BOB II Workshop
Sensor Testing

A Collaborative

Workshop

March 17-19, 2010

Ashton Wheeler and Brittany Baker, Beaufort High School

Introduction to the Basic Observation Buoy BOB II Workshop

In January 2009, twenty people from the SECOORA region with support from COSEE SE, including faculty and students from eight universities, informal and formal educators, worked with Doug Levin from NOAA's Chesapeake Bay Office to improve the prototype design platform for the Basic Observation Buoy (BOB).

On March 17-19, 2010 a second workshop, BOB II, was held at the University of North Carolina-Wilmington Center for Marine Science, sponsored by NOAA's Chesapeake Bay Office, the Southeast Coastal Ocean Observing Regional Association (SECOORA) and COSEE SE. The goal of this workshop was to reveal the next generation of BOB design with a focus on sensor instrumentation. Workshop participants included water quality sensor manufacturers, high school students, researchers, and university faculty and students. Participants collaborated to discuss the BOB concept, outlined the future of small monitoring buoys, and developed regional strategies for outreach.

This document details the BOB II workshop outcomes.

Table of Contents

Workshop Sponsors

Informal Greetings and Expectations
"What are we doing here? What are our intentions?"

The first night of the workshop focused on reacquainting with folks that attended BOB I, getting to know one another, identifying how participants have used and modified BOBs, and clarifying the expectations for the workshop. A summary of participants can be found in Appendix B. The items below summarize the discussion of expectations.

Workshop Expectations

- Collaboration
    - Engaging partners in the BOB efforts
    - Networking opportunity in the SECOORA region, extending to the mid-Atlantic and Chesapeake Bay
    - Building a BOB community for sustained communication and exchange of idea and materials
- Applications
    - Understand connections to phytoplankton monitoring efforts
    - Learn the scope of what BOB as a platform for sensors can address
    - Discuss how BOB can be used for long term (~week) tidal monitoring, and alternative application, i.e. use in rice fields
    - BABs (Build a Buoy) elementary program beginning at the kindergarten level, where kids are building an observation buoy
- Technical
    - Sensors – what will work, what cost, what parameters, what size
    - Integrating information into the data portal
    - Resolve power sources - longevity issues, data communication

Where are we now?

The University of North Florida (Pat Welsh and Mike Toth) presented their instrumented buoy project that built upon the BOB idea, modified to collect EPA quality data. YSI was also an invited participant, and Kevin McClurg, a company representative, provided an overview of the technologies YSI had for sensor development and the expertise they can provide to the BOB efforts. The first evening ended with these presentations and a general discussion of BOB applications.

- Mike Toth – UNF – Presented on Pro-BOB, a water quality monitoring platform for collecting EPA quality data.
    - Send text alerts (cellular technologies) if parameters measured fall out of set limits (also has 900 mHz Free wave radio communication) using omni direction antennas (8db gain)
    - RF connectors were the most expensive part due to climate
    - Self sufficient solar power (2 ft by 2 ft ~ 15 lbs) & lightning protection
    - $12k for sensors & data sondes- YSI 6600 V2
    - Used Campbell scientific CR800 data logger (~$800) because that was what they had available- there are cheaper loggers out there
    - Lexan platform with an aluminum frame- need to change to a more flexible (bow board) so that it won't crack

- Kevin McClurg – YSI – presented on the various sensors available off the shelf. Lowest cost is approximately $1500. Sensors can be bought individually and added to a BOB for $100 each.
    - Sensors, wireless communication, underwater swimming platforms and much more for water quality monitoring
    - Carmanah – (www.carmanah.com) cheap hazard light- own battery & own solar power ($200)- Canadian company
    - For $1500 you can have 1 optical (DO, turbidity, etc) and temp, pH, conductivity depth are included – runs on 4AA batteries – From YSI
    - Copper tape can be added to lower priced systems to help extend deployment time
    - Anti fouling paint helps for about a week- just not as protective as the copper
    - Raw sensors cost about $100 , we could take raw sensors and incorporate into the BOB
    - Also have EcoNet, a service that provides an interface into the data.
    - Xbow sensors were introduced as a relatively low cost solution for water quality data observation collection (www.xbow.com).

