

Willamette River Basin

A Brief History of Time

Rick Hafele



Willamette River Basin

What has changed from 1850 to today?

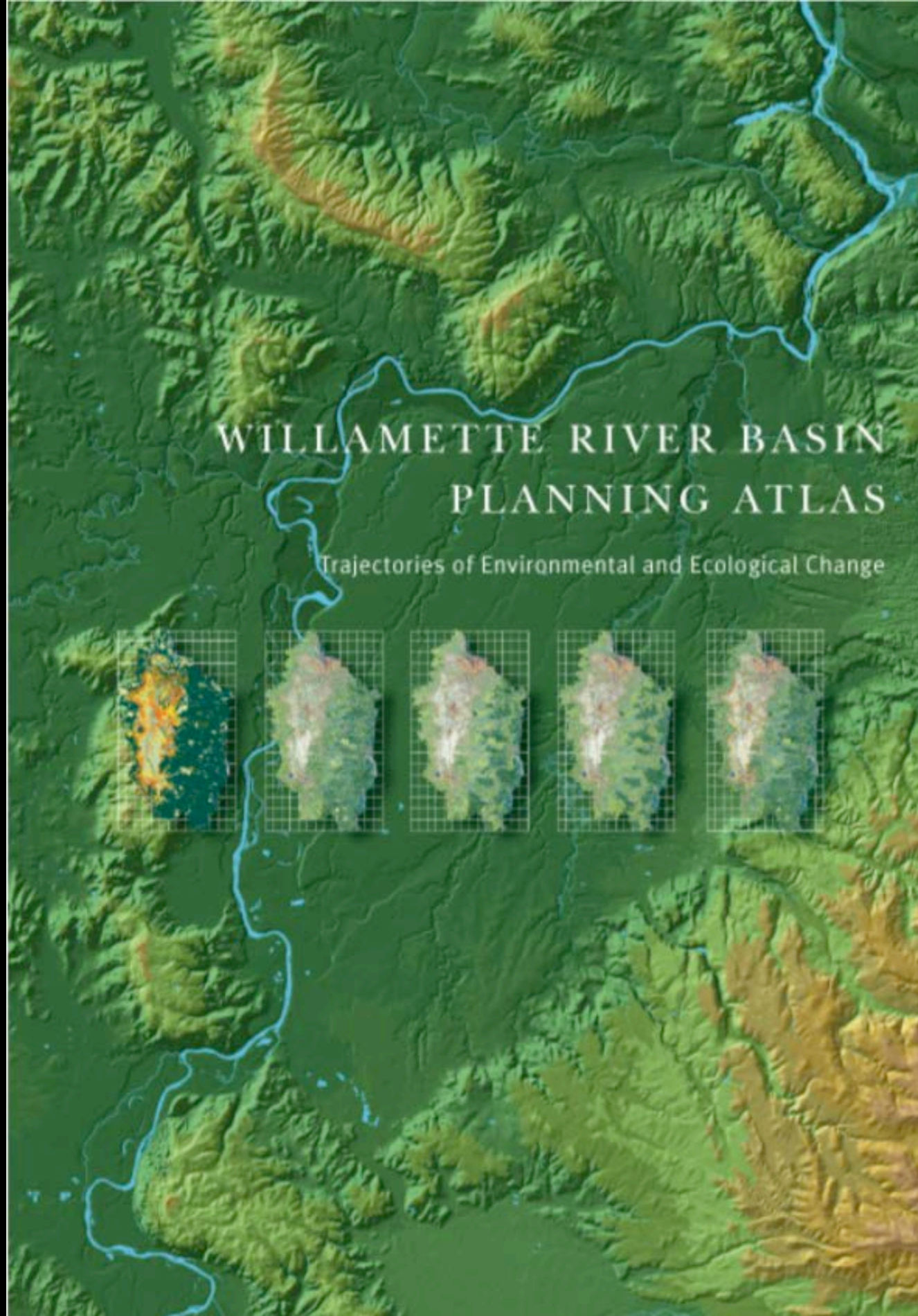
- 1) Land use - Land Cover
- 2) Channel morphology and habitat.
- 3) Flow changes - low and high flows
- 4) Water quality
- 5) Fish and aquatic life



*Willamette River Basin
Planning Atlas*, Edited by D.
Hulse, S. Gregory, and J. Baker.
2002, OSU Press.

**Environmental Protection
Agency**

- **How has human disturbance affected aquatic life in the Willamette Basin and Puget Lowland?**
- **20+ aquatic biologists from State and County agencies in Oregon and Washington involved.**
- **Need to know what conditions were like without human disturbance -**
- **What's the human disturbance history?**



Edited by David Hulse, Stan Gregory, and Joan Baker
for the Pacific Northwest Ecosystem Research Consortium

The Geologic History of the Willamette Basin

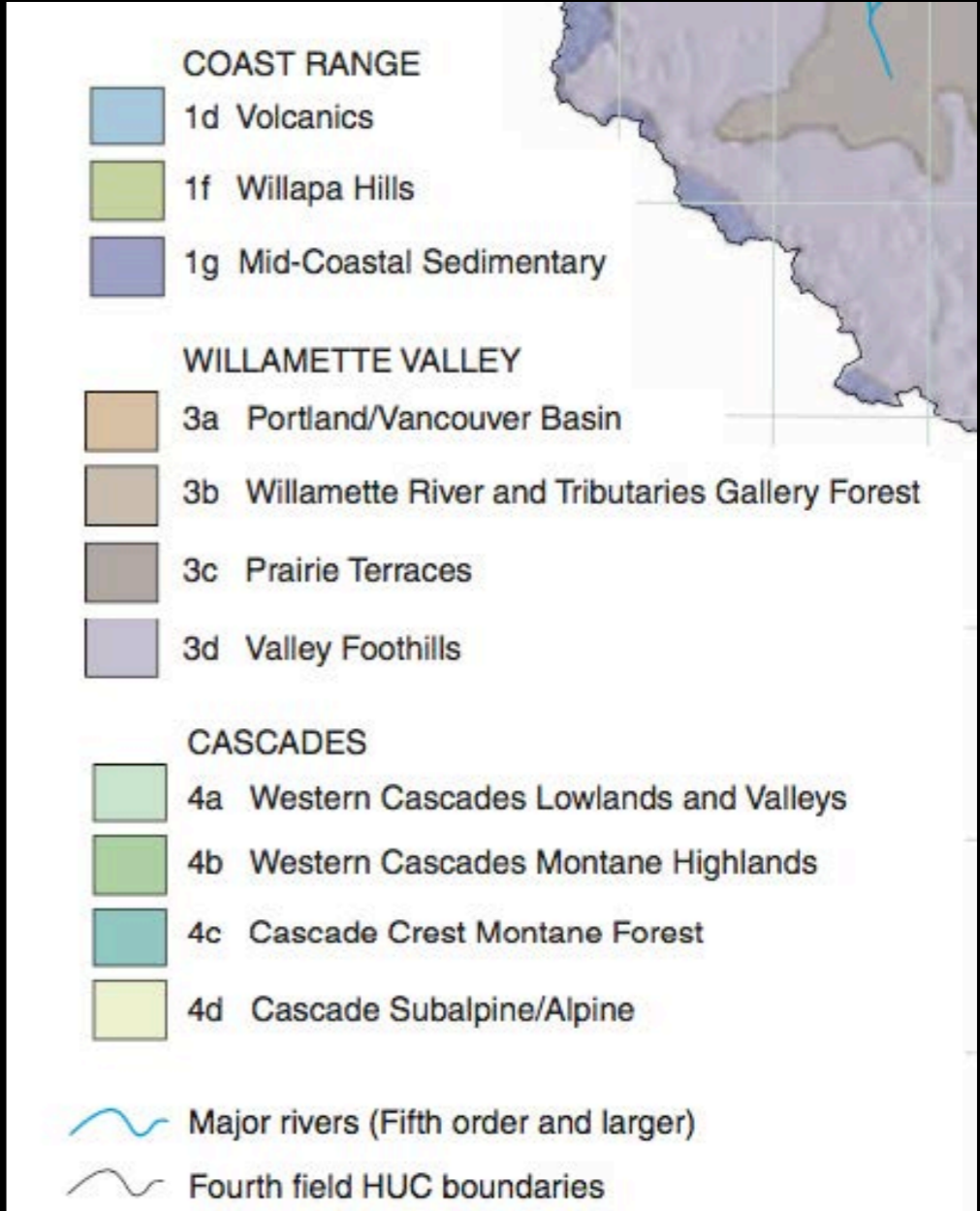
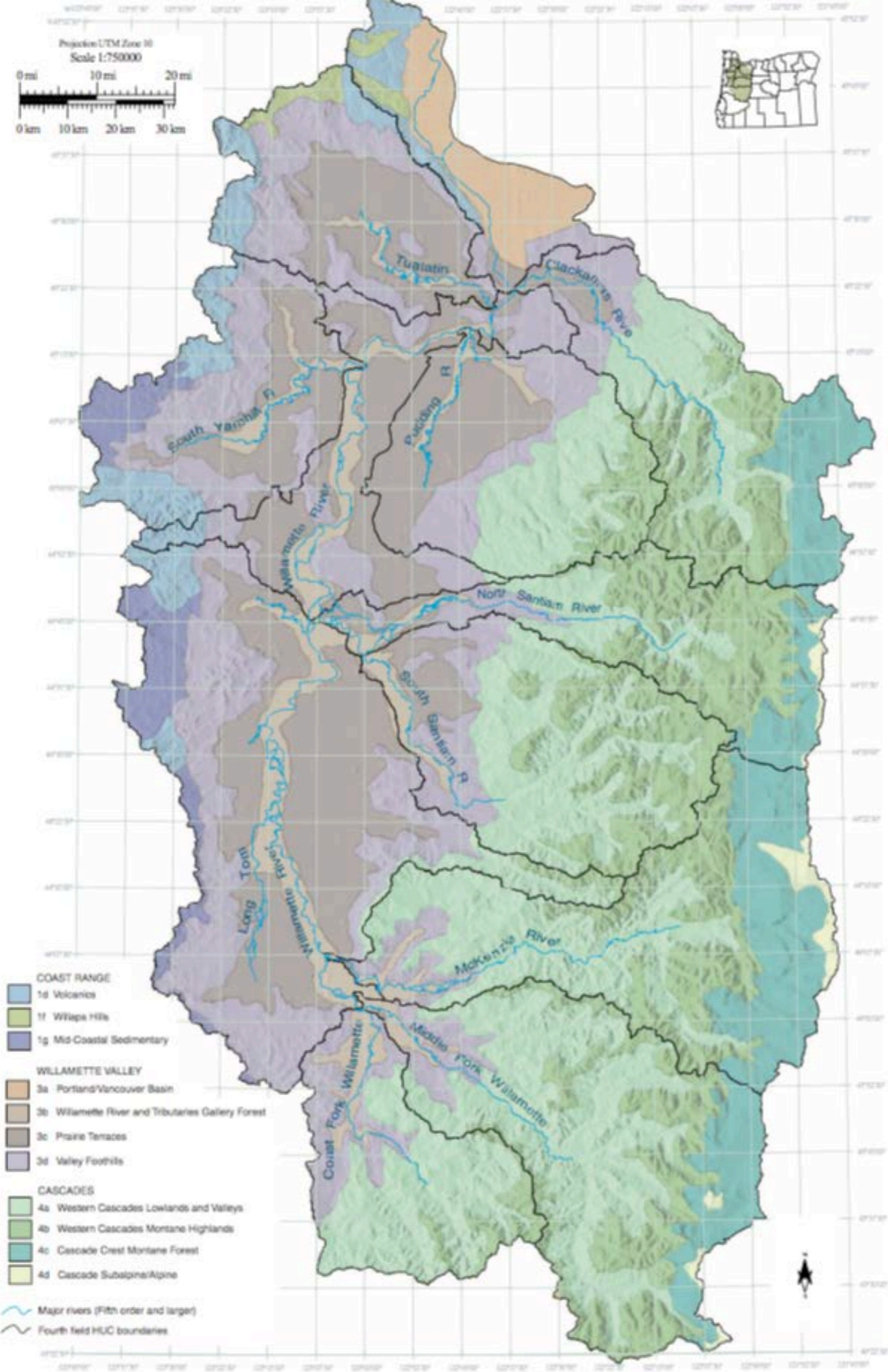
- ~20 mya: A shallow inland sea existed where the valley is today.
- ~15 mya: Valley floor uplifted and Cascade Mountains formed creating the Willamette Valley roughly as we see it today.
- 40-13 thousand years ago: Last great ice age. Major ice sheets did not reach as far south as Oregon. BUT
- 15-13 thousand years ago: As many as several dozen great floods - known as the Bretz Floods or Missoula Floods - occurred across the entire Columbia Basin and flooded the Willamette Valley to a depth as high as 400 feet.
- Much of the top soil in the Willamette Valley was left behind by these great floods.

