COST-EFFECTIVE AUTOMATED WATER QUALITY MONITORING SYSTEMS PROVIDING HIGH-RESOLUTION DATA IN NEAR REAL-TIME

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YSI Inc. - Integrated Systems & Services
1. High Resolution Data
2. Sensors
3. Monitoring Systems
4. Scenarios / Case Studies
SECTION ONE

High-Resolution Data
Why High Resolution Data? (Temporal & Spatial)

1. Data Quality
   - Improved Understanding of the Environment
   - Increases accuracy

2. Improved Management Decisions
   - Early Warning
   - Detect ‘events’
   - Identify point sources, trends, anomalies
   - Measure the impact of restoration, land management, and development
   - Data for forecasting & modeling
Temporal Data
The under-sampling problem
Data Accuracy

The under-sampling problem

DO Data - Weekly Interval

AVERAGE = 80.4%

DO Data - Daily Interval

AVERAGE = 79%

DO Data - 15 Minute Interval

AVERAGE = 85.2%

Data Accuracy

The under-sampling problem
Chlorophyll spike in the raw water in May 2008 that was tied to customer taste and odor calls in the finished water distribution system.

The signal increases from the baseline. ~4X in 3 hours.

The entire event is over in less than 1.5 days. Would sampling have detected it?
Evolution of Technology

- Low power sensors & electronics
- Smaller electronics
- More stable sensors
- Anti-fouling systems
- Low cost real-time communication
Sensors for Real-World Conditions
30-day deployment – Severe Conditions

With anti-fouling

Without
30-day deployment – Severe Conditions

With anti-fouling

Without
Water Quality Sensors

Physical Property & Electrochemical Sensors
- Temperature Conductivity
- Depth
- PAR
- pH & ORP (Redox)

Optical Sensors
- Optical DO
- Blue-Green Algae
- Turbidity
- Chlorophyll
Additional Sensors

In addition to a water quality sonde, additional sensors are integrated into the DCP to provide one, consolidated data stream

- MET (wind speed/direction, barometer, humidity)
- Nitrate Analyzer
- Multi-Nutrient Systems
- Hydrocarbons
Evolution of Monitoring Systems

1. Grab Sampling
   Lab Analysis

2. Continuous Monitoring

3. Spot Sampling

4. Buoy Based Real Time Continuous Monitoring

5. Real Time Monitoring

6. Moored Continuous Monitoring

7. High Res, Real Time, Vertical Profiling

8. High Res, Real Time, Horizontal (Spatial) Profiling
Vertical Profilers
Automated Vertical Profiling

- Variations in temperature, wind, rainfall, sunlight, and salinity cause changes in the vertical structure of a water column, varying from highly stratified to well-mixed.

- The Vertical Profiler collects data continuously to shed light on the impacts of the physical environment of the water body.
Vertical Profiling Applications

- Monitor changes in stratification
- Track vertical distribution of phytoplankton and/or blue-green algae populations
- Evaluate the impacts of storms with turbidity sensors
- Monitor dissolved oxygen concentrations and detect onset of low oxygen events
- Generate the most comprehensive baseline water quality record
Profiler Data

Profiler Animation
YSI EcoMapper

Autonomous Underwater Vehicle

~ A Cost-Effective Water Quality & Bottom Mapping Tool ~

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Autonomous Underwater Vehicle (AUV)

The EcoMapper AUV is a cost-effective tool for quickly and easily collecting high-resolution water quality, bathymetry, and sonar data.
Key Features

- Small, portable, lightweight (~50lbs)
- Single Person-deployable
- Autonomous (self-navigating)
- Easy and fast mission planning
- Large sensor payload (18 parameters)
- Long Endurance (9 hours run time)
- Quick Recharge (3 hours)
- Expansion Capability
EcoMapper Components

1. **Electronics / Processor** -
   - Low Power processor running Windows XP

2. **Power** -
   - Rechargeable Lithium-ion Batteries

3. **Communications – (wireless)** -
   - Wi-fi
   - Radio (optional)
   - Cellular (optional)

4. **Propulsion / Control** -
   - Four independent control fins
   - DC motor with propeller

5. **Navigation** -
   - GPS - when on the surface
   - DVL – bottom/water track when below the surface

6. **Expandable Payload** -
   - 10 YSI sensors (18 param)
   - Altimeter
   - Doppler Velocity/Currents
5 Steps to an EcoMapper Mission

1. **Vector Map**
   - Point and click mission planning onto a geo-referenced map

2. **UVC Software**
   - Start EcoMapper with key fob
   - Load mission in EcoMapper UVC Software

