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

MINUTES

Purpose of Meeting – Bob Beardsley (Woods Hole Oceanographic Institution)

At their October 2003 meeting OMSAP requested that MWRA (Massachusetts Water Resources Authority) conduct this workshop: to convene 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 (Massachusetts Water Resources Authority)

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 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

MWRA's workshop briefing lists the monitoring questions that must be addressed, and the key features that must be captured by MWRA's water column monitoring.

Long-term monitoring in Massachusetts Bay: 1989-present – Brad Butman (US Geological Survey)

B. Butman described how 15 years of results from long-term moorings in Mass Bay have addressed USGS program objectives:

1. Understand transport and long-term fate of sediments and associated contaminants.
2. Document infrequent catastrophic events.
3. Provide observations for development and testing of numerical (sediment-transport) models.
4. Document interannual changes in currents, hydrography and suspended sediments.
5. Coordinate with MWRA outfall permit monitoring plan.

The USGS Site "A" (1989-present) is located near the Boston Approach Navigation Buoy about 1 km southeast of the MWRA outfall. USGS Site "B" (1997-2004) was deployed off of Plymouth but has been removed. Two non-USGS moorings provide supplemental data: the GoMOOS "A" mooring (2001-present) located south of Cape Ann, and the NOAA buoy 44013 (1993-present) was previously located near USGS Site "A" but is now further southeast.

USGS 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. USGS Site "B" was outfitted with an ADCP and a sediment trap. Data are recorded *in situ* and processed upon recovery at 4-month intervals. Experimental telemetry through an acoustic link was successful at Site "B"; however, acoustic 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. Transmissometers, fluorometers, and conductivity sensors require special anti-fouling measures. Sensors are less fouled near the bottom and can more readily survive the four-month deployment. B. Butman then summarized other USGS measurements in Mass Bay. For more information go to: http://woodshole.er.usgs.gov/.

B. Butman identified ideas and opportunities but cautioned that it is important to decide what observations are needed to test specific hypotheses:

1. Develop partnerships to develop a "Massachusetts Bay Ocean Observatory".

2. Telemeter and distribute the data through existing infrastructure.
3. Increase measurements throughout the water column.
4. Measurements at the upstream boundary for modeling.

Sensors: nutrients – Al Hanson (University of Rhode Island & SubChem Systems, Inc.)

A. Hanson and colleagues have used novel electro-fluidic and optical detection technologies to develop a series of *in-situ* submersible chemical analyzers to study thin plankton layers, steep nutrient gradients, fine-scale chemical variability, and chemical plumes of oxygen, pH, nitrite, and iron.

The chemical analyzers work well on moving platforms for rapid sampling, but power and reagent consumption limit deployments to a couple of days. In general, moored chemical analyzers are still in development, although one optical nitrate sensor is fully operational.

Sensors: oxygen – Paul Dragos (Battelle)

MWRA's monitoring team has shipboard experience with three brands of dissolved oxygen (DO) sensors (Beckman, YSI, and SeaBird Model 43) in conjunction with two brands of CTD (Seabird and Ocean Sensors). It has been valuable to compare shipboard and moored DO data. USGS Mass Bay Mooring "A" has been collecting data since 1989, and began using the newer types of DO sensors (Seabird 43 and Aanderaa Optode) in 2001. GoMOOS "A" has been collecting data since 2001 including DO at 50-m depth using a Seabird 43 DO sensor.

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.

Although dissolved oxygen sensor technology is improving, there are caveats. The Seabird 43 has to be pumped longer than expected on moored deployments. The Aanderaa Optode needs no pumping because it does not consume O2, but being optical instrument it may still be sensitive to fouling. We need to gain more experience with the Optode in real applications to determine its sensitivity to fouling and overall reliability.

Moored sensors provide good temporal coverage and reveal short-term variability, but biofouling is one of the attendant problems. Telemetry, redundant systems, and contingency plans are needed to increase mooring reliability.