Willamette Basin



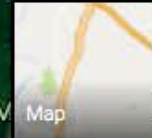
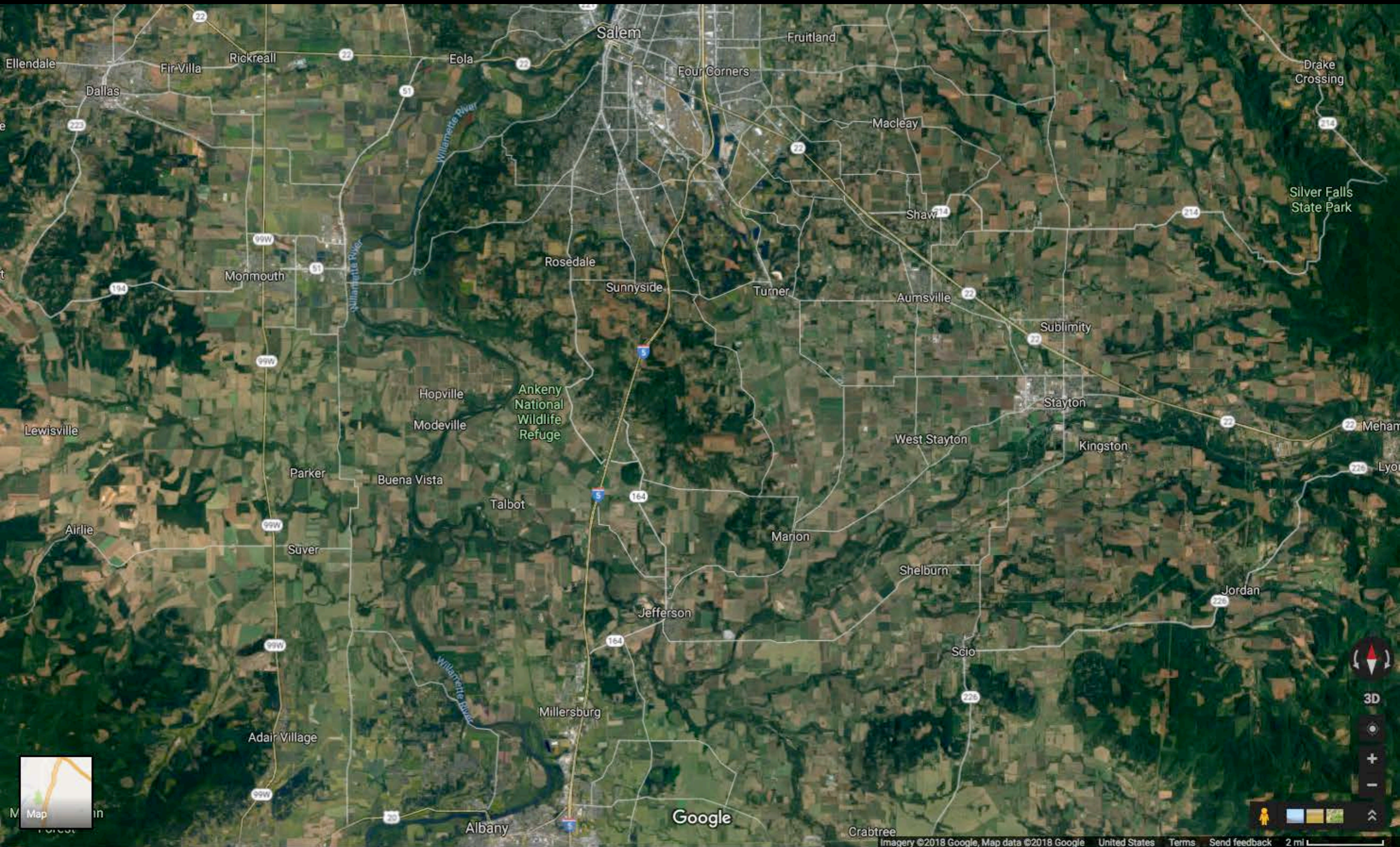
- 1) 11,478 square miles
- 2) Length of mainstem Willamette ~180 miles
- 3) 12 Major sub-basins
- 4) ~100 miles wide from crest of Coast Range to Cascades
- 5) Valley floor ranges from 450 feet above sea level at southern end to 10 feet ASL at Columbia River.
- 6) Mary's Peak highest point in Coast Range: 4,097 ft.
- 7) Mount Jefferson highest point in Cascades: 10,495 ft

