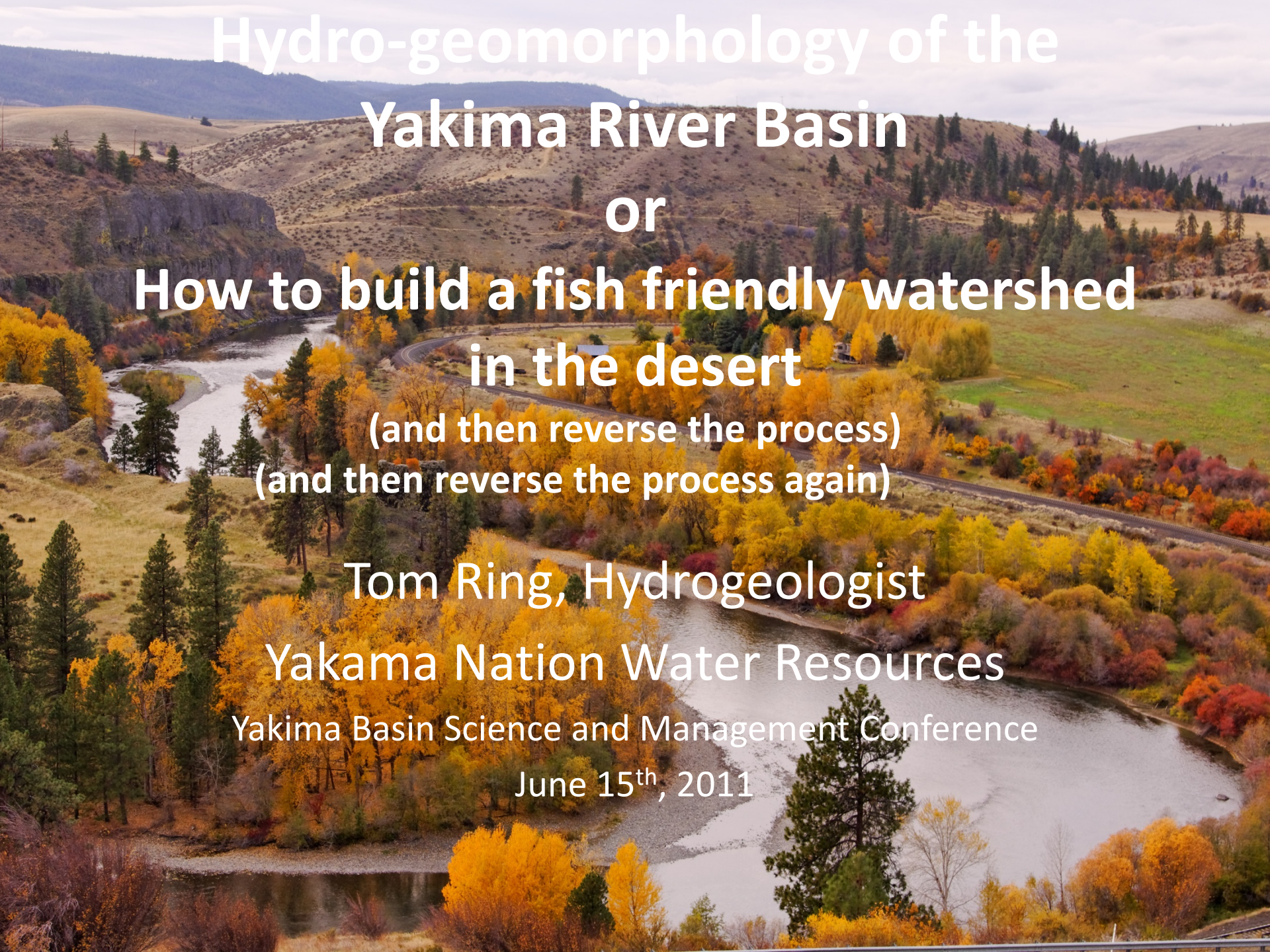


Hydro-geomorphology of the Yakima River Basin or How to build a fish friendly watershed in the desert

(and then reverse the process)

(and then reverse the process again)

Tom Ring, Hydrogeologist

Yakama Nation Water Resources

Yakima Basin Science and Management Conference

June 15th, 2011

Disclaimers

- Disclaimer 1. I do not speak for the Yakama Nation. Opinions expressed are my own. Facts cited are from reputable sources or made up for this talk.

- Disclaimer 2. **Hydro-geomorphology** is probably not actually a word. But Dave Fast assigned me the title, so I have to attempt to speak about it.

Itenerary

- Build the watershed from scratch
- Water it up
- Wreck it …er… improve it
- Improve the improvements

Yakima River Basin 101

Largest watershed within WA

Drains east slope of south WA Cascades

Discharges to Columbia above Wallula Gap (note the ridges)

Yakima Basin 101
The Fish

- Before before
  - Upper Yakima habitat under glacier ice
- Before
  - Abundant populations of Chinook, Sockeye, Coho, Steelhead etc
- Between then and now
  - Chinook severely reduced
  - Sockeye, Coho extirpated
  - Steelhead, Bull Trout listed
- Now
  - Recovery well under way

Yakima Basin Geology 100&1/2 Building the basic structure

- Yakima Basin History features
  - Plate Tectonics
    - Built the whole state
  - Volcanic History
    - Cascades
    - Flood basalts
  - Alpine Glaciation
    - Erosion in upper basin
    - Deposition in valleys
  - Armwrestling
    - Naches v. Upper Mainstem

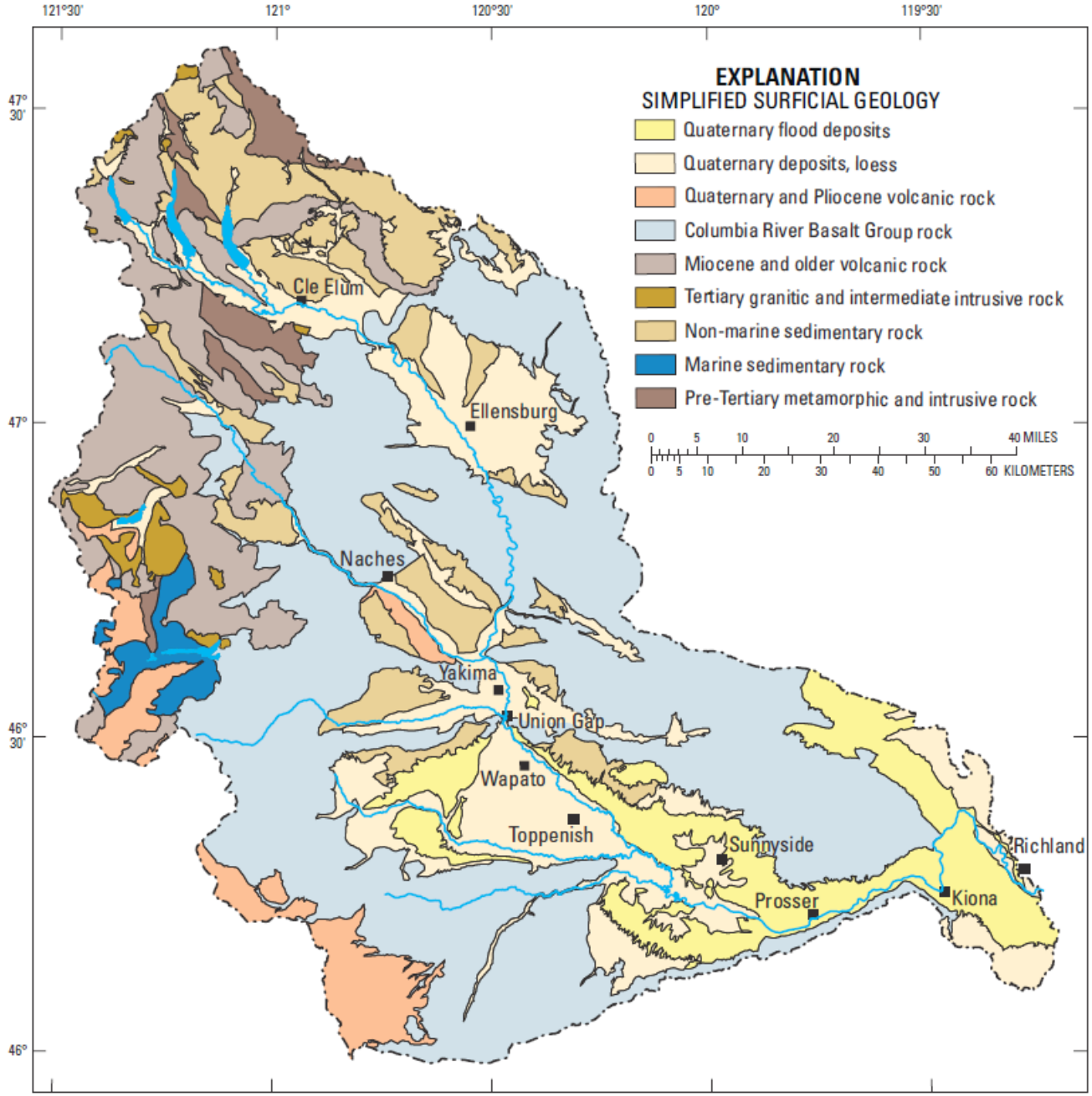
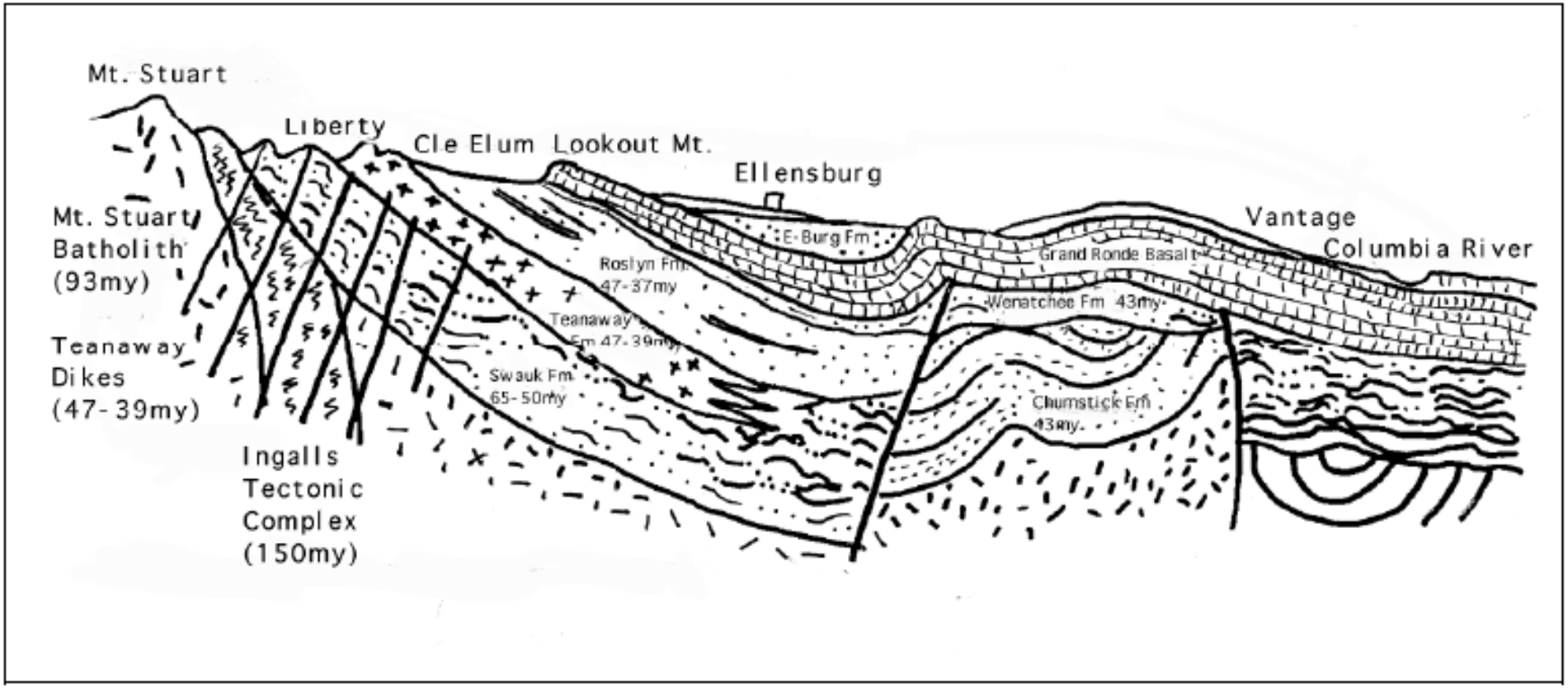


Figure 4. Simplified surficial geology of the Yakima River Basin, Washington. From Fuhrer and others, 1994.

Down Under

Cross Section from Mt Stuart to Col. Riv.

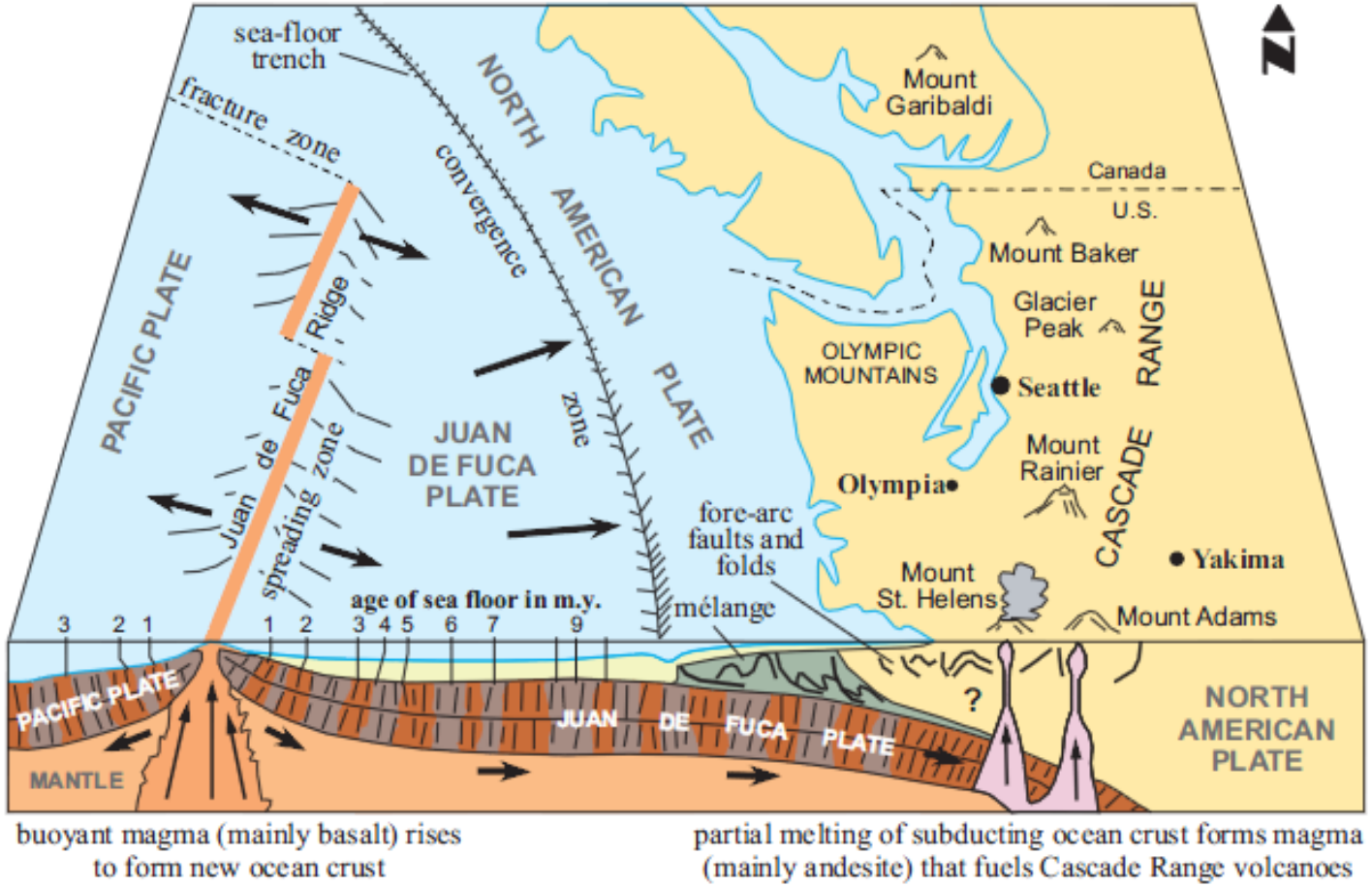


From: **Field Trip Guidebook to the Natural History of Kittitas County**
Jana Jones Mabry

http://sharepoint.snoqualmie.k12.wa.us/mshs/mabryj/Field%20trip%20Guide%20Book/mabry%20FieldTrip%20Guidebook.pdf

