An Introduction to Sedimentsheds: Sediment and its Relationship to Chesapeake Bay Water Clarity

STAC Workshop Report
January 30-31, 2007
Annapolis, MD

STAC Publication 07-002

About the Scientific and Technical Advisory Committee

The Scientific and Technical Advisory Committee (STAC) provides scientific and technical guidance to the Chesapeake Bay Program on measures to restore and protect the Chesapeake Bay. As an advisory committee, STAC reports periodically to the Implementation Committee and annually to the Executive Council. Since it's creation in December 1984, STAC has worked to enhance scientific communication and outreach throughout the Chesapeake Bay watershed and beyond. STAC provides scientific and technical advice in various ways, including (1) technical reports and papers, (2) discussion groups, (3) assistance in organizing merit reviews of CBP programs and projects, (4) technical conferences and workshops, and (5) service by STAC members on CBP subcommittees and workgroups. In addition, STAC has the mechanisms in place that will allow STAC to hold meetings, workshops, and reviews in rapid response to CBP subcommittee and workgroup requests for scientific and technical input. This will allow STAC to provide the CBP subcommittees and workgroups with information and support needed as specific issues arise while working towards meeting the goals outlined in the *Chesapeake 2000* agreement. STAC also acts proactively to bring the most recent scientific information to the Bay Program and its partners. For additional information about STAC, please visit the STAC website at www.chesapeake.org/stac.

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Cover photo of sediment plumes provided by Jeff Halka, Maryland Department of Natural Resources.

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Executive Summary

On January 30-31, 2007 the Chesapeake Bay Program's (CBP) Sediment Workgroup and the CBP's Science and Technical Advisory Committee convened a workshop titled: "An Introduction to Sedimentsheds: Sediment and its Relationship to Chesapeake Bay Water Clarity." Sedimentshed is a new concept, and is defined as the area that contributes the sediment which directly influences water clarity in near-shore Submerged Aquatic Vegetation (SAV) grow zones. For further explanation of sedimentshed, please see the recently released report available at www.chesapeakebay.net/pubs/FinalSedshedsReport.pdf. The twenty-six invited participants to the STAC workshop included technical experts in sediment, submerged aquatic vegetation (SAV) and water clarity and policy experts in state programs and total maximum daily load (TMDL) implementation.

Goals:

- To provide a forum to share important insights from all invited experts on sediment, its impacts on water clarity and SAV.
- To review and comment on the Sediment Workgroup's draft report "An Introduction to Sedimentsheds: Addressing Sediment and Its Relationship to Chesapeake Bay Water Clarity."
- To provide the Sediment Workgroup with focused guidance and next steps for addressing sediment impacts to Bay water clarity.

Conclusions:

1. Different types of sediment have different ecosystem effects, and should be regulated accordingly.
    a. Sand is a prerequisite for the establishment of healthy SAV beds. Sources of sand may need to be maintained rather than reduced.
    b. Silts are beneficial to marshes, though they also play a role in increasing turbidity.
    c. The smallest clay-sized materials are the most readily suspended and are the ones of most concern for water clarity. This type of sediment requires the most regulatory attention. This so-called **background, or continuously suspended sediment** is the least studied and least understood aspect of sediment dynamics in the Bay.

2. There appears to be a relationship between nutrient loading and the amount of small material (clays, algae and microscopic remains of organisms) that remain in suspension during the SAV growing season. This **background suspended sediment** appears to settle more slowly in a eutrophic system, exacerbating water clarity problems. Further reduction of nutrients coming into Bay waters may assist in reducing the background suspended sediment concentrations and increase water clarity.

3. SAV recovery and/or restoration require many factors besides decreased suspended sediments. Bottom sediment composition (especially sand content),

low to moderate dissolved nutrients, minimum bed dimensions, adequate recruitment, proper water temperature, and species appropriate to the local environment are among these factors. Some rapid SAV recovery is occurring in areas with high turbidity, which is not entirely understood.

4. We need to understand what has changed historically in the Bay to help determine appropriate management actions to improve water clarity to help restore SAV. In particular, why was the Bay ecosystem healthier in the past in spite of apparently equal or greater sediment loads from watershed sources? Examination of historic information could also be used to ensure the appropriate mechanistic processes have been included in the new 2007 CBP Water Quality model.

5. The 2007 CBP Water Quality model is much more advanced than the 2002 model. It is based on our current understanding of sediment transport and the relationship to clarity and SAV. It will be a useful tool to provide insight into sediment sources and transport processes in the Bay and help evaluate management scenarios to improve water clarity. However, it is still under development and will require significant verification, sensitivity testing, and adjustment before its predictions may be considered reliable. Some of the remaining questions for Sedimentshed delineation coincide with the testing needs of the model and therefore may be pursued simultaneously. The model should not be relied on exclusively; other research and management tools can offer insights that the model cannot. Historical and paleoecology investigations that correlate chronological onset of stressors and long-term trends of valued living resources and water quality conditions may offer a means to prioritize among these stressors.

6. The Sediment Workgroup (SedWG) created the foundation required to develop Sedimentsheds and advanced our understanding of sediment sources to the Bay. Using advanced statistical techniques, it identified similar segments of the Bay where excessive suspended sediments are causing water clarity impairment. Delineation of Sedimentsheds is not currently feasible with the available data sets, but it will be advanced through the use of the forthcoming CBP Sediment Transport model and possibly by sediment tracer studies using biological and geochemical sediment “fingerprints.”

