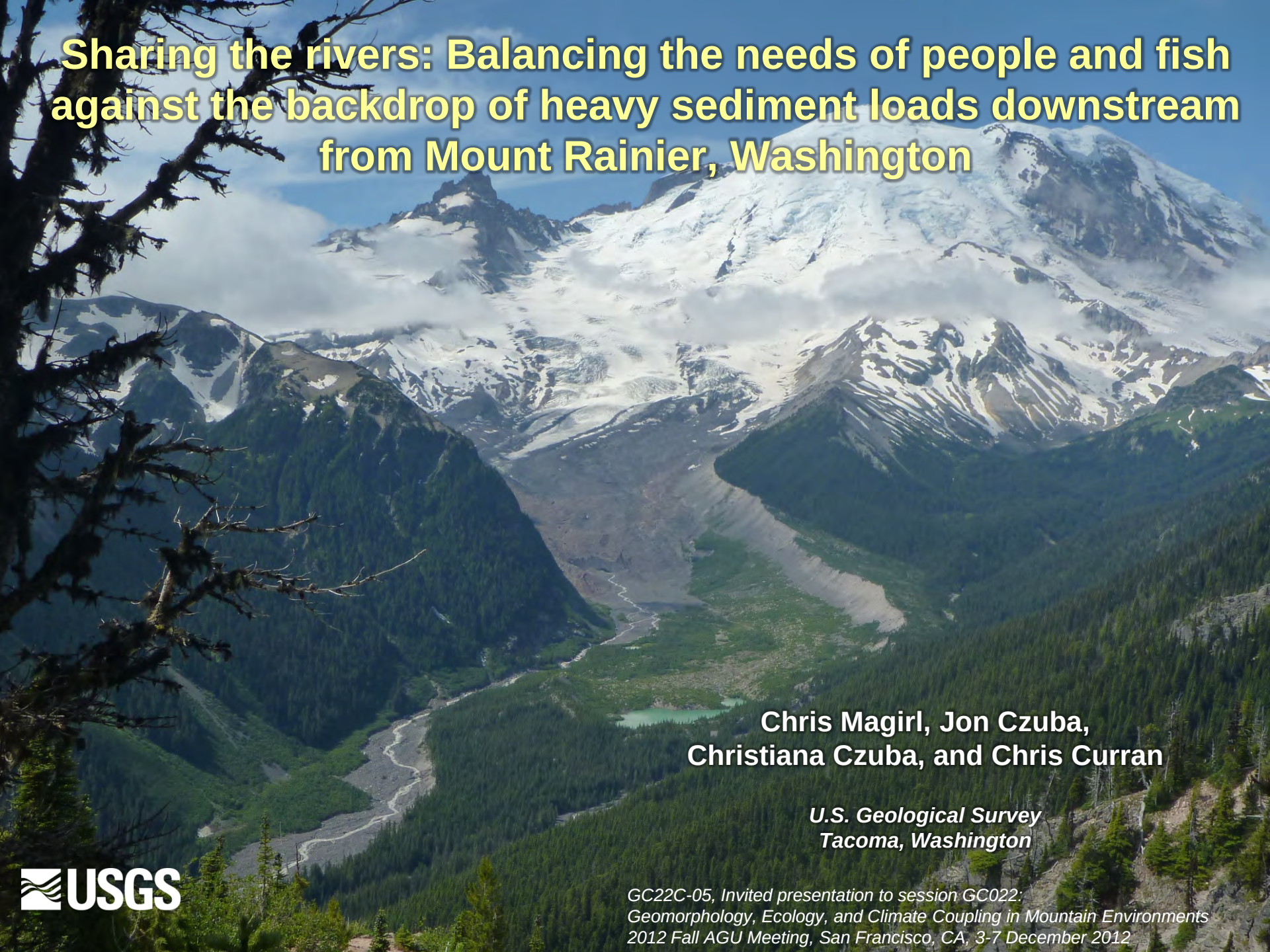


Sharing the rivers: Balancing the needs of people and fish against the backdrop of heavy sediment loads downstream from Mount Rainier, Washington

Chris Magirl, Jon Czuba, Christiana Czuba, and Chris Curran

U.S. Geological Survey
Tacoma, Washington

USGS

GC22C-05, Invited presentation to session GC022: Geomorphology, Ecology, and Climate Coupling in Mountain Environments
2012 Fall AGU Meeting, San Francisco, CA, 3-7 December 2012