Willamette Basin includes Three Ecoregions



LAND USES

Mid Willamette Valley



Google

Looking East Towards Cascades

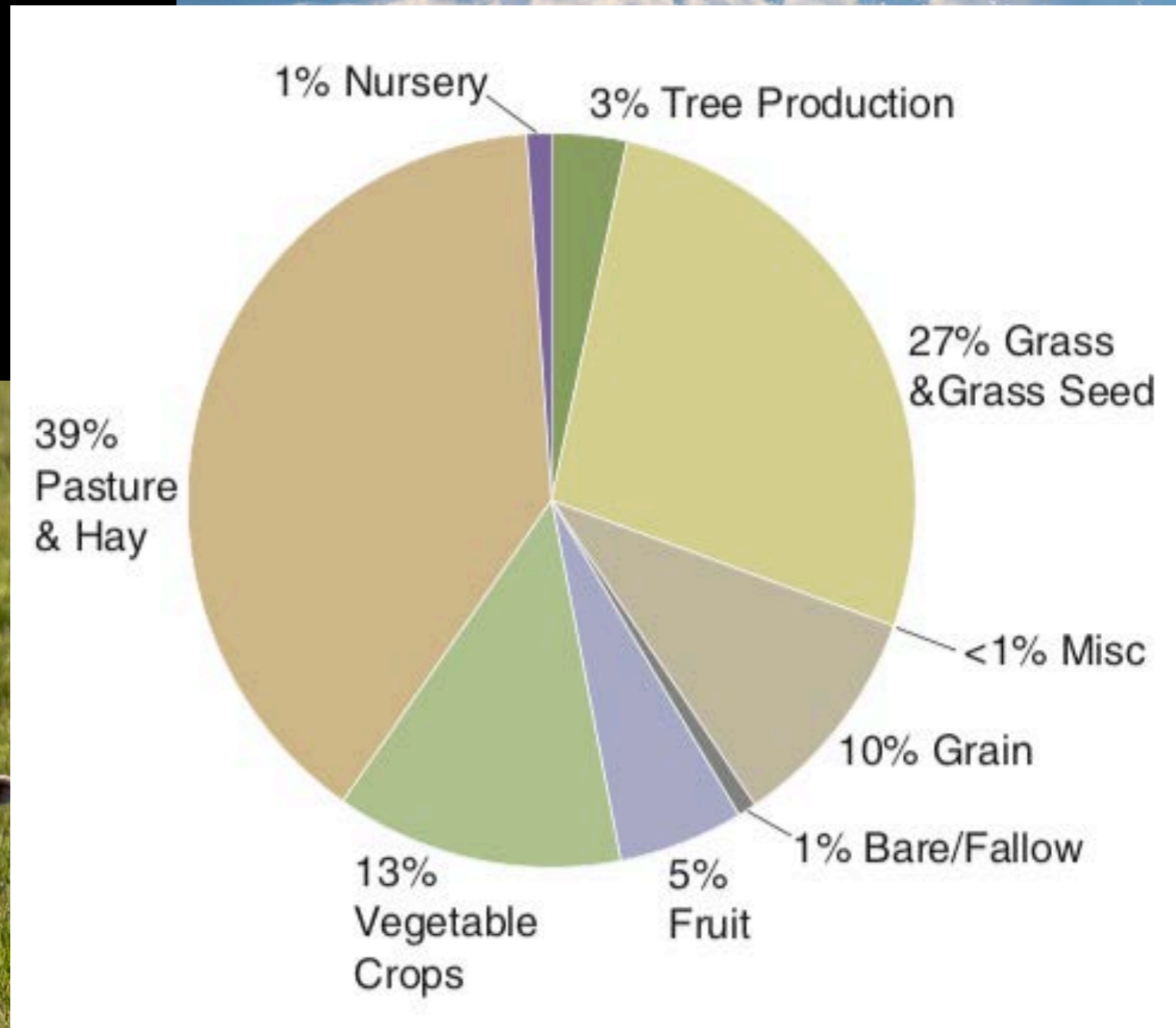


Looking West Towards Coast Range

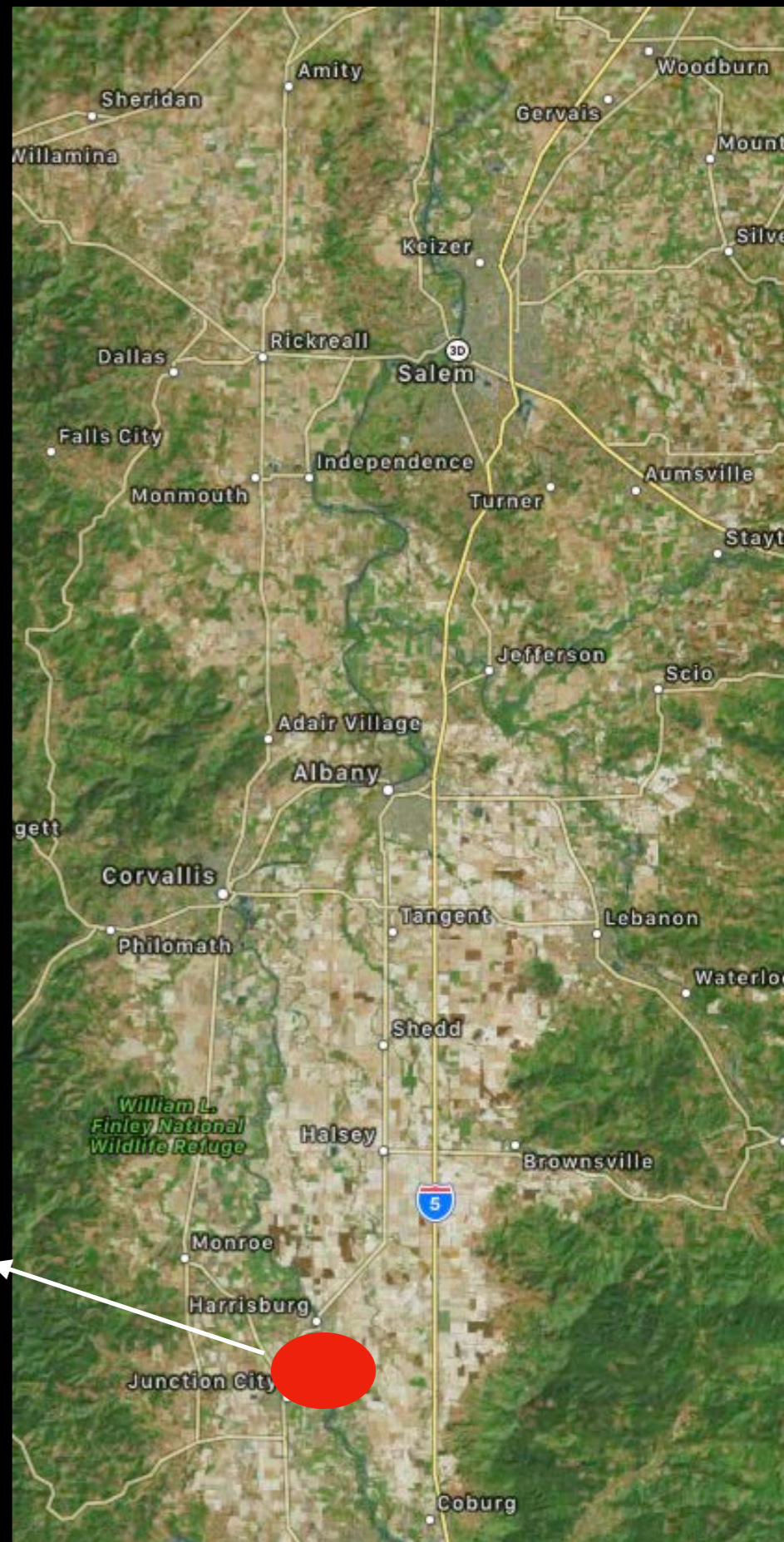


Land Uses: Crops, Animals, and Industry

Agricultural Land Use ca 1990



Mid Willamette Valley



Mainstem Willamette River



Calapooia River - Mid Willamette Valley

Google



Calapooia River - Mid Willamette Valley



Aerial view of Calapooia drainage in winter



Coast Range foothills higher gradient wadeable stream



History of European Settlement

- 1818-1830: Fur trappers with Hudson Bay Company were the first major influx of Europeans to the Willamette Valley.
- By the late 1830's beaver had been almost completely eliminated as part of the Hudson Bay Company's policy of creating a "fur desert." This was the first major impact Europeans had on Willamette Valley streams.
- 1836: Fur trappers settled at French Prairie (near present day Champoeg Park) creating one of the first colonies in the Willamette Valley.
- 1850: European population in Willamette Valley approximately 1200.
- 1860: European population about 10,000.
- 1900: Population ~ 115,000.
- 2015: 2.8 million = 70% of Oregon's total population of 4.1 million.
- Native Americans?
- 90% of Native Americans in Willamette Valley died of malaria and other diseases by the early 1830's.



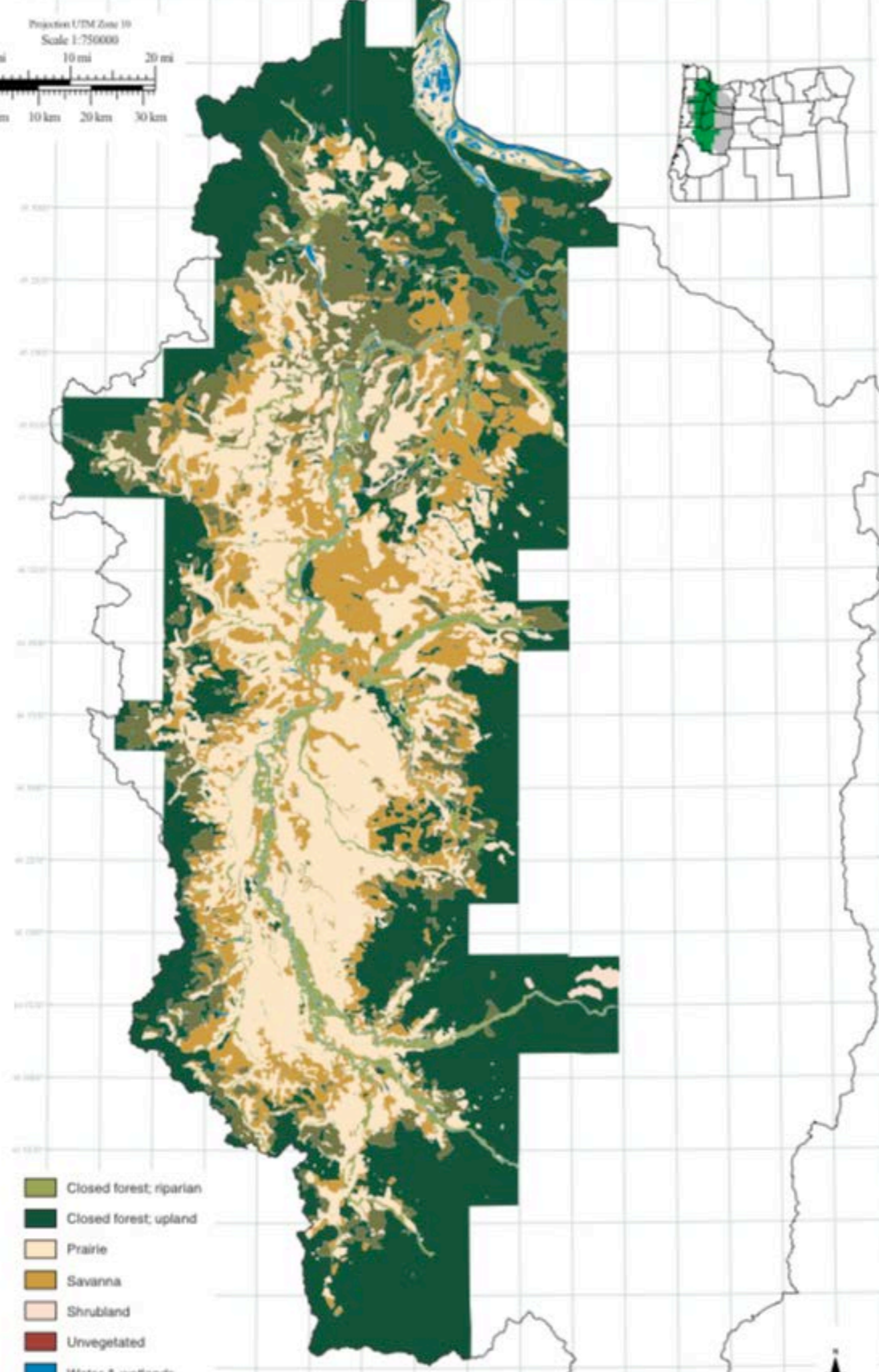
Willamette Valley Vegetation & Land Cover 1851 vs 1990

1851 data from General Land Office Surveys

| Vegetation | Percent Cover 1851 | Percent Cover 1990 |
|--------------------------|--------------------|--------------------|
| Natural Grass | 18.9 | 0.6 |
| Natural Shrub | 13.3 | 7.6 |
| Savanna | 13 | 0 |
| Wetland | 7.9 | 0.4 |
| Conifer Forest | 36.6 | 23.3 |
| Development (e.g. Urban) | ~0 | 10.7 |
| Agriculture | ~0 | 33.5 |

From Willamette River Basin Planning Atlas, Edited by D. Hulse, S. Gregory, and J. Baker. 2002, OSU Press.

