Large Wood in Estuaries: Structure, Hydrologic and Ecological Functions, and Influence on Fish Survival: Implications for Restoration

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CREC 2016: Recent Anomalous Environmental Conditions – Drivers and Consequences

Why the impetus for restoration in the estuary?

Reduced estuary mortality could reduce declines (e.g., Kareiva et al. 2000).

- Focus on upriver wild stocks
- Benefit all stocks – wild and hatchery

REPORTS

Recovery and Management Options for Spring/Summer Chinook Salmon in the Columbia River Basin

Peter Kareiva,* Michelle Marvier,† Michelle McClure‡

About 62% of floodplain lost to diking and flow regulation.

ERTG was tasked with evaluating salmon benefits of restoration in the 235km LCRE

Tidal Brackish and Freshwater Emergent Marshes Covered Large Areas

As did Tidal Forested Swamps – Scrub-Shrub and Spruce

Wetland Restoration in Salmon River Estuary

Site Scale
- Use
- Growth
- Residency

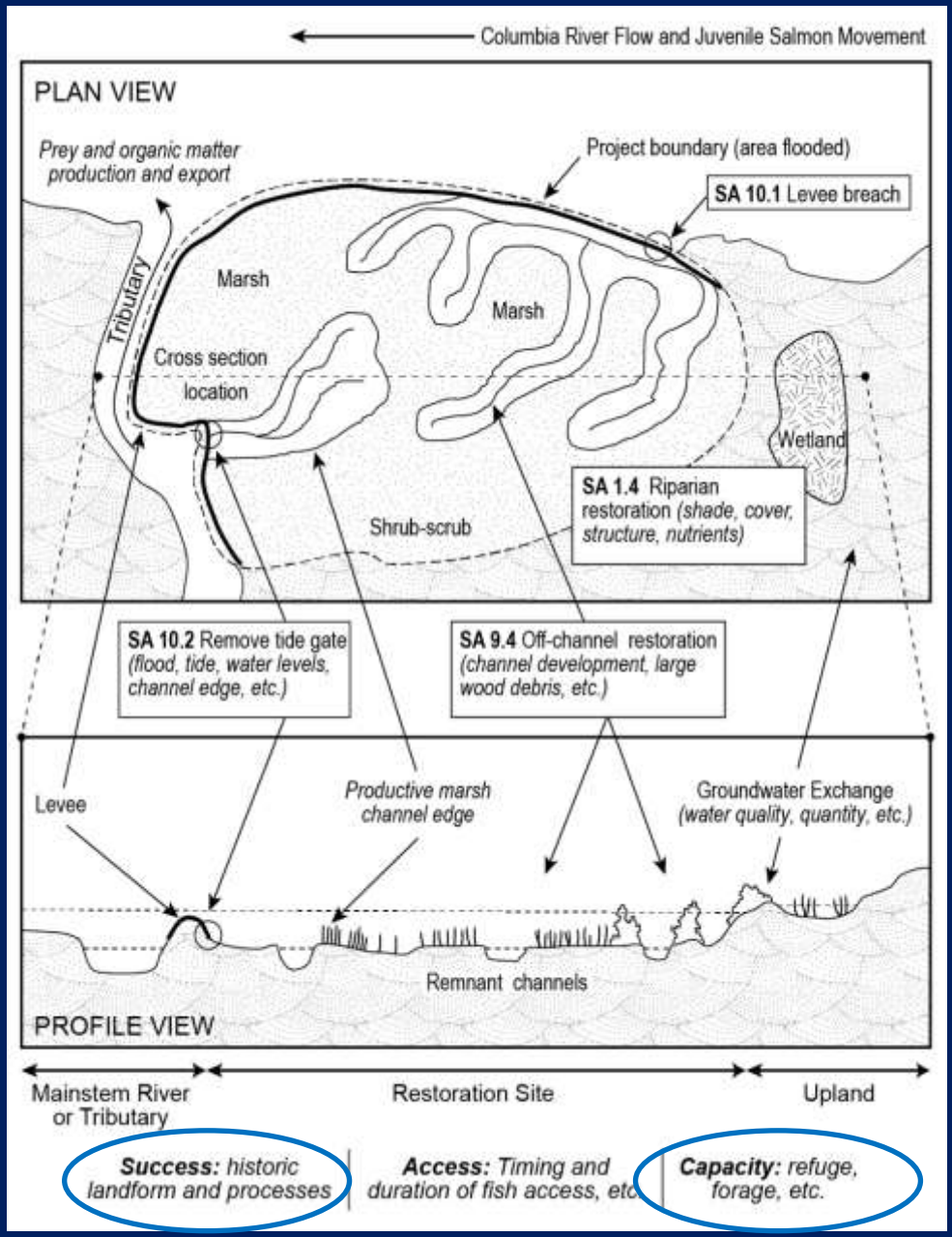
Population and Watershed Scale
- Survival
- Life history diversity
- Contribution to adult population

Conceptual Model Tidal Marshes

Primary consideration is restoration of natural processes & structure that create and maintain habitat conditions.