Plate Tectonics

The General Contractor



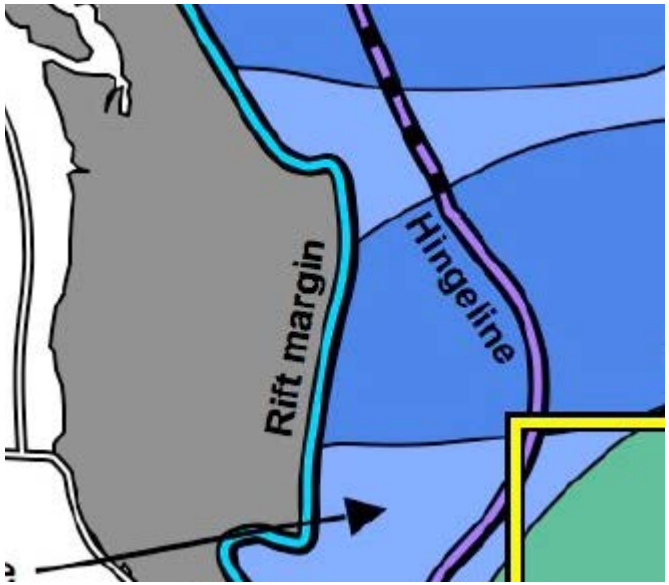
A diagrammatic cross section through the Juan de Fuca spreading ridge and the Cascadia subduction zone (the area from the trench east to where the Juan de Fuca plate sinks beneath the North American plate)

Information Circular 107, **Roadside Geology of Mount Rainier National Park and Vicinity,** by Patrick T. Pringle, 2008

ftp://ww4.dnr.wa.gov/geology/pubs/ic107/ic107_mt_rainier_guide_complete.pdf

Port Spokane

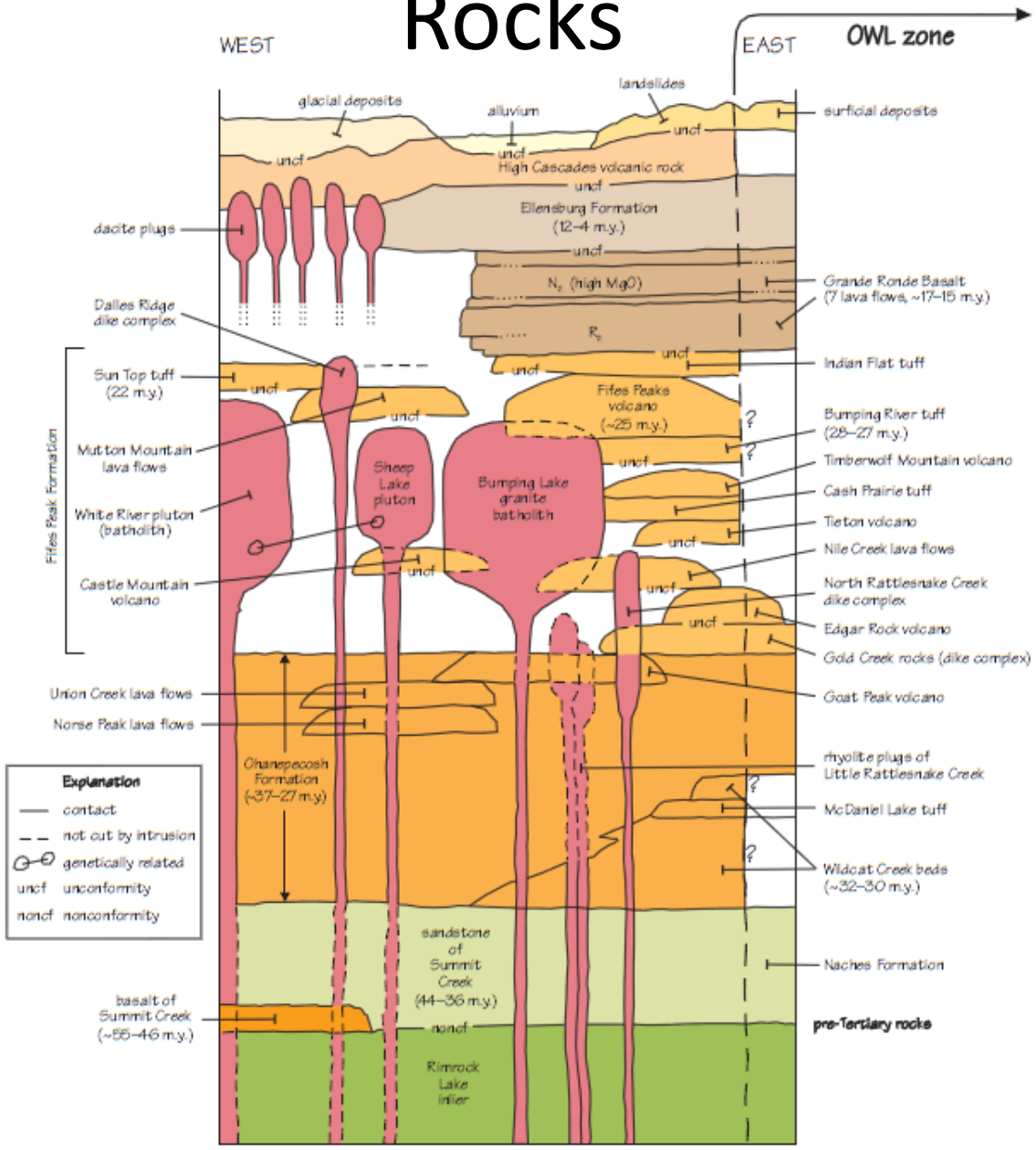
- Prior to about 200 million years ago, the western margin of N Am. was near Idaho border
- Plate tectonic processes formed WA
- Yakima basin was excellent adult salmon habitat, not so good for spawning and rearing



http://pages.uoregon.edu/ghump/papers/Backbone.pdf

http://www.ccsf.edu/Departments/History_of_Time_and_Life/PDFs/NorthAmericanMarginSubducts36x36.pdf

Rocks



ftp://ww4.dnr.wa.gov/geology/pubs/ic107/ic107_mt_rainier_guide_complete.pdf

Figure 18. A schematic columnar section of principal rock units east of Mount Rainier National park. Units are shown in stratigraphic order—no scale in time, thickness, or size implied. OWL zone, rock units of the Olympic–Wallowa lineament. Modified from an unpublished section by Paul E. Hammond, 2008.

← Glacial, surficial deposits

←More Volcanoes

← Ellensburg Formation (lahars)

← The Great Flood
Columbia River Basalts

←Hot, Hot, Hot
Many subduction related volcanoes

← Backbone (Volcanic)

← Sedimentary basin fill

← Basement (imported)

Columbia River Basalts

ftp://ww4.dnr.wa.gov/geology/pubs/ic107/ic107_mt_rainier_guide_complete.pdf

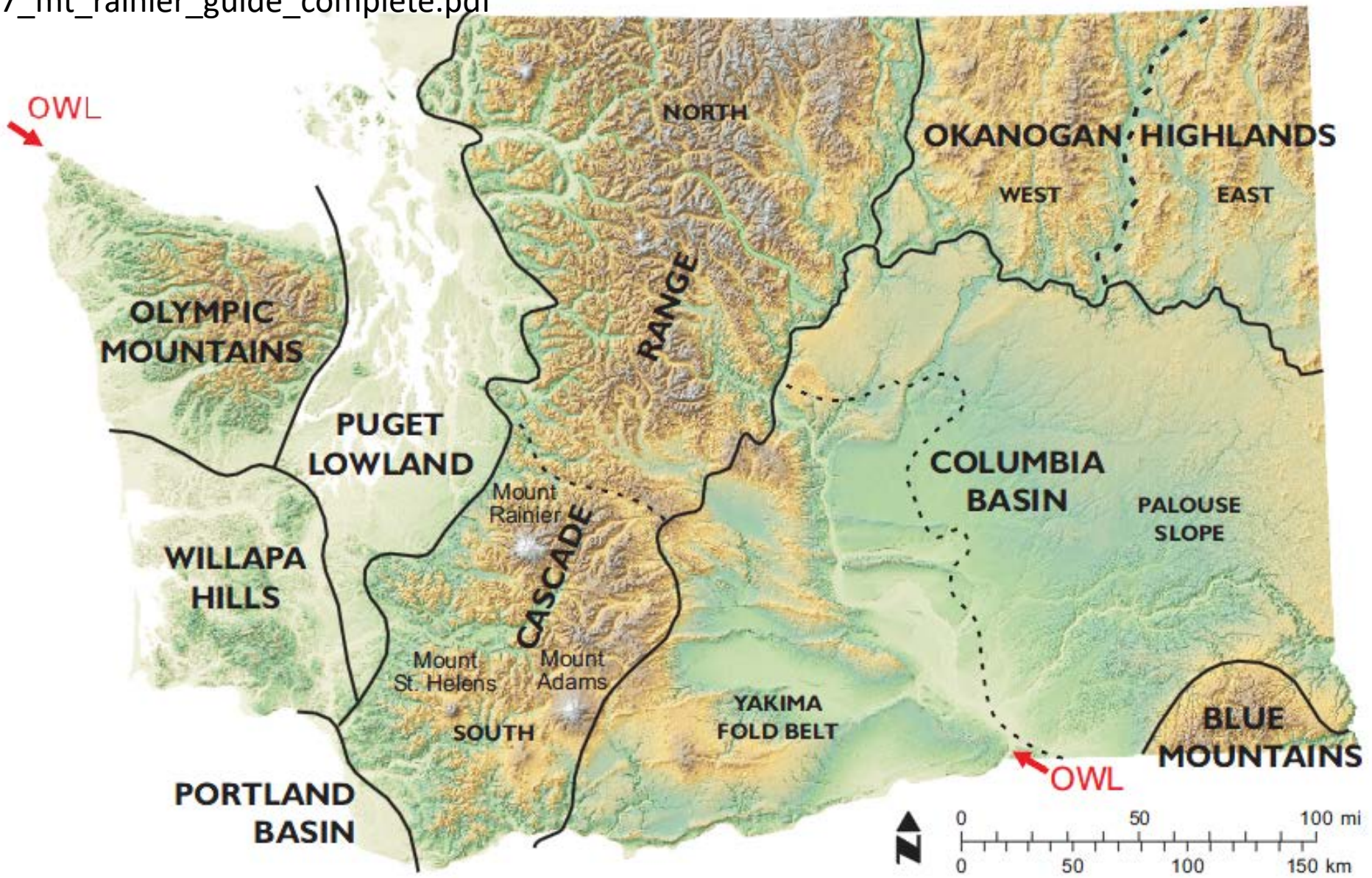
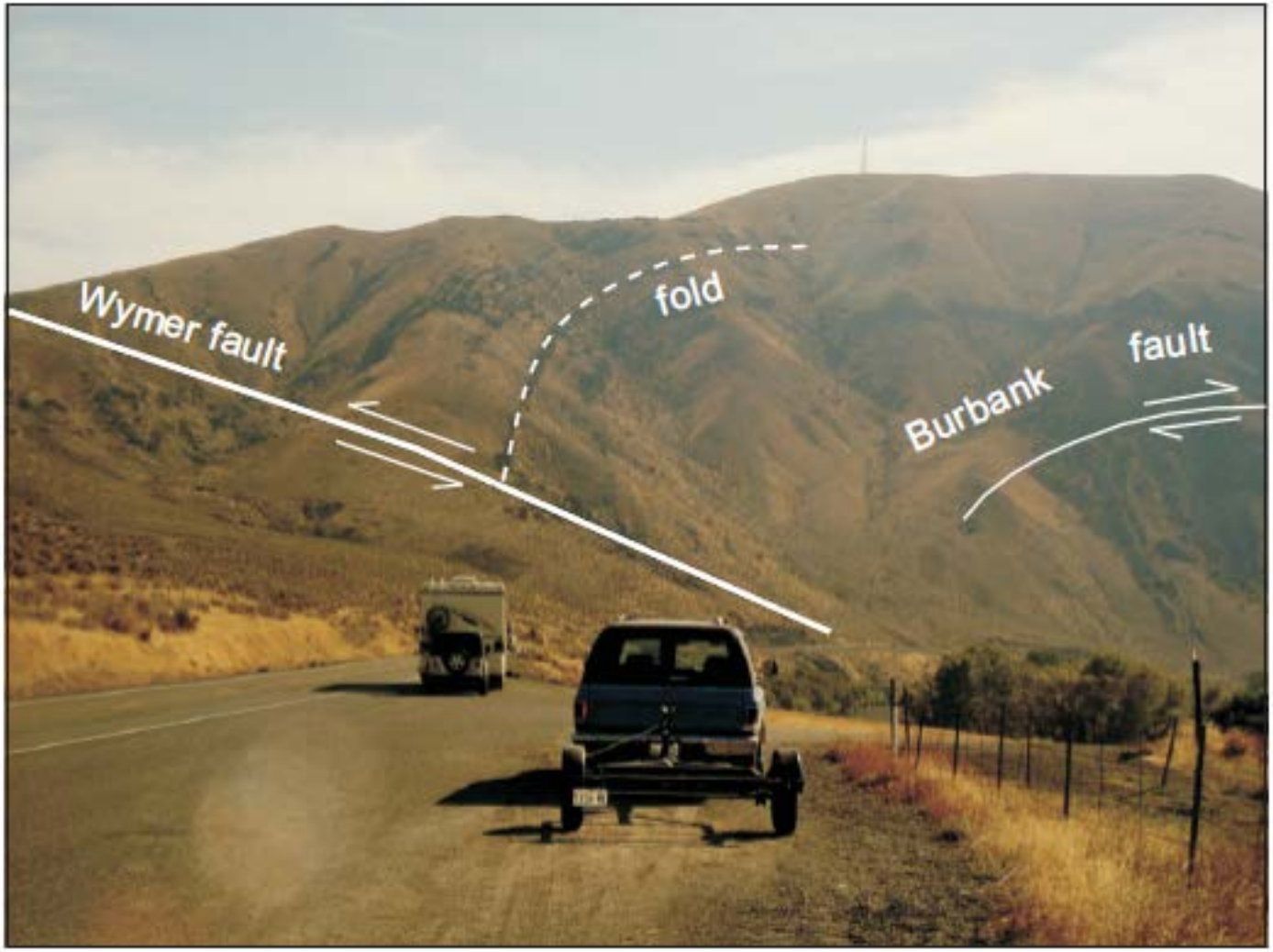


Figure 5. Relief map showing the physiographic provinces and subprovinces of Washington State. Red arrows show the general trend of the Olympic–Wallowa lineament or OWL.

Fold, Fault and Mutilate



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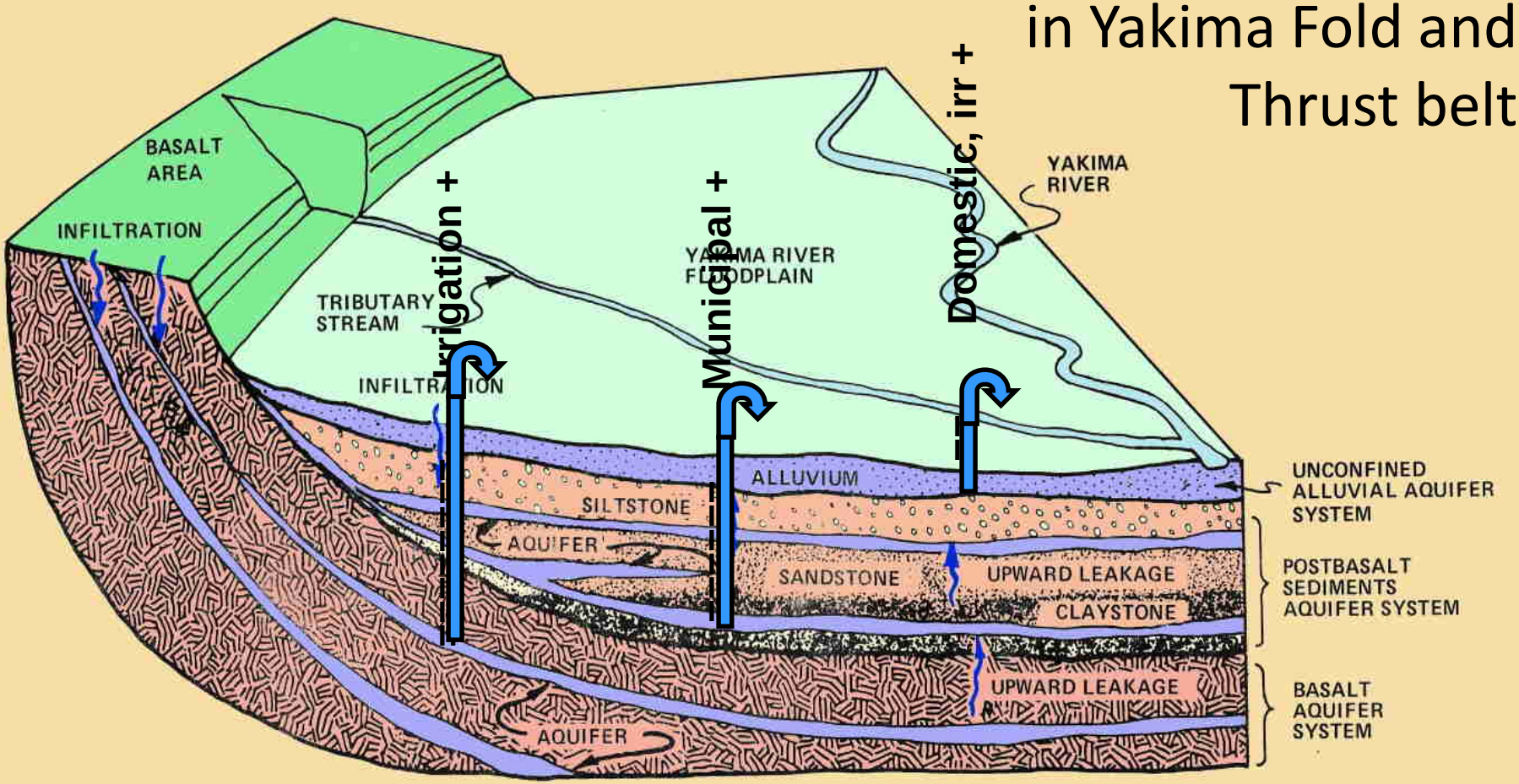
Synclinal Basin in Yakima Fold and Thrust belt