Projection UTM Zone 10
Scale 1:750000
0 mi 10 mi 20 mi
0 km 10 km 20 km 30 km



Pre-settlement Vegetation (1851)

From: *Willamette River Basin Planning Atlas*

-  Closed forest; riparian
-  Closed forest; upland
-  Prairie
-  Savanna
-  Shrubland
-  Unvegetated
-  Water & wetlands
-  Woodland

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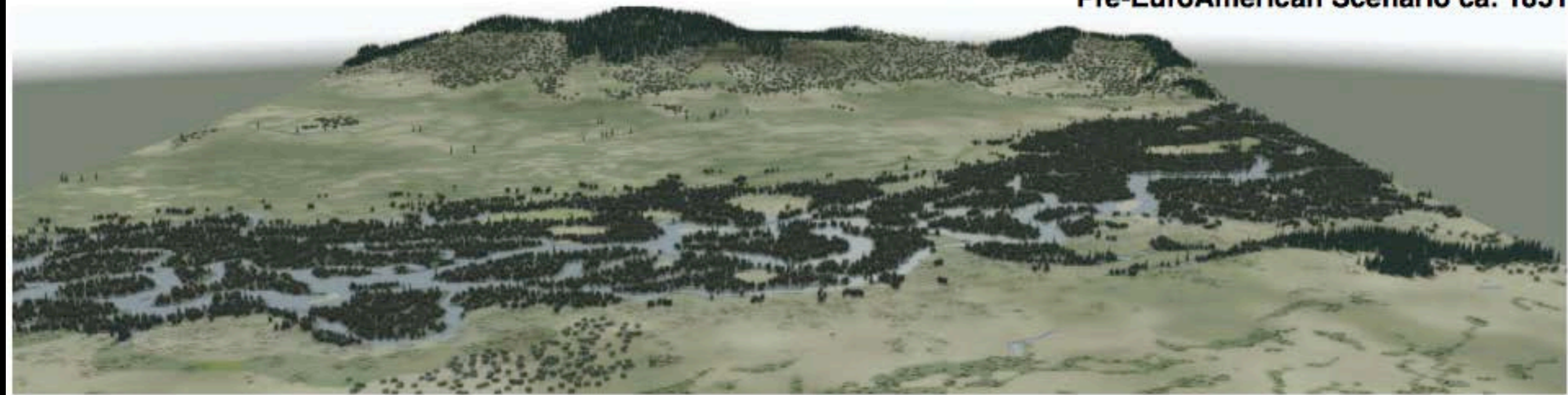
Restoration of Oak Savannah: Graham Oaks Natural Area



Camasia quamash - Indian Camas



Pre-EuroAmerican Scenario ca. 1851



Land Use and Land Cover 1990



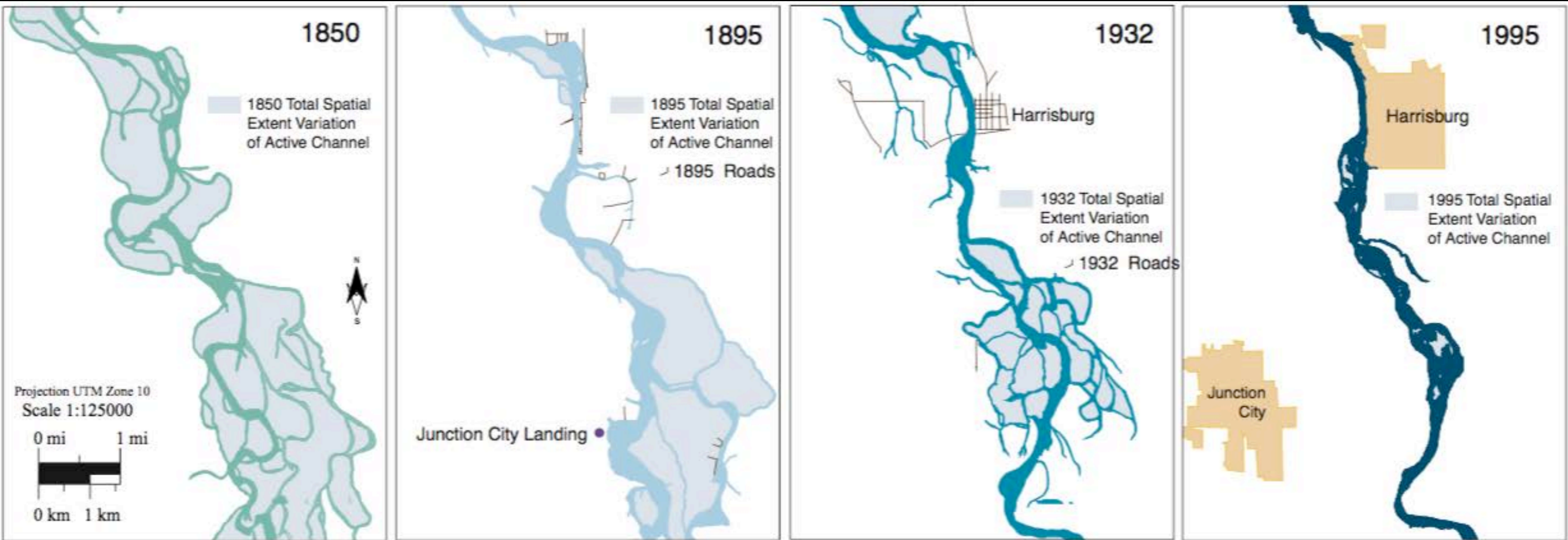
Computer simulation of the upper Willamette River and floodplain between Harrisburg and Eugene-Springfield, ca. 1850 and ca. 1990. (From USEPA 2002b).

| TOTAL RIVER LENGTH - PERCENT COMPOSITION OF CHANNEL | | | | | |
|---|---------------|---------|------|--------------|-------|
| | Channel Types | | | Total Length | |
| | Primary | Alcoves | Side | km | miles |
| 1850 | 51.2 | 7.8 | 41.0 | 571.3 | 355.0 |
| 1895 | 55.1 | 8.9 | 36.0 | 492.2 | 305.8 |
| 1932 | 55.8 | 6.6 | 37.6 | 487.2 | 302.7 |
| 1995 | 64.8 | 11.8 | 23.4 | 424.1 | 263.5 |

| TOTAL RIVER LENGTH - % CHANGE VS. 1850 | | | | |
|--|---------------|---------|-------|--------------|
| | Channel Types | | | |
| | Primary | Alcoves | Side | Total Length |
| 1895 | -7.3 | -0.9 | -24.5 | -13.8 |
| 1932 | -7.1 | -27.8 | -21.8 | -14.7 |
| 1995 | -6.1 | 13.1 | -57.7 | -25.8 |

Changes in the length of the mainstem Willamette River, from Portland to Eugene, between 1850 and 1995. This table shows the absolute changes in length of each of these channel types as well as the percent change from 1850 to the present. Calculation of the changes since 1850 is based on actual lengths.

Channel Complexity Changes



Willamette Valley Vegetation & Land Cover 1850 vs 1990 and under three development scenarios.

| LOWLAND ECOREGION - 120 METER RIPARIAN AREA: 1- 4th ORDER STREAMS | | | | | | | | | |
|---|--------|---------------------|------|----------|----------|------|---------|-----------|----------|
| | | Percent composition | | | | | | | |
| | Acres | Devlp | Ag | NatGrass | Natshrub | Hdwd | Mix For | Conif For | Wetlands |
| PESVEG | 467693 | 0.0 | 0.0 | 16.8 | 13.9 | 24.7 | 5.1 | 25.4 | 14.2 |
| LULC90 | 470071 | 10.3 | 41.6 | 1.0 | 12.7 | 9.9 | 13.2 | 9.6 | 1.1 |
| PT2050 | 470072 | 12.7 | 40.5 | 0.9 | 12.1 | 9.7 | 12.5 | 9.9 | 1.1 |
| CON2050 | 469072 | 11.7 | 26.7 | 5.7 | 15.4 | 11.9 | 14.9 | 9.9 | 3.5 |
| DEV2050 | 470089 | 15.8 | 36.8 | 1.0 | 13.5 | 9.3 | 12.1 | 9.8 | 1.1 |

| UPLAND ECOREGION - 120 METER RIPARIAN AREA: 1 - 4th ORDER STREAMS | | | | | | | | | |
|---|--------|---------------------|-----|----------|----------|------|---------|-----------|----------|
| | | Percent composition | | | | | | | |
| | Acres | Devlp | Ag | NatGrass | Natshrub | Hdwd | Mix For | Conif For | Wetlands |
| PESVEG | 590522 | 0.0 | 0.0 | 0.4 | 0.7 | 0.1 | 0.3 | 98.2 | 0.1 |
| LULC90 | 587954 | 0.9 | 0.7 | 0.0 | 0.6 | 9.0 | 36.6 | 52.1 | 0.0 |
| PT2050 | 587959 | 0.9 | 0.7 | 0.0 | 0.6 | 9.0 | 36.3 | 52.4 | 0.0 |
| CON2050 | 588012 | 0.9 | 0.5 | 0.0 | 0.6 | 9.1 | 36.6 | 52.2 | 0.0 |
| DEV2050 | 587912 | 1.0 | 0.6 | 0.0 | 0.6 | 9.0 | 36.2 | 52.5 | 0.0 |

From *Willamette River Basin Planning Atlas*, Edited by D. Hulse, S. Gregory, and J. Baker. 2002, OSU Press.