Rivers draining Mount Rainier

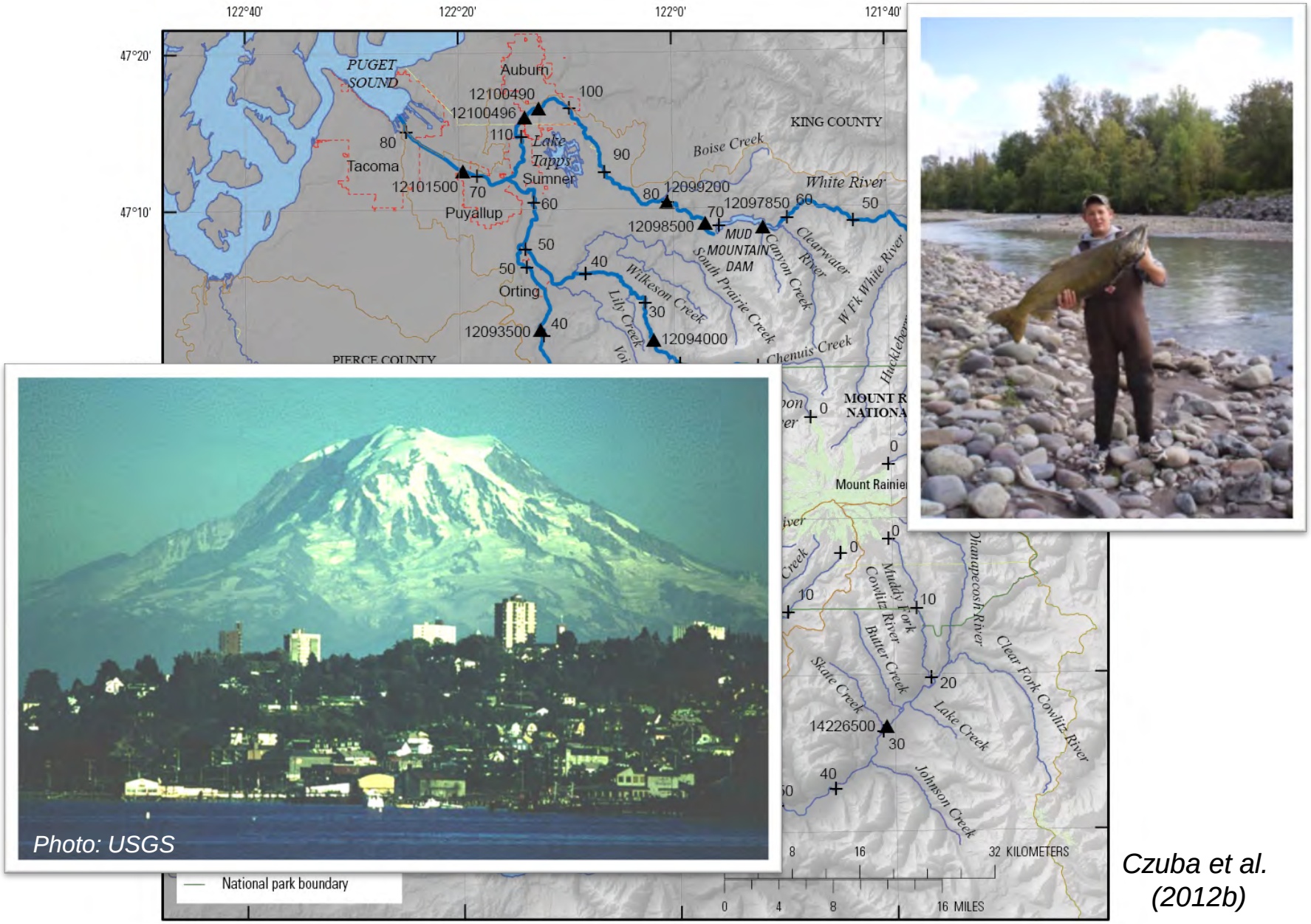
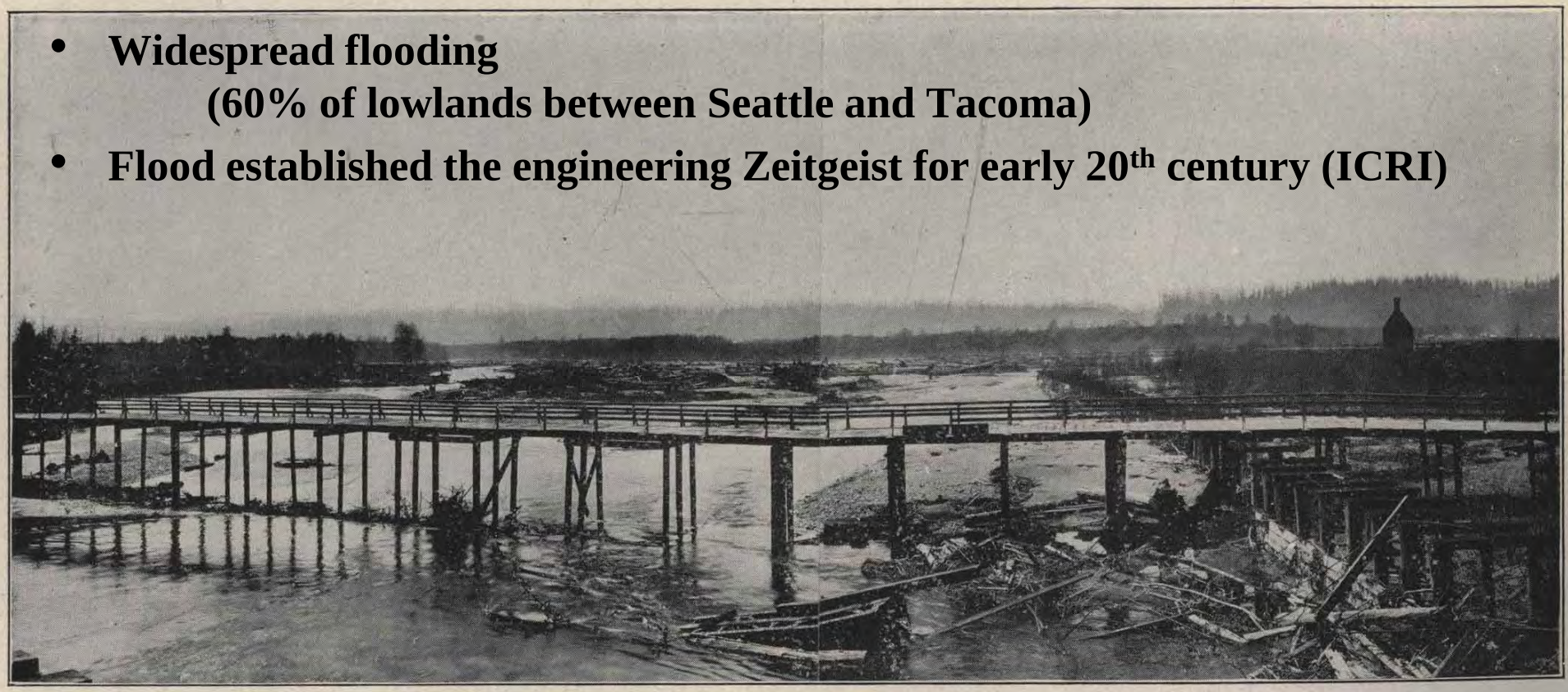


Photo: USGS

Czuba et al. (2012b)

White River floods of November 1906

- **Widespread flooding**
  (60% of lowlands between Seattle and Tacoma)
- **Flood established the engineering Zeitgeist for early 20th century (ICRI)**



STUCK VALLEY BELOW NORTHERN PACIFIC BRIDGE.