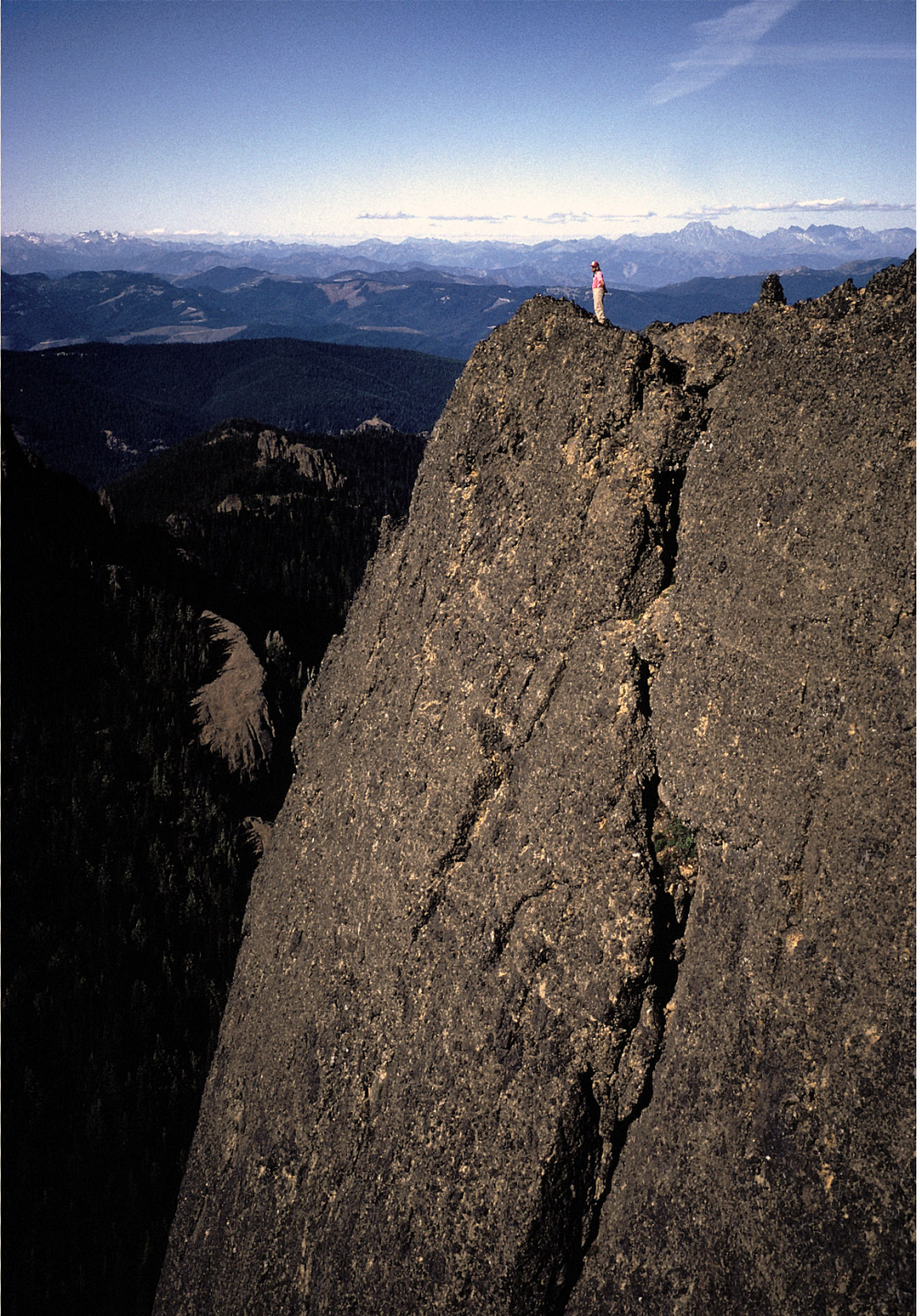
Not rivers, but leaky sheets of folded layer cake geology
In basalts, interflow zones most permeable
Alluvial aquifer water young like me, basalts old

Figure 3. The Three Principal Aquifer Systems in the Yakima River Basin

From U.S. Army Corps of Engineers, 1978,
Yakima Valley Regional Water Management Study

Why is the Naches Arm Different from the Upper Mainstem?

- In Naches Arm
  - Glaciers didn't flow as far
  - Quaternary lava flows did
    - Especially in Tieton



Fifes Peak

Tertiary Volcanics

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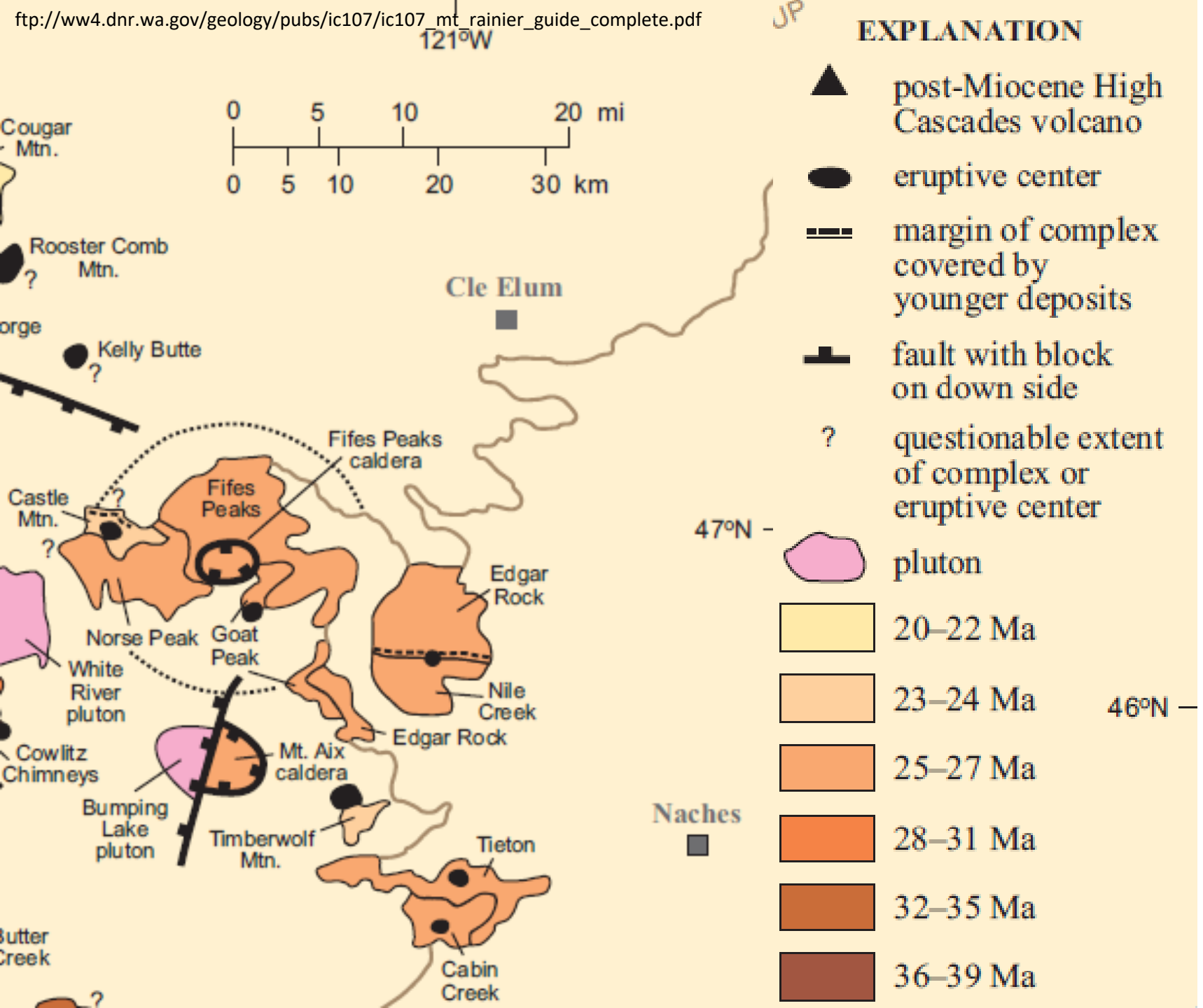


Spiral Butte

Quaternary Volcano

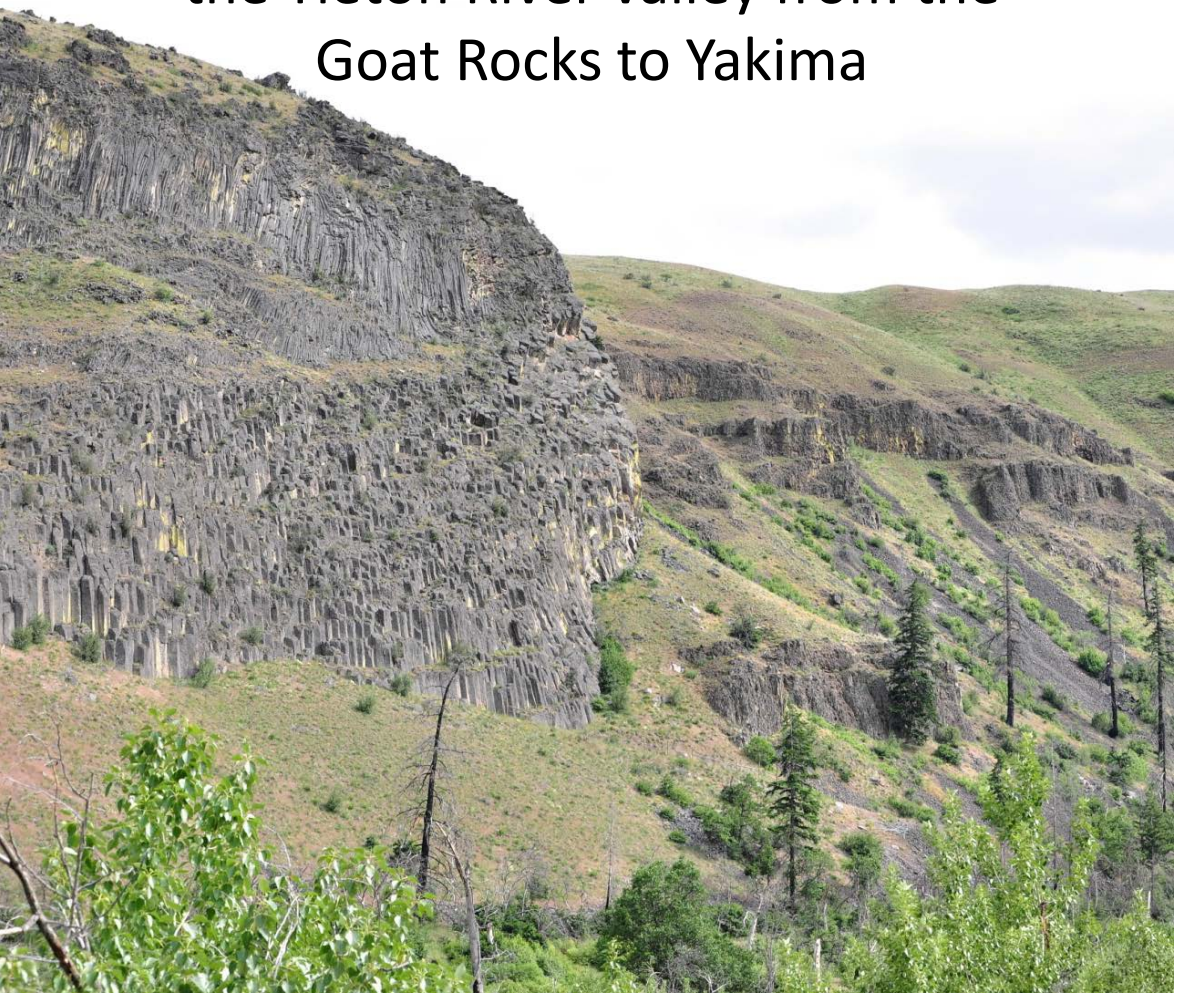
Goat Rocks and Glaciers

Quaternary Volcano in Naches Arm

The Tieton

A recent excavation project

The Tieton Andesite flowed down the Tieton River valley from the Goat Rocks to Yakima



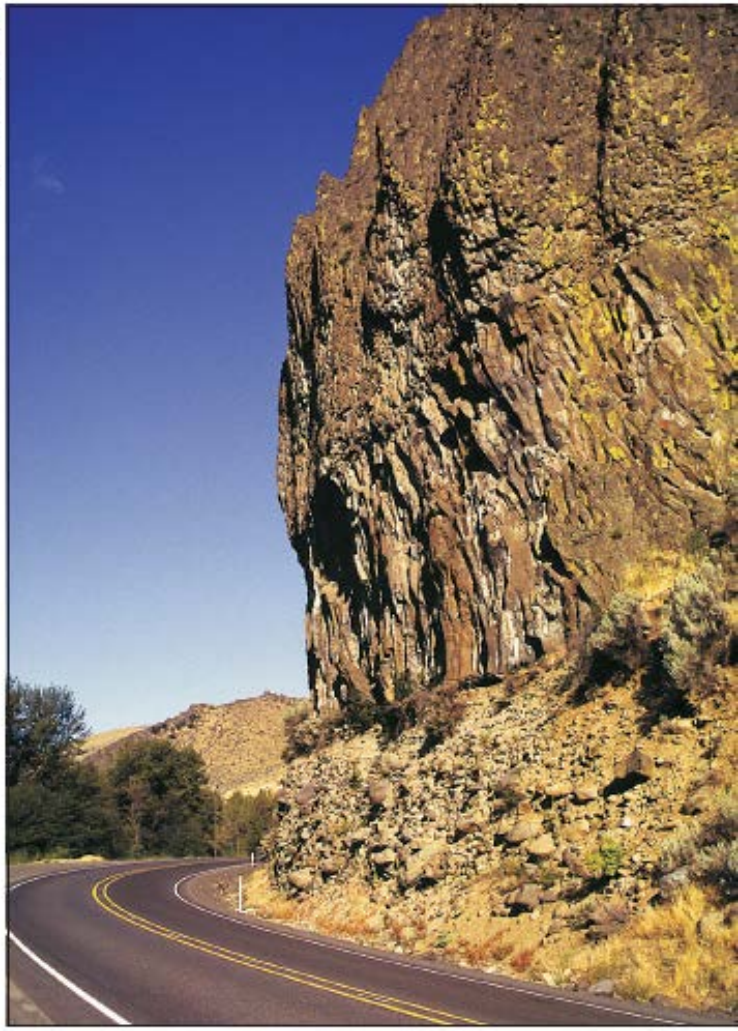


Figure H-26. Tieton Andesite overlying coarse fluvial gravel View is to the west along US 12.

ftp://ww4.dnr.wa.gov/geology/pubs/ic107/ic107_mt_rainier_guide_complete.pdf

Building the Basin
The Finish Work
Glaciation

- The Ice Age was a local phenomenon
- Continental glaciation did not reach this far south
- Alpine glaciation profoundly modified Yakima basin