Hydrology - Floods & Flood Control

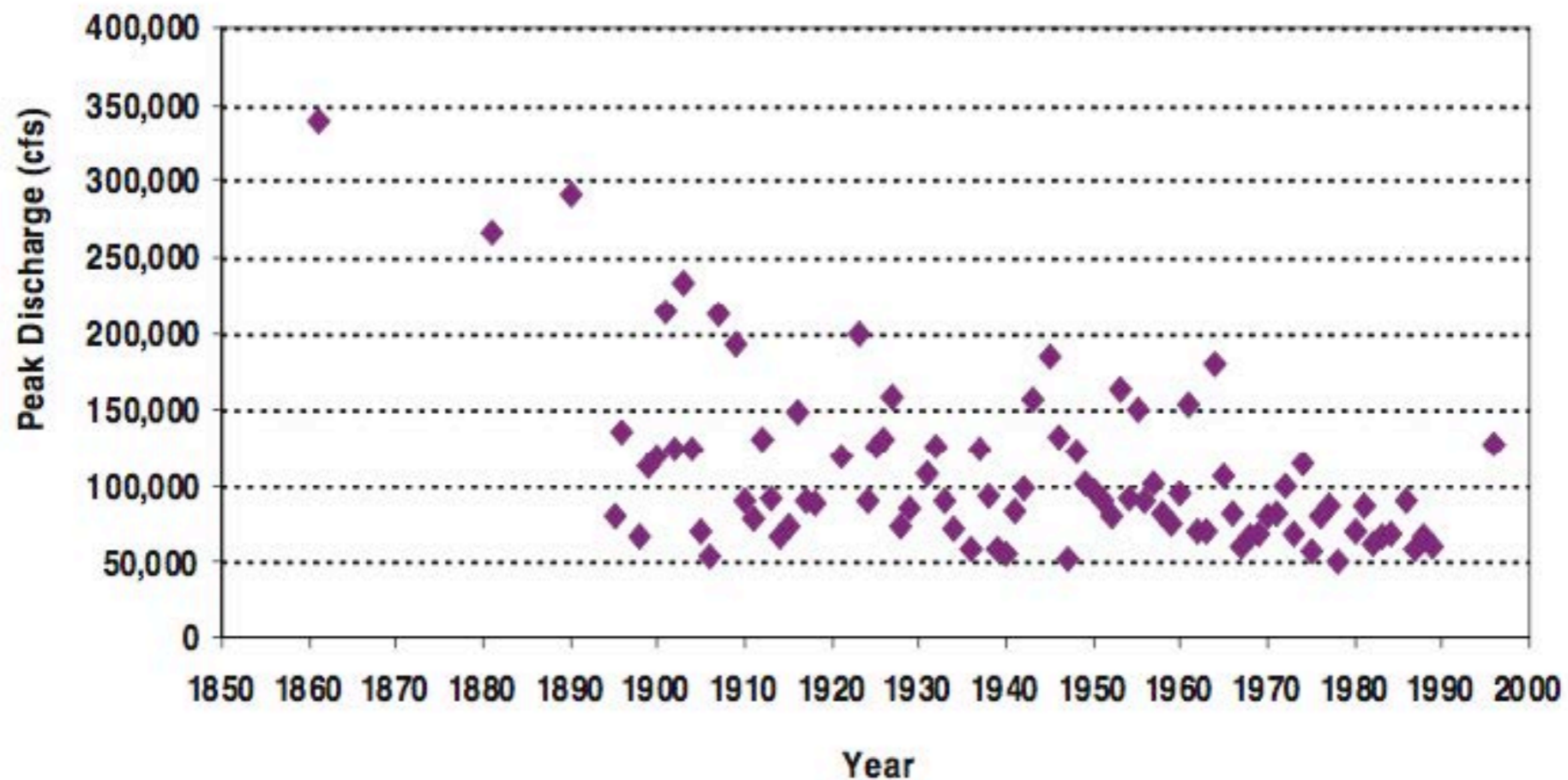


The November, 1996 flood, upstream of Corvallis, near Harrisburg. This flood was estimated to be an “fourteen-year” sized event since dams moderated floods’ sizes, with a peak flow of about 85,000 cubic feet per second (cfs) at the Harrisburg gage. The flood connected the river channel with its floodplain, and deposited rich sediment on the river’s bottomlands.

Hydrology - Floods & Flood Control

From: *Willamette River Basin Planning Atlas*

Maximum Annual Peak Flows at Albany 1861 - 1996



Peak Flows (in cubic feet per second) of Major Floods at the Albany Gauge

| 1861 | 1890 | 1943/1945 | 1964 | 1996 |
|---------|---------|-----------|---------|---------|
| 340,000 | 291,000 | 210,000 | 180,000 | 117,000 |

Floods

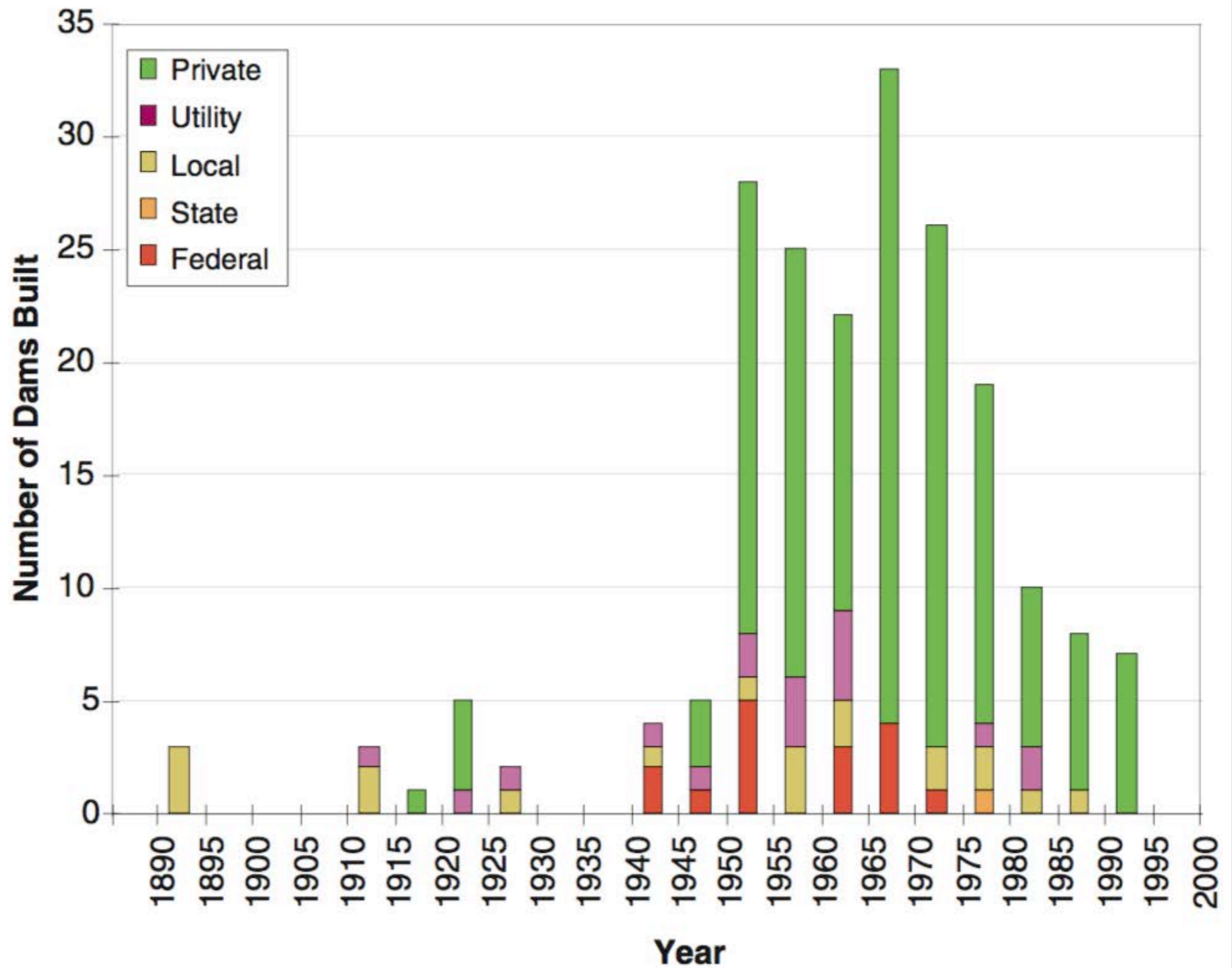
Historic Willamette River high water flood levels marked on a tree in Champoeg State Park downstream from Newberg, Oregon. Base of the tree is roughly 40 feet above normal water level of the river.

1861 Flood (340,000 cfs)

1996 Flood (117,000 cfs)



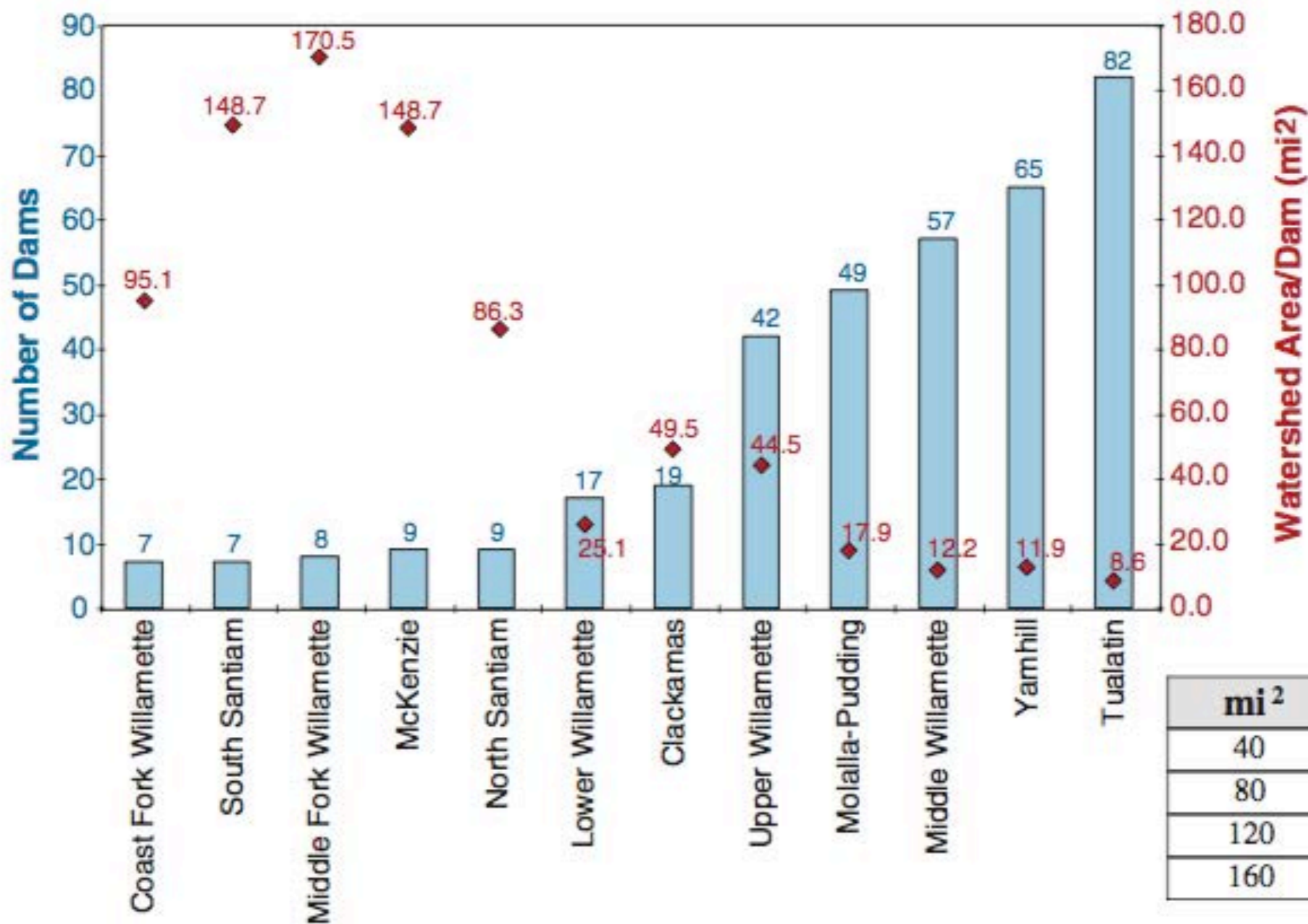
Dams: Total of 371 dams in the Willamette River Basin



Dams: Total of 371 dams in the Basin

From: Willamette River Basin Planning Atlas

Number of dams within each watershed of the WRB. The concentration is greatest when the watershed area per dam is smallest.



