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science for a changing world

# Continuous Water-Quality Monitoring in Oregon with a Historical Perspective
## (and *What Can You Do With All These Data?*)

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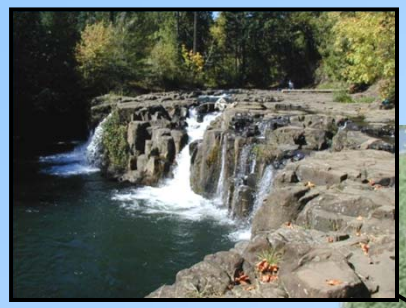
**USGS**
**Oregon Water Science Center**
**Portland, OR**

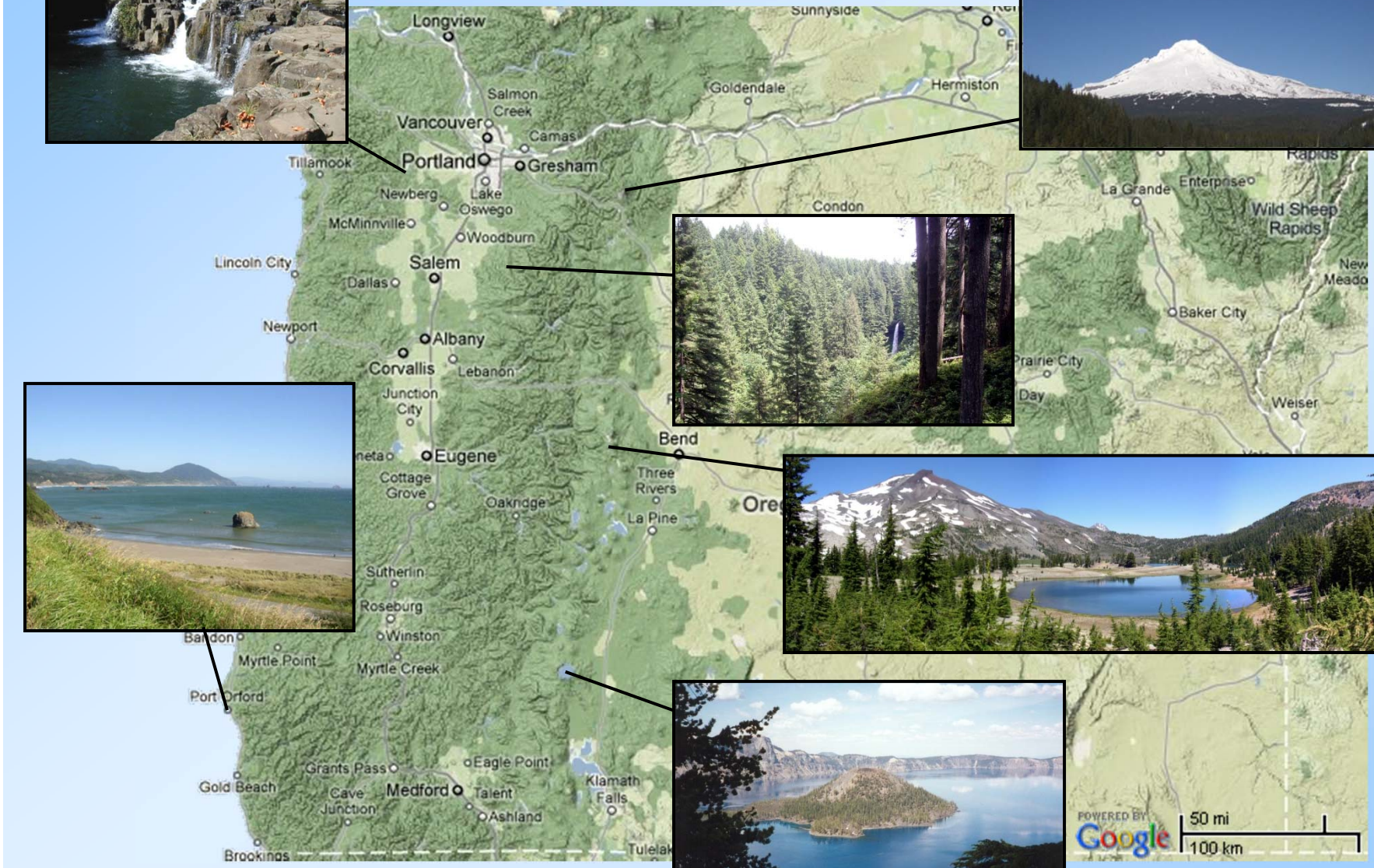
**U.S. Department of the Interior**
**U.S. Geological Survey**

# Welcome to Oregon!







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photos by Stewart Rounds, USGS

# Continuous Water-Quality Monitoring

- **Continuous monitors provide rich datasets for:**
  - **Filling data gaps at fine temporal scales**
  - **Assessing water quality**
  - **Detecting temporal variations (seasonal, daily, event, etc.)**
  - **Triggering sample-collection events**
  - **Feedback for regulatory and operational purposes**
  - **Increasing process-based knowledge**
  - **Estimating concentrations of unmeasured constituents**
  - **Providing data for modeling**
  - **Forecasting water quality**

**Time-dense information to improve our understanding and management of water resources**

photo by Kurt Carpenter, USGS

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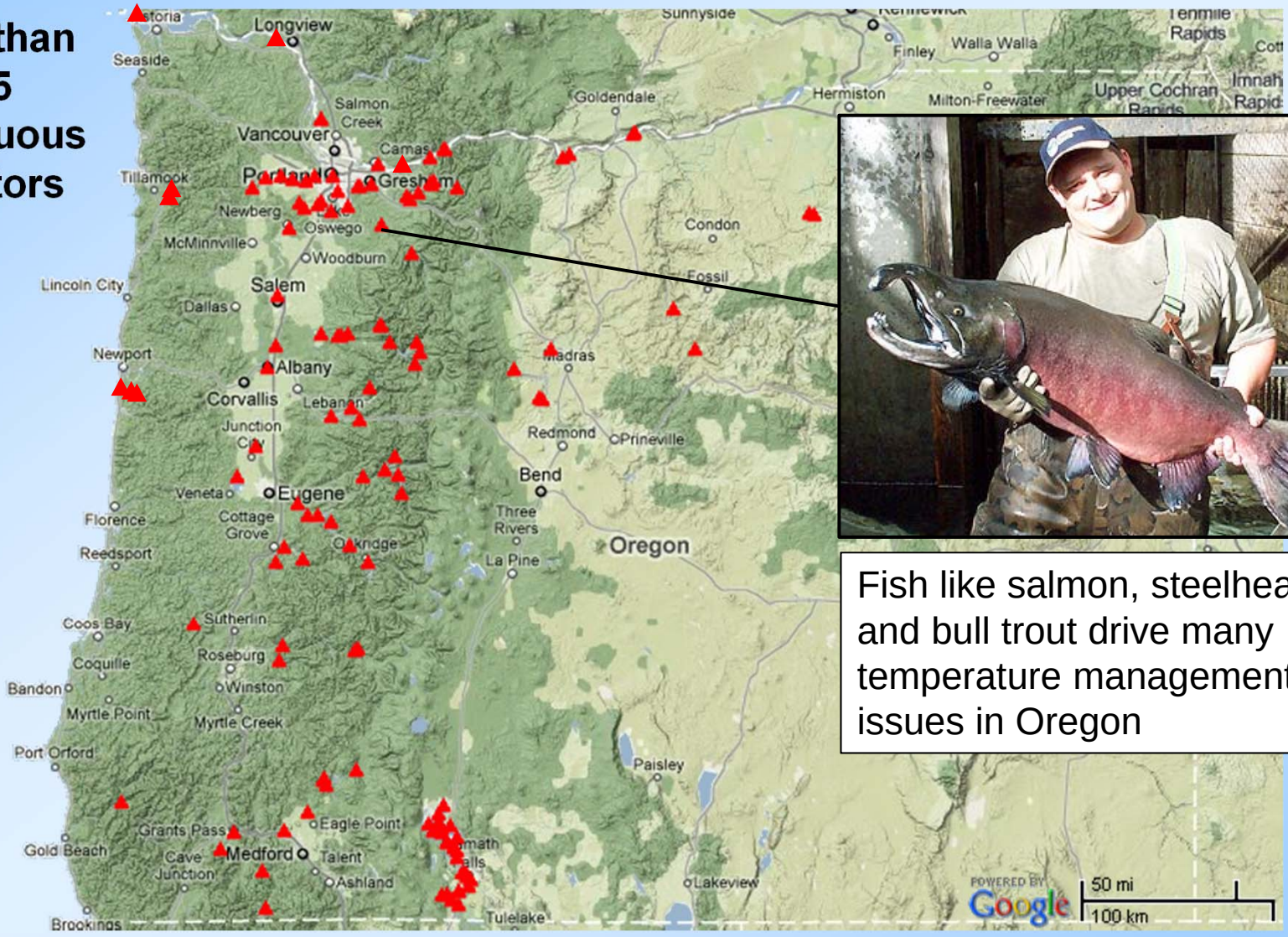
# Water Temperature

**more than 125 continuous monitors**




Fish like salmon, steelhead, and bull trout drive many temperature management issues in Oregon

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Coho salmon photo from PGE

# Dam Operations Rely on Continuous Monitoring of Water Temperature

Detroit Dam
463 feet tall
Multiple outlets:
- Spillway
- Power penstocks
- Upper regulating outlets
- Lower regulating outlets

Temperature affects fish habitat and the timing of migration, spawning, egg incubation & emergence, etc.

