Water Quality Monitoring, Education & Partnership Project
Jackson Bottom Wetlands Preserve

Final Report for Metro 2004 Grant

Frank Opila
Project Manager
Jackson Bottom Wetlands Preserve
August 31, 2005

1. Summary of Grant Activities

a) Tasks Completed

The *Water Quality Monitoring, Education & Partnership Project* is a three-year project that provides a unique blend of technical water quality monitoring, public education, and collaboration among watershed stakeholders. We consider this year of the project to be highly successful and have met all of the main goals projected for the first year. With the help of our partners, we have deployed the new monitoring station (Goal 1); commenced the development and initial implementation of our public education efforts (Goal 2); established collaborative relationships with our partners in a *Technical Advisory Group* and are establishing education partnerships with leaders in field-based, science inquiry methods (Goal 3).

With the collective grants that we received for the first year (July 2004 – June 2005) of this project, we completed the following specific tasks:

Tasks Completed
TECHNICAL ADVISORY GROUP (TAG) • Form TAG • Convene TAG monthly in person and/or by conference call or email • Engage TAG in providing technical and implementation advice
MONITORING SYSTEM DEPLOYMENT • Install the continuous water quality monitoring station on the Tualatin River • Integrate new monitoring station with the existing data collection system • Ongoing maintenance: cleaning/calibrating and troubleshooting
DATA MANAGEMENT, QUALITY & DELIVERY • Develop QA/QC procedures. • Update the web site, including near real-time data and graphs. See http://www.jacksonbottom.org/wetlandsmonitoring.htm • Improve database design to include both raw and quality-controlled data. • Enhance data delivery options for agencies and other users.
PUBLIC EDUCATION **Programs for Schools** • Integrate water quality data into currently offered elementary school programs at the Preserve (Biodiversity, Science Inquiry) • Develop strategy and promotion of research opportunities with formal education partners o Formed *Science Education Focus Group*, which has met on twice. • Integrate water quality curriculums in Teacher Education Programs o Science Institute – Portland Public Schools o Field Natural History – Lewis and Clark College o Project WET Teacher In-service Program **Presentations and Citizen Involvement** • Water Quality Volunteer Program Train citizen volunteers for project deployment and ongoing maintenance, including sensor cleaning and calibration • Water Quality presentations o Urban Ecology & Conservation Symposium o JBWP Volunteer Meeting o Clean Water Festival o Cleveland HS o JBWP Board o Tualatin River Watershed Council event • Develop informative and interactive water quality displays o Enhance water quality exhibit in Jackson Bottom Wetlands Education Center o Enhance web display, providing informative graphs and capability for data download for academic assignments and research • Periodic articles for publications and web site

Water quality data are now available in the following ways:

- Graphs and tables of raw data on Jackson Bottom wet site: http://www.jacksonbottom.org/wetlandsmonitoring.htm
- Comma-delimited text available from web site for download into spreadsheet (including a Help page)
- Quality Controlled data available upon request
- USGS web Data Grapher: http://or.water.usgs.gov/cgi-bin/grapher/graph_setup.pl?basin_id=tualatin
- Water level data (corrected based on staff gage readings), delivered to Oregon Water Resources Department monthly

b) Actual Total Budget

The actual total budget is attached at the end, including supporting documentation and copies of receipts.

c) Volunteer Hours, Number of Participants, and List of Partners

Volunteer Hours

Volunteer Hours (water quality monitoring site installation and cleaning/calibration of sensors)	240.5
Professional in-kind hours (Technical Advisory Group)	119.4

Volunteers:

Monitoring site installation: Wolfgang, Beth, Tara, Chris, Ian, Larry, Fred, Todd, REI (4), planters (4), Tom, Nicole

Cleaning/calibration: Wolfgang, Tara, Bill, Kari, Nicole

Number of Participants

For period: July 2004-June 2005

Audience	Actual Numbers	Projected Numbers	Participation
Students Elementary High School College/University	 1260 est. 40 est. 62	 1700 100 100	• Local events (Children's Clean Water Festival) • Programs at the JBWP Education Center • JBWP traveling programs • Research and academic assignments
Teachers	50 est.	50	• Integrate water quality curriculums in Teacher Education Programs • Symposiums and conferences
Water Quality Volunteer Program	20	6-10	• Train volunteers for ongoing system maintenance, including sensor cleaning and calibration • Educate volunteers in understanding and interpreting basic WQ concepts and data to support presentations to visitors
General Public, Visitors to Wetlands Education Center, JBWP Members	11777	10000	• In-person visits to the Center • Programs and presentations at the Education Center
Technical Advisory Group (TAG)	7	6-10	• Participation in guiding project • Providing technical expertise • Utilization of WQ data
Natural resource professionals and watershed community	250 est.	500	• Symposiums and conferences • Presentations to local organizations • Utilization of WQ data

est. = estimate

List of Partners

Sponsors & Grants

- The Tualatin Valley Water Quality Endowment Fund of The Oregon Community Foundation
- Clean Water Services
- Spirit Mountain Community Fund
- Metro Greenspaces Grant Program funded by the US Fish and Wildlife Service and offered in partnership with Metro Regional Government.

Technical Advisory Group

- United States Geological Survey - Water Resources of Oregon
- Clean Water Services
- Oregon Water Resources Department - District 18
- Portland Community College - Department of Engineering
- Portland State University - Environmental Sciences and Resources
- Partners for Clean Water - Tualatin River Watershed
- Tualatin River Watershed Council

Science Education Focus Group

- Beaverton School District (BSD)
- Hillsboro School District (HSD)
- Lewis & Clark College
- PCC - Biology and ESR
- PCC - Engineering and Technology Dept.
- PSU - Center for Science Education (CSE)
- PSU - Environmental Sciences and Resources (ESR)
- Clean Water Services (CWS)

2. Evaluation

The *Technical Advisory Group* (TAG) has continued to review the project's technical aspects including evaluation of the monitoring system deployment, data management, data quality and effectiveness of presentation. Changes have been implemented based on feedback from the TAG. Improvements have been made in the Quality Assurance/Quality Control of the data.

The evaluation includes comparing attendance counts in classes and visitors at the Wetlands Education Center with the estimated numbers of affected people. This information is shown in the section *Number of Participants*. The numbers are relatively close and for many audiences exceed the projected numbers. We fell short in high school student participation, but we are currently developing relationships with the Beaverton and Hillsboro School Districts. I participated as a judge in several science fairs and continue to make contacts with high school educators.

In our grant narrative, we listed the following additional measures of success. The interspersed paragraphs following the bulleted items make up the evaluation of the preceding bulleted items.

- 3 - 4 classes (high school and undergraduate level) utilizing data from this system in academic assignments
- 4 high school research projects presented at local/regional events or science fairs
- 3 undergraduate and/or graduate level research projects undertaken

Classes in PCC Department of Engineering have utilized data from used the Jackson Bottom Wetlands Preserve web site for academic assignments. I am currently working with two high school/community college students, independently of the school systems. One student is investigating macro-invertebrate populations and their relationship to turbidity and other water quality standards. A doctoral student from PSU is currently conducting research on the wetland-river interactions and is using the data from this project. We have formed a Science Education Focus Group and are currently developing relationships with the Beaverton and Hillsboro School Districts and believe that we are in good position for engaging more student projects for the coming school year.

- 20 classes (elementary level) participating in the Biodiversity and Science Inquiry programs at the Preserve

During 2004-05, we taught 12 Biodiversity programs, 10 Inquiry Programs and 10 Riparian Inquiry Programs to approximately 960 students, plus 32 teachers, plus 65 parent helpers. Water quality and/or watershed health concepts have been incorporated into each of these programs.

- 6 - 10 community volunteers trained and involved in supporting water quality monitoring technology (Volunteer hours will be tracked).

In addition to the many volunteers who helped in the installation of the new water quality monitoring station, 6 volunteers have been trained and involved in cleaning and calibration of the water quality monitoring probes.

- **8 - 10 presentations for local community groups and at symposiums and conferences**

We have worked diligently to participate in as many presentation opportunities as possible in this first year of the project for promotional, educational and scientific sharing purposes. Presentations have been conducted at the Urban Ecology & Conservation Symposium, JBWP Volunteer Meeting, Children's Clean Water Festival, Cleveland HS, JBWP Board meeting, and a Tualatin River Watershed Council event.

- **3 articles for publications and/or web site**

We've been complemented many times on our web site. See http://www.jacksonbottom.org/wetlandsmonitoring.htm.

- **2 media hits with focus on the *Water Quality Monitoring, Education, & Partnership Project***

Our national award-winning documentary video *Out Here: A Visit to Jackson Bottom Wetlands* features the water quality monitoring project, in addition to our education and volunteer programs here at the Preserve. This 12 minute documentary on Jackson Bottom Wetlands Preserve won two awards for best director and nature/wildlife category in the prestigious 26th annual Telly Awards competition.

- **6 - 10 organizations actively engaged on the Technical Advisory Group**

Seven organizations are actively participating on the Technical Advisory Group.

3. Photo Documentation

See the Final Report CD included with this report. Photo documentation is in the folder **Photos.**

4. Maintenance Plan

This was not a restoration/enhancement project.

5. Acreage Affected

This was not a restoration/enhancement project.

