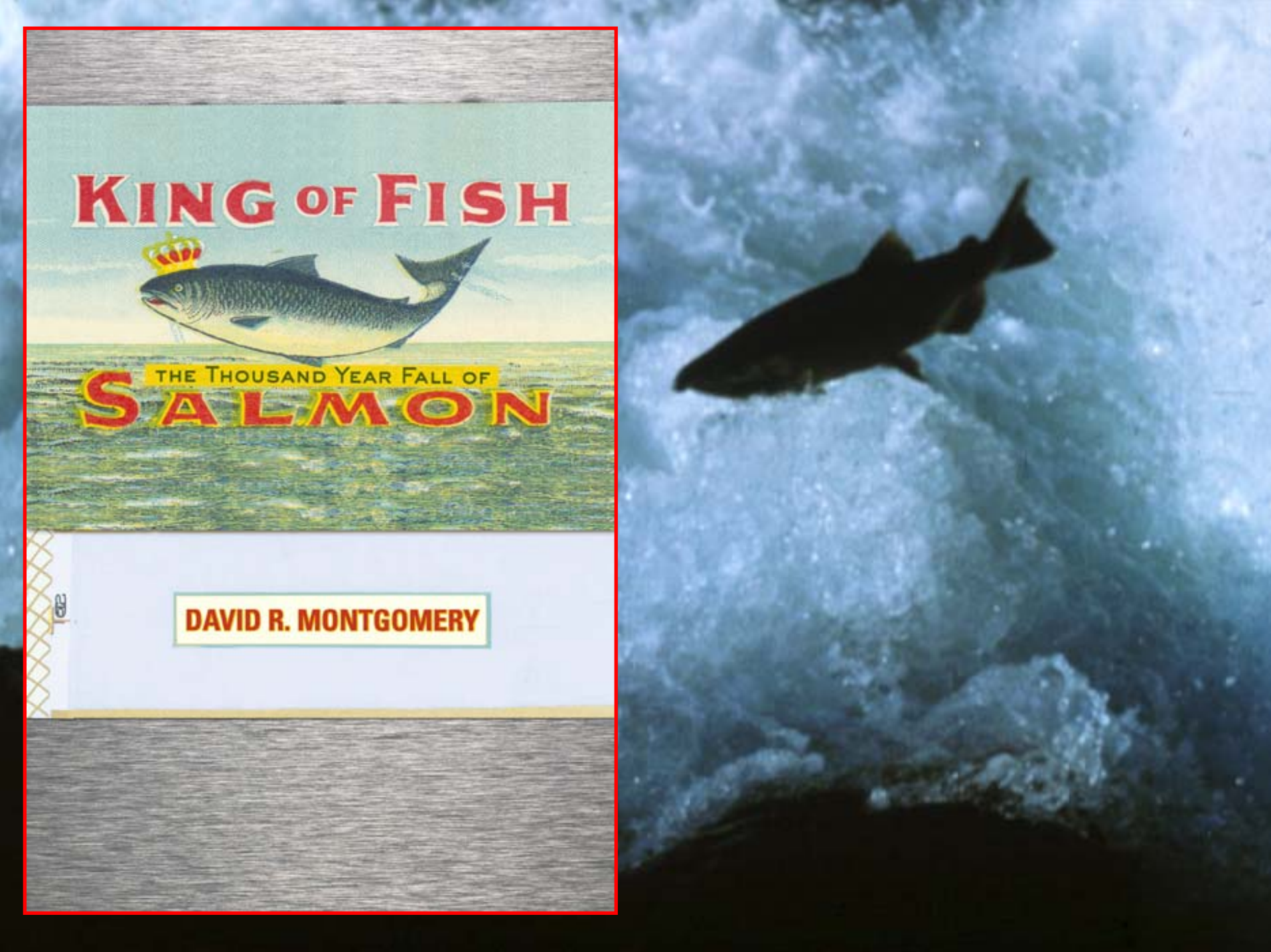

KING OF FISH
THE THOUSAND YEAR FALL OF
SALMON
DAVID R. MONTGOMERY

Mad Hatter:

My dear, something seems to be troubling you.

Won't you tell us all about it?

March Hare:

Start at the beginning…

THE SALMON FAMILY TREE

RAY TROLL 2003

Classical Hypothesis for Pacific Salmon Evolution and Diversification

- Isolation during glacial advances
- Problem: Fossil salmon pre-date Pleistocene glaciations!

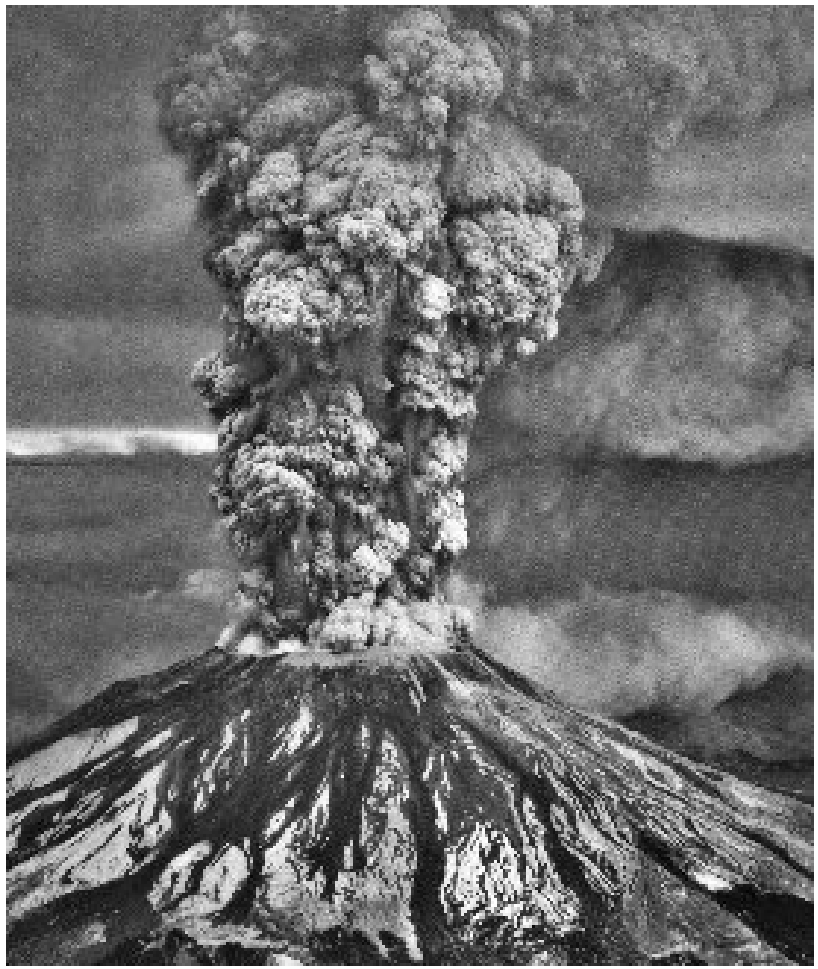
Evolution of the Pacific Salmon

- Pacific salmon evolved between 20 million and 6 million years ago (Miocene).

- Radiation of Pacific salmon into distinct species coincides with uplift of Pacific Rim topography.

Salmon and Natural Disturbances

For millions of years salmon thrived in a landscape shaped by floods, volcanic eruptions, and natural disturbances.



Archaeological excavations along the Columbia River confirm extensive salmon fishing for >9300 years…

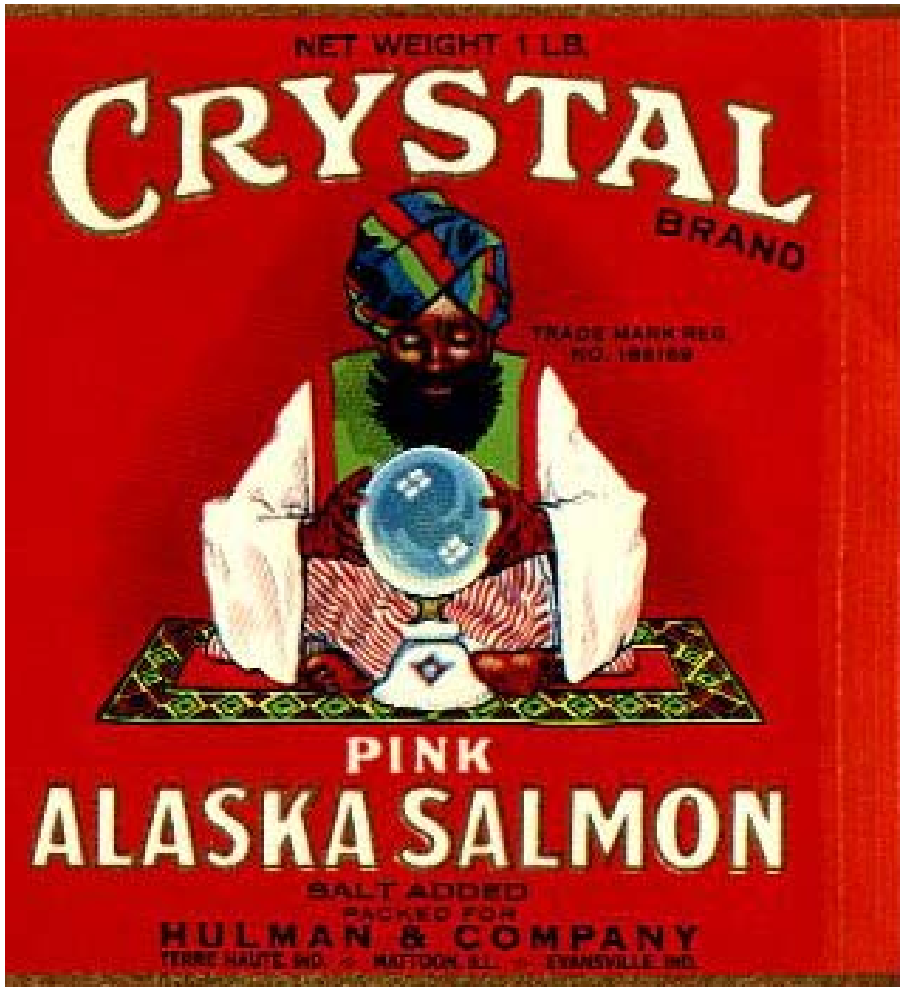
Butler and O'Connor, Quaternary Research, v. 62, p 1-8, 2004