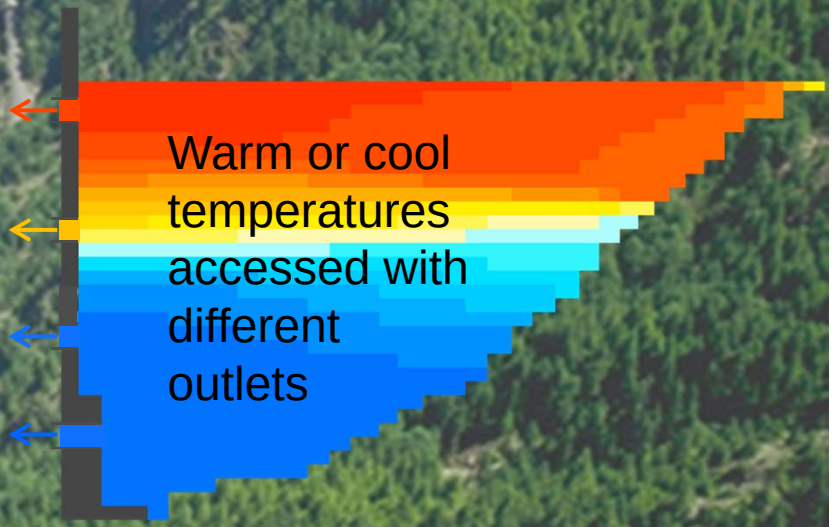


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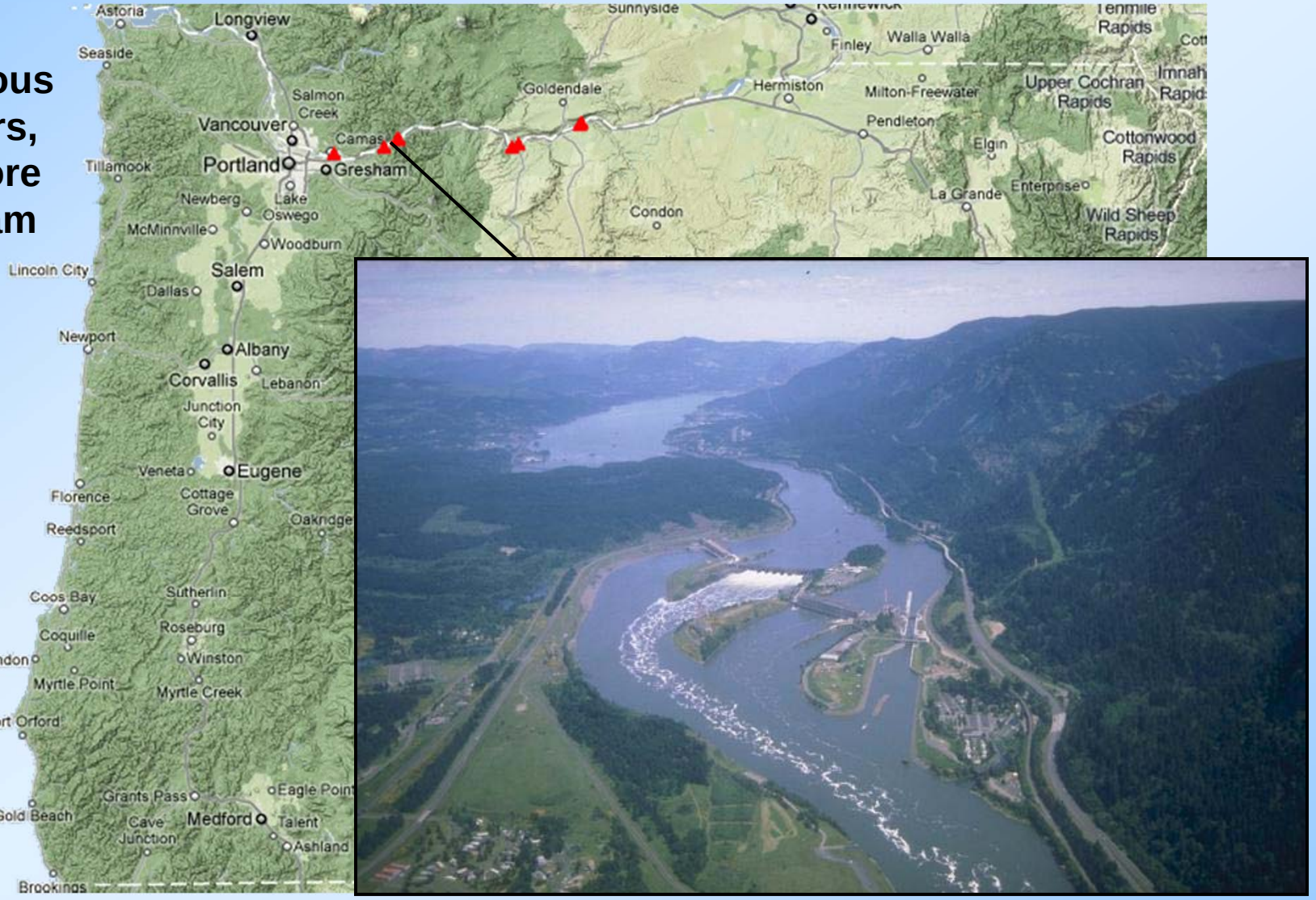
photo from U.S. Army Corps of Engineers

# Total Dissolved Gas

**8 continuous monitors, with more upstream**




**Columbia River at Bonneville Dam**

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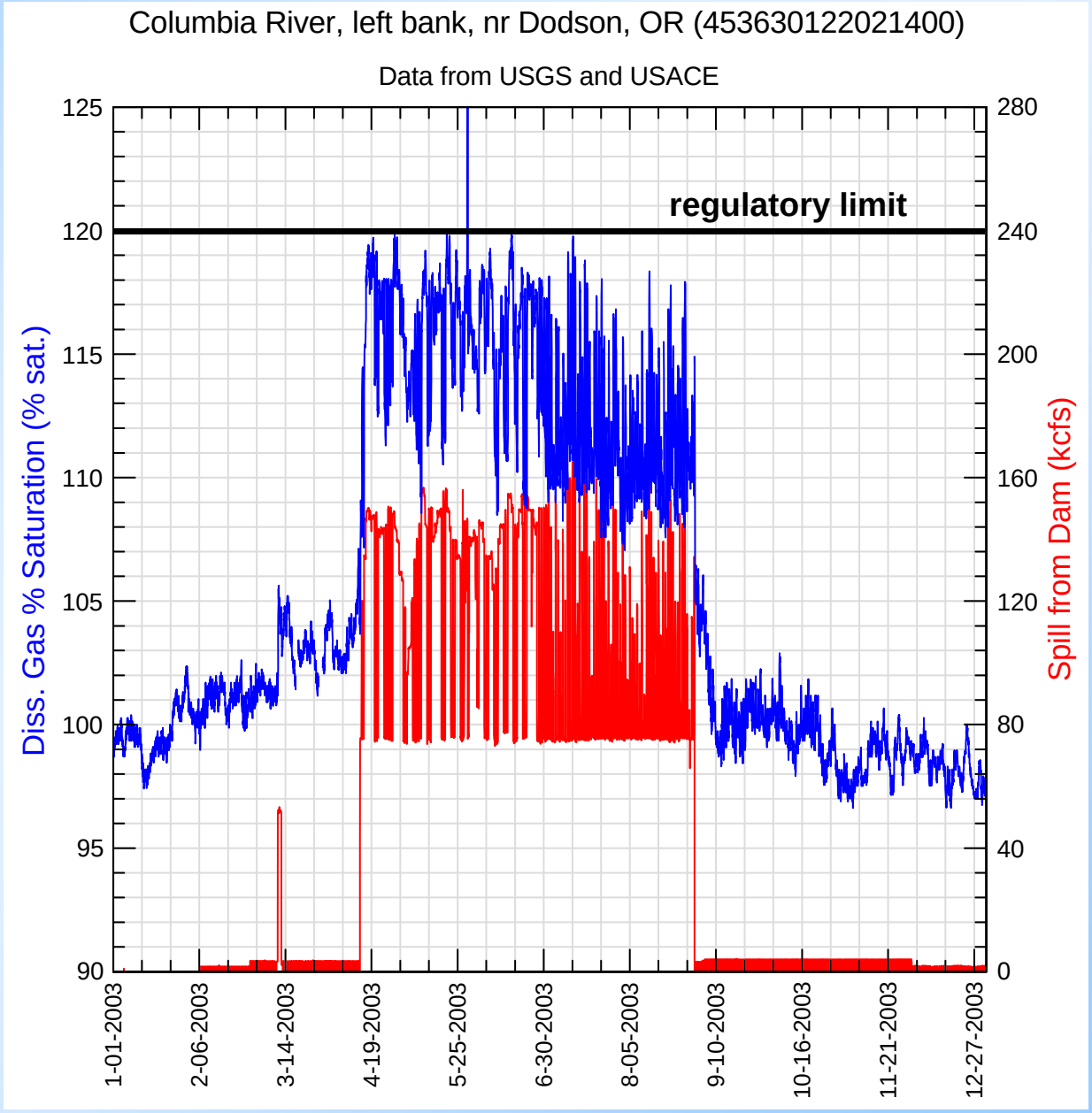
**photo from U.S. Army Corps of Engineers**