6. Products of the Grant Project

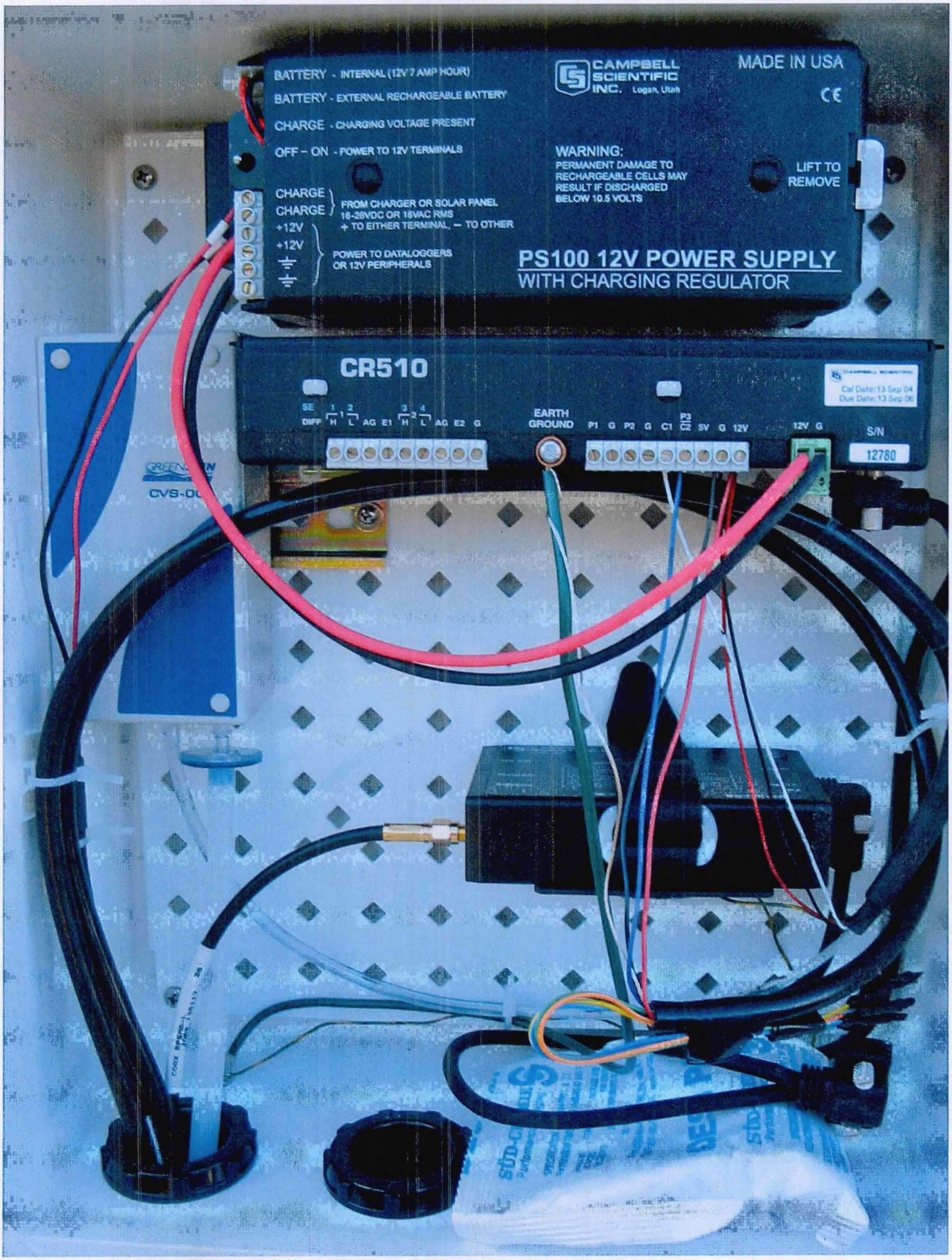
See the Final Report CD included with this report. The products are in the folder **Presentations.**

The following products (along with several variations) were created for this project:

- *JBWP Monitoring Overview 2005* – an overview presentation of the project.
- *Water Quality DO and Algae* – a presentation for high school students and adults on some water quality concepts. This presentation generally included some hands-on use of water quality monitoring probes, along with examination of algal samples under microscopes.
- *UERC 2005 Posters*
- *WMS_Overview_GISmap.bmp* – a map of the Wetlands Monitoring System, showing the water quality monitoring sites.


JACKSON BOTTOM
WETLANDS PRESERVE
3


Nick
JACKSON HOLE


BATTERY - INTERNAL (12V 7 AMP HOUR)
BATTERY - EXTERNAL RECHARGEABLE BATTERY
CHARGE - CHARGING VOLTAGE PRESENT
OFF – ON - POWER TO 12V TERMINALS
CAMPBELL SCIENTIFIC INC. Logan, Utah
MADE IN USA
CE
WARNING:
PERMANENT DAMAGE TO RECHARGEABLE CELLS MAY RESULT IF DISCHARGED BELOW 10.5 VOLTS
LIFT TO REMOVE
CHARGE
CHARGE
FROM CHARGER OR SOLAR PANEL
16-28VDC OR 18VAC RMS
+ TO EITHER TERMINAL, – TO OTHER
+12V
+12V
POWER TO DATALOGGERS OR 12V PERIPHERALS
PS100 12V POWER SUPPLY
WITH CHARGING REGULATOR
CR510
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5V
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S/N
12780
Cal Date: 13 Sep 04
Due Date: 13 Sep 06


EXIT
WETLANDS


Wetlands Monitoring System

Wetlands Monitoring System
at the Preserve

Jackson Bottom Wetlands Preserve

Aerial photograph July 2004

- Preserve Boundary
- Shelters
- Trails
- Water Quality Monitoring Site
- Weather Station

N

Water Quality Monitoring

at the Preserve

Ruminations on Dissolved Oxygen and Algae

Water Quality Monitoring, Education and Partnership Project

Life in the Gene Pool 1-Jul-2004

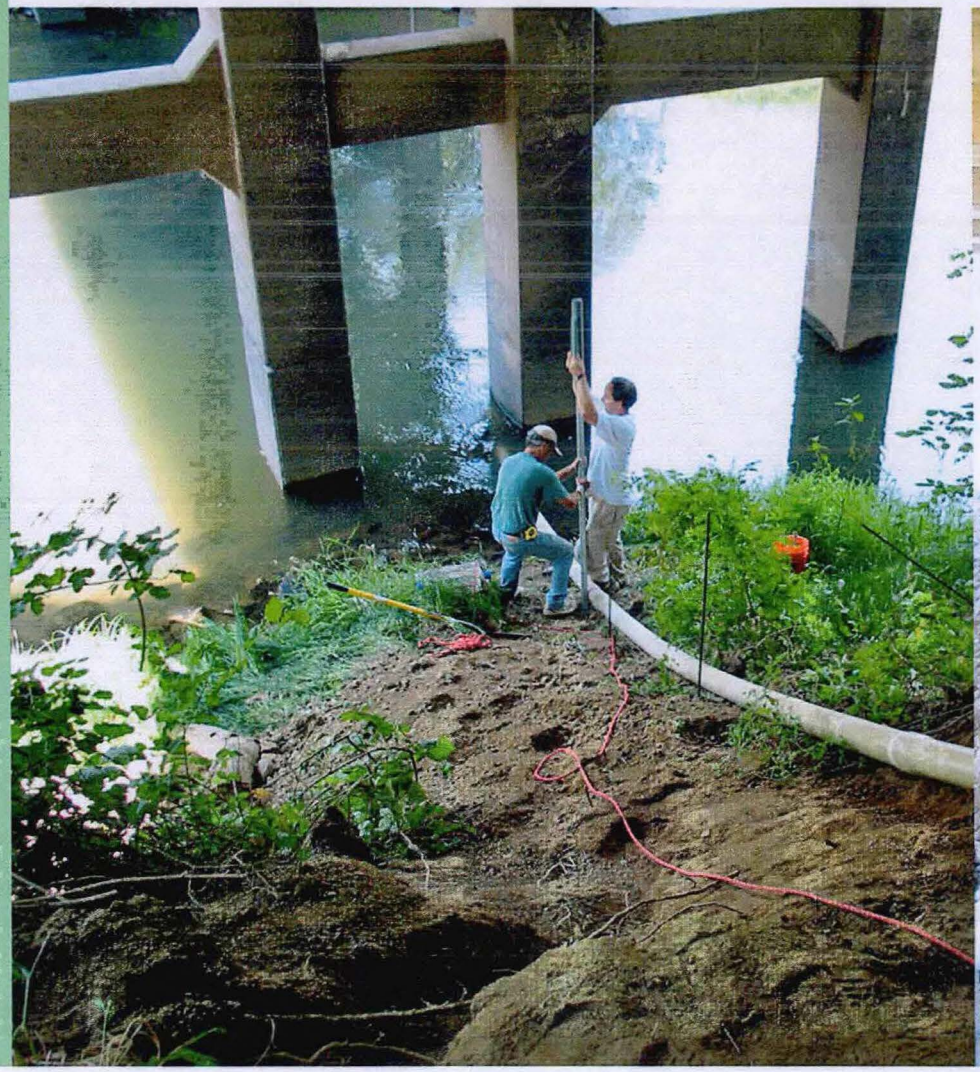
Water Quality Monitoring Stations

- Tualatin River at River Mile 44.4
  Deployed since Oct-2004

- Wetland Pond (Gene Pool)
  Deployed since Nov-2002

Gene Pool Monitoring Station

Tualatin River Station



Parameters Measured Every Hour

- Temperature
- Specific Conductance
- pH
- Dissolved Oxygen
- Turbidity
  (river station only)
- Water Level
  (separate sensor)

DO Effects on Fish

Level of Effect	Salmonid (mg/L)	Non salmonid
Early life stages (eggs and fry)		
No production impairment	11 (8)	6.5
Slight production impairment	9 (6)	5.5
Moderate production impairment	8 (5)	5.0
Severe production impairment	7 (4)	4.5
Limit to avoid acute mortality	6 (3)	4.0
Other life stages		
No production impairment	8 (0)	6.0
Slight production impairment	6 (0)	5.0
Moderate production impairment	5 (0)	4.0
Severe production impairment	4 (0)	3.5
Limit to avoid acute mortality	3 (0)	3.0

DO in the gravel spawning substrate (shown in parentheses)

Factors Affecting DO

- Photosynthesis and Light Levels
- Respiration
- Decomposition
- Temperature
- Water Velocity
- Wind
- Depth
- Groundwater Inflow
- Season