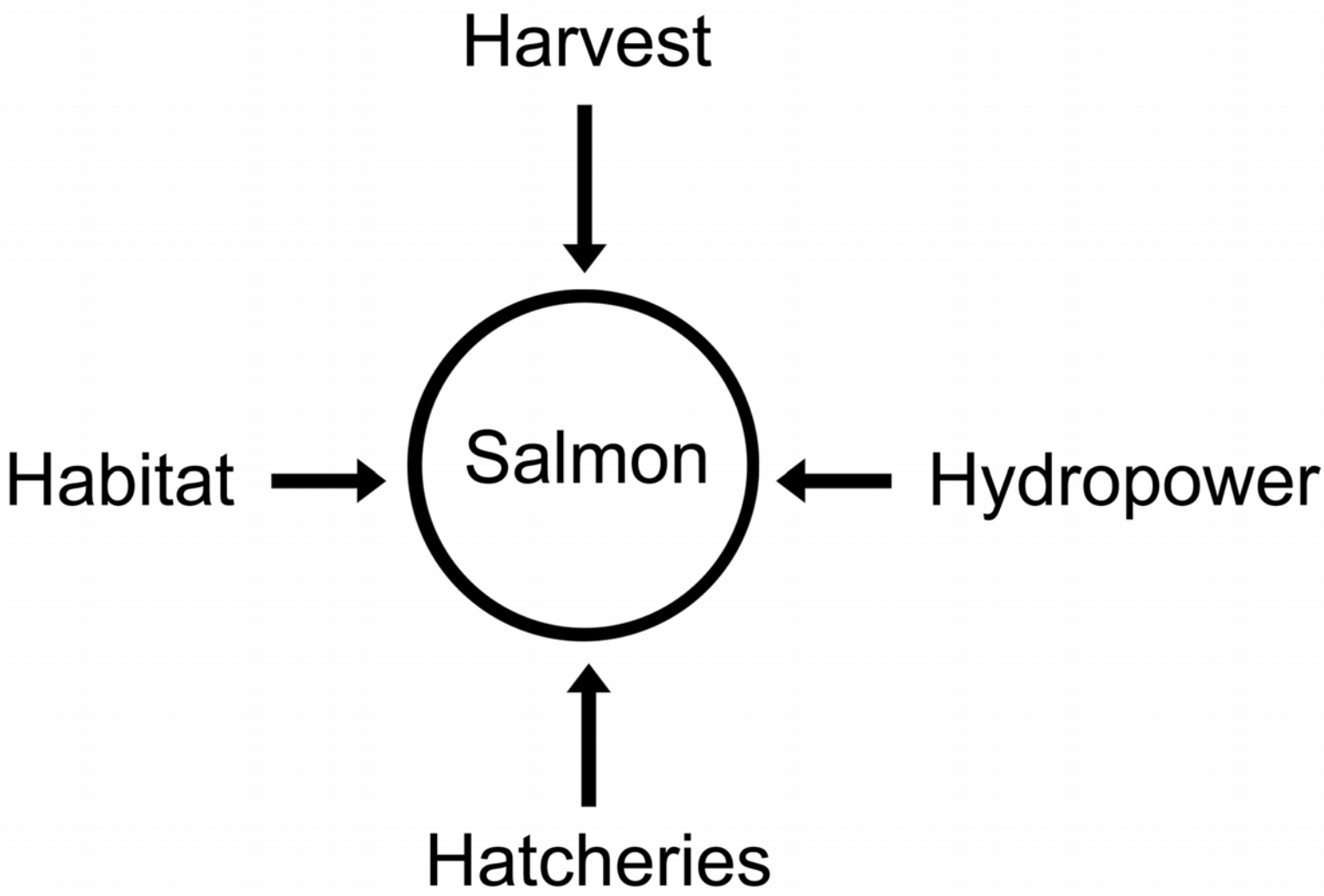
Status of Salmon Populations Today

Region	Percent of Historical Run Size
• Alaska	106
• British Columbia	36
• Puget Sound	8
• Washington	<2
• Columbia Basin	<2
• Oregon	7
• California	5
• California, Oregon, Washington, Idaho	5

Gresh, T., J. Lichatowich and P. Schoonmaker (2000) An estimation of historic and current levels of salmon production in the Northeast Pacific ecosystem: Evidence of a nutrient deficit in the freshwater systems of the Pacific Northwest. Fisheries, 25(1): 15-21.

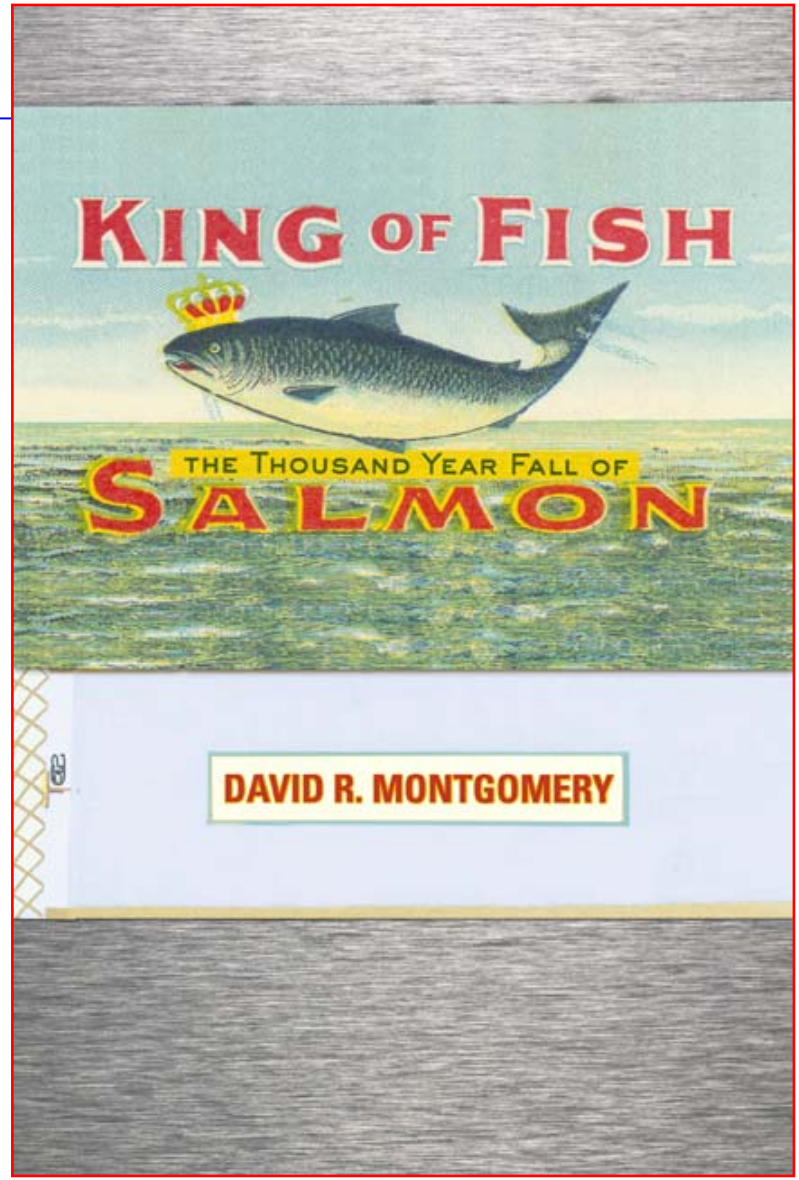
Will current strategies and restoration efforts work for Pacific salmon?




Harvest
Habitat
Salmon
Hydropower
Hatcheries

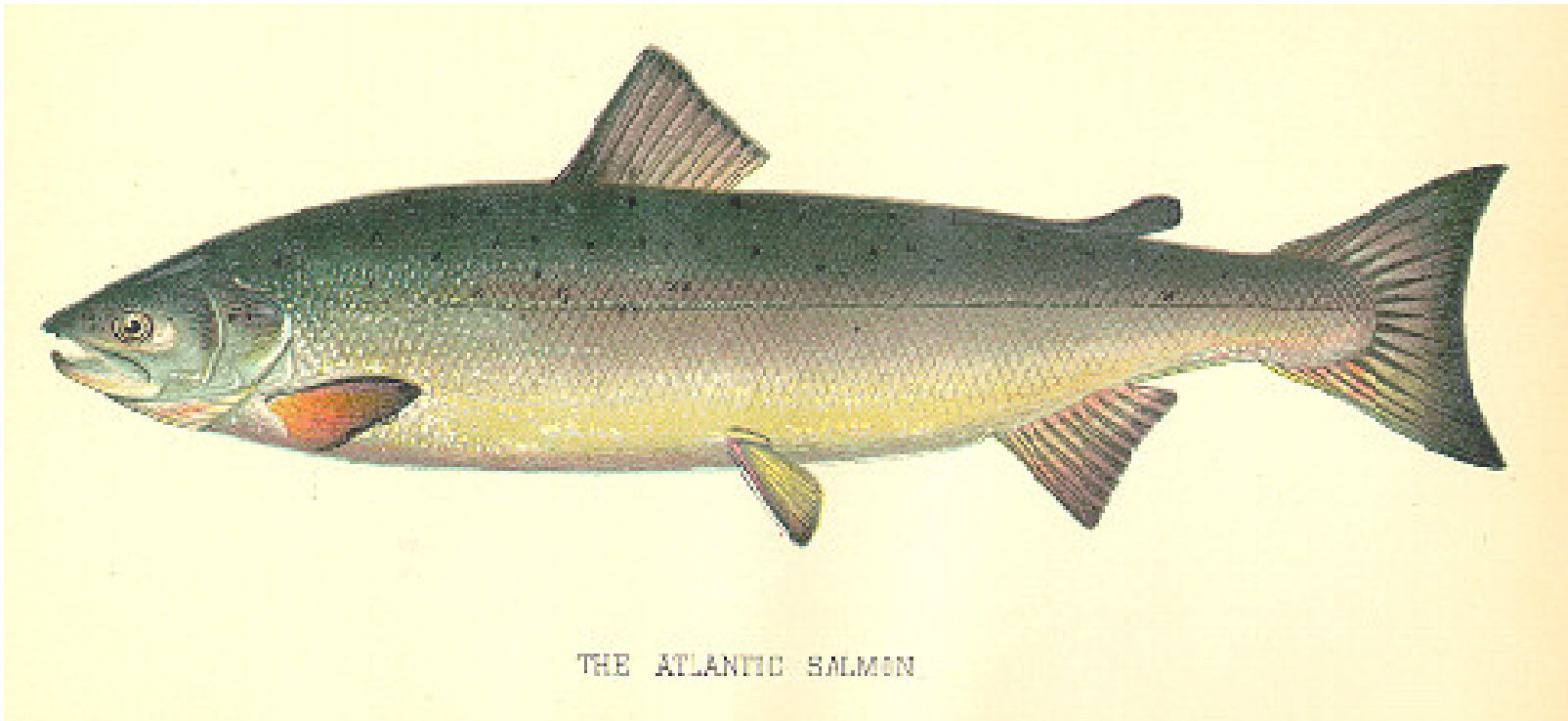
History, The 5th H

Strikingly similar pattern of changes to river systems and salmon crises in Great Britain, New England, and now the Pacific Northwest.



Harvest

The earliest recorded salmon-fishing legislation was an edict issued by King Malcolm II of Scotland in 1030 that established a closed season for taking "old salmon".



Habitat

A statute dating from the reign of Richard the Lion-hearted declared that rivers must be kept free of obstructions so as to permit a well-fed three-year-old pig, standing sideways in the stream, not to touch either side.

Hydro (dams)

An Act passed in the reign of King Robert the First, in 1318, forbade the erection of fixtures of any size or dimensions that would prevent the progress of salmon up and down a river.

George I Tries to Save the Salmon

In 1714 George I enacted a law to prevent blocking salmon from their spawning grounds in seventeen English rivers.