Sensors: phytoplankton and productivity – Collin Roesler (Bigelow Laboratory)

C. Roesler described GoMOOS' 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 (Woods Hole Oceanographic Institution)

S. Gallager described recent innovations in long-term sensor deployment in arrays and new concepts for integration of many types of simultaneous measurements into an operational observatory. 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 Next Generation of *in situ* Biological and Chemical Sensors in the Ocean" http://www.whoi.edu/institutes/oli/activities/symposia_sensors.htm and "The Autonomous Vertically Profiling Plankton Observatory" http://4dgeo.whoi.edu/vpr/.

General Discussion

The group then discussed technical options for MWRA monitoring.

Pop-up mooring. Real-time data acquisition requires a surface radio antenna, but the surface is hazardous in the shipping lane. A bottom-mounted profiler would be less exposed in shipping lanes because it is rarely at the surface. S. Gallager's profiler is bottom mounted with heavy winches from Deep-Sea Systems Inc but that platform is not off-the shelf. YSI is in the process of commercializing a bottom-mounted profiler based on another WHOI design http://www.ciceet.unh.edu/bulletins/geyer.html. K. McClurg said that the YSI vehicle would rest on the seafloor except when profiling and can carry two CTD-sized devices. The target battery length is 6 months and this instrument can be used in coastal waters up to 50m deep. (Surface-mounted profilers are of course commercially available, for example YSI's profiler traverses 100m at hourly intervals.) C. Roesler mentioned that a variable-buoyancy feature could reduce a profiler's power requirements.

Use existing big buoys. The existing USCG "B" buoy and NOAA's buoy 44013 survive in the shipping lane. Either could provide a mount for a surface radio antenna if underwater acoustic telemetry were effective. The "B" buoy however is too noisy. K. McClurg suggested that MWRA work with the Coast Guard to replace the Boston Buoy with a less noisy one so that data could be telemetered from USGS Site "A". This has been done at other locations (e.g. U. Southern Florida http://comps.marine.usf.edu/). 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 the USCG would not have to service it as often (such servicing tends to break fragile equipment).

Move out of the shipping lane. 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 (60m). 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). W. Brown stressed the importance of combining observations with model results.

R. Geyer thinks that given the subtle effects of the outfall, 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.

Partnerships. 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. 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.

Sensors. 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. J. Kremer suggested that nutrients be added to the list after year three or four of the study.

Processes. 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 a larger area, there is a net flow downstream of the outfall. J. Kremer thinks that if a small stock of phytoplankton were 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. A. Subramaniam supported this idea by describing temporal coupling in SeaWiFS chlorophyll between those buoy locations. C. Olsen suggested that pCO_2 be added to the list of parameters measured so that we have an idea of how much atmospheric CO_2 is being sequestered (and thus seek DOE funding).

A. Hansen suggested that MWRA fund a "white paper" to further develop these technical options.

Summary. B. Beardsley then summarized the workshop. Today we heard about new technologies and the group discussed suggestions for MWRA monitoring.

The telemetry problem could potentially be solved by: (1) collaborating with the Coast Guard to replace the noisy Boston Buoy, (2) using a bottom-mounted profiler, or (3) moving out of the shipping lane.

Augmenting existing moorings with additional sensors - GoMOOS A, USGS - biooptics package, nutrients.

Promoting collaborative efforts and seeking additional funding.

ADJOURNED

MEETING HANDOUTS:

- Agenda and MWRA briefing packet TechnicalOptions-briefing.pdf

PRESENTATIONS

1Mickelson-20040519.pdf
2Butman-20040519.pdf
3Hanson-20040519.pdf
4Dragos-20040519.pdf
5Roesler-20040519.pdf
6Gallager-20040519.pdf

OUTFALL MONITORING SCIENCE ADVISORY PANEL (OMSAP) MEETING
Monday, September 27, 2004, 10:00 AM to 2:00 PM, WHOI

MINUTES

AGENDA TOPICS

- 2004 winter flounder lesions
- Monitoring update
- 2004 *Phaeocystis* exceedances
- Update on 2004 Deer Island power failures

ATTENDANCE

Members Present: Bob Beardsley, WHOI; Norb Jaworski, retired; Bob Kenney, U. Rhode Island; Judy Pederson, MIT/Sea Grant (chair for this meeting); Mike Shiaris, U. Mass Boston; and Juanita Urban-Rich, U. Mass Boston.

