Scientific and Technical Advisory Committee
September 13-14th, 2016 Quarterly Meeting Minutes
O'Callaghan Hotel - Annapolis, MD

Tuesday, September 13th Minutes

Attendance: (T: Telecommute)

Members: Joshua Behr, Donna Bilkovic (T), John Karl (JK) Bohlke, Kathleen Boomer, Christopher Brosch, Bill Dennison, Alix Dowling Fink (T), Zachary Easton, Lara Fowler, Marjy Friedrichs, Kirk Havens, Maria Herrmann, Carl Hershner (T), Robert Hirsch, Jason Hubbart, Thomas Ihde, Hamid Karimi, Peter Kleinman, Martin Lowenfish (T), Mark Luckenbach (T), Andrew Miller, Mark Monaco, Steve Newbold (T), David Newburn, Marc Ribaudo, David Sample, Adel Shirmohammadi, Kurt Stephenson (T), Lisa Wainger, Denice Wardrop, Gene Yagow

Guests: Karl Blankenship (T), Vicki Blazer, Dee Carlson (T), Suzanne Dorsey, Rachel Felver (T), Emilie Franke (T), Patricia Glibert, Hassan Mirsajadi (T), Alisha Mulkey (T), Scott Phillips, Kyle Runion, Gary Shenk, Joan Smedinghoff, Stephanie Smith, Ken Staver, Peter Tango, Richard Tian, Ping Wang

Administration: Bill Ball, Rachel Dixon, Melissa Fagan, Elaine Hinrichs, Renee Kelly

Call to Order – *Lisa Wainger (STAC Chair - UMCES)*

Wainger called the meeting to order shortly after 10:00 am. New STAC Federal Appointees, John Karl (JK) Bohlke (USGS) and Martin Lowenfish (USDA-NRCS) provided brief introductions to the membership. New STAC staff, Elaine Hinrichs (CRC) introduced herself to the membership. Wainger announced that STAC's Executive Board (EB) nominated Andrew Miller (UMBC) to serve on the board, and requested a motion to approve Miller's appointment; motion approved. Next, Wainger requested a motion to approve the June 2016 quarterly meeting minutes and July 2016 EB meeting minutes. STAC members approved both minutes, pending a few suggested revisions. STAC Coordinator, Rachel Dixon (CRC) reviewed minor revisions to the Workshop Protocols document. STAC members suggested further language revisions, then approved the document with those changes. A full discussion of the workshop process and protocols will continue at the December 2016 quarterly meeting.

DECISION: **Wainger** requested a motion to approve the appointment of Miller to STAC's EB. Result: Motion carried.

DECISION: **Wainger** requested a motion to approve the June 2016 quarterly meeting minutes and July 2016 EB meeting minutes. Result: Motion carried, pending suggested revisions to the June 2016 quarterly meeting minutes.

DECISION: **Wainger** requested a motion to approve revisions to the Workshop Protocols document. Result: Motion carried, pending suggested language revisions.

Recap of STAC June Quarterly Meeting/Introduction of September Theme – *Lisa Wainger (UMCES)*

Wainger highlighted key discussions and outcomes from the June quarterly meeting. Wainger then reviewed the September agenda and introduced the meeting theme: water quality trends and implications for aquatic life and management. STAC members participated in a brief question and answer (Q&A) session following each presentation throughout the meeting.

United States Geological Survey (USGS) Non-Tidal Network Trends Report – *Bob Hirsch (USGS)*

Hirsch presented results from a recently published comprehensive analysis of trends in nutrient and sediment loads on the Chesapeake Bay watershed. USGS and other water-quality monitoring partners have been working on the Chesapeake Bay non-tidal monitoring network for three decades. There are currently 117 stations where daily discharge is recorded and 12 routine and 8 stormflow samples are taken annually. Hirsch explained a number of analysis issues with the nutrient loading data. The data are highly related to streamflow and season, highly skewed, and sometimes censored. The influence of flow means that random but persistent patterns of wet and dry years can easily confuse assessments of progress. To address these issues, Hirsch and colleagues developed a flexible statistical model, called Weighted Regressions on Time, Discharge, and Season (WRTDS), to determine the expected value of concentration for any possible combination of date and discharge during the period of record. Hirsch presented the flow-normalized trend results from 2005 to 2014 for total nitrogen (N), total phosphorus (P), and dissolved orthophosphorus, all of which improved at a majority of the sites. Generally, the Susquehanna watershed had improving trends for all three nutrients, but loads coming out of the Conowingo Dam are either steady or increasing. Degrading trends were seen in the Delmarva Peninsula for all three nutrients, and in other specific areas of the Bay watershed. These results are being used to explain change, enhance models, measure progress, and inform strategies.