3. **Start Mission**
   - Place vehicle in water and start mission

4. **Remote Control**
   - When EcoMapper is on the surface and within range, view data and monitor progress or take manual control

5. **Retrieve EcoMapper**
   - at planned PARK location and download data via Wi-Fi link

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SECTION FOUR

SCENARIOS

1. Source Water Protection
2. Ecosystem restoration
3. Source Water Management
4. Environmental Impact
Falls Lake
North Carolina, USA

Problem:
- Falls Lake is a primary drinking water source for the Triangle area. Blue-green algae can cause taste-and-odor problems in water supplies. Some species also produce toxins that can negatively impact human health.
Source Water Protection

Falls Lake
North Carolina, USA

Solution:
- Continuous vertical profiling system monitors algae levels
- Early warning of possible taste and odor or toxin events
- Reduce trips to field for sampling and analysis
- Improve water quality and PR

http://www.ncsu.edu/wq/RTRM/dp14profiler.html
Ecosystem Restoration

Lake Elsinore
California, USA

Problem:
• Need to improve poor water quality by efficiently operating aeration system to replenish oxygen and reduce fish kills and algal blooms
Ecosystem Restoration

Lake Elsinore
California, USA

Solution:

- Continuous vertical profiling system monitors DO levels
- Real-time data optimizes use of aerator
- Reduces energy usage by 50% (saves >$13K/year per aerator)
Drinking Water Reservoir Survey
New Bedford, MA

Problem:
- The City of New Bedford did not have accurate data on the volume of drinking water in their reservoirs. They were searching for a cost-effective means of collecting this data in their large and complex reservoir system.
Source Water Management

Drinking Water Reservoirs
New Bedford, MA

Solution:
- Automates water quality and bathymetry mapping

$ Low overhead, 2 operators, 1 small boat

$ Reduce survey time through use of multiple vehicles

$ Collect bathymetry and water quality data simultaneously

Dissolved Oxygen(% Sat)
Source Water Management

<table>
<thead>
<tr>
<th>Pond</th>
<th>Date</th>
<th>AUV</th>
<th>Mission Hours</th>
<th>Sample Points</th>
<th>Surface Area (acres)</th>
<th>Volume (cubic feet) (millions)</th>
<th>Gallons Water (billions)</th>
<th>Gallons Water/inch (millions)</th>
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</thead>
<tbody>
<tr>
<td>Little Quittacas</td>
<td>05/15/08</td>
<td>4</td>
<td>8:30:45</td>
<td>30,550</td>
<td>297</td>
<td>84.5</td>
<td>0.6</td>
<td>8</td>
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<td>08/07/08</td>
<td>3</td>
<td>12:31:26</td>
<td>44,840</td>
<td>1,128</td>
<td>641</td>
<td>4.8</td>
<td>31</td>
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<tr>
<td>Assawompset</td>
<td>08/21/08</td>
<td>3</td>
<td>15:18:53</td>
<td>61,135</td>
<td>2,091</td>
<td>811</td>
<td>6.1</td>
<td>57</td>
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<tr>
<td>Pocksha</td>
<td>09/19/08</td>
<td>1</td>
<td>2:41:22</td>
<td>9,647</td>
<td>563</td>
<td>226</td>
<td>1.7</td>
<td>15</td>
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<tr>
<td>Long</td>
<td>10/10/08</td>
<td>3</td>
<td>10:09:49</td>
<td>36,432</td>
<td>1,721</td>
<td>627</td>
<td>4.7</td>
<td>47</td>
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<td><strong>Total</strong></td>
<td><strong>14</strong></td>
<td><strong>49:12:15</strong></td>
<td><strong>182,604</strong></td>
<td><strong>5,800</strong></td>
<td><strong>2389</strong></td>
<td><strong>17.9</strong></td>
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</tr>
</tbody>
</table>
Environmental Impact/Mapping

Lake used for Thermal Cooling
Midwest State, United States

Problem:
- Power generation company uses important recreational lake for cooling reactor water. State requires environmental impact assessment of hot water discharge. Plant wants to determine if increase discharge to increase production.
Environmental Impact/Mapping

Midwest Lake, US

Solution:
- Automates water quality and bathymetry mapping at multiple depths
- Low overhead, 2 operators, launch from shore
- Eliminate need for remote sensing
- Meet regulatory requirements
- Maximize production
Spatial Data
Questions?

IMPORTANT LINKS

http://www.youtube.com/user/YSIinc
http://truecostofdata.com/index.php

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EcoMapper Animation