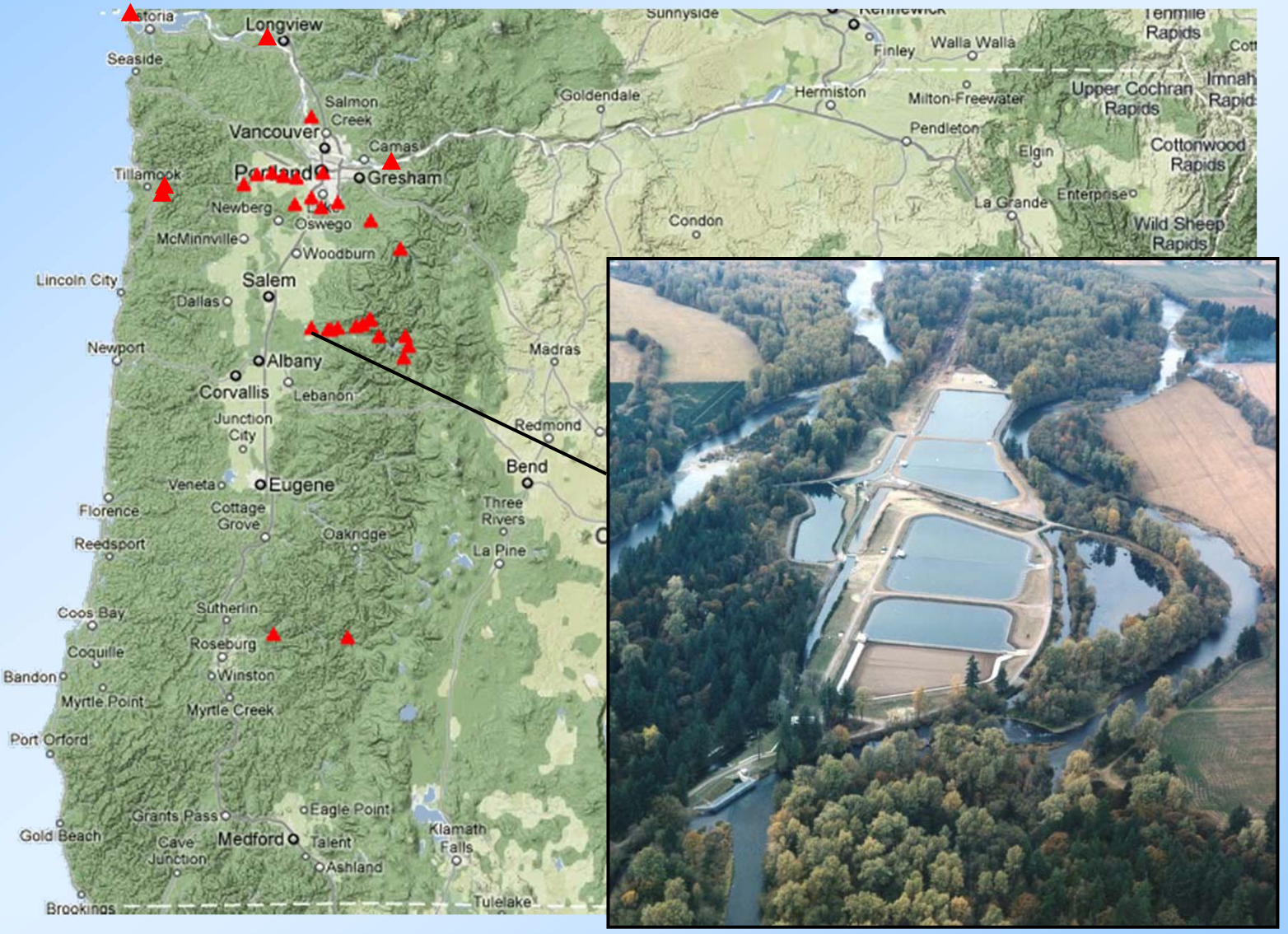
# Total Dissolved Gas

**Used for operational & regulatory feedback for dam releases**

USGS **(photo from USGS)**



# Turbidity






**Geren Island drinking water treatment facility**

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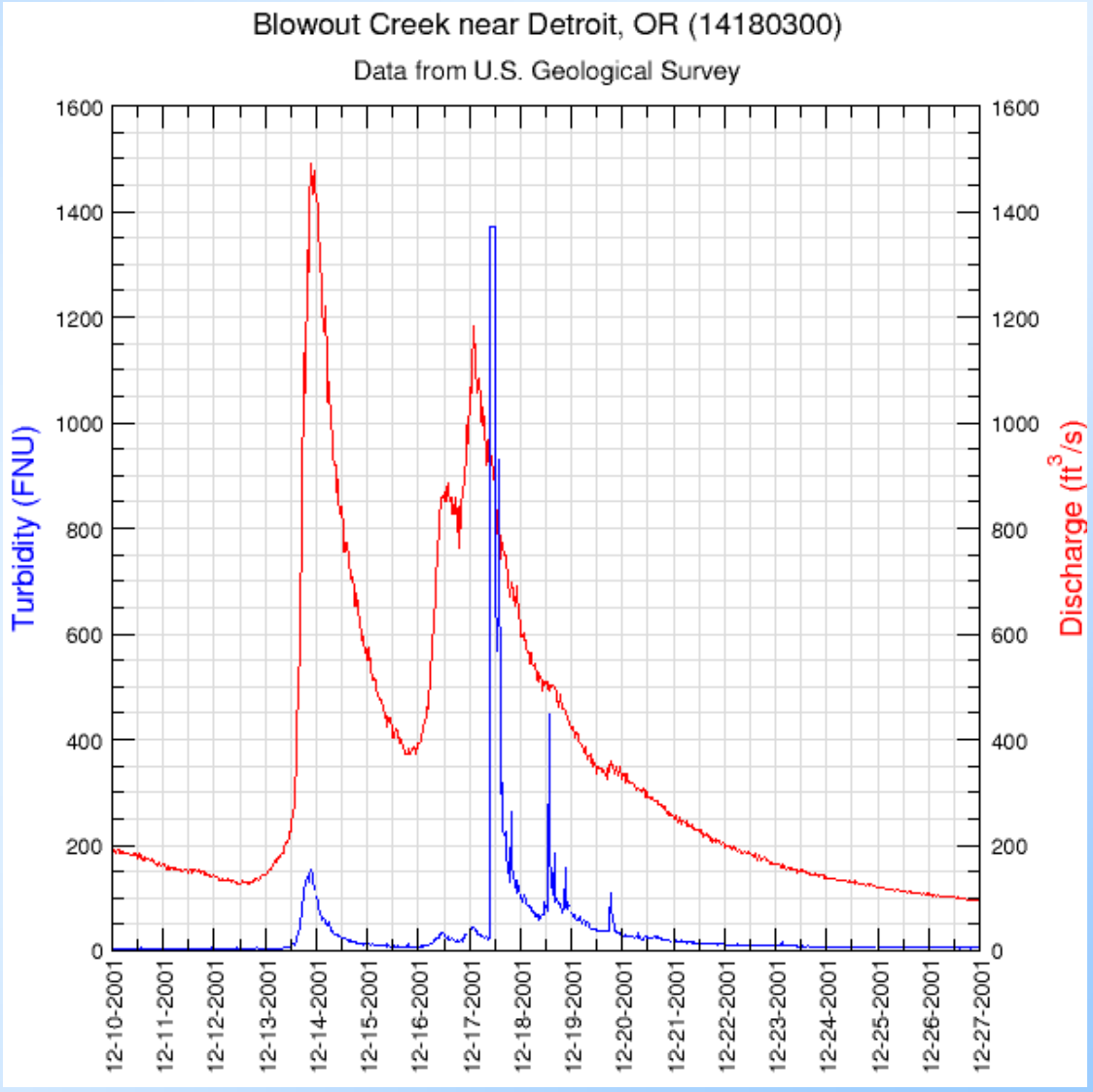
**photo from City of Salem, OR**