Reconciling findings from field studies of P loss with monitoring and modeling results – *Ken Staver (UMD)*

For the past 30 years, Staver has been studying nutrient transport patterns across the full spectrum of agricultural management scenarios to identify drivers of nutrient loss and options for changing those drivers to reduce nutrient losses. Staver's research has looked primarily at small-scale drivers in small agricultural watersheds on Maryland's Eastern Shore that have close interfaces with tidal waters. Staver explained that the adoption of reduced tillage, cover crops, and other strategies on the Eastern Shore have effectively reduced soil erosion. Unfortunately, erosion control has not translated to P control because these strategies do not prevent the movement of small nutrient-rich particles. Staver's field experiments comparing no-till and till revealed that switching from till to no-till resulted in no difference in surface runoff volume and total N losses, huge decreases in suspended soils, but approximately double the total P losses. Total P losses from fields were dominated by dissolved P, but Staver explained that particulate P appears as the main P water quality problem on a larger scale. Staver and colleagues have been testing methods such as incorporation, vertical till, and injection with the goal of moving soluble P off the soil surface in reduced tillage fields. Overall, soil P levels on the Eastern Shore

continue to increase, although at a decreasing rate, as a result of intensifying poultry production and the continued effects of legacy P. Staver noted that tracking of soil P is straightforward, but difficult because of privacy issues and costs. Previous versions of the Chesapeake Bay Watershed Model (CBWM) have not considered soil P concentrations or manure/inorganic fertilizer application methods, and thus model results have inaccurately communicated to the public that P pollution has been sufficiently reduced. This is important because dissolved P losses due to increasing soil P and reduced tillage are a large problem for water quality.

CRC Staffer Presentation – *Joan Smedinghoff (CRC): Communications Workgroup Staffer*

CRC's Environmental Management Career Development Program provides early career professionals with a stepping stone to a future career in the fields of environmental science, policy and management, and outreach and education. Staffers provide technical and administrative support to the various Chesapeake Bay Program (CBP) partnership committees, Goal Implementation Teams (GITs) and workgroups and not only gain a solid professional foundation from which to build their careers, but also individualized development and career exploration opportunities. Smedinghoff provided an update on current Communications workgroup activities as well as her own work and future plans.

The global problems of legacy P and P loss in artificial drainage – *Peter Kleinman (USDA-ARS)*

Kleinman presented on the issues of P loss in drainage systems and legacy P, including their emergence as some of the most intractable management issues. These issues are particularly relevant to the Delmarva Peninsula but are also of global concern. For the issue of P in drainage water, Kleinman discussed three problem areas: tile drains, open ditches, and sloping landscapes. The basic issue with P is that concentrated flows bypass natural buffers. Kleinman presented research on drainage ditches in the Delmarva Peninsula and in the western Lake Erie Basin that showed shallow groundwater to be the primary pathway of soil P transfers to drainage ditches. Kleinman also explained the approach to managing P losses from fields, which is built on targeting "hot spots" and "hot moments." This approach requires the identification of "critical source areas" where a P source and transport mechanism intersect, then the separation of the source and the transport mechanism. However, P management is currently hindered by poor modeling of subsurface P transfers. A recent peer review of all the major watershed models concluded that the models were not just deficient in representing subsurface or drainage P losses – they did not represent those processes at all. Kleinman stressed the need for STAC to emphasize this omission because the CBWM also lacks subsurface or drainage P processes.

Kleinman then explained how the legacy of past management can be seen in soil P tests, and how legacy P - P that was applied to watersheds historically and contributes to present loads - can continue to affect the watershed even if P application is curtailed or cut off today. A variety of studies demonstrate that artificial drainage, as well as the intensification of poultry houses on the Delmarva Peninsula, interacts with legacy P to compound the P problem downstream. Kleinman concluded by briefly explaining that fragipan soils on slopes enhance surface runoff generation, and that emerging science indicates that subsurface flow, even in sloping landscapes, is an important phenomenon.