Biochemical Processes affecting DO

Photosynthesis of Algae and Aquatic Plants

$6\,H_20 + 6\,CO_2$ + chlorophyll (acted on by sunlight) $\longrightarrow C_6H_{12}0_6 + 6\ O_2$

Produces O_2

Cellular Respiration

$C_6H_{12}0_6 + 6\ O_2 \longrightarrow 6\,H_20 + 6\,CO_2$

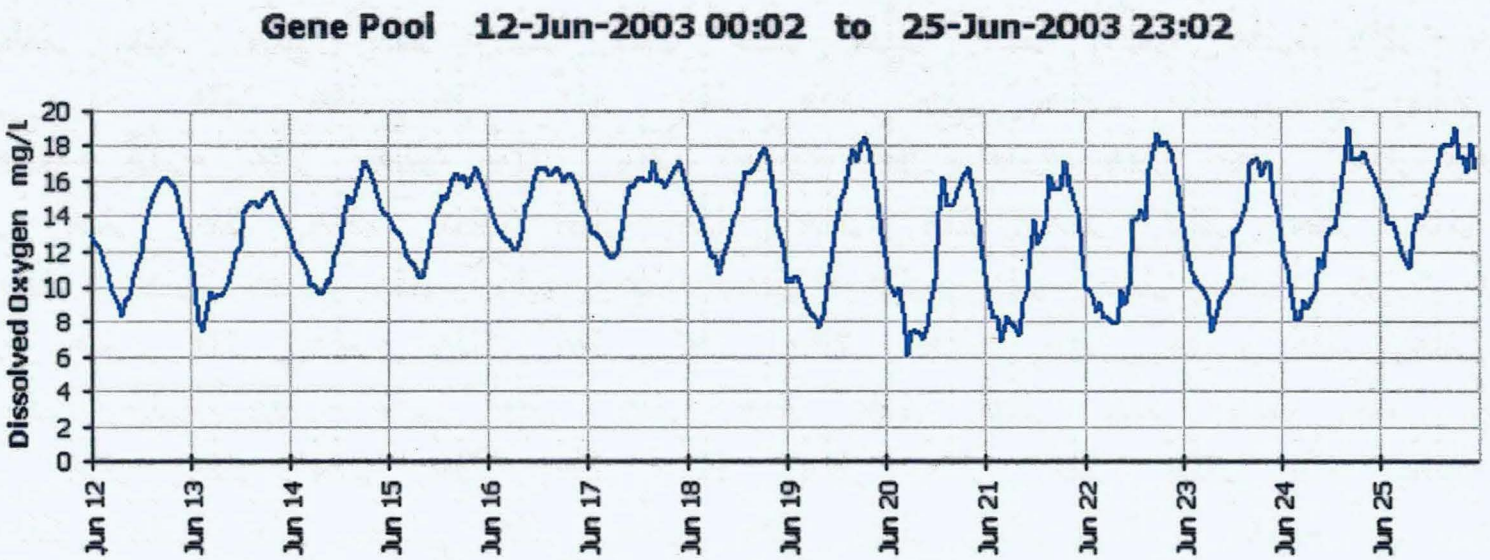
Consumes O_2

Aerobic Decomposition

The breakdown of organic matter by bacteria and fungi.