# Monitoring Provides Early Warning, Helps ID Sources, Quantify Loads

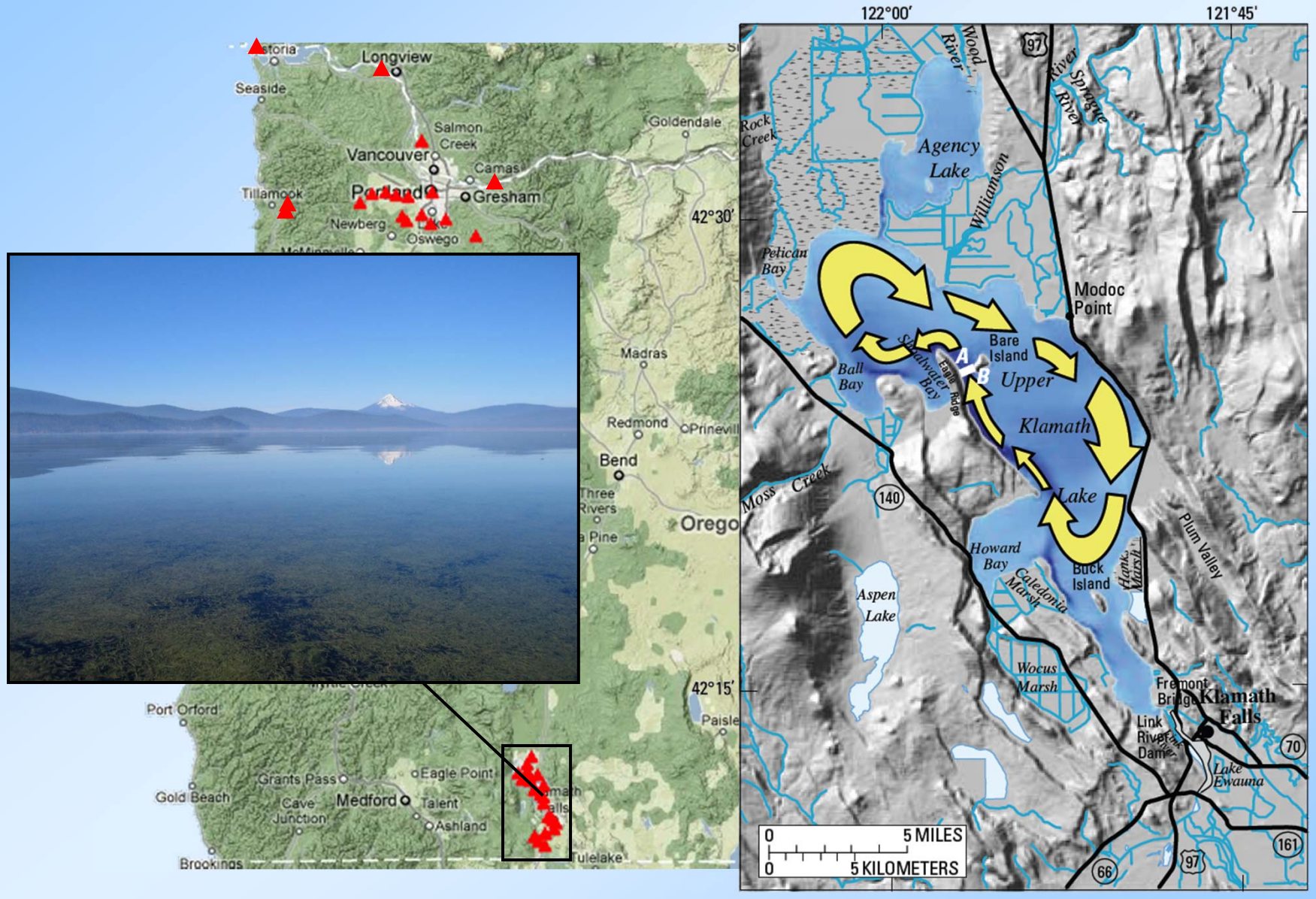



USGS (photos from USGS)

# Chlorophyll and/or Phycocyanin


photos by Kurt Carpenter and Rip Shively, USGS

# pH




from Wood, Hoilman, and Lindenberg (2006)

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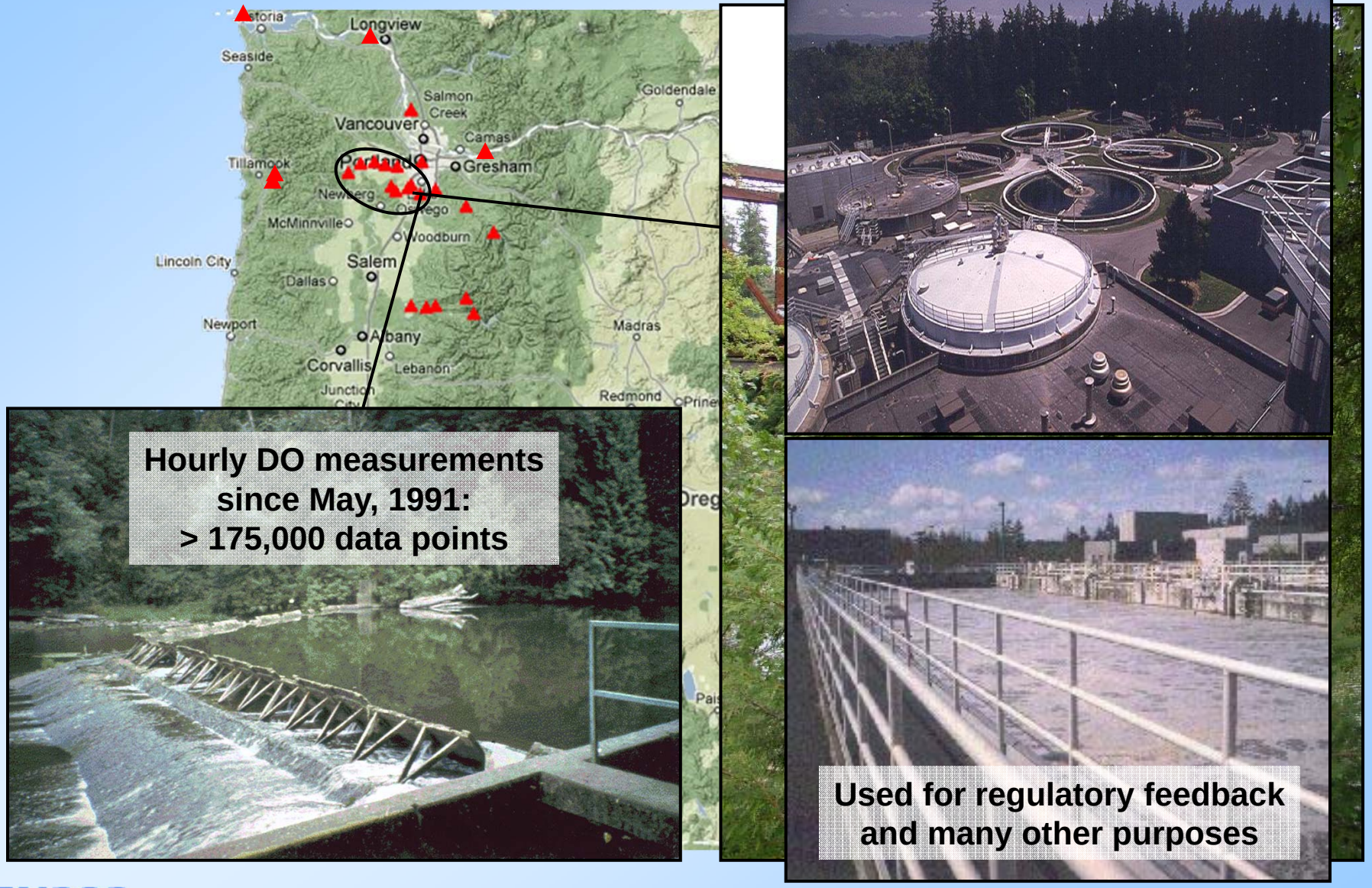
# Dissolved Oxygen

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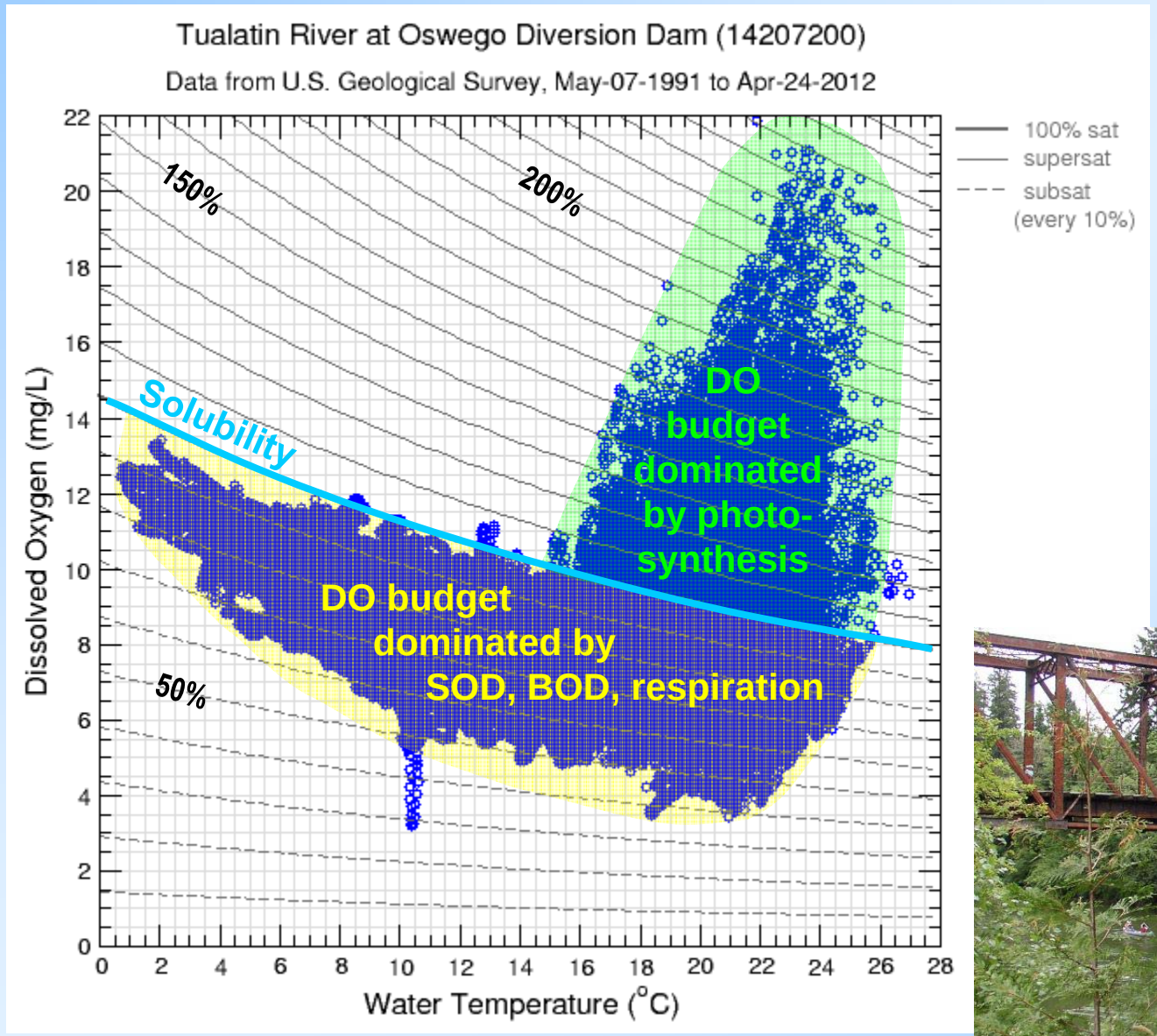
photos by Stewart Rounds, Dennis Lynch, and Denny Wentz, USGS