Observers: Don Anderson, WHOI; Dave Borkman, U. Rhode Island; Peter Borrelli, Center for Coastal Studies; Mike Bothner, USGS; Todd Callaghan, MCZM; Cathy Coniaris, MADEP; David Dow, NMFS; Dave Duest, MWRA; Bruce Estrella, MADMF; Patty Foley, Save the Harbor/Save the Bay; Maury Hall, MWRA; Carlton Hunt, Battelle; Mingshun Jiang, U. Mass Boston; Chris John, MWRA; Ken Keay, MWRA; Wendy Leo, MWRA; Scott Libby, Battelle; Matt Liebman, EPA; Megan Lim, Save the Harbor/Save the Bay; Stormy Mayo, Center for Coastal Studies; Mike Mickelson, MWRA; Michael Moore, WHOI; Tara Nye, Association to Preserve Cape Cod; Andrea Rex, MWRA; Steve Rhode, MWRA; Jack Schwartz, MADMF; J. Smith, MCZM; and Steve Tucker, Cape Cod Commission.

MINUTES

OMSAP approved the October 21, 2003 meeting summary with no amendments.

2004 WINTER FLOUNDER LESIONS

M. Moore presented data from winter flounder monitoring conducted by MWRA, MA Division of Marine Fisheries (MADMF), and National Marine Fisheries Service (NMFS). From 1979-1983, NMFS observed a low prevalence of winter flounder skin ulcerations in Eastern Massachusetts Bay (0.1%) and greater Boston Harbor (0.07%). Between 2002-2003, MWRA, NMFS, and MADMF observed between 6-24% of winter flounder sampled with skin ulceration in western Mass Bay and at Deer Island Flats. In 2004, MWRA, NMFS, and MADMF expanded their spring 2004 surveys. They used a consistent protocol for identifying and scoring lesions among agencies. Histopathology was conducted to look for infectious and non-infectious agents. Aerobic and anaerobic bacteria were cultured from tissue samples and identified taxonomically. MWRA sampled the Outfall Site, Deer Island Flats, Nantasket Beach, Broad Sound, eastern Cape Cod Bay, and four other MWRA stations (FF09, FF14, FF01A, FF11). In addition, MWRA conducted (in June 2004) and will conduct (September and December 2004, and February 2005) supplemental surveys at Deer Island, the outfall site, and Broad Sound to monitor changes in prevalence over time.

M. Moore then compared 2003 and 2004 results.

Station	Apr. 28-30, '03	Mar. 2 – May 2, '04	June 23, '04
outfall site	24 % (n = 50)	36% (n = 50)	14% (n = 50)
Broad Sound	16% (n = 50)	12% (n = 50)	0% (n = 48)
Nantasket Beach	6% (n = 50)	30% (n = 50)	6% (n = 16)
eastern CCB	0% (n = 50)	0% (n = 50)	not sampled
Deer Island Flats	20-27% (n = 15)	22% (n = 50)	0% (n = 50)

M. Moore described the bacteriological results. Overall, no major fish pathogens were recognized and many fish tissue samples contained multiple organisms (both healthy skin and lesion samples). The bacteria were largely background species normally found in seawater, with some opportunist and probiotic (from aquaculture operations) species. No viral, mycobacterial, or fungal infections were identified in tissue samples.

M. Moore then described previous flounder studies. A migration study by Howe and Coates in 1975 showed that winter flounder north of Cape Cod moved short distances to deeper water to avoid warm summer temperatures. In 1963, a migration study by McCracken found that winter flounder north of Cape Cod move to deeper, warmer water in mid-winter, possibly to spawn. A laboratory study by Robohm and Brown in 1978 found that flounder with physical skin traumas that break the scale barrier can develop ulcerogenic infections. A study of a Baltic flounder skin ulcer disease by Wiklund in 1994 isolated atypical *Aeromonas salmonicida*, but this pathogen was not isolated here in Mass. Bay.