Recommendations:

Workshop recommendations are organized in five categories: recommendations for further research, further analysis of existing data, 2007 Water Quality model, Sediment Workgroup action, and sediment management techniques.

1. Recommendations for further research

a. What controls the dynamics and abundance of the background suspended sediment load most responsible for surface water turbidity in shallow water SAV grow zones?

b. What are the specific sources of suspended sediment affecting nearshore SAV habitat in upper, middle and lower areas of the Bay? Consider targeted sediment tracer studies.

c. How do different shoreline stabilization techniques affect local SAV habitat quality?

d. When and where are other causes of SAV habitat degradation more important than suspended sediment associated turbidity?

e. Quantify the sediment trapping ability of the Estuarine Turbidity Maximum (ETM) for both fine grained and coarse sediment. Consider seasonal characteristics, especially the SAV growing season.

f. Determine if tidal tributaries are a source or sink of fine grained sediment to the Bay.

2. Recommendations for further analysis of existing data

a. Are there quantifiable trends in Bay surface water turbidity? Is there a seasonal cycle in background turbidity, and how does background turbidity vary spatially? Are long term trends quantifiable? If so, are the trends different in nearshore and offshore waters? Are there clear correlations between turbidity trends and SAV coverage? Both CBP monitoring data and historical data prior to initiation of regular CBP monitoring should be explored.

b. What is the relationship, if any, between nearshore turbidity and center-channel turbidity? Does lateral transport of suspended sediments allow for close connections, or are the two environments essentially independent, and under what conditions? Both the CBP monitoring program databases and separately funded studies can be brought to bear on this issue.

c. Analyze recently acquired nearshore water clarity data for model verification.

3. Recommendations for the new 2007 CBP Water Quality model related to nearshore clarity and Sedimentshed delineation

A variety of exploratory analyses using the new Water Quality model with its improved sediment transport representation will help to clarify questions of fundamental importance for nearshore water clarity and the delineation of Sedimentsheds. Among these are:

a. Adjusting the settling speed of the slowest settling particle class to investigate potential turbidity improvements due to nutrient reductions.

b. Reducing different sediment sources separately to investigate changes in nearshore turbidity. This should include changing the relative proportions of the different sediment classes in the input loads to test model sensitivity to this relatively unknown factor. As a corollary, ask whether planned reductions in watershed sediment sources

due to phosphorus controls will achieve water clarity goals, or whether additional actions will be required, or whether any watershed reductions will have a measurable affect on nearshore water clarity downstream of the ETM.

c. Decreasing the erodibility of fine sediments to represent biostabilisation by oyster beds, SAV beds, benthic biofilms, etc. Also increasing erodibility in some areas to represent the effects of increased bioturbation as benthic habitat quality improves.

d. Further develop nearshore model cells to include increased wave forcing in shallow water, sediment trapping in marshes, and improved time variability of shoreline erosion.

4. Recommendations for Sediment Workgroup Action

a. Coordinate more with the Modeling Subcommittee in the near future. Specifically, the SedWG can assist modeling staff with suspended sediment scenario development and help verify sediment transport model predictions.

b. Coordinate with on-going SAV recovery and restoration activities by identifying nearshore sand sources in the Bay, and nearshore sediment distributions conducive for SAV recovery and restoration.

c. Coordinate with USACE Shoreline Erosion Study regarding regional determination of appropriate, environmentally-sensitive shoreline-stabilization measures to use when shoreline hardening is to occur.

d. Coordinate analysis of data on historic sediment load trends.

e. Continue to identify research needs to help fill in knowledge gaps.

5. Proposed sediment management techniques

a. Consider separate management techniques for fine and coarse sediments.

b. Develop better targeting of SAV plantings that take into consideration bottom sediment characteristics for SAV restoration.

c. Examine site specific, environmentally-sensitive shoreline management activities for SAV habitat improvement.

d. Evaluate the efficacy of sediment management through wetland creation/restoration.

e. Consider the beneficial placement of dredged material (particularly sandy dredged material)

Agenda

An Introduction to Sedimentsheds: Sediment and Its Relationship to Chesapeake Bay Water Clarity
January 30-31, 2007
Doubletree Hotel, 210 Holiday Court, Annapolis, MD
Calvert "C" Room

Objectives:

1. To provide a forum to share important insights from all invited experts on sediment and its consequent impacts on water clarity and submerged aquatic vegetation.
2. To review and comment on the Sediment Workgroup's efforts to date on sediment and its relationship to Chesapeake Bay water clarity.
3. To provide the Sediment Workgroup with focused guidance in determining appropriate next steps for addressing sediment impacts to Bay water clarity as necessitated by the 2010 reevaluation.

Tuesday, January 30th

8:15 Registration, coffee, continental breakfast available

9:00 Welcome, Introductions, Needs and Outcome of Workshop: Jeff Halka, MGS and Keely Clifford, EPA

9:15 Overview of Major Sediment Sources – Jeff Halka
Draft Sediment Budget, "Good"vs."Bad" Sediment

9:45 Water Quality/Clarity Criteria and Needs for 2010 Re-evaluation – Rich Batiuk, EPA
How new state water clarity criteria/water quality regulations were developed and why.
What the water clarity regulations are and how do we measure attainment?
What needs to happen with sediment during the next 3 years leading up to the 2010 Re-evaluation?