# A Useful Plot for Understanding Instream Processes




- Slow reaeration
- Significant SOD and BOD
- Algal growth in summer

photo by Stewart Rounds, USGS

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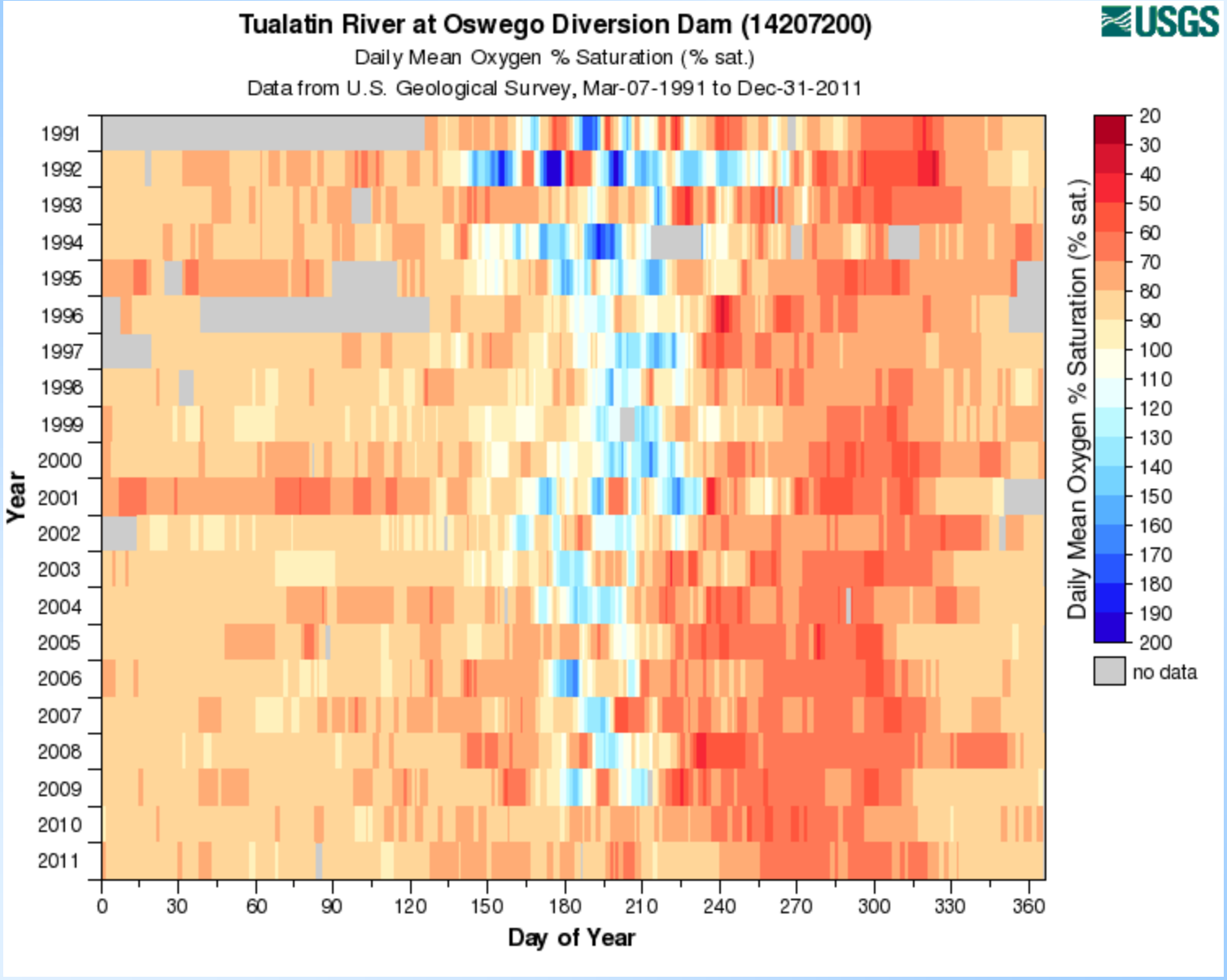
# Visualizing the Same Data with a Color Map

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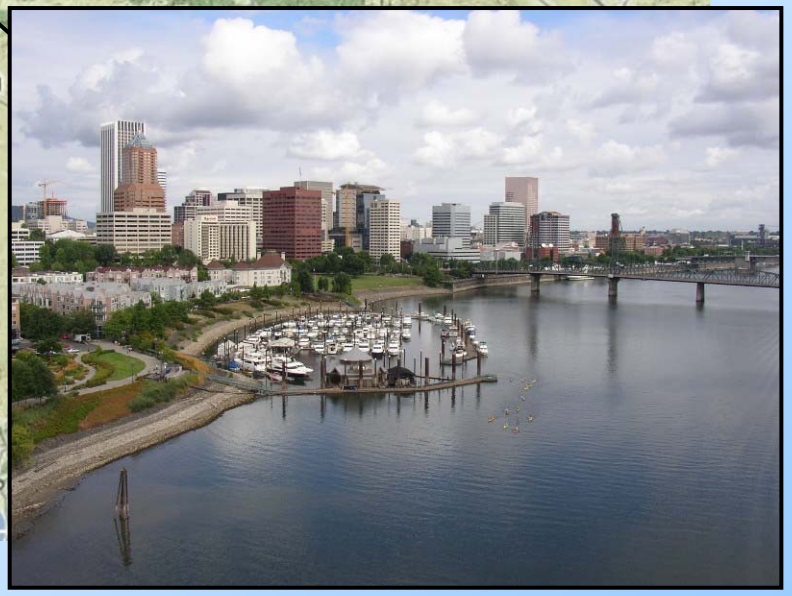
# The Willamette River: Some Historical Perspective



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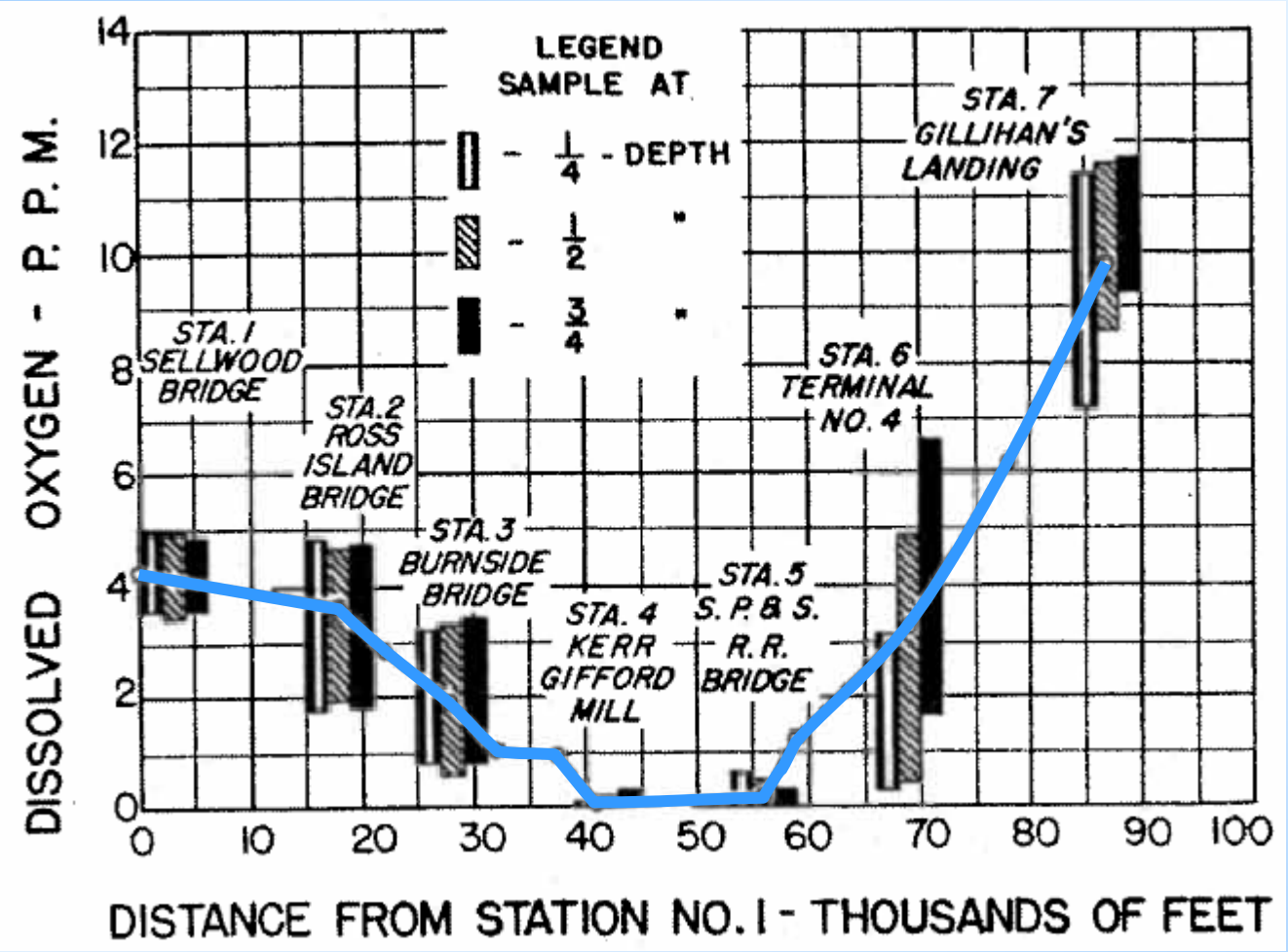
photos by USGS and U.S. Army Corps of Engineers