M. Moore presented additional information about this phenomenon. The highest ulcer prevalence is in northwestern Mass. Bay, extending 50 km east-southeast. Individual fish with lesions were found in Cape Cod Bay, off of Cape Ann, off of Portland, and near Cape Sable, Nova Scotia. Lesions were found on the blind side of the flounder, suggesting that contact with the sediments plays a role. There has not been a measured general increase of contaminants in nearfield (or farfield) sediments since the outfall has gone on-line. Lesion data suggest that this phenomenon is seasonal, with a peak in the late winter/early spring, healing lesions during the summer months, and a rarity of lesions observed in the fall. There are many seasonal and interannual factors that could hypothetically be associated with the occurrence of the lesions. For example, biological changes in flounder during the spawning season, seasonal precipitation, sediment resuspension and transport, interannual climate variations, and undetected changes in effluent chemistry.

M. Moore recommends several actions. He suggests that the trawl surveys continue until next spring to assess ulcer prevalence with time; that MWRA continue to quantify the prevalence and severity of the lesions during April 2005 flounder monitoring studies; that MWRA continue to cooperate with state and federal fisheries agencies and scientists to evaluate the condition; and that MWRA further evaluate the long-term USGS mooring, sediment trap, and surficial sediment data for seasonal or interannual changes in sediment quality, either natural or anthropogenic, that might be related to the syndrome.

The group then discussed the results. M. Shiaris asked if they measure how stressed the fish are. M. Moore feels that the physiology of stress, and the markers used to measure stress, are susceptible to artifacts, especially since the fish becomes extremely stressed when caught. N. Jaworski asked if the bacteriological data show a seasonal pattern. M. Moore does not know if there is a seasonal pattern in the bacteria since they have not had lesions to sample in the fall. Also, nothing to date shows that bacteria are causing the lesions. M. Bothner asked if it would be possible to look for a chemical signal in both the sediments and fish tissue. M. Moore said that there are a variety of laboratory studies that could be done to look for linkages, and an ulceration model could be developed, but it would be a significant investment without the promise of a great return.

J. Pederson wondered if some sort of abrasion is the cause of the lesions, then what sort of trauma could affect a large population. M. Moore replied that abrasions could be caused either physically or chemically, but in this case, he doubts that it is physical. N. Jaworski asked if there is any connection with the flounder lesions here and the striped bass lesions found in Chesapeake Bay. M. Moore replied that the striped bass have mycobacteriosis. This does not seem to be the primary infectious agent in the winter flounder. D. Dow asked if they noticed any patterns in the age of the flounder and lesions. M. Moore replied that all fish sampled by MWRA were greater than 30 cm long, so they were adults. D. Dow suggested that perhaps smaller fish are escaping through fishing nets and getting injured in the process. B. Beardsley asked about

station locations. D. Dow replied that NMFS chooses stations to sample fish randomly. J. Pederson added that MADMF uses the same approach. K. Keay noted that there are some areas that are never sampled because the trawl nets would be damaged by rocks.

T. Callaghan asked if we know whether flounder with healed lesions are able to feed and reproduce normally. If this is the case, then are we overly concerned about this seasonal lesion occurrence? M. Moore replied that we could study this in the laboratory, but based on other studies, he doe not believe that the lesions are negatively affecting the flounder. T. Callaghan asked if the lesions are purely external. M. Moore replied that they do find striated muscle tissue where there are lesions, but the biggest problem is that the lesions are visually distasteful to consumers. M. Lim asked if it would make sense to conduct a survey with broader geographical coverage, and she also asked how we know that the lesions are really healing. M. Moore replied that more data are always useful, but based on what we have seen, he does not see a need to increase the number of stations. In terms of whether the flounder are healing and surviving the lesions, this would require a laboratory experiment, and that introduces a whole new set of issues.

M. Liebman asked if lesions could occur without some sort of abrasion. M. Moore replied if so, then it would have to be caused by a new type of fish pathogen that we have not seen before. M. Shiaris asked if mycobacteriosis has definitely been ruled out. M. Moore replied yes.