How N:P Can Cascade through the Food Web – *Patricia Glibert (UMCES)*

Glibert presented on changes in N:P stoichiometry in time and space and consequences for the composition of primary producers, which is altering the food web at all levels. Glibert's talk addressed anthropogenically-driven nutrient changes on a global scale, then drilled down to cell physiology and food web effects using examples from various ecosystems, and concluded with the modeling of these effects. The global trend of increasing N:P ratios is driven by both increases in N loads and decreases in P loads. The ratio of N:P loads is also increasing in the Chesapeake Bay. In addition, the ratios of N fertilizer forms are changing, with increases in organic N forms compared to inorganic forms and in ammonium (NH_4+) compared to nitrate. Classically, NH_4+ is considered phytoplankton's "preferred" form of N. However, different cellular regulation of NH_4+ and nitrate uptake, depending on concentration and water temperature, also affects how phytoplankton respond. Additionally, as waters warm and NH_4+ dominates, or as N:P ratios increase, the composition of the algal community tends to shift toward dinoflagellates, many of which form harmful algal blooms (HABs). Glibert explained that, contrary to belief, the ratio of N:P matters even when both N and P are available in concentrations normally taken to be sufficient for growth. Many algal toxins are also promoted at higher N:P ratios.

The entire food web is affected by changes in nutrient stoichiometry and form, and subsequent shifts in the phytoplankton community. Glibert suggested that the total nutrient load sets the total amount of productivity, but the relative nutrient proportions set the quality of productivity. Grazers feeding on high N:P algae tend to have proportionately higher N excretion, which accentuates high N:P in the water, creating a positive feedback loop. Glibert presented studies from comparative ecosystems around the world that show similar trajectories of algal community and ecosystem change with increasing N:P and/or increasing chemically reduced N forms. Glibert concluded that nutrient form must be considered while managing for total N and total P and there is much to be learned about organismal and ecosystem responses to saturated, super-saturated, and imbalanced nutrient levels.

Endocrine Disruptors – *Vicki Blazer (USGS)*

Blazer provided an overview of observed biological effects associated with contaminants and sources of endocrine disruptors. Endocrine disrupting chemicals (EDCs) can affect the endocrine system in two major ways: 1) EDCs can attach to receptors and mimic normal hormone function by "fooling" the body and causing an inappropriate response; and 2) EDCs can attach to receptors and block the effects of hormones, thereby interfering with normal function. EDCs come from many different sources, including wastewater treatment plant (WWTP) effluent, various industries, and runoff from developed and agricultural land. Blazer detailed the many compounds (some of which are toxic contaminants) that have been shown to induce intersex in a variety of fish experimentally. Early research investigating the cause of major fish kills in the Potomac River in 2003 found a multitude of pathogens, parasites, virus, but nothing consistent, indicating an impaired ecosystem and immunosuppression in fish. Findings from other areas in the Bay watershed also indicated that the same chemicals affecting the immune response of fish may also be inducing intersex. Blazer shared findings of her effects-based monitoring and research, which focused largely on effects of estrogenic endocrine disruption,

and the relationship between disease and indicators of estrogenic exposure to land use, contaminant source, and spatiotemporal variation. Additional factors to consider include the temporal nature of chemical exposures and exposure pathways during crucial life stages. Blazer concluded by explaining why other changes in the Chesapeake Bay watershed that might be associated with other endocrine disruptors, like other hormones and herbicides, must be investigated further.

Discussion: CBP Executive Council Letter – *Lisa Wainger (UMCES)*

Each year, STAC presents a letter of key issues to the CBP Executive Council (EC) before the annual EC meeting. This year's letter described STAC's successes from the past year and recommended three themes to focus on in the coming year: 1) contaminants of emerging concern; 2) science needs for adaptive management; and 3) applying systems approaches to identify strategic actions. Wainger asked STAC to continue focusing on these themes throughout the year, and to think about products STAC can continue to produce throughout the year.