By 1868, all seventeen rivers protected by George I were either blocked or poisoned by pollution.
[habitat and hydro]

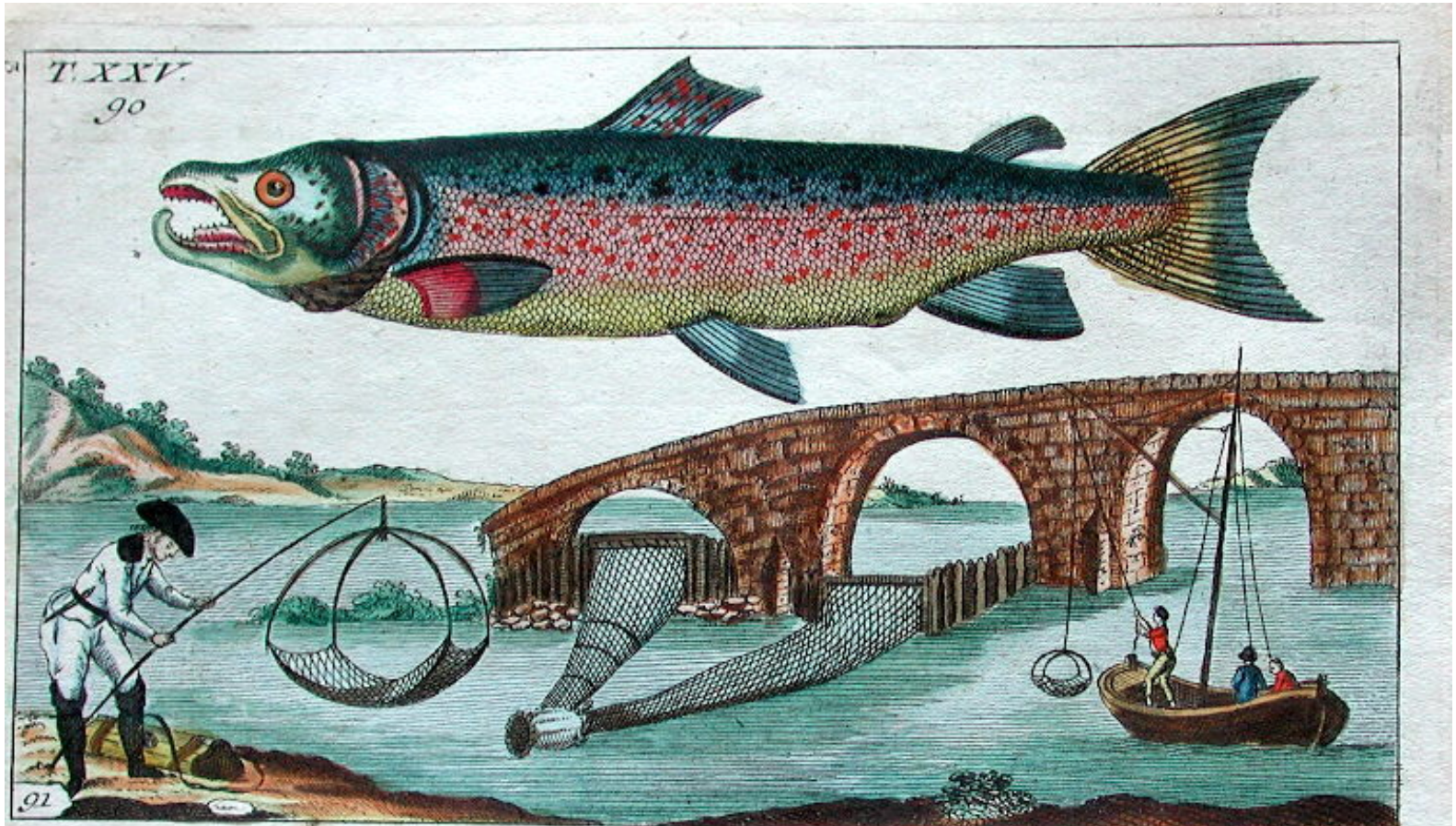
Alexander Fraser proposed steps to increase the number of salmon in Scottish rivers (1833):

(1) don't block the ability of salmon to migrate up or down stream [hydro];

(2) limit fishing intensity so as to not take the majority of the spawners [harvest];

(3) prevent habitat degradation that could damage the fishery [habitat].

By the middle of the 19th century the plight of English salmon began to arouse widespread public concern over the danger of regional extinction.



" The cry of 'Salmon in Danger!' is now resounding throughout the length and breadth of the land. A few years, a little more over-population, a few more tons of factory poisons, a few fresh poaching devices … and the salmon will be gone—he will be extinct.

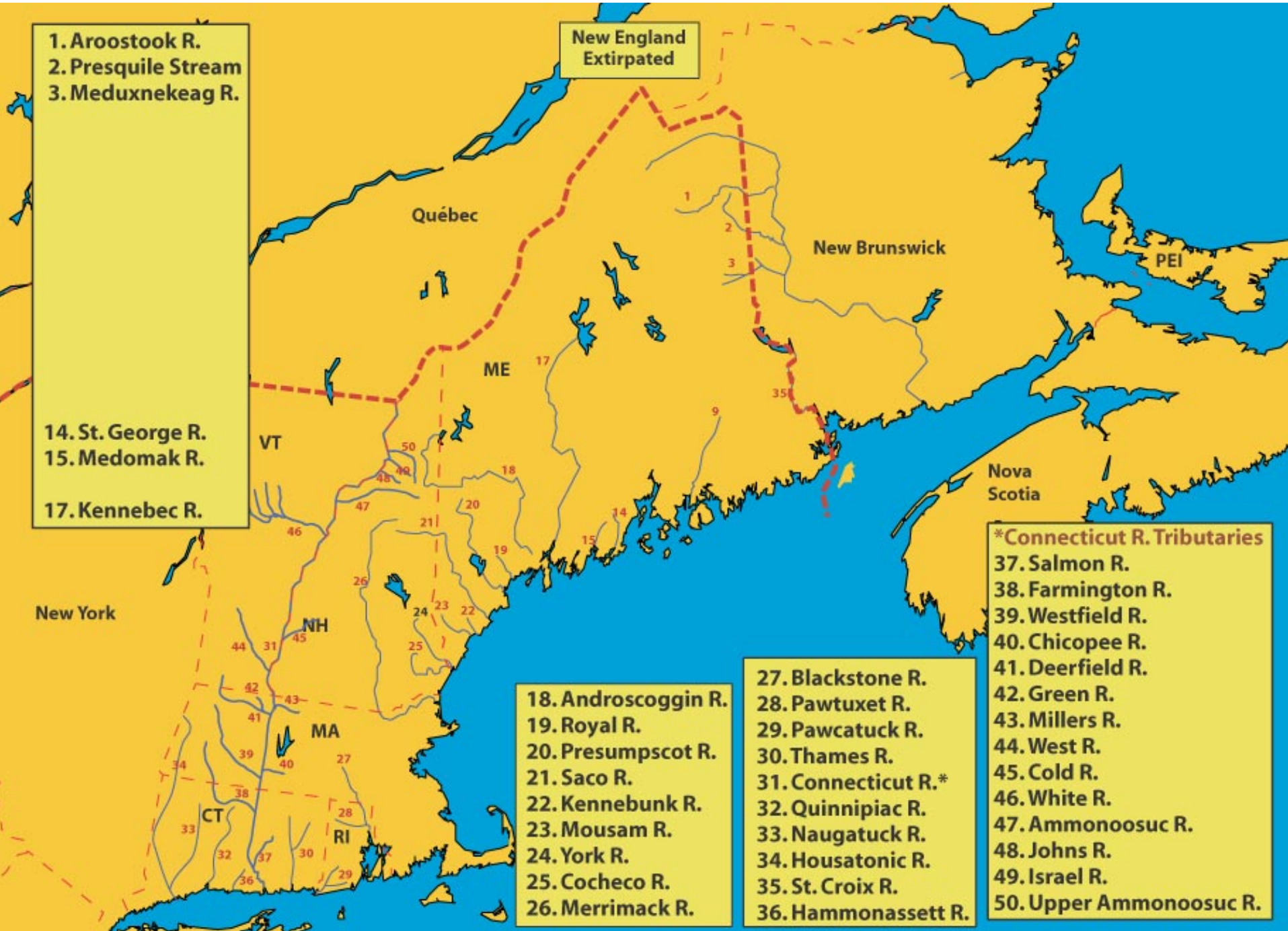
Shall we not step in between wanton destruction … and so ward off the obloquy which will be attached to our age when the historians of the nineteen-sixties will be forced to record that: 'The inhabitants of the last century destroyed the salmon'…"

— Charles Dickens (1861).

New World Salmon

"If the Pigeons plagued us by their abundance, the Salmon gave us even more trouble. So large a quantity of them enters into this river that at night one is unable to sleep, so great is the noise they make in falling upon the water after having thrown or darted themselves in to the air."

— N. Denys (1672 , p. 199).


1. Aroostook R.
2. Presquile Stream
3. Meduxnekeag R.
14. St. George R.
15. Medomak R.
17. Kennebec R.
New England Extirpated
Québec
New Brunswick
PEI
Nova Scotia
ME
VT
NH
MA
CT
RI
New York
18. Androscoggin R.
19. Royal R.
20. Presumpscot R.
21. Saco R.
22. Kennebunk R.
23. Mousam R.
24. York R.
25. Cocheco R.
26. Merrimack R.
27. Blackstone R.
28. Pawtuxet R.
29. Pawcatuck R.
30. Thames R.
31. Connecticut R.*
32. Quinnipiac R.
33. Naugatuck R.
34. Housatonic R.
35. St. Croix R.
36. Hammonassett R.
*Connecticut R. Tributaries
37. Salmon R.
38. Farmington R.
39. Westfield R.
40. Chicopee R.
41. Deerfield R.
42. Green R.
43. Millers R.
44. West R.
45. Cold R.
46. White R.
47. Ammonoosuc R.
48. Johns R.
49. Israel R.
50. Upper Ammonoosuc R.

The proliferation of small dams gradually blocked salmon from New England's rivers.

Between 1820 and 1880 over one hundred and fifty fishery laws relating to salmon were passed by the state of Maine.

Enforcement, provided for at the local level, was virtually nonexistant.