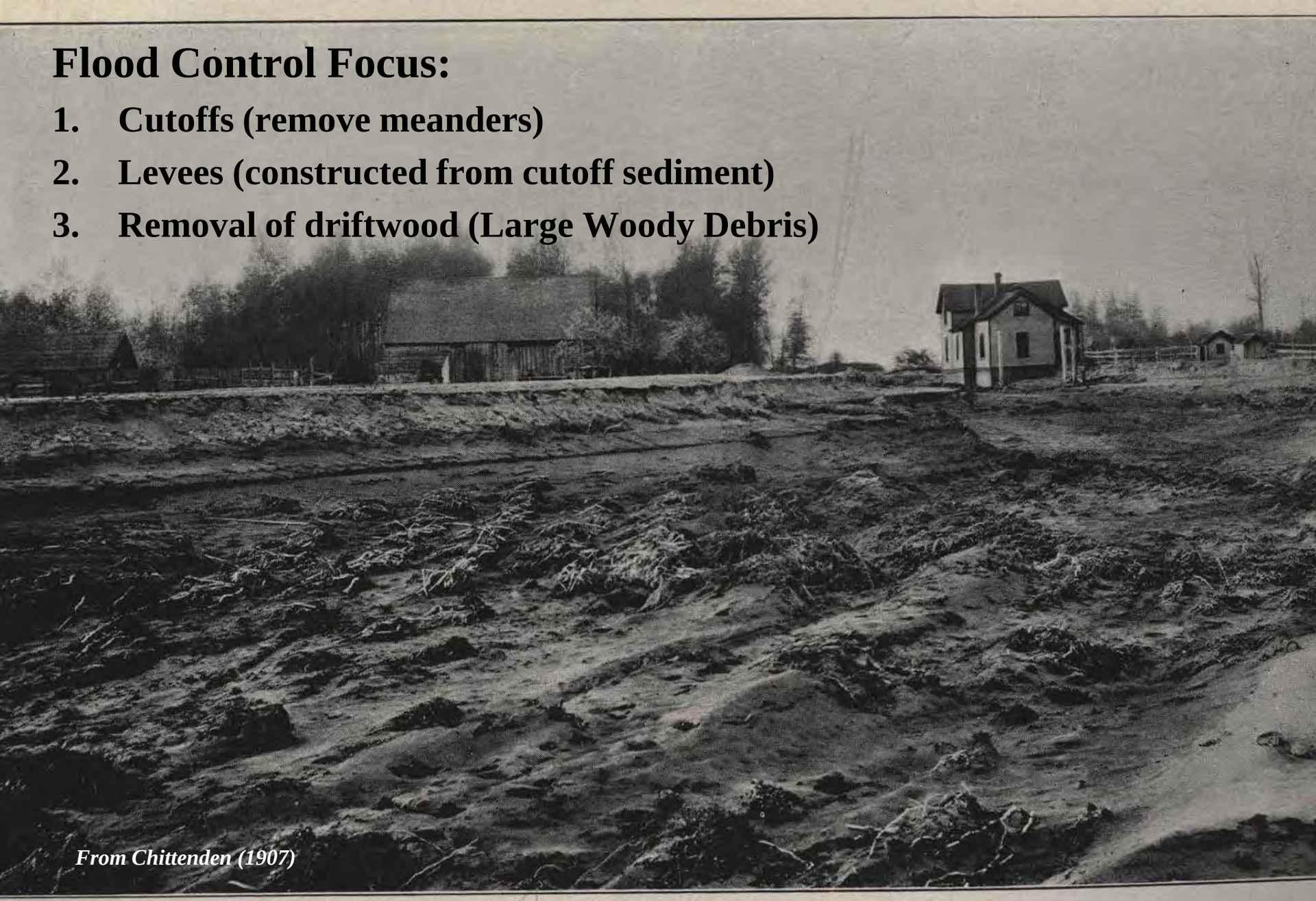
Showing great width of river bed cut out of arable land by flood of November, 1906. Showing also extensive accumulations of driftwood brought down by flood. Temporary County Bridge in foreground. Pacific "City" in right background.

From Chittenden (1907)

USGS

Flood Control Focus:

1. Cutoffs (remove meanders)
2. Levees (constructed from cutoff sediment)
3. Removal of driftwood (Large Woody Debris)



From Chittenden (1907)

WORK OF FLOOD IN LOWER PUYALLUP VALLEY, NOVEMBER, 1906.

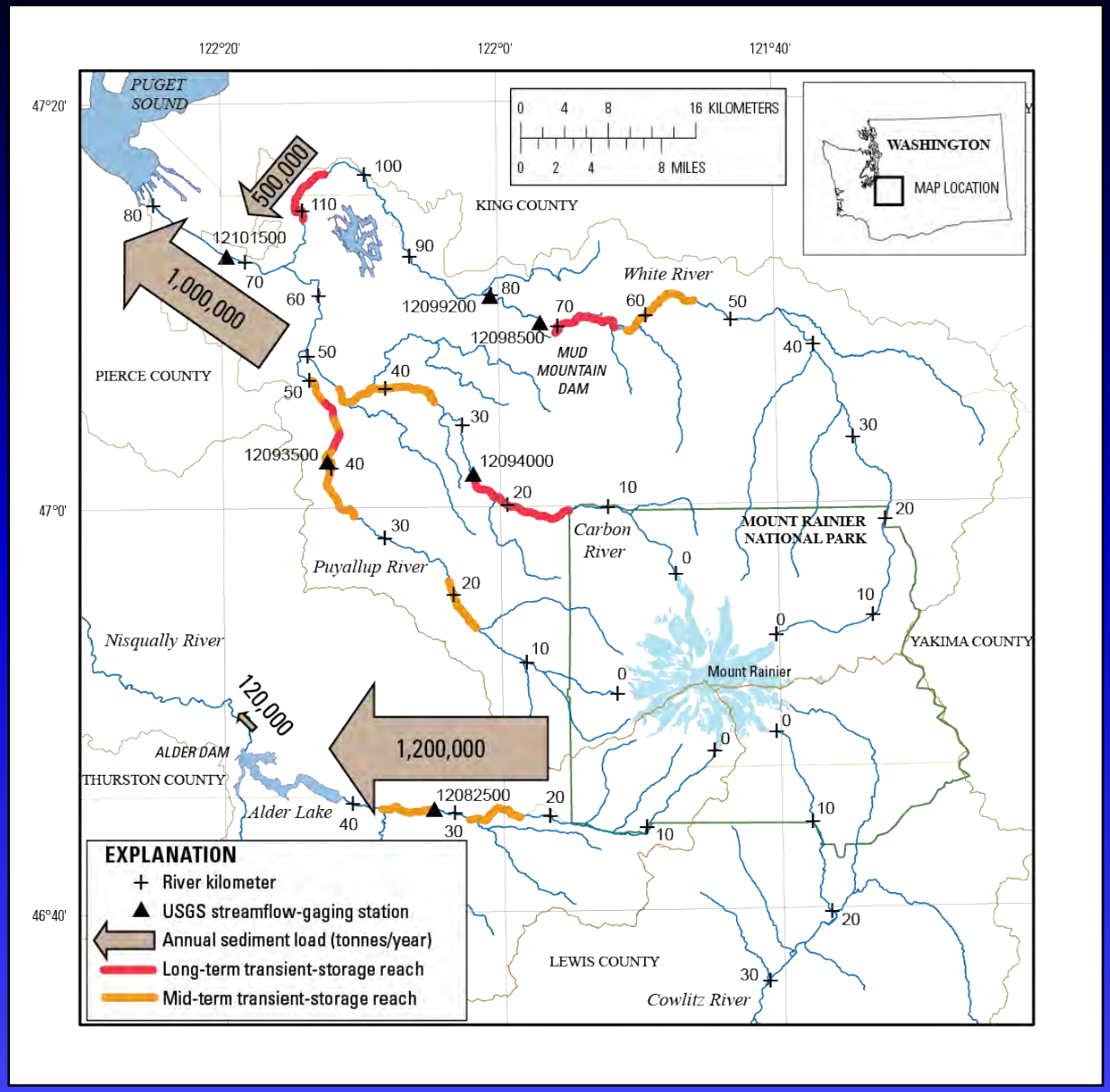
Foreground shows original surface of ground. Bank in background, about five feet high, is all deposit from the flood.