OMSAP then reviewed M. Moore's list of recommendations (see above). M. Moore said that he would like to see the Broad Sound station kept, at least through next year, because it has been a historically interesting station. N. Jaworski asked how much public interest there is regarding this issue. M. Moore replied that the Boston Globe considered writing an article on this, but decided not to when it appeared that the lesions were healing. M. Shiaris said that a migration study would give us some insight on the flounder population. N. Jaworski asked why there is no recommendation to further analyze bacteria temporally and spatially. M. Moore replied that they have looked at the available data carefully. The next step would be a microbiological ecology study, and that would be a difficult and expensive endeavor. B. Beardsley said that he would also be supportive of some sort of migration study. M. Moore said that previous studies have clearly shown that winter flounder do not have to migrate far in this area to avoid temperatures greater than 15 degrees Celsius.

P. Foley asked whether OMSAP felt that this was an important enough issue to bring to the attention of the public. J. Pederson thinks that as of now, it is difficult to be able to say anything to the public about what is causing the lesions, whether it is a public health concern, and whether it is affecting the health of the fish. N. Jaworski asked what the commercial fishermen do with flounder with lesions. M. Moore replied that recreational fishermen probably throw them back, but commercial fishermen will sell them since flounder is sold as fillets. He added that MWRA has been very responsive in funding the extra studies to find out more about what is causing the flounder lesions, but he feels that we still should not rule out the outfall as one of the potential causes of the outfall.

P. Foley asked for more feedback as to what to tell the public. C. Hunt suggested that what can be discussed is that we have identified lesions on winter flounder during the early spring. No one has found out what is causing these lesions, but they are being monitored and studied. M. Moore and M. Shiaris added that flounder with lesions are not harmful to eat. J. Pederson agreed with the general feeling of the group – that it is difficult to figure out what is causing these lesions, and that it is also difficult to convey this problem to the public. She summarized that OMSAP members agree that there are still steps that need to be taken regarding the flounder lesion investigations and they also agree with M. Moore's listed recommendations.

MONITORING UPDATE

M. Mickelson summarized the OMSAP-recommended, and MWRA-sponsored workshop entitled: "Workshop on technical options for monitoring the MWRA outfall" on May 19, 2004 at Woods Hole. The workshop was chaired by OMSAP members J. Pederson and B. Beardsley and attended by experts in mooring technologies from throughout New England [for a draft workshop summary, go to: http://www.epa.gov/region01/omsap/pdfs/MooringSummary.pdf]. The presentations covered the latest mooring platforms, sensors, and telemetry. We learned what other groups are doing, as well as what technologies are available now "off the shelf", and which technologies are still in the development phase. Workshop attendees recommended that additional optical and dissolved oxygen sensors be used on the current moorings in Mass. Bay. They felt that though nutrient sensors show promise, the technology should not be implemented for a few years. The group also made suggestions regarding the USGS mooring. They felt that it should be replaced with a larger buoy or with a pop-up buoy (that stays out of the way of ships), or completely moved out of the shipping channel where it is currently located. M. Mickelson then listed what MWRA has been doing since this workshop. They have been working with the Gulf of Maine Ocean Observing System (GoMOOS) to add instruments to the GoMOOS' Cape Ann mooring. MWRA has also been working with USGS to work through the telemetry problem that they have been having with the USGS mooring. New dissolved oxygen and fluorescence sensors have also been purchased.

D. Dow added that difficulties with data analysis were also discussed at the meeting. There are tremendous amounts of data being collected, and it is difficult to translate these data to managers. We need to make sure that we look at this aspect too. B. Beardsley agreed. J. Pederson pointed out that the goal of the workshop was to look at new technologies and see if MWRA's current outfall monitoring could be augmented so that we could learn more and better understand the dynamics of the outfall in Mass. Bay. B. Beardsley noted that on October 8th, 2004, there will be a Northeast Ocean Observing workshop hosted by WHOI. NSF has a project called Orion that will develop various observatories, one of which is an ocean observatory and this effort is helping to bring groups together.

N. Jaworski asked whether this workshop considered what MWRA should be measuring in the future (e.g. flame retardants, MTBE, etc.). M. Mickelson replied that this workshop focused on nutrients, dissolved oxygen, and physical oceanography. A. Rex added that the issue of what contaminants should be measured in wastewater is currently being reviewed on a national level and MWRA is following any new developments. B. Beardsley asked if USGS is doing any work on this. M. Bothner replied that USGS currently measures inorganics only, but it would be helpful to archive samples for future analysis. For example, techniques are being developed to measure flame retardants, but the USGS is not analyzing for these kinds of chemicals at this time. N. Jaworski agreed to put together a list of chemicals of concern that are not currently measured in wastewater effluent.