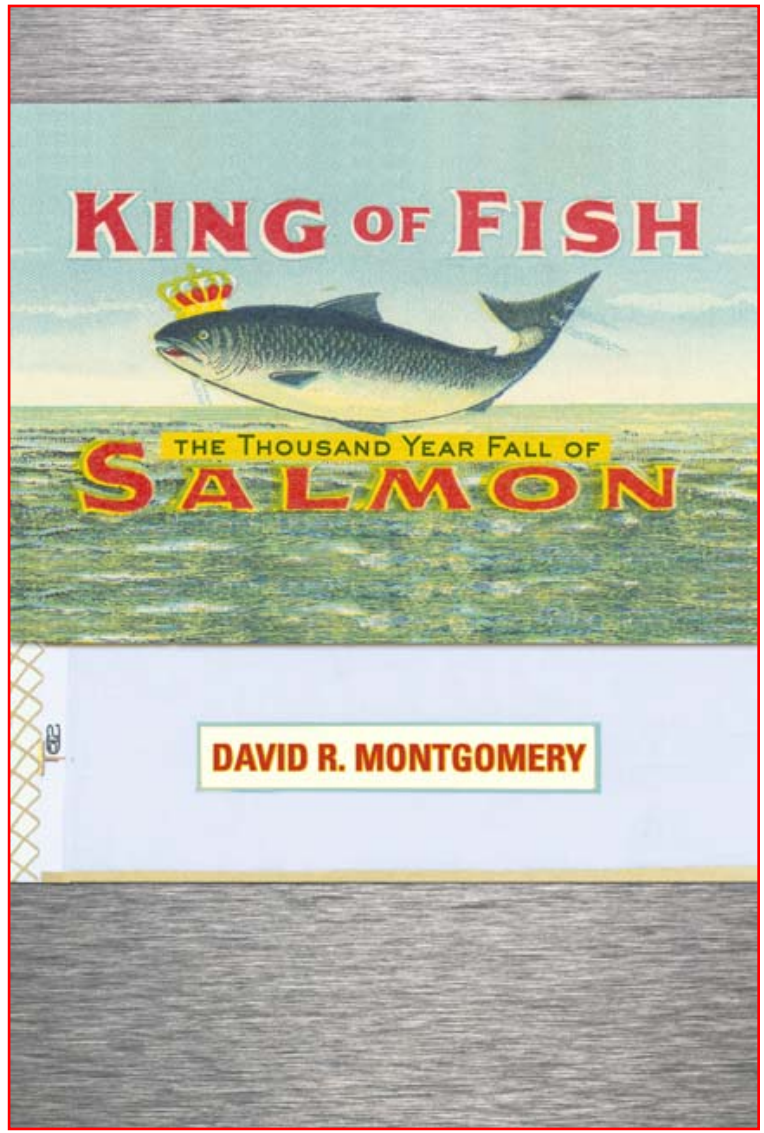
Greatworks Dam, Penobscot River

Key factors in British and New England salmon declines

Local control / lax enforcement

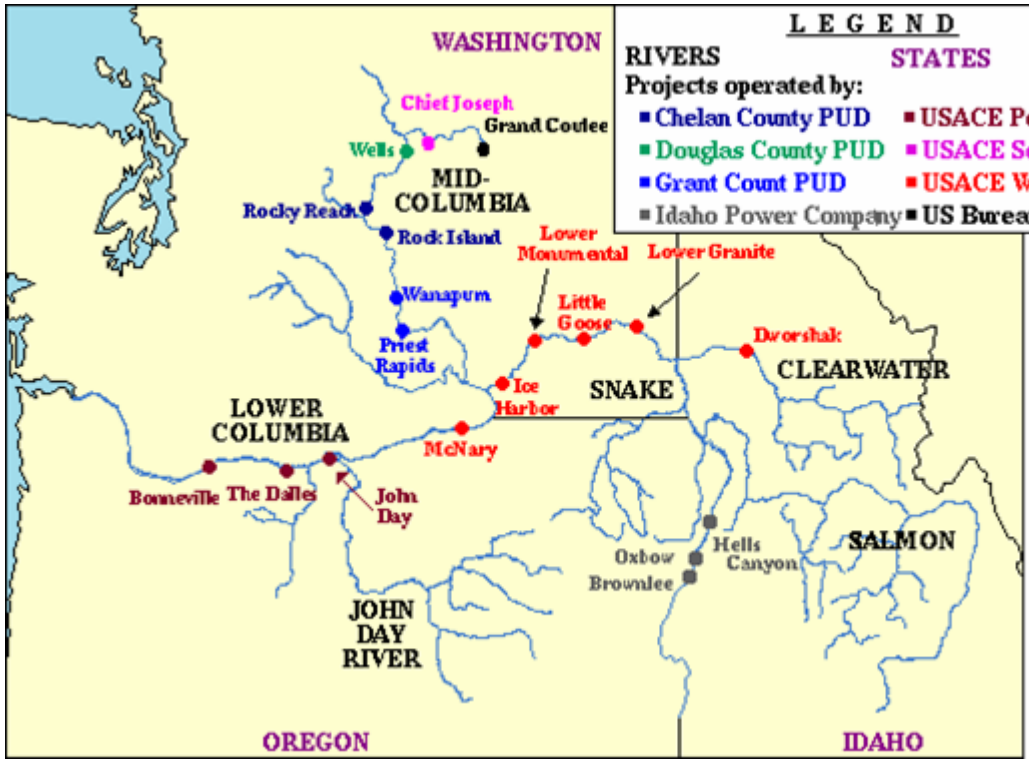
Gradual accumulation of many individual habitat impacts

Over-reliance on hatcheries



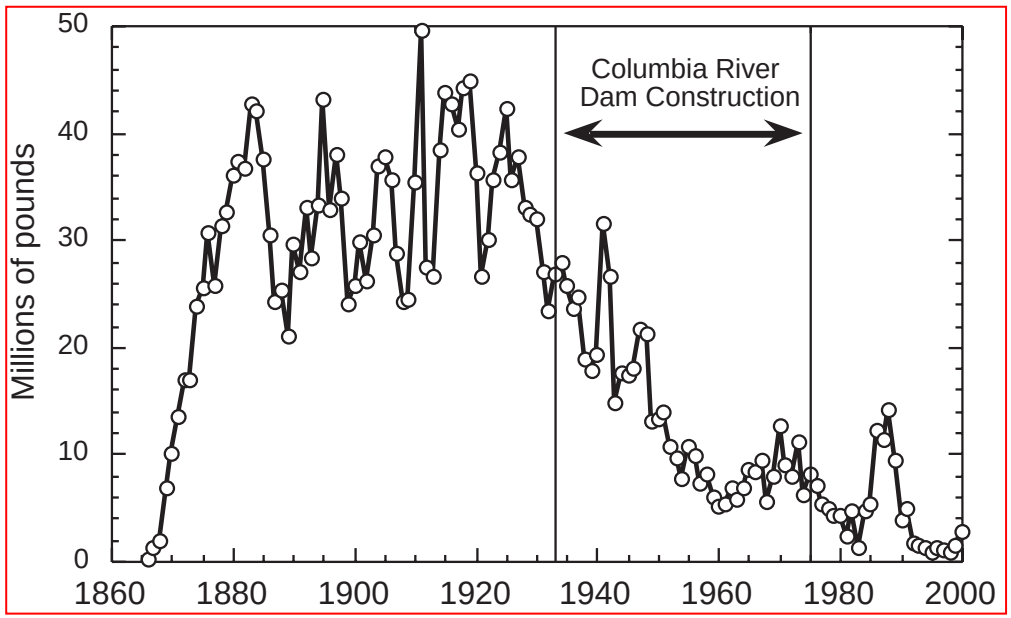
Is the Pacific Northwest repeating the series of choices that led to the decline of the Atlantic salmon?

Harvest


WASHINGTON
LEGEND
RIVERS
STATES
Projects operated by:
Chelan County PUD
Douglas County PUD
Grant Count PUD
Idaho Power Company
USACE Portland District
USACE Seattle District
USACE Walla Walla District
US Bureau of Reclamation
Chief Joseph
Grand Coulee
Wells
MID-COLUMBIA
Rocky Reach
Rock Island
Lower Monumental
Lower Granite
Wanapum
Little Goose
Priest Rapids
Dworshak
CLEARWATER
Ice Harbor
SNAKE
LOWER COLUMBIA
McNary
Bonneville
The Dalles
John Day
Oxbow
Hells Canyon
Brownlee
SALMON
JOHN DAY RIVER
OREGON
IDAHO


TO-4847
500'
10-17-56

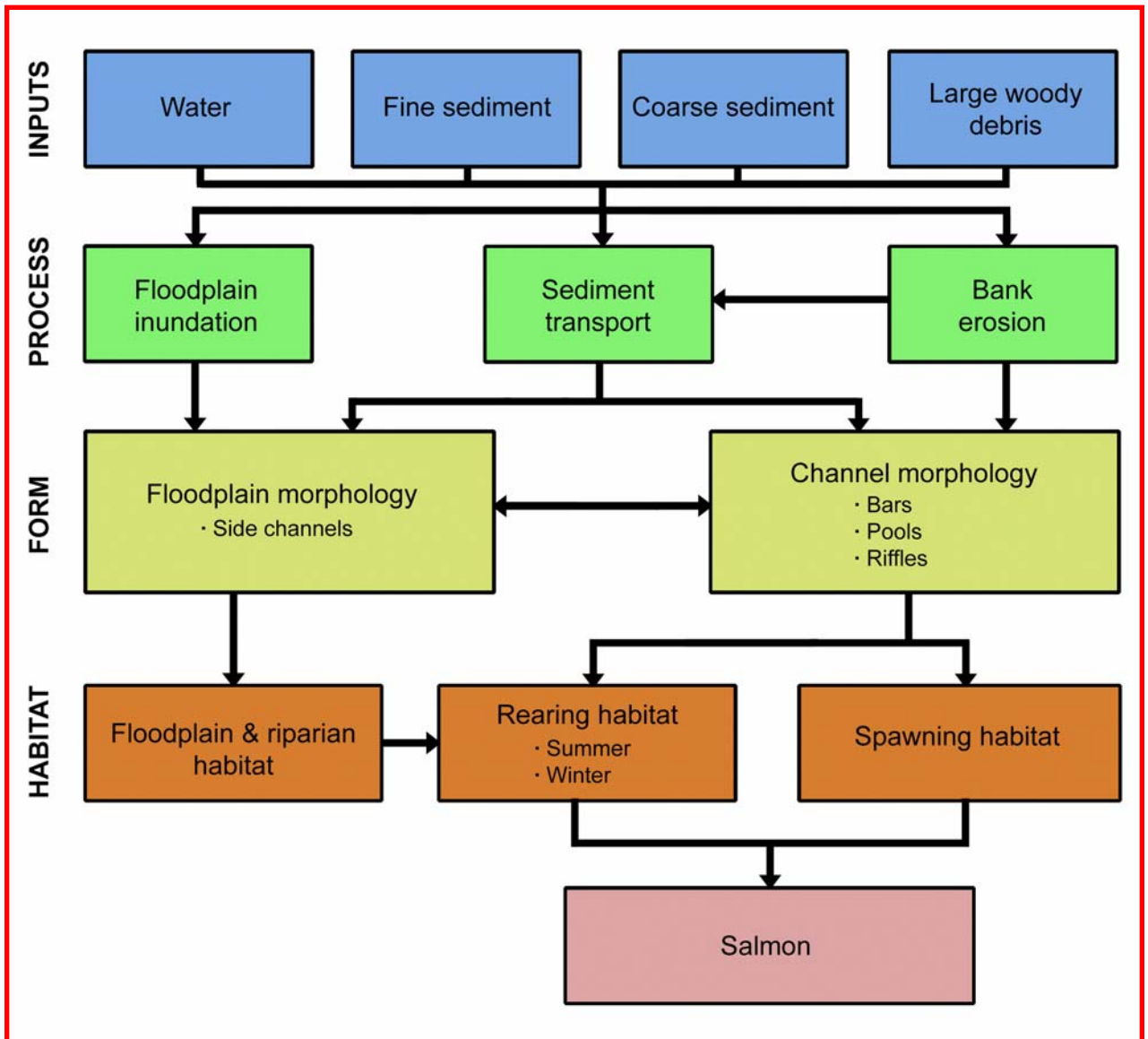
Hydro


Millions of pounds
50
40
30
20
10
0
1860
1880
1900
1920
1940
1960
1980
2000
Columbia River Dam Construction

