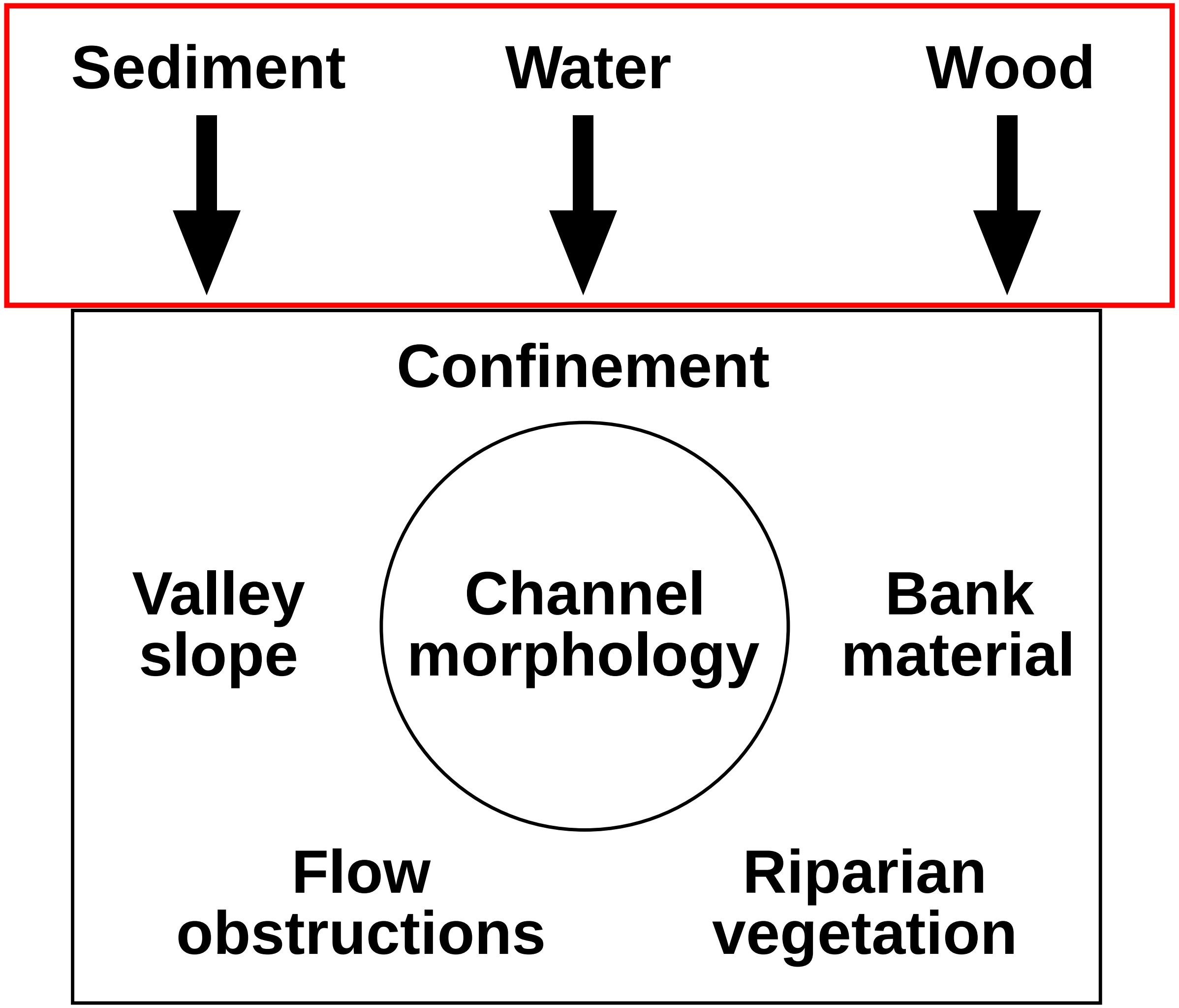
Human Impacts to Rivers

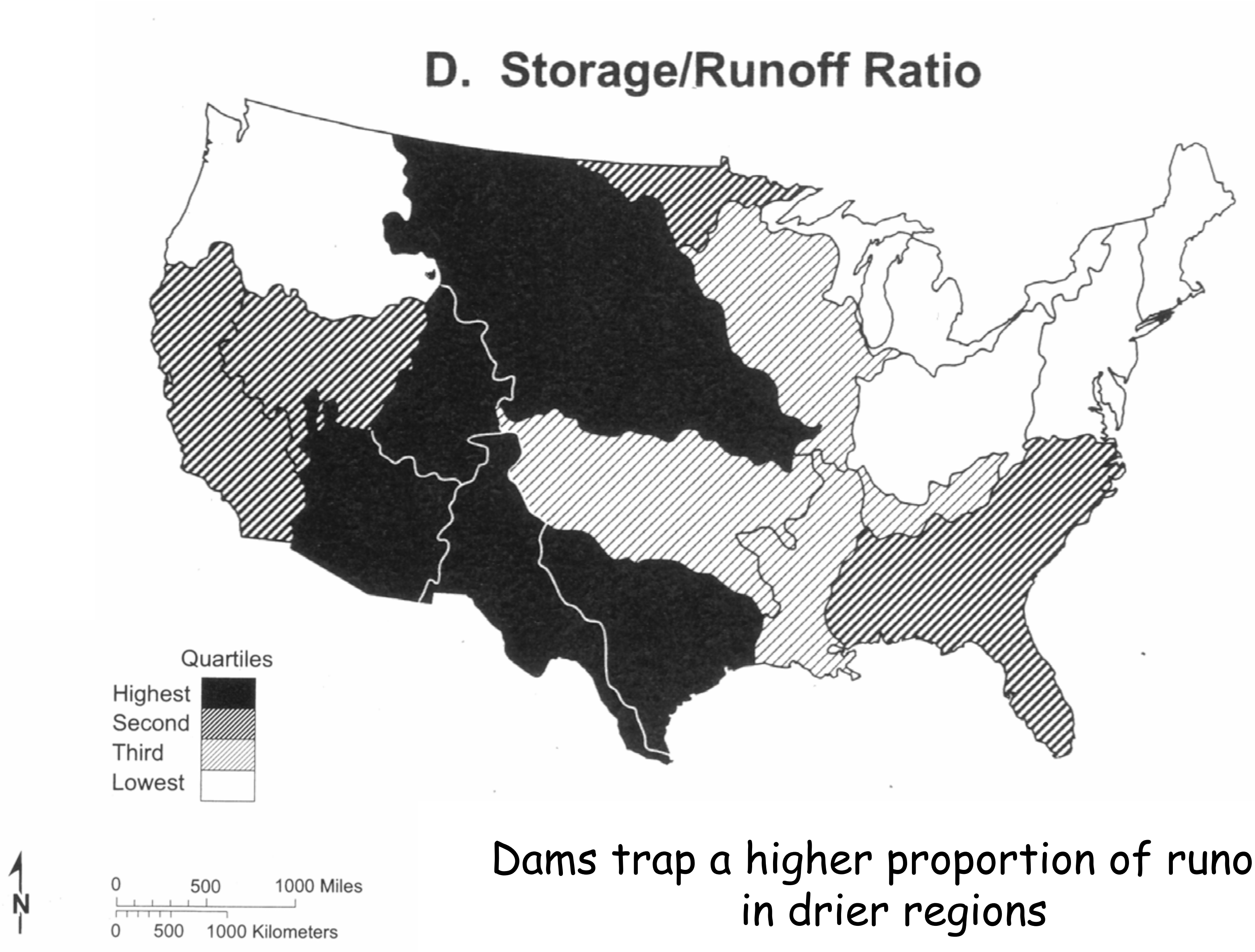


Human Impacts on Rivers

- dams
- channelization
- loss of woody debris/riparian forests

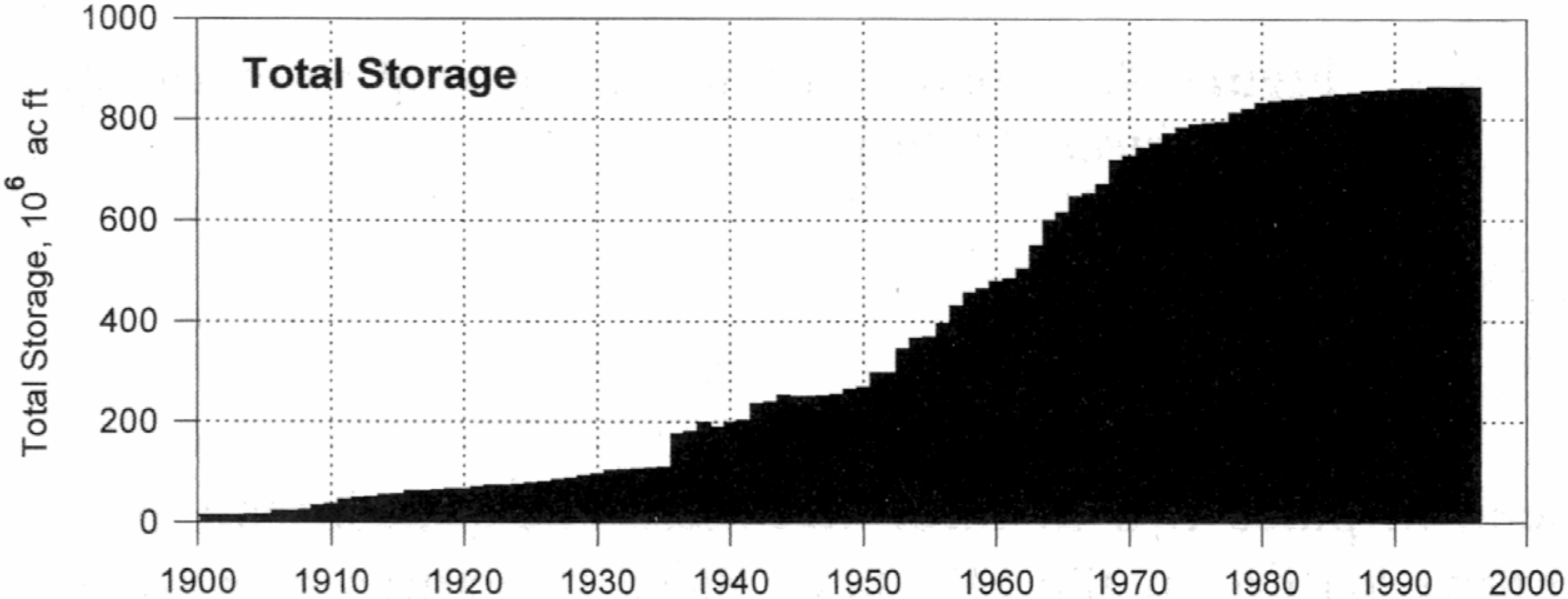
More than 80,000 dams affect > 90% of the nation's 5.8 million km of rivers.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