Mount Rainier is a prodigious sediment generator

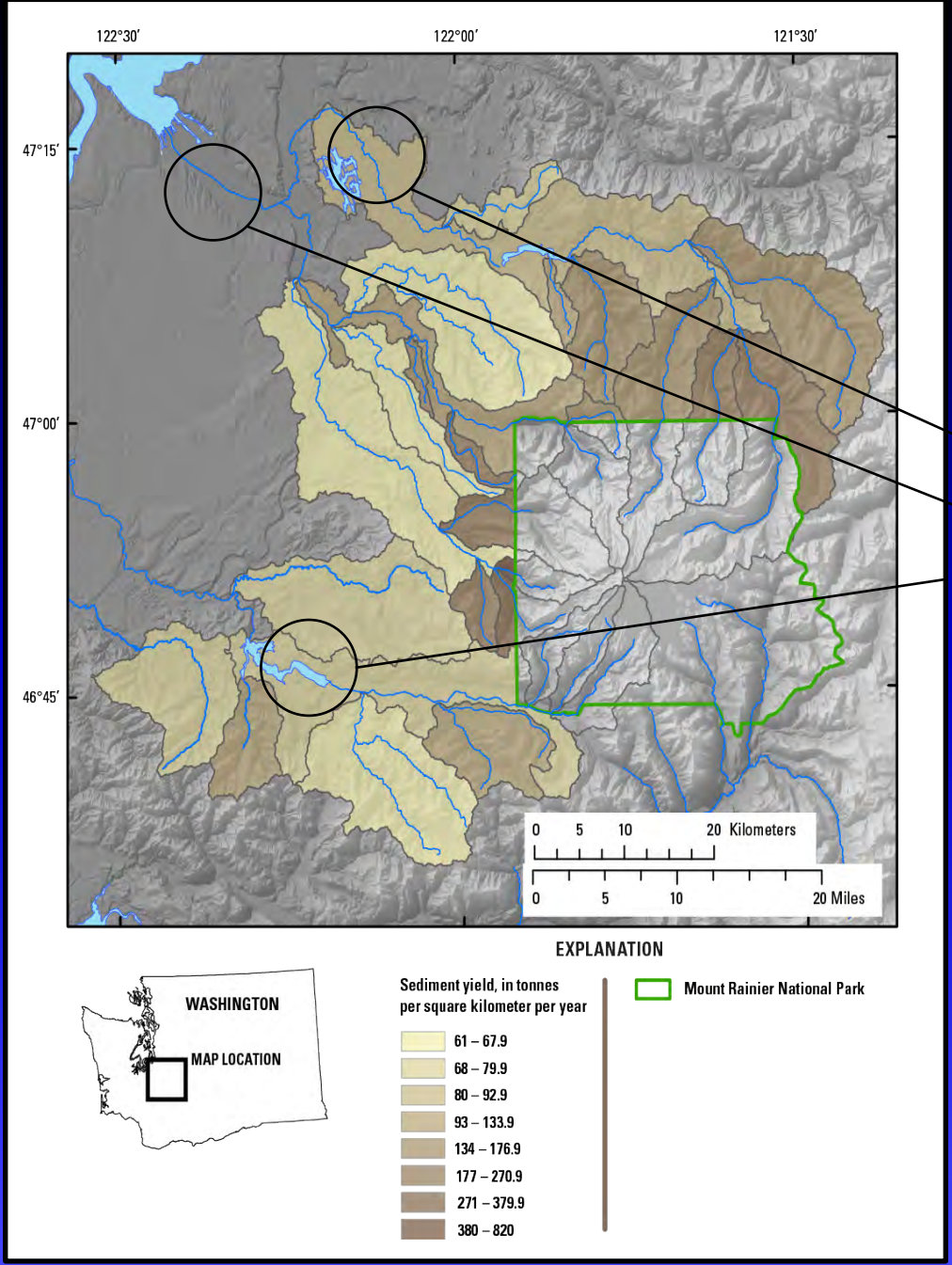
White River (June 2009)

Nisqually River (November 2010)

Sediment load in Mount Rainier rivers



Czuba et al. (2012a, 2012b)



Sediment-production potential from Mount Rainier National Park (MORA):

- Between 51-91% of total White River sediment load originates from MORA
- Between 58-93% of the total lower Puyallup River sediment load originates from MORA
- Between 83-98% of the total Nisqually River sediment load into Alder Lake originates from MORA

Czuba et al. (2012b)

Carbon Glacier (July 2011)

