

OUTFALL MONITORING SCIENCE ADVISORY PANEL (OMSAP)
Workshop on technical options for monitoring the MWRA outfall
Wednesday May 19, 2004 10:00 AM - 3:00 PM
Woods Hole Oceanographic Institution, Quissett Campus, Carriage House

DRAFT MINUTES

ATTENDANCE

Bob Beardsley (WHOI, OMSAP, co-chair), Judy Pederson (MIT/Sea Grant, OMSAP, co-chair), Wendell Brown (U. Mass. Dartmouth), Brad Butman (USGS), Todd Callaghan (MCZM), Rich Camilli (WHOI), Cathy Coniaris (MADEP), Mark Dennett (WHOI), Winnie Donnelly (MADEP), David Dow (NMFS), Paul Dragos (Battelle), Scott Gallagher (WHOI), Rocky Geyer (WHOI), Al Hanson (URI), Mingshun Jiang (U. Mass. Boston), Jim Kremer (U. Conn.), Wendy Leo (MWRA), Scott Libby (Battelle), Matt Liebman (EPA), Kevin McClurg (YSI, Inc.), Mike Mickelson (MWRA), Curtis Olsen (U. Mass. Boston), Rob Olson (WHOI), Neal Pettigrew (U. Maine), Josie Quintrell (GoMOOS), Andrea Rex (MWRA), Collin Roesler (Bigelow Lab), Heather Saffert (URI), Larry Schafer (retired), Heidi Sosik (WHOI), Myron Spaulding (Aanderaa Instruments), Ajit Subramaniam (Columbia U.), and Dave Taylor (MWRA).

MINUTES

Purpose of Meeting – Bob Beardsley (WHOI)

As requested by the Outfall Monitoring Science Advisory Panel at their October 2003 meeting, the Massachusetts Water Resources Authority (MWRA) has convened a group of experts to discuss the goals, issues, technologies, and costs of augmenting MWRA's ambient monitoring with continuous water quality monitoring and additional use of satellite data. Workshop discussion and conclusions will be provided to the OMSAP. OMSAP may then recommend further evaluation, or may recommend implementation of specific technology (for example adding chlorophyll sensors to the existing GoMOOS mooring off Cape Ann, or providing USGS mooring data in real-time). Some recommendations could be implemented later in 2004.

MWRA Monitoring Requirements – Mike Mickelson (MWRA)

M. Mickelson outlined MWRA's monitoring requirements. MWRA requires that their monitoring use commercially available sensors and platforms that have known cost and proven performance. The practical duration of a technical option could be long-term or short-term, as appropriate.

A technical option would be have special merit for MWRA if it could:

1. Reduce or contain costs
2. Provide some advantage over current methods
3. Answer a testable monitoring question
4. Address a key feature
5. Speed the availability and dissemination of data
6. Help explain extreme events, including threshold exceedances
7. Provide early warning of extreme events and potential threshold exceedances

M. Mickelson then outlined the monitoring questions that MWRA monitoring is designed to address and key features observed by the monitoring in Mass Bay (for more information, see MWRA's workshop briefing).

Long-term monitoring in Massachusetts Bay: 1989-present – Brad Butman (USGS)

B. Butman presented Mass Bay long-term monitoring results. He described the moorings that collect(ed) data in Massachusetts Bay. Site "A" has been collecting data from 1989 to the present and is located near the Boston Approach Navigation Buoy about 1 km southeast of the MWRA outfall. Site "B" was deployed from 1997 to 2004 off of Plymouth. The Gulf of Maine Ocean Observing System (GoMOOS) has been collecting data from their GoMOOS "A" mooring south of Cape Ann from 2001 to the present. NOAA 44013 is a mooring that was previously located near Site "A" but is now further southeast and has been collecting data from 1993 to the present.

Site "A" has instruments that measure salinity, temperature, pressure, light transmission, and currents (Acoustic Doppler Current Profiler). There are also sediment traps and a camera. Site "B" was outfitted with an ADCP and a sediment trap. Data are recorded *in situ* and processed upon recovery. Experimental telemetry through an acoustic link was successful at Site "B", however, telemetry at Site "A" has not been successful because of noise interference from the Boston Buoy. A surface buoy is probably not feasible at Site "A" because it is in the middle of a major shipping lane. Optical sensors become fouled so anti-fouling measures need to be taken. Sensors are less fouled near the bottom where they can be deployed for about four months at a time. B. Butman then summarized other USGS measurements in Mass Bay. For more information go to: <http://woodshole.er.usgs.gov/>.