2004 *PHAEOCYSTIS* EXCEEDANCES

S. Libby described the nearfield *Phaeocystis* Contingency Plan thresholds and 2004 bloom. MWRA's Contingency Plan includes seasonal *Phaeocystis* caution level thresholds based on pre-outfall baseline conditions. The winter/spring threshold is 2,020,000 cells/L and in 2004, the seasonal mean was 2,870,000 cells/L. The summer threshold is 357 cells/L, and in 2004, the seasonal mean was 164,000 cells/L. S. Libby then compared the 2004 nearfield bloom to previous years; listed the types and quantities of phytoplankton in the nearfield measured from February to June 2004; showed 2004 region-wide phytoplankton bloom development in Massachusetts and Cape Cod Bays using satellite photographs; and showed the distribution of *Phaeocystis*, with the highest concentrations in Boston Harbor. This was the largest *Phaeocystis* bloom observed by MWRA monitoring and was simultaneously measured throughout western Gulf of Maine, including Boothbay Harbor, Maine and Narragansett Bay, Rhode Island, albeit at lower abundances than those seen in Massachusetts and Cape Cod Bays. There are no indications of adverse impacts from this bloom. Zooplankton abundance was low, but within the baseline range. In particular, *Calanus finmarchicus* was not affected, and right whales were observed feeding in Cape Cod Bay during the bloom. The bottom

water dissolved oxygen was relatively high into early September (>8 mg/L). There were no aesthetic nuisances reported, and there is no obvious association between the magnitude and duration of the bloom with the MWRA outfall. *Phaeocystis* continues to be evaluated on an ongoing basis. There are a number of factors that need to be investigated further. For example:

- Why does *Phaeocystis* bloom or not bloom?
- What controls the magnitude and duration of the blooms? Temperature may influence duration.
- *Phaeocystis* blooms play a complex ecological role (bloom dynamics are inter-related with diatoms, zooplankton, temperature, biomass, and production).
- The outfall may have a localized influence on the magnitude and duration of the *Phaeocystis* bloom due to the increased availability of ammonium, a higher dissolved inorganic nitrogen to silicate ratio, and lower oxidized nitrogen to reduced nitrogen ratios.

OMSAP then discussed these results. N. Jaworski noted that there has been some work looking at temperature and *Phaeocystis* blooms in estuaries. S. Libby said that they have not looked at that work, but they could examine the MWRA data to see if there is a temperature correlation. M. Shiaris asked if anyone has done any laboratory experiments to study *Phaeocystis* physiology. S. Libby replied that there have been microcosm experiments that studied *Phaeocystis* ammonium uptake and found that they can outcompete diatoms when ammonium concentrations are elevated.

D. Dow asked if they have any ideas as to why *Calanus* abundances and the right whale feeding behavior were not affected by this large *Phaeocystis* bloom. S. Libby said that he did not know because there are so many factors that can affect whether right whales enter and feed in Cape Cod Bay. S. Mayo added that it is clear that if the zooplankton are there, the right whales will come to feed. This year was probably the first in 20 years when there was a strong *Phaeocystis* bloom, and nothing unusual occurred with the zooplankton abundances. The Calanoid abundances were a little low, and bloomed a little late, but they did coincide with *Phaeocystis*. D. Dow suggested that temperature measurements taken by NOAA to study the North Atlantic Oscillation could be used to compare to *Phaeocystis* data to see if there is a correlation.

B. Beardsley asked if *Phaeocystis* is present in Mass. Bay even when it is not in bloom. He also asked if blooms are advected into Mass. Bay, or form locally. D. Borkman replied that *Phaeocystis* has two main life forms – colonial and unicellular. The unicellular form is not always identifiable. M. Mickelson added that the unicellular forms would be classified as unidentified microflagellates and these are always present in low numbers. D. Borkman commented that it is difficult to quantify *Phaeocystis* between blooms because the ambient monitoring plan is designed to measure blooms. B. Beardsley said that it seems like *Phaeocystis* is ubiquitous since blooms are region-wide.