Discussion Points:

- Cost Conscious - BOB's goal has always been $1000. BOB is an educational tool. There is value to having students figure out what sensors they need to place on a BOB, build it to the specifications, and figure out how to interpret the data. "Bad" data are a good opportunity. It helps in learning limitations.
- There is a differentiation between collecting high quality data and creating a learning experience.
- Security Issues - Need ideas for securing our BOBs
    - Mark with "high voltage" (not supported by BOB group) or university property
    - Communication to campus security
    - Deploy underwater when possible, attached to pier or dock
    - Engage community in the BOB project recruit ownership and security through involvement

Testing the Sensors

The morning of the second day of the workshop consisted of reviewing the various sensors available and testing their capabilities for BOB applications. Sensors were deployed in an aquarium, flow-through seawater system, and off the UNC-W dock in the Intracoastal Waterway. This section provides an overview of the variety of sensors tested as well as outcomes and issues.

Pasco Sensors

Deployed off dock and recorded in 10 min intervals
Testing: pH, Conductivity, DO, and Water temperature
Deployed in aquarium
Testing: pH, Conductivity, DO
Summary: Using DataStudio, we tried to import data from flash drive. It did not work from flash drive, so we imported directly from BOB. Data fairly consistent with other sensors. Rain did have an impact because the sensors were high up in the water column. Use data in excel typically.

NOTE REGARDING ACCURATE DO MEASUREMENTS: It seems like letting it go into sleep mode and then wake up to take samples has no negative effect on the readings. I don't know who said that it was a problem, but I can't reproduce it. So like Doug Levin said, just set the auto shut off time to 60 minutes and set the sampling time to something less than 60 minutes and it should work fine. It will go into sleep mode but it will wake up to take a reading. My tests show that the readings stay stable doing it this way, if someone finds differently let me know. (Mike Toth, UNF)

PASCO with accelerometer

Typically sits on top of a buoy, tested on a desk
Measures: x, y, z acceleration and altitude (~ waves)
Summary: Flow is measured in feet per second, and records 20 samples per second. Need to zero out acceleration due to gravity.
Applications: Analyze wave traffic generated by recreational boat activity to see impacts of creek erosion. Can also add turbidity sensors and/or conductivity and/or light sensors.
Issues: Propellers get clogged in estuarine systems.

PME T-chain thermistor array

Deployed in bucket in room in two water temperatures
Testing: DO and Pressure (depth)

6 -series YSI Datasonde

Deployed off dock and recorded in 5 min intervals
Testing: pH, Conductivity, DO, Water temperature, Turbidity, Chlorophyll, Blue green
Summary: Use a cable to display to computer and use EcoWatch (freeware on the Web site) to view tabular and graphical display. Technical error -- We did not rename files so there was no data collection.

Vernier

Deployed in aquarium, **Testing**: DO
Deployed in flow through tank; **Testing:** Salinity, pH, Water temperature
Summary: Designed for educational purposed and great for routine sampling. Calibration (other than DO) holds up for a week. Download of data is through a micro USB port. Use LoggerPro is freeware to show graphical and tabular data.

Issues: Too much interference – cannot have two probes close together due to internal and physical interference. This would not work well in a BOB system, but you can measure from beginning of dock to the end to see trends. $300 for handheld $100-150 a probe, approximately $800 for a system.

Overall Discussion Point: Should think about adopting a standardized calibration spreadsheet.

Data Portal Discussion

There is currently a beta version of a BOB data portal developed by UNC-W . Xiaoyan Qi provided a demonstration of the portal and initiated a good discussion of portal needs. Participants provided ideas for feedback generated on the various components.

Units of Measurement of the various parameters (e.g., salinity, temperature)

Need for standardized data (units, etc) for "interoperatability"

- Biologist may prefer salinity might be in parts per thousand o/00 or for chemists in mg/l or molarity; engineers might be in normality or metric units
- Temperature could be in C or F units
- We may need to have a conversion calculator for certain parameters on the website

Metadata

Metdata "data about the data" is critical for the long term value of the data. This includes date, time and place, units, standards, instruments, calibration, evaluation of maintenance (quality of data taken). Collecting metadata allows data to be archived with some assurance of quality so that we can predict trends based on past information.

Tiered Data

Differentiation for level of data quality. It is up to the input person to identify the level of quality assurance and make sure that really bad data obviously is checked and flagged. BOB data fits under "citizens science" information; it can be used to alert state/county/researchers to take additional measurements at this site.

- Tier 1 for research. If BOB uses Tier 1 instruments such a the YSI 6 series, then it is EPA quality.
- Tier 2 for BOB or Citizens Monitoring Information.