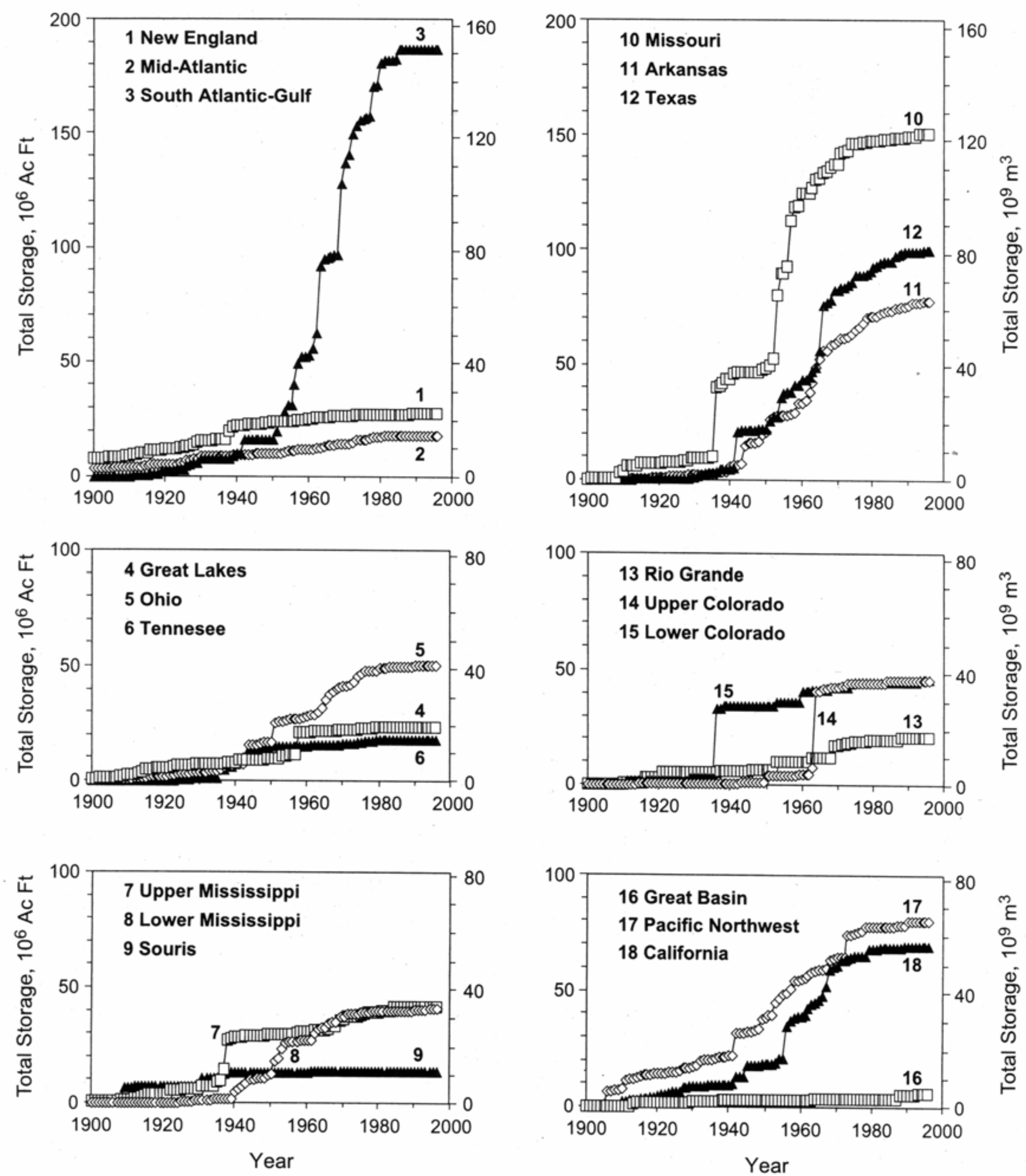


Dams trap a higher proportion of runoff in drier regions

U.S. Dam construction leveled of in 1980s at almost a billion acre-feet



Timing of Dam construction varied regionally, but was fastest between 1940 and 1980.



Hoover Dam

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Timber crib dam in Michigan

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Reservoirs often trap 40% to >80% of the sediment carried by large rivers, reducing the sediment delivered to coastal environments despite increased soil erosion in upland environments.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Impact of Humans on the Flux of Terrestrial Sediment to the Global Coastal Ocean, James P. M. Syvitski, Charles J. Vörösmarty, Albert J. Kettner, Pamela Green, *Science*, v. 308, p. 376-380.

Human's increased annual sediment delivery to rivers by 2.3 billion tons, from about 6.5 billion tons to almost 9 billion tons

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

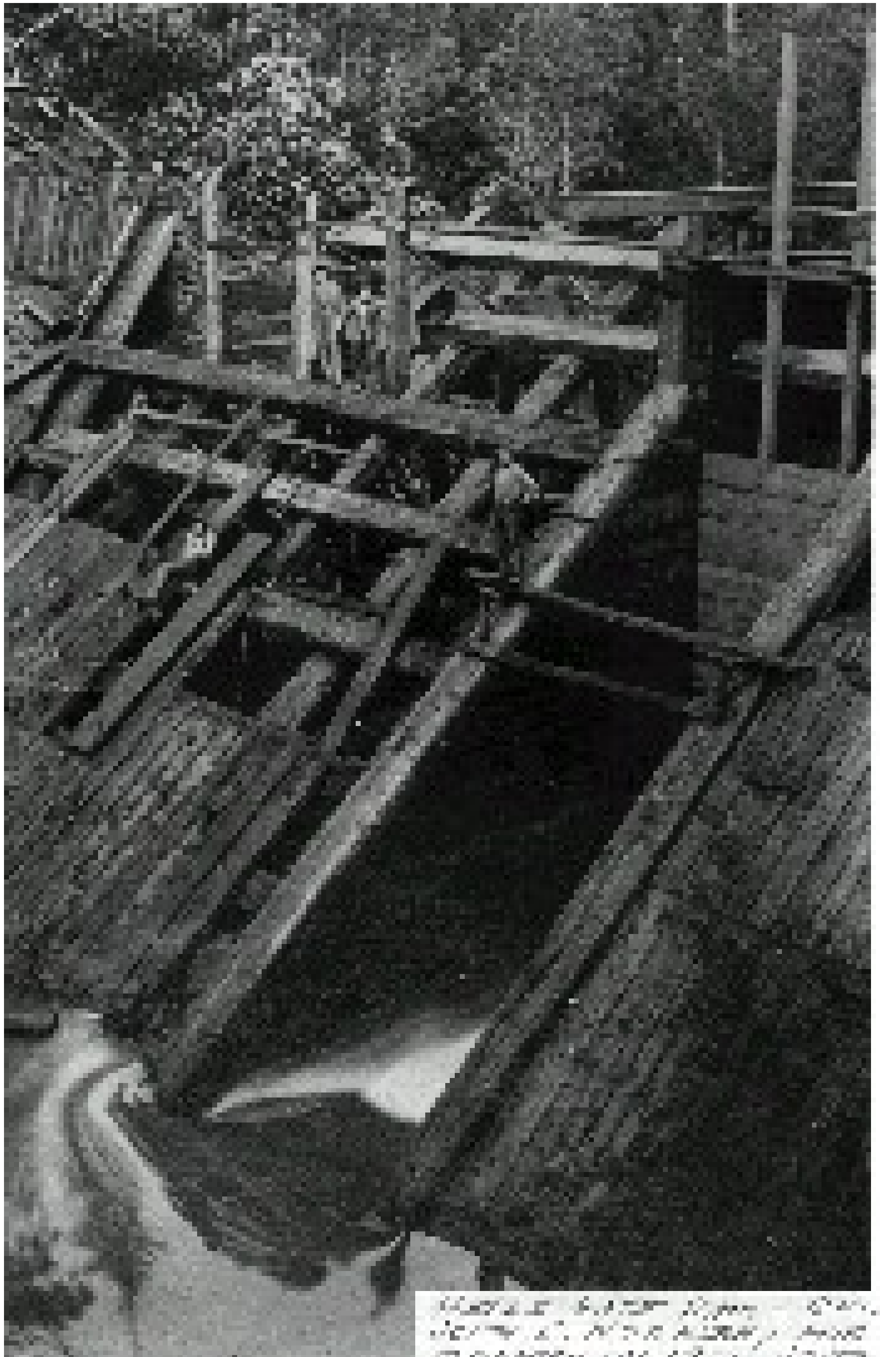
Human's decreased annual sediment delivery to oceans by 1.4 billion tons, from about 6.5 billion tons to about 5 billion tons

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Less sediment reaches the coast in Asia and parts of the Americas due to dam construction

Humans have simultaneously increased the sediment transport by global rivers through soil erosion (by 2.3 ± 0.6 billion metric tons per year), yet reduced the flux of sediment reaching the world's coasts (by 1.4 ± 0.3 billion metric tons per year) because of retention within reservoirs.

Splash dams



[illegible]

PROBABLY MALLORY LOGS – WATER DRIVING ON BIG RIVER.

Human Impacts on Rivers

- dams
- channelization
- loss of woody debris/riparian forests

Los Angeles River at Vernon

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Los Angeles River at Canoga Ave.

California

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Missouri

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Connecticut

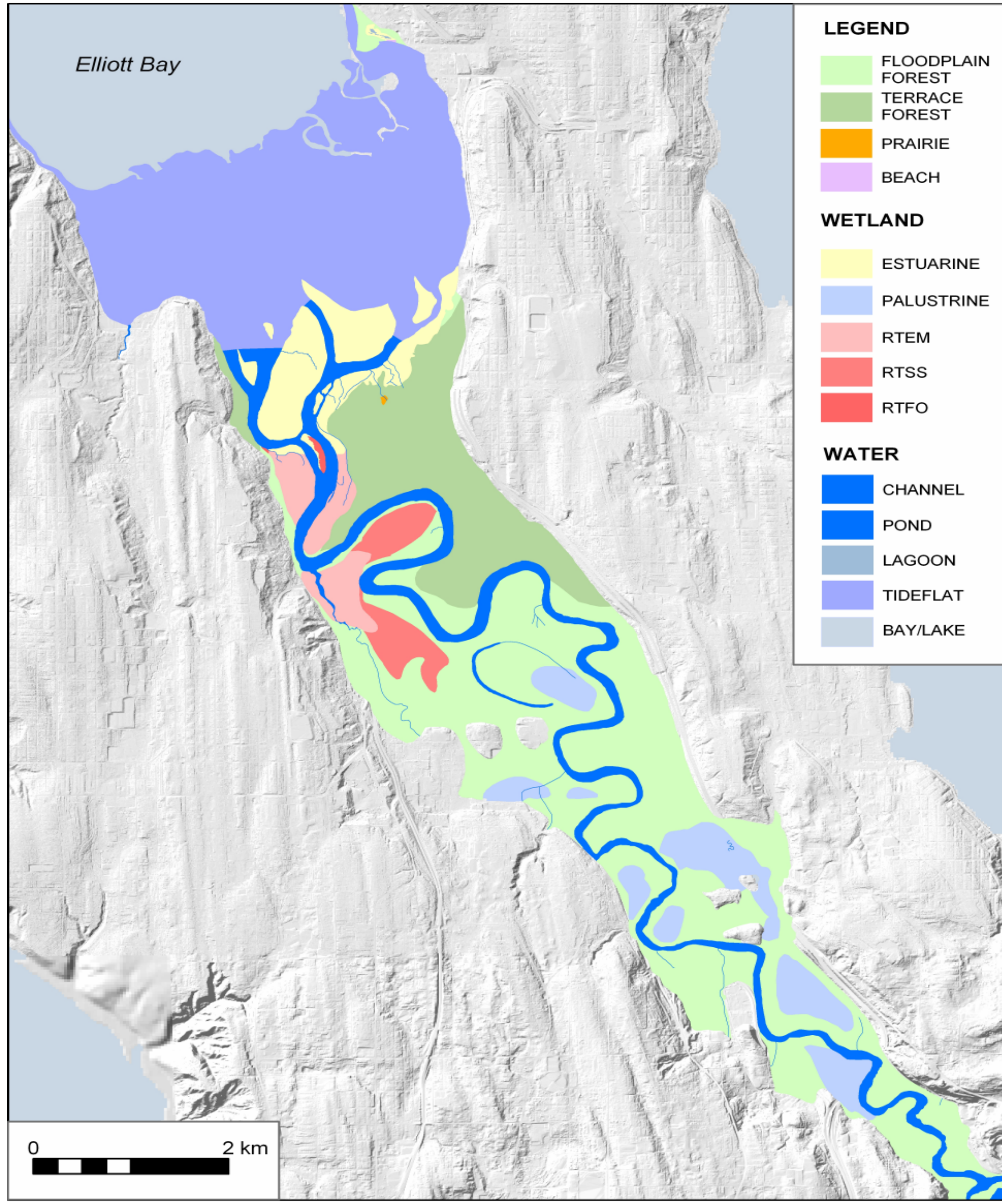
QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Illinois

