OUTFALL MONITORING SCIENCE ADVISORY PANEL (OMSAP) MEETING
Tuesday, August 8, 2006 10:00 AM to 2:00 PM, WHOI, Woods Hole, MA

MEETING SUMMARY

AGENDA TOPICS

- 2005 and 2006 *Alexandrium* bloom
- Model Evaluation Group report
- Endocrine disruptors in Boston Harbor and Massachusetts Bay
- Update on enhanced instrumentation on moorings
- MWRA/DITP performance during the Mother's Day flood of 2006
- Report on trace contaminant monitoring in DITP effluent 2000-2005
- Winter flounder lesion update

ATTENDANCE

Members Present: Bob Beardsley, WHOI; Norb Jaworski, retired; Scott Nixon, U. Rhode Island; Judy Pederson, MIT/Sea Grant (acting chair); Mike Shiaris, U. Mass Boston; Jim Shine, Harvard School of Public Health; and Juanita Urban-Rich, U. Mass Boston.

Observers: Eric Adams, MIT; Don Anderson, WHOI; Bruce Berman, Save the Harbor/Save the Bay; Peter Borrelli, Center for Coastal Studies; Jeanine Boyle, Battelle; Brad Butman, USGS; Todd Callaghan, MCZM; Ellie Baptiste Carpenter, Battelle; Mike Delaney, MWRA; Dave Duest, MWRA; Maury Hall, MWRA; Kodie Harold, public; Mingshun Jiang, U. Mass Boston; Ken Keay, MWRA; Yong Lao, MWRA; Ben Lasley, SH/SB; Scott Libby, Battelle; Matt Liebman, EPA; Mike Mickelson, MWRA; Andrea Rex, MWRA; Larry Schafer, MWRA WAC; Jack Schwartz, MADMF; Ray Siegener, META Environmental, Inc.; Rich Signell, USGS; Steve Tucker, Cape Cod Commission/Mass. Bays Program; Cathy Vakalopoulos, MassDEP; and Lauren Thirer Wexler, SH/SB.

MEETING SUMMARY

OMSAP approved the August 11, 2005 meeting summary with no amendments.

2005 AND 2006 *ALEXANDRIUM* BLOOMS

D. Anderson compared the 2005 and 2006 *Alexandrium* blooms. The 2005 bloom was the largest bloom on record, encompassing the western Gulf of Maine (GOM) south to Nantucket, Martha's Vineyard, and Buzzards Bay. Many areas experienced record shellfish toxicity levels. This bloom also caused shellfish toxicity for the first time in many areas, mostly in the southern section of the bloom. The 2006 bloom was substantially shorter in duration and smaller in size, with less extensive shellfish bed closures in Massachusetts and Cape Cod Bays than in 2005.

There are three factors that are hypothesized to have contributed to the magnitude of the 2005 bloom: (1) high concentrations of *Alexandrium* cysts in the western GOM sediments; (2) northeast winds that caused a strong onshore advection of the *Alexandrium* population; and (3) increased river runoff which increased alongshore transport and also provided large amounts of nutrients. These hypotheses were tested by running their nested physical/biological numerical model for *Alexandrium* bloom dynamics in the GOM. However, this model did not take into account the increased nutrient concentrations from river runoff. D. Anderson described the model results and lessons that were learned. The high abundance of cysts in the western GOM

was a dominant factor in the 2005 bloom. Wind forcing played a key role in transporting the bloom into the southern GOM and Massachusetts Bay sooner in the year. Runoff enhanced alongshore transport but did not affect the Gulf-wide distribution. This model is a useful management tool. D. Anderson hypothesized that we have entered a "new regime", with high and frequent toxicity in the western GOM.

After the 2005 *Alexandrium* bloom, sediment surveys were conducted to see if the bloom deposited cysts in new areas. Remarkably, there does not appear to be a southward expansion of cyst beds. The two main beds are still in the Bay of Fundy and the western GOM.

D. Anderson is currently involved in a large five year regional research program. Unfortunately, the Massachusetts Bay *Alexandrium* work remains unfunded.