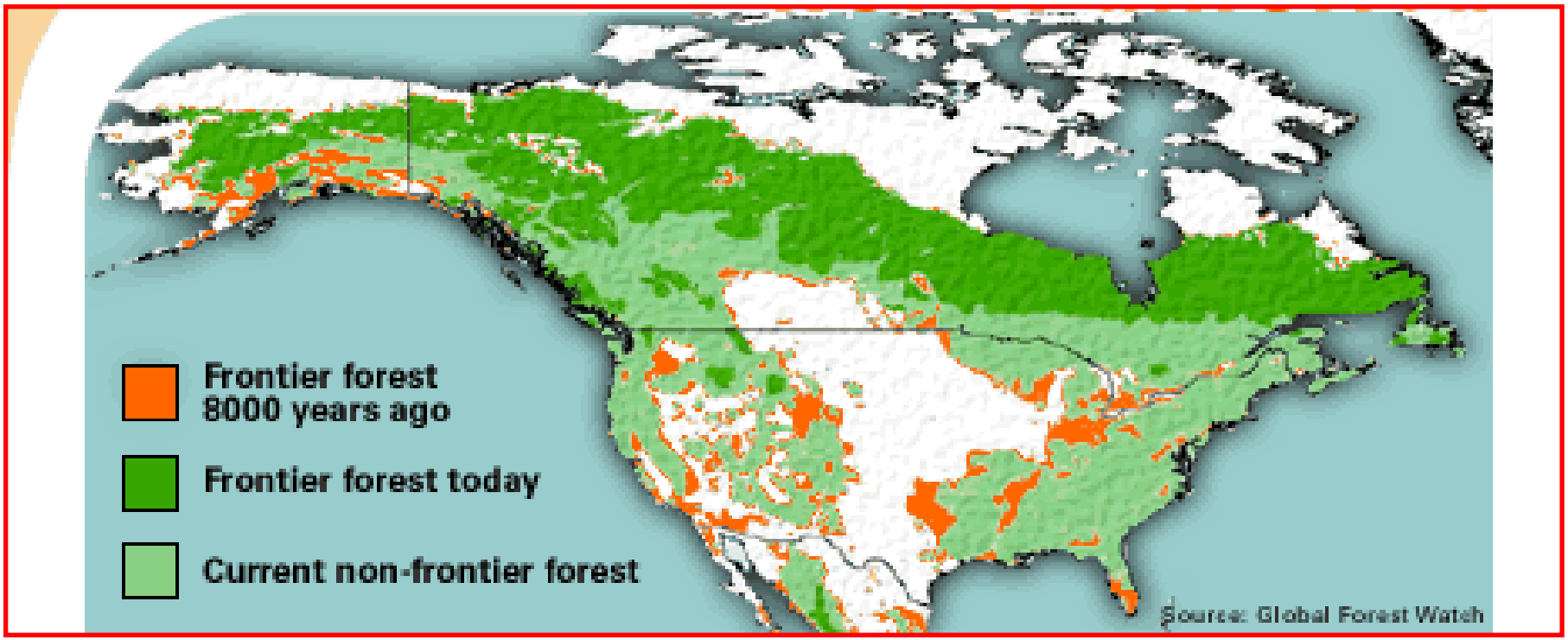

OPERATION FISH RUN II
CORPS OF ENGINEERS

Habitat

The supply and transport of water, sediment, and wood interact to structure salmon habitat.



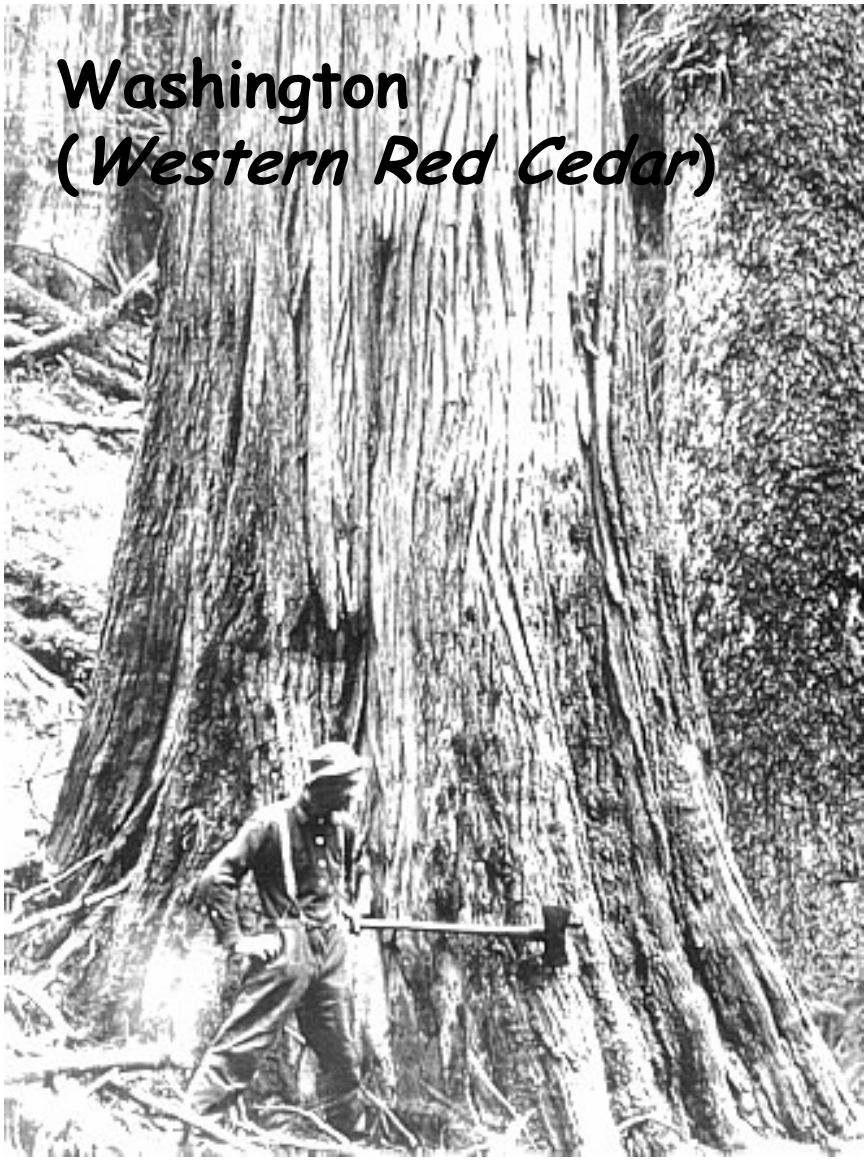
How well do we know what we are trying to restore?

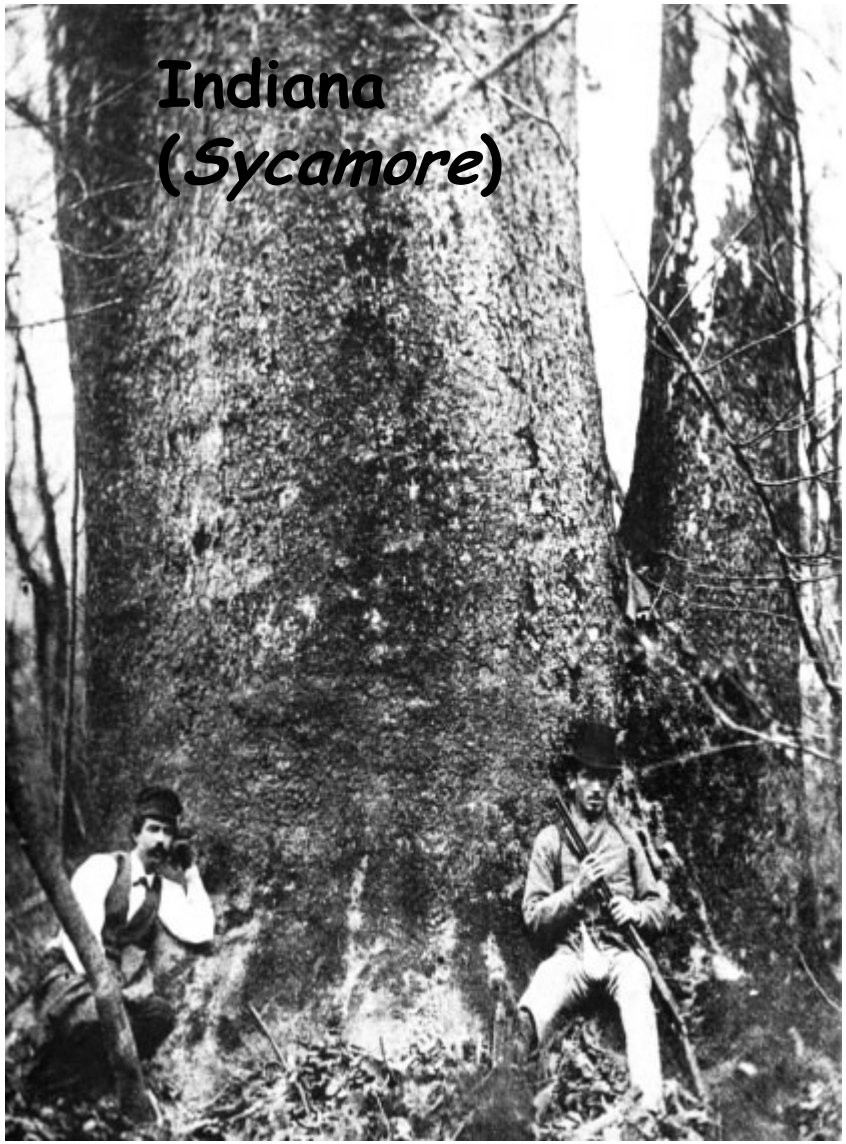


Most studies of fluvial systems come from areas that no longer host "frontier forests". How representative is our understanding of wood in world rivers?