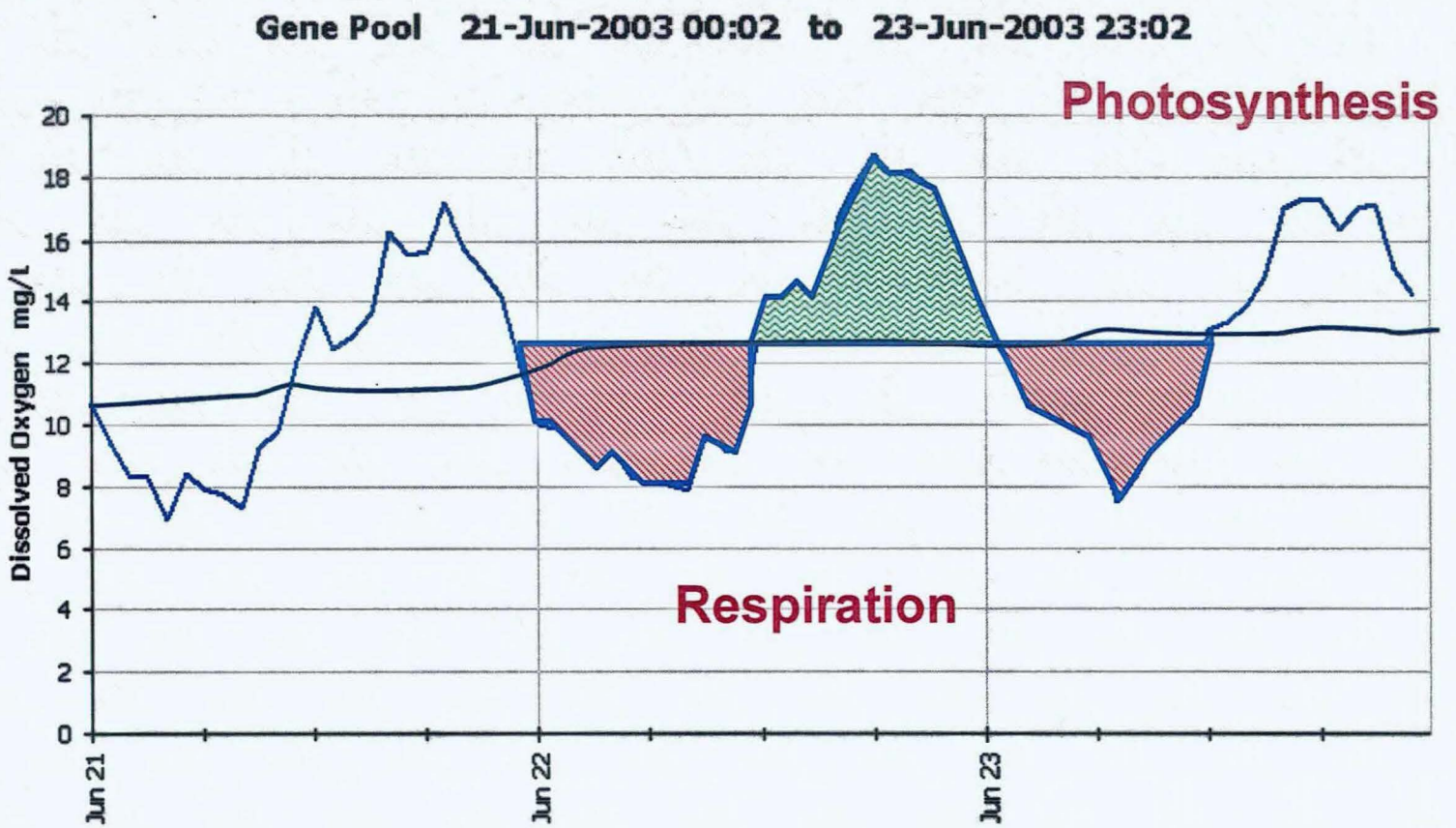
Consumes O_2

DO in Gene Pool - Early Summer 2003



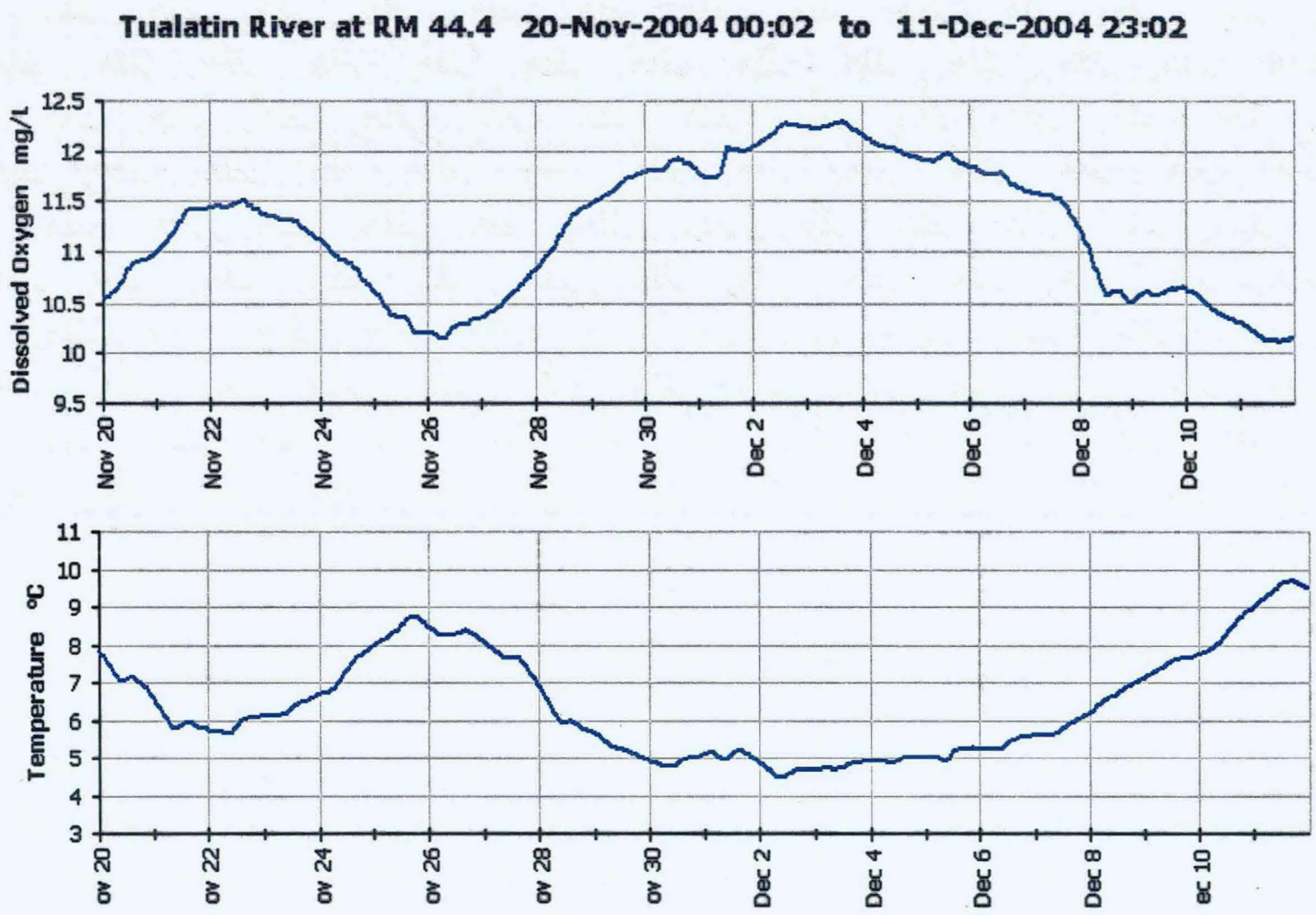
Diurnal Cycle

DO Diurnal Cycle



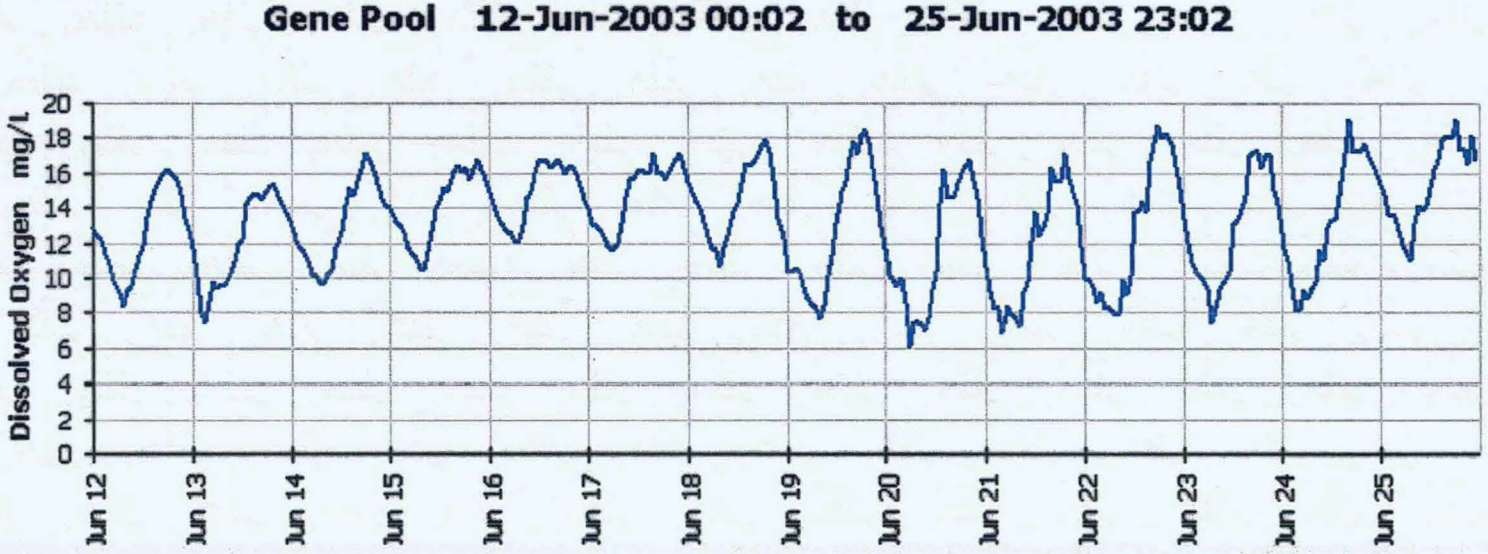
DO in the Tualatin River

Effect of Temperature on DO

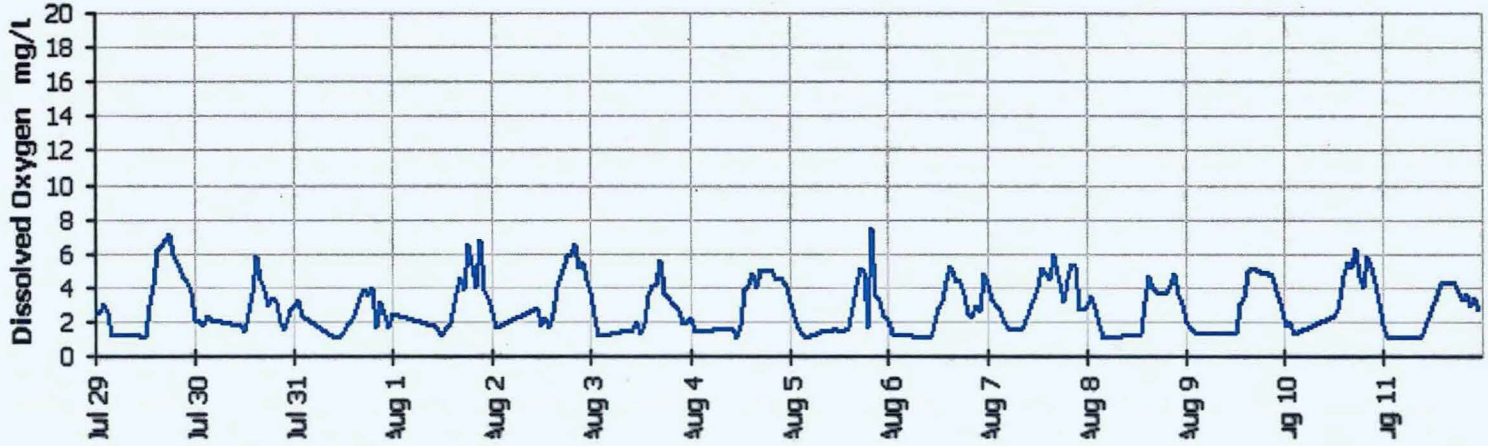


Dissolved Oxygen Comparison

Early Summer



Mid Summer



Are Algae Bad?

- **Vancouver Lake was closed to swimmers in the summers of 2003 and 2004 due to blue-green algal blooms.**

  Toxins typically include:

  - neurotoxins (which disrupt muscle functions)
  - hepatotoxins (which affect the liver)
  - cytotoxins (which can cause skin irritations, diarrhea and vomiting).

- **In the 1980's unsightly algal blooms were common in the lower reaches of the Tualatin River.**

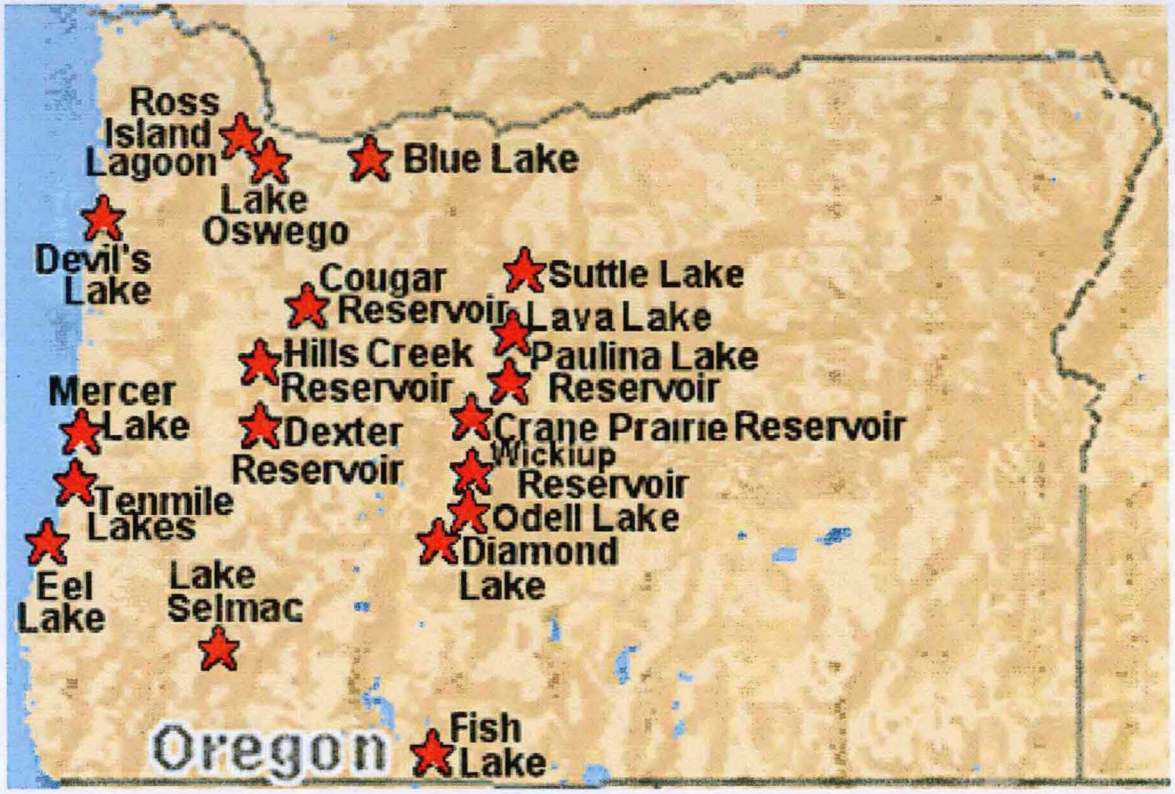
  - Algal blooms caused wide fluctuations in dissolved oxygen (4 to 20 mg/L) and pH (6.8 to 9.5).
  - The algal blooms were due to sluggish water and high phosphorus concentrations.

Are Algae Bad?