# Willamette River Harbor: September, 1934




**Downtown Portland**

**Columbia River**

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from G.W. Gleeson's Sanitary Survey, OSU, 1936

# The Willamette River: 1930s

In the 1930s, the Willamette River was basically an open sewer, with untreated wastes from cities, food processors, lumber mills, etc.

By the time the water arrived in Portland, its quality was very poor.

Photos from a 16mm film by the Oregon State Board of Health, http://media.oregonstate.edu/index.php/show/?id=0_wykdi7ls

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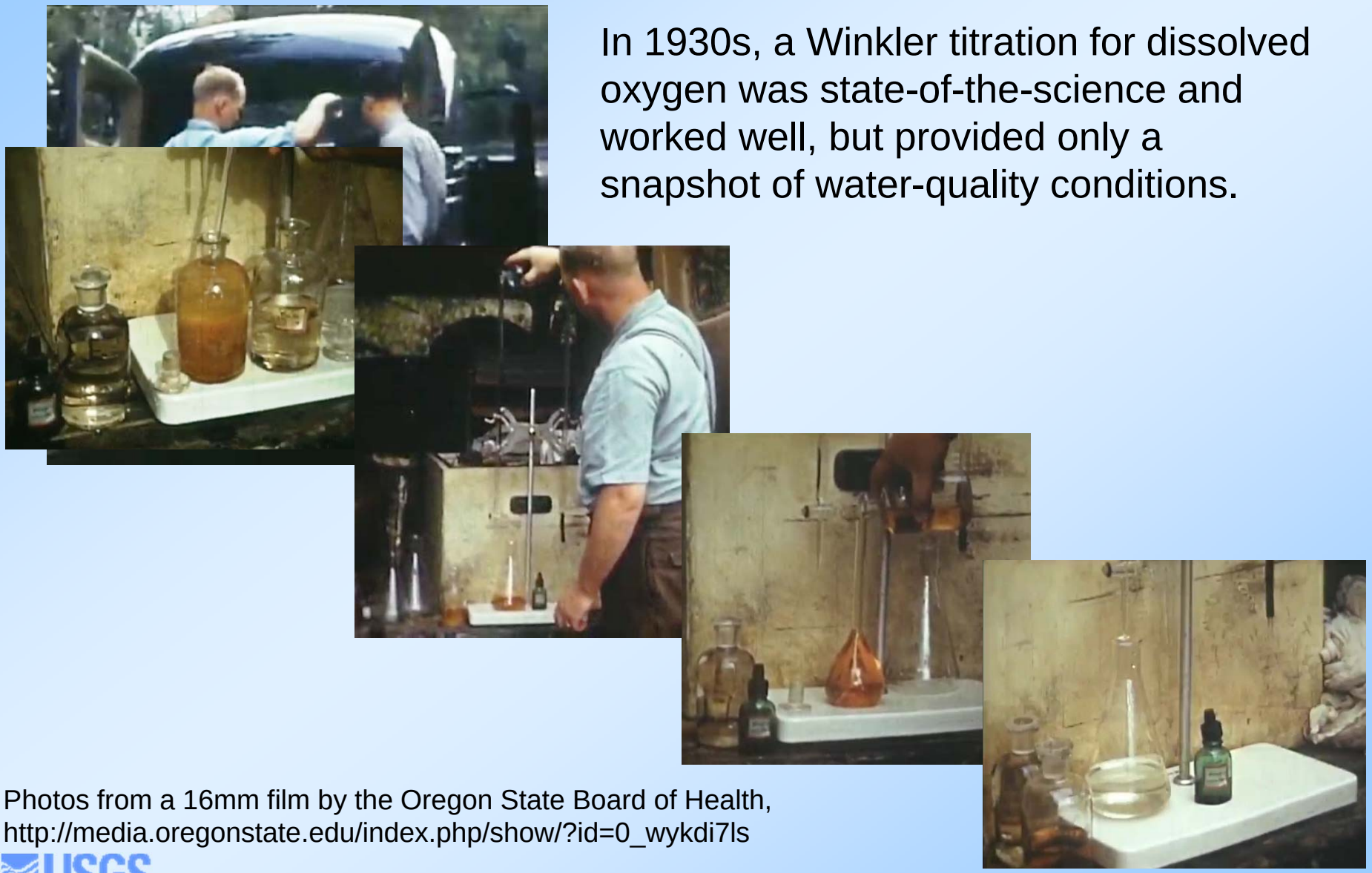
# Water Quality Surveys Were Time-Consuming



In 1930s, a Winkler titration for dissolved oxygen was state-of-the-science and worked well, but provided only a snapshot of water-quality conditions.

Photos from a 16mm film by the Oregon State Board of Health,
http://media.oregonstate.edu/index.php/show/?id=0_wykdi7ls

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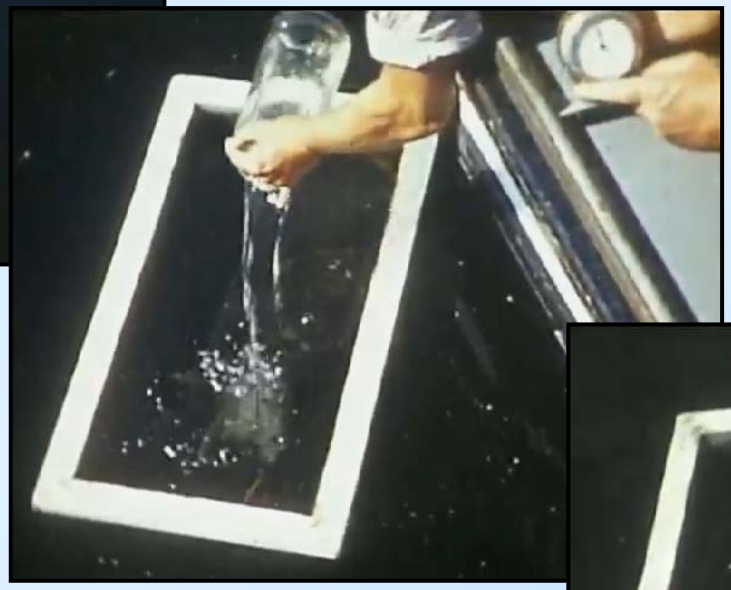
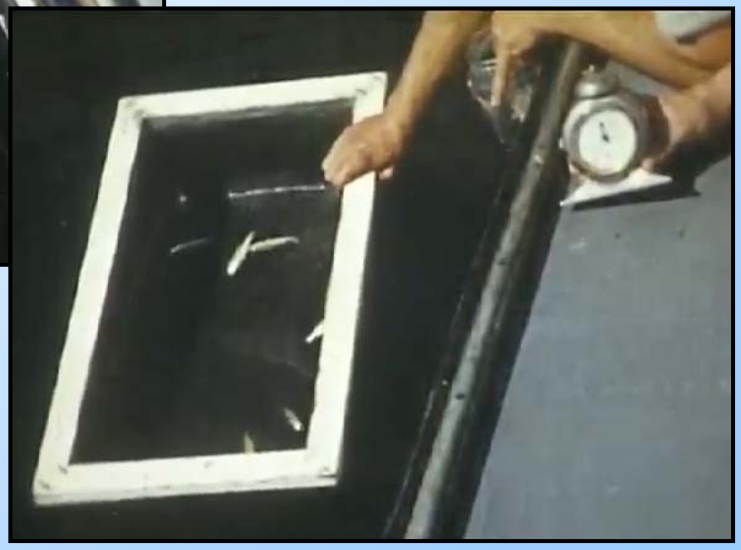
# No Continuous WQ Monitors in 1930s…

Here's an interesting way to test the water quality of the river…

Let's see how long fingerling salmon can survive…



…when we expose them to river water.