BOB Data Portal Overview

Example of other relevant data portals developed by UNC-W.

- CORMP – displays real time buoy data, meteorological and wave rider buoys. Users can choose parameters and download or visualize data as well as compare multiple spectrum with multiple buoys.
- Carolina RCOOS – includes NERRS, NWS, NDBC integrates all of the CORMP data. Also has comparison capabilities.

BOB Data Portal

The current data portal is built on GoogleMaps. Users can graph and compare data. To add data, you need a user login provided by Xiaoyan.

FieldScope by National Geographic

Suggestions for upgrades:

- Need to cover all of southeastern region and up through MD/VA.
- When you Login, you should be able to add data, edit data, and provide metadata for a station -- station name, lat long, times, weather narrative, sensor types, operator and contact info.
- Upload data page should list stations with deployment history and also integrate collection of metadata.
- Instructions

- Remind users they need to look at data before going in too far to able to define number of parameter columns.
- Uploading data - note that CSV files are necessary.
- Unit of measurement must align with parameter
- Default temps it to be loaded in centigrade and display numerous ways.

Discussion Points:

- Metadata is critical and we may need some training as a group.
- The next BOB workshop should focus on the data.

Sustaining BOB Collaboration

Current BOB Status

- January 2009 BOB I Workshop
    - Focused on platform design. PASCO sensors were given to 7 participants.
    - Information about BOB I is found on the COSEE SE website: cosee-se.org
- BOB Club has been formed at Beaufort High School. At the Sea Island Science Fair (regional for science and engineering) BHS won first in their division.
- BOB incorporated into undergraduate and graduate courses at UNC-Wilmington
- University of North Florida developed the "Pro-BOB" and presented at an international conference (ONR/MTS Buoy Workshop) in Monterey March 2010
- Jacksonville University uses it in an Intro marine science project
- Mary Baldwin College NOAA Bay Watershed Education and Training (B-WET) project in land use and water quality for teacher education working with Governor's School. Researching application in rivers. One student reaching out to 4th graders to do baby BOBS. Integrates with buoybay.org.
- UNC W Marine Quest Summer Education
- Citadel is testing applications for rice impoundments
- Kennesaw State is working with Hilton Head Prep and Discovery Museum to implement BOB program
- Old Dominion University B-WET - Building BOB in Western Branch of Elizabeth River
- Presentations: NMEA, MTS Oceans '09 (Lundie Spence, Doug Levin, Quint White), CERF (Quint White), Proceeding MTS Journal, Coastal Legacy Summer 2010 , ASLO 10 (Lisa Adams)
- March 2010 BOB II Workshop
    - Focus on Sensors. PASCO is acceptable tool for sensors; with limitations, but excellent data for short periods.

The Future of BOB

- Sensor Research Needs
    - R&D for cell phone communication of data
    - Testing for vandalism avoidance and gunshots
    - For longer term and better data consider YSI applications ($1,500 for 6 series)
    - Research ONSET HOBO and Cross bow as middle range sensors as well.
- Education - New angles with BAB for elementary school age kids
- Building the Community
    - Web Presence for BOB Community
        - Via SECOORA Web Site , Data Portal, Facebook following
        - Blog - http://bob-buoy.blogspot.com/
- Future Workshops
    - BOB I and II for Florida area 2010 or 2011 (Ask SECOORA for funding 10-13K)
    - Symposium on investigations and new applications of BOB and ocean observing 2010 or 2011
- Funding
    - BOB Bucks: Sea Grant, SECOORA, CSC NASA Space Grant
    - UNF wants to propose BOB as part of the SECOORA IOOS FY 2011 at the level of 200K

Idea Generation -- Notes

South Carolina
Research tool has potential in quiet waters. Continuous monitoring with students and High School Teachers; Charleston
Build a community of high school and undergraduate partners: Could partner Beaufort High School and Hilton Head Prep and have a raffle for instruments.
Teacher engagement from state. To add diversity, present at SCABSE Myrtle in Jan/Feb and include the Elliot Smalley Charleston School District.

Portsmouth Education Community CHROME

Florida
St Johns Rivers has 70 Tributaries there is simply not enough water quality data for assessment. Idea is to get monitoring into tributaries through Volunteer BOB Programs in Schools coordinated by JU and UNF Hubs

Extension Nationwide
Use the example of the Rhode Island Youth Watershed Council. This group used aerial flights to see connections of rivers to sea. Getting young people involved and using the RiverKeeper as the hub. Use of video and multimedia critical to raise awareness.