10:15 Break

10:30 Factors Affecting Light Attenuation and Shallow Water Clarity Impairment – Chuck Gallegos, Smithsonian Environmental Research Center
Discussion of suspended sediment, light penetration and other light attenuation components

11:00 SAV Habitat Requirements Other Than Light – Evamaria Koch, UMCES
Geological and geochemical processes that affect SAV growth and survival

11:30 Fine-Grained Sediment Transport Processes in Chesapeake Bay – Larry Sanford, UMCES, and Carl Friedrichs, VIMS
Physical, geological, and biological processes that control suspended sediment concentrations and transport patterns from sources to sinks in the estuary and its tidal tributaries

12:00 New Water Quality/Sediment Transport Model and Expected Outputs – Carl Cerco, U.S. Army Corps of Engineers, ERDC
Expected improvements in suspended sediment predictions and identification of remaining shortcomings; overview of how the model addresses components of light attenuation including filter feeders; expected model outputs; expected uses

12:30 Lunch (provided)

1:30 What Sediment Workgroup Has Done So Far, plus discussion – Lee Curry, MDE

2:30 Overview of Break Out Sessions and Discussion of Topics – Keely Clifford
We will break into two groups for each of the three workshop breakout sessions, with assigned facilitators and recorders for each group. Groups will brainstorm for 1 hour on assigned questions then report major findings back to the entire group for plenary discussion. Suggested topics are listed in Appendix 1; final topics and the order in which they will be addressed will be decided during this discussion. Breakout rooms are the primary meeting room (Calvert C) and the Talbot Room.

3:00 Break

3:15 Break Out Session 1

4:15 Breakout Group Reports and Plenary Discussion

5:00 Adjourn

6:00 Group dinner at Rams Head Tavern, 33 West Street, Annapolis (we reserved the Tea Room)

Wednesday, January 31st, 2007

8:15 Continental breakfast

9:00 Summary of Day 1: Jeff Halka

9:15 Break Out Session 2

10:15 Break

10:30 Break Out Session 3

11:30 Breakout Group Reports and Plenary Discussion for both morning sessions

12:30 Lunch (provided)

1:30 Final Plenary Session
- summary discussion of breakout results and workshop conclusions
- recommendations for Sediment Workgroup to help determine next steps and appropriate actions for addressing sediment impacts to Bay water clarity

2:30 Discussion of Workshop Report writing responsibilities. Participants without writing responsibilities may leave.

3:00 Adjourn

Appendix 1 - Suggested Breakout Session Topics

Three questions are identified here with the idea that both breakout groups will address the same question during each breakout session. The different perspectives will be compared and unified during the subsequent plenary discussions. However, additional or alternative topics may be identified and agreed upon by the workshop participants during the 2:30 discussion on January 30, such that the total number of questions may range between 3 and 6 and the order of the questions may change.

Question 1:
What aspects of suspended sediment variability are most important for water clarity?

Question 2:
Does sediment have the same impact on water clarity and SAV in all areas of the Bay? Which areas of the Bay would most likely benefit from local sediment reductions?

Question 3:
What is the appropriate scale and once decided, what is the optimum approach to delineating sedimentsheds?

Presentation Summaries

Please see full presentations at:
http://www.chesapeakebay.net/calendar.cfm?EventDetails=8176&DefaultView=2:

Needs and Outcome of Workshop – Keely Clifford, EPA/CBPO

- Forum to share expert information on sediment, water clarity and SAV
- Review and comment on SedWG work
- Provide SedWG guidance for next steps

Overview of Major Sediment Sources – Jeff Halka, SedWG co-chair, MGS

- Sediment comes from the watershed, tidal areas, ocean and internal processes; Resuspension can contribute huge quantities to suspended particle loads
- "Good" and "bad" sediment
- Transport of "bad" fine-grained sediment is poorly understood

Primer for Chesapeake Bay Water Clarity Criteria, Shallow-Water Designated Use and State's Water Quality Standards – Rich Batiuk, EPA/CBPO

- MD, VA, DE, and DC have adopted the 185,000 acre shallow-water Bay grasses restoration goal into their state water quality standard regulations.
- These state water quality standards regulations have water clarity criteria, SAV restoration acreages and detailed criteria attainment assessment procedures.
- We are heading into a Baywide Total Maximum Daily Load (TMDL) by 2010.

SAV Habitat Requirements Other Than Light – Evamaria Koch, UMCES

- SAV stabilize the sediments they colonize.
- Sediment composition is a key parameter for SAV.
- Breakwaters do not appear to benefit SAV in the long-term, only in the short-term.
- Loss of land can induce loss of SAV via:
    - Increased wave exposure
    - Increased current velocities
    - Increased water depth and bottom scour
    - A change in sediment composition
- Loss of land and induce gain of SAV via:
    - Ample supply of sand
    - Creation of new shallow water habitat within photic zone
    - Provision of sediment to maintain existing shallow water habitat within photic zone

Factors Affecting Light Attenuation and Shallow Water Clarity Impairment – Chuck Gallegos, SERC

- Presented evidence that eutrophication leads to higher concentrations of inorganic suspended solids.

- He thinks organic loading to the sediment may make it a fluff, which does not readily settle.
- Turbidity problem cannot be solved by limiting TSS loading alone.
- To solve the turbidity problem we need to solve the nutrient loading problem.

Fine Grained Sediment Transport Processes in Chesapeake Bay – Larry Sanford, UMCES & Carl Friedrichs, VIMS

- There are at least two separate suspended sediment populations:
    - Inorganic, rapidly settling sediment concentrated near bottom. Sediment transport researchers have generally focused their work on these sediments, however, these sediments are probably **not** causing water clarity/light attenuation problems in the upper water column.
    - "Background sediments," which are less aggregated, more organic and slowly settling particles. There has been relatively less research on these likely detrimental sediments which cause water clarity problems.