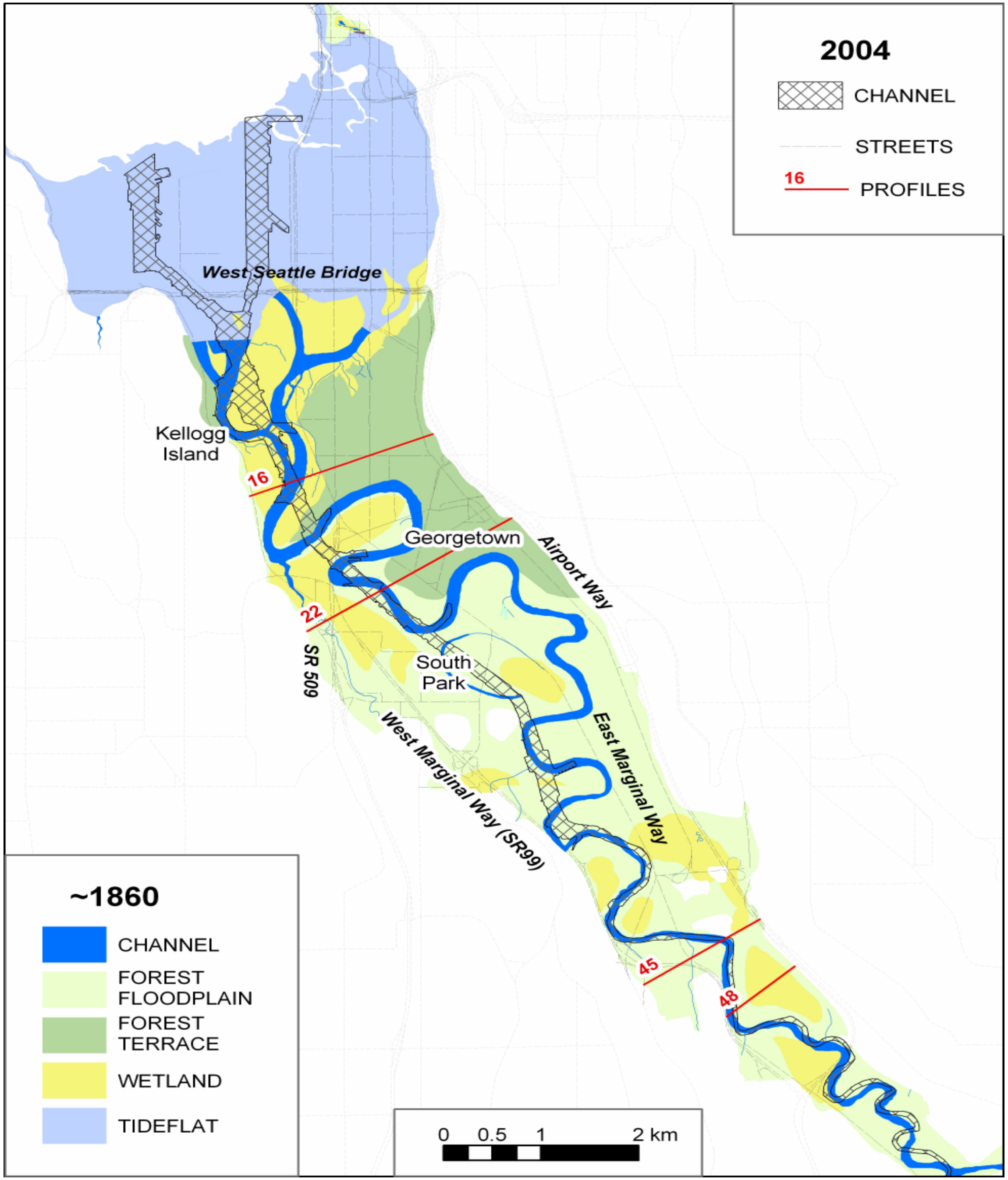
QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Port of Seattle circa 1870

Lower Duwamish River and estuary



Lower Duwamish River today



Human Impacts on Rivers

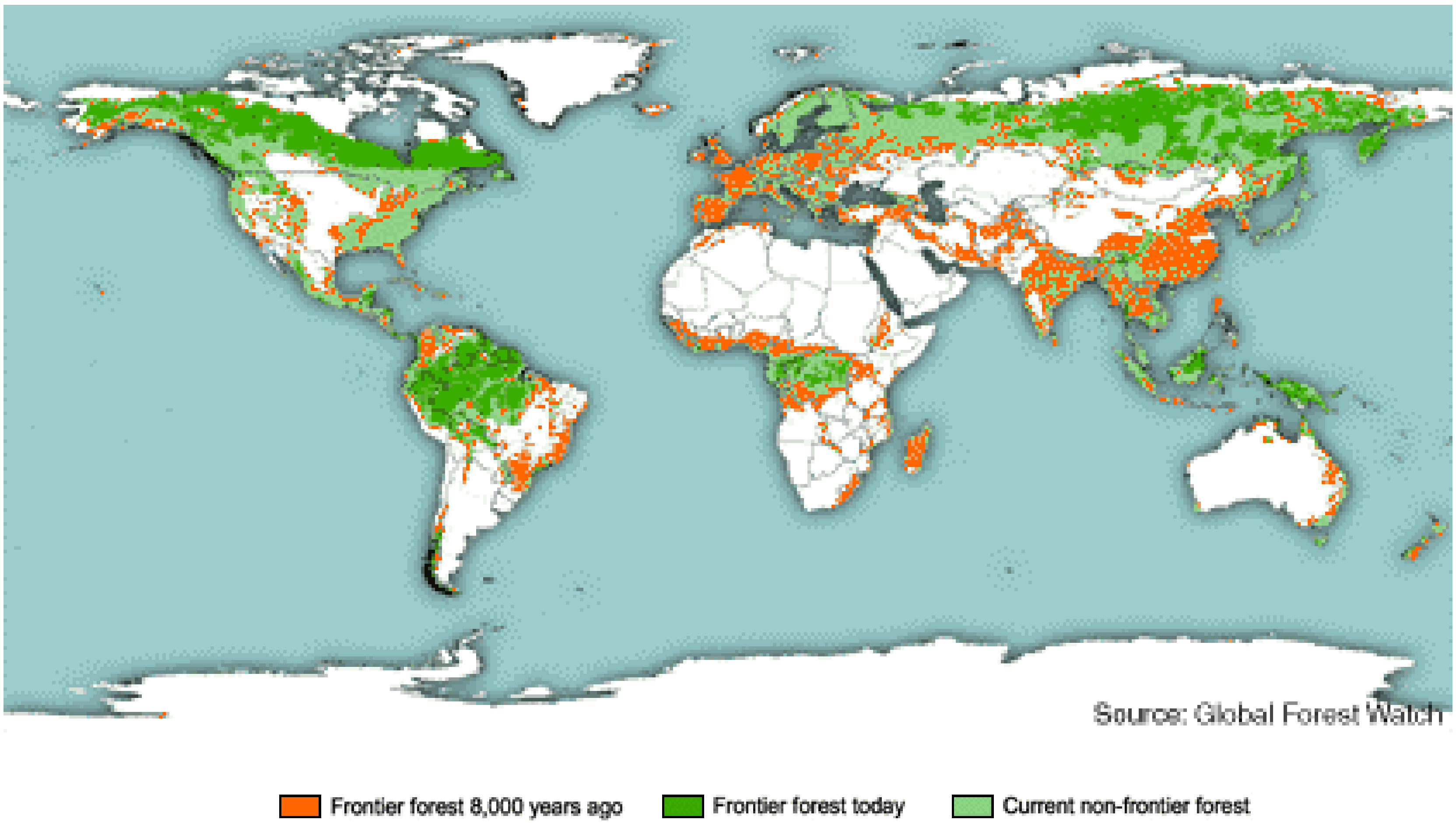
- dams
- sediment input
- channelization
- loss of woody debris/riparian forests

Extent of global forests

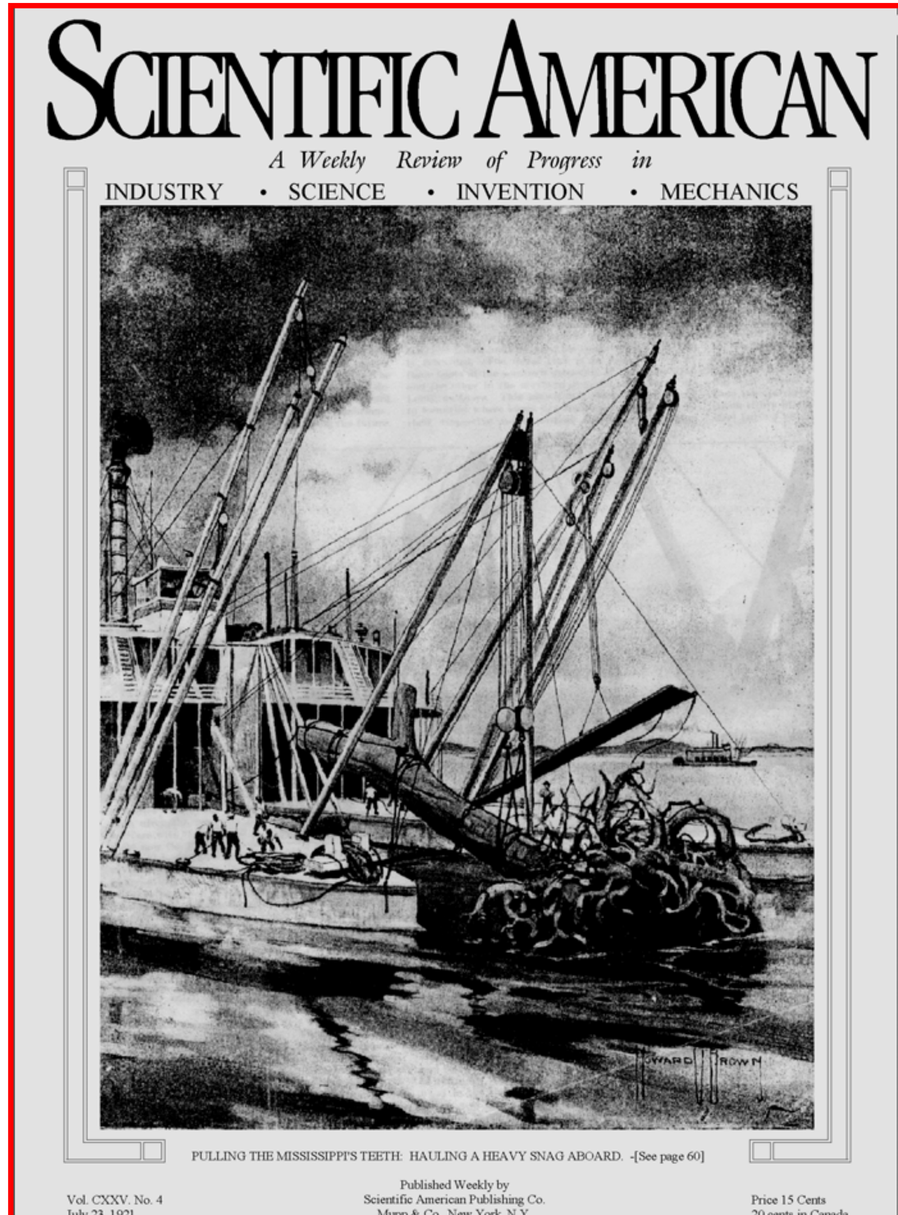
Forests have covered about one-third of the Earth's land surface during the Holocene.

But the extent of forest cover has changed substantially ...