Health Advisories: Blue-green Algae (Cyanobacteria)

http://www.dhs.state.or.us/publichealth/esc/docs/maadvisories.cfm

Click location on map for advisories:



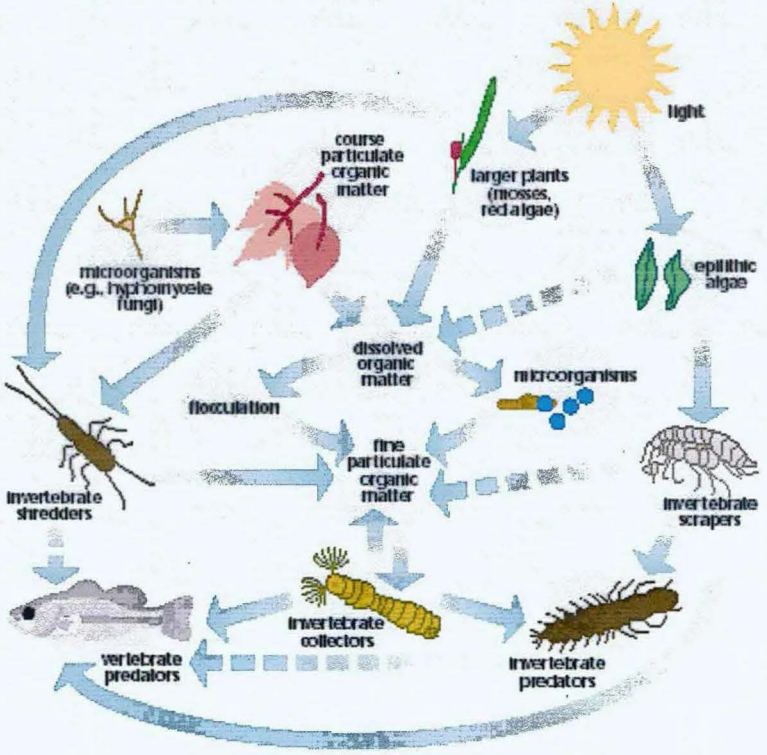
Importance of Algae

Freshwater microscopic algae (phytoplankton and benthic algae) form the base of the

Aquatic Food Chain

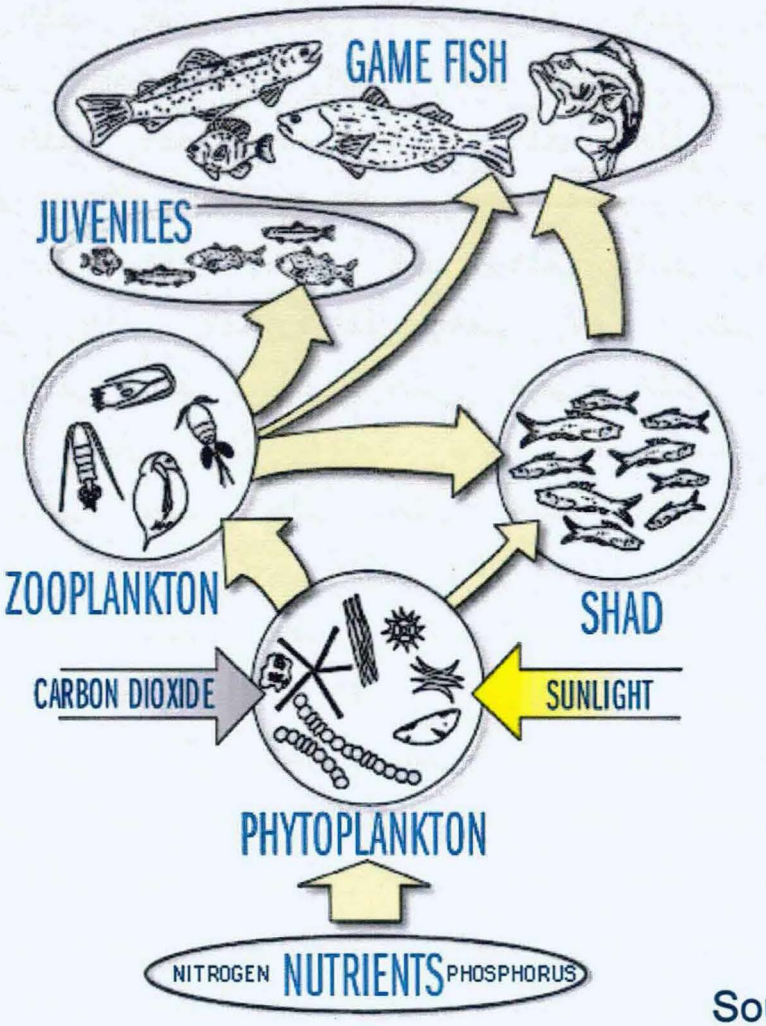
without which freshwater fisheries could not exist.

Food Web in a Stream



Source: Stream Corridor Restoration: Principles, Processes, and Practices

Food Web in a Lake



Source: Water on the Web

What Algae Need to Grow

- Water
- Carbon Dioxide (CO_2)
- Phosphorus
- Fixed nitrogen
- Sunlight (for photosynthesis)

➢ **What Causes Algal Blooms?**

➢ **Why do we have Algal Blooms in the Gene Pool?**

➢ **Why do we no longer have Algal Blooms in the Tualatin River?**

What are Algae?

When the term **Algae** is used today, it refers to simple eukaryotic [cells have a nucleus], photosynthetic organisms, unicellular or multicellular, which have their pigments localized in membrane-bounded intracellular bodies (plastids), have no vascular system, and do not develop from an embryo.

This includes microscopic unicells at one end of the scale and giant ocean kelp at the other.

Source: Micrographia.com

Algae in Herbivore-Dominated Food Webs

Many microorganisms "graze" on algae

- Zooplankton
- Protists (including amoebae)

Algal Defenses

- Very small cell size and extremely rapid cell division
- Growth in the cold season when populations of herbivores are relatively low
- Chemical deterrents (toxins)

Algal Bloom in Gene Pool - July 2004

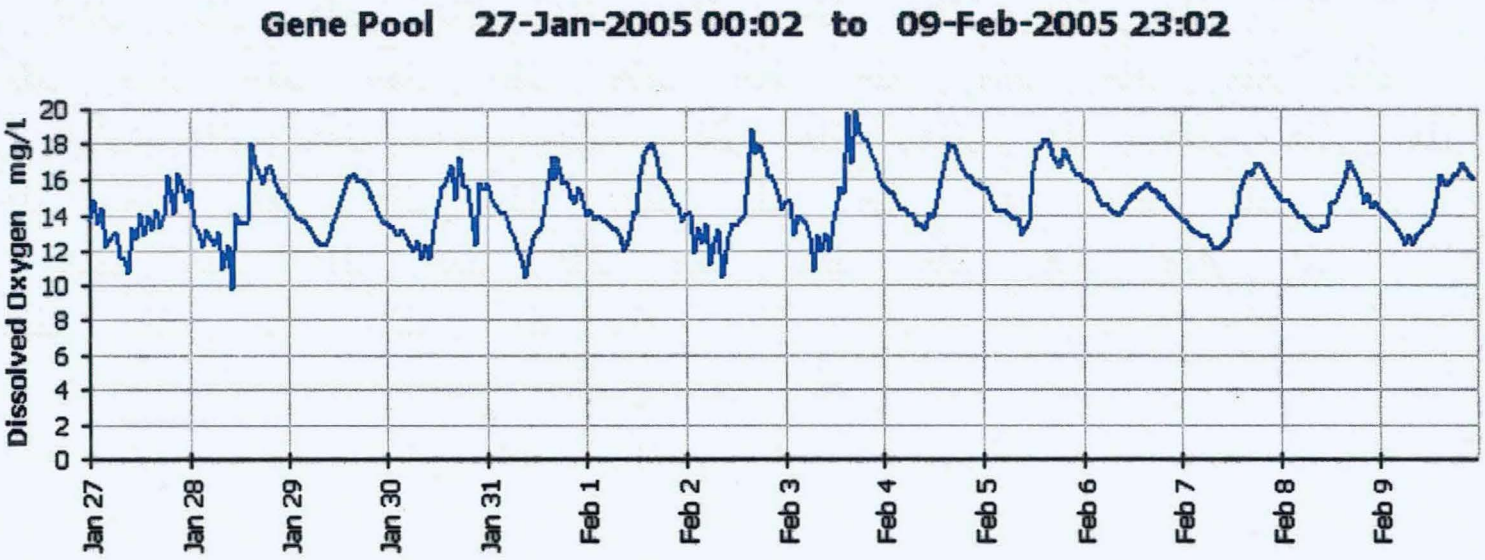
Spirogyra - Filamentous Green Alga

- Very fine bright dark-green filaments that move gently with the currents in the water.
- Slimy to the touch when attempts are made to collect it.

The slime serves to deter creatures which otherwise attach themselves to underwater plants, so Spirogyra under the microscope is usually spotless.

x1000

What's Going On in Winter?