Glaciers: the final major Modification
Alpine, not Continental

Glaciers Erode
Glaciers Deposit

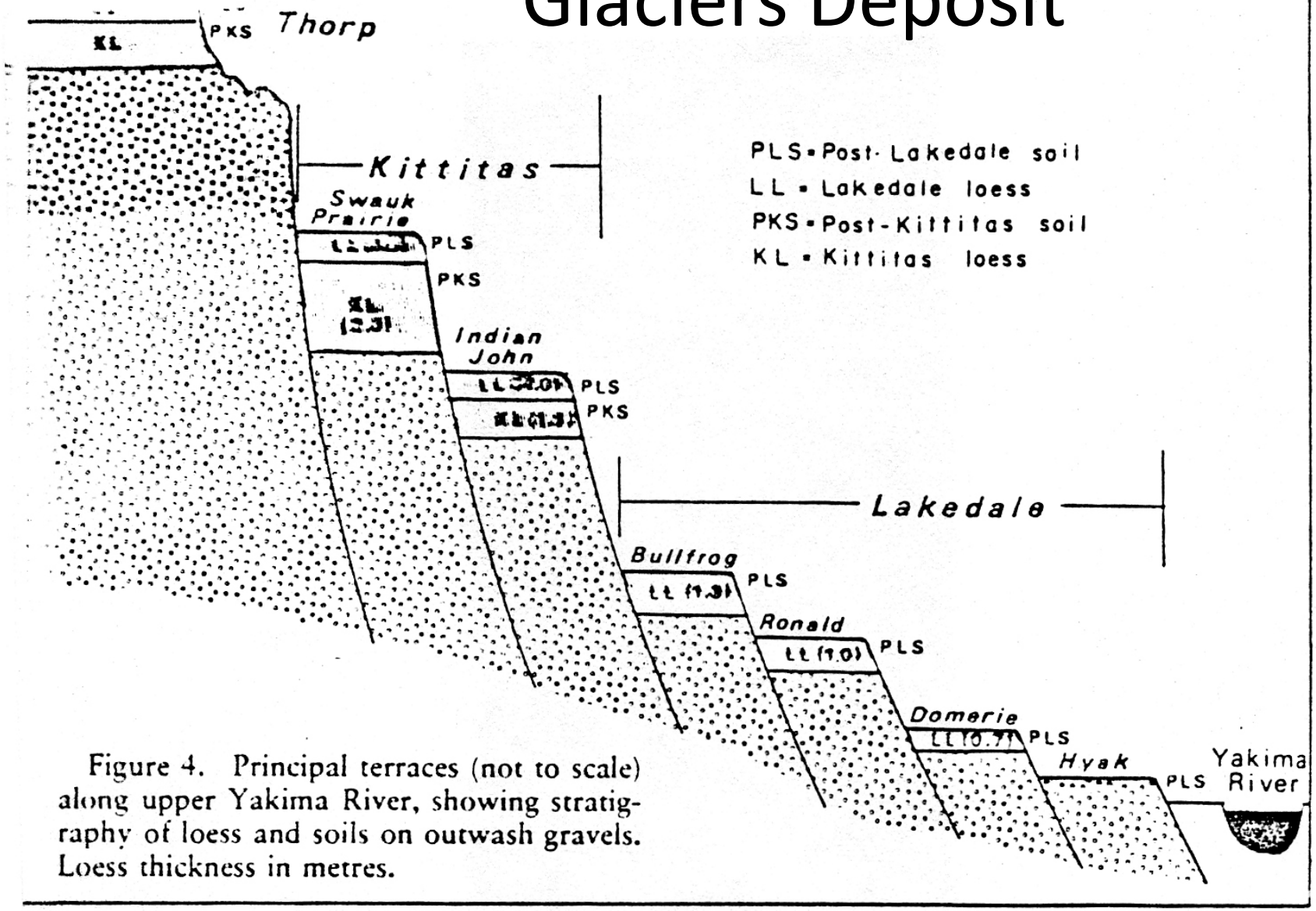
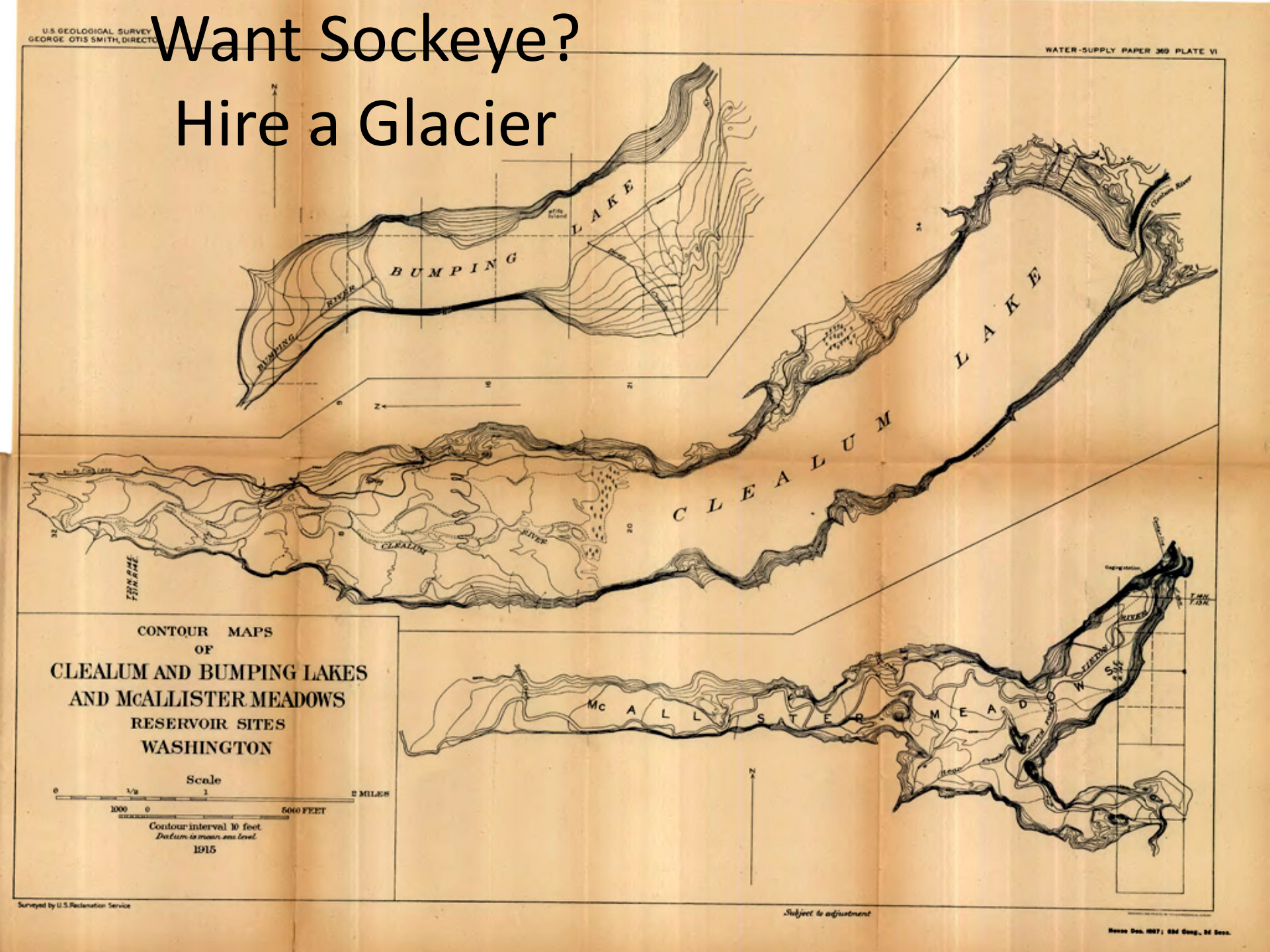


Figure 4. Principal terraces (not to scale) along upper Yakima River, showing stratigraphy of loess and soils on outwash gravels. Loess thickness in metres.

Waitt, 1980

Want Sockeye?
Hire a Glacier



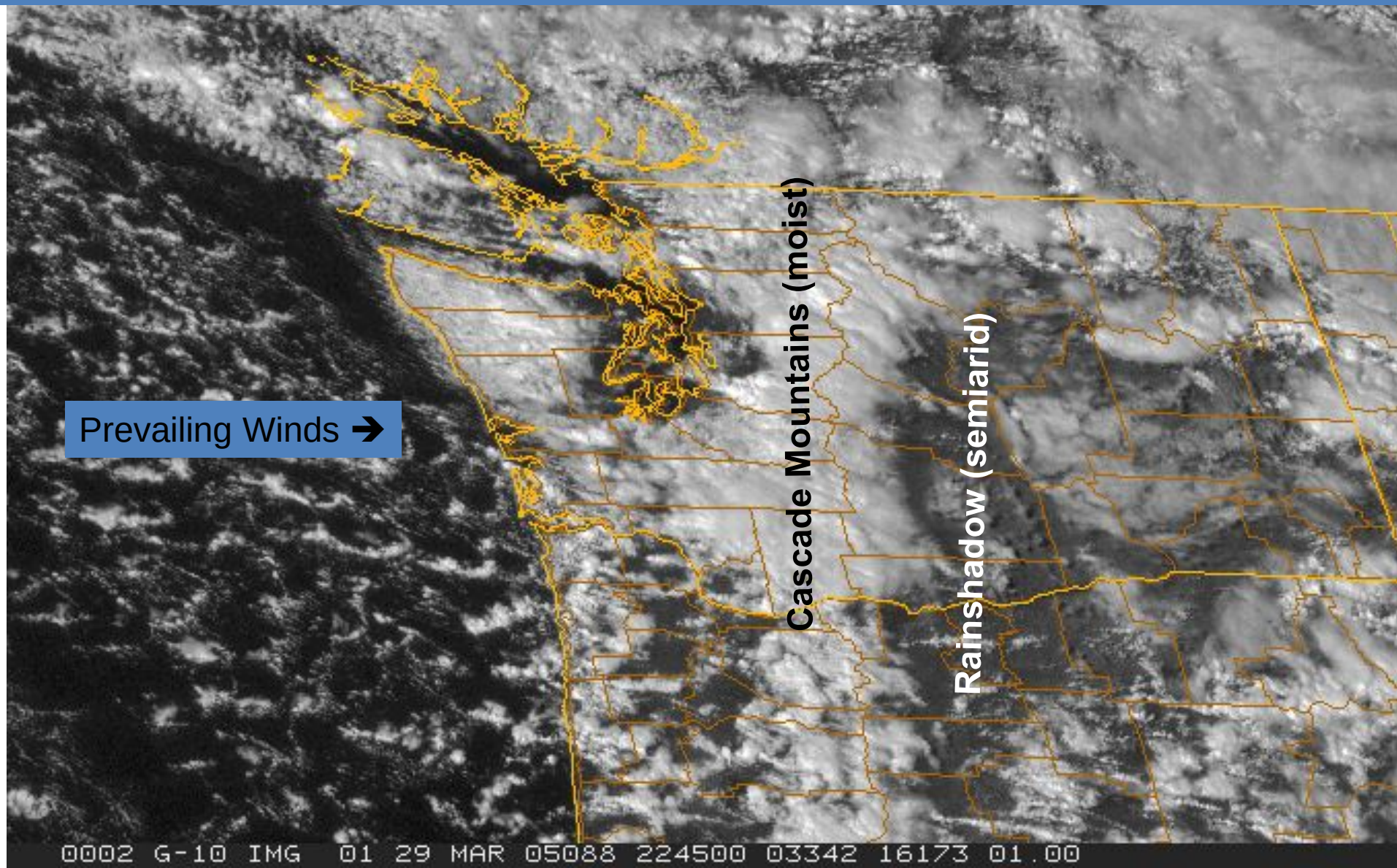
Ice Age?

- Glaciers hanging on
- Upper Cle Elum
- Upper Tieton

Cascades catch 100 inches of precip mostly as winter snow

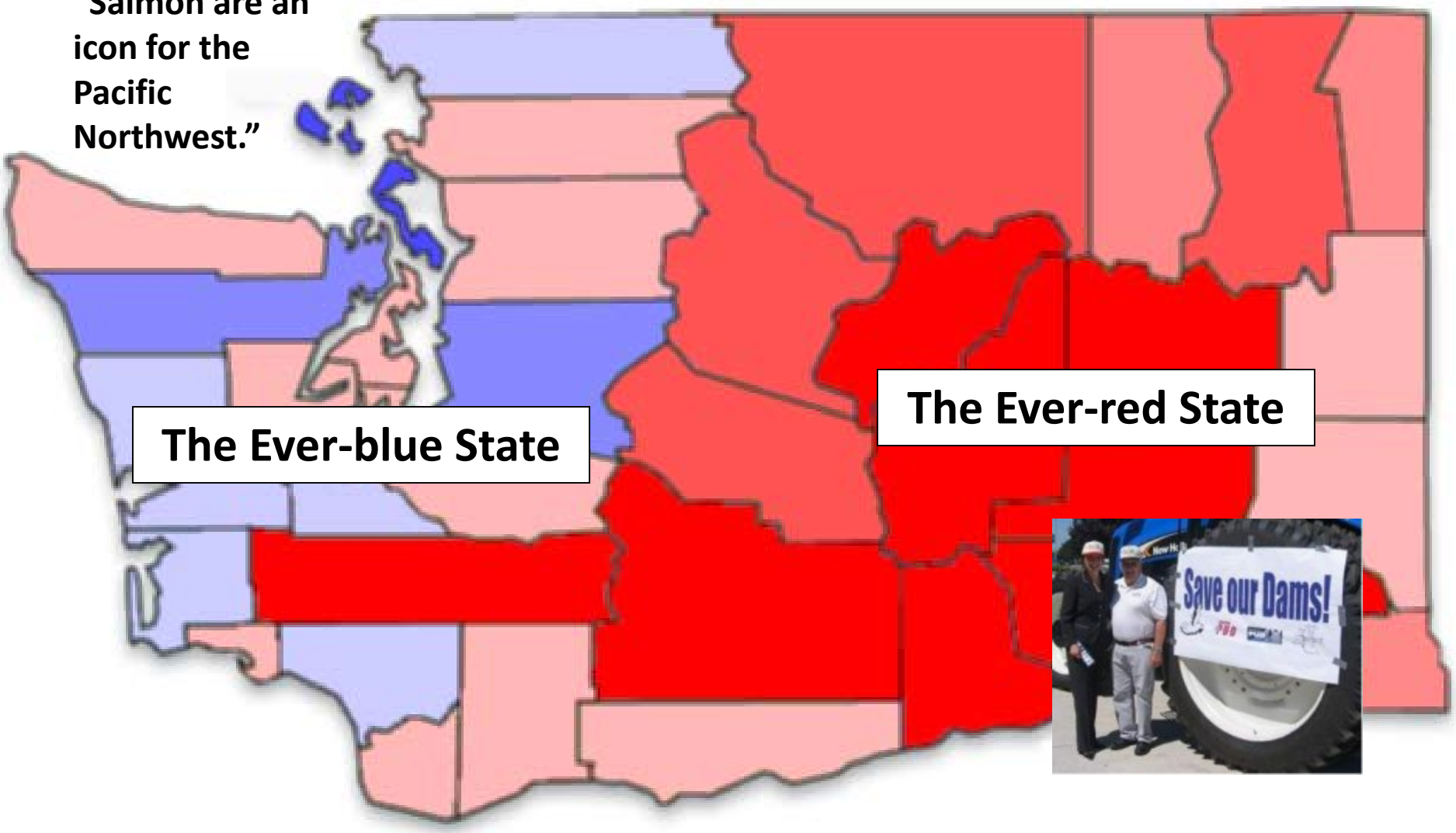
Yakima Valley is in the rainshadow. Lowlands get less than 20 inches

The Yakima Basin lies on the Dry side of the Cascade Mountains:
Snowmelt dominated streams drain the Cascades.
Cascades block flow of moisture from Pacific Ocean.
Streams flow east through semiarid lowlands and discharge to Columbia River.

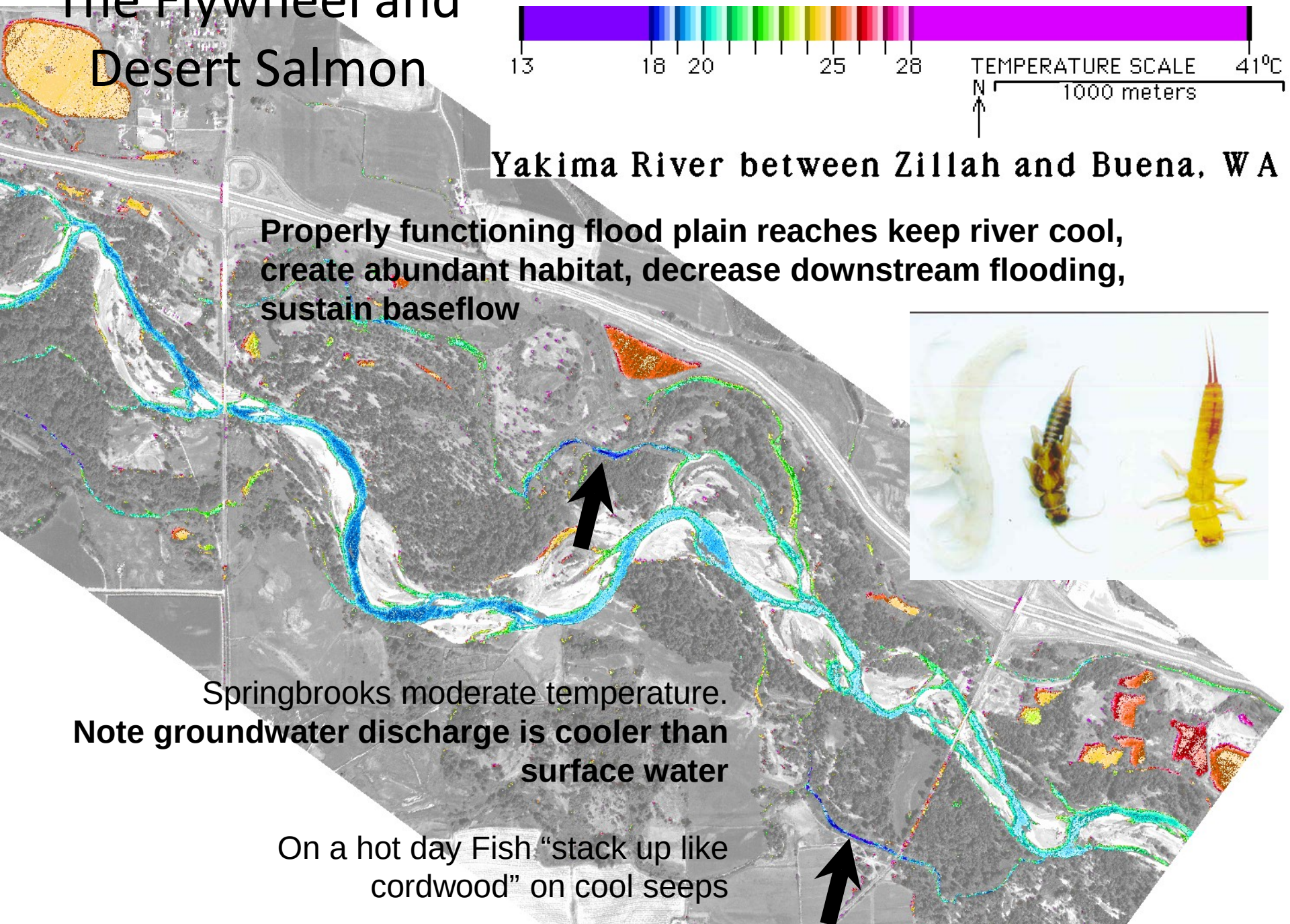


The Evergreen State

“Salmon are an icon for the Pacific Northwest.”