ACTION: The draft EC annual report from STAC was reviewed and approved. **Dixon** will finalize the document for distribution to the EC. **UPDATE:** Dixon submitted report to the EC on 9/13/16.

Discussion: What do P trends and potential biotic impacts suggest about science needs?

STAC discussed next steps in forwarding the science of P dynamics as a function of biophysical, economic, and social drivers. This discussion was an effort to distill findings from the day's presentations that can be used to develop a strategy to improve science. Kleinman began the conversation by sharing a few possible discussion topics: the concept of ecosystem stoichiometry and the potential for a STAC workshop on dissolved P. STAC members discussed the need to overcome the perception that the P loading goal has been met through sediment control and the need to promote "combined nutrient reduction." Specific comments from members included:

- Is there a way to use optimization strategies with models to identify systems that produce N:P in stoichiometric balance while also minimizing N and P?
- Be wary of using terms that the public will not understand easily, like ecosystem stoichiometry, and a recommendation to communicate the complexity of these issues effectively and accurately to avoid confusion or misinterpretation.
- There is a need to evaluate and use the large amount of watershed and in-estuary long-term monitoring data already collected rather than rely strictly on models.
- Reminders that the Chesapeake Bay Model and CBWM are available for use, and of the importance of multiple models and a suite of indicators.
- Caution against STAC's tendency to try to generate guidance immediately during workshops and discussions, and a suggestion that STAC try to use workshops and discussions as opportunities to explore uncertainties and to reconnect adaptive management and our understanding the system.
- A suggestion to look into adaptive monitoring, particularly the potential worth of more sediment monitoring.

Wainger and Kleinman suggested creating a workshop or a factsheet based around the concepts of trade-offs, N:P ratios, and adaptive management. Two potential outcomes to strive for include addressing the unintended consequences of conservation practices and informing producers on emerging contaminants.

Atlantis, a Decision-Support Tool to Support CBP Workgroups – with application to Predicting the Cumulative Effects of Multiple, Simultaneous Stressors – *Tom Ihde (ERT)*

Ihde presented the Chesapeake Atlantis Model (CAM), a full-system modeling approach that simulates production in the brackish portion of the Bay and its tributaries. CAM was first developed about 5 years ago, and now can be used to visualize productivity changes expected from recently specified CBP Management Strategy Outcomes and Key Actions in the context of predicted climate change and attainment of the total maximum daily load (TMDL). CAM is one of many applications of Atlantis, an ecosystem model that considers social, economic, management, fishing, assessment, and biophysical factors in marine ecosystems. One of the ideas behind Atlantis is putting information on the same scale in order to see the importance of certain factors. Ihde outlined some of the ways in which CAM could be used to complement water-quality modeling at the CBP.

CAM – a 3-dimension model - simulates populations of management interest, forage species, protected species, and three habitats (submerged aquatic vegetation (SAV), marsh, and oysters). Ihde presented a simple experiment that examines cumulative effects of multiple stressors in the ecosystem. The results indicated that increased water temperature produces relatively strong effects on production compared to assumed losses of marsh, losses of SAV, or water quality improvements.

Ihde concluded that CAM is a readily available strategic tool able to support many of the critical needs of the CBP workgroup's Outcomes and Key Actions not directly focused on water quality. In addition, Ihde cautioned that modeling stressors without the expected increase in water temperature could be misleading due to temperature's strong effect on production. Reasonable trends can be predicted when modeling a single stressor only if it happens to be the dominant stressor, and that the risk to production of important Chesapeake fisheries is relatively large if CBP workgroups miss the dominant stressor. Ihde also detailed next steps for the CAM project: 1) the project needs to be moved under the CBP due to funding availability; 2) specific CBP workgroups need to prioritize use of the model (so that the EPA will see CAM as a fundable tool); and 3) approximately a quarter of a fiscal year of focused activity will be required to support an individual question from a workgroup. Ihde emphasized that the ideal application of CAM would be iterative conversations with the workgroups.