Sensors: nutrients – Al Hanson

A. Hanson described research he has been involved with using nutrient analyzers at sea. He then reviewed various commercially available instruments that fall into four different categories.

1. Fixed depth: Can be cabled or autonomous and can be used from a boat, dock, pier, or moored buoy.
2. Vertical profiles: Ship-deployed vertical profiler (CTD) or autonomous moored vertical profiler (IOPC).
3. Horizontal profiles: Underway shipboard sampling system.
4. Horizontal and vertical profiles:
 - a. Ship-deployed towed undulating vehicle: Acrobat (URI, WET Labs, SubChem), and Nu-Shuttle (NMFS).
 - b. Autonomous underwater vehicle (AUV): propeller (i.e. REMUS – URI, UMASS, NUWC), Glider (i.e. Slocum glider – WHOI, Rutgers), and drifters/floats.

A. Hanson then reviewed new submersible analyzer technologies: the SubChemPak Profiling Analyzer, the Autonomous Profiling Nutrient Analyzer, the SubChem Analyzer Payload for REMUS, the WET Labs Cycle (Moored Nutrient Analyzer), and the SubBio Analyzer (Bacterial Indicators).

A series of submersible chemical analyzers have been developed and are being utilized for the measurement of various chemicals from multiple oceanographic platforms. The novel electro-fluidic and optical detection technologies enable high-resolution chemical sensing in real-time at trace concentration levels. The submersible analyzer technology is being adapted for cabled shipboard deployments on

vertical profilers and towed vehicles and for remote deployments on AUVs, gliders, moorings, and moored profilers.

Sensors: oxygen – Paul Dragos

P. Dragos described the shipboard CTD profiles conducted by the MWRA. Through 2003, there were 17 surveys per year and 48 stations throughout Boston Harbor, Massachusetts and Cape Cod Bays. CTDs used were Seabird and Ocean Sensors and dissolved oxygen (DO) sensors used were Beckman, YSI, and SeaBird Model 43.

He then described the sensors on the USGS and GoMOOS moorings that have been collecting DO data in Massachusetts Bay. USGS Mass Bay Mooring “A” has been collecting data since 1989 (DO since 2001) throughout water column using Seabird 43 and new Aanderaa Optode Sensors. GoMOOS “A” has been collecting data since 2001 including DO throughout water column using Seabird 43 Sensors.

In 2002, the Seabird 43 DO data were found to be lower than other DO measurements and it was discovered that the Seabird 43 needed to be pumped longer to get rid of build-up within the instrument. Increasing the pumping time seems to have solved this problem.

He summarized by saying that dissolved oxygen sensor technology improving, however, though the Seabird 43 is an improvement, it has to be pumped longer on moored deployments, and optodes are an optical technology and therefore, calibrations still need to be run. DO sensors on moorings provide the temporal coverage and show short-term variability, however, biofouling is a problem. Telemetry, redundant systems, and contingency plans are needed to increase mooring reliability.

Sensors: phytoplankton and productivity – Collin Roesler

C. Roesler described the GoMOOS’s real time hourly reporting buoy array. She also described how phytoplankton biomass, community structure, and productivity are measured using sensors. Phytoplankton biomass is measured using either chlorophyll fluorescence or chlorophyll absorption. Phytoplankton community structure can be measured using spectral absorption or by examining size structure. Phytoplankton productivity can be estimated by using light/chlorophyll models, light/absorption models and photochemical quenching. She believes that robust technology exists for real time *in situ* observations of phytoplankton biomass and production. This technology requires in-house calibration/characterization, and pre/post calibrations to assess biofouling. There is redundancy for each parameter as well as a range of bio-optical products that are operational.

Integrated Sensor Systems: The Autonomous Vertically Profiling Plankton Observatory – Scott Gallager

S. Gallager described recent innovations in long term sensor deployment in arrays. Issues to consider are: reliability, self-calibration, fouling, power efficiency, cost, and environmental impact.

He then described recent work using an autonomous vehicle to study plankton and other parameters (including conductivity, temperature, depth, light absorption and attenuation, downwelling irradiance, upwelling radiance, and fluorescence). Plankton are measured using a Video Plankton Recorder (VPR) that records digital images for taxonomic composition analysis. S. Gallager showed data from the 2001 and 2002 three-month deployments over Stellwagen Bank.