The Flywheel and Desert Salmon



Properly functioning flood plain reaches keep river cool, create abundant habitat, decrease downstream flooding, sustain baseflow

Springbrooks moderate temperature.
Note groundwater discharge is cooler than surface water

On a hot day Fish “stack up like cordwood” on cool seeps

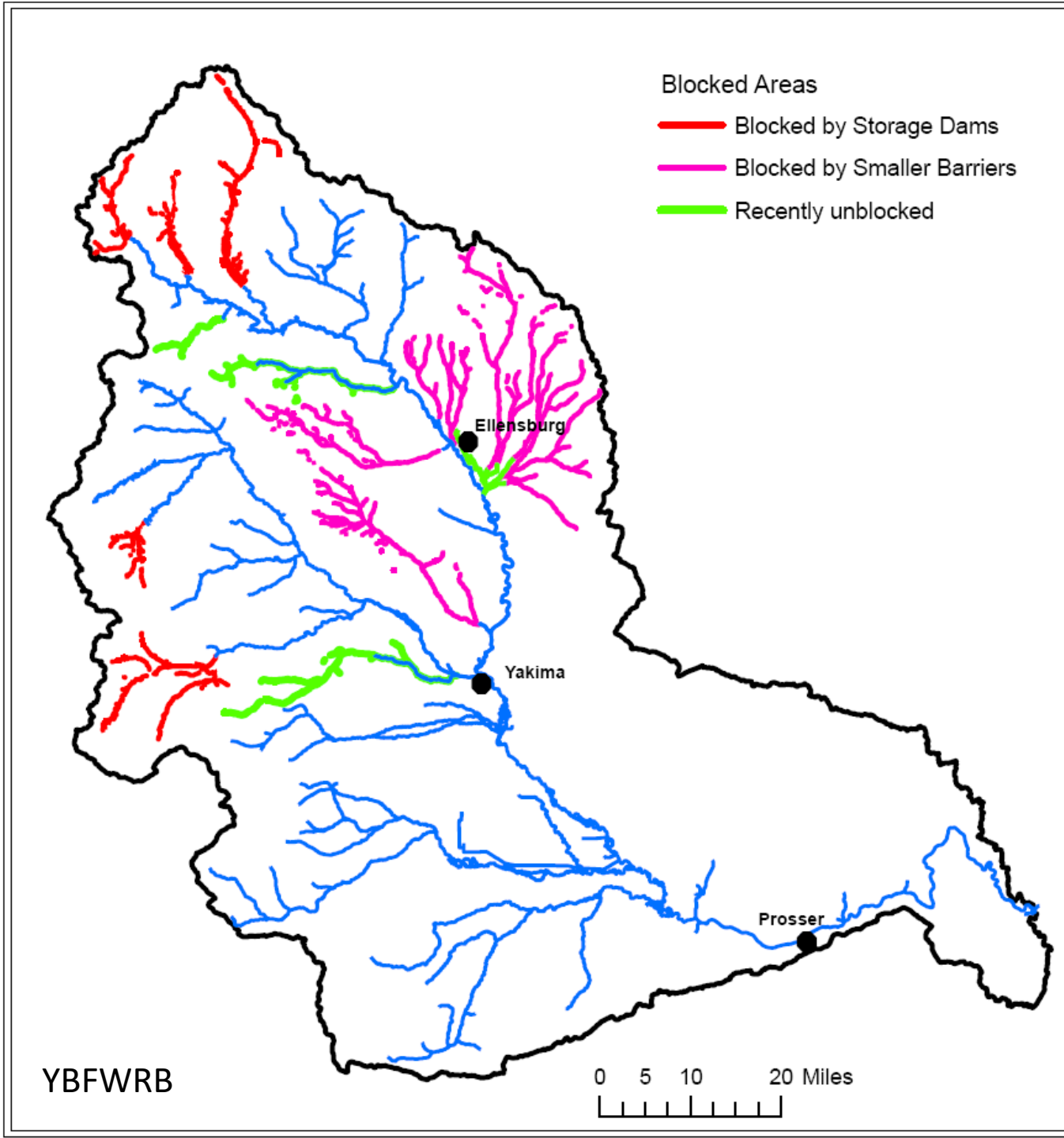
Now fix it

(like you fix a pet)

or

How to make a fish hostile watershed

- Start by blocking passage of fish into the coolest habitat with relatively pristine habitat and an unregulated hydrograph



A bounty of irrigated agriculture has replaced a bounty of aquatic resources

- 500,000 irrigated acres
- Irrigation water rights >2/3 of mean annual runoff
- Hydrographs profoundly altered by combination of reservoir storage and irrigation diversions
- Legacy of unscreened/impassible diversions, dewatered tribs, dewatered redds, water quality degradation

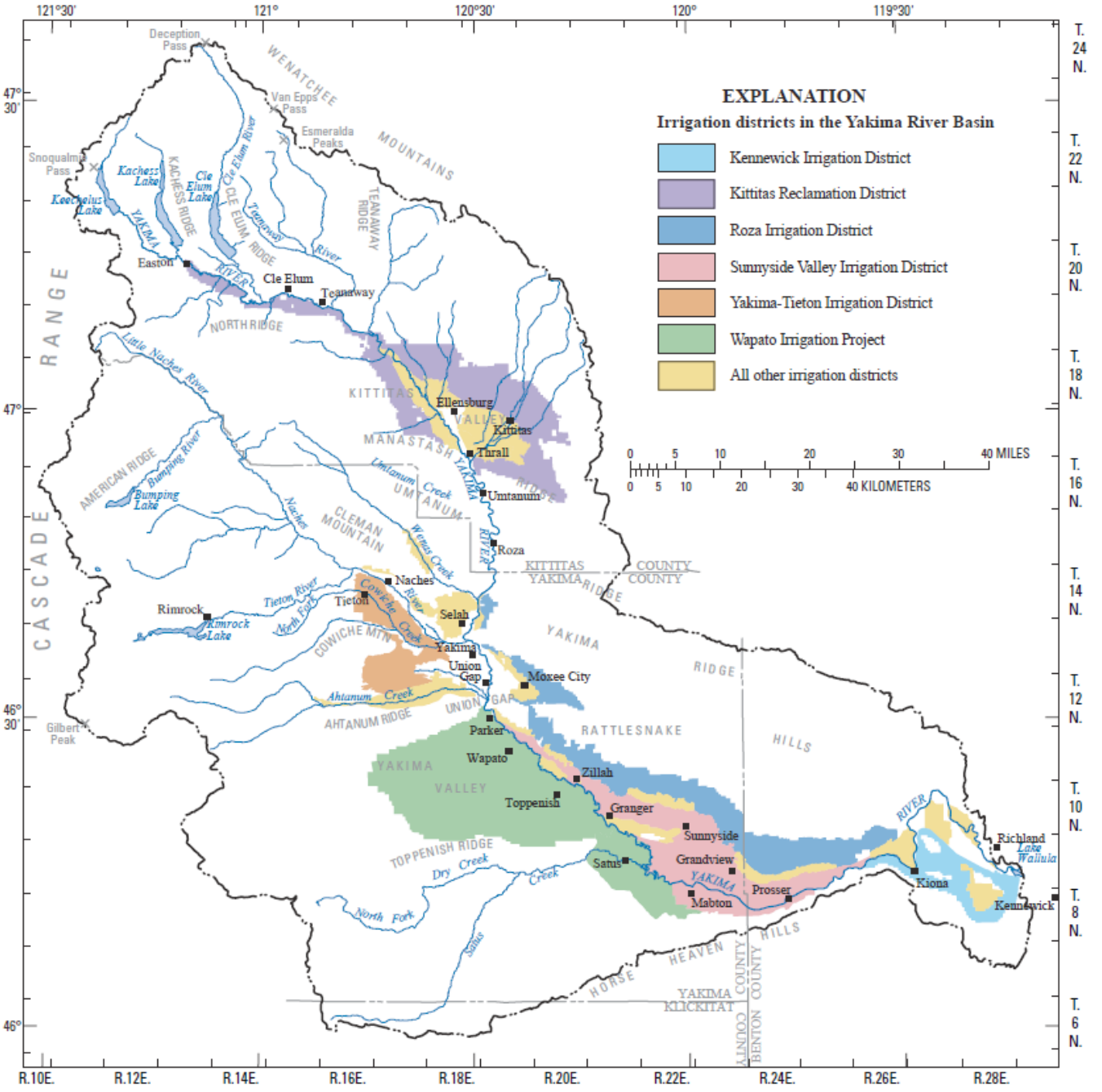
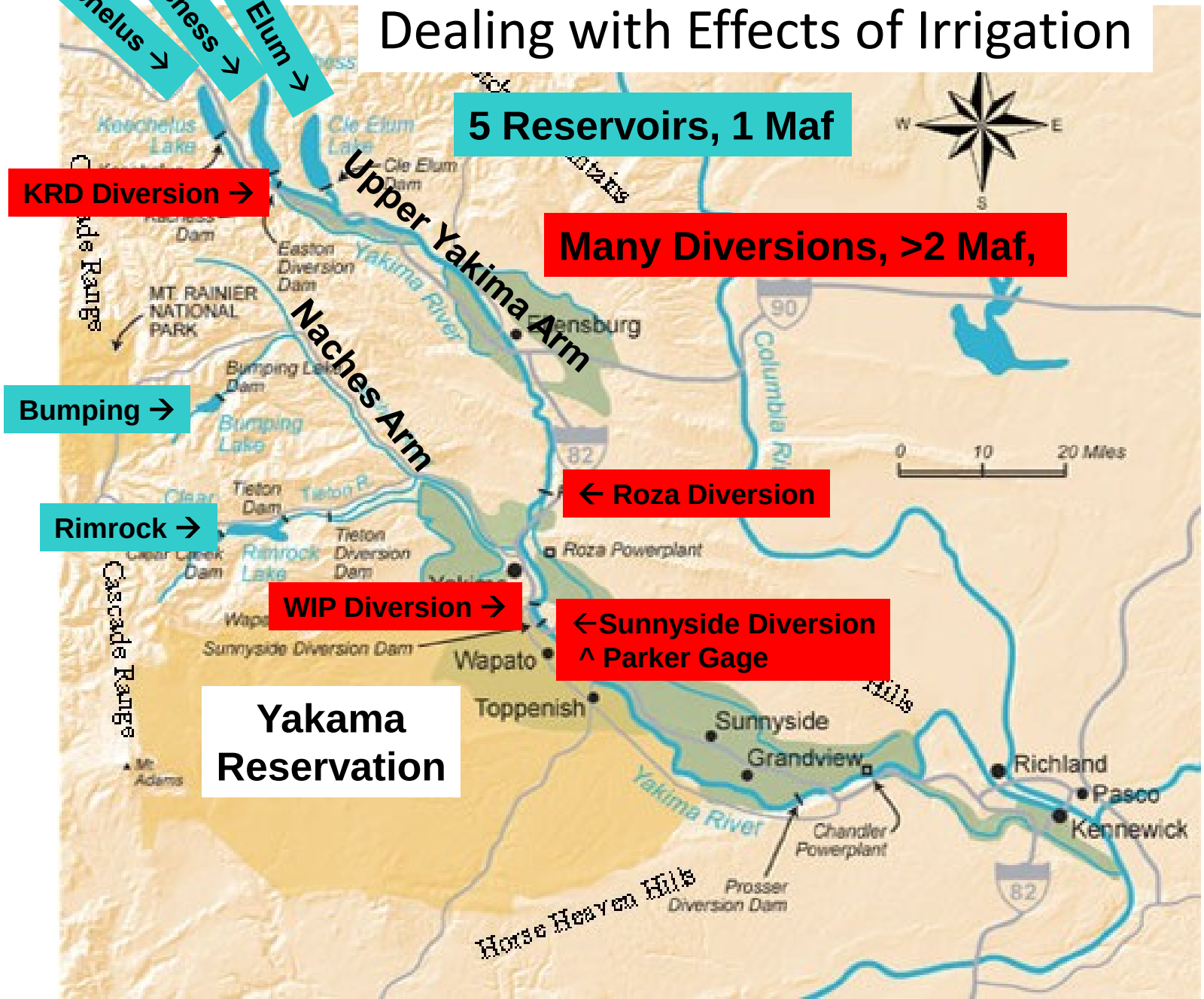


Figure 6. Surface-water irrigation districts, Yakima River Basin, Washington.

Yakima Basin
Dealing with Effects of Irrigation



Changing hydrograph
Effects of storage and diversion

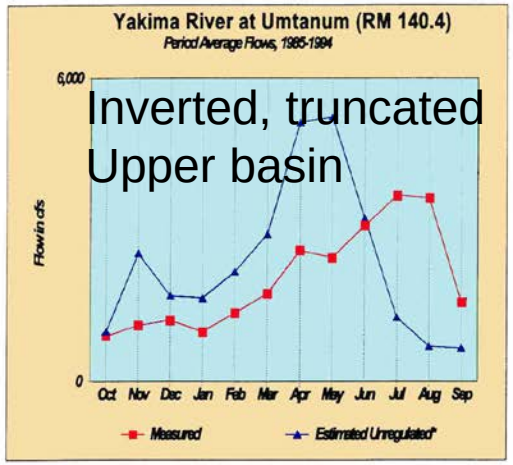


Figure III-1a

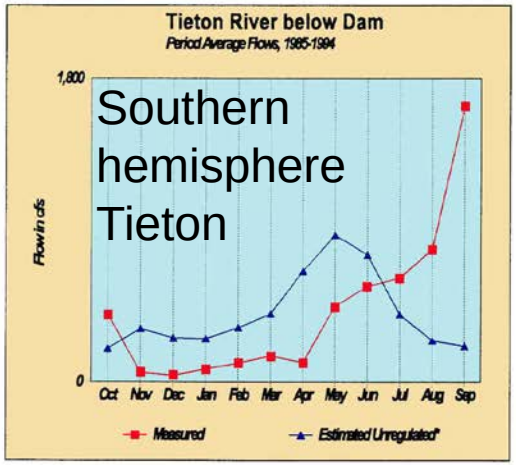


Figure III-1b

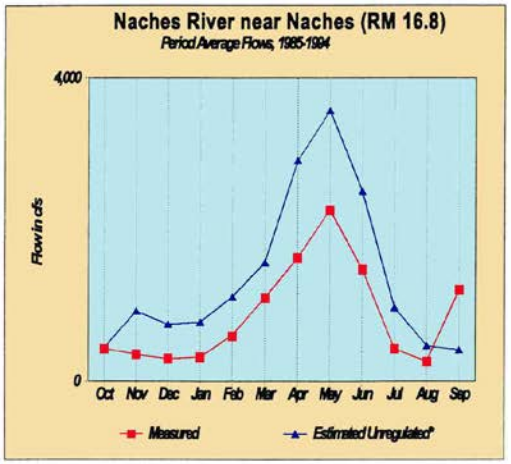


Figure III-1c

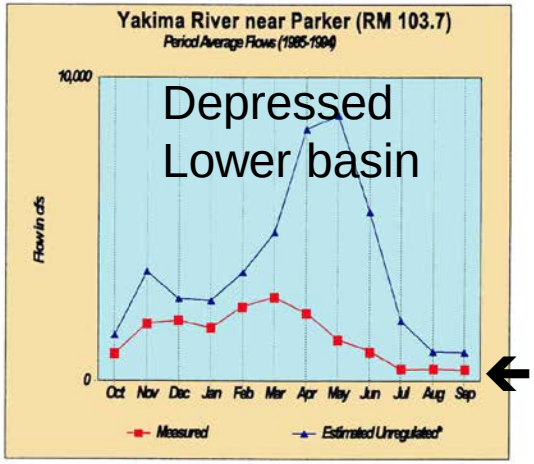
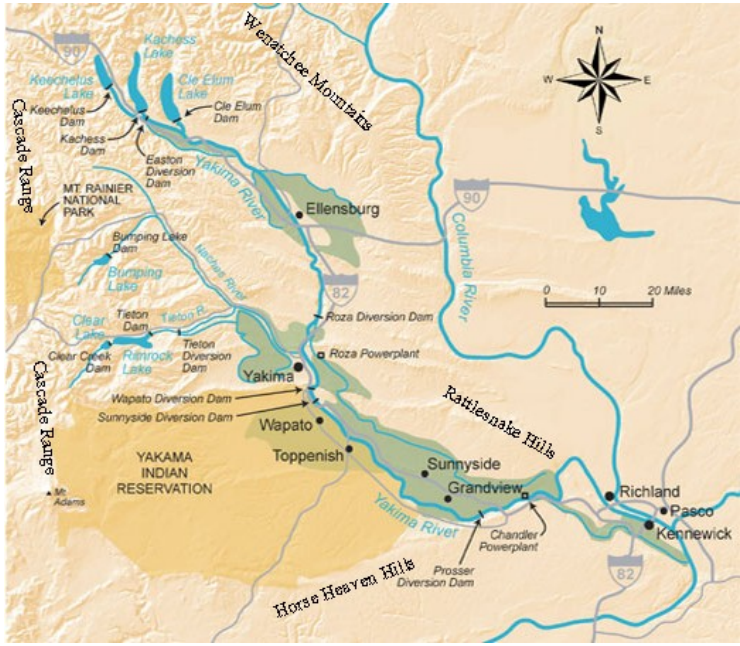


Figure III-1d



← Storage control

Figure III-1.—Conceptual comparison of measured flow and estimated unregulated flow (measured flow corrected for storage, estimated diversions, and estimated return flows).