June 2011 Nisqually rock avalanche

Image courtesy Peter VIZY

Glaciers carry sediment

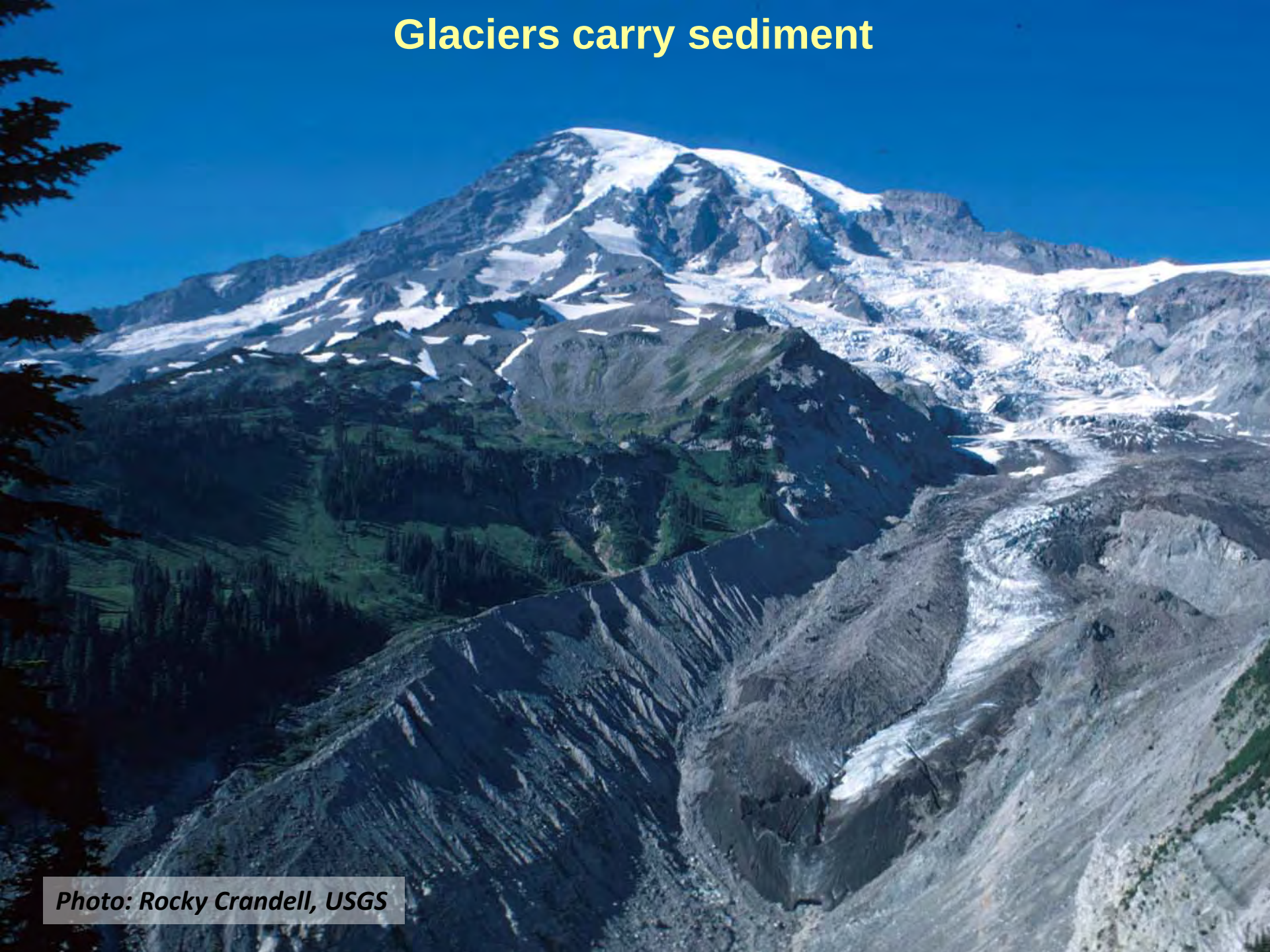
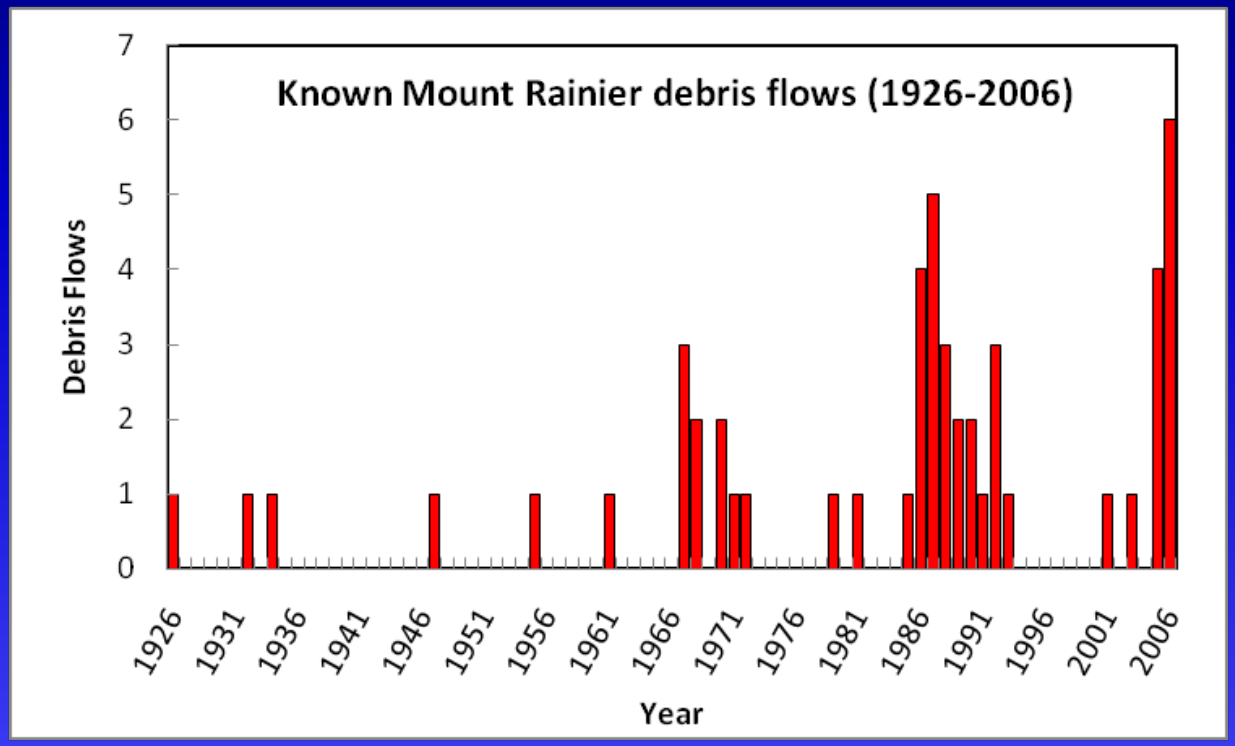


Photo: Rocky Crandell, USGS

Debris-Flow Activity from Mount Rainier

- 51 *known* debris flows from recently de-glaciated regions of Mount Rainier
- Historical debris-flow record incomplete
- Debris flows transport sediment