New Water Quality/Sediment Transport Model and Expected Outputs – Carl Cerco, USACE, ERDC

- The 2007 Water Quality model is much more advanced than the 2002 model
- New model incorporates: mechanistic sediment transport including resuspension by waves and currents, 3 solids classes (clay, silt and sand), advanced optical model, revised expert estimates of bank sediment loads, and solids filtration by living resources.
- It will give outputs relating to load reductions.

What the SedWG has done so far – Lee Currey, MDE, Sediment Workgroup Co-Chair

- The Sediment Workgroup created the foundation required to develop a sedimentshed (area, including upland, nearshore and sub-aqueous, that contributes the suspended sediment loads that directly influence water clarity in SAV grow zones).
- Using Bay monitoring data and cluster analysis with light attenuation, salinity, and fixed suspended solids (FSS) as the input parameters, the Sediment Workgroup clustered segments of the Bay where excessive FSS was causing water clarity impairment.

Discussion Notes:

** Notes on presentations capture discussion following the presentations, not the presentations themselves. **

DAY ONE (January 30, 2007)

Workshop Goals and Objectives **Keely Clifford**

1. No significant comments/discussion

Overview of Major Sediment Sources **Jeff Halka**

Jeff Halka, MD Geological Survey, gave a presentation on the draft Chesapeake Bay sediment budget.

Comments/Discussion Following Presentation:

- Q: Is it appropriate to consider a holistic sediment budget if the concern is excess suspended sediments that impair water clarity to the detriment of SAV?
    - A: What is most needed is a suspended sediment budget.
- Q: Does the Chesapeake Bay Sediment Budget table (Table 3-1 in the sedimentsheds report) take into consideration major episodic or unusual events, such as Agnes?
    - A: If events are captured in the monitoring data, they will be included. Agnes is not included in the budget, but more recent events, such as the January 1996 flood and a few March flooding events that occurred in recent years show up in the RIM data for the Susquehanna.
- Q: What about sediments behind dams?
    - A: This is something we are aware of, but we are not yet sure how to deal with. It could be that more sediment is added to the system as dams fill up and lose capacity to trap sediment.
- Q: Is it going to be impossible to achieve our sediment goal when taking into account unusual events and dams?
    - A: 40+ dams across the watershed are built into the Phase 5 model.
- It was pointed out that we cannot assume that hardening stops near-shore erosion. Jeff said he did not assume this when developing the budget.
- What point are you trying to make with this table? Where do we stand? Can you even do an error analysis on the estimates? What studies need to be done to get estimates?
- Q: Do we actually need a well-constrained budget?
    - A: We do need to have a sediment budget as we move into TMDLs.
- Recommendations to improve the sediment budget table:
    - Need to take a cut at error estimates as was recommended in the STAC review of the Phase 5 model.
    - Should try to fill in the table over this year with our best estimates.
    - Need a sense of uncertainty and certainty.
    - Would look like a gap analysis, which would be helpful.
    - When you have a new number, you need to defend why it changed.

- Q: Should resuspension be included in the sediment budget?
    - A: Perhaps resuspension should not be included in the budget because resuspension is not really an external source. Since it is not new material, it has already been accounted for.
    - However, resuspension does have a huge impact on water clarity and SAV.
    - A line could be added to the budget for deposition to cancel out resuspension.
    - A sediment budget needs both sinks and sources, and the current table only shows the sources. Maybe this is a table of sediment sources, and not a sediment budget.
- The budget's time scale should be clarified. (Are we talking about the growing season? Winter? Etc.)

Water Quality/Clarity Criteria and Needs for 2010 Re-evaluation **Rich Batiuk**

Rich Batiuk, EPA, gave a presentation on the water quality/clarity criteria and needs for the 2010 re-evaluation.

Comments/Discussion Following Presentation:

- What about the no-grow zone? How is this accounted for? Should it be included or not? This should be addressed as the states move to update their regulations.
- Q: How do you create a pass/fail grid for turbidity?
    - Take measurements in the shallows at calibration stations, set up tables to compare turbidity measurements, and compare and calibrate to the Kd measurement.
    - Look at tributary levels.
    - As more data comes in, calibration will be updated.
- The SAV Workgroup is considering updating/revising the SAV goal. There are very shallow areas and/or areas that have not had large growth previously that are now being rewarded. How would data be included in the standards if improved data for the new goal becomes available?
- Q: Is it a problem that we are extrapolating the data from deeper areas into the shallows? Is this an accurate picture?
    - A: Yes, we acknowledge it, but we are not sure what else to do at this point (Rich Batiuk).
    - Suggestion: Could you make adjustments to the light requirements to account for areas where you are not monitoring to make up for the use of extrapolations from the deep water?

Factors Affecting Light Attenuation and Shallow Water Clarity Impairment **Chuck Gallegos**

Chuck Gallegos, Smithsonian Environmental Research Center, gave a presentation on suspended sediment, light penetration, and other light attenuation components.

Comments/Discussion Following Presentation:

- Historically, SAV and oysters were high, sediments were high, and nutrients were low.
- We need a better understanding and consideration of historical information.

- We have areas where nutrients have decreased, but there were little changes in light, and positive changes in SAV (such as the Patuxent River).