Water Use Impacts on Stream flow of 2nd to 4th Order Streams ca. 1990

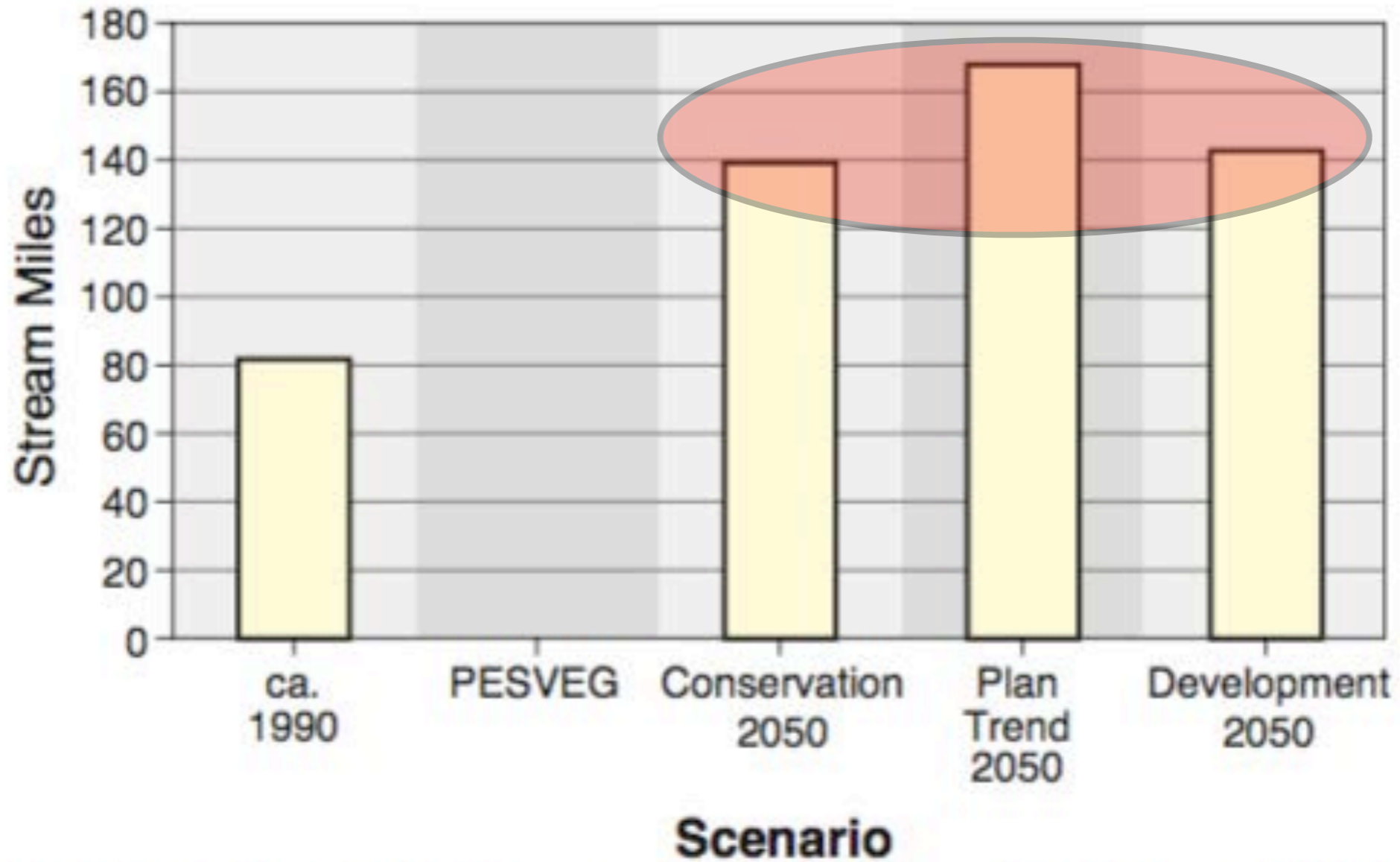
Lowland Streams

- 47% of stream miles with more than 10% of natural summer flow consumed.
- 12% of streams miles with more than 50% of natural summer flow consumed.

Upland Streams

- 10% of stream miles with more than 10% of natural summer flow consumed.

Number of 2nd-4th order stream miles that go dry from water withdrawals



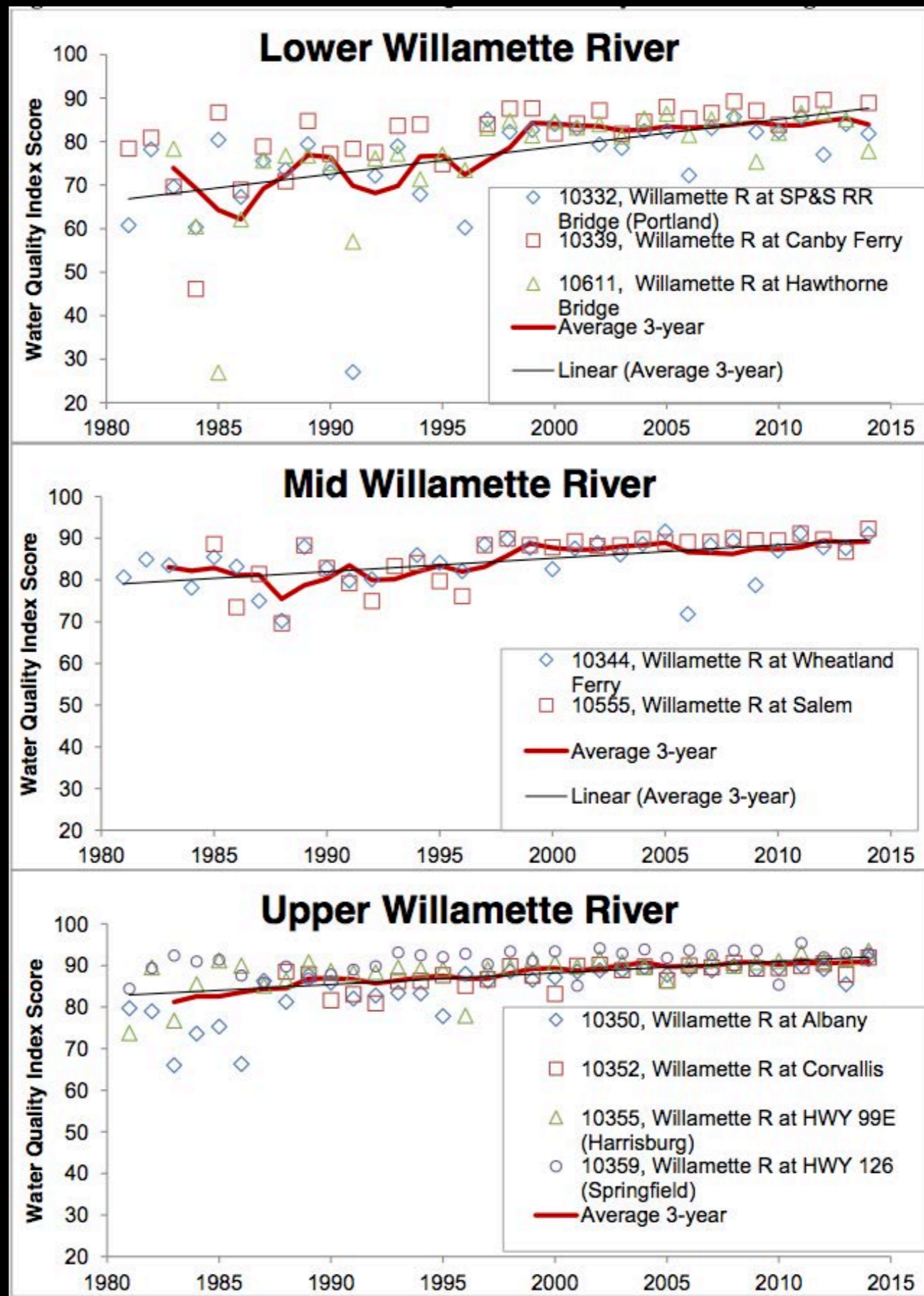
Miles of stream expected to go completely dry in August and September of a moderately dry year.

Water Quality

Water quality declined as human population and percent of agricultural land use increased.

- **1920s: Untreated human and animal waste dumped into Willamette R.**
- **Dissolved oxygen in Portland area never higher than 4.0mg/l**
- **Upper reach of Willamette (Eugene area) remained above 8.0mg/l**
- **1939 Oregon Sanitary Authority established by Oregon Legislature**
- **1944 study: Water quality worse than in late 1920s at all sites.**
 - **DO in Portland near 1.0mg/l**
 - **DO lower at all sites on Willamette**
 - **Bacteria concentrations high**
 - **Caged cutthroat trout in South Santiam river died within 2 minutes due to low DO and toxic materials.**
- **1950s federal dollars used for sewage treatment plant construction.**
 - **Most Federal dam projects in Willamette Basin completed in 1950s and 60s.**
- **1969 the Oregon Department of Environmental Quality established.**