Big trees influenced big rivers

Big trees were not limited to the Pacific Northwest

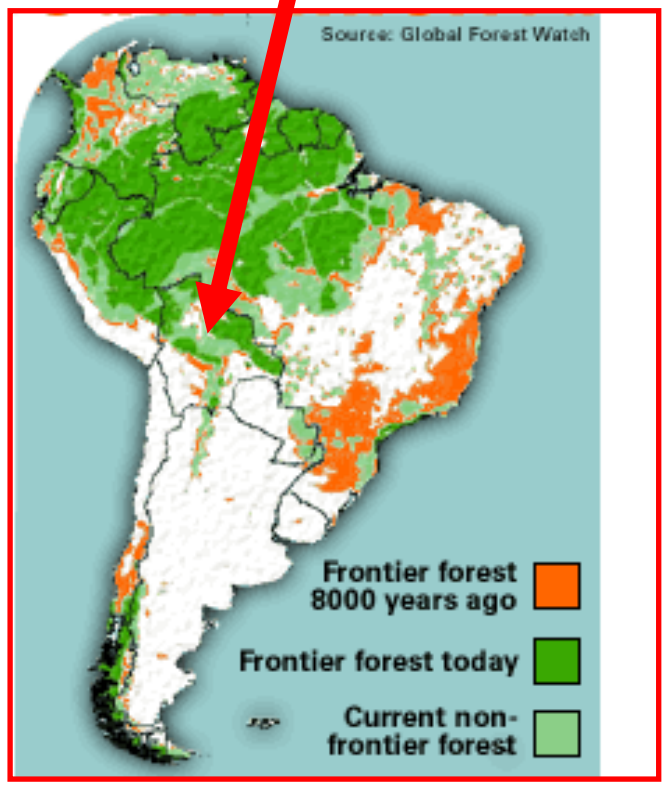




Snags on the Missouri

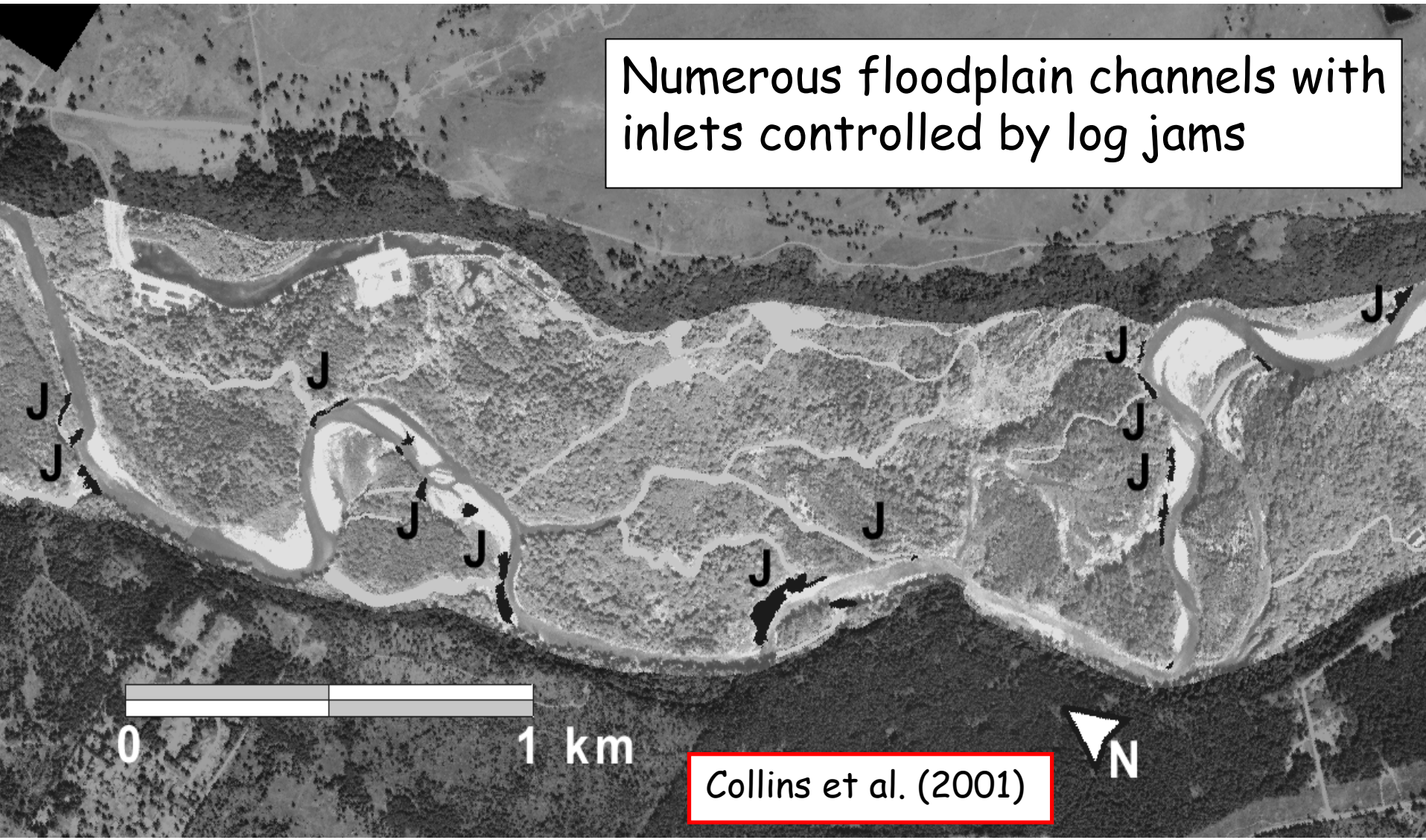
Karl Bodmer, circa 1840

Rio Beni
Bolivia

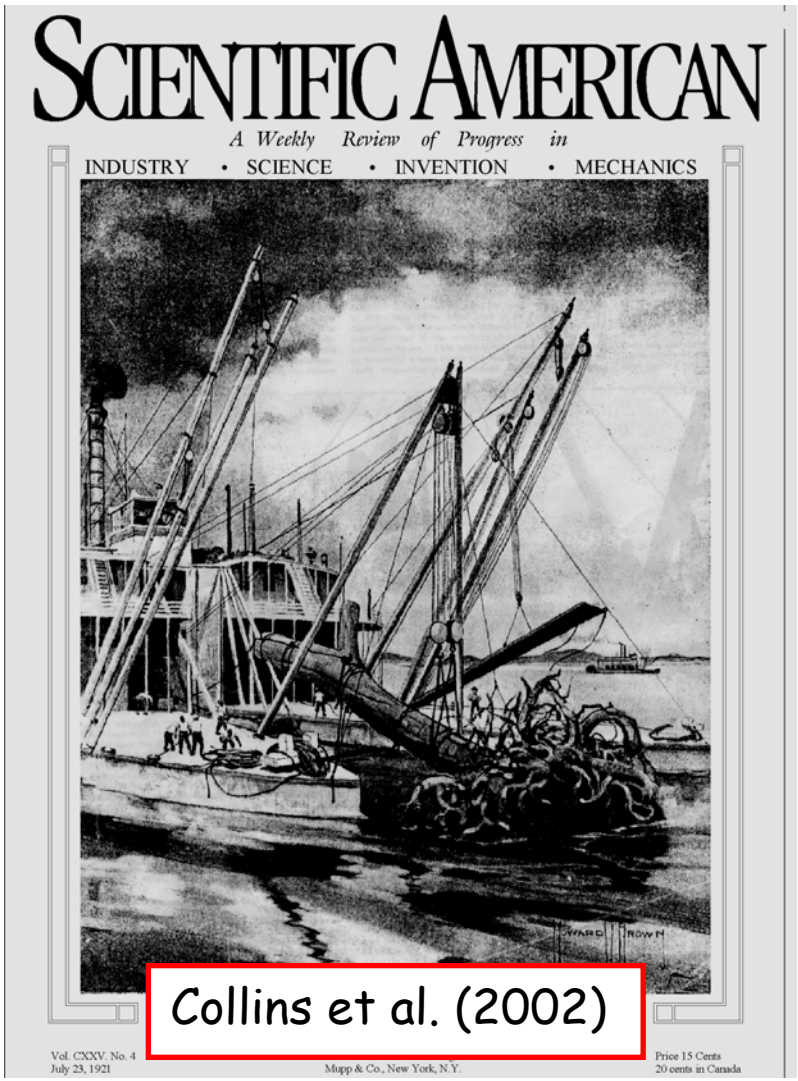