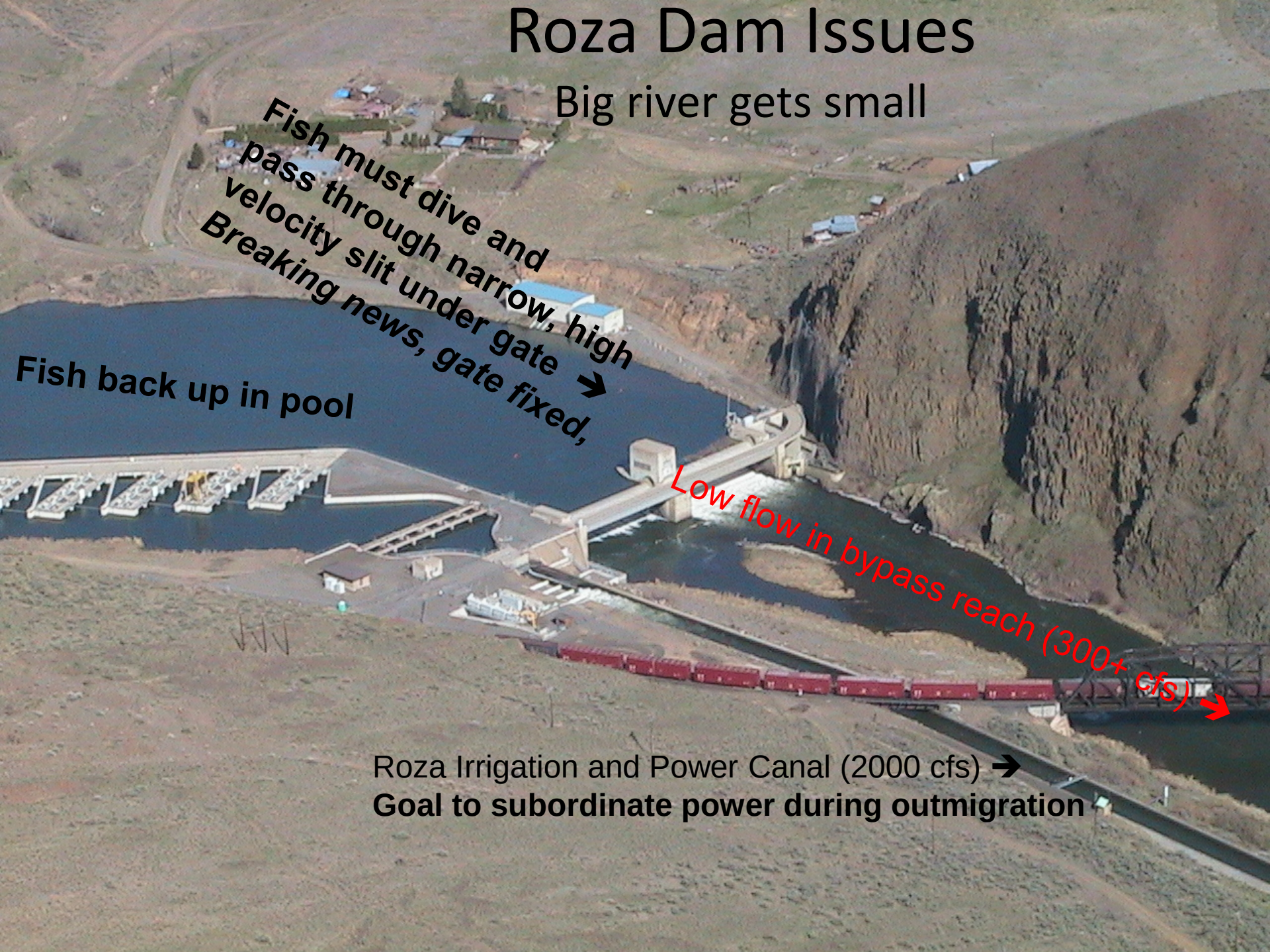
From YRBWEP Draft Programmatic Environmental Impact Statement

Yakima Basin 101
The Water

- Yakima River Anomalies 1
  - Normal River
    - Starts small, gets big, gets bigger
  - Yakima River
    - Starts small, gets big, gets small, gets big, gets small…

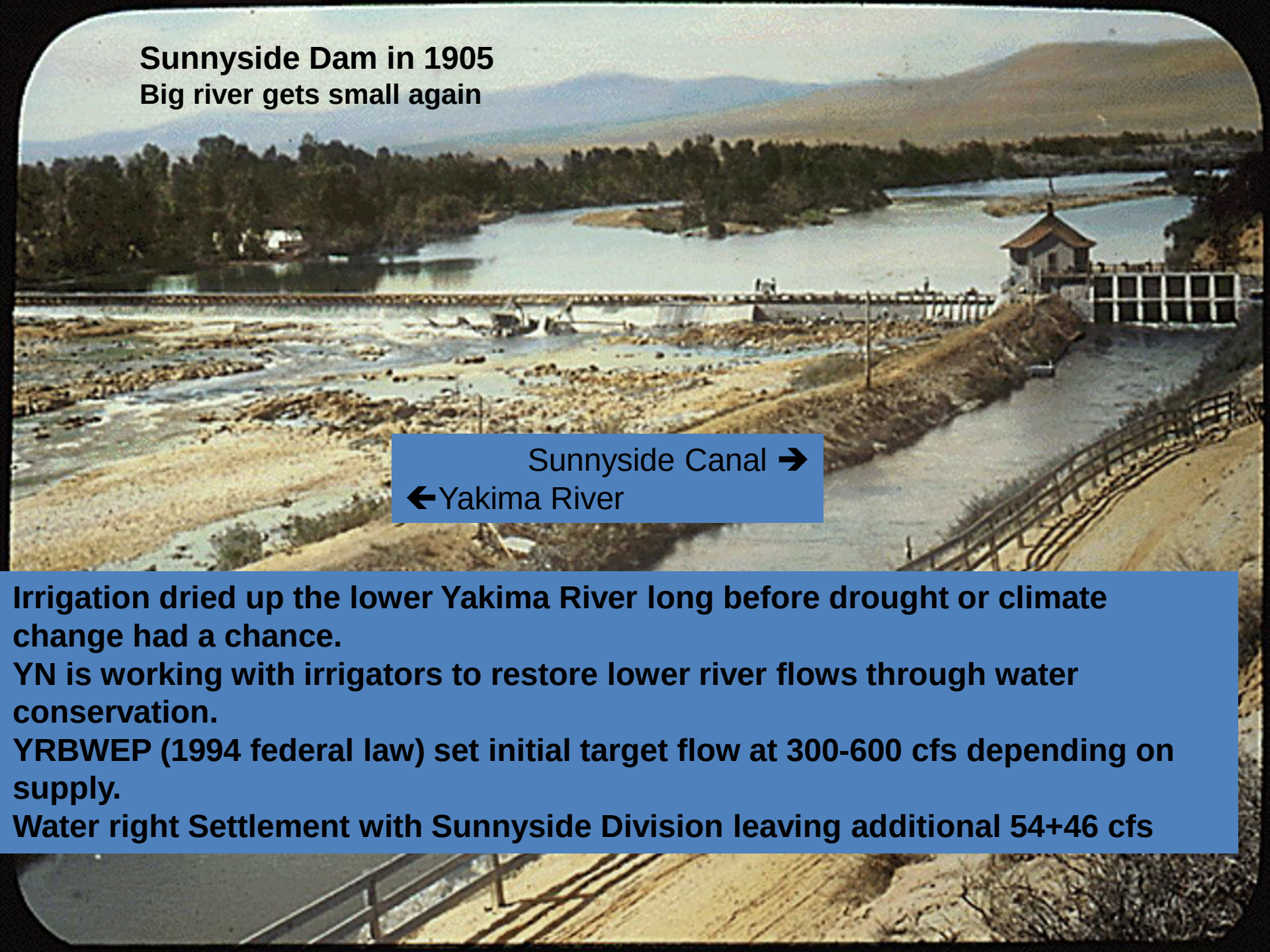
Roza Dam Issues

Big river gets small



Roza Irrigation and Power Canal (2000 cfs) ➔

Goal to subordinate power during outmigration



Irrigation dried up the lower Yakima River long before drought or climate change had a chance.

YN is working with irrigators to restore lower river flows through water conservation.

YRBWEP (1994 federal law) set initial target flow at 300-600 cfs depending on supply.

Water right Settlement with Sunnyside Division leaving additional 54+46 cfs

Prosser

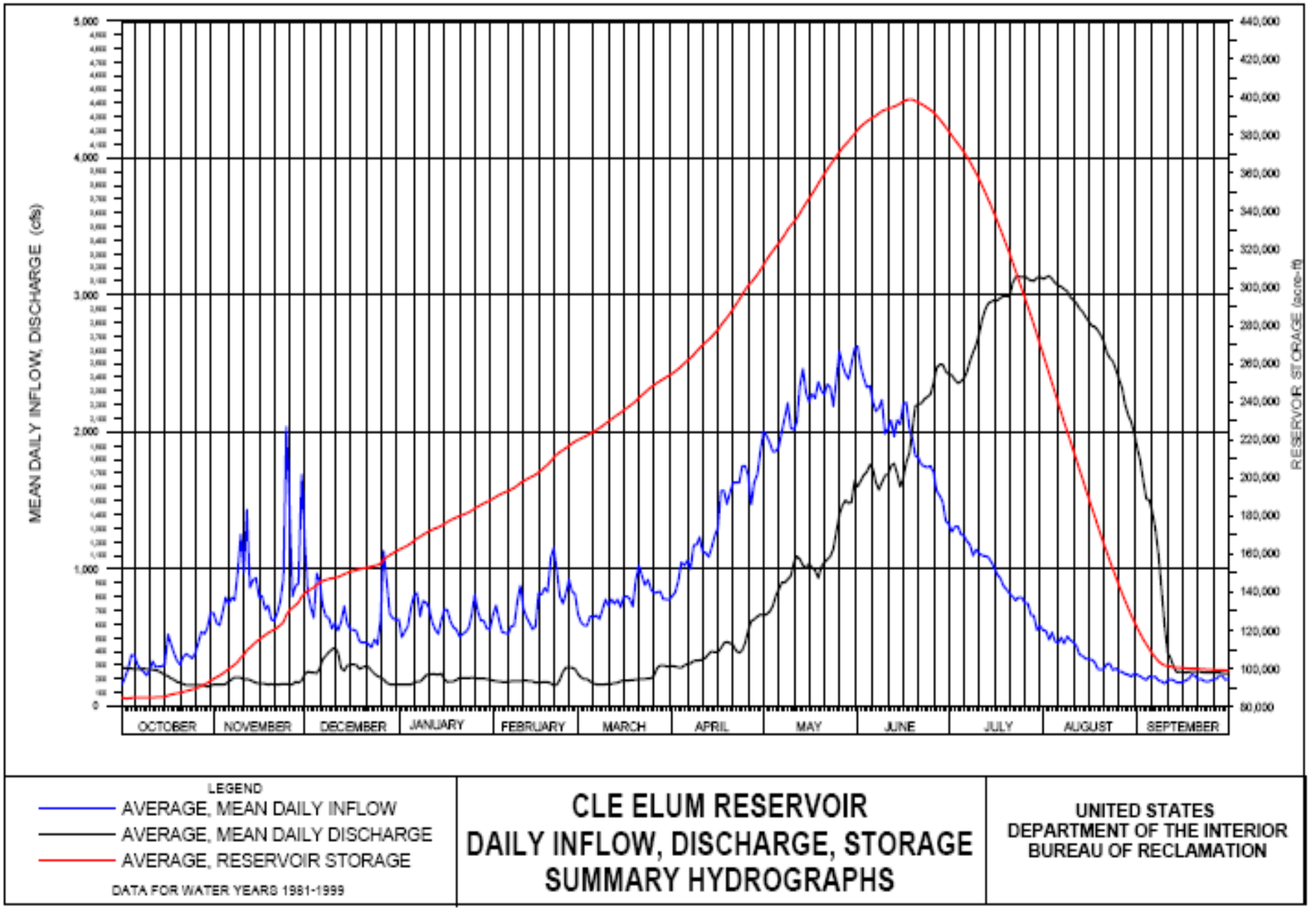
Big River Gets Small for the Last Time

Back to 300-600 plus conservation plus KID move

Yakima River Anomalies 2

- Normal smowmelt dominated rivers in the northern hemisphere peak in spring-early summer and recede gradually in late summer
- The upper Yakima River peaks in August
- The Tieton River (trib to Yakima) has its spring freshet each September
- Flows below the reservoirs drop dramatically at the end of irrigation season

Cle Elum


MEAN DAILY INFLOW, DISCHARGE (cfs)
RESERVOIR STORAGE (acre-ft)
5,000
4,000
3,000
2,000
1,000
0
440,000
420,000
400,000
380,000
360,000
340,000
320,000
300,000
280,000
260,000
240,000
220,000
200,000
180,000
160,000
140,000
120,000
100,000
80,000
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
LEGEND
AVERAGE, MEAN DAILY INFLOW
AVERAGE, MEAN DAILY DISCHARGE
AVERAGE, RESERVOIR STORAGE
DATA FOR WATER YEARS 1981-1999
CLE ELUM RESERVOIR
DAILY INFLOW, DISCHARGE, STORAGE
SUMMARY HYDROGRAPHS
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Flip-Flop

Flow reduction as flow improvement (less is more and vice versa)

See Quackenbush

Upper Mainstem reservoir releases ramp down to shrink river before spawning begins