- Dike/levee breach
- Levee removal/lower
- Tidal channel

What is the presence or role, if any, of large wood in these habitats?



Three Criteria[1] for Scoring Projects

- **Opportunity/Access**
  - *Connectivity for most species and life history types; Priority sites on the mainstem; Unencumbered access*
- **Capacity/Quality**
  - *Complexity; Disturbance regime; Channel/edge network; Prey production and export; Invasive species and nuisance predators; Water quality/temperature; Size*
- **Certainty of Success**
  - *Natural processes/landforms; Proven method; Self maintaining; Risk of detrimental effects; Project complexity; Certainty of fish benefit; Risk of exotic/invasive species*

[1]Based on - Simenstad and Cordell (2000); Thom et al. (2011)

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How to evaluate incremental influence of wood

Sources of Information

- Published literature
- Ecosystem analogs
- Historic surveys or photos
- Undisturbed or reference systems

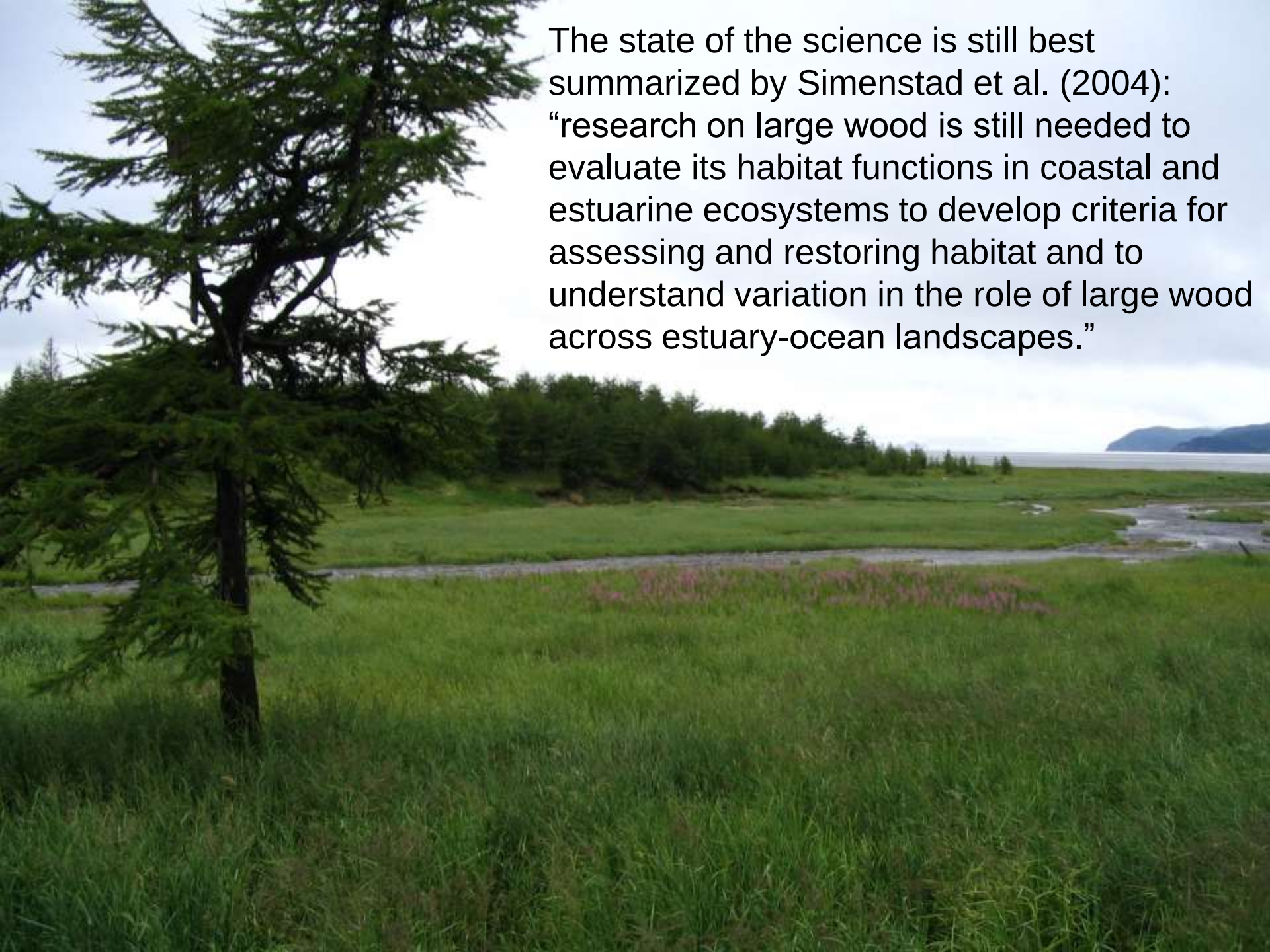
Published literature

Gonor et al. 1988. What We Know About Large Trees in Estuaries, in the Sea, and on Coastal Beaches.

Wick, A.J. 2002. Ecological function and spatial dynamics of large woody debris in oligohaline brackish estuarine sloughs for juvenile Pacific salmon. Master's thesis. University of Washington, Seattle.

Simenstad et al. 2004. Dynamics and Ecological Functions of Wood in Estuarine and Coastal Marine Ecosystems.

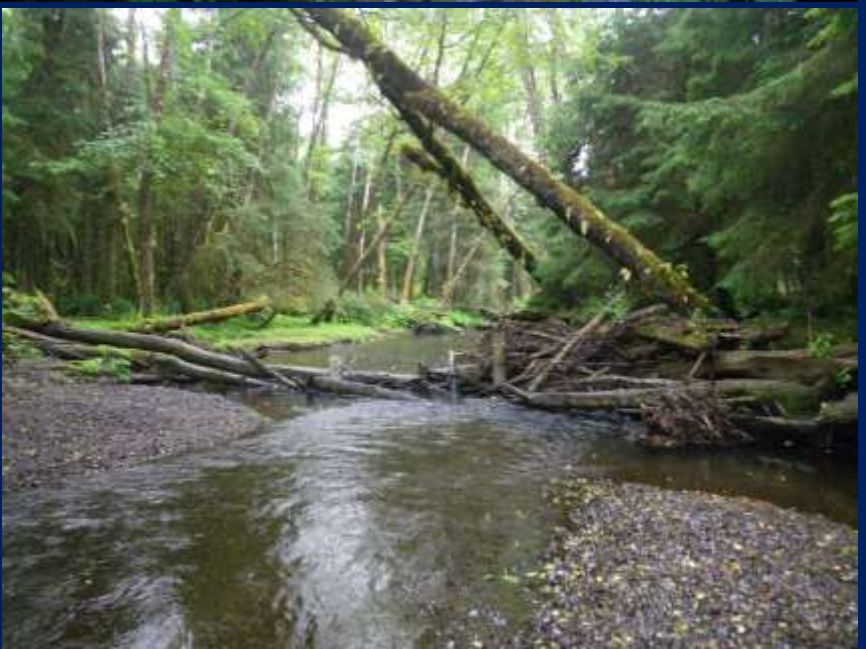
Diefenderfer, H. and D. Montgomery 2009. Pool spacing, channel morphology, and the restoration of tidal forested wetlands of the Columbia River, U.S.A.