- There are no visible algal blooms (except on rafts)
- Turbidity is low – the water is clear

Alga on raft in Gene Pool – Feb 2005

- In class *Tribophyceae*
- Consist of long filaments that are really just a single cell with many chloroplasts

Vaucheria sp., x 640, sewage drain exit

References on the Web

- Jackson Bottom Wetlands Monitoring
  http://www.jacksonbottom.org/wetlandsmonitoring.htm
- Water on the Web
  http://waterontheweb.org/under/waterquality/index.html
- Micrographia.com – Freshwater Algae
  http://www.micrographia.com/specbiol/alg/alghome/alggen01.htm

Other References

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- Graham, Linda E. and Wilcox, Lee W. 2000. *Algae*. Prentice-Hall, Inc.
- Lynch, Dennis D., Oregon District, U.S. Geological Survey. 2003. *CSREES Pacific Northwest Regional Water Quality Program, Conference on TMDLs, 2003* Abstract: Quantification of Background Sources of Phosphorus in the Tualatin River Basin, Oregon: Implications for the TMDL Process.
- Oregon Department of Environmental Quality. August 2001. *Tualatin Subbasin Total Maximum Daily Load (TMDL).*
- Oregon Department of Human Services, Environmental Toxicology http://www.dhs.state.or.us/publichealth/esc/docs/maadvisories.cfm (accessed 8-Mar-05)
- US Department of Agriculture et al. The Federal Interagency Stream Restoration Working Group. 1998. *Stream Corridor Restoration: Principles, Processes, and Practices*. http://www.nrcs.usda.gov/technical/stream_restoration/newgra.html

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- Liberty High School
- Partners for Clean Water - Tualatin River Watershed
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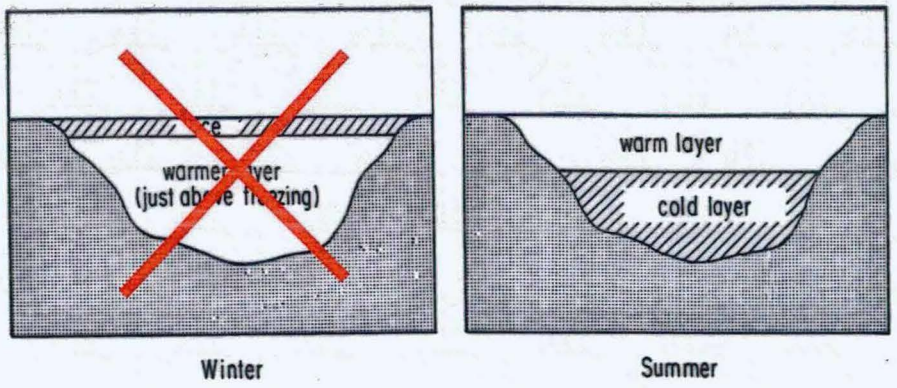
Thermal Stratification Through the Seasons



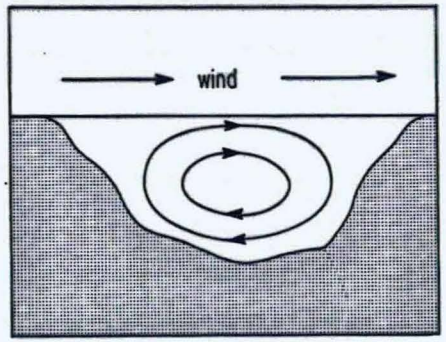
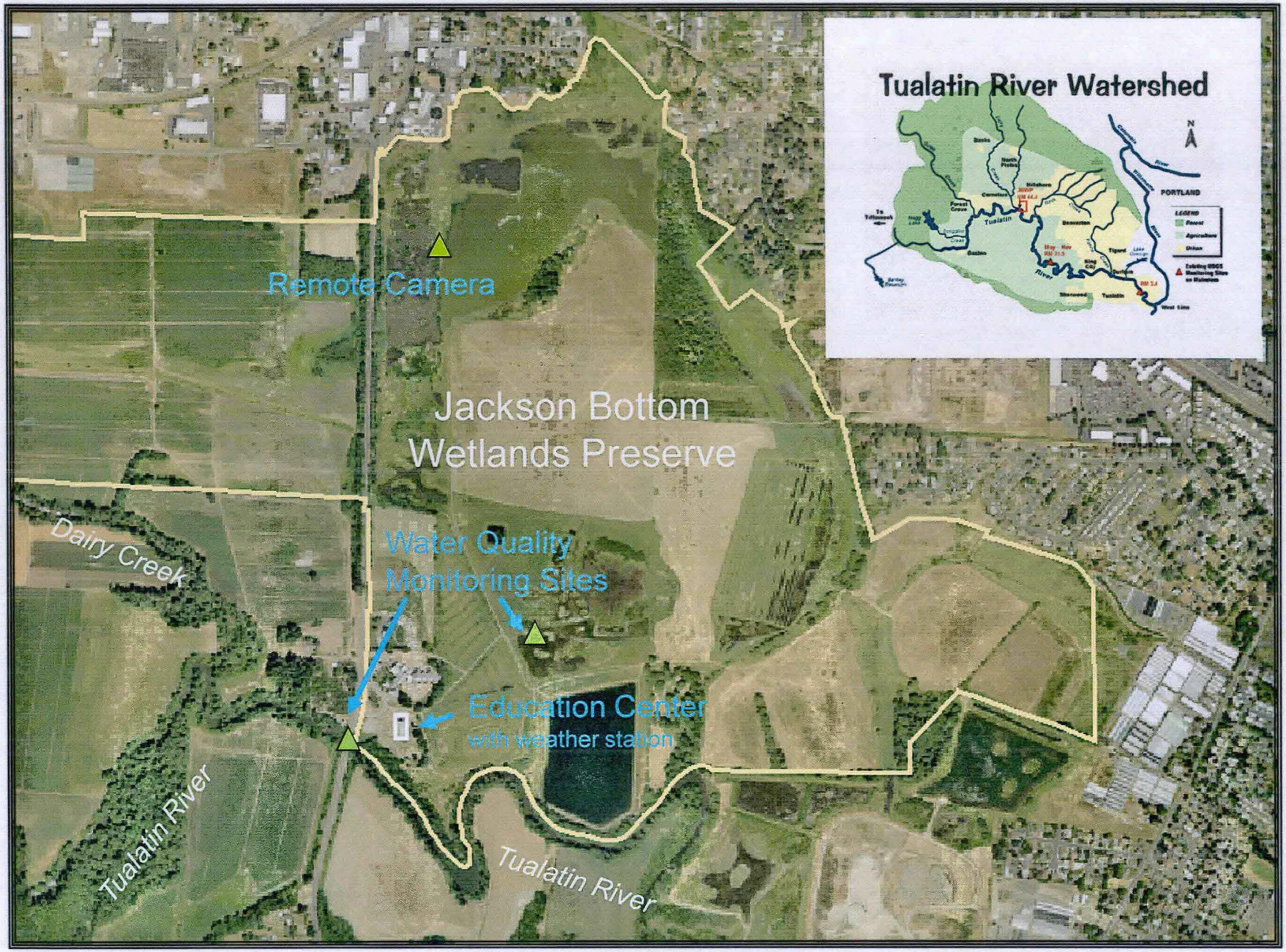


FIGURE 3–51: The pond through the seasons. Thermal stratification occurs during the winter and summer in temperate regions. Spring and fall are times of thermal mixing.

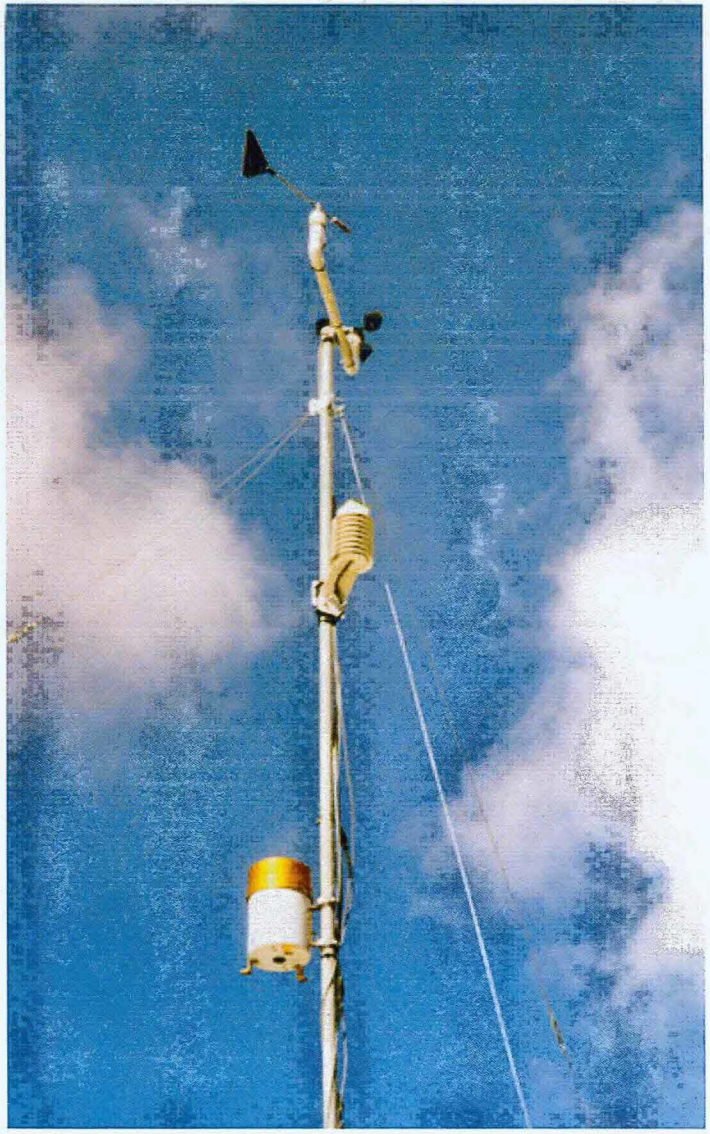
Wetlands Monitoring System
at
Jackson Bottom Wetlands Preserve

Water Quality Monitoring, Education and Partnership Project

Overview - July 2005


Tualatin River Watershed
PORTLAND
Remote Camera
Jackson Bottom
Wetlands Preserve
Dairy Creek
Water Quality
Monitoring Sites
Education Center
with weather station
Tualatin River
Tualatin River
Miles
0
0.125
0.25
0.5
0.75
1
N
W
E
S

Weather Station



Measures:

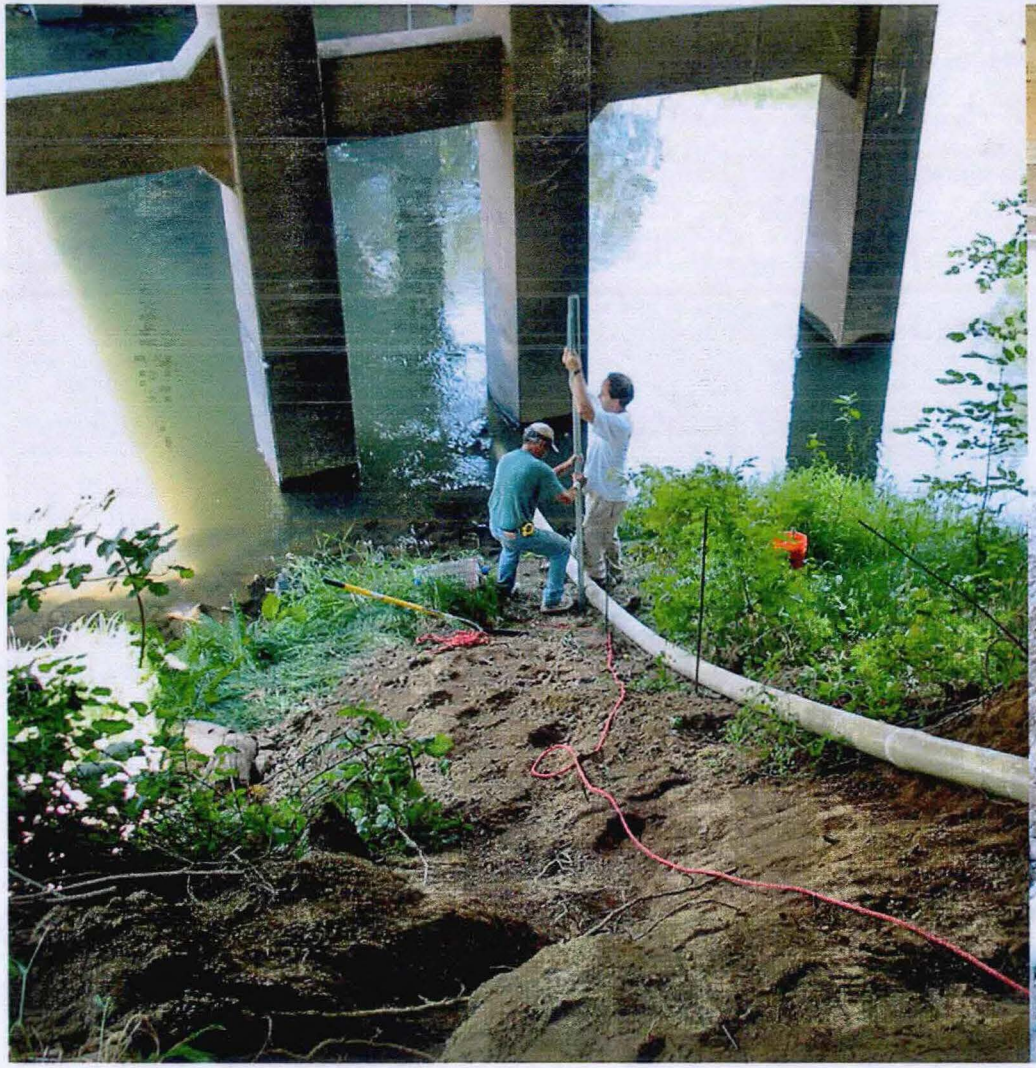
- temperature
- barometric pressure
- rainfall
- relative humidity
- dew point
- wind speed and direction
- solar radiation
- leaf wetness

Gene Pool WQ Monitoring Station

Deployed since Nov-2002

Tualatin River WQ Monitoring Station

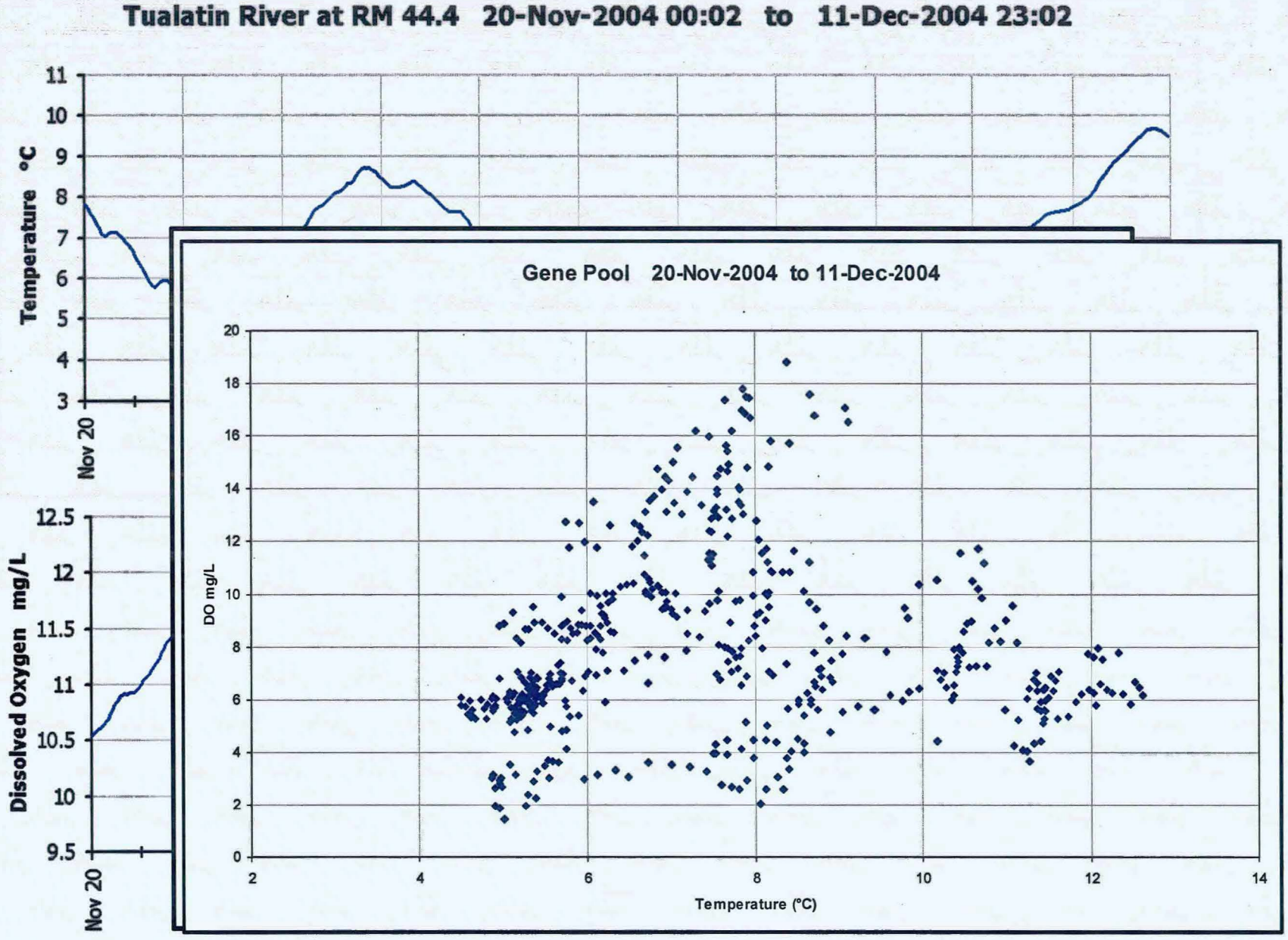
Deployed since Oct-2004



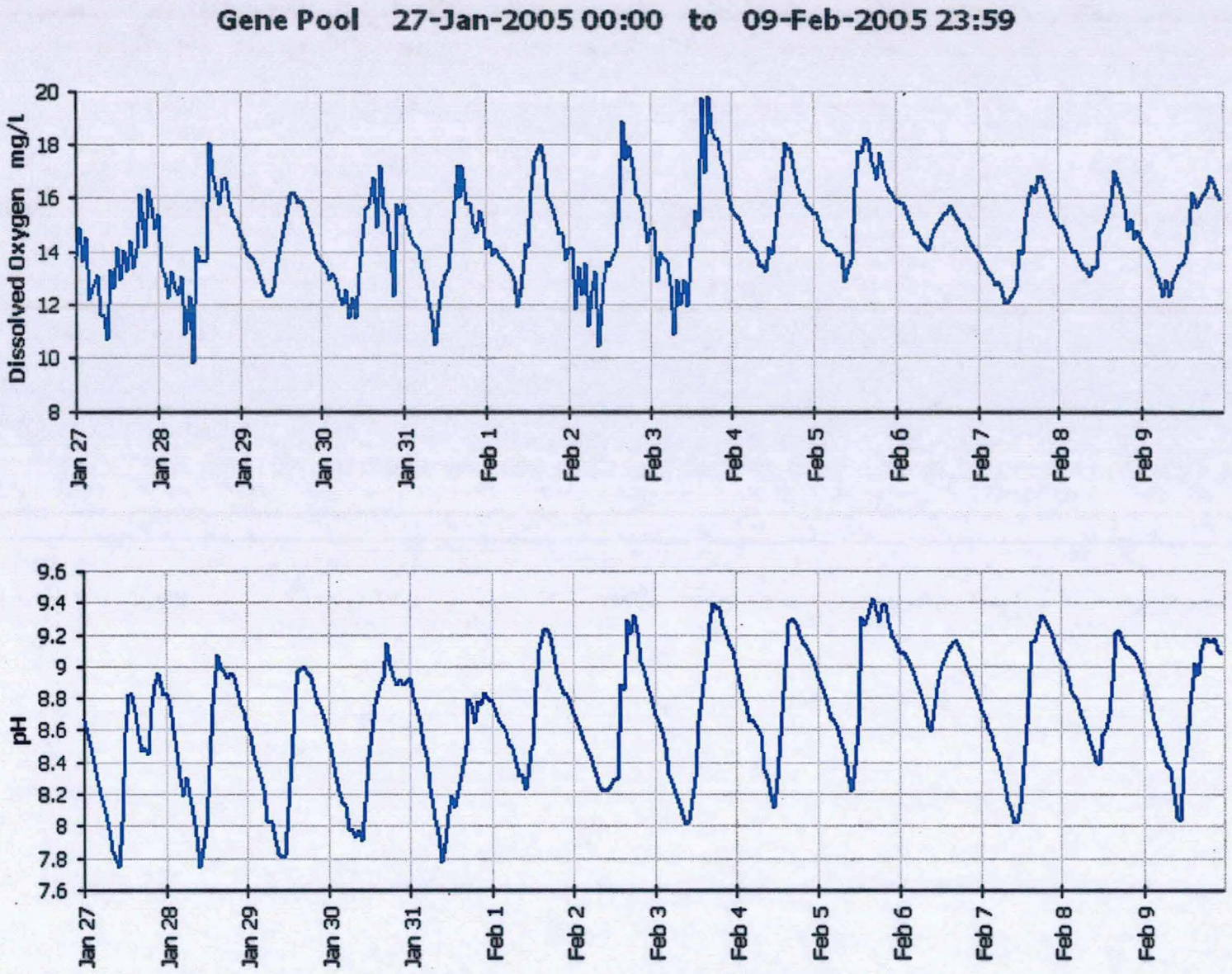
Parameters Measured Every Hour

- Temperature
- Specific Conductance
- pH
- Dissolved Oxygen
- Turbidity
  (river station only)
- Water Level
  (separate sensor)