P. Borrelli asked why is there so much variability in the western GOM cyst abundances when the Bay of Fundy cyst abundances are more consistent. D. Anderson replied that there was an unusual bloom in the western GOM in the fall of 2004 that deposited new cysts. B. Butman asked how deep in the sediments do they sample. D. Anderson replied three to five centimeters. Cysts will not germinate under anoxic conditions. Most of the cysts that germinate are in the top three centimeters. B. Butman asked why blooms initiate near the coast when there are also cyst beds offshore. D. Anderson replied that in March, the cysts in shallower areas within the coastal current germinate. B. Beardsley added that winds that cause upwelling conditions must also help the cells come to the surface. He asked how long does it take for cysts in waters 100 meters deep to reach the surface. D. Anderson replied that they have not measured this, but the cells swim and move with the currents. R. Signell asked if they need to obtain detailed cyst maps to improve the model. D. Anderson replied that sampling such a large area is difficult, but it is important information. Instead of mapping all of GOM, they are focusing on "hot spots". J. Shine asked if these are the only cyst maps. D. Anderson replied that these are the most extensive cyst maps. S. Nixon asked if they also record the sediment properties. D. Anderson replied that they have only done this for one cyst map since it is very time consuming. J. Schwartz asked if the May 2006 flooding affected the bloom. D. Anderson said that they think it did. J. Schwartz asked how micronutrients affect the blooms. D. Anderson believes that they may influence blooms, along with humic substances in river runoff.

B. Beardsley pointed out the cyst bed in the western GOM in 2004. There was a large bloom in 2005, yet there wasn't a major bloom in 2004. He asked how a cyst bed forms. D. Anderson replied that we do not know. Blooms and cyst bed formation do not seem to fit a predictable pattern. B. Beardsley asked if they have modeled the fall yet. D. Anderson replied no, but they plan to.

J. Pederson asked whether the data from 2005-2006 are comparable to 1972. D. Anderson replied that there were no cyst maps back then, Massachusetts did not know that a bloom was on its way, and when it arrived, they just closed all shellfish beds. He thinks that the 1972 bloom measurements are meaningless. However, there are problems with the 2005 data because once an area was closed, it was not re-sampled.

S. Libby then discussed whether or not the outfall plays a role in *Alexandrium* blooms. Based on data from 1972-2000, it was hypothesized that there could be an outfall effect if shellfish in the South Shore of Massachusetts became toxic before (or more toxic) than shellfish on the North Shore. In the 2005 bloom, shellfish toxicity and *Alexandrium* cell abundance was greater on the South Shore. So was this an outfall effect? S. Libby showed the atypical meteorological conditions that pushed GOM waters into Massachusetts Bay and areas to the south. The 2006 bloom pattern was similar to 2004, however, one station in Cohasset (on the South Shore) had higher values than the north. This will be examined in more detail as more data become available.

Overall, the MWRA outfall does not appear to be associated with the *Alexandrium* blooms on a regional level. Both the 2005 and 2006 blooms were followed as the progressed from the north to the south. A local effect of the outfall is difficult to assess in the 2005 bloom, due to the magnitude of the bloom. However, at the completion of the bloom, as cell abundances dropped dramatically, there was not apparent outfall effect prolonging the bloom around the outfall. In addition, nutrient concentrations from the outfall were not significantly different from other years, conditions were very well mixed in the nearfield in May, and in June stratification kept nutrients below the pycnocline. However, further work is needed to more closely examine relationship between nutrients and *Alexandrium*. Conditions were different in 2005 and 2006, and there is no evident localized outfall effect, however ongoing data analyses and modeling are continuing to evaluate this question.

N. Jaworski asked whether cell abundance and toxicity are linearly related. D. Anderson replied that they are not, that it depends on the nutrients. The cells have less toxin if they are limited by nitrogen and phosphorus. It is not a simple function of cell numbers. N. Jaworski asked if they plan to evaluate this further. S. Libby replied yes. D. Anderson added that the model does take nutrient limitation into account since cells form into cysts when they are nutrient limited. They plan on running the model with the outfall "on", and the outfall "off", as well as examine toxin vs. nutrients in the toxin sub-model. J. Shine asked if silicate and diatoms affect blooms. D. Anderson replied that the model does not have that level of ecosystem dynamics. R. Signell added that the model was designed to look at bloom initiation. Perhaps the model can be modified to examine cyst formation too. D. Anderson said that it is difficult for this model to "turn off" blooms well. Bloom termination is now being addressed with nutrient limitation and grazing. M. Liebman asked if micronutrients from the outfall could be modeled. D. Anderson replied that it may be possible. M. Liebman asked how well does that model predict salinity. D. Anderson replied that though the model does well with salinity, it is not able to model to the level of detail of freshwater from the outfall.

MODEL EVALUATION GROUP REPORT

E. Adams, chair of the Model Evaluation Group (MEG), reported to OMSAP on the MEG meeting that convened on September 12, 2005. For the MEG meeting summary, recommendations, membership, and attendance, go to: http://www.epa.gov/region01/omsap/omsapm.html. Overall, the MEG felt that the Bays Eutrophication Model ("the model"), which consists of a coupled hydrodynamic and water quality model, seems to be working. The MEG agreed that the modeling efforts should continue and that collaborations among scientists that use the model should be encouraged. The MEG provided recommendations to the modelers, many of which have been implemented.