Nisqually River

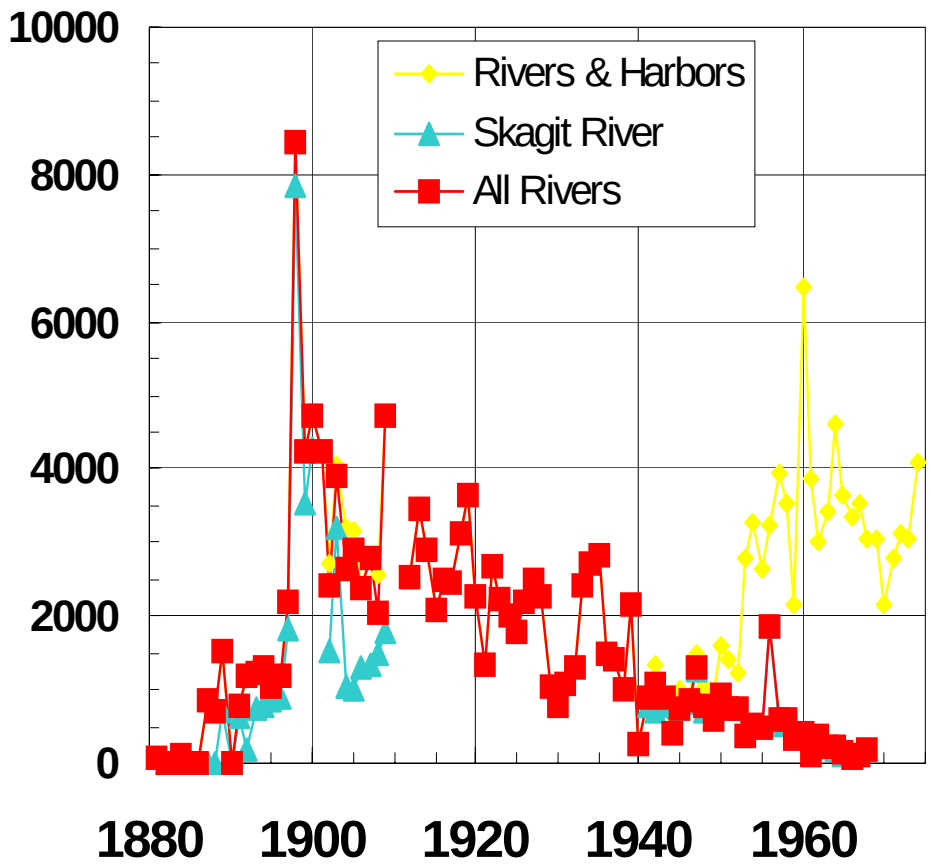
Nisqually River Floodplain



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

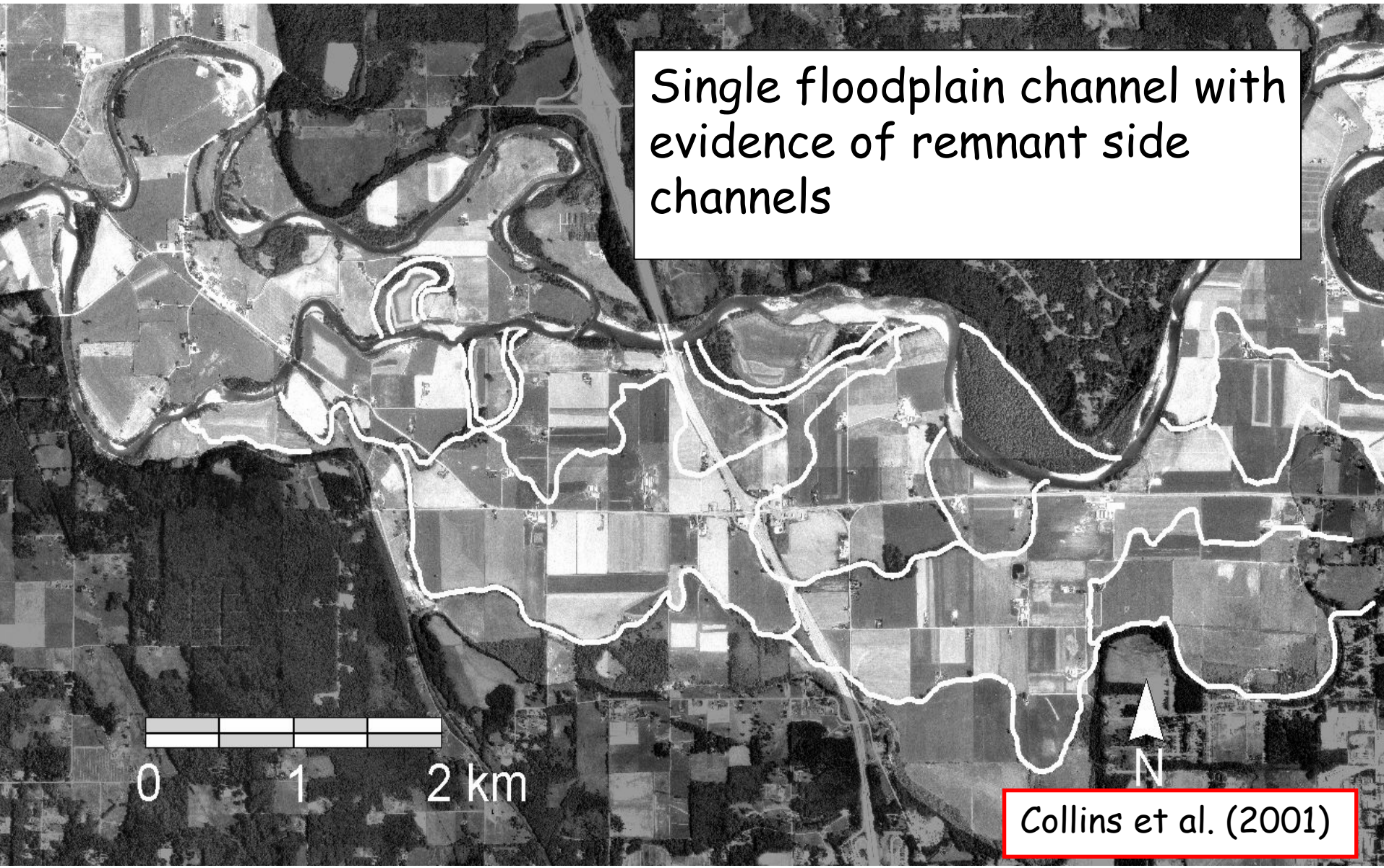


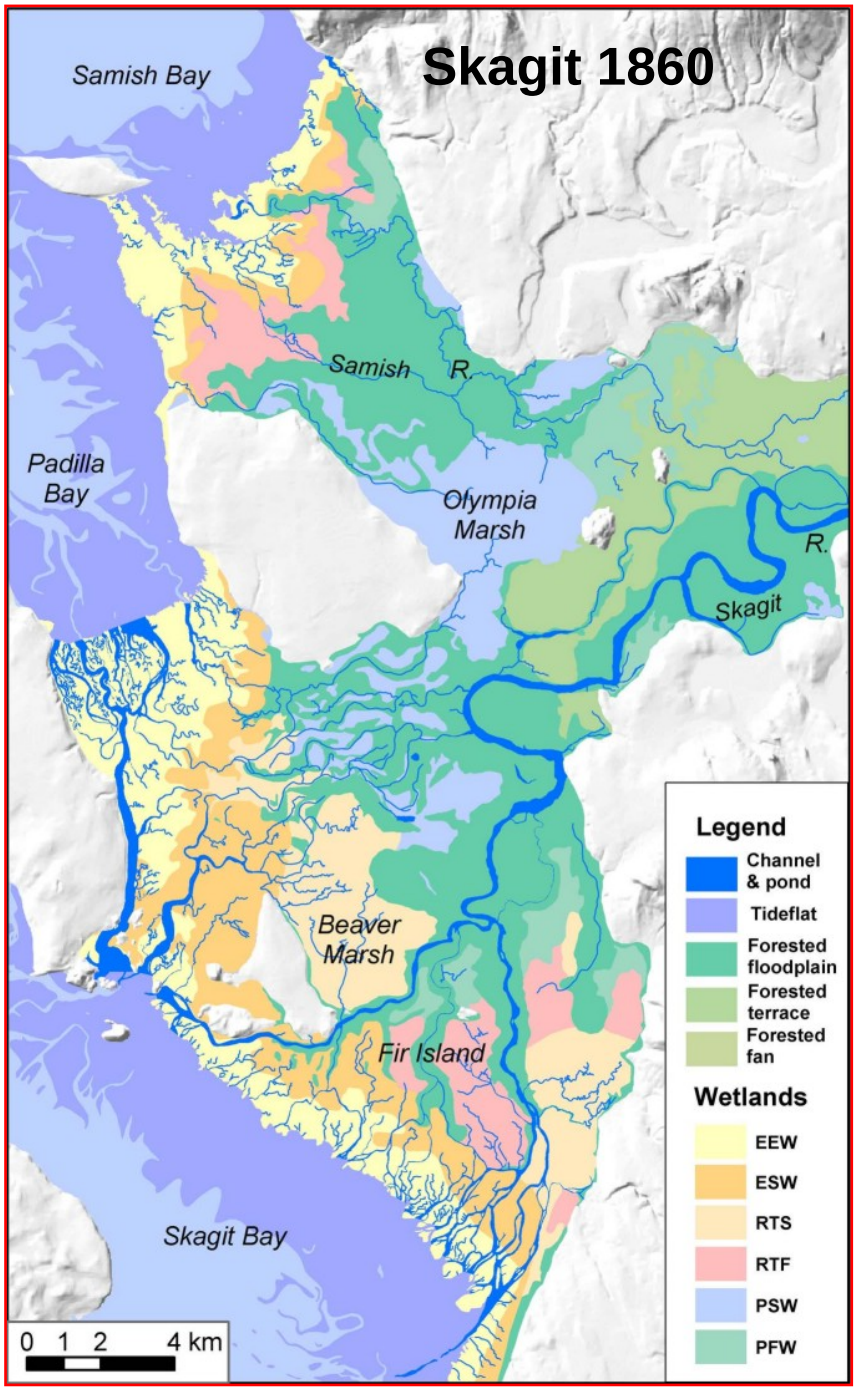
Collins et al. (2002)