Few of the worlds forests retain "frontier" conditions

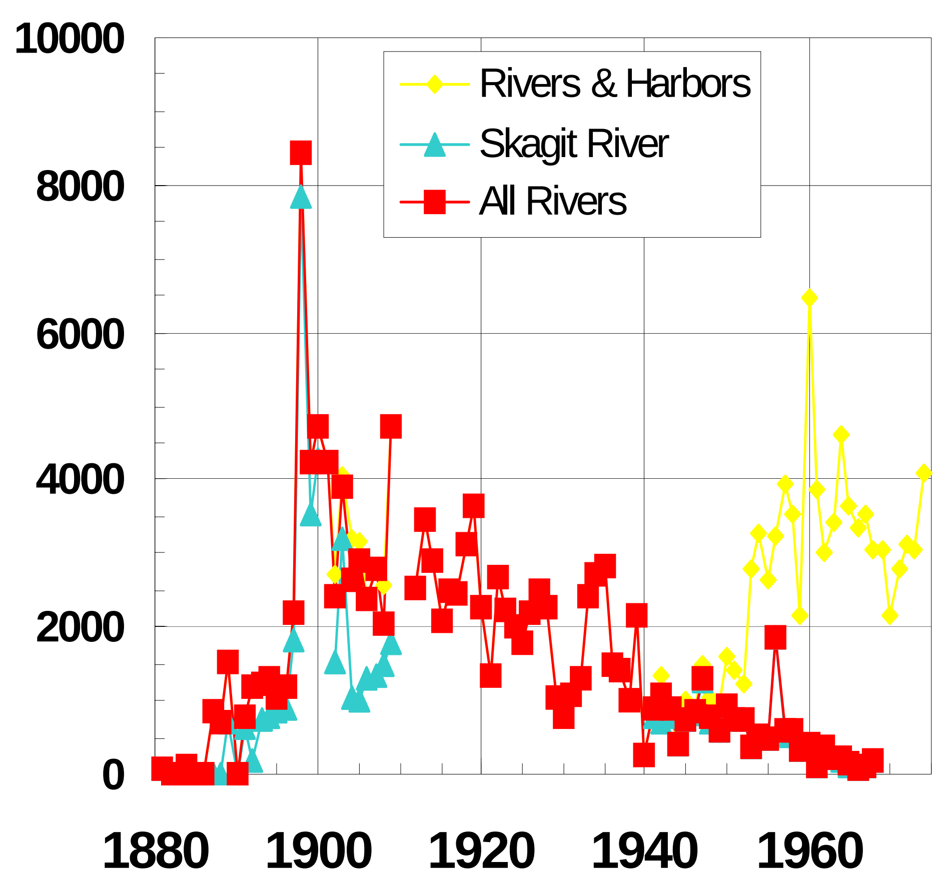


Log jams were significant obstacles to navigation and land development in the western U.S.



Army Corps of Engineers aggressively "de-snagged" American Rivers

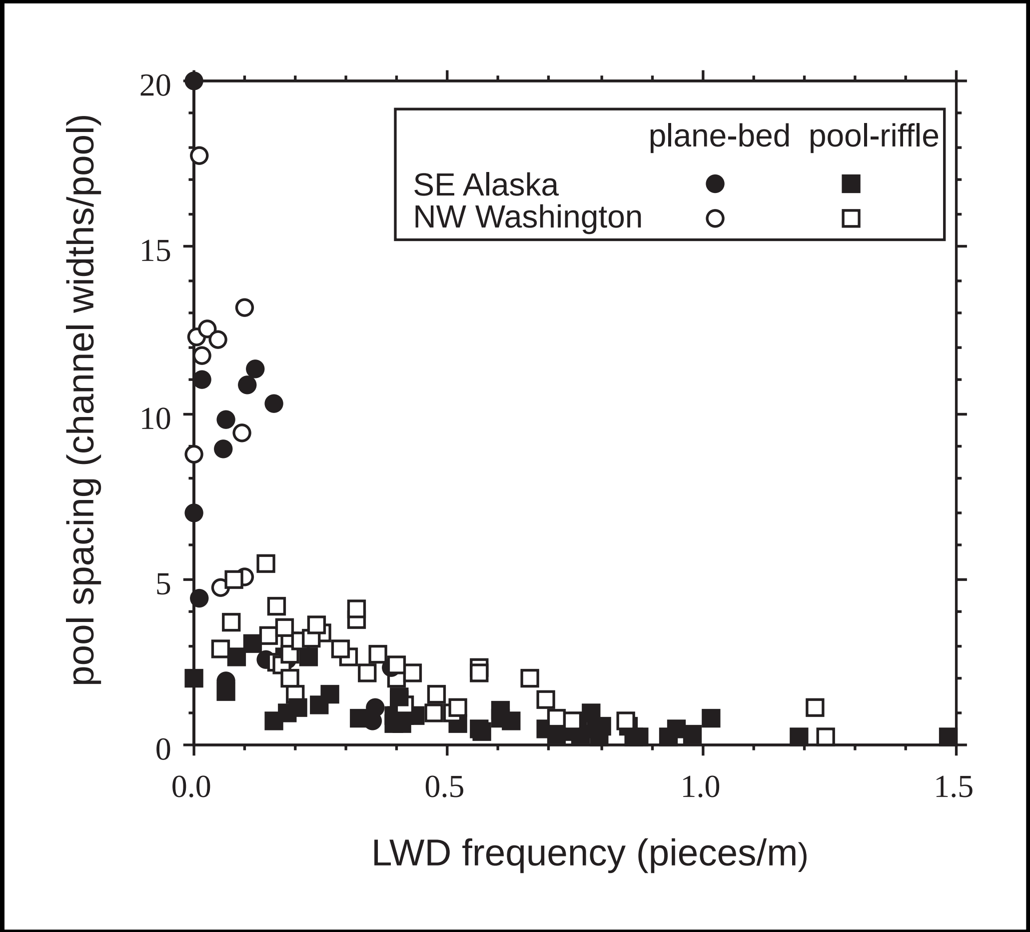
Thousands of snags were removed from Puget Sound rivers between 1880 and the mid-20th Century



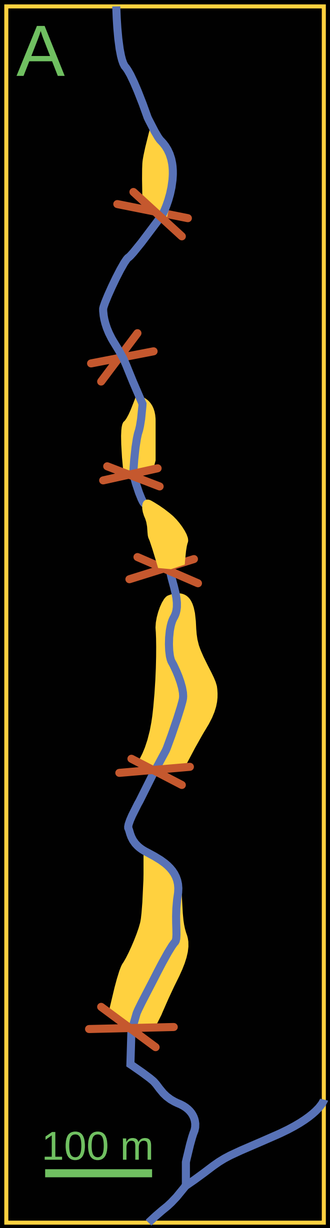
LWD can control the formation of pools and bars, and thereby channel reach morphology

Greater wood loading leads to more pools

For channels we've surveyed in Alaska and Washington, a plane-bed morphology occurs only at low LWD loading

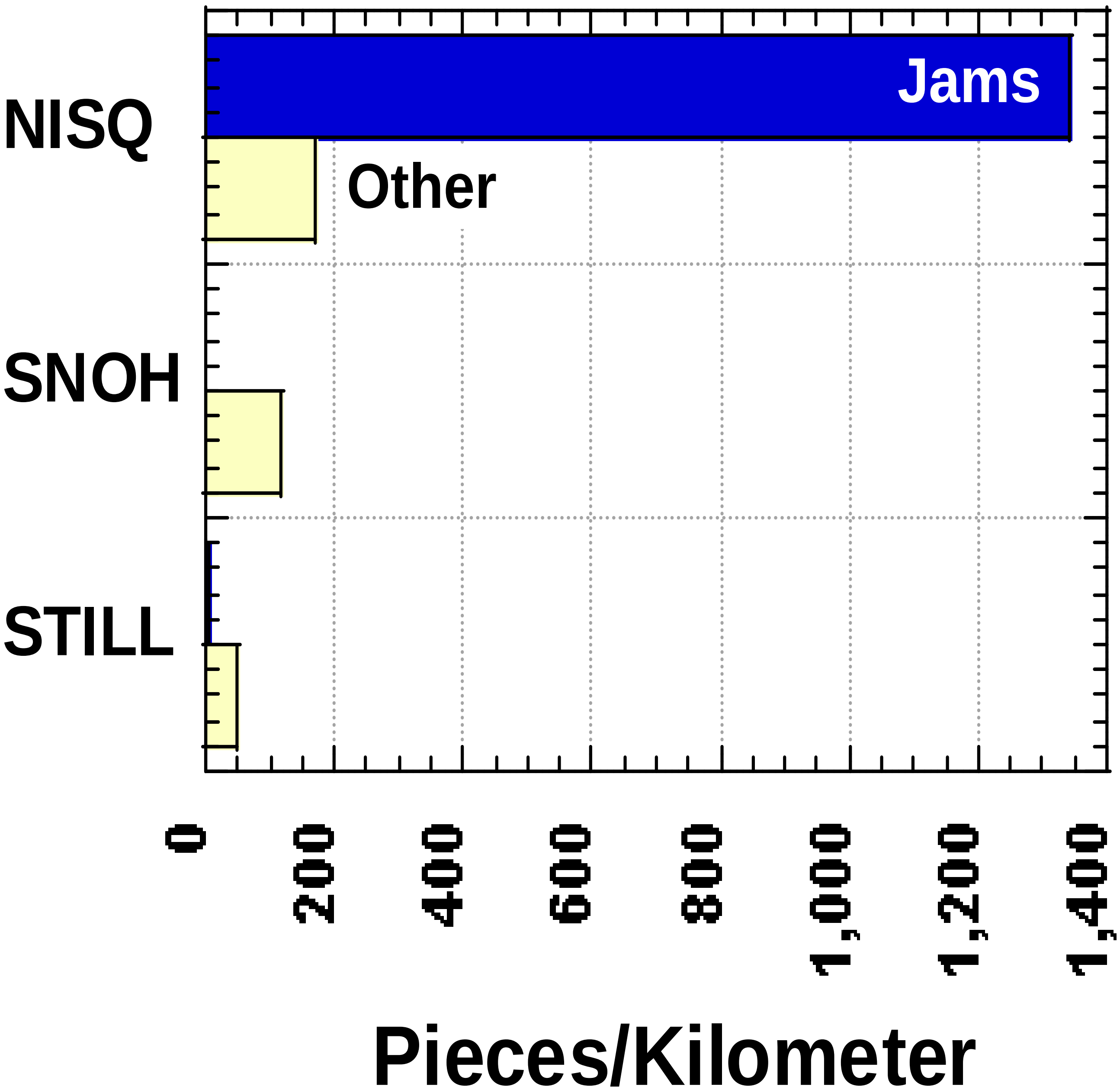


Log jams trap copious amounts of sediment and aggrade entire reaches of channel.



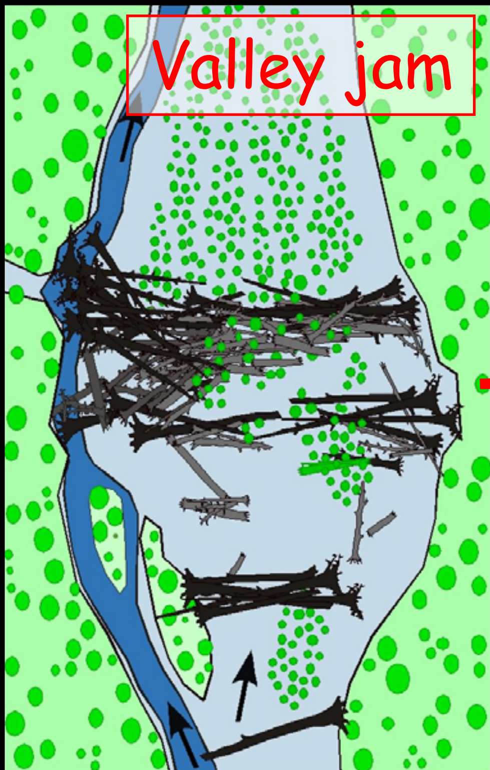
How big does a log have to be in order to influence a river?