Water Quality

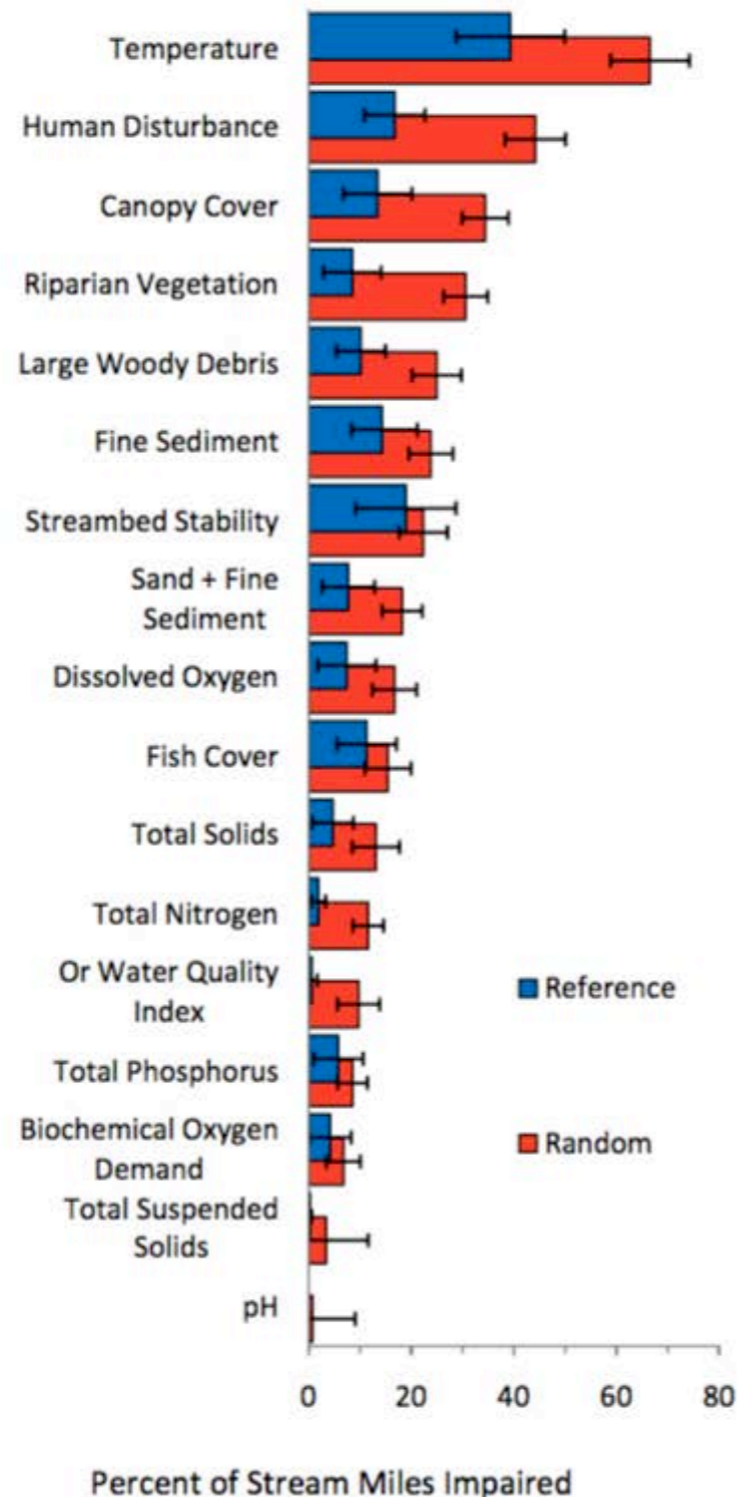


Willamette River annual OWQI scores with 3-year reach average and reach trend. (from Mulvey 2015)

Willamette Basin Stream Conditions

Condition of Willamette Basin Rivers and Streams

Willamette Basin Impairments



- ~450 Random sites
- ~240 Reference sites
- Large river and wadeable sites included in assessment.
- 32 sites large river sites. All the rest wadeable stream sites

“The reference condition is not intended to be a model of basin conditions at some historical time, such as pre European-American settlement of Oregon. It estimates what the biological, water quality and habitat condition of the basin would look like if all streams were in the condition of the best streams we can find today.” (Whittier et al. 2007)

From: *Willamette Basin Rivers and Stream Assessment*. (Mulvey et al. 2009)

Productivity - Fish Abundance

Written on the back of this undated postcard is, "Mr. Reed, friends of Earl's, Corvallis, Oregon."

Apparently Mr. Reed had a good day fishing on the Willamette.



Oregonian Newspaper (circa 1923)

The Rickreal provided excellent fishing from its mouth near Eola to its source. In the fall, the Dolly Varden ran up this stream to spawn. During hop-picking time, the hop pickers at the Horst Brothers' hop ranch added to the larder with Dollies that ran five to ten pounds and more. Some of local did likewise.

History of Anadromous Fish

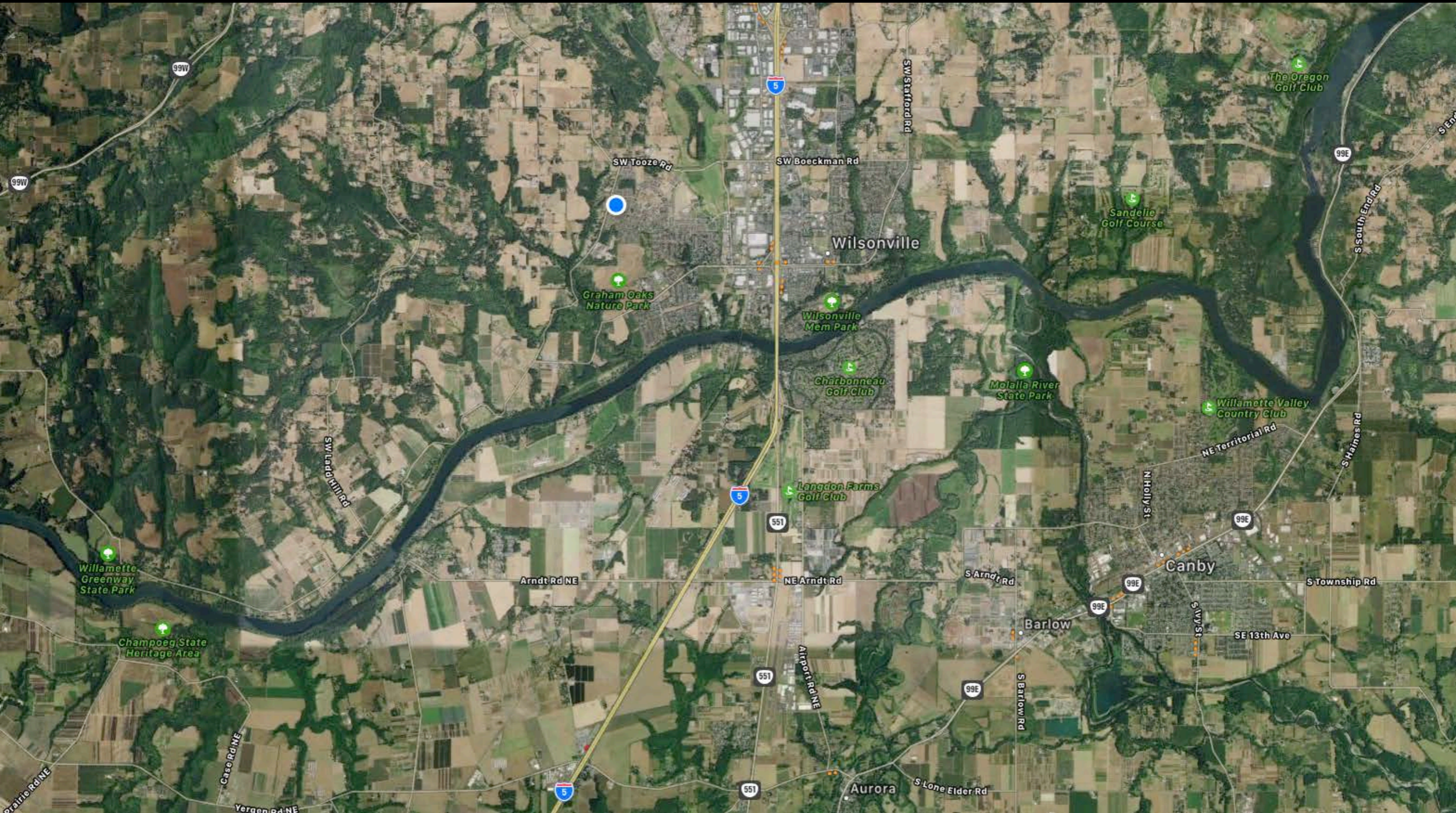


Productivity - Fish Abundance

Table 3. Summary of fish counts at Willamette Falls.

| Fish Run | 1850 (historical accounts) | 50 year average | Maximum (Year) | Minimum (Year) | 2017 |
|---------------------|----------------------------------|--------------------|-------------------|-------------------|--------|
| Spring Chinook | ~450,000 ~275,000 (1920) | 41,478 | 96,725 (2004) | 14,000 (2008) | 36,628 |
| Winter Steelhead | N.A. | 9,486 | 23,378 (1988) | 822 (2017) | 822 |
| Summer Steelhead | | 13,909 | 40,719 (1986) | 690 (1972) | 2,182 |
| Fall Chinook | | 8,831 | 34,189 (1974) | 352 (1999) | 3,462 |
| Coho | | 7,822 | 27,392 (2009) | 683 (1993) | 5,721 |

Willamette Basin 2018 and Beyond?