S. Nixon said that he is always skeptical when modelers say that a model is working well. He feels that it is healthy to always question the model. He thinks that the MEG had a good discussion at their meeting, but he doesn't think that the MEG discussed the future role of the model and its strengths and weaknesses enough. He feels that there needs to be more time dedicated to wrestling with these issues.

J. Shine asked how important the role of the sediments is in the modeling. E. Adams thinks that they could be important in the modeling, but since the MEG spent time reviewing U. Mass. Boston's work since taking over the model, they did not have time to discuss sediments in depth.

S. Nixon thinks that grazing seems to be an issue and that perhaps a grazing component should be added. J. Shine asked why should we model if there is already so much monitoring data being collected. E. Adams replied that the modeling helps fill in the spatial and temporal gaps. With more years' worth of modeling runs, we gain more experience with the model. M. Jiang added that they are trying to move the model in a

new direction by developing a forecasting model and a finer resolution model for Boston Harbor and the outfall area.

J. Urban-Rich said that knowing what the value of the model is to MWRA will help guide what goes into it. R. Signell gave an example of how the model could be important to MWRA. He said that if there is a low dissolved oxygen event in Cape Cod Bay, U. Mass. Boston could run the model with and without the outfall to see what effect the outfall has on the low dissolved oxygen. A. Rex noted that the model was able to successfully predict the increase in dissolved oxygen and the decrease in chlorophyll in Boston Harbor.

S. Nixon and J. Pederson recommended that OMSAP and the MEG meet together to discuss the model's strengths, weaknesses, and future direction.

ENDOCRINE DISRUPTORS IN BOSTON HARBOR AND MASSACHUSETTS BAY

R. Siegener presented research conducted with Dr. Bob Chen (U Mass Boston) on the distribution of several environmental endocrine disruptors, overall estrogenic activity, and caffeine (as a tracer) in Boston Harbor and Massachusetts Bay. The research goals were to: determine which compounds are being discharged in the DITP treated effluent, measure activity, and degradation. Due to the low concentration of EEDs in the marine environment, caffeine was examined as a surrogate. R. Siegener then described the study methods, sewage sample analysis, extraction and degradation results. Results indicate that 4-nonylphenol is the major EED entering the marine environment. Estimates of estrogenic activity are an order of magnitude lower with the new outfall due to the increase in dilution, and are below observed effects levels. Though caffeine concentrations fluctuate in Boston Harbor, it appears to be a good tracer of water soluble contaminants, since its concentration decreases with increased salinity.

The group then asked questions about the research. S. Nixon asked if there has been work done on tracers for septic system contamination. R. Siegener thinks that this work was been proposed by others. M. Liebman asked what the most active EED was. R. Siegener replied estrone, though it is not commonly found.

UPDATE ON ENHANCED INSTRUMENTATION ON MOORINGS

M. Mickelson updated the group on MWRA's investigation into enhancing continuous monitoring on moorings in Massachusetts Bay. The best option is to add sensors to the National Data Buoy Center's (NDBC) Buoy 44013 due to the fact that is an already existing platform, data telemetry, web availability of data, and its relative safety out of shipping lanes. It is a weather buoy that is also used as a navigation buoy and is located at the Boston end of the shipping traffic separation zone. It is also near MWRA nearfield station N07 at a water depth of 55m. The buoy measures weather conditions, sea surface temperature, and waves. In the fall of 2006, the buoy will be replaced with one that also measures surface salinity, chlorophyll fluorescence, and dissolved oxygen. It will also measure salinity at 5, 10, 18, and 28m and include an Acoustic Doppler Current Profiler (ADCP).

B. Beardsley commented that measuring shortwave radiation would be critical information when studying the biology. Longwave radiation measurements would also be useful. S. Nixon asked if the buoy is close enough to MWRA station N07 to be able to compare data. M. Mickelson replied yes. B. Berman asked about servicing. M. Mickelson replied that the buoy is switched out every two years and the sensors are serviced every four months. The group then discussed the ADCP. B. Butman thinks that they will have a problem with the ADCP during storms since it is not going to be placed on the bottom. M. Mickelson said

that he would like to work on this issue with B. Butman. J. Pederson added that if this effort is successful then continuous monitoring could eventually replace some shipboard monitoring and hopefully other researchers could add additional sensors to further increase data collection.

MWRA/DITP PERFORMANCE DURING THE MOTHER'S DAY FLOOD OF 2006

D. Duest presented information on the performance of the Deer Island Treatment Plant (DITP) and MWRA sewer system during May and June 2006, the wettest two consecutive months on record at the Logan Airport weather station. In May 2006, there was 12.48" of rain and in June 2006, there was 10.09" of rain. There was massive flooding in areas north of Boston and power outages that caused sewer line breaks and treatment plants to go off-line.