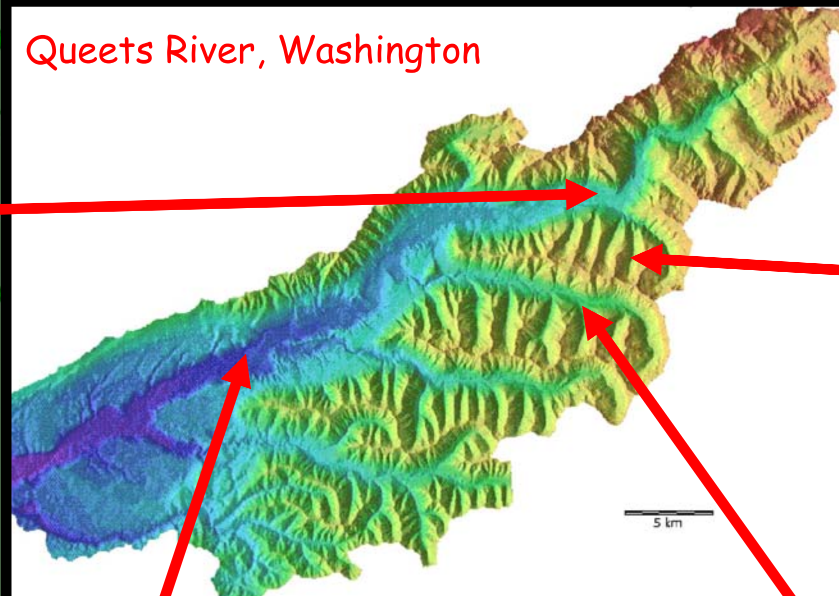
The "key member" logs that anchor log jams tend to have a diameter ≥half the channel depth and a length ≥ half the channel width.

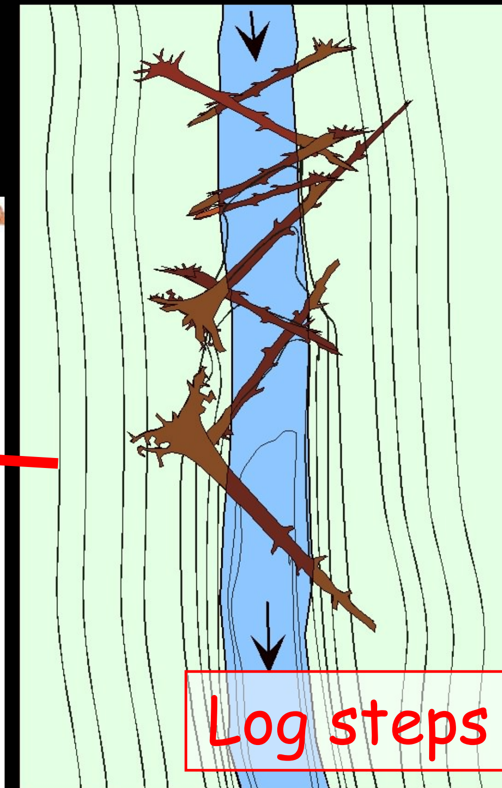


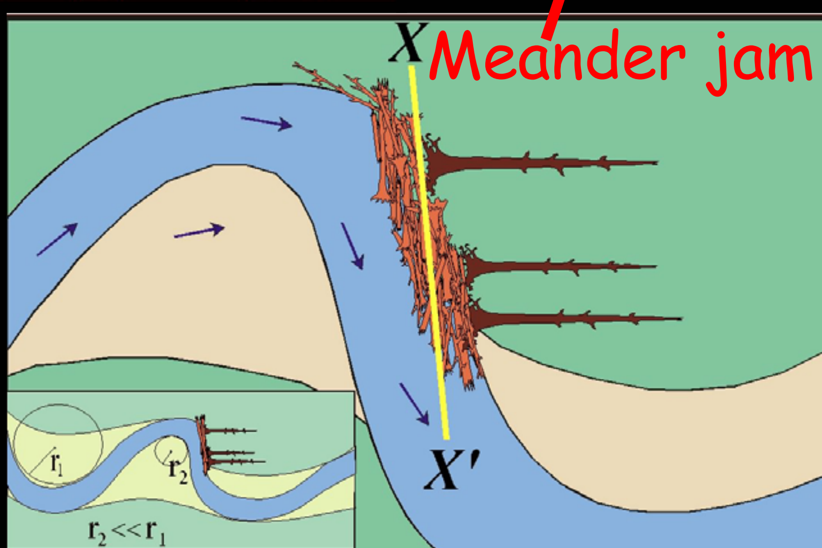
NISQ
SNOH
STILL
Jams
Other
0
200
400
600
800
1,000
1,200
1,400
Pieces/Kilometer