Naches Arm reservoir releases ramp up to make up the difference

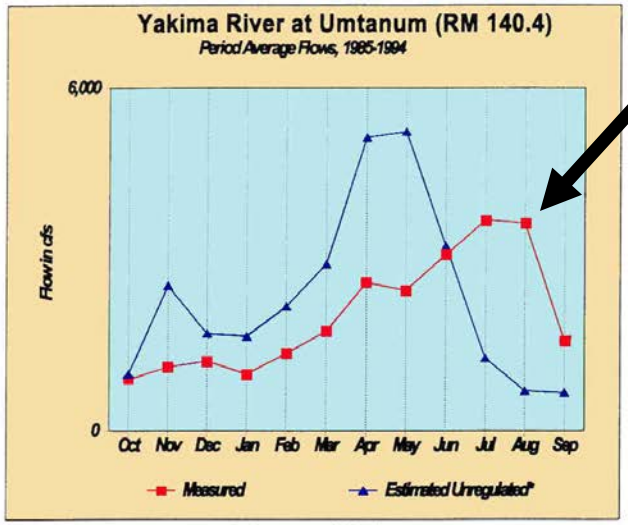


Figure III-1a

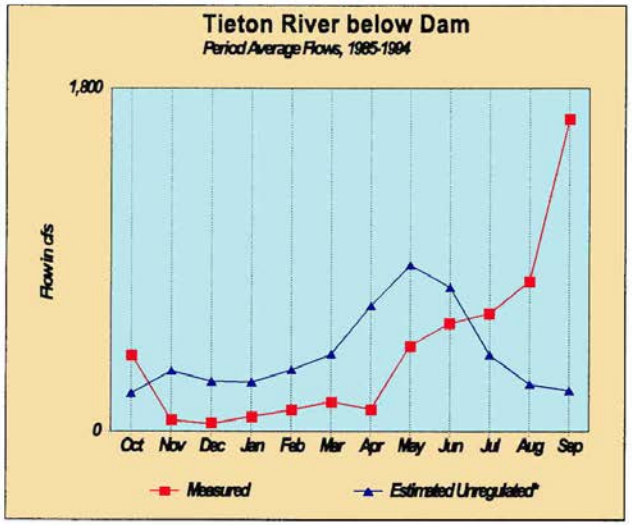


Figure III-1b

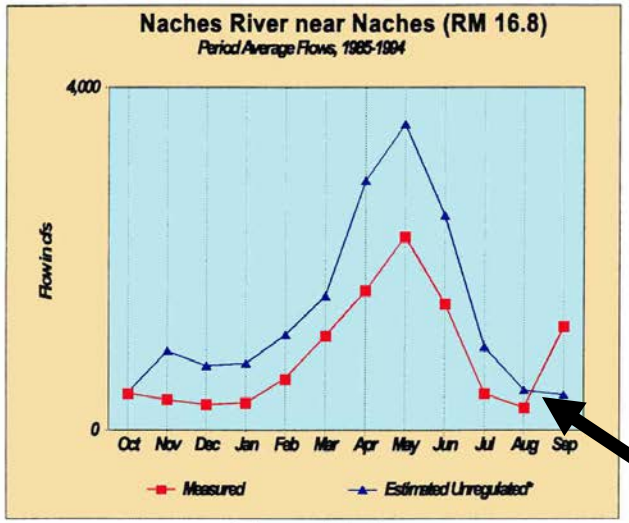


Figure III-1c

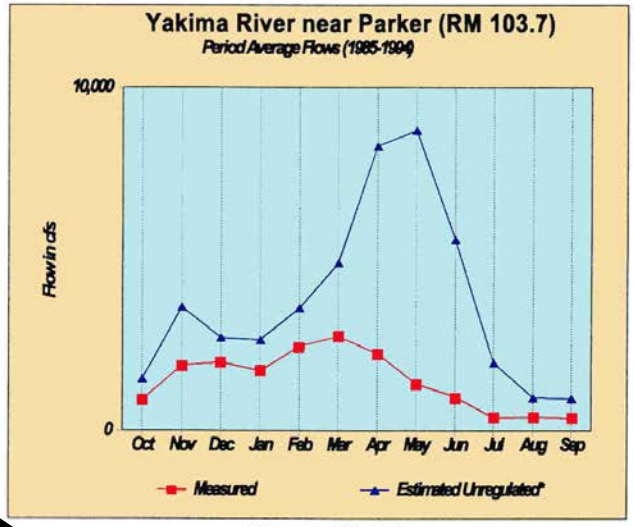


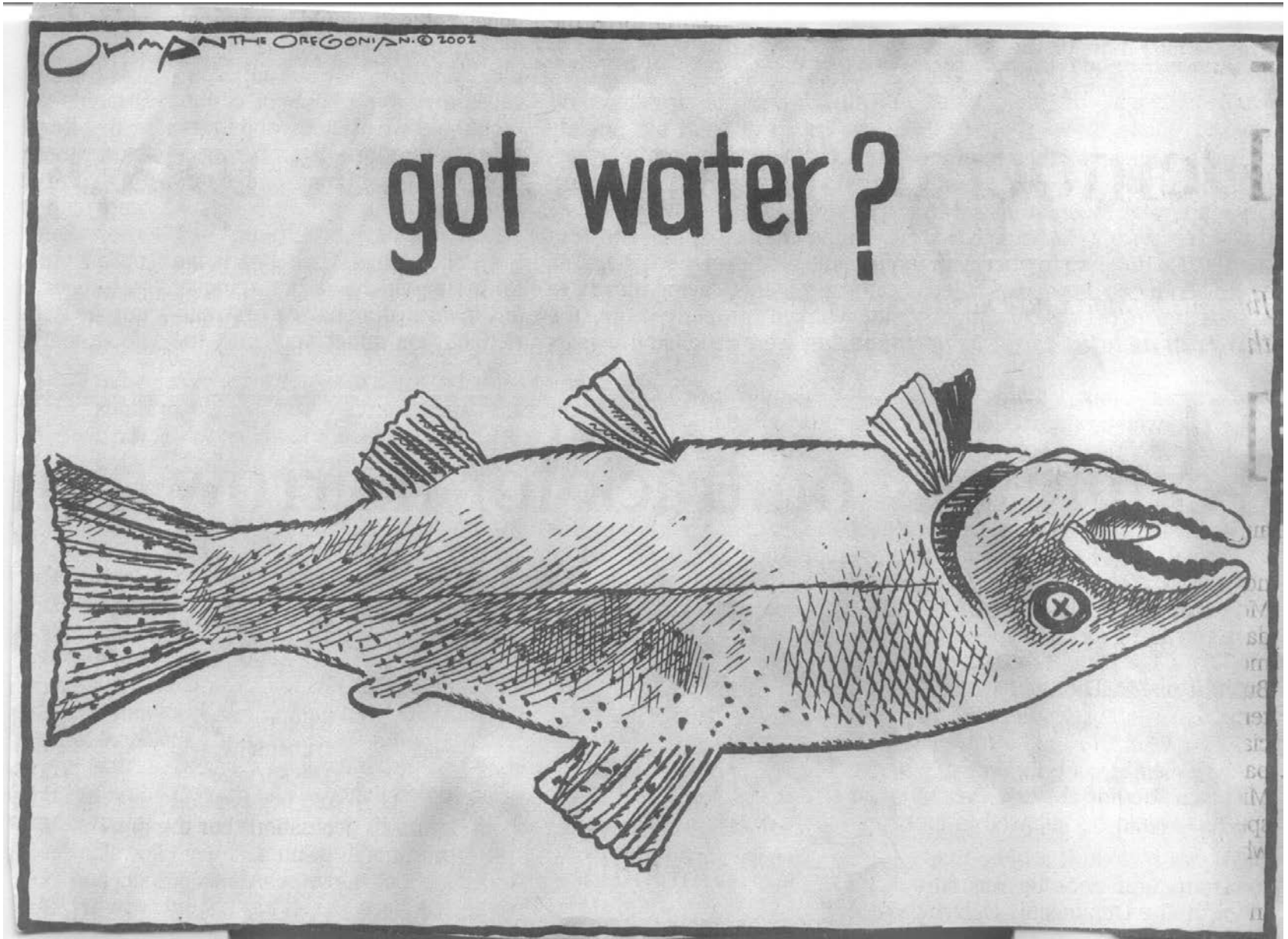
Figure III-1d

Figure III-1.—Conceptual comparison of measured flow and estimated unregulated flow (measured flow corrected for storage, estimated diversions, and estimated return flows).

From YRBWEP Draft Programmatic Environmental Impact Statement

Now the Tributaries

Are You Sure You Want To Delete This Icon? Y/N



Manastash Creek

(Below the diversions)

Work is ongoing to remove fish barriers and acquire or reroute water for instream flow

We can share what we got of yours,
cuz we done shared all of mine.
Grateful Dead - 1972

So Waddyagonnadoaboutit?
Categories of Improvements in Water Management

- Stopping the bleeding
- Making a bad thing not quite as bad
- Getting fish to where the flow regime doesn't need improving
- Conservation/diversion reductions to benefit a stream reach
- The package deal (YRBWEP III, see Wendy)

Stopping the bleeding as flow "improvement"

The Black Rock Moxee Groundwater Appeals stopped permitting of hundreds of new irrigation wells pumping hundreds of cfs of groundwater tributary to the Yakima River

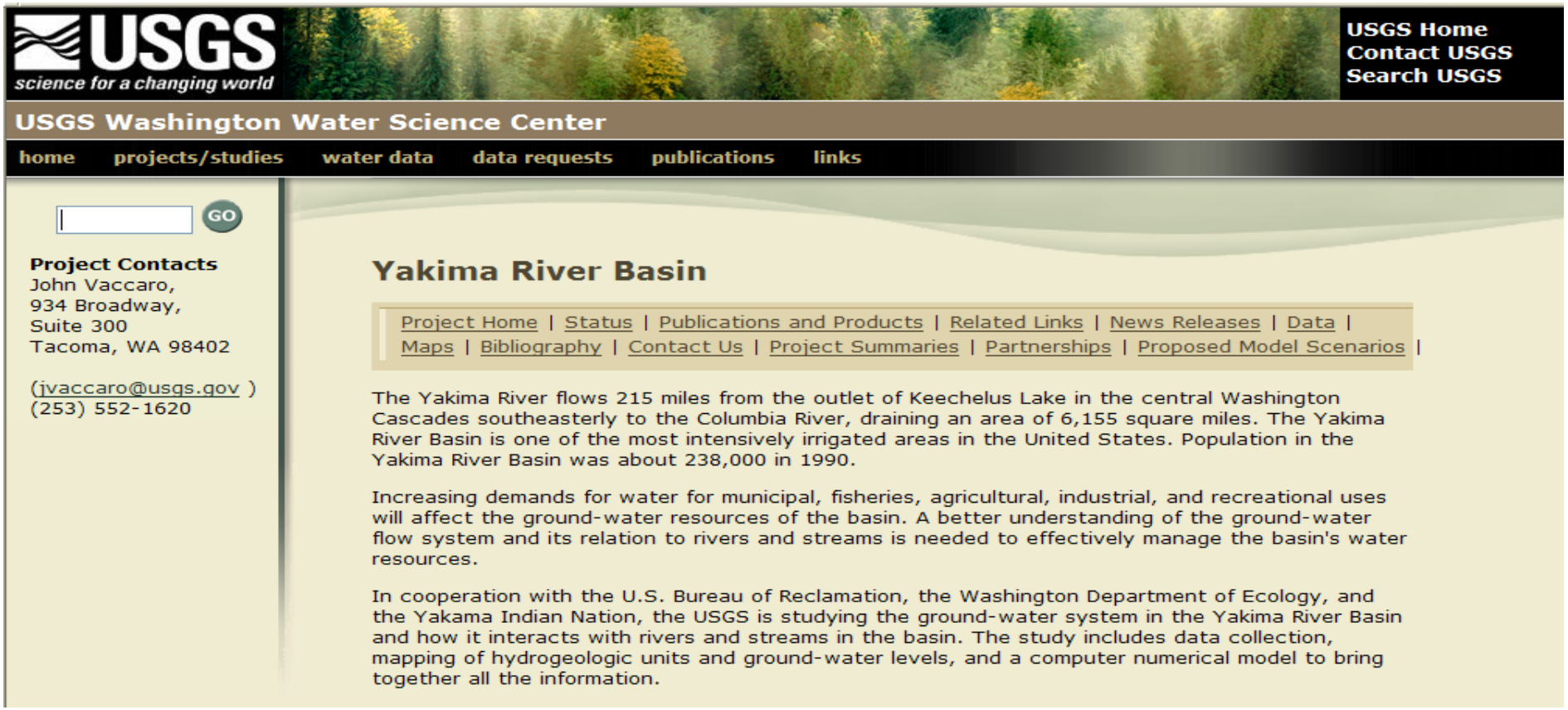
IDAHO

LAW REVIEW

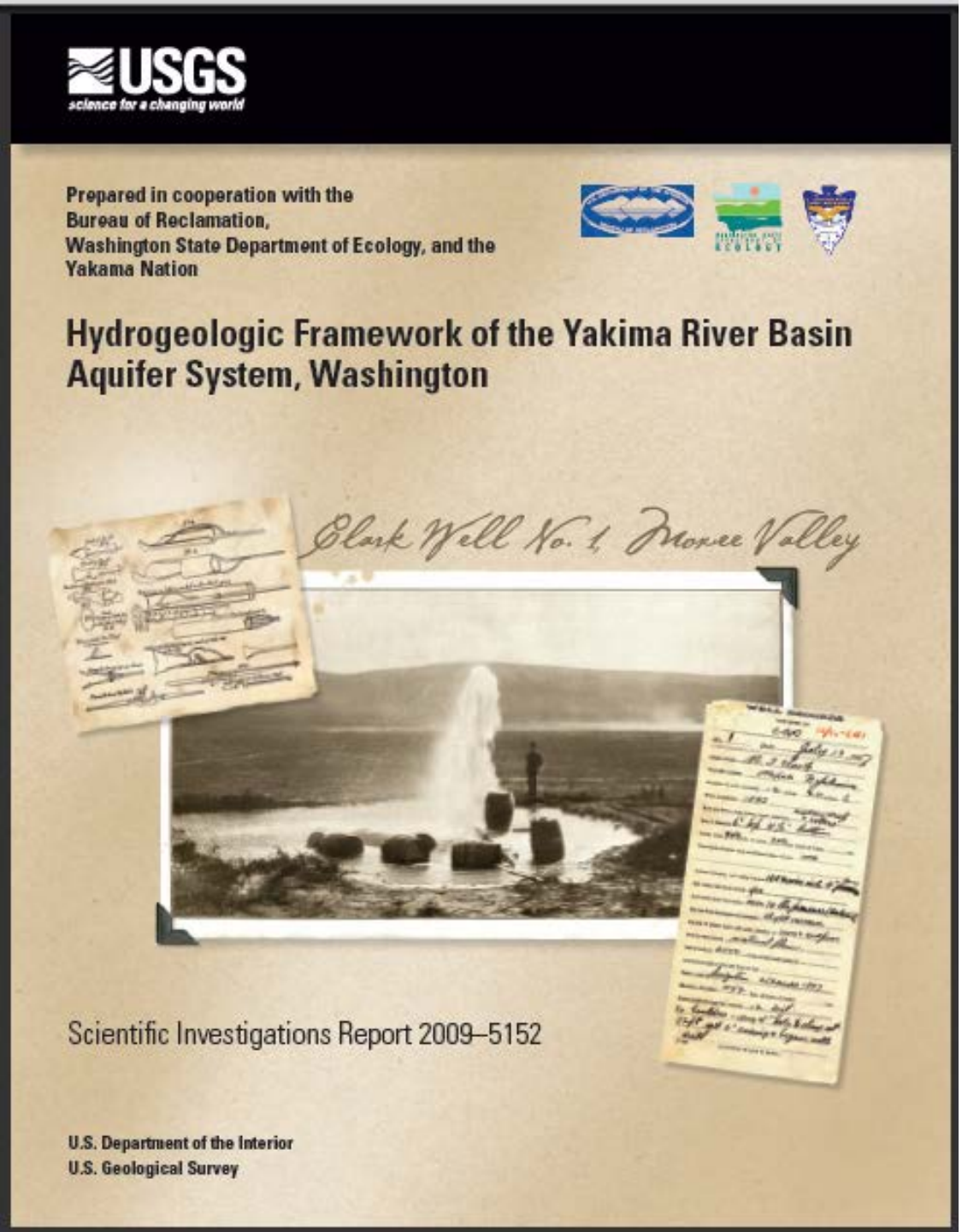
After the Black Rock study was issued, but prior to issuance of water right decisions, the tribal hydrogeologist prepared a review of scientific literature, summing up dozens of existing reports.[12]

The Study

http://wa.water.usgs.gov/projects/yakimagw/



Preliminary Finding:
Existing rates of groundwater use will result in about 200 cfs reduction in surface water budget (at equilibrium)



One Stop Shopping

Framework Report compiles task reports and synthesizes

- Geology: Stratigraphy and Structure
- Hydrogeologic Units
  - Hydraulic Characteristics
    - Lateral and Vertical Hydraulic Conductivities
      - Necessary to calculate horizontal and vertical groundwater flow (Darcy's Law)
    - Storage Coefficients
      - Necessary for transient simulations of pumping
- Hydrochemistry
- Groundwater
  - Recharge
  - Water levels
  - Flow System
  - Pumpage
    - is about 312,284 acre-ft (about 430 ft^3/s) (in 2000)
- Water Budget

YRBWEP III

The next big fix

- Each generation takes its shot at a big fix for the Yakima Basin. This is ours.
- YN has developed Integrated Package with irrigators, others. We have consensus on…
- Seven components to start fixing the big problems in the Yakima Basin.
  - Fish Passage at Reclamation Reservoirs
  - Habitat Improvements and Passage in Tributaries
  - Modifying Existing Structures and Operations
  - New Reservoir Storage
  - Groundwater Storage
  - Enhanced Water Conservation
  - Market-Based Reallocation
- Additional land acquisition for mitigation

YN on Black Rock DEIS

It's Not Just About Storage

- Tribal Chairman sent letter with Roza ID Board Chairman recommending **package approach** as alternative to Black Rock
  - Incorporate passage at reservoirs
  - Passage in tribs
  - Reevaluate headwaters storage
  - Look for affordable options
  - Explicit YN Treaty Water

Bumping Reservoir Salmon-free for a century

Status Quo

- No fish passage
- No anadromous fish
- Bull trout isolated

Expansion

- Some habitat loss above and below lake
- Reintroduction of salmon
- Allows migration of Bull Trout
- USFWS supports package