D. Duest described the pre-emptive steps that MWRA took, in anticipation of the storms. MWRA activated their Emergency Operation Center, issued community advisories, increased staffing at all facilities, and operated DITP's back-up generators in the event of a power failure. During the May 2006 rain event, DITP experienced sustained flow rates greater than one billion gallons a day for over 84 hours. During the June 2006 rain event, DITP experienced sustained flow rated greater than one billion gallons a day for over 30 hours. Though there was an increase in stress on the equipment and staff, overall, the DITP performed well, even though most plant flows were broken, there were no interruptions in power, and all effluent standards were met.

B. Butman asked about the high total suspended solids (TSS). D. Duest replied that these are the effluent data. The TSS in the influent is much higher. Also, the sewage is more difficult to treat when it is more diluted, and when flow to secondary is doubled, there is a risk of losing the bacterial biomass responsible for secondary treatment. N. Jaworski asked approximately how much sewage was lost to combined sewer overflows. A. Rex replied that this volume cannot be calculated.

M. Shiaris asked about building windmills at Deer Island. D. Duest replied that MWRA proposed building a few to help power the treatment plant, but so far the Federal Aviation Administration has denied this request due to the proximity to Logan Airport. J. Shine asked how much electricity is produced from the methane that is captured from the sludge digesters. D. Duest replied that 3.5 MW is produced from the methane DITP also has a 0.75 MW hydroelectric plant that captures the energy as the treated effluent drops down into the outfall tunnel.

REPORT ON TRACE CONTAMINANT MONITORING IN DITP EFFLUENT 2000-2005

M. Delaney presented data analyses from a report that is in preparation that examines trace contaminants in DITP effluent from August 2000 to July 2005. The parameters include trace metals, cyanide, pesticides, PCBs, PAHs, volatile organic chemicals, and semivolatile organic chemicals. MWRA used methods that were more sensitive than the MWRA-approved methods for pesticides, PCBs, and PAHs. Despite these low detection methods, there were many "non-detects" due to extremely low concentrations in the MWRA effluent. Most of the contaminants met the state Water Quality Standards even before taking the 70:1 dilution of the outfall into account. MWRA is required by its NPDES permit to measure PCBs as Aroclor mixtures, and thus PCBs were never detected. However, MWRA did detect a few PCB congeners. This finding is difficult to interpret due to the lack of PCB data in the ambient environment.

This report also compares percent blending of primary and secondary effluent versus contaminant concentrations. Though there is a positive correlation between the two, one caveat is that during wet weather

blending, the concentration of some contaminants increases, while the concentration of others decreases. This effect of changes in influent concentrations was not examined.

M. Shiaris asked if the increase in PAHs was related to precipitation and storm runoff. M. Delaney replied yes. B. Berman asked how the concentrations of organics in the effluent are affected by 100% blending versus 0% blending. M. Delaney replied that it depends on the chemical since some are readily biodegradable, while others, such as PCBs, are fairly resistant to treatment.

WINTER FLOUNDER LESION UPDATE

M. Hall briefly described the flounder monitoring program. There are six stations that have been sampled during the Outfall Monitoring Program. The stations are located at the Outfall Site, Broad Sound (recently discontinued), Deer Island Flats, off Nantasket Beach, farfield station FF09, and in Eastern Cape Cod Bay. M. Hall then showed prevalence over time in these areas. In 2006, lesions were still found on winter flounder, but with decreased prevalence. At the Outfall Site, 36% percent of flounder had lesions during the April-May 2004 survey, 14% had lesions during the May 2005 survey, and 2% had lesions during the April 2006 survey. M. Shiaris asked if there were any new clues as to the cause of the lesions. M. Hall replied no. S. Nixon asked if there was a pattern of lesion occurrence related to the size and age of the flounder. M. Hall replied that they sample three to six year old flounder and didn't see a pattern. MA Department of Marine Fisheries collected younger flounder in 2004 and did not find any lesions. B. Berman asked if the lesions later healed. M. Hall replied that they only sampled in April in 2006. Marine Fisheries had a later survey and only reported a few lesions. S. Tucker asked if there is mortality since there are no surveys later in the year to examine the healing of the lesions. M. Hall replied that they are not finding dead fish, nor have there been reports from others. K. Keay added that we are also not sure how long healed lesions are visible.

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MEETING HANDOUTS:

- Agenda
- August 2005 draft OMSAP meeting summary
- August 2005 draft Public Interest Advisory Committee meeting summary
- Information briefings

Summary prepared by C. Vakalopoulos.