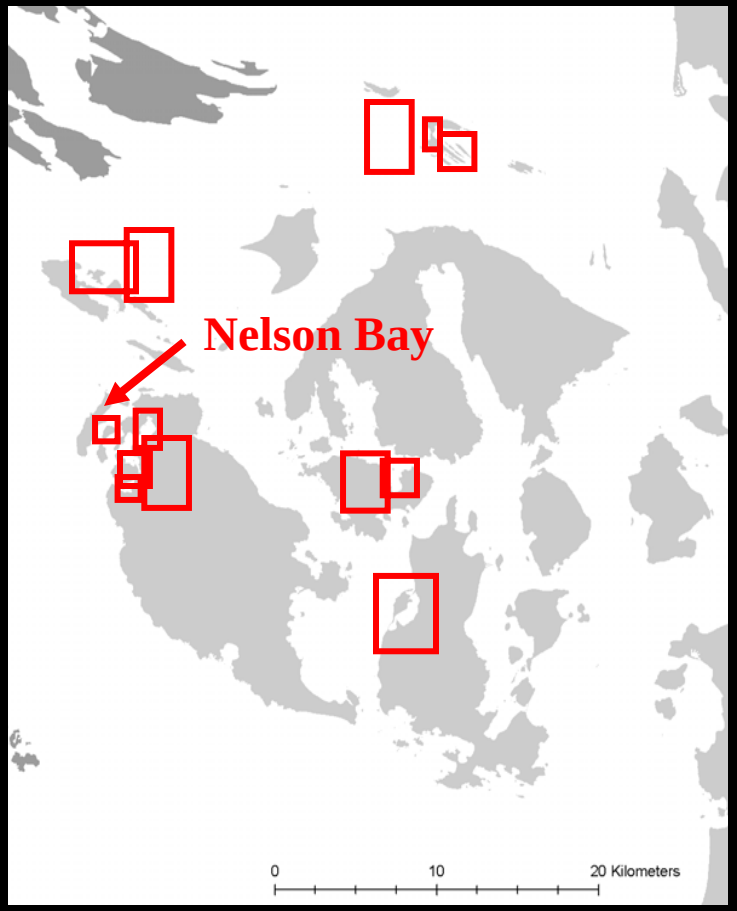


Increase temperature, salinity
Decrease dissolved oxygen
Lower flow velocities, mixing
Siltation, turbidity
Increase/decrease nutrient

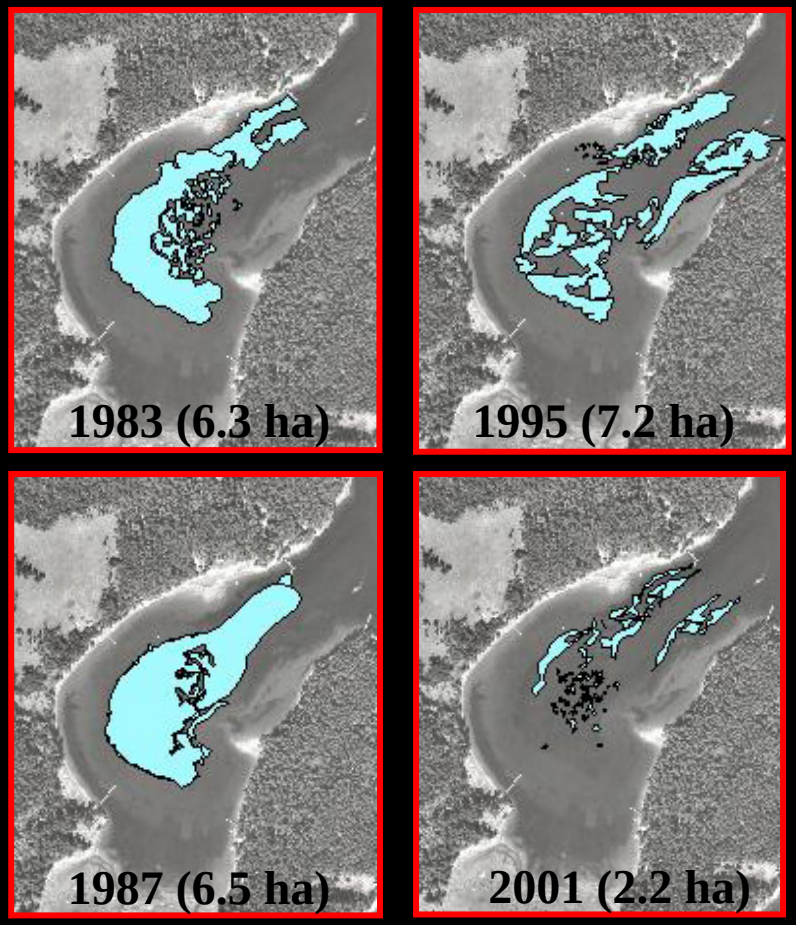
Change in water quality and habitat;
- tolerate range in Temp/Salinity
- can eelgrass adapt? DNA studies
Increase algal growth?
Substrate/benthic community change
Eutrophication?