Water Quality data on the web



Water Quality data on the web



Current Education Offerings

- Serve students in K-6 in Tualatin Basin
- 160 classes, 4640 students in last year

Teacher Education Programs

- Offered state-wide with local requests given priority
- Focus is for educators working with students (rather than for professional growth)
- Allows teachers to introduce science activities to students using innovative, proven teaching methods
- Examples of programs:
  - Creeks and Kids (OWEB)
  - Project WET (National program)

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Science Education Partners

- Hillsboro School District
- Beaverton School District
- Portland Community College
  - Environmental Studies
  - Dept. of Engineering
- Lewis & Clark College
- Portland State University
  - Center for Science Education
  - Environmental Sciences and Resources
- Clean Water Services

Images from Remote Camera System

Jackson Bottom Wetlands Preserve web site:

http://www.jacksonbottom.org/

Water Quality Monitoring, Education & Partnership Project

Jackson Bottom Wetlands Preserve

Two Water Quality Monitoring Stations

- Tualatin River at River Mile 44.4 Deployed since Oct-2004
- Wetland Pond (Gene Pool) Deployed since Nov-2002

Water Quality Parameters measured every hour

- Temperature
- Specific Conductance
- pH
- Dissolved Oxygen
- Turbidity (river station only)
- Water Level

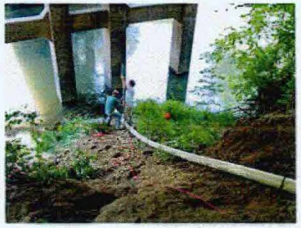
Weather Station

- Records microclimate at the Preserve

Gene Pool Water Quality Station

Project Goals

1) To provide environmental education opportunities to connect citizens of all ages to the Tualatin watershed and to promote watershed health throughout the Tualatin Basin.
2) To implement a community partnership alliance among key organizations in the Tualatin Basin that have need for water quality data from this monitoring system.
3) To augment an existing water quality monitoring system by adding new monitoring station on the mainstem of the Tualatin River.



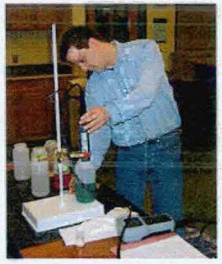
Construction of the Tualatin River Water Quality Station

Weather Station

Retreiving the water quality probe from the raft at the Gene Pool station

Education Opportunities

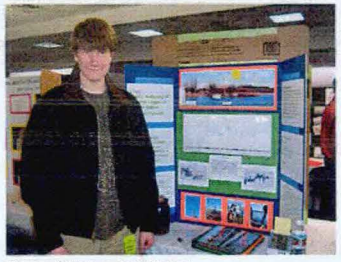
- Research, including how the wetland ecosystem and the river are interrelated.
- Academic Assignments (all levels)
- High School Science Fair projects
- Volunteer Opportunities
- Monitoring Project Assistance (help with cleaning/calibration of sensors and quality control of data)
- We are seeking additional education partners at all levels from grade school to university.



Calibrating the Water Quality Probe

Partners

- United States Geological Survey - Water Resources of Oregon
- Clean Water Services
- Oregon Water Resources Department - District 18
- Portland Community College - Department of Engineering
- Portland State University - Environmental Sciences and Resources
- Liberty High School
- Partners for Clean Water - Tualatin River Watershed
- Tualatin River Watershed Council



Successful Science Fair Project

Funding Sponsors

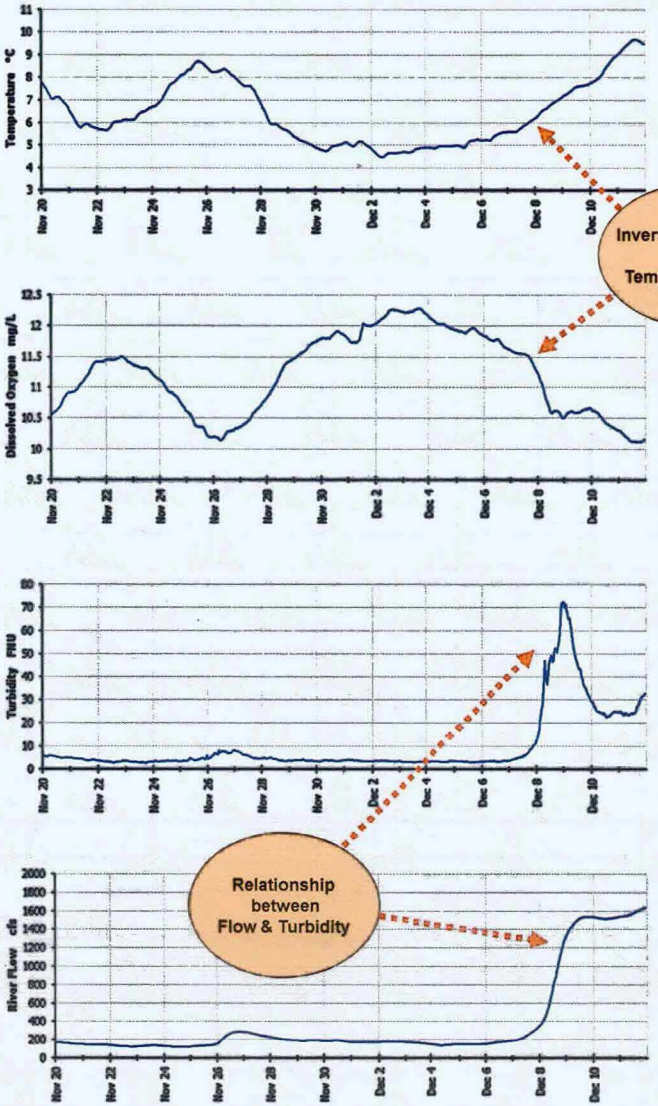
- Tualatin Valley Water Quality Endowment Fund of the Oregon Community Foundation
- Clean Water Services
- Metro Greenspaces Program with US Fish & Wildlife Service
- Spirit Mountain Community Fund
- Intel

Sample Water Quality Data

Same Time Period for All Graphs

Tualatin River (River Mile 44.4)

Tualatin River at RM 44.4 20-Nov-2004 00:02 to 11-Dec-2004 23:02

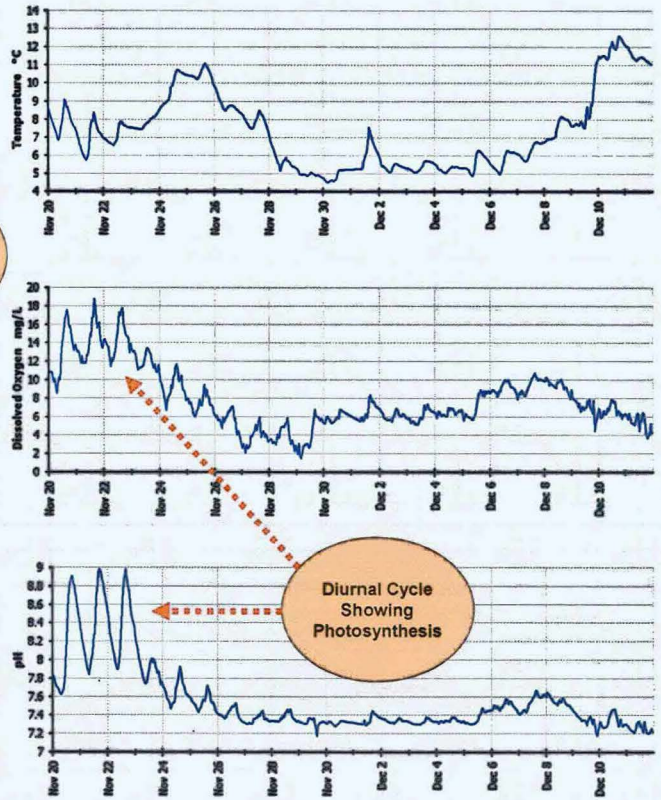


Inverse Relationship between Temperature & DO

Relationship between Flow & Turbidity

Gene Pool (wetland pond)

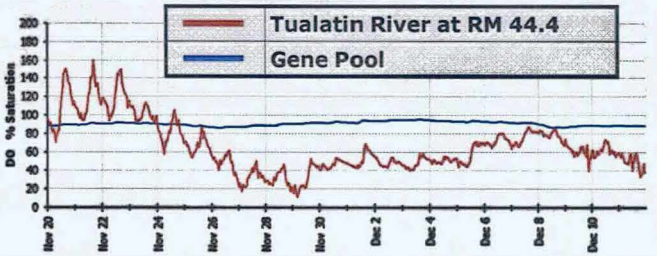
Gene Pool 20-Nov-2004 00:02 to 11-Dec-2004 23:02



Diurnal Cycle Showing Photosynthesis

Site Comparison

Dissolved Oxygen Saturation



Graphs & Tables are updated hourly on web

http:// www.jacksonbottom.org / wetlandsmonitoring.htm