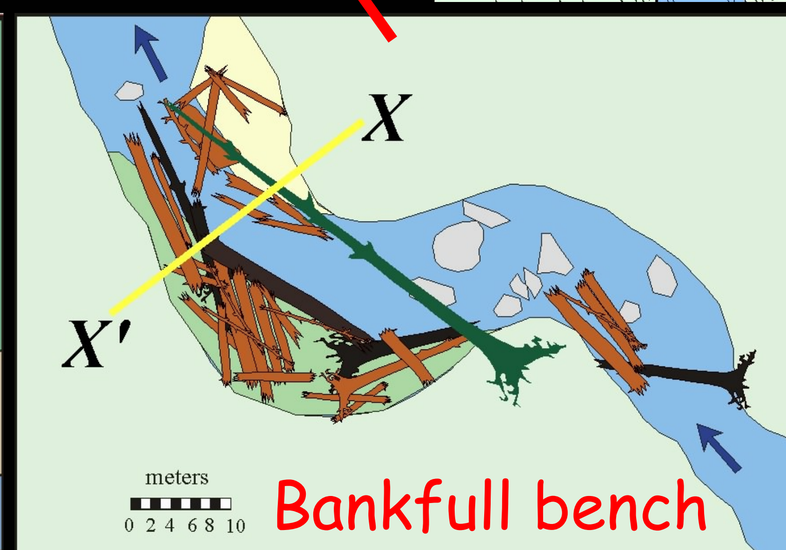
Position in Channel Network



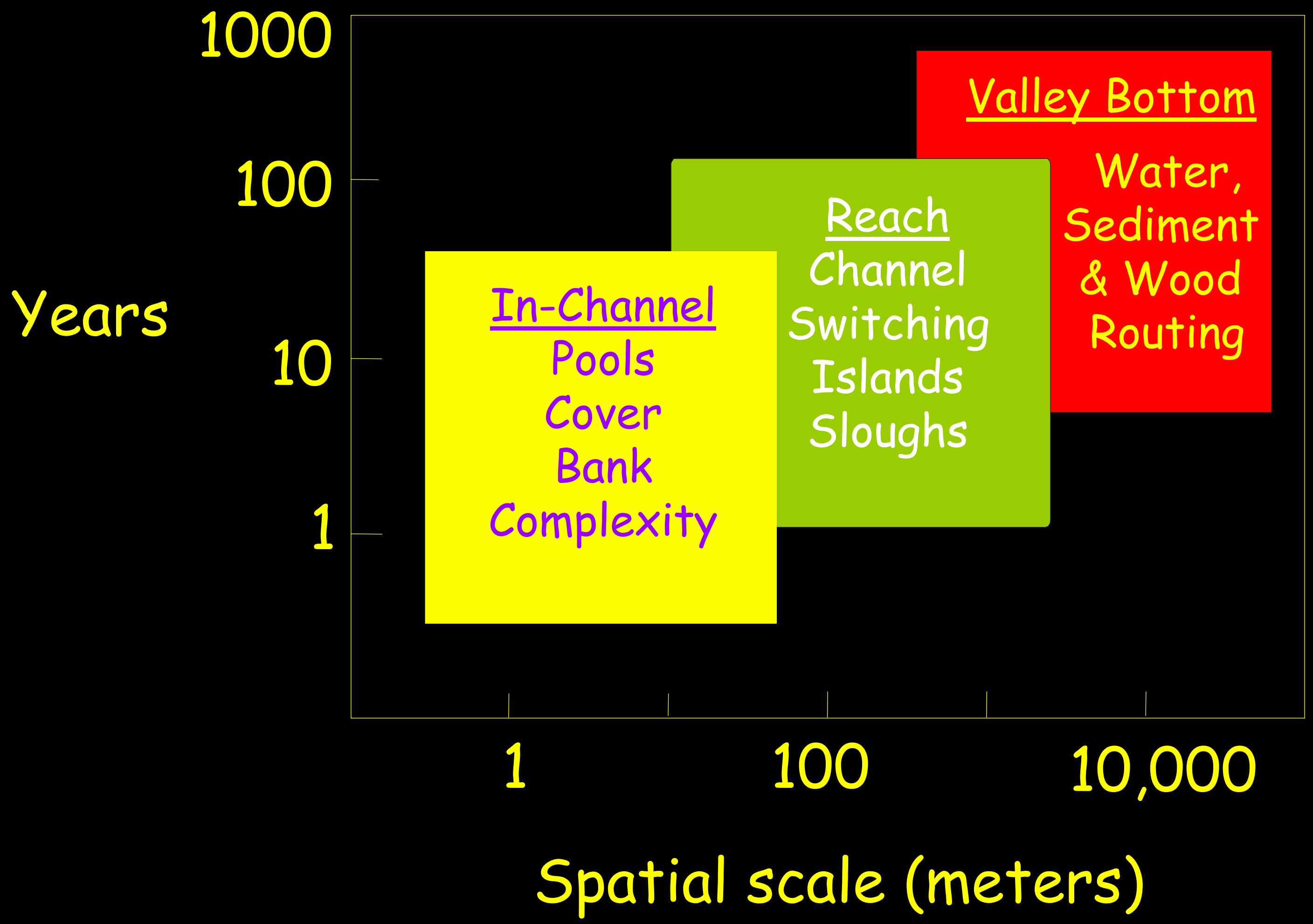








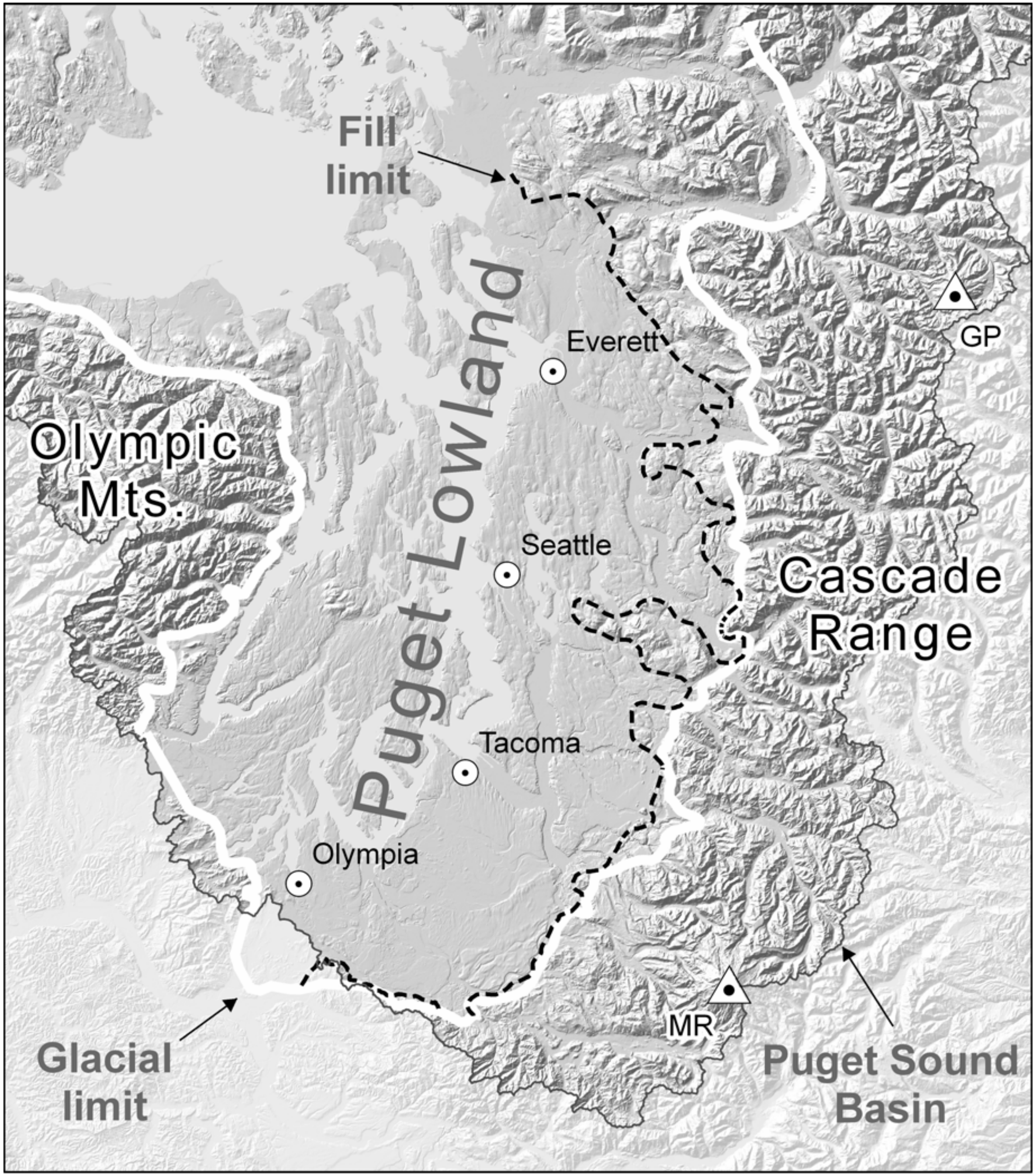
Effects of Wood in Rivers



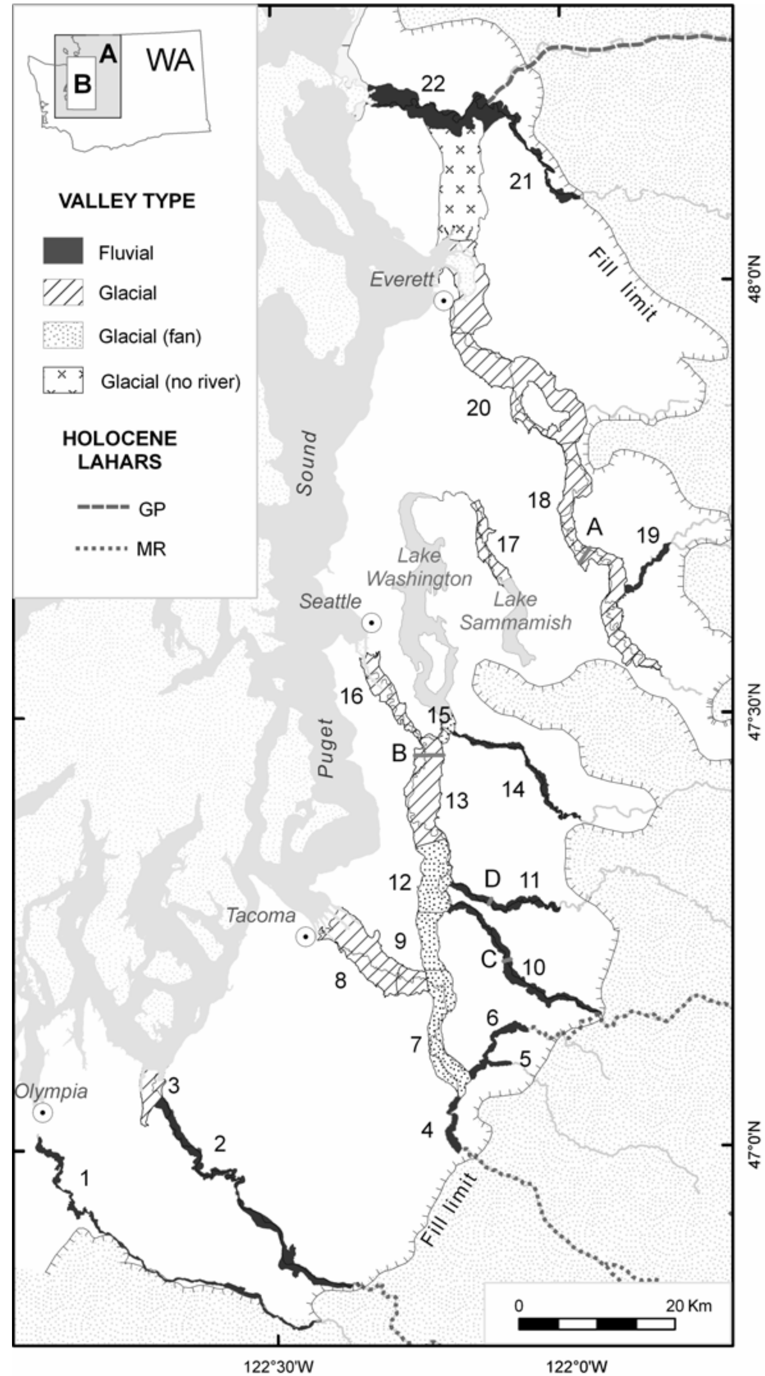
Environmental History of Puget Sound Rivers

Two dominant types of river valleys: Pleistocene (glacial) and Holocene (fluvial)

Pleistocene (glacial) valleys were incised by meltwater beneath the Puget Lobe glacier

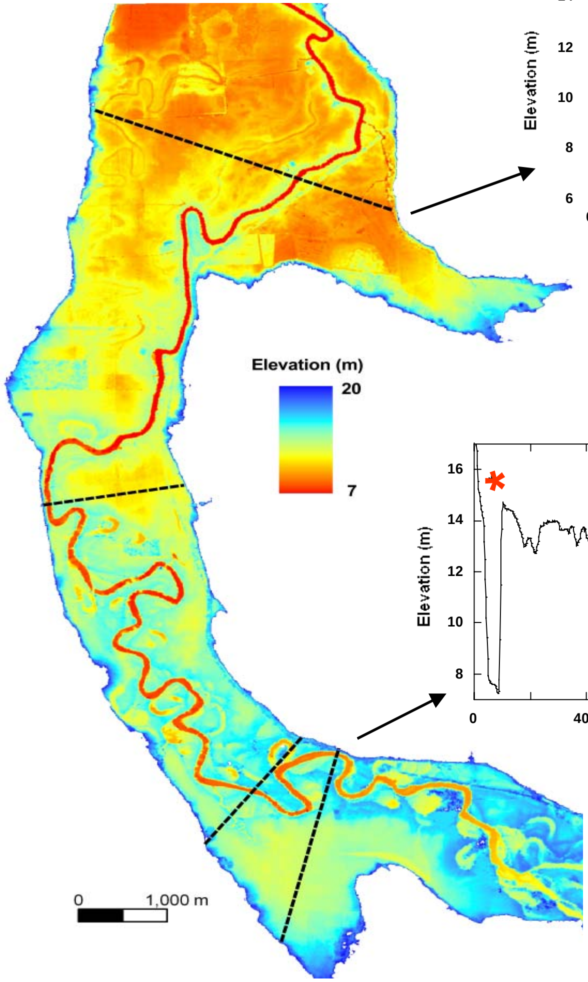


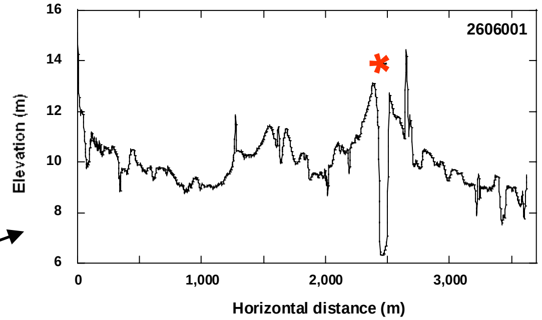
Holocene (fluvial) valleys were incised by rivers into the Puget Lowland after deglaciation



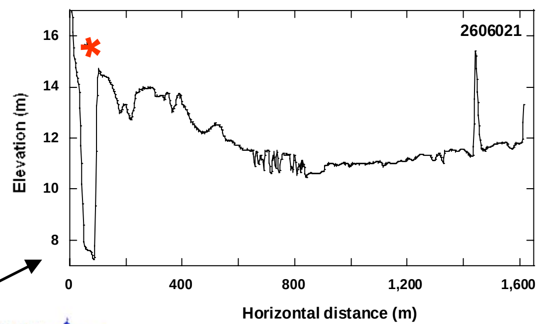
Pleistocene (glacial) valley: Snoqualmie River

Lidar DEM

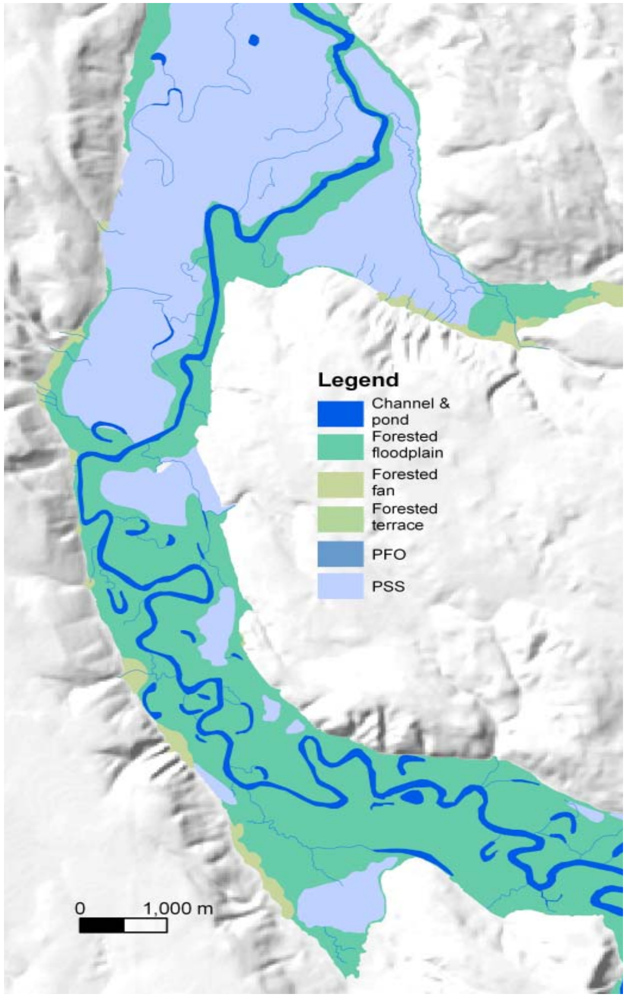




* = Snoqualmie river channel

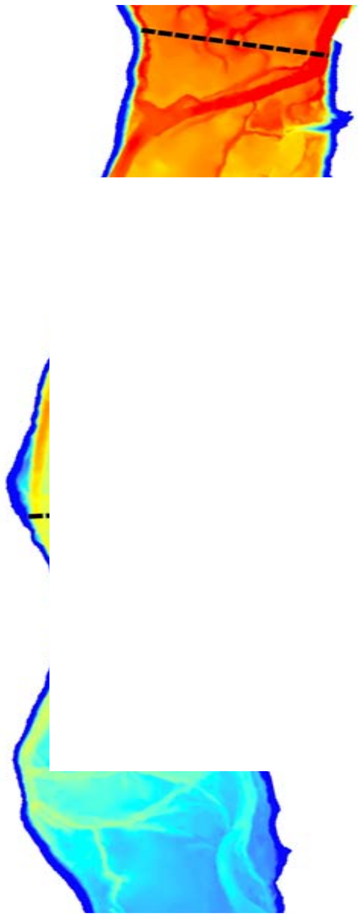


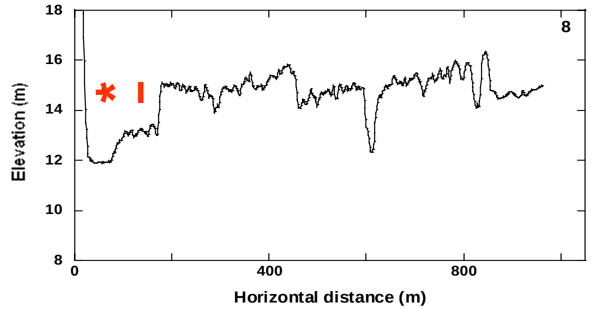
~1870 Landscape



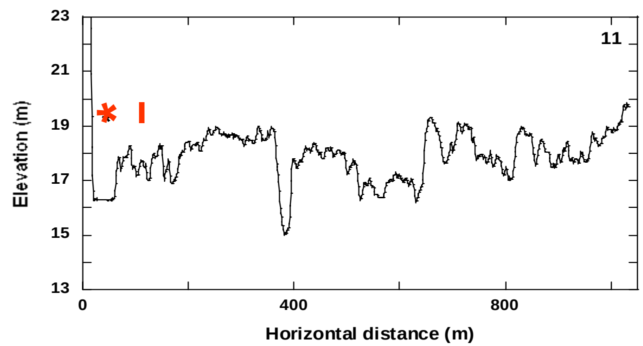
Channel pattern: **Meandering**
Habitats: **Oxbows and large depressional wetlands**
Cross valley profile: **Convex**

