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

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Welcome to Oregon!

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
Water Temperature

more than 125 continuous monitors

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

Coho salmon photo from PGE
Detroit Dam
463 feet tall
Multiple outlets:
- Spillway
- Power penstocks
- Upper regulating outlets
- Lower regulating outlets

Dam Operations Rely on Continuous Monitoring of Water Temperature

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

Warm or cool temperatures accessed with different outlets

photo from U.S. Army Corps of Engineers
Total Dissolved Gas

8 continuous monitors, with more upstream

Columbia River at Bonneville Dam

photo from U.S. Army Corps of Engineers
Used for operational & regulatory feedback for dam releases

Data from USGS and USACE

Total Dissolved Gas

Columbia River, left bank, nr Dodson, OR (453630122021400)

Spill from Dam (kcfs)

Diss. Gas % Saturation (% sat.)

regulatory limit

(photo from USGS)
Turbidity

Geren Island drinking water treatment facility

photo from City of Salem, OR
Monitoring Provides Early Warning, Helps ID Sources, Quantify Loads

Blowout Creek near Detroit, OR (14180300)
Data from U.S. Geological Survey

Turbidity (FNU) vs. Discharge (ft³/s)

(photos from USGS)
Chlorophyll and/or Phycocyanin

photos by Kurt Carpenter and Rip Shively, USGS
pH

from Wood, Hoilman, and Lindenberg (2006)
Dissolved Oxygen

- Hourly DO measurements since May, 1991: > 175,000 data points
- Used for regulatory feedback and many other purposes

photos by Stewart Rounds, Dennis Lynch, and Denny Wentz, USGS
A Useful Plot for Understanding Instream Processes

Tualatin River at Oswego Diversion Dam (14207200)
Data from U.S. Geological Survey, May-07-1991 to Apr-24-2012

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

photo by Stewart Rounds, USGS
Visualizing the Same Data with a Color Map

Tualatin River at Oswego Diversion Dam (14207200)
Daily Mean Oxygen % Saturation (% sat.)
Data from U.S. Geological Survey, Mar-07-1991 to Dec-31-2011
The Willamette River: Some Historical Perspective

photos by USGS and U.S. Army Corps of Engineers
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
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
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
Willamette River DO Survey: July 5 – Aug. 18, 1973

ammonia nitrification

Falls & tributary

SOD

Columbia River tidal influence

from USGS Willamette River assessment, 1977
Willamette River: August, 1992

from Tetra Tech modeling study, 1995

ammonia issues eliminated
Continuous Monitors Have Improved…

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

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

(photos from an old USGS report from Ohio)

(many manufacturers, no endorsement intended)
Willamette River: Continuous Monitoring Today

Morrison Bridge

USGS site 14211720

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

Too turbid

Good fishing

Turbidity (FNU)

3-26-2012 3-29-2012 4-01-2012 4-04-2012 4-07-2012 4-10-2012 4-13-2012 4-16-2012 4-19-2012 4-22-2012 4-25-2012
Color Map Showing Algal Bloom in 2009

Willamette River at Portland, OR (14211720)
Total Chlorophyll (µg/L)
Data from U.S. Geological Survey, May-01-2009 to Sep-30-2009

USGS
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