Rationale for identifying which sensors are important. Diurnal cycle, (middle school) Decisions on intervals of data taking, correlations,
Meaningful Watershed Educational Experiences definition helped to define an investigation in Chesapeake Bay Tamra is sending definitions. Cape Fear River Watch Organization should set up the water shed.

Sensor for turbidity: Light sensor PASCO above water; underwater sensor needs some investigations flow through turbidity clear acrylic tube with light sensor sealed inside. PASCO relative number for water clarity that correlates light with turbidity—problem of fouling. Jeremy is going to ask Kevin about DO YSI sensors.
UNC CH Alex Dean BOB and BAB
USF

MTS 10 Seattle early September Booth

Publication in Current Journal of Marine Education; there is anecdotal, is it really effective; what is the efficacy; Dan and Tamra evaluation component BEG BIG
What is the pre-assessment treatment question from LISA and GA
Academic Magnet High School with Citadel BOBs Mrs. Katherine Metnzer-Roop Maybe BOB Club
Nosiette Creek In the marine science class.
Local Weather Station with data
Water temperature for bass masters
One small competitive education proposal and grants; SECOORA or EPA
YSI $25,000 grant check with for next year;

Next STEM (ROV, BOB), now AUV
AUVs in the Bay for applications, kits
UNF Pat and Mike ATV forRapid Storm Assessment (hunting vehicle) HD cameras gps locations , position and time two tornado results connections with NASA
Kites in technology education (satellite data) and glider with 15 cameras on the glider, false color for moisture, heat
Rice Fields
http://www.citadel.edu/computing/mm/test/cb/survey/berkeley/kittredge/fields/field1.html

Appendix A: Basic Observation Buoy BOB II Workshop Agenda

Wednesday , March 17, 2010
Ameristay Inn & Suites at 5600 Carolina Beach Road, Wilmington, NC 28412
UNC-W Center for Marine Science at 5600 Marvin K. Moss Lane, Wilmington, NC 28409

3pm-5pm Hotel and Center for Marine Science
Participants check in to hotel and travel to Center for Marine Science

5pm-6pm Center for Marine Science
Informal Greetings and Expectations (Lundie Spence and Doug Levin)
"What are we doing here? What are our intentions?"
Informal around the room introduction of "Who's doing what, where & why?" (All)
Participants that brought BOBs set them up, and any sensors (either in BOBs or separate) start calibration and check.

6pm-7pm Catered dinner at Lab (pizza, etc.)

7pm-9pm Where are we now?
Industry representatives introduce themselves/hands-on demonstrations of sensors
Building collaborations and sharing "BOB War Stories" – Why BOB? (All, facilitated by Lundie)

Thursday , March 18, 2010
UNC-W Center for Marine Science at 5600 Marvin K. Moss Lane, Wilmington, NC 28409

9am-10:30am Testing the Sensors
Meet and deploy sensors with and without BOB platforms off dock for about 3-5 hours

10:20am-12pm Sensor Discussion (All, facilitated by Doug Levin and Industry Reps)
What is a successful BOB?
Address current technical issues (from BOB I workshop) and identify solutions and/or next steps
Brainstorm future sensor needs and identify related applications; develop a quick rubric to assess qualities of the various sensors that are being tested and are known.

12pm-1pm Catered lunch at Center for Marine Science

1pm-2pm Return sensors to lab

2pm-5pm Data Portal Discussion (ALL)

Download data to laptops

Demo of Data Portal - load data collected (Jen Dorton and Xiaoyan Qi)

Discussion of the ease of use of data portal and detail potential enhancements and upgrades

Brainstorm other opportunities for sharing data and information related to BOB amongst participants

Brainstorm relation of this workshop and its objectives to SECOORA and other RAs

6pm until Meet for dinner at Rucker Johns (5564 Carolina Beach Rd)

Friday , March 19, 2010

UNC-W Center for Marine Science at 5600 Marvin K. Moss Lane, Wilmington, NC 28409

9am-12pm *Sustaining this collaboration* (ALL, facilitated by Lundie Spence and Doug Levin)

Review the results from sensor testing and complete rubric assessment

Develop "next step" plan for building and sustaining a BOB community

Develop a plan for extending BOB training to formal and informal education leaders and for undergraduate faculty in regional colleges and universities.