Holocene (fluvial) valley: Nisqually River

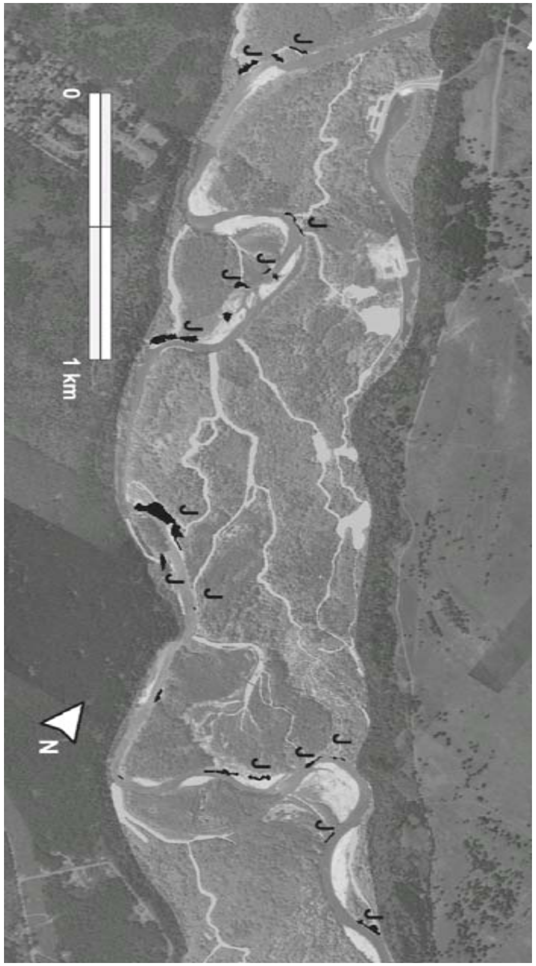




* = main channel



1999 aerial & 2000 field

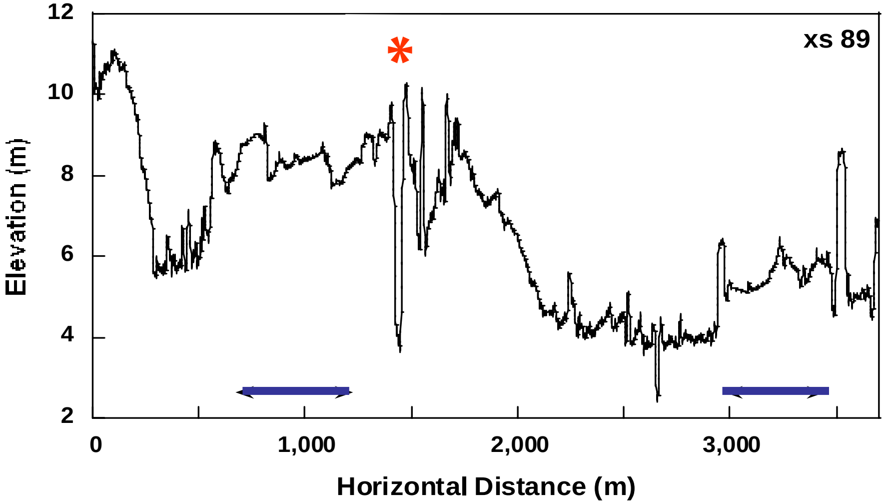


Channel pattern: Anastomosing
Habitats: Multiple channels & floodplain sloughs
Cross valley profile: “Corrugated” from channels & islands

Examples of cross-valley topography

Pleistocene valleys

Green River in Tukwila

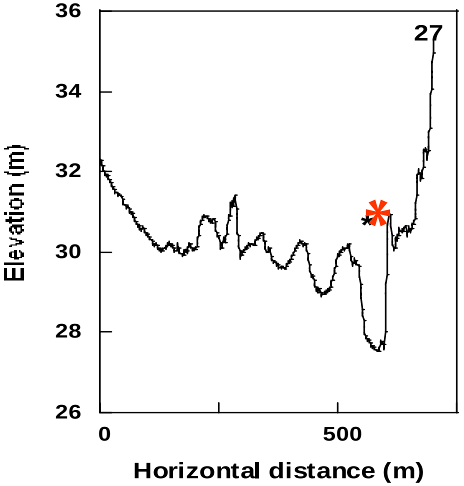


▬ = regraded areas (e.g. Southcenter Mall)