Photos from a 16mm film by the Oregon State Board of Health, http://media.oregonstate.edu/index.php/show/?id=0_wykdi7ls

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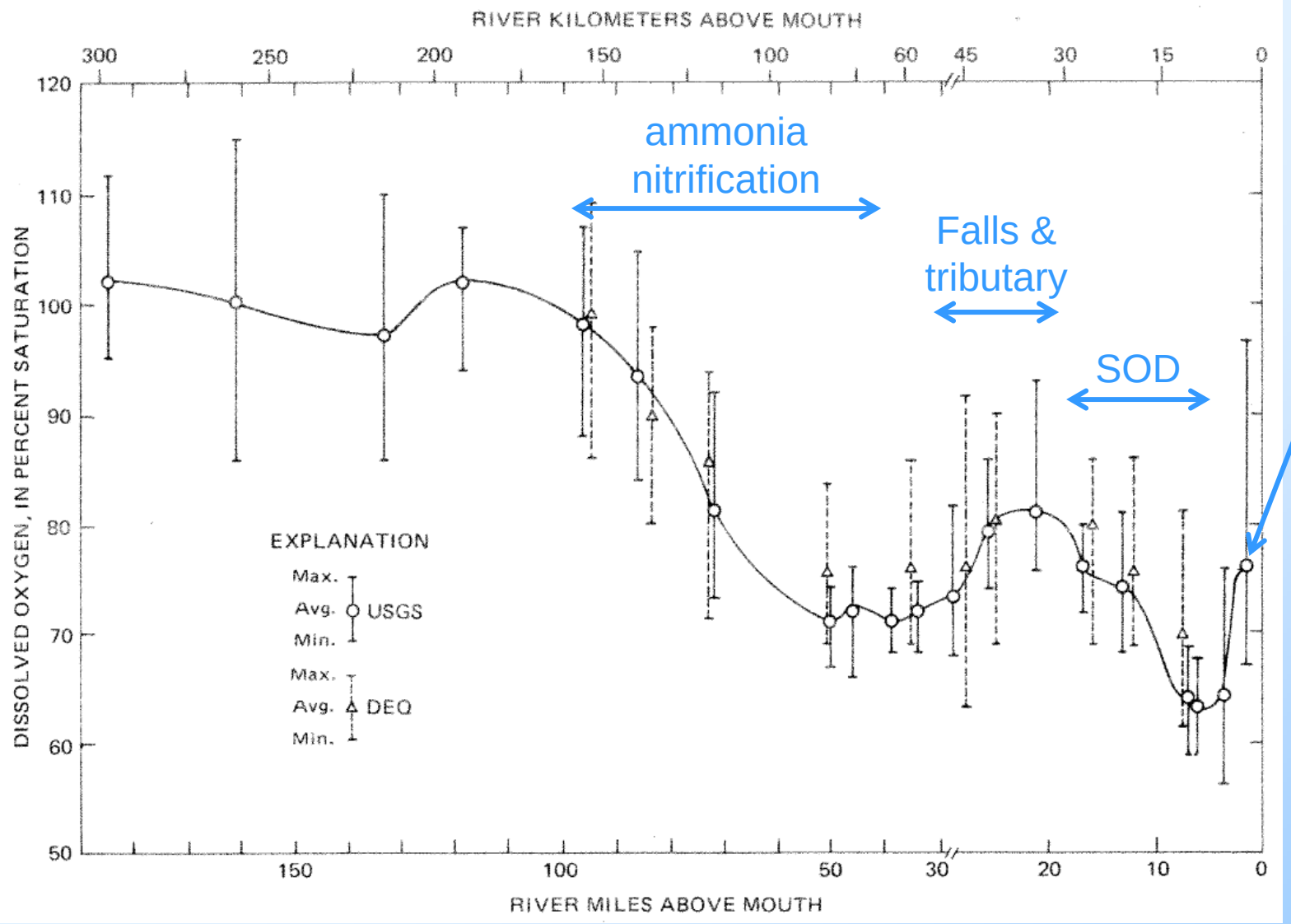
# Willamette River DO Survey: July 5 – Aug. 18, 1973

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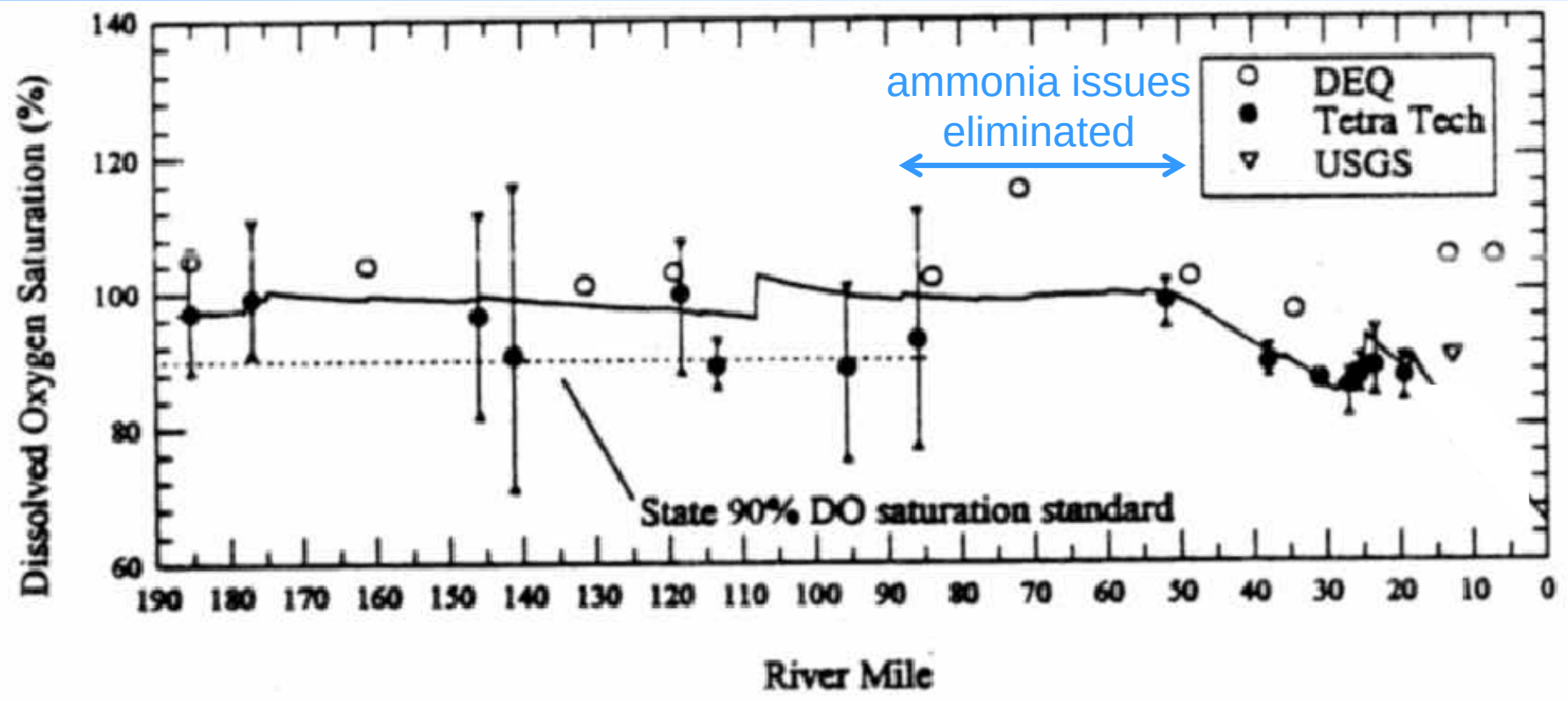
from USGS Willamette River assessment, 1977

# Willamette River: August, 1992

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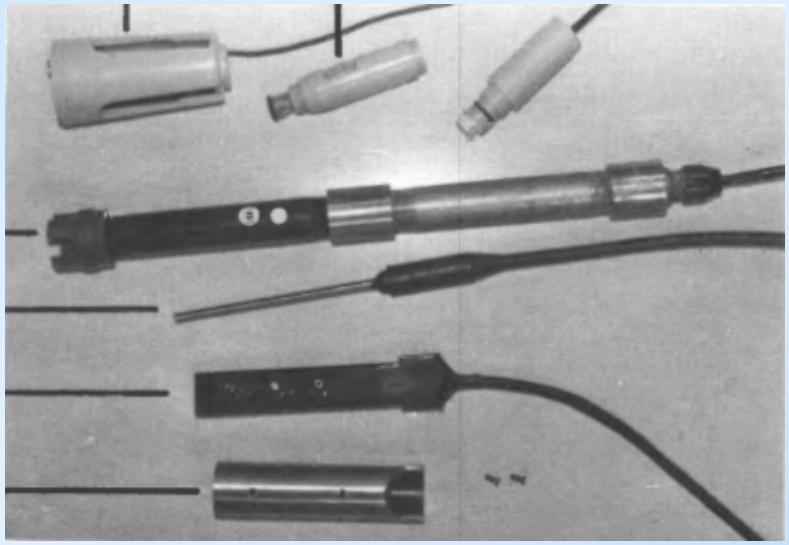
from Tetra Tech modeling study, 1995

# Continuous Monitors Have Improved…

The USGS “mini-monitor” from the early 1990s was great at the time!