Eelgrass Meadow “Die-Offs”

San Juan Islands



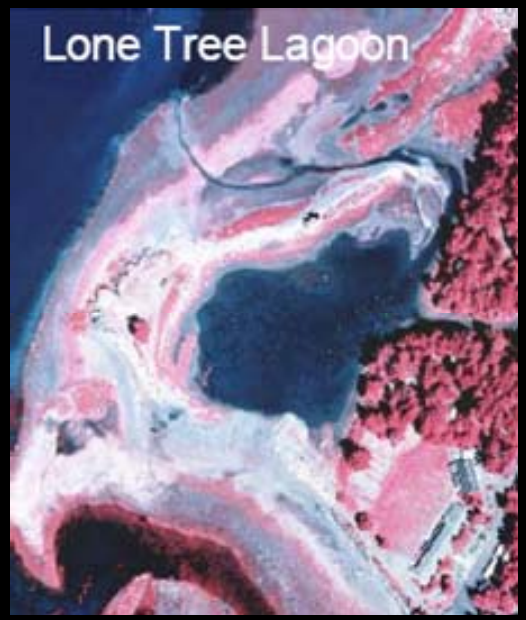
Nelson Bay, SJI



Wyllie-Echeverria et al. (2003)

Pocket Estuaries

Nursery/forage habitat, Important along migration corridors

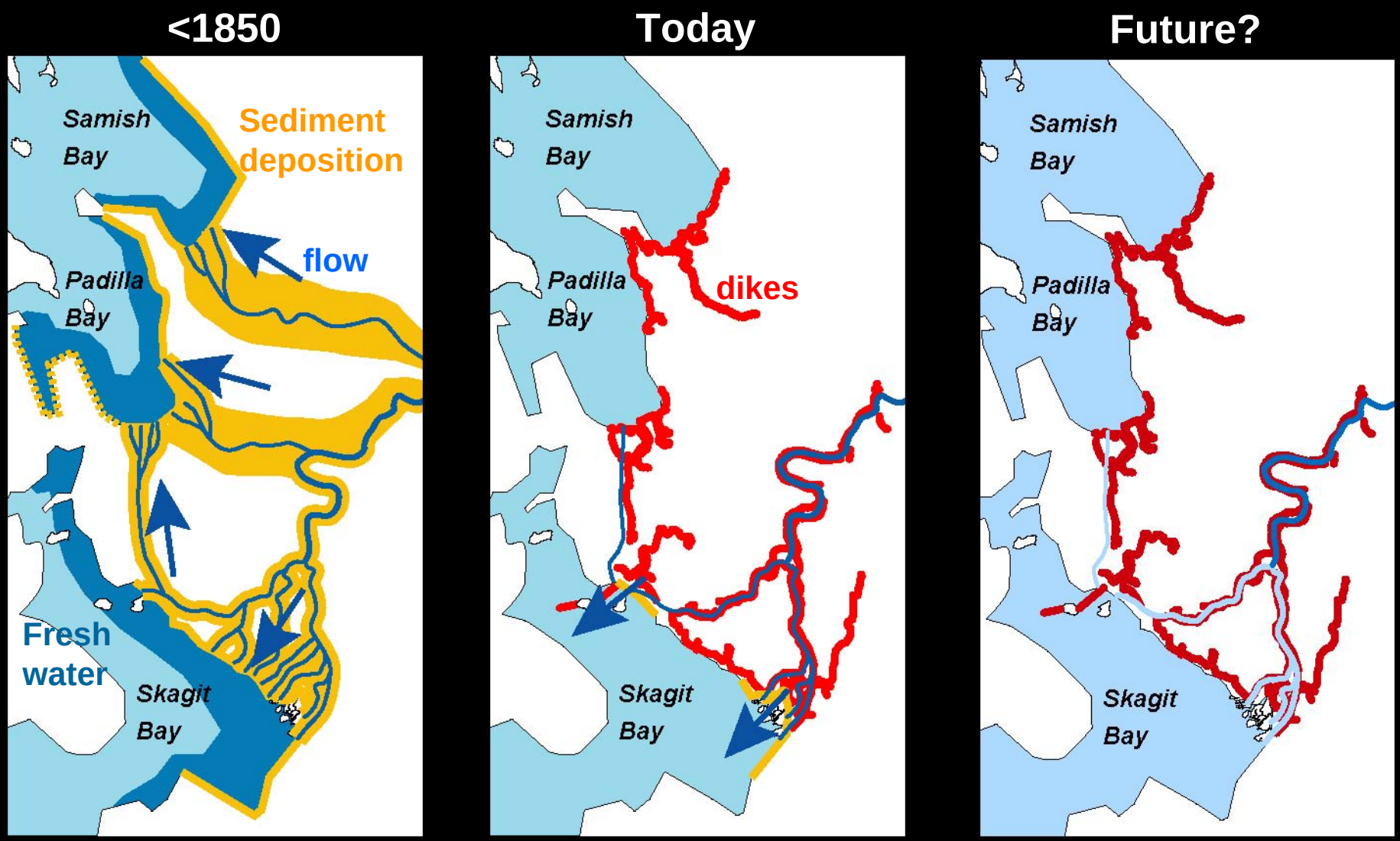


Increase temperature, salinity
Decrease dissolved oxygen
Siltation, turbidity
Increase/decrease nutrient

Change in access to habitat
Change in substrate
Change in benthic community
Eutrophication?

89% decrease in pocket estuary habitat in Skagit Bay alone
(Beamer et al. 2003)

Migration Corridors



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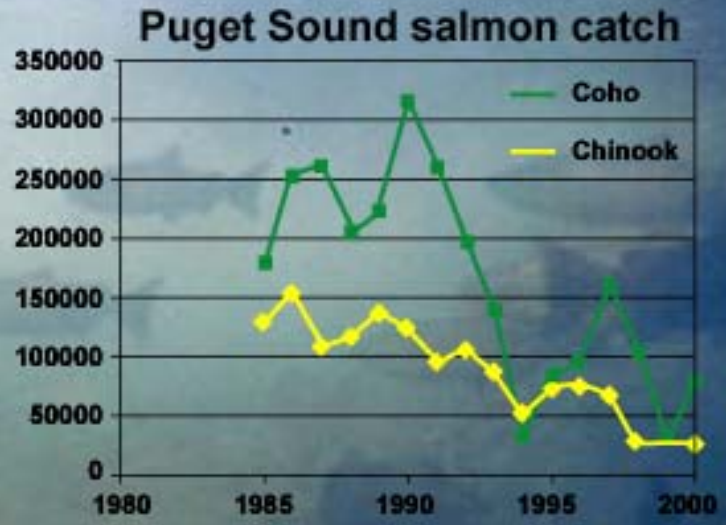
Conclusions



1) Climate change impacts will add complexity to ecosystems already affected by human activities

2) Dynamic ecological interactions require improved understanding of spatial/temporal variability

3) NEED:
- baseline and environmental variability data
- monitoring to evaluate change and test models
- public interest and engagement in process