SAV Habitat Requirements Other Than Light **Evamaria Koch**

Evamaria Koch, University of Maryland Center for Environmental Science, gave a presentation on the geological and geochemical processes that affect SAV growth and survival.

Comments/Discussion Following Presentation:

It was suggested that degradable fabric bags filled with sand be used as breakwaters in front of SAV beds. These tubes would degrade over the years, releasing sand. However, when they degrade, wave action over the SAV beds would increase. Would this destroy the SAV? If the area has waves above the threshold for survival, yes. Also, once the bags degrade, the supply of sand will eventually end.

- Q: Is data available to determine sand sources and how far away they are from SAV beds?
    - A: That is currently being worked on.
- It was suggested that we determine where the Bay's sand sources are and then try to "protect" (i.e. allow them to erode making the sand available to the ecosystem) those areas since, according to Evamaria's presentation, sand is needed for SAV establishment/growth.
- Issues and considerations in the upper Bay and freshwater systems are different than what is presented here.

Fine-Grained Sediment Transport Processes in Chesapeake Bay **Larry Sanford & Carl Friedrichs**

Larry Sanford, University of Maryland Center for Environmental Science, and Carl Friedrichs, Virginia Institute of Marine Science, gave a presentation on the physical, geological, and biological processes that control suspended sediment concentrations and transport patterns from sources to sinks in the estuary and its tidal tributaries.

Comments/Discussion Following Presentation:

- Need to look at the relationship between shoreline erosion and SAV growing seasons.
- Q: How does low-density floc fit into the model and to what do they correspond?
    - A: In the model, they are being treated as clay. The model does not know particle size and density, just settlement rates.
    - What are the management implications? Different sediment categories have different strategies.
- Does the formation of sediment "blobs" (agglomerates) decrease clarity? Is there a seasonal component? Would clarity increase by pulling sediment all together to form "blobs"?
- How does turbidity change in relation to concentrations of particles at various sizes?
- We should look into how different size and settling rate particles affect turbidity.
- Q: How effective is the ETM as a sediment trap?
    - A: Maybe more effective than we previously thought.

- How do the patterns occurring in the main-stem Bay affect the near-shore SAV/water clarity?
- What is the implication of the exchange, if any, between the background sediment population and the resuspended sediment population for water clarity?

New Water Quality/Sediment Transport Model and Expected Outputs **Carl Cerco**

Carl Cerco, U.S. Army Corps of Engineers Engineer Research and Development Center, gave a presentation on the new water quality/sediment transport model.

Comments/Discussion Following Presentation:

- Q: Is the potential connection between nutrients and suspended solids dynamics included in the model, or is there room to include it in the future?
    - A: It is not there yet, but it might be able to be included in the future. The relationship needs to be documented first to ensure that it is happening. It needs to be studied and understood and then put into mathematics for incorporation into the model.
- Q: How do you account for SAV when the minimum model depth is 5 feet?
    - A: An SAV sub-grid, which is divided into increments of 0.25 meters, is incorporated into model littoral cells and can be used to look at things like light.
- Q: Can you resolve the resuspension issues in the shallows?
    - A: The modeling team does not have information on light attenuation in the shallows. Data needs to be provided to the modeling team in order to validate it in the model.
- Q: Can the model separate impact of clarity in shallow sources (upland, bank loads, resuspension, etc.)?
    - A: Yes, to the best that can be done right now.
- Q: What are the management questions that the model can handle?
    - A: It is oriented towards being able to respond to questions about load reductions.
- Q: Can the model run historic scenarios from times when watershed and shoreline sediment loading were perhaps greater, but oysters were healthy, nutrient loading lower, and SAV greater?
    - A: The scenarios can be run but there is no guarantee the results will agree with our conception of the past. Substantial effort is required to assemble historic data sets and to develop appropriate model parameters.

What the Sediment Workgroup Has Done So Far **Lee Curry**

Lee Currey, MD Department of the Environment, gave a presentation on what the Sediment Workgroup has done so far regarding the sedimentsheds concept.

Comments/Discussion Following Presentation:

- Are there simple rules to determine where sediment is coming from and can you use the model to test these rules?
- Q: Do we need to look at both natural sources and anthropogenic sources of sediment?

    - A: Yes, we need to recognize both of these components, but also recognize that in cases where natural sources are being delivered at natural rates it is not clearly appropriate (and may not be practicable) to intervene to alter this. For example, shoreline erosion generates suspended solids, but it is a fundamental natural process of the Bay ecosystem.
- Need to recognize what the problems are and reduce uncertainty before developing management actions.
- Q: Can the model forecast feedback from nutrient reductions? Can it help look at the relationship between sediments and nutrients?
    - A: Looking at the relationship between sediments and nutrients may not make it into the model update for Phase 5, which is to be completed in April.
- Are the western tributaries beyond management for suspended solids?
- Some participants were concerned about what would happen if we over-controlled for sediment problems, which would result in the loss good sediment. Good sediment is important for certain watershed components like wetlands. Rich Batiuk said that he was not concerned about this at this time given current sediment rates.
- We are trying to achieve a reduction in suspended solids (sediment) in the water column.
- Ways that we know to reduce sediment include no-till, buffers, etc. However, these are watershed fixes. Are there tidal water fixes?
- The relationship between load reductions and suspended sediment is not linear.
- What reductions would you see over what timeframe and where? Can we make certain reductions in certain areas and not see improvement in clarity or SAV? We need to look at this as it will be important for management decisions/actions.
- It is thought that sediment loading to the Bay from watershed sources was greater during the late 19th and 20th centuries than at present. Yet, the Bay was healthier. Additionally, shoreline erosion has been essentially stopped in many urban waterways via stabilization measures; thus natural loading from shoreline erosion is also reduced. Maybe we should explore this more.
- SAV recovery is going to be very local. Since water quality monitoring data is taken from the middle of the Bay, does it relate to the near-shore turbidity levels?
- The battle will be won with SAV, not clarity, and there may or may not be a firm relationship.
- We should determine what sediment sources should be "protected" – free from certain management practices. We also should look for areas that need protection to keep sediments in place.
- There is a possibility that we may not be able to do anything to reduce suspended sediment levels in the mesohaline Bay if sediment is derived from resuspension and near shore erosion. Greater historic SAV health in this area may be related to former historic presence of massive oyster beds in middle Bay.
- Julie Herman noted that there is a model for Northumberland County, VA that is used to determine suitable living shorelines.