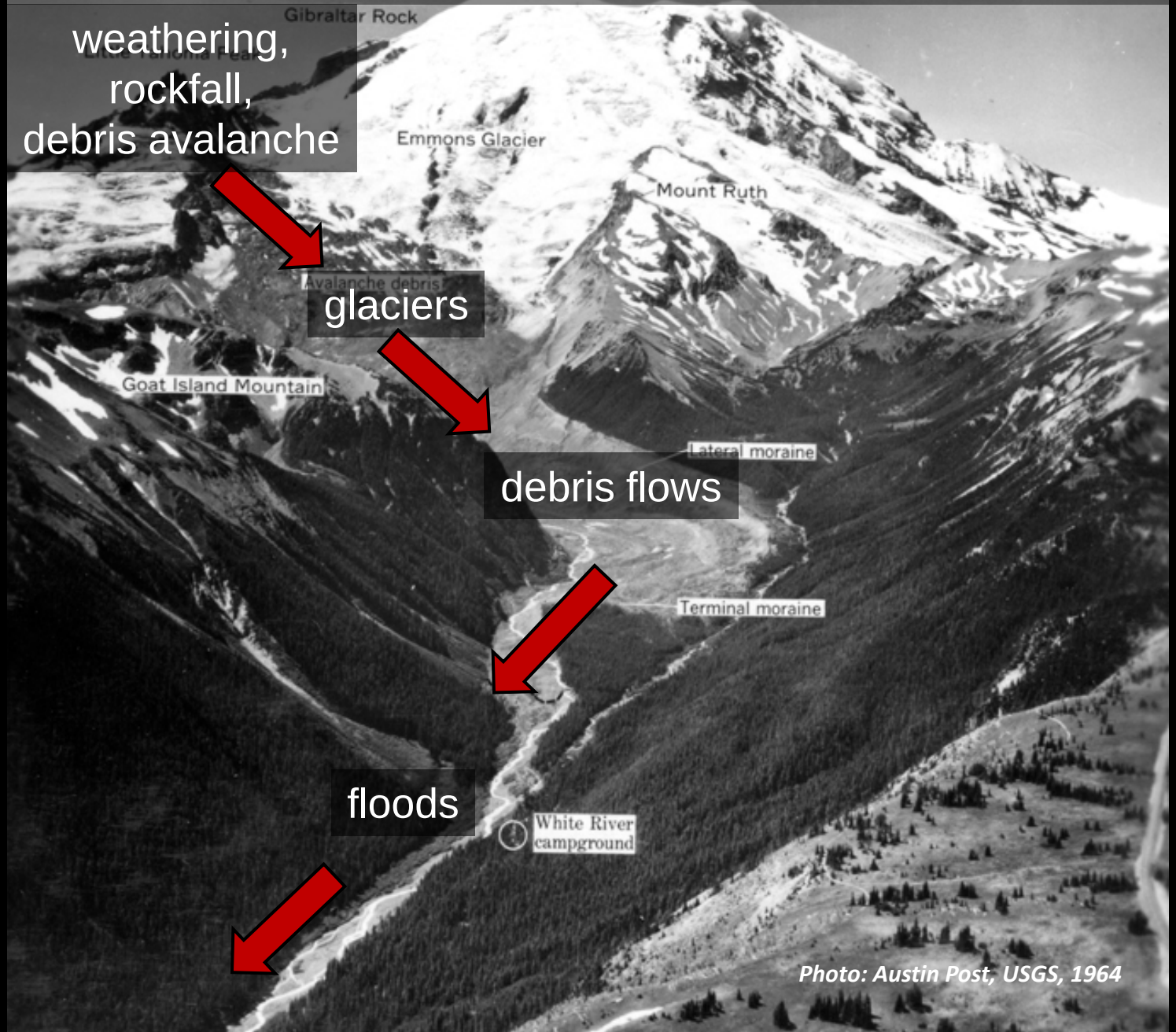


From Copeland (2009)

Floods move sediment

looding along Nisqually River at Longmire, Mount Rainier National Park, November 2006
hoto courtesy National Park Service