M. Liebman asked to be reminded of the *Phaeocystis* and zooplankton relationship. S. Libby said that some believe that *Phaeocystis* is unpalatable to zooplankton (which prefer diatoms). Others believe that zooplankton do well feeding on *Phaeocystis*, while others still believe that zooplankton feeding on *Phaeocystis* have lower fecundity. In addition, the gelatinous *Phaeocystis* colonies are believed to interfere with zooplankton patch formation that right whales love to feed on.

D. Anderson feels that this is similar to *Alexandrium*, in that the ambient monitoring plan is not designed to answer questions about nuisance blooms in low concentrations. It may take a special study to examine these questions further. B. Beardsley asked if MWRA stores archived samples. S. Libby did not think that archived samples could be counted for *Phaeocystis*. D. Borkman added that the iodine-based preservative only preserves the cellular structure for about a month. M. Shiaris asked if there has been any molecular work done on *Phaeocystis*. D. Anderson replied that he thinks that this is something that could be done.

C. Hunt believes that micronutrients, especially complexations of metals, may affect *Phaeocystis*. B. Beardsley asked if MWRA is looking at micronutrients. S. Libby replied no. B. Beardsley thinks that MWRA should consider measuring whether *Phaeocystis* is in Mass. Bay in low quantities year-round, as well as examining factors that may trigger *Phaeocystis* blooms such as micronutrients.

UPDATE ON 2004 DEER ISLAND POWER FAILURES

D. Duest described the power outage events at the Deer Island Treatment Plant (DITP) on April 3 and 11, 2004 [for detailed descriptions of both events, go to: http://www.mwra.state.ma.us/harbor/pdf/20040403_power.pdf and http://www.mwra.state.ma.us/harbor/pdf/20040411_power.pdf].

D. Duest then outlined MWRA's corrective actions to date.

- MWRA retained two electrical engineering consulting firms to audit and review the two incidents.
- MWRA retained an electrical testing firm to test all battery backup systems at the DITP.
- MWRA staff has performed a thorough investigation of all systems involved in the events, independent of the consulting firms.
- Repairs were made to major equipment that either failed during the events or were damaged as a result of the failure. The facility was also cleaned up after the power outages.
- NSTAR replaced the leaking roof on their building that began the cascade of events on April 3.
- MWRA changed their maintenance procedures for testing battery backup systems at the DITP to identify issues before they become problems.
- In August, MWRA performed a follow-up black start test for the thermal power plant systems.
- Staff performed a detailed analysis of all potential pump station single-point of failure mechanisms that may occur.
- MWRA is continuing to work on implementing almost all of the 61 recommendations by the consulting firms.

N. Jaworski asked if there were a major power failure throughout the New England grid, what would MWRA do at Deer Island. D. Duest replied that MWRA would activate one or two combustion turbine generators located on Deer Island depending on the need. He said that on August 20th, both A and B buses went down, but there were no south system or Winthrop terminal headworks flow interruptions. The flows at North Main did go to zero but all power and flow were restored within 10 minutes. Deer Island routinely experiences 2-3 power "blips" per year. C. Coniaris asked if MWRA conducted the black start scheduled for last week. D. Duest replied that they postponed the exercise because they should perform these types of tests during dry weather (because of lower flows going through the treatment plant).

D. Dow asked about the increased storage that MWRA has agreed to build, and when it will be ready. D. Duest replied that MWRA will build a storage tunnel under South Boston. During storms, this increased storage capacity will significantly reduce CSO discharges to Dorchester Bay beaches. A. Rex said this project is scheduled to be completed in 2011 for South Boston beaches, and 2017 for Reserved Channel.

ADJOURNED

MEETING HANDOUTS:

- Agenda
- October 2003 draft OMSAP meeting summary
- November 2003 Public Interest Advisory Committee meeting summary
- May 2004 Workshop on technical options for monitoring the MWRA outfall meeting summary
- MWRA information briefings

Summary prepared by C. Coniaris. Post-meeting comments are included in [brackets]. All such comments have been inserted for clarification only. They do not, nor are they intended to, suggest that such insertions were part of the live meeting components and have been expressly set-off so as to avoid such inference.