- Q: Did historical large oyster reefs affect wave attenuation, thereby affecting SAV? Do we need to consider this in the timeframe of the historical SAV data used to determine the SAV goals?
    - A: Maybe in Virginia where intertidal reefs historically occurred, but not in Maryland. Maryland's historic oyster reefs were deeper and probably largely below active wave depth.

DAY TWO (January 31, 2007)

Discussion **All**

Greg Allen, EPA, and Kelly Shenk, EPA, facilitated a discussion on the second day of the workshop. Questions to be addressed in the discussion included:

- What questions can we ask the model?
- What management questions can it not answer?
- What is the added value of delineating sedimentsheds?
- What information do we need to address tidal erosion?

QUESTION: What are the management questions that we feel are important to have answers for? (Responses below are in no particular order.)

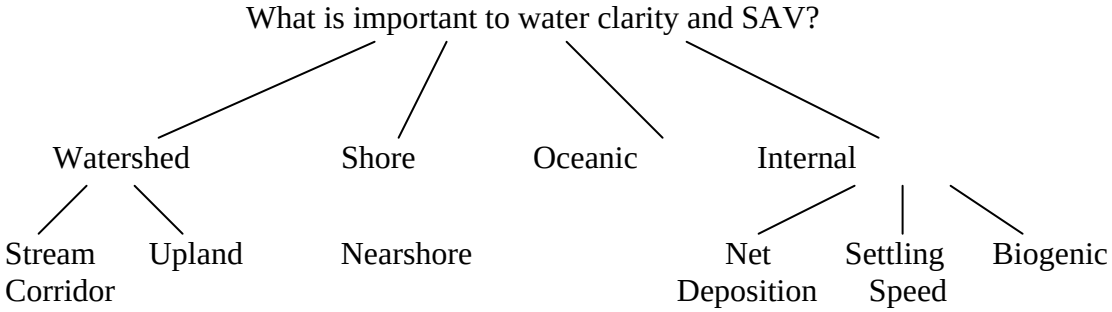
1) It is anticipated that a substantial portion of the remaining Bay shoreline that is not yet stabilized will ultimately be stabilized, since property owners have the legal right to do this. What will the model show in terms of sediment reductions? Would there be benefits to SAV by implementing living shoreline techniques versus other less environmentally-sensitive techniques?
2) If we implement living shorelines on X% of the possible shoreline, what will the model show in terms of sediment reductions?
3) What are the key factors affecting where SAV beds were historically? Is there a way to target these factors based on historical information?
    - The model could be used to guess at trends (shell reefs, deposition rates, etc.).
4) If we reduce watershed inputs, does it have a significant effect on near-shore water clarity?
5) Will controlling phosphorus in the watershed sufficiently address water clarity in the Bay? Or are additional actions needed to control sediment?
6) Where is deposition most likely to occur?
    - The model can be used for this, although they haven't used it to answer this question yet.
    - Does the model agree with historic patterns of deposition? The model's deposition predictions should be compared to literature deposition rates.
7) Where does oceanic input go?
    - Into the Bay and up the tributaries?
    - A grain size profile would be useful.
8) Why was the Chesapeake Bay clearer in the historic past and less clear now? What role does sediment play in this? How many changes (oyster beds, SAV beds, sediment loading rates from watershed and shoreline sources, sediment

velocity, reduction in nutrient loading, etc.) have to occur and to what degree in order to get the water as clear as it was 100 years ago?
    - A better understanding of the historic trends is needed to better predict/understand future conditions/predictions. We need a better understanding of historical trends around resources of concern.
    - Explore deposition rates, settling velocities, shell on bottom, and SAV.
    - Conduct sensitivity analyses: (1) shut off watershed sediment inputs, (2) shut off shoreline erosion inputs, and (3) increase net deposition/decrease settling speeds.
    - The model cannot address SAV burial.
9) Extreme weather events, such as Agnes, should be simulated. Model input decks would need to be generated in order to do this. Look at the affects Agnes had on SAV.
10) Is the ETM a significant sediment trap, or is it just a "toll plaza"?
11) What dominates sediment loads in the upper, middle, and lower Bay and above and below the ETM (tidal energies, legacy sediments, etc.)? How does this affect management?
12) Are tidal tributaries sources or sinks (particularly below the ETM)?
    - Julie Herman looked at this on the York River.
    - Use velocity from the hydrodynamic model with TSS data.
13) Where are the sediments coming from (mouth of the Bay, head of the Bay, etc.) that negatively affect near-shore water clarity?
    - Answering this question will help prioritize the other questions listed in this discussion and it will help direct management.
    - Are legacy sediments significantly affecting water clarity? What is the quality of the legacy sediment?
    - Which watershed sources are having a more significant negative impact on water clarity: upland sources or channel corridor sources?
    - Are the watershed sources important? Stream bank sources? Ocean sources?
    - Are the internal processes dominant?
    - Is there a relationship between the river input data for TSS and the down-tide water clarity?
    - Where is suspended sediment in SAV beds coming from?
    - Suggestion: Fingerprint the suspended sediment affecting SAV in near-shore areas.
14) If a particular source of sediment is reduced by X%, what % improvement would we see in water clarity and SAV?
    - Lag time and timescales should be considered for management measures.
    - What would the lag time be?
    - Monitoring is needed to determine if (and by how much) a particular Best Management Practice (BMP) actually reduces sediment and results in a water clarity improvement.
    - Monitoring data should be analyzed so that we better understand the connection between water column concentrations and clarity.