Wednesday, September 14th Minutes

Attendance: (T: Telecommute)

Members: Joshua Behr, Donna Bilkovic (T), John Karl (JK) Bohlke, Kathleen Boomer, Christopher Brosch, Amy Collick (T), Bill Dennison, Alix Dowling Fink (T), Zachary Easton, Lara Fowler, Marjy Friedrichs, Kirk Havens, Maria Herrmann, Carl Hershner (T), Robert Hirsch,

Jason Hubbart, Thomas Ihde, Hamid Karimi, Peter Kleinman, Martin Lowenfish, Mark Monaco, Steve Newbold (T), David Newburn, Marc Ribaudo (T), David Sample, Adel Shirmohammadi, Kurt Stephenson (T), Lisa Wainger, Denice Wardrop, Gene Yagow

Guests: Rich Batiuk, Gopal Bhatt (T), Cairn Bisland, Karl Blankenship (T), Peter Claggett, Olivia Devereus (T), Suzanne Dorsey, Norm Goulet, Matt Johnston, Alisha Mulkey (T), Kristin Saunders, Gary Shenk, Stephanie Smith, Andrew Sommerlot, Jeff Sweeney (T)

Administration: Bill Ball, Rachel Dixon, Melissa Fagan, Elaine Hinrichs, Renee Kelly

2017 Quarterly Meeting Dates – *Renee Kelly (CRC)*

Kelly presented the dates for the 2017 quarterly meetings: March 14-15, June 13-14, September 12-13, and December 5-6. STAC staff will distribute electronic calendar invites for these dates. These invites are intended to help STAC members with annual planning by putting early holds on the calendar.

ACTION: **STAC staff** will send electronic calendar invites to STAC Members for 2017 Quarterly Meeting Dates. **UPDATE**: Hinrichs distributed the calendar invites on 9/20/16.

Modeling Beyond 2018 Workshop Update – *Rachel Dixon (CRC)*

Dixon updated STAC on the status of the 'Modeling Beyond 2018' workshop, one of five proposals approved for FY 2016 STAC workshop funding. During early planning discussions, some members of the steering committee expressed concerns for the workshop timing. Due to the shift in the deadline for the Midpoint Assessment (MPA) models from January 2017 to June 2017, and the concern regarding the availability of key members on the modeling workgroup, the committee proposed postponing the workshop from late spring 2017 to spring 2018. However, given other timely topics in the CBP modeling suite, the workshop chair alternatively suggested holding two workshops – one to proceed as planned in spring 2017, as an academic identification of strategic directions for model advancement within the CBP – then apply for funds to hold a second, follow-up workshop in spring 2018 focusing on regulatory issues. Dixon presented the EB with both options: (1) holding the approved funding for a single workshop as outlined in the proposal for FY 2017, or (2) have the steering committee re-compete for funds for a follow-up workshop to address the regularly component. After discussion with the workshop chair and weighing the trade-offs, the EB approved the steering committee's request that funds for this workshop be held until FY 2017. This request has been approved by STAC's cooperative agreement, and would not affect the total amount of funding available for FY 2017 workshops.

The above minutes reflect a detailed account of the discussion and decision process on this topic by STAC Staff, included here as requested during the September meeting.

Overview of STAC Workshop Report: Evaluating Proprietary BMPs: Is it time for a State, Regional, or National Program? – *David Sample (VT) and Norm Goulet (NVRC)*

Sample and Goulet presented findings, recommendations, and next steps from the March 2015 STAC workshop. Sample presented some background on Proprietary Best Management Practices (BMPs), also called Manufactured Treatment Devices (MTDs), commonly used in urban areas for stormwater treatment. Workshop participants recommended that a Bay-wide program, the Chesapeake Bay Technology Assessment Protocol (CBTAP), should be adopted, with a version of existing protocols such as the Virginia Technology Assessment Protocol (VTAP) as a starting point, to be decided by an advisory expert panel. Expert panel members will include manufacturers, regulators, academics, and consultants. The panel is charged with selecting a protocol to evaluate individual BMPs, providing guidance for implementation and administering the program, and assessing financial requirements. Participants also recommended that: 1) outputs from the panel be submitted to the EC; 2) the panel and the ultimate CBTAP program be administered through the Urban Stormwater Workgroup (USWG); 3) approval of recommended water quality performance credits through CBTAP be integrated into the CBWM as soon as practical; and 4) should an acceptable national program emerge, CBTAP should coordinate its operations with that program. Regarding next steps, the workshop committee has sent invitations to participate in the expert panel and received many acceptances, and