Bumping River
Below Dam

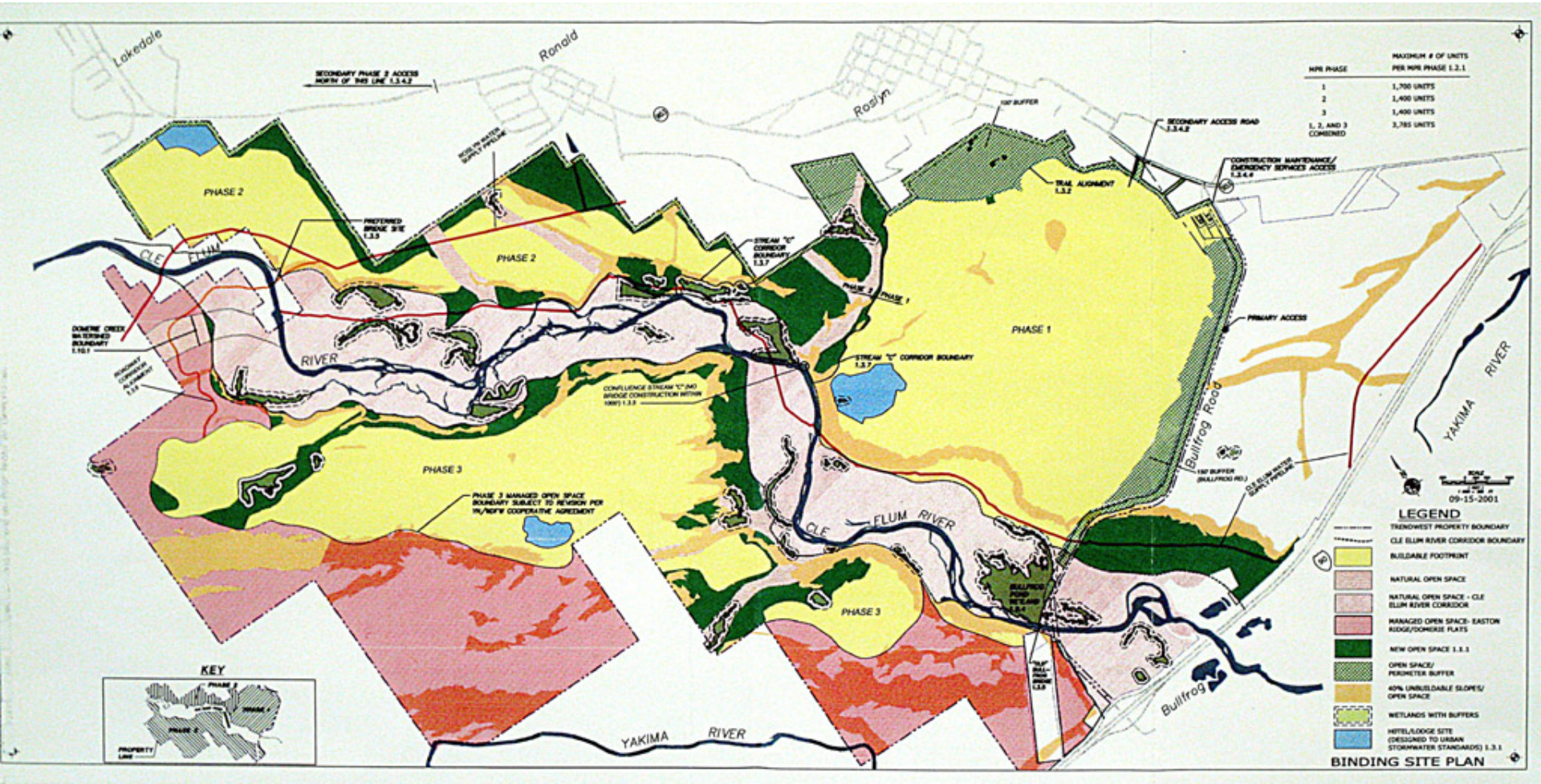

YN is actively purchasing and restoring floodplain habitat throughout the region
Image © 2005 DigitalGlobe
Google
Pointer 46°32'25.90" N 120°28'07.42" W elev 967 ft
Streaming 100%
Eye alt 6399 ft

Suncadia

Example of Resource Management by Cooperative Agreement with Private Entity

YN worked with developer early on. Results:

- No new water rights or exempt wells. Developer acquired all water needed for resort.
- At YN urging developer removed all planned dwellings from Cle Elum River floodplain, placed geomorphic floodplain in conservation easement jointly held with YN, WDFW Pink area).



Taneum Creek

Making *after* look like *before*

- Restore winter flow ☑
- Remove Barrier ☑
- Replace irrigation water ☑
- Place LWD ☑
- Release Coho ☑
- Make speech ☑

- Cooperators
  - YN/YKFP, WDFW, Wa Water Trust, WSDOT, USBR, Kittitas Conservation Trust, Taneum Creek irrigators, WDOE, BPA

Salmon return Taneum Creek

Event celebrates salmon recovery project

For **THE DAILY RECORD**

Salmon will be able to reach 30 miles of premier habitat in tributaries of the Yakima River in Kittitas County next week when crews put the finishing touches on a Taneum Creek dam removal project northwest of Ellensburg.

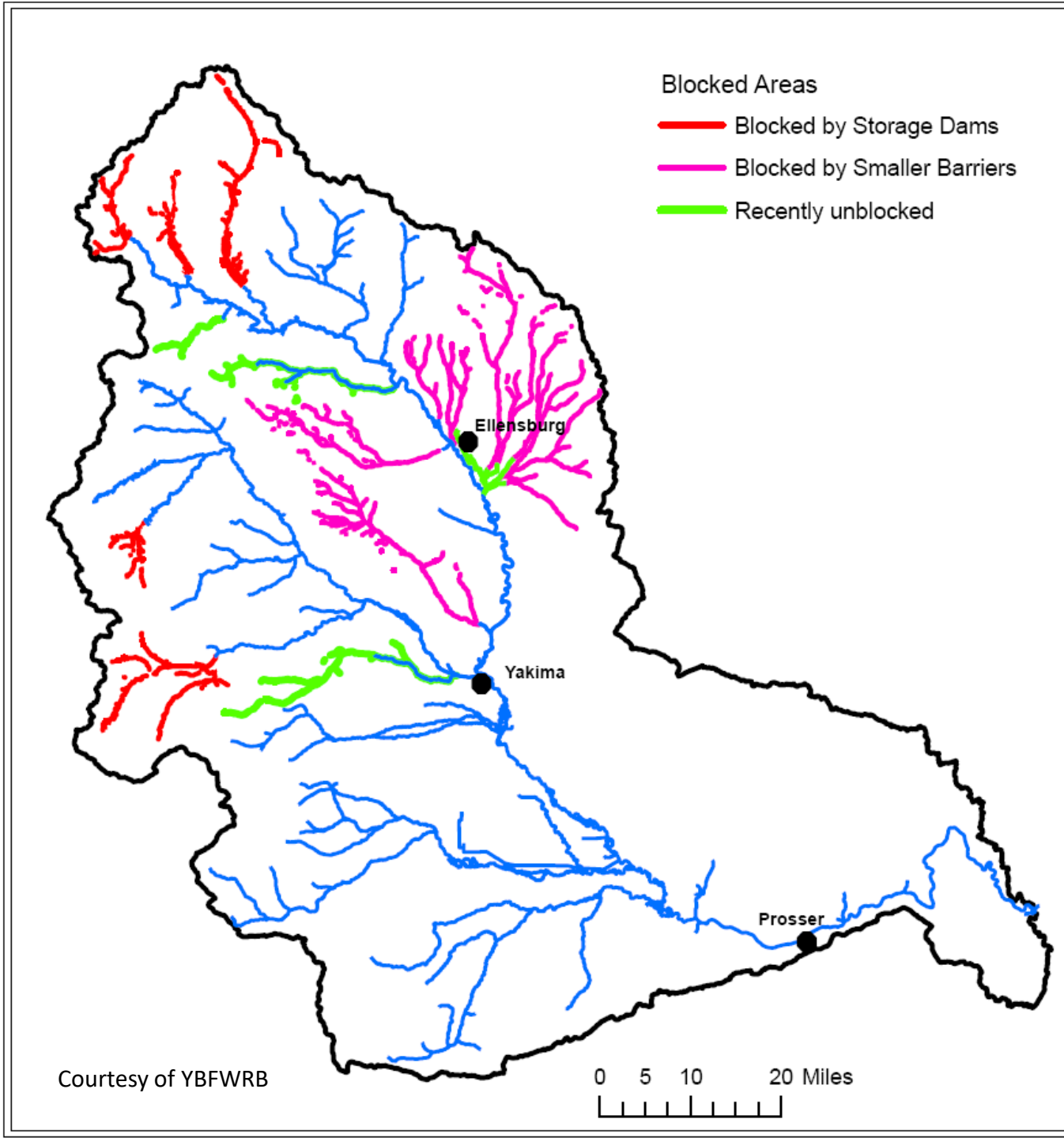
A public celebration, which includes release of coho salmon into the creek, will begin with a tour of the project at 10 a.m., Nov. 12, at 3661 E. Taneum Road, near

Contributed

Crews work to remove the Bruton diversion dam on Taneum Creek northwest of Ellensburg near Interstate 90 this fall.

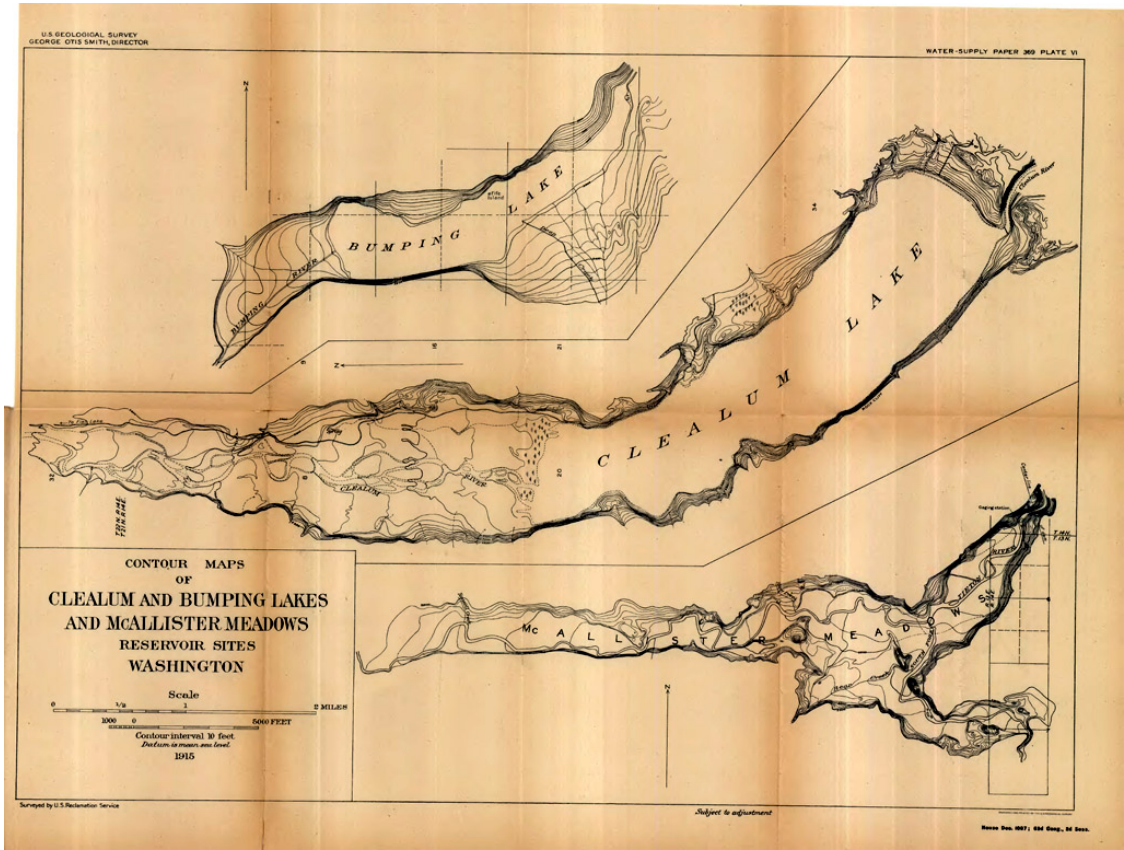
http://www.usbr.gov/pn/programs/yrbwep/phase2/taneumcreek/taneumcreekstudy-final.pdf

Lack of fish passage at Reclamation reservoirs (red) and many smaller irrigation diversions (purple) greatly impedes salmon recovery.



Fish Passage at Reclamation Storage Reservoirs

- All five Yakima Project storage dams completely blocked fish passage for salmon, steelhead, and bull trout.
- Four were built on natural lakes that hosted sockeye, which were extirpated in the basin
- Habitat above reservoirs is relatively intact, publicly owned, and has relatively cool temperatures and unregulated flow regime
- YN Goal: Restoration of passage to all historic habitat, reintroduction of sockeye, enhancement of Coho, spring Chinook, steelhead, and bull trout



Cle Elum River Above Dam

Pristine Habitat, No Salmon, until…

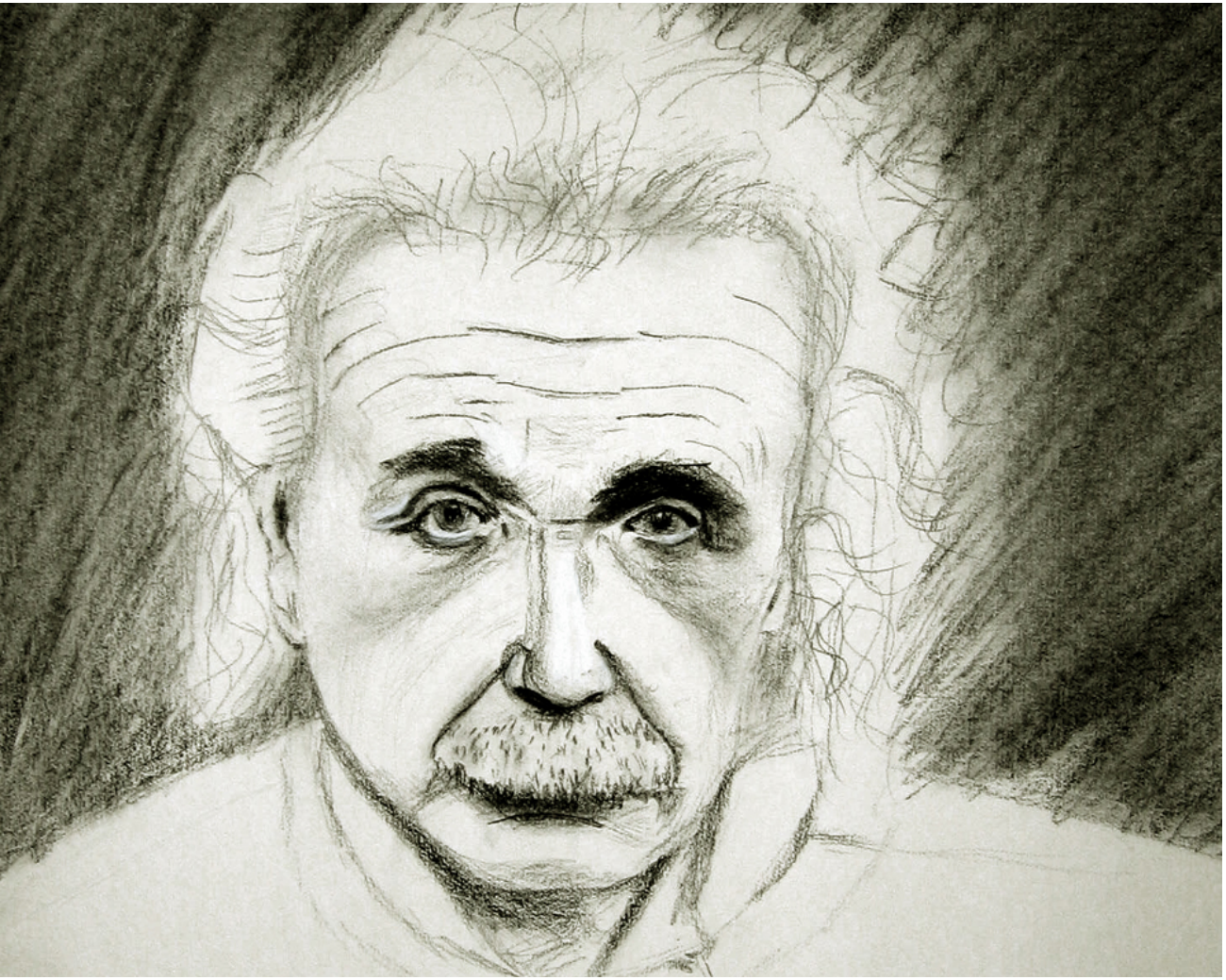
Temporary Juv. Passage

Brian Saluskin will detail tomorrow


Summer 2009
YN Reintroduces sockeye to
Yakima Basin


Cle Elum River, Fall 2009: First spawning Sockeye Salmon in Yakima Basin in nearly a century
William Meyer Photo

Conclusion One



We can't solve problems by using the same kind of thinking we used when we created them

Albert Einstein

Conclusion Two

We can **only** solve problems by using the same kind of thinking we used when we created them - Tom Ring 2005