DO stirrer DO probe



pH probe

Temp. probe

SC probe

SC shield

(photos from an old USGS report from Ohio)

Water-quality instrumentation has come a long way since then…


(many manufacturers, no endorsement intended)

# Willamette River: Continuous Monitoring Today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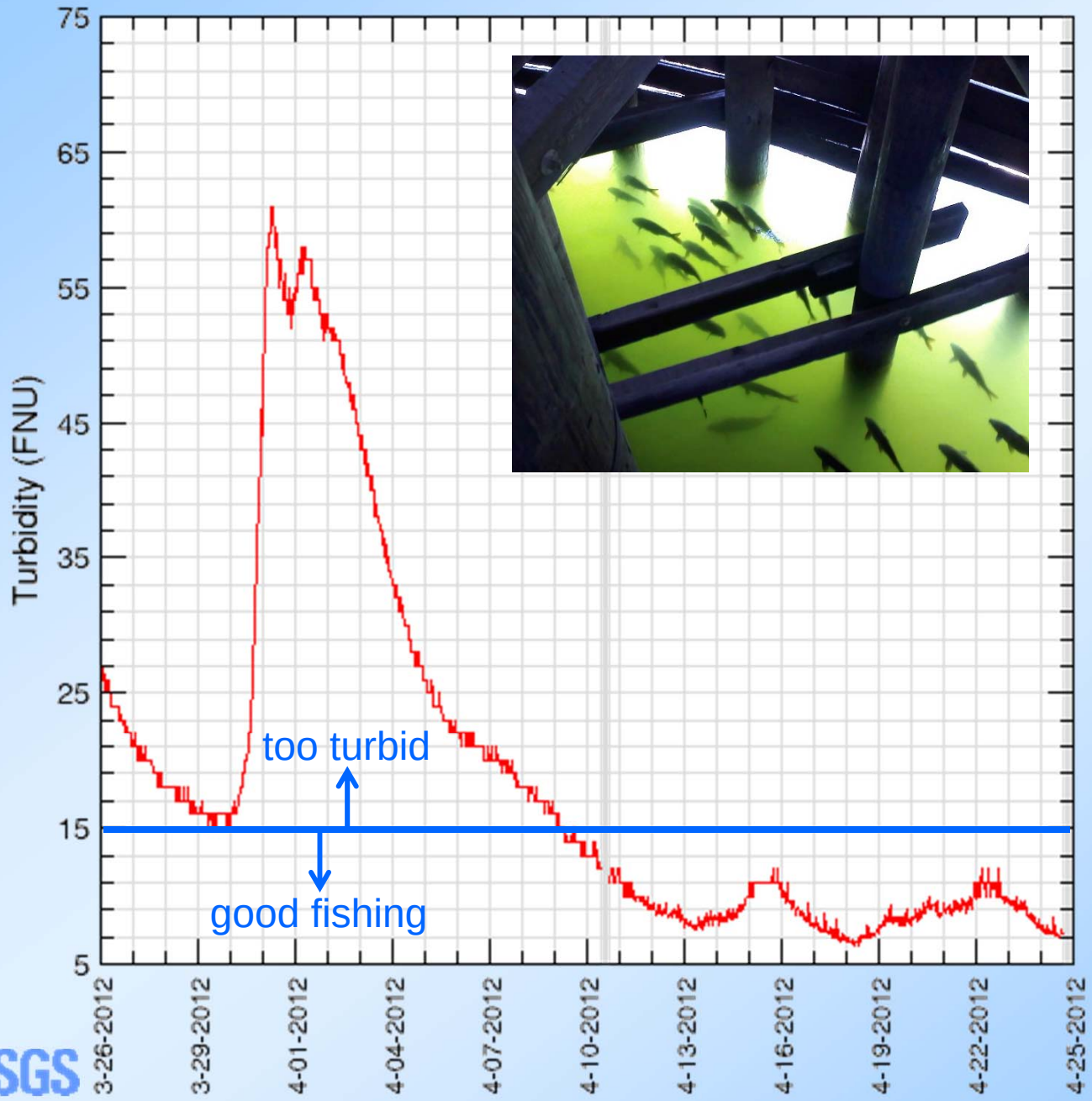
photos by USGS and U.S. Army Corps of Engineers

# Many Uses for Continuous Data






- Turbidity data used by sport fishermen!
- If turbidity is less than 15 FNU, the fishing is good
- Our most popular website during the spring salmon run

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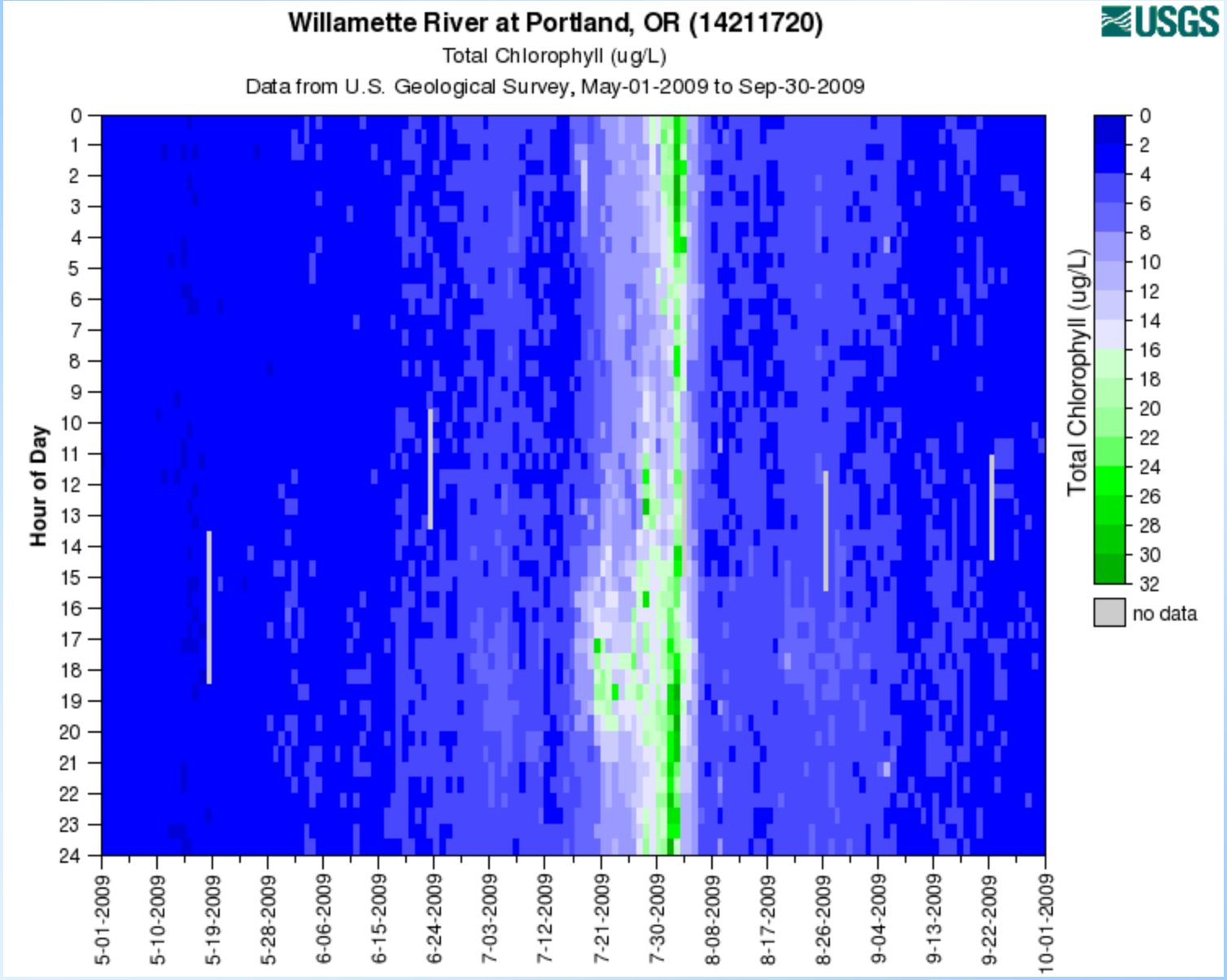
# Color Map Showing Algal Bloom in 2009

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# Why Aren't We "There" Yet?

- **Where is "There?" Will we recognize it?**
  - Remember where we've been, and "Here" is pretty darn good
  - But, we don't yet have "Water Quality Information, Anywhere at Anytime"
- **Expense**
  - Monitoring is expensive (*Not monitoring also can be expensive*)
  - Need to reduce barriers to use (decrease costs, streamline processes)
- **Equipment**
  - Instruments need to retain calibration longer & resist fouling
  - Need new probes & instruments (algal toxins, specific threats/hazards)
- **Value**
  - Recognize opportunities for real-time feedback (operations, regulations)
  - Need to make better use of the data → ADD VALUE!
    - Compute surrogates, uncertainties, exceedance probabilities
  - Need tools to forecast future conditions and extend data spatially