- Suggestion: Use a tracer at a source location to help understand sources, patterns, transit time, lag time, etc.
    - Tracers are only good on a small scale and they need to be repeatedly released and tracked.
    - Allen Gellis told the group that there was an RFP submitted to the Chesapeake Bay Program on sediment transit time, but the project did not get funded. This project could have also quantified whether sediment got through the ETM.

15) Is water clarity different in the shallows compared to in the channel? Since water quality monitoring data is taken from the middle of the Bay, does it relate to near-shore turbidity levels?
    - Suggestion: This needs to be in the model.
    - Instead of looking at segment averages for clarity, could we focus on near-shore clarity only, since that is the only area important for SAV?
16) What is the background turbidity? Why is background turbidity higher in the summer than in the winter?
17) How do we manage for different species of SAV with different water clarity requirements?
    - Suggestion: Track changes in species of SAV overtime.
18) Should we try to preferentially manage fine versus coarse sediment or encourage continued delivery/availability of coarse sediment?
19) Should we be managing for mid-Bay?
20) What parameters need to be changed for the water to be clear?
    - Decrease erodibility
    - Increase fall velocity
    - How much do these need to change to clear the water column?
    - Classify by sediment grain size.
21) Look at impacts of wetlands on sediment grain size and transport.
    - Is there a mechanism in the model to remove fines as a result of wetland removal, since wetlands trap fines?
    - Does an increase in wetland acreage lead to increased water clarity? (possibly test with the model)
22) The hypothesis that nutrient reduction may result in more improvements in water clarity than originally expected due to its connection with sediment settling is an idea that merits further study.

QUESTION: What is important to SAV and water clarity?



- Are current efforts to reduce phosphorus in the Watershed already reducing sediment enough or is more needed?
- What spatial scale should be used?
    - Shoreline cells
    - Above ETMs
    - Below ETMs
    - Upper, middle, and lower Bay
    - Tributary
- Model output should be analyzed at different scales to determine what scale is meaningful and to look for relationships between sources and water clarity/SAV. How are each of these stressing water clarity and SAV?
- Spatial and temporal considerations.
- Fine vs. coarse grains- anthropogenic changes.

QUESTION: What questions can we ask the model?

- What model parameters can be changed to improve water clarity? To what degree must the parameters change?
- What is needed in the model to have increased water clarity with increased sediment loads? (As was the case in the late 1800's to early 1900s)

QUESTION: Would it be helpful to examine historic trends and compare them to current conditions? Is a historic model run critical and/or feasible?

- Gaining a better understanding of why the water was historically clearer despite the presence of increased sediment loads from watershed and shoreline sources would help us better understand processes related to clarity.
- Is it proven that there were higher sediment loads and increased water clarity historically? May want to look for data to back up this statement.
    - There is at least one paper from the 1950s that discusses water clarity in the Chesapeake Bay.
    - Some reservoir sedimentation surveys go pretty far back.
- A historic model run may not be absolutely necessary. It would require a significant amount of time and money.
- It was suggested that historic data sets be analyzed independent of the model using causal inference techniques. Look more closely at the relationship between sediment loads and water clarity as far back as possible. Where should we look for historic sediment load data?
- It was also suggested that we use the model to do a more general model run in order to see what it takes to have increased water clarity with increased sediment loads. No 1950s input deck will be created at this time.
- Can we look at cores for grain size distribution?
    - Cores in headwater tributaries show substantial increases in sediment rates following European settlement, and likely changes in grain-size. Cores in the open bay shallow margins do not show increases in rates or grain-size because physical processes (largely wave energy) have remained largely

consistent, preventing excess deposition and maintaining consistent bottom grain-size.

- Throughout this process, keep in mind natural vs. anthropogenic sediment processes.
- Has grain-size changed? Today do we have more fines (bad sediments) than sands (good sediments)?
    - Is urban development transporting more fines to the system?
    - It is important to manage fines over sands at this point.

QUESTION: What are suggested follow-ups for the Sediment Workgroup?

- Determine what we need from the model now
    - Historical
    - Affected areas- What areas of the Bay are SAV and water clarity are impacted and by what sources?
- What do we need to put into the model?
    - What data analyses need to be done
    - Develop scenarios for model runs
- What do we need to verify the model? Research studies to fill in gaps?

QUESTION: What can we do between now and when the model is available?

- Assemble data sets needed to tweak the model to simulate historical conditions
    - Focused on getting a historical output
    - Look at relationship between loads and clarity
- Critical to look at data independently of the model
    - Data available from USGS, Marsha Olson, CBI/CBL

QUESTION: What are some management techniques that could be used to decrease sediment loads in the tidal zone?