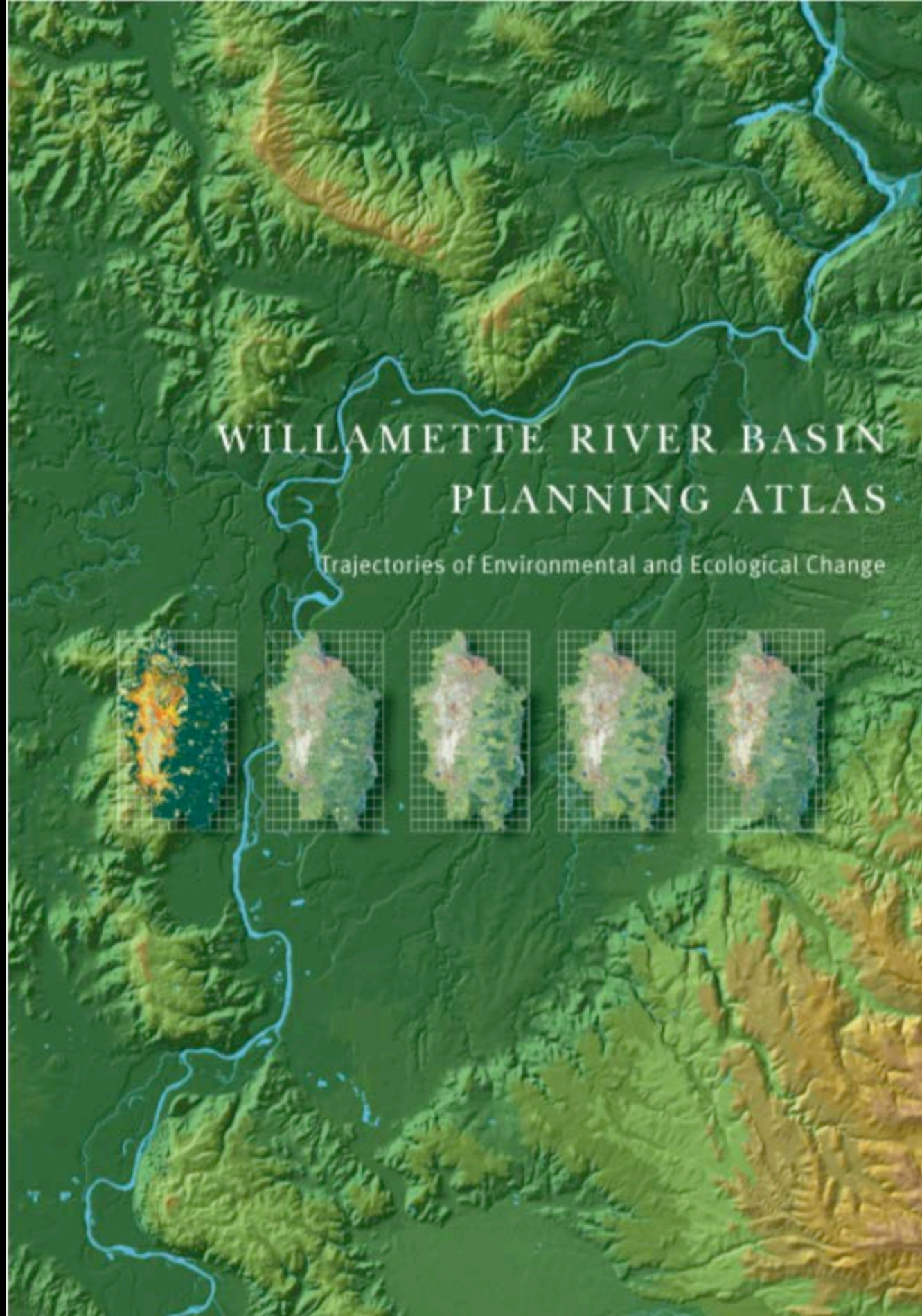
Willamette Valley

- 70% of Oregon's population
- Population 1850: 1200
- Population 2015: 2.8 million
- Population 2050: ??

Value of Knowing the History

- Can't turn back the clock to 1850, but knowing the history can -
- Help develop better plans for restoration projects
- Continue to identify and protect the best of what's left
- Not lose sight of where we've been **AND** where we're going

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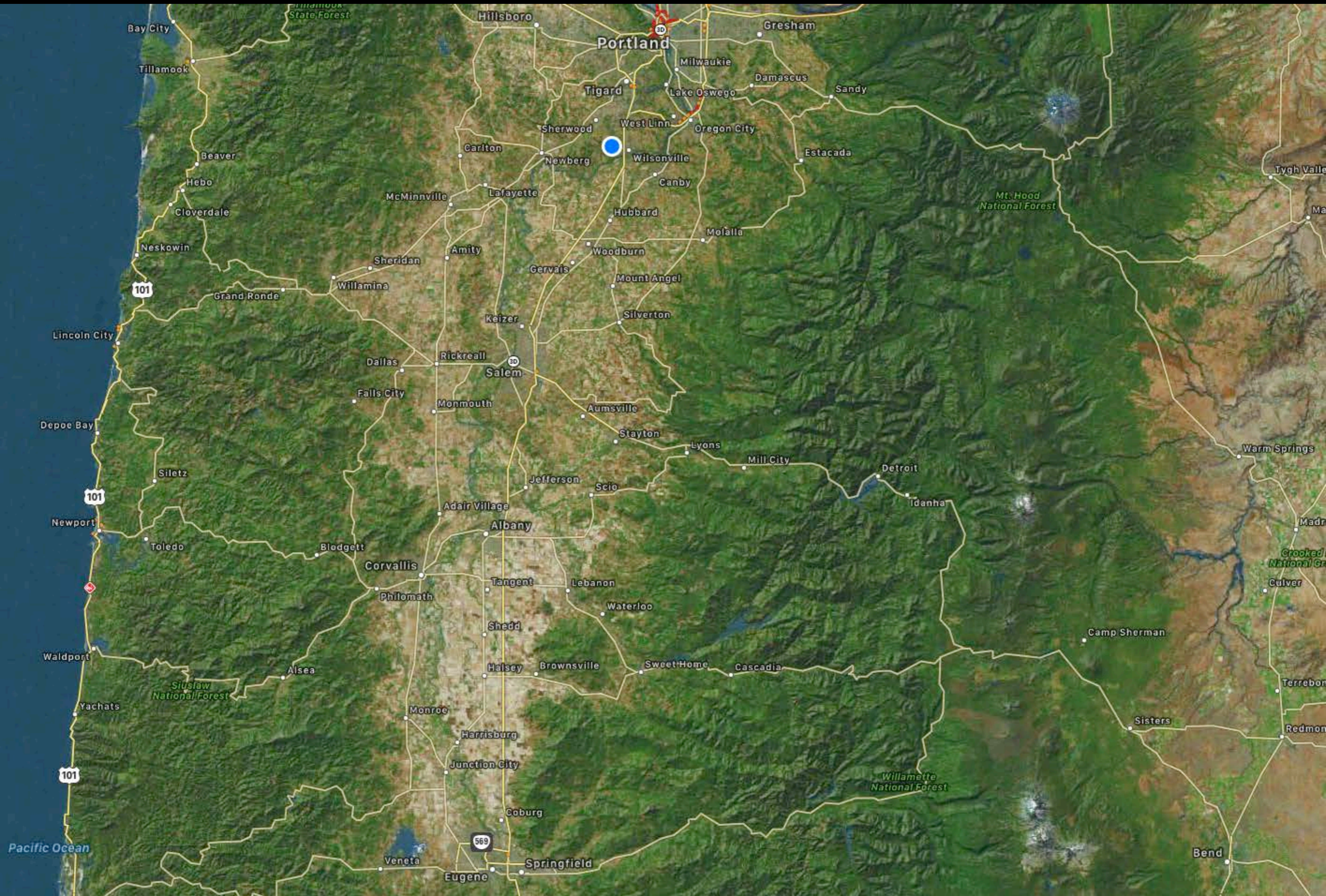
For Great Information & Ways to Help Protect the Willamette River

- Willamette River Water Trail: <http://willamettewatertrail.org>
- Willamette Riverkeeper: <http://willamette-riverkeeper.org>
- DEQ: <https://www.oregon.gov/deq/wq/Pages/Willamette-River-Report.aspx>

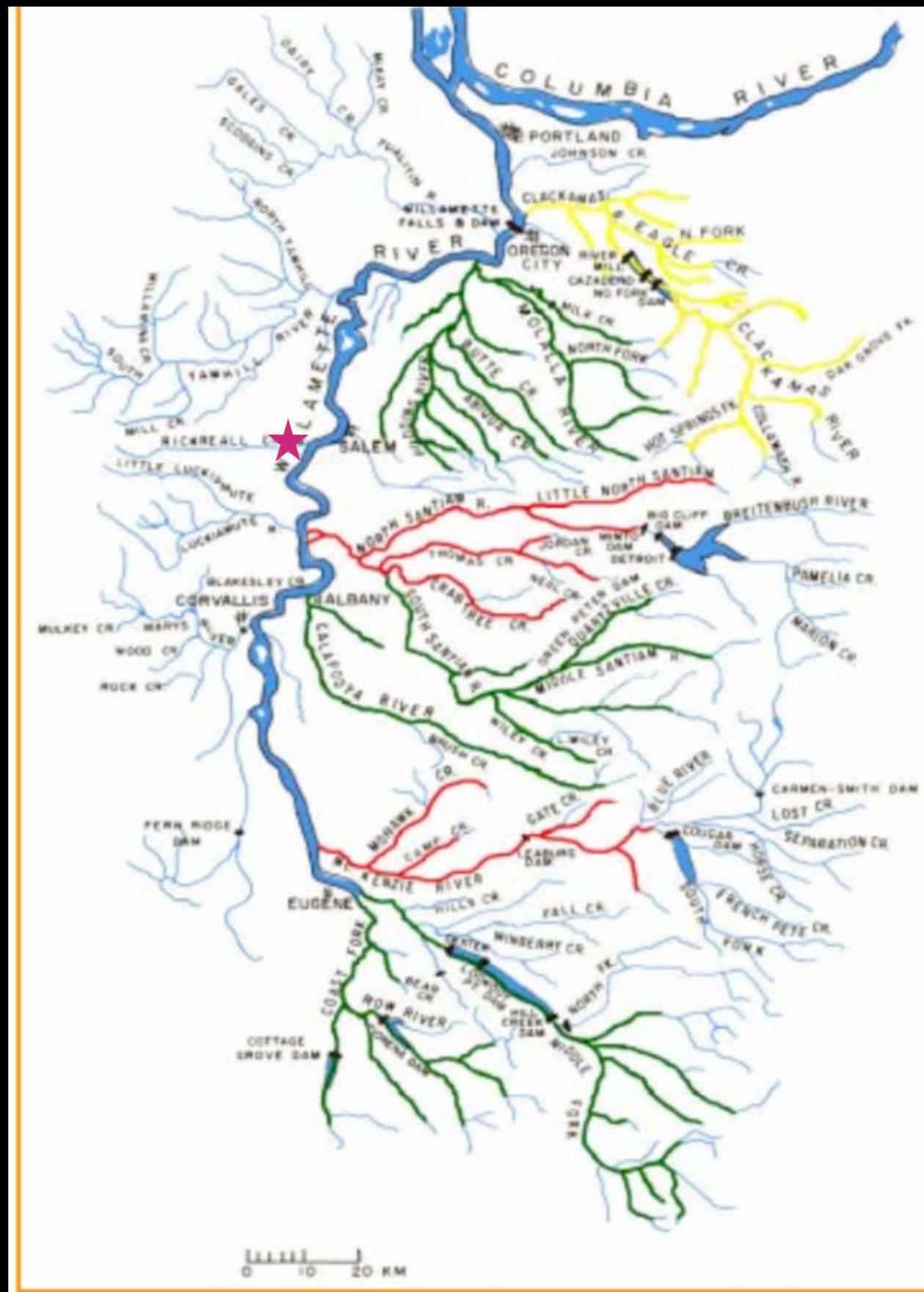
THANKS TO

- **Patagonia Store**
- **Earthrise Law Center**





Spring Chinook Distribution



Current and historical distribution of spring Chinook in the Willamette Basin. Green shows extinct populations and red shows existing populations. The Clackamas population is shown in yellow. (From Kostow 1995)