River perched above floodplain

Holocene valleys

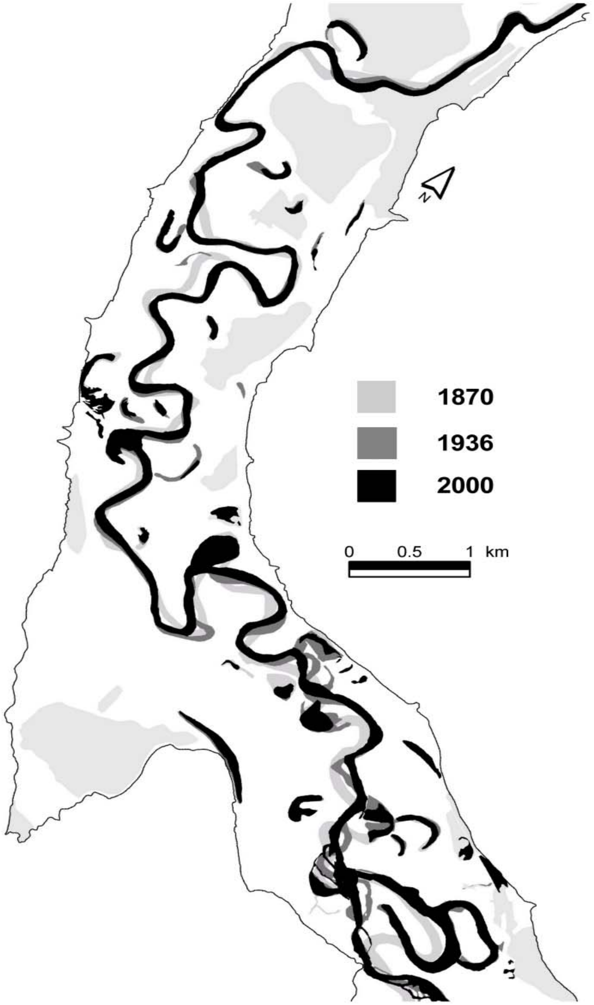
Cedar River near Elliott



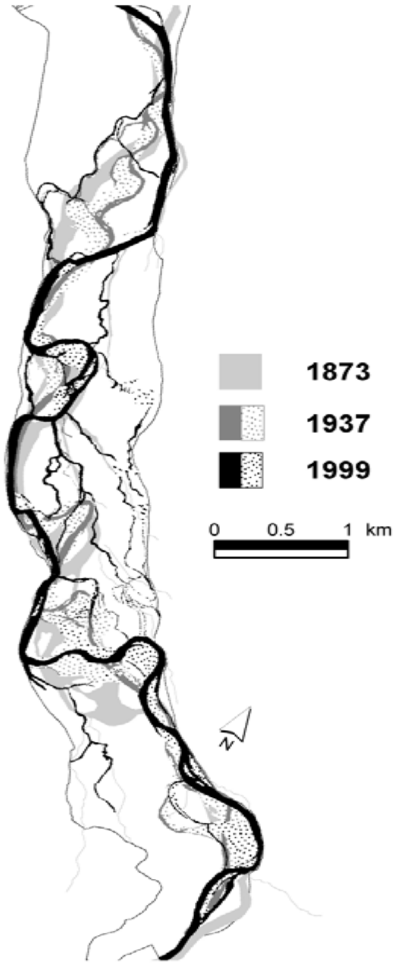
River at low point of floodplain

Comparative river dynamics

Snoqualmie
RM 11 - RM 22



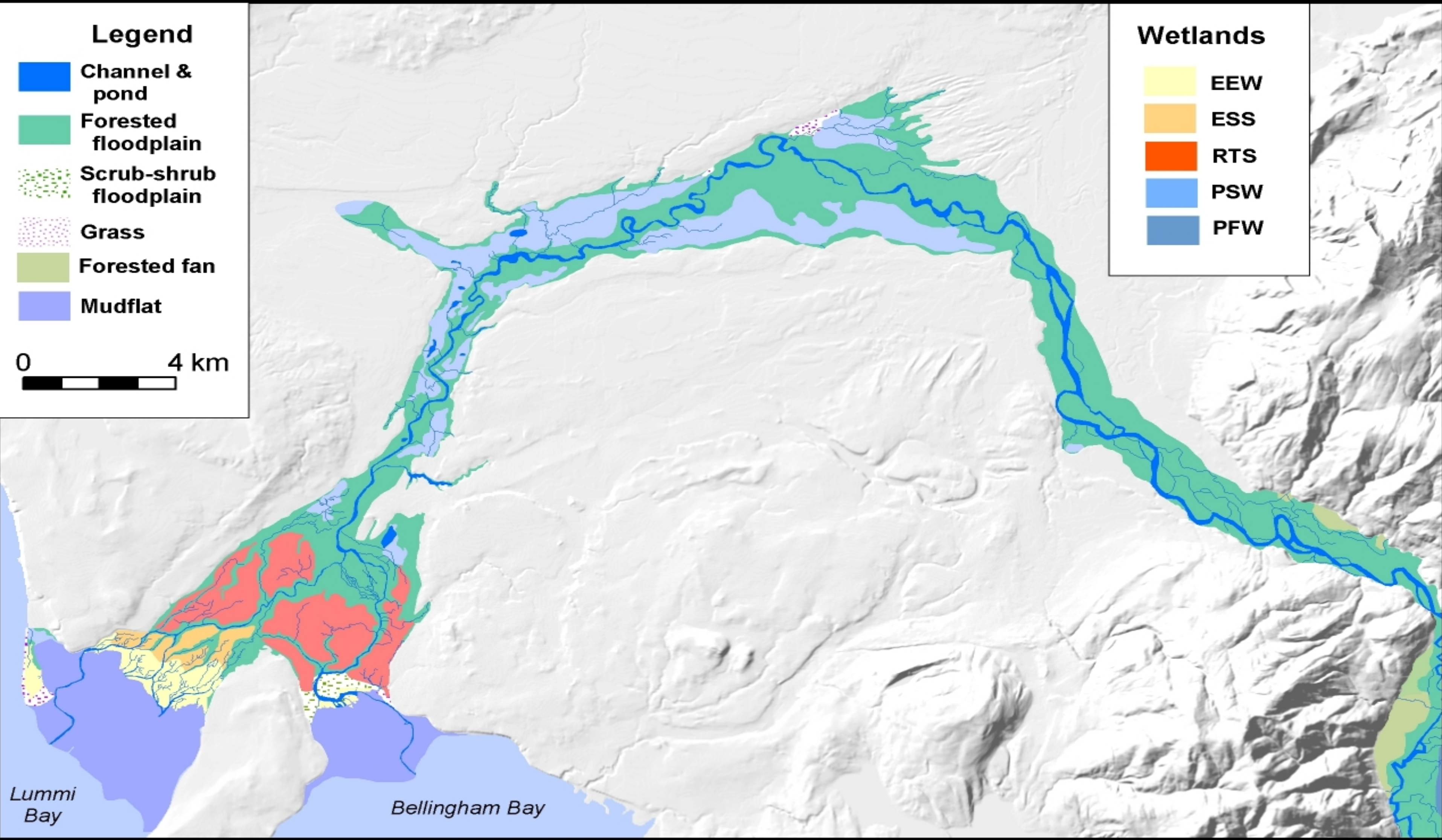
Nisqually
RM 4 - RM 11



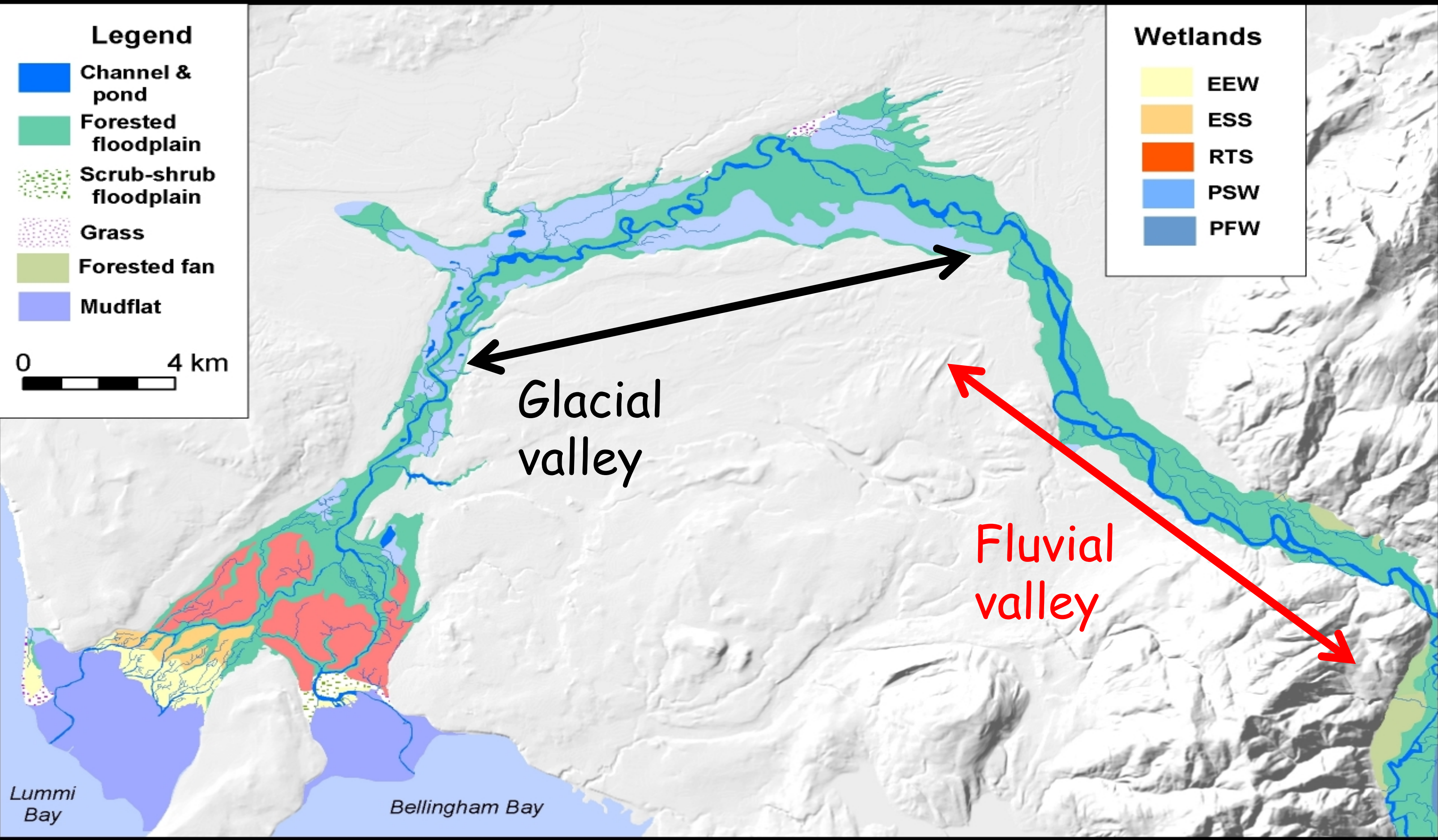
	Snoqualmie	Nisqually
• **Avulsion type:**	Meander cutoff	Channel switching
• **Floodplain occupation rate:**	Slow	Rapid
• **Migration & avulsion zone:**	Narrow	Wide

Metric	Prediction	
	Pleistocene	Holocene
MORPHOLOGY		
1. Channel gradient	Low	High
2. Stable forested islands (surrogate for branching pattern)	Few	Many
3. Sinuosity	Meandering	Strait
4. Cross-valley topography	Convex	"Corrugated"
HABITATS		
5. Wetland area	High	Low
6. Oxbow ponds	Many	Few
7. Total length of floodplain sloughs	Variable	High
DYNAMICS		
8. Dominant avulsion type	Meander cutoff	Channel switching
9. Channel migration zone	Narrow Slow rate	Wide Rapid rate

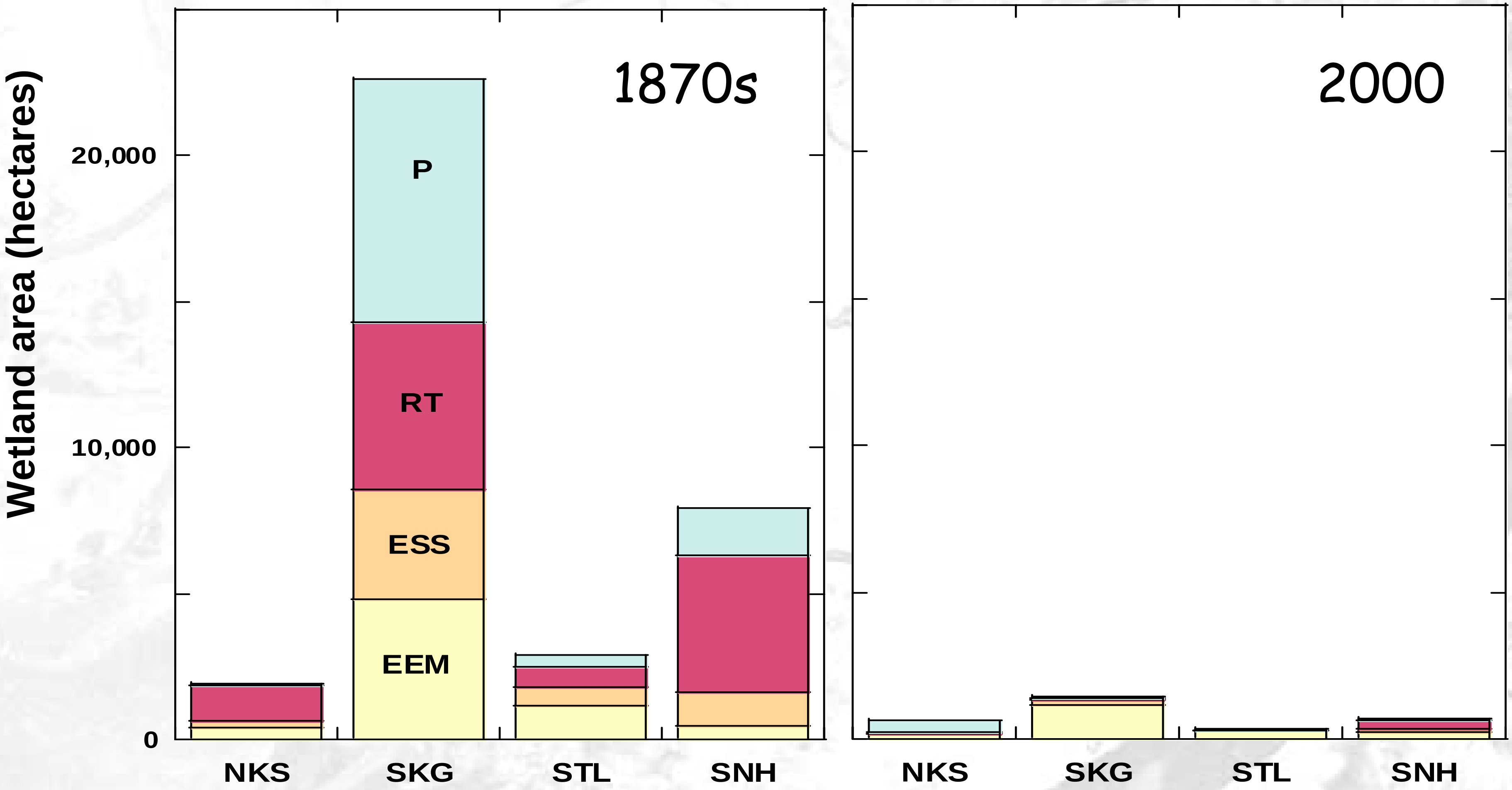
Nooksack River



Nooksack River



Change to wetland area in four North Sound estuaries/deltas



EEM=estuarine emergent; ESS=estuarine scrub-shrub; RT=riverine-tidal; P=palustrine

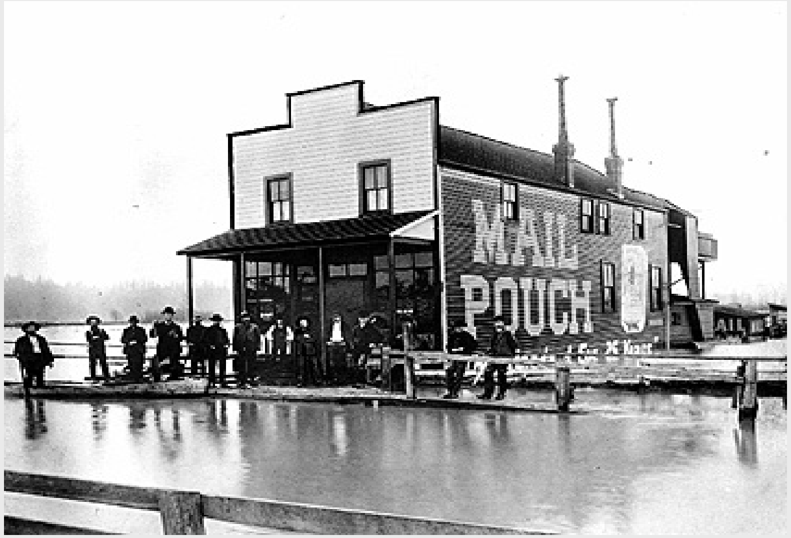
Hazard prediction and zoning

Pleistocene valleys

Rivers migrate slowly within ~10% of the valley,
but *floodwaters* fill the valley with regularity

Holocene valleys

Rivers avulse & migrate with high frequency within ~60-70% of the valley



In other words:

in a "Pleistocene valley" the *river channel* won't visit but the *water* will--frequently

a "Holocene valley" *river channel* will knock on your door before long

Restoring rivers, habitats, and species