Sediment Delivery from Mount Rainier



Typical elevation

14,000'–10,000' — weathering, rockfall, debris avalanche

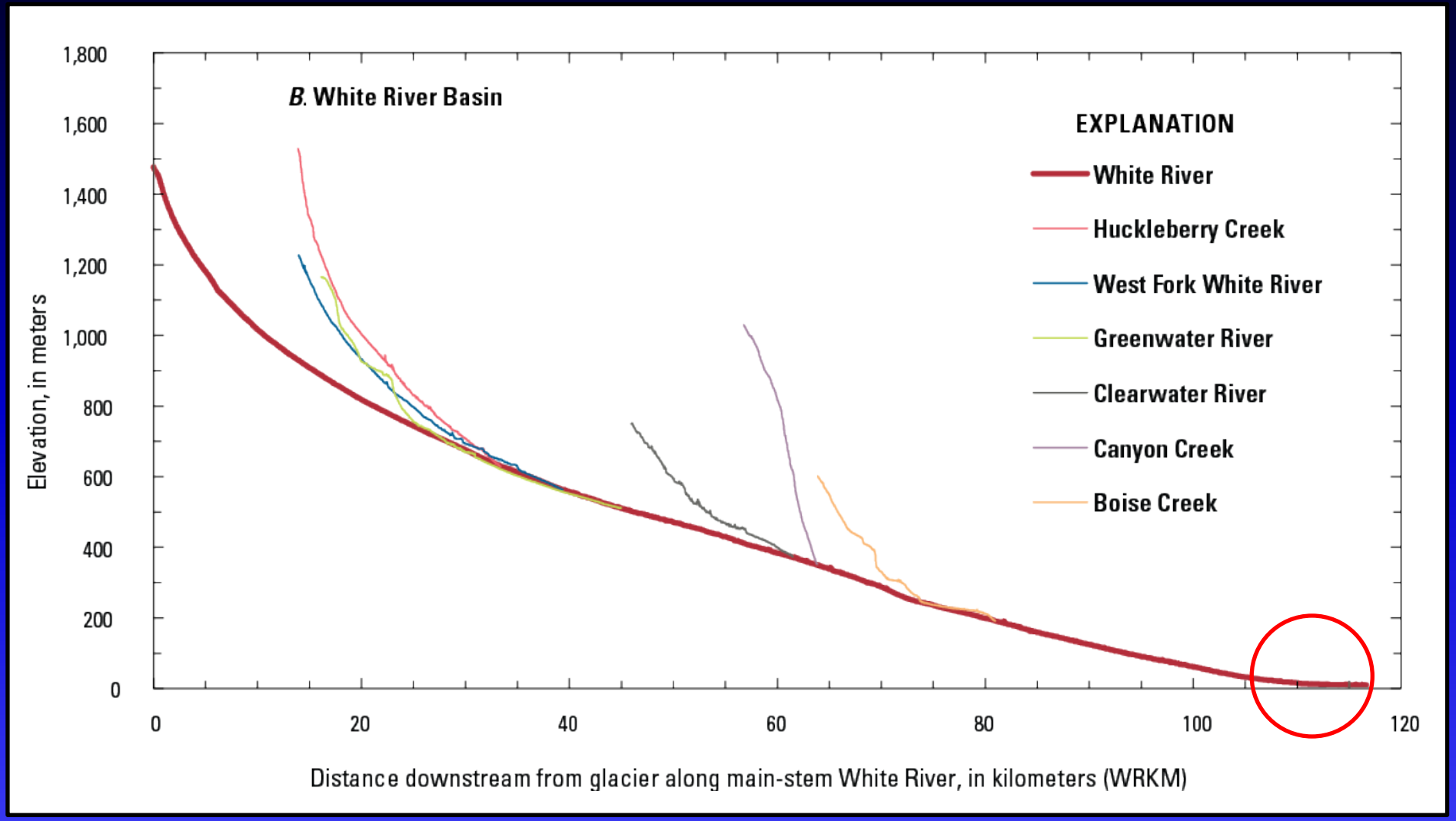
10,000'–5,000' — glaciers

8,000'–3,000' — debris flows

< 3,000' — floods

Photo: Austin Post, USGS, 1964

Slope of the White River



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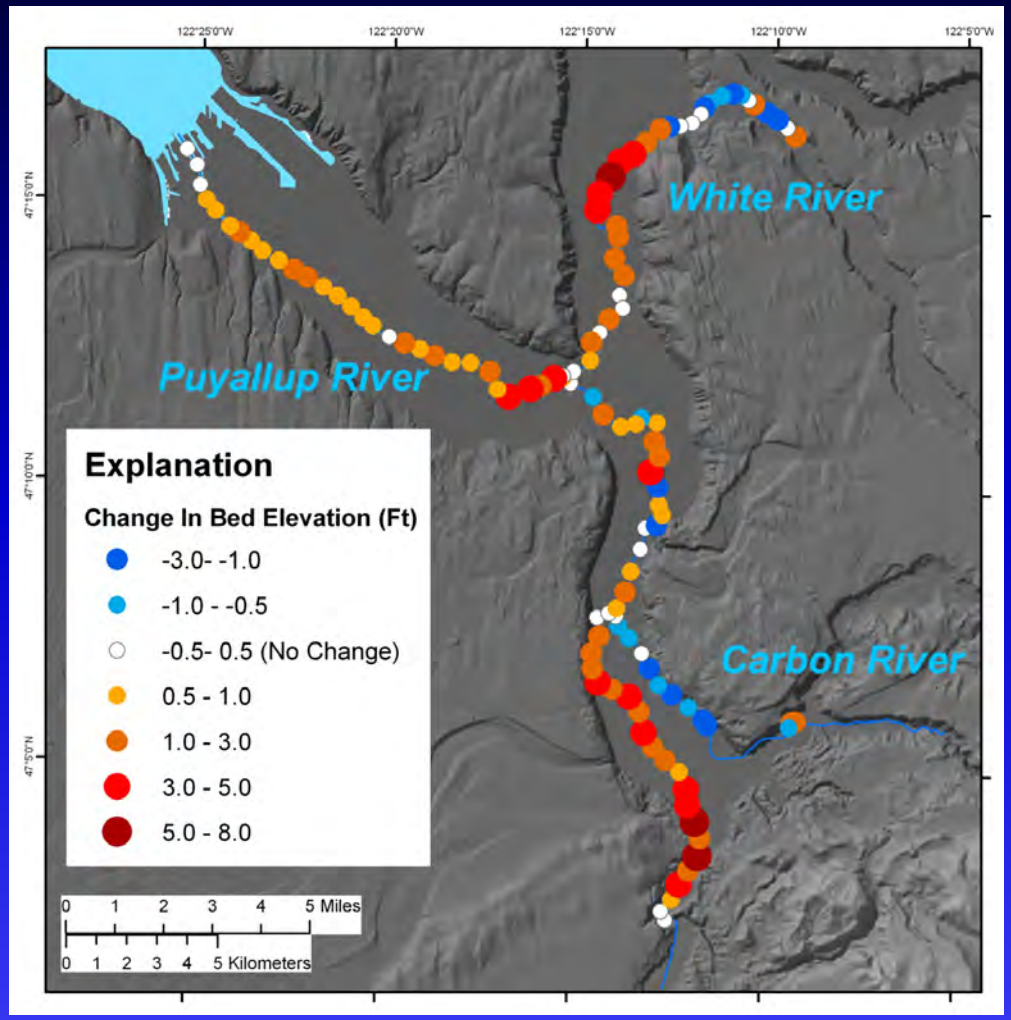
Czuba et al. (2012b)

Sedimentation in Puget Lowland Rivers 1984 - 2009



From Czuba et al. (2010)

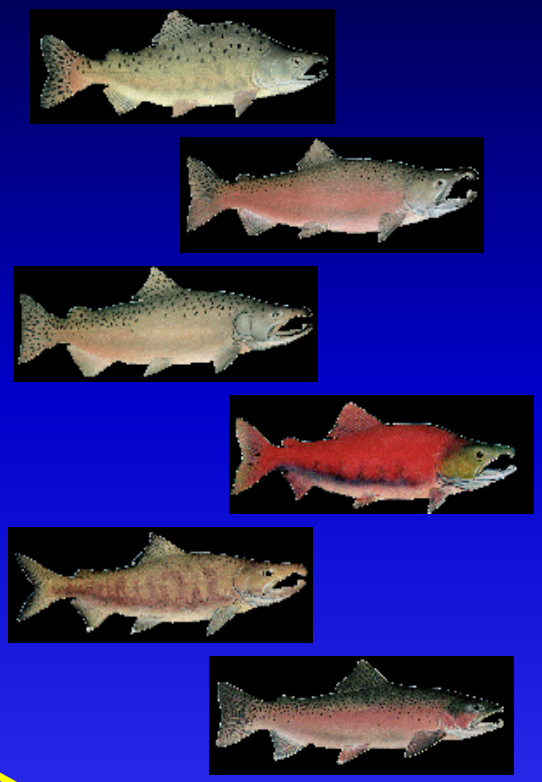
Filling with sediment...

(…particularly, large rocks)

USGS

Photo: Inter-County River Improvement Commission

Fish and the ESA



Gravel removal laws updated in Washington State in 1994 (WAC 220-110-140)

Levees in the news…

Close Up

GIVING WATER ITS SPACE

'NATURAL RIVER DEFENSES' | As floods along the Mississippi show the limits of dams and levees, some advocate new strategies of widening flood plains and wetlands so rivers can safely run freer.

BY BRIAN VASTAG AND FRANCES STEAD SELLERS
The Washington Post

A rising Mississippi River has forced hundreds of residents from their homes in a surge of rainwater and snowmelt that has been predicted to break records dating to 1927.

And last week, the Army Corps of Engineers pulled a trick it had not been forced to use in nearly 75 years: It blew open a two-mile run of a Missouri levee, sacrificing about 130,000 acres of farmland and 100 homes to save the town of Cairo, Ill.

The dramatic trade-off "reactivated the flood plain," in engineer-speak. It also highlighted limitations in the long-term strategy of hemming in rivers with levees and dams, then pushing farms and towns up against the river walls.

"For decades we've treated levees as the only line of defense" against floods, said Andrew Fahlund, senior vice president of American Rivers, which advocates for healthy waterways. "They ought to

flooded 15 times over the past 20 years — will soon spread out a bit more. Engineers have started pushing back levees, mile by mile. The straightened, channelized river could no longer handle the increased snowmelt from Mount Rainier, said county engineer Dennis Dixon. "After 100 years, we're seeing that's not quite working."

Meanwhile, Cedar Rapids, Iowa, has been buying out 1,300 homes and 100 businesses in a flood plain inundated by the town's "800-year flood" of 2008, said Mayor Ron Corbett. "We're really moving people out of harm's way," he said, to establish a 220-acre "floodable greenway."

But on May 3, the city's voters narrowly rejected a 1-cent increase in the sales tax to pay for revamped, gently sloped levees. The corps also rejected part of the plan, leaving the city to search for other funding. The project is now jeopardized, Corbett said.