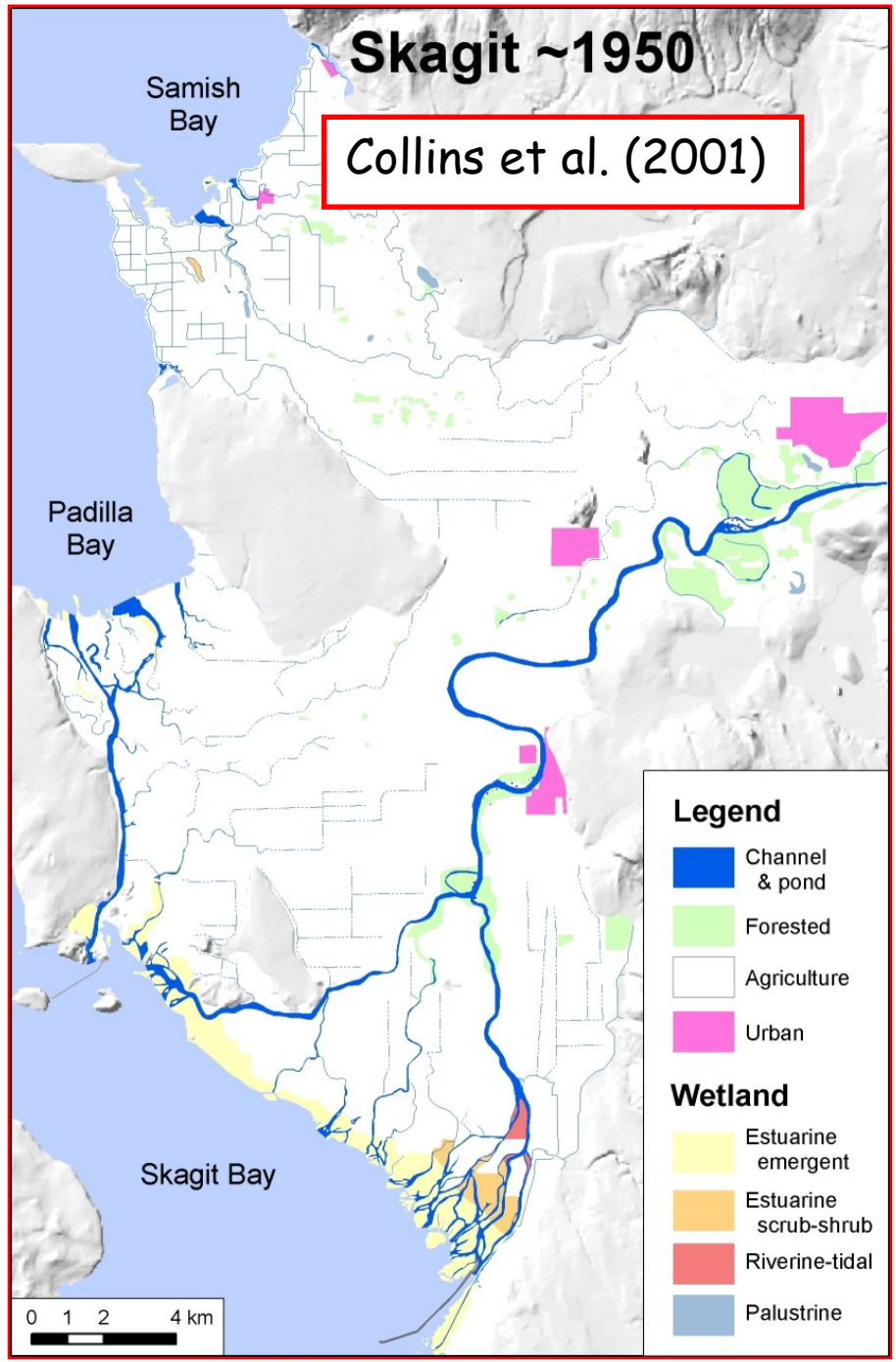


Snohomish River

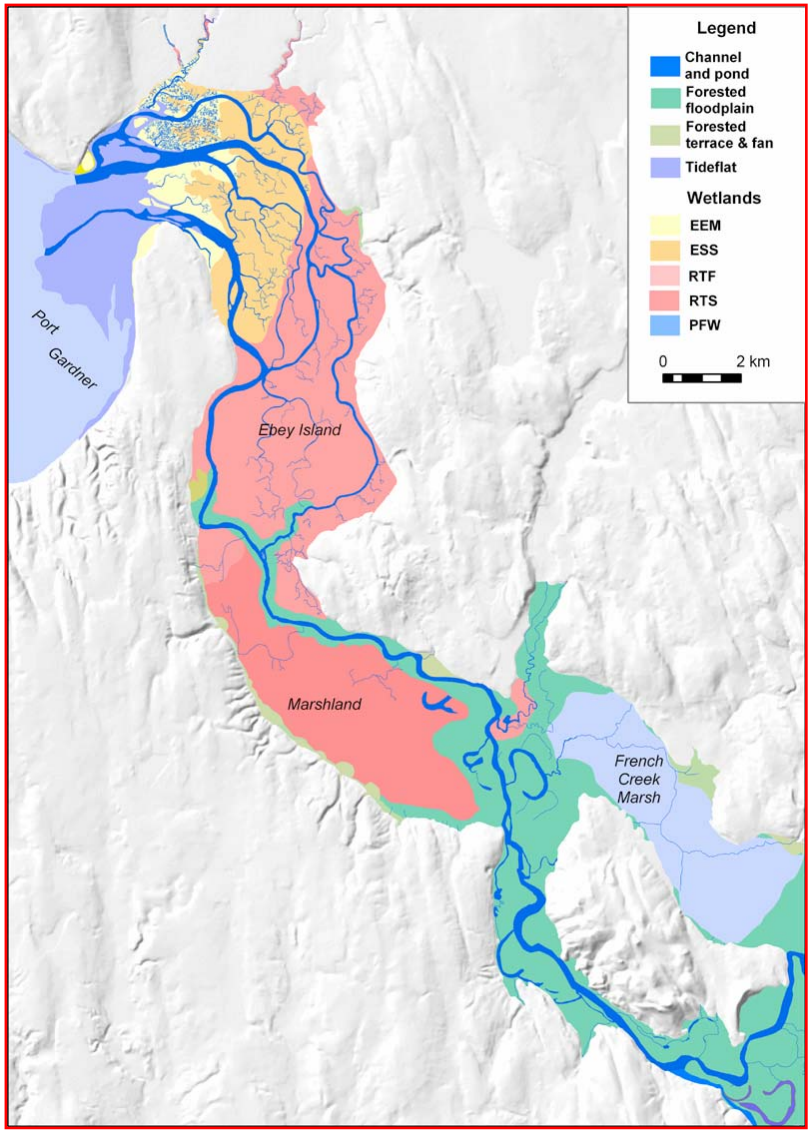
Stillaguamish River, Washington

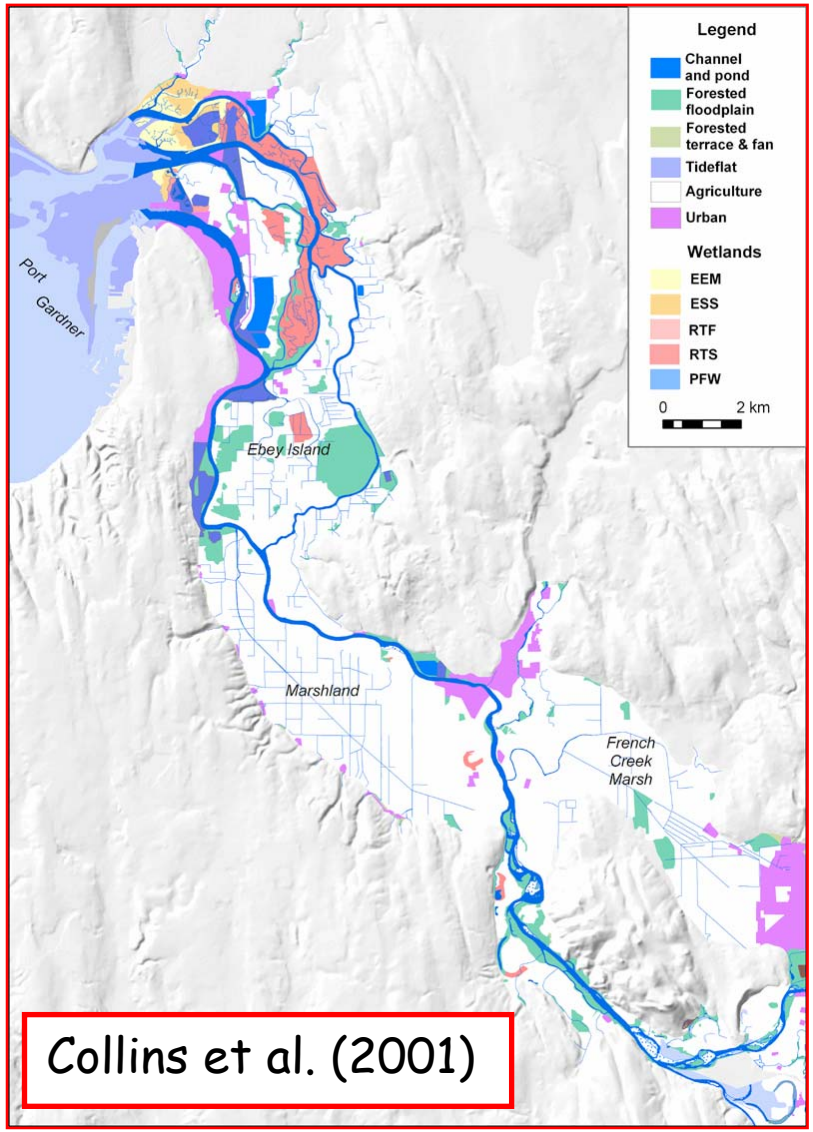



Skagit 1860
Samish Bay
Samish R.
Padilla Bay
Olympia Marsh
R.
Skagit
Beaver Marsh
Fir Island
Skagit Bay
0 1 2 4 km
Legend
Channel & pond
Tideflat
Forested floodplain
Forested terrace
Forested fan
Wetlands
EEW
ESW
RTS
RTF
PSW
PFW


Skagit ~1950
Collins et al. (2001)
Samish Bay
Padilla Bay
Skagit Bay
0 1 2 4 km
Legend
Channel & pond
Forested
Agriculture
Urban
Wetland
Estuarine emergent
Estuarine scrub-shrub
Riverine-tidal
Palustrine

Huge losses of side channels and valley bottom wetlands along most major Puget Sound rivers, yet the story for each river is unique.

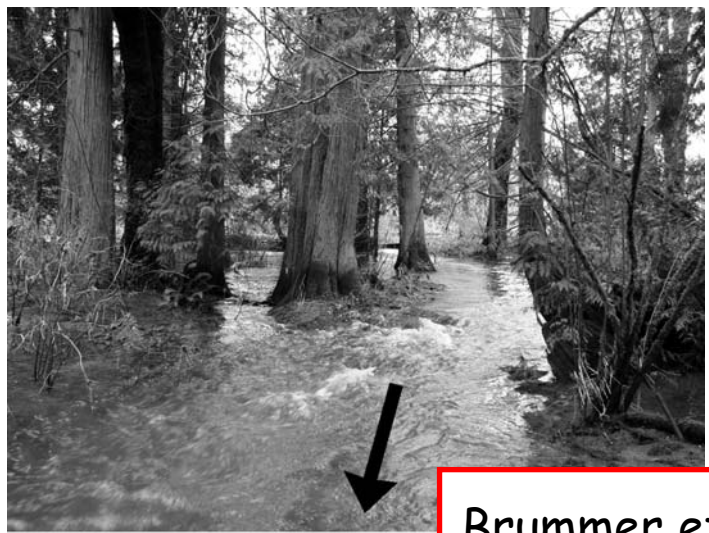




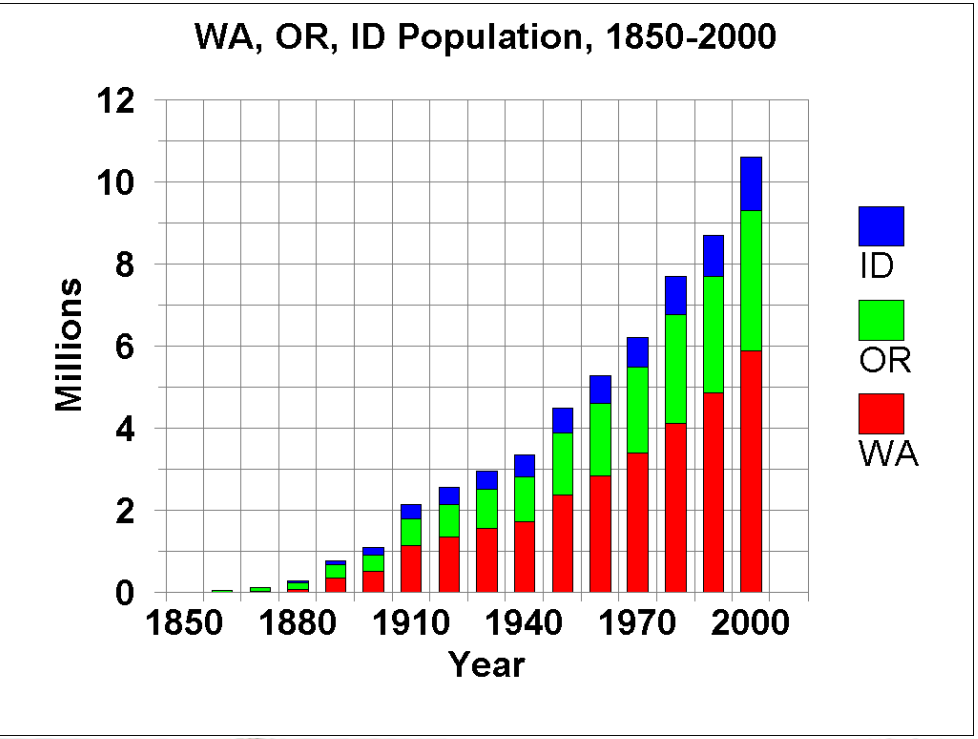
Collins et al. (2001)

Reintroduction of large woody debris leads to reactivated channel avulsion

Deschutes River 2001



Brummer et al. (in review)


WA, OR, ID Population, 1850-2000
Millions
12
10
8
6
4
2
0
1850
1880
1910
1940
1970
2000
Year
ID
OR
WA


The Seattle Times / Harley Soltes via AP


Restore?
Write off?
Rehabilitate?

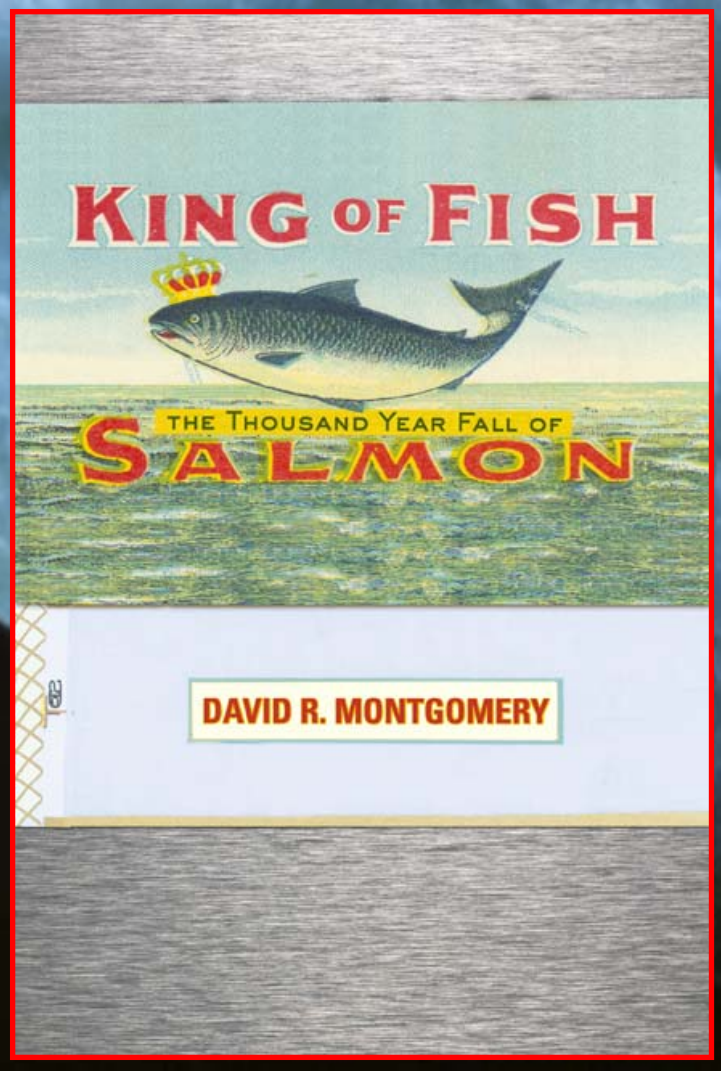
Provide some refuge for the salmon, and provide it quickly, before complications arise which may make it impracticable, or at least very difficult. … If we procrastinate and put off our rescuing mission too long, it may be too late to do any good. After the rivers are ruined and the salmon gone they cannot be reclaimed … all the power of the United States cannot restore salmon to the rivers after the work of destruction has been completed.

— Livingston Stone (1892)

One of the few strategies that might work over the long run would be to create a network of Salmon Sanctuaries by restoring forested river corridors along river floodplains.


1) Restore floodplains
2) Open blocked habitat
3) Provide adequate in-stream flows
4) Hire and empower riverkeepers
5) Isolate fish farms from wild fish
6) Stop fishing engandered runs!
The Seattle Times / Harley Soltes via AP

History



Process