He then proceeded to outline suggestions for the research community:

1. Accelerate development of miniaturized analytical and molecular systems using Micro Electro Mechanical devices (MEMS) and microfluidic technologies but maximize robustness, long-term reliability, sensitivity, resistance to fouling, novel methods of sample preparation, common interface.
2. Integrate multiple sensors into instruments and high-density arrays to address specific questions and increase functionality (e.g. carbon cycling- pCO₂, DIC, POC, pH, microbial biosensor, plankton abundance, temperature, conductivity, u, v, w).
3. Develop a sensor coordinating committee to advise funding agencies, science users, and engineers on issues in 1 and 2. Use NASA sensor development program as model and operate under ORION.

For more information go to the following link for materials from the workshop entitled: The Next Generation of *in situ* Biological and Chemical Sensors in the Ocean
http://www.whoi.edu/institutes/oli/activities/symposia_sensors.htm

Summary of Discussion

The group then discussed technical options for MWRA monitoring. Someone mentioned the Frye Package. K. McClurg said that YSI in the process of commercializing this instrument and it has not been officially named yet. This is a vertical profiling device that sits on the seafloor and can carry up to 2 CTD-sized devices. The target battery length is 6 months and this instrument can be used in coastal waters up to 50m deep. He also mentioned another instrument by YSI that is currently commercially available. This is a surface-mounted winch vertical profiling device that can be attached to things like pilings, pontoons, and oil rigs. It can be used in waters up to 100m deep and can do up to one profile per hour.

B. Beardsley suggested that one option for MWRA could be to fund the addition of instruments that measure biological parameters (e.g. phytoplankton) to the GoMOOS mooring off of Cape Ann. It would also be useful to add a DO sensor at the bottom. C. Roesler suggested a buoyancy-driven package which uses much less power and does about one profile per day.

K. McClurg suggested that MWRA could perhaps work with the Coast Guard to replace the Boston Buoy with a less noisy one so that data could be telemetered from Site "A". This has been done at other locations (e.g. U. Southern Florida). B. Beardsley and B. Butman thought that was a very good idea. B. Butman added that if the Coast Guard replaces the buoy with a newer model, then they would not have to service it as often.

C. Olsen asked if there is a better location to add a mooring. R. Geyer suggested a location in the nearfield 0.5-1 km from the diffusers, but not in the zone of initial dilution. Someone noted that effluent would take about two hours to flow that distance. C. Olsen pointed out that a bloom takes about a day to form so 1 km away from the outfall may not be far enough. C. Roesler said that since the GoMOOS mooring is collecting data upstream of the outfall and these data are used in the modeling, model results should be able to tell us where to put a mooring downstream of the outfall.

D. Dow thinks that the location of a new mooring should be chosen based on episodic events such as low DO and nuisance/harmful algal blooms. Someone asked about the status of the GoMOOS model. N. Pettigrew said that the GoMOOS model is a circulation model. A biological model is currently being developed. It can successfully pick up blooms off of Nantucket Shoals but not near the coast (the model predicts higher chlorophyll for nearshore areas than what is actually measured).

R. Geyer thinks that MWRA should invest in technology that looks for subtle long term ecosystem changes. A. Rex said that some of that is already done with the collaborative USGS/MWRA project. J. Pederson thinks that there should be a state coastal monitoring/research effort but since the likelihood for this is not good, perhaps if we can provide a list of questions, then collaborative efforts with organizations such as MITSG, USGS, and others can fund such work.

R. Geyer suggested that the first step is to make sure the basics are covered – temperature, salinity, DO, light transmission, photosynthetically active radiation (PAR), and fluorescence. P. Dragos suggested that the problems with data telemetry be worked out. J. Kremer suggested that nutrients be added to the list after year three or four of the study.

The group then discussed biomass and flow at the outfall. B. Butman said that net mean flow is zero at the outfall. M. Jiang added that over the long term, there is a net flow downstream of the outfall. J. Kremer thinks that if a small stock of phytoplankton is stimulated to grow by nutrients, it would take about a week for a bloom to form. C. Roesler suggested adding a biomass measurement at the GoMOOS “A” mooring (off of Cape Ann). Since this is already being measured at the GoMOOS “B” mooring (between Portland, ME and Portsmouth, NH), this would give us an idea of biomass growth rates. C. Olsen suggested that pCO₂ be added to the list of parameters measured so that we have an idea of how much atmospheric CO₂ is being sequestered.

B. Beardsley then summarized the workshop. Today we heard about new technologies and the group discussed suggestions for MWRA monitoring. Some ideas include: collaborating with the Coast Guard to replace the Boston Buoy so that USGS/MWRA can telemeter data from Site “A” back to land; using winches to collect vertical profiles; and adding instruments to the current moorings.

ADJOURNED

MEETING HANDOUTS:

- Agenda and MWRA briefing packet