A fundamental change

which can trigger more intense deluges, said Kenneth Trenberth, a senior scientist at the National Center for Atmospheric Research. A report published in the journal Nature in February concluded that North America ex-

this year — on top of a "thousand-year" deluge in Tennessee last year and widespread flooding in the Upper Midwest in 2008 — will prompt greater adoption of natural flood defenses.

The Dutch — often consid-

won back from the wet: More than 60 percent of the population lives at or below sea level.

But the country has been gradually sinking inside its giant defenses and is crossed by increasingly tempestuous

which involves lowering dikes in some areas and moving them back, inviting the rivers to flood, and creating space for them to do so safely.

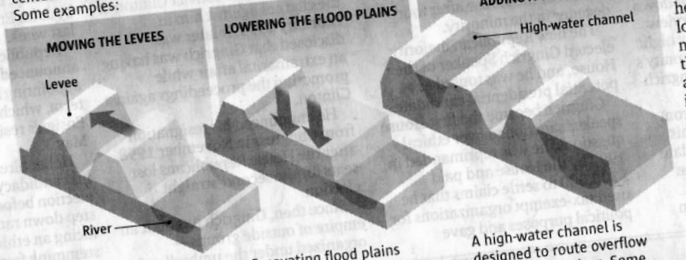
"Room for the river"

Called "ruimte voor de rivier" or "room for the river," the strategy is intended to help the rivers "cope with a lot more water than they do now," said spokeswoman Esther van Dijk. It involves about 35 projects — including relocating dikes, deepening riverbeds and even permanently turning farmland back into flood plain — at a cost of more than $3 billion. The effort is expected to be completed by 2015. Households and neighborhoods, meanwhile, do their part by finding ways to store stormwater temporarily, by using cisterns or flooding public parking garages.

The scale is different along the mighty Mississippi, but similar "economic and human capital is at risk," Morris said. The Dutch, who have offered advice on integrated water management in several parts of the United States, including the Sacramento River in California, have not

Giving a river room to overflow

Some of the flood-control methods being put in place by the Dutch, who have battled water for centuries, might be useful in this country. The goal is to give the river space to flood safely. Some examples:



Pulling levees inland makes the flood plain wider. Some levees will be removed completely to allow once-reclaimed land to flood.

Excavating flood plains will allow them to hold more water. Channels and riverbeds will be dug deeper in some places as well.

A high-water channel is designed to route overflow away from the river. Some water will be routed to lake beds for temporary storage.

THE WASHINGTON POST

Sources: Room for the River, American Rivers

Key Take-Aways So Far

- Mount Rainier rivers carry ~1 million tonnes/yr, a sediment surplus
- Heavy loads from Mount Rainier will continue
- Challenges for flood-risk management

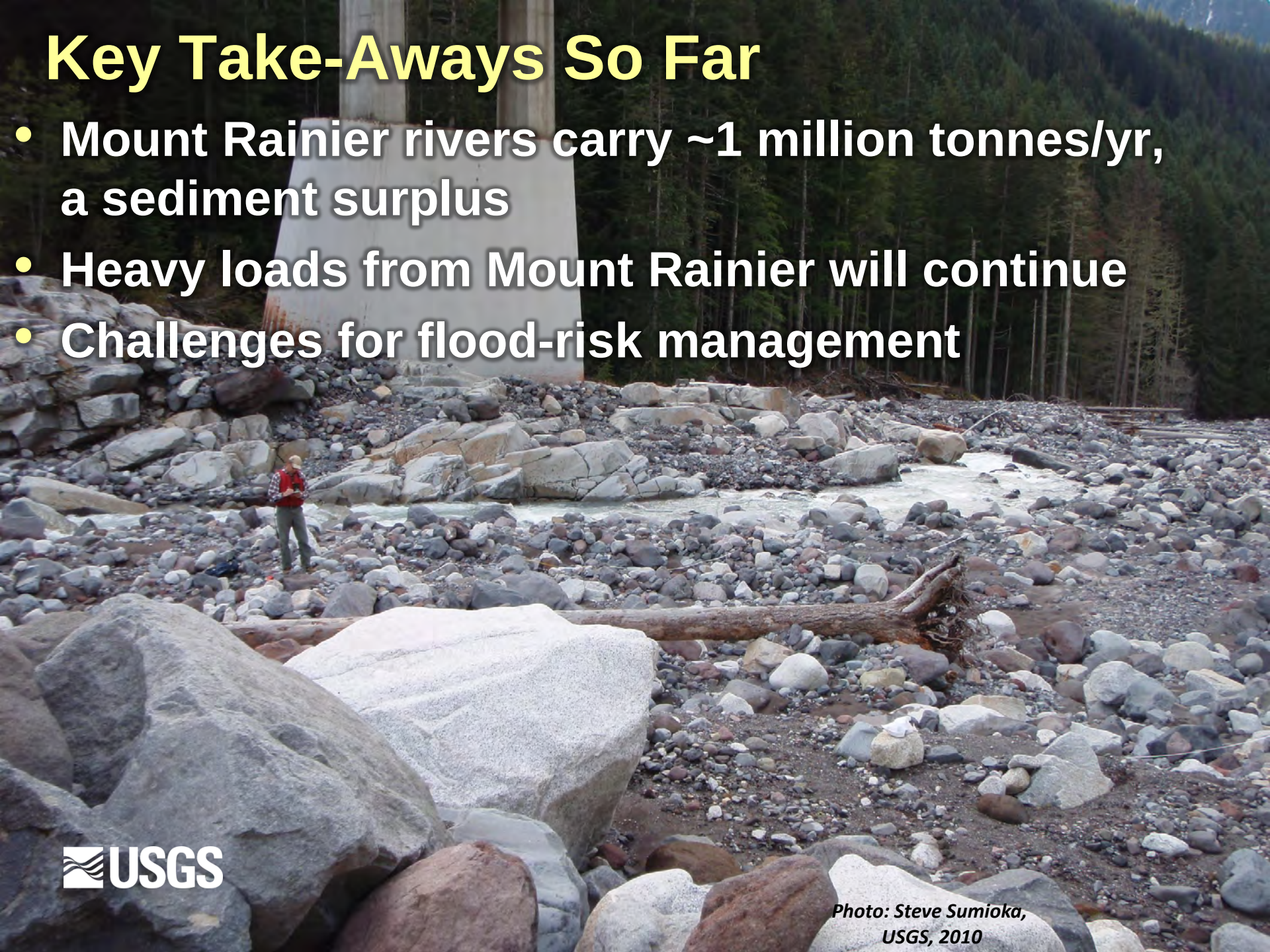


Photo: Steve Sumioka, USGS, 2010

Acknowledgments

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USGS

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