- SAV plantings
    - Have been largely unsuccessful except for in sandy areas.
    - Is domain of Living Resources Subcommittee, but may be an inadequate consideration of bottom sediment character and future bottom sediment character as function of proximity to shoreline stabilization structures.
    - More targeted and calculated restoration (spread sand first, sand-based breakwaters, temporary breakwaters, etc.)
    - Better targeting of where to plant
- Continued efforts to increase populations of oysters/filter feeders.
    - Target oyster restoration in geographic areas that would help SAV restoration.
    - Current research suggests that unless you have a huge amount of filter feeders, clarity doesn't really change.
    - Could oyster beds serve as a breakwater for SAV beds?
        - Offshore oyster beds have shown essentially no impact on near-shore water clarity and SAV beds.
- Continue to tackle eutrophication issues and nutrient reductions.

- Target shoreline protection efforts where significant improvements in SAV beds are most likely to be seen; however this would compromise natural shoreline character fundamental to the Bay ecosystem, and might induce future SAV losses via interruption of processes that create and maintain shallow water habitats.
- Wetland creation/restoration.
- Beneficial placement of dredged material (particularly sandy dredged material).

QUESTION: What is the added value of delineating sedimentsheds? What does this concept provide that we do not already have?

- It may be particularly important to delineate sedimentsheds in areas where SAV is not doing well, such as in the Mid Bay. Surprisingly, SAV is doing well (meeting recovery goals) in many areas above the ETMs that receive the greatest delivery of watershed sediments.
- If ETM crosses sedimentsheds – divide sedimentsheds above and below ETM. Controlling sediment above and below the ETM may require very different approaches.
- Currently, the Sediment Workgroup is just laying the groundwork for sedimentsheds. There is not yet enough information to delineate sedimentsheds.
- This question will naturally be addressed through the process that we discussed earlier (see above flow chart). It does not need to be decided now.
- Establishing sediment sources should be added to priority research list.

QUESTION: What information do we need to address tidal erosion?

- Shoreline erosion is a fundamental natural process. Is there a need from an SAV management perspective to promote measures that stabilize shorelines if it compromises overall ecosystem health and may cause long-term problems for the SAV resource (via interfering with processes that create and maintain shallow water habitats)
- Natural shoreline extent is utilized as an indicator of ecosystem health in Maryland's coastal bay tributaries. Should a comparable indicator be applied to the Bay's tributaries?
- Look at good vs. bad sediment, natural processes, man-made effects
- Consequences of hardened shorelines and how to reverse
- The feasibility of applying tracer techniques to determine sources of suspended material in shallow water.
    - Geochemical tracers to track background vs. suspended vs. on ground sediments, as well as upper vs. lower Bay sediments.
- Leave “natural” erosion processes alone that produce “good” sediment.
- How do offshore breakwaters work to promote SAV growth and what are the best designs?
    - Maryland Regulatory “order of preference” favors non-structural alternatives, environmentally sensitive erosion control techniques, living shorelines where/when feasible during permitting process.
    - Better guidance needed for regulators in making permit decisions

The workshop proceedings and a summary of workshop highlights will be sent to all participants for comments to ensure that everyone can and will support the recommendations that come out of these discussions.

List of Attendees

DAY ONE

Greg Allen	U.S. Environmental Protection Agency- Chesapeake Bay Program
Rich Batiuk	U.S. Environmental Protection Agency- Chesapeake Bay Program
Peter Bergstrom	National Oceanic and Atmospheric Administration
Sally Bradley	Chesapeake Research Consortium
Carl Cerco	U.S. Army Corps of Engineers
Keely Clifford	U.S. Environmental Protection Agency- Chesapeake Bay Program
Lee Currey	Maryland Department of the Environment
Rich Eskin	Maryland Department of the Environment
Melissa Fagan	Chesapeake Research Consortium
Nina Fisher	Freelance Technical Writer
Carl Friedrichs	Virginia Institute of Marine Science
Jack Frye	Virginia Department of Conservation and Recreation
Chuck Gallegos	Smithsonian Environmental Research Center
Allen Gellis	U.S. Geological Survey
Jeff Halka	Maryland Geological Survey
Julie Herman	Virginia Institute of Marine Science
Michael Kemp	University of Maryland Center for Environmental Science
Evamaria Koch	University of Maryland Center for Environmental Science
Doug Levin	National Oceanic and Atmospheric Administration
Shah Nawaz	DC Department of Health
Mike Naylor	Maryland Department of Natural Resources
Cindy Palinkas	University of Maryland Center for Environmental Science
Sara Parr	Chesapeake Research Consortium
Nancy Rybicki	U.S. Geological Survey
Larry Sanford	University of Maryland Center for Environmental Science
Kelly Shenk	U.S. Environmental Protection Agency- Chesapeake Bay Program
Chris Spaur	U.S. Army Corps of Engineers
Becky Thur	Chesapeake Research Consortium
Liz Van Dolah	Chesapeake Research Consortium
Jennifer Volk	DE Department of Natural Resources and Environmental Control
Ping Wang	University of Maryland Center for Environmental Science

DAY TWO

Greg Allen	U.S. Environmental Protection Agency- Chesapeake Bay Program
Rich Batiuk	U.S. Environmental Protection Agency- Chesapeake Bay Program
Peter Bergstrom	National Oceanic and Atmospheric Administration
Sally Bradley	Chesapeake Research Consortium
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