Develop proposal for exhibition/demonstration booth at Oceans 2010

Evaluation and Wrap Up Comments

Appendix B: Basic Observation Buoy BOB II Workshop Participants

Name	Organization	Email
Doug Levin	NOAA Chesapeake Bay Office	doug.levin@noaa.gov
Ashton Wheeler	Beaufort High School	
Brittany Baker	Beaufort High School	
Kinsler Mack	Beaufort High School	kbmack@islc.net
Angela Bliss	COSEE SE	acbliss@uga.edu
Lundie Spence	COSEE SE	lundie.spence@scseagrant.org
Lex Waters	Jacksonville University	lwaters2@ju.edu
Quint White	Jacksonville University	qwhite@ju.edu
Lisa Adams	Kennasaw State Univ	ladams@kennesaw.edu
Tamra Willis	Mary Baldwin College	twillis@mbc.edu
Terri Kirby Hathaway	NC Sea Grant	terrikh@csi.northcarolina.edu
Dan Dickerson	Old Dominion University	ddickers@odu.edu
Megan Treml	SECOORA	megan.treml@gmail.com
Joe Kelley	The Citadel	joe.kelley@citadel.edu
John Black	The Citadel	
Jeremy Burnett	University of North Carolina Wilmington	Burnettj@uncw.edu
Joe Oliver	University of North Carolina Wilmington	jao7670@uncw.edu
Jennifer Dorton	University of North Carolina Wilmington	dortonj@uncw.edu
Michael Toth	University of North Florida	totm0001@unf.edu
Pat Welsh	University of North Florida	pwelsh@unf.edu
Kevin McClurg	YS I incorporated	kmcclurg@ysi.com

Appendix C: Workshop Evaluation Summary

1) 1. Did you attend the BOB I Workshop January 2009?
    a. Split basically in half -- half were at BOB I and for the other half BOB II was first workshop experience.

2) If yes, what sort of activities have you done that extended that workshop?
    a. Communicated with other BOB I collaborators
    b. Presentations about BOB as a science application (where)
        i. OCEAN 2009 and CERF Portland
    c. Presentations about BOB as an STEM education application (where)
        i. OCEAN 2009 and CERF Portland
    d. Outreach to local community (please describe, e.g., Ocean Day Fair or open house)
        i. Integrated into professional development workshop
        ii. demo to teachers workshop in Spring 2009
    e. Engaged graduate or undergraduates in BOB design or in course
        i. Undergraduate courses in ocean observing field methods
        ii. High school students
        iii. Partnered with local high school
        iv. MSC101- UG course
    f. Other:
        i. Developed and presented a more advanced BOB
        ii. Introduced local agencies to BOB design

3) What was the main reason to participate in BOB II?
    a. Understand the sensors
    b. Expose students to professionals

4) Please provide some assessment of your experience in BOB II.
    a. Location -- many comments on the wonderful Marine Science Center
    b. Agenda -- could have been 2 full days, would not have spent so much time on the website.
    c. Outcome -- great connections, BOB II was even better in terms of efficiency/productivity than BOB I, many new project ideas, renewed interest

5) Do you think that you can use a BOB and sensors in a quiet water monitoring study? Please describe whether for research or education as major use.
    a. to compare to other study locations
    b. as an educational supplement to research
    c. research

6) BOB II was focused on sensors and data reporting.
    d. Which sensors, if any, meet your needs?
        i. YSI optical DO, CTD
        ii. Pasco does not have quality
        iii. YSI products

iv. Thermistor
v. YSI - secure and seemingly reliable DO measuring
vi. PASCO met budget, YSI met dreams
vii. PASCO
viii. PASCO works in some situation
ix. YSI particulars and PASCO accelerometer

e. If no sensors that you have experienced meet your needs, what would you want?
    i. Problems with battery life, calibration, visibility, vandalism issues

f. What are your suggestions for the web site for loading data? How to improve or use or share?
    i. Advertise it!
    ii. Keep it simple
    iii. Make it easy to use
    iv. Integrate metadata

7) BOB II is a regional workshop from VA, MD, NC, SC, GA, FL. Would you be willing to host a sub regional workshop recruiting for either science or education applications? What support would you need to coordinate a BOB workshop?
    g. There were many yes's! Funding, logistical assistance, and contacts were primary needs identified to coordinate a workshop.

8) Other comments for workshop coordinators and SECOORA?
    h. Consider involving aquariums
    i. Great facilitation and discussion
    j. Link BOB to other ideas like ROVs
    k. SC2 would be a good conference to share with teachers