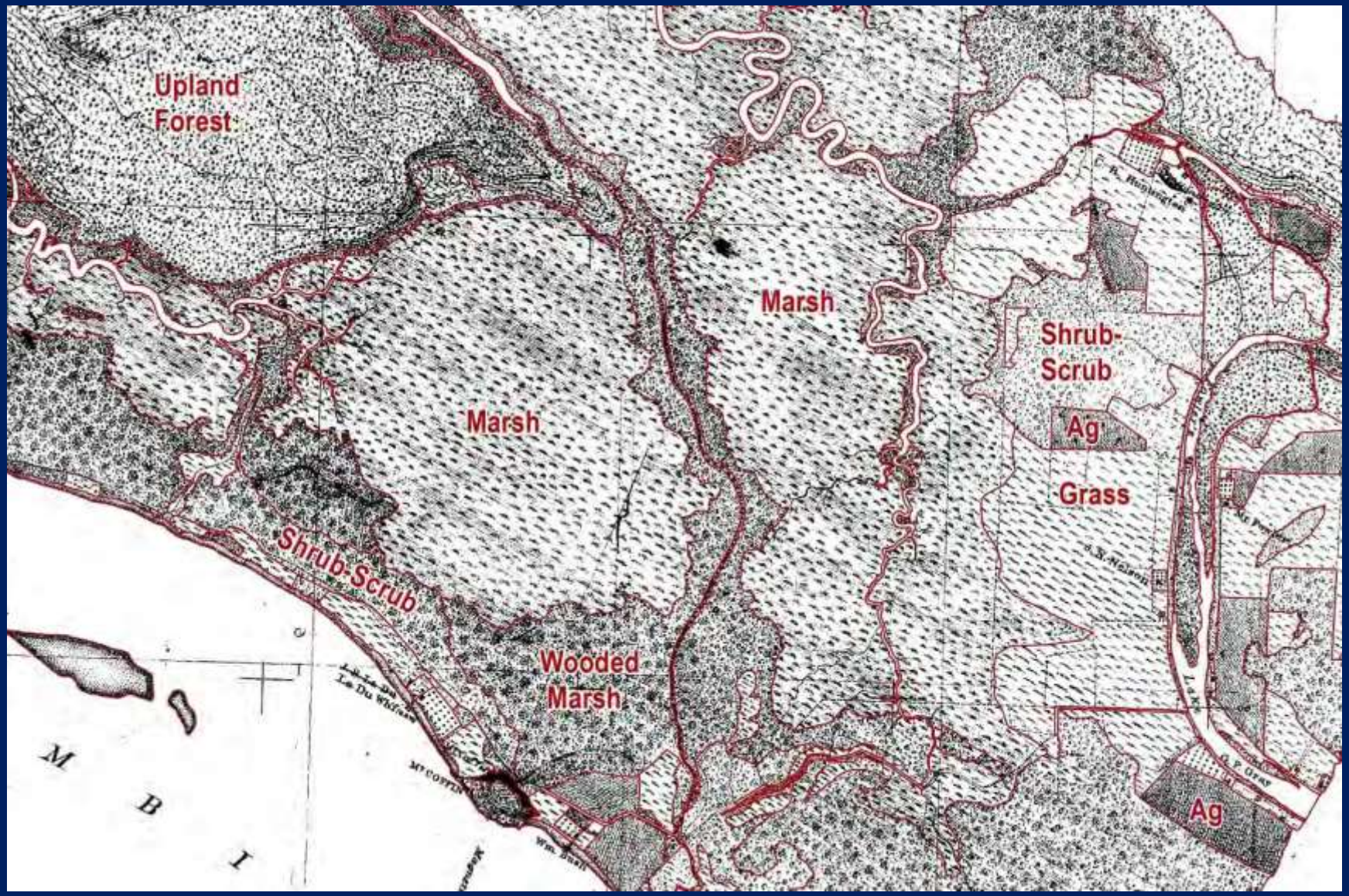
The state of the science is still best summarized by Simenstad et al. (2004): “research on large wood is still needed to evaluate its habitat functions in coastal and estuarine ecosystems to develop criteria for assessing and restoring habitat and to understand variation in the role of large wood across estuary-ocean landscapes.”

Stream systems as estuary analogs?

Hydrologic processes - fluvial
Geomorphic template
Source and movement of wood
Fish-habitat relationships



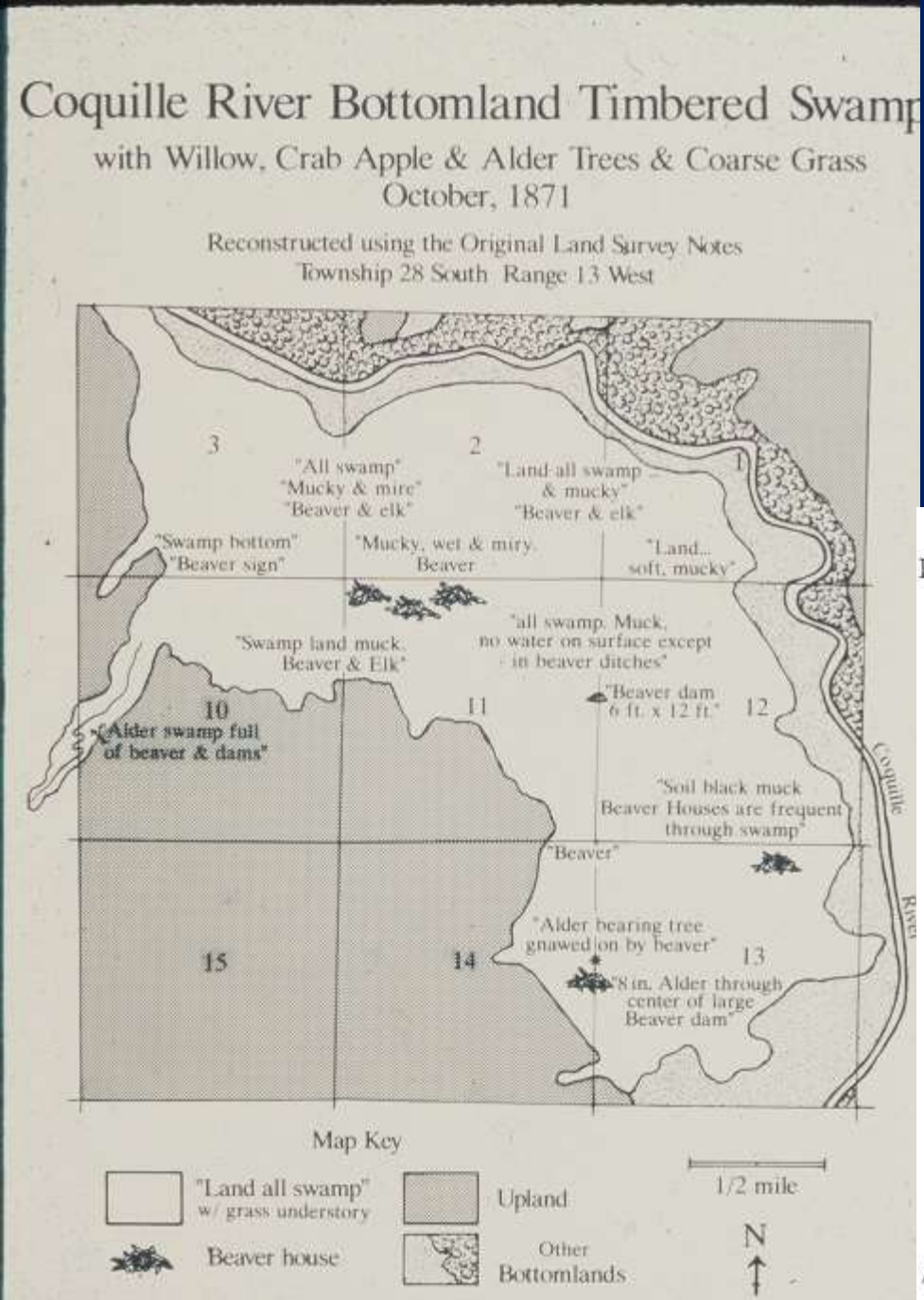
Columbia River Estuary 1870



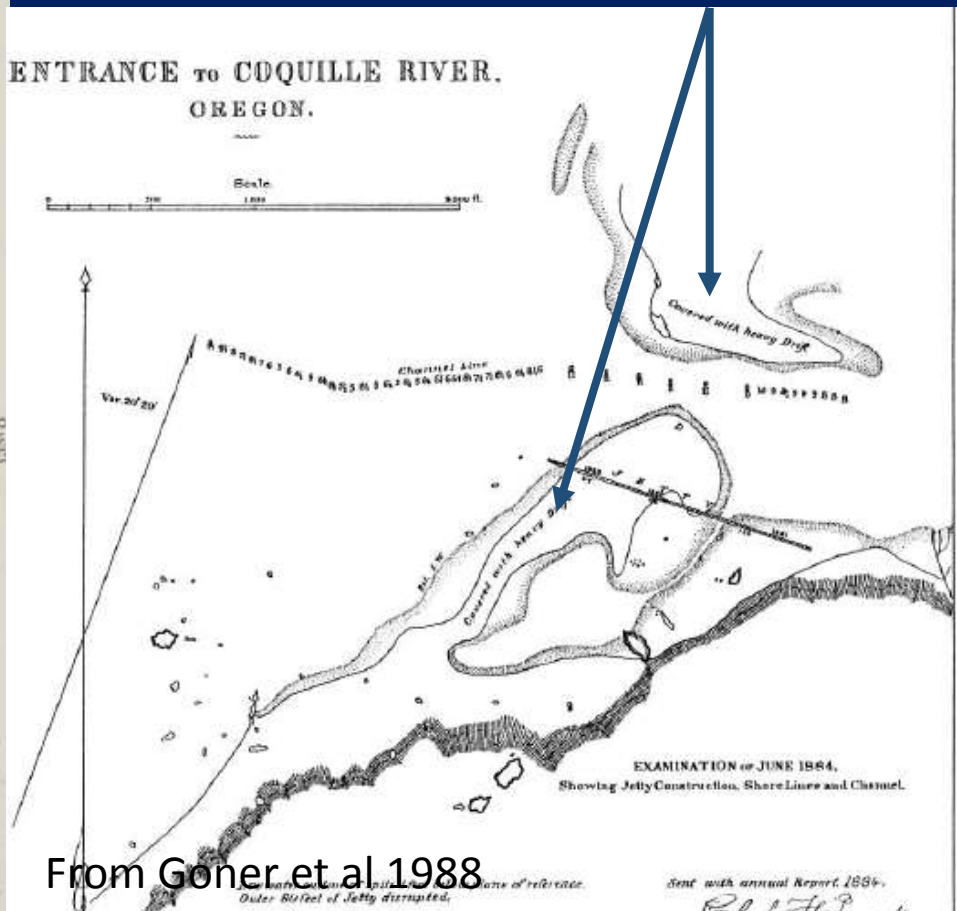
From Marcoe and Pilson 2012. Historical Habitat Change in the Lower Columbia River, 1870 - 2010

Coquille River
1870-84

“Covered with Heavy Drift”



Courtesy of Patricia Benner

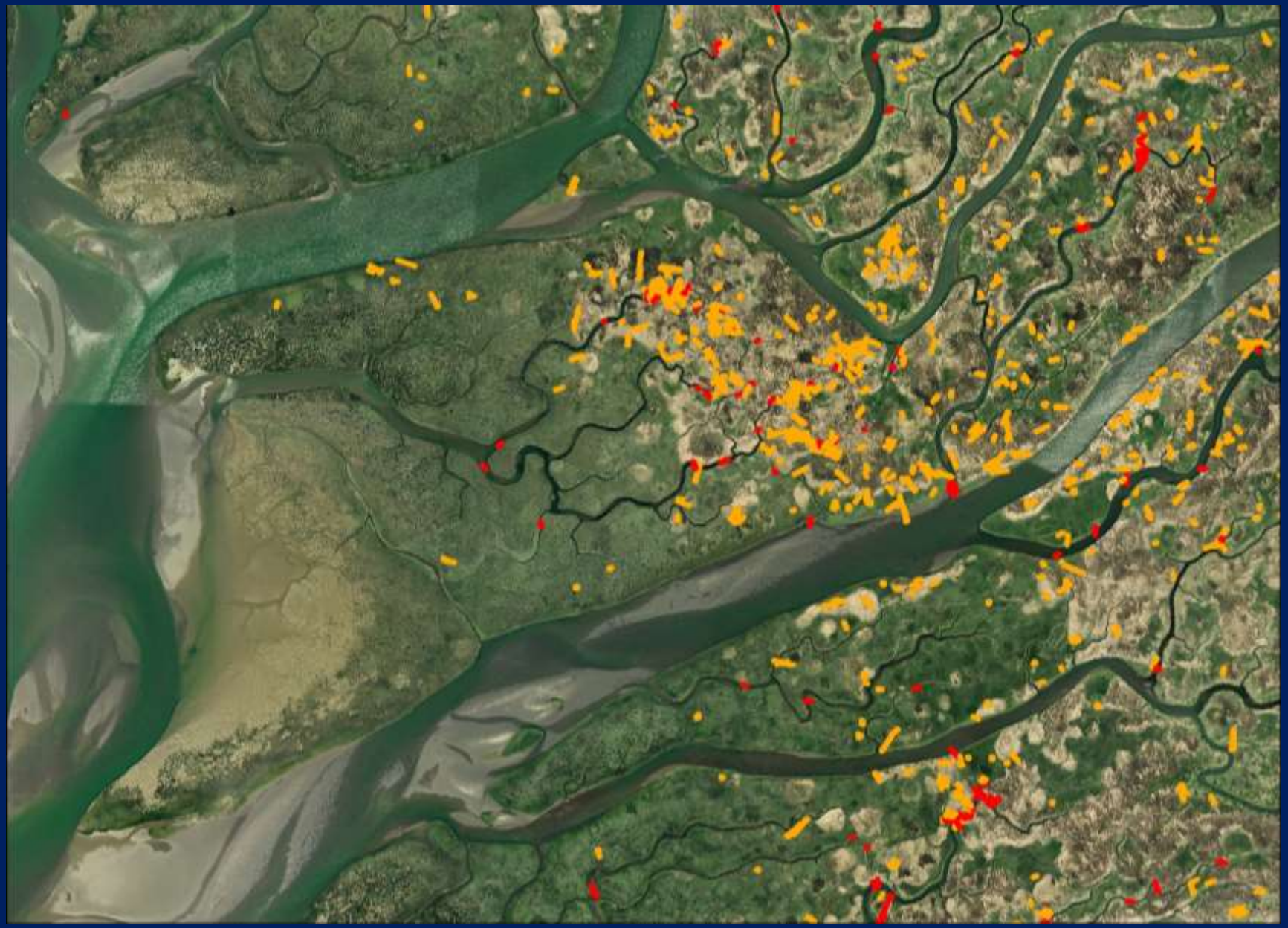


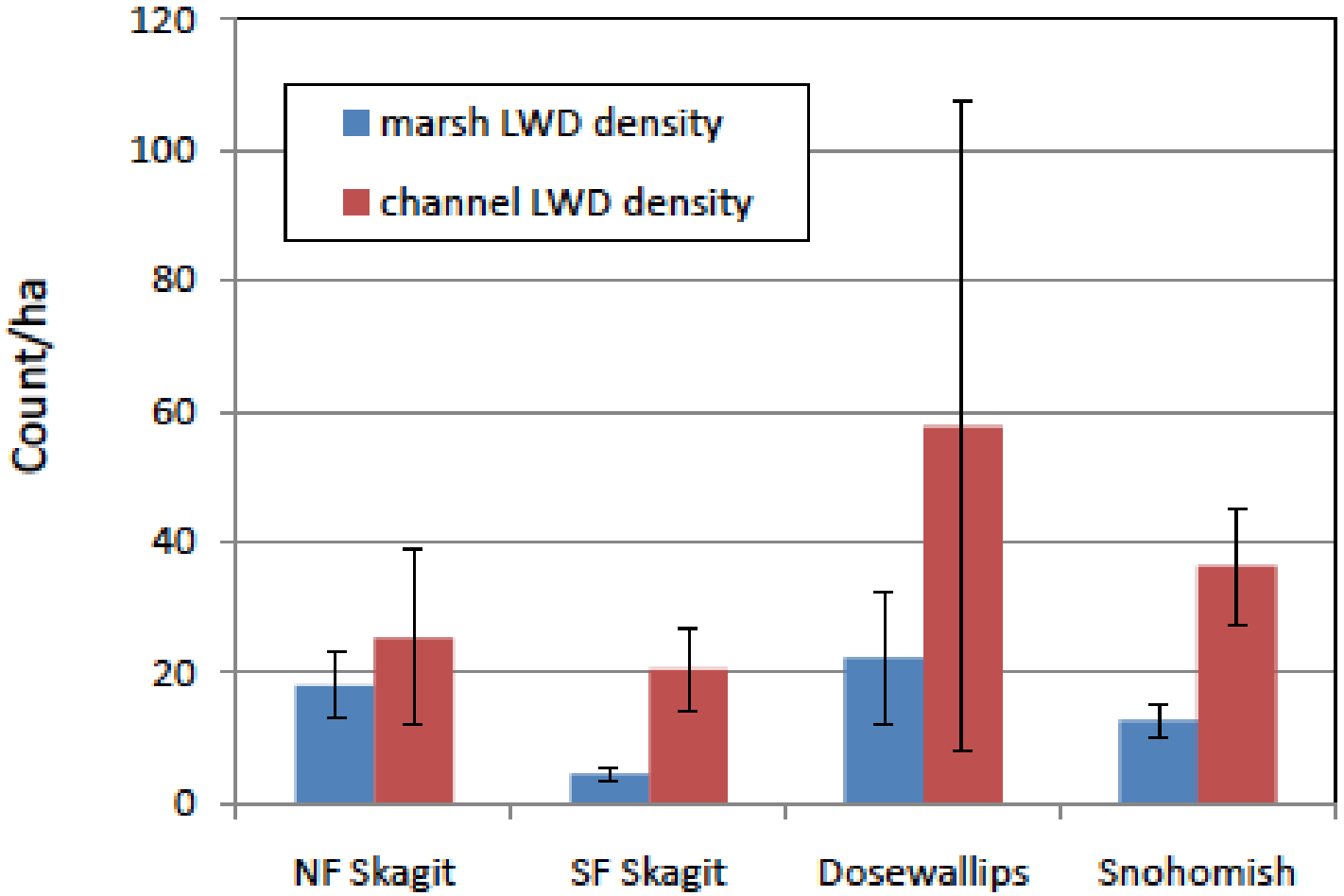
From Goner et al 1988

Salmon River Estuary 1952

Reference Sites

Dr. Greg Hood, Skagit Delta





Average 1 piece ~50-100m^2 on marsh surface; 1 piece ~50 – 100m of channel

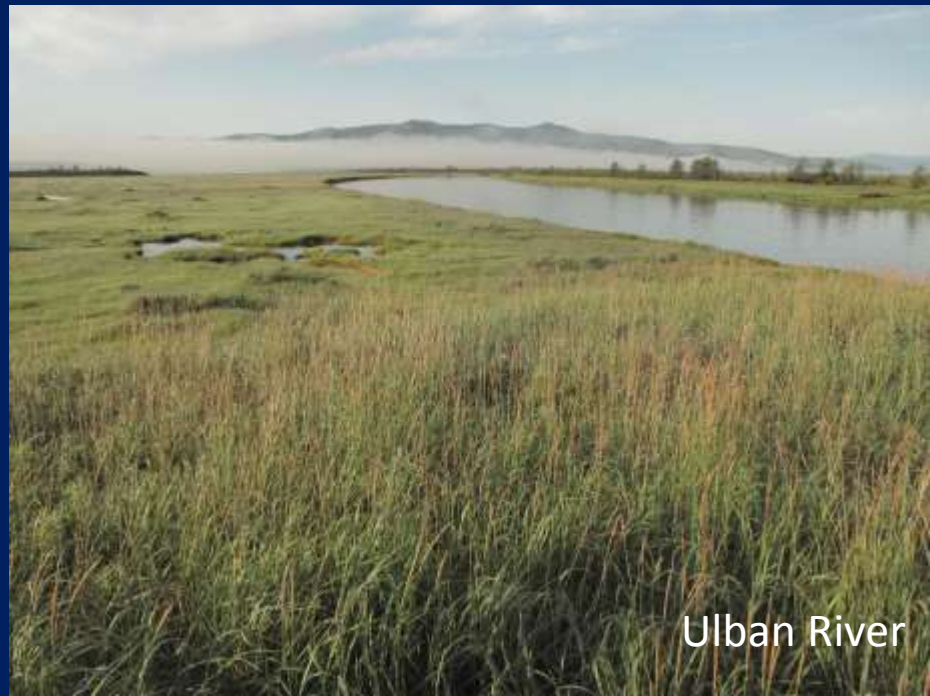
Compiled by G. Hood

Estuaries in Russian Far East in the Sea of Okhotsk and Sea of Japan

Dr. Sergei Zolotukhin
Pacific Research Fisheries Center
Khabarovsk, Russia

Eikan River

Aldoma River



Ulban River


Unnamed, Ulbansky Bay


Unnamed, Big Shantar Island, Yakshina Bay


Iska River, Sakhalinsky Bay


Khadia River

Natural Distribution and Amount of Large Wood

- Spruce Swamps
  - Large single pieces or accumulations
  - Increases step pools
- Shrub-Scrub wetlands
  - Abundance of small standing and downed trees and shrubs inundated at high tide
  - Beavers can be a primary structural engineer
- Emergent wetlands
  - Few pieces of wood in channels; not a structural feature
  - Scattered pieces on marsh surface, can be mobile and create small “pans”, nurse logs
  - Large amounts rafted at upper tide line, depending on wind fetch and source amounts

Uncertainties of wood in estuaries

- Wood amount and distributionvaries by habitat type; longitudinal position in the river/estuary; location in the channel vs. on the marsh surface; location relative to local topography; effect of tide range, fetch, recruitment, retention, and export rate
- Stream systems are not analogs for inferring processes, distribution, or configurations
- Influence of cabled or fixed pieces on development of channel morphology is not known or tested
- Effects on improvement in fish growth or survival is unknown (estuaries are already productive)
- The uncertainty level, in terms of site response, recovery, function, and benefits to salmon, is positively correlated with the amount of departure from historical structure and function.

We question whether these types of structures either mimic natural forms in streams or estuaries, or provide additional benefit to channel forming processes or ecology of system.

Experimental Design – Wood in Emergent Marshes

Primary questions to be addressed regarding channels and marshes containing LWD as compared to those lacking LWD

1. Do juvenile salmon congregate in tidal channels in greater or lesser densities?
2. Do juvenile salmon consume more or less prey?
3. Do juvenile salmon reside for shorter or longer periods of time?
4. Do fish in channel reaches with LWD have lower or greater vulnerability to predation (due to greater availability of cover)?
5. Do fish survive at a lower or higher rate as juveniles to ocean entry or to adult?

Recommendations

- Do no harm
- Explain why
- Mimic natural processes
- Treat wood as an experiment
- Address the key uncertainties

We discourage inclusion of LWD in habitat restoration projects in tidal environments unless the need is explicitly justified. If large wood is included in a restoration project, we recommend rigorous monitoring of hydrologic, geomorphic, and fish community responses.

https://www.cbfish.org/EstuaryAction.mvc/Documents

Thanks especially to all the restoration practitioners

https://www.cbfish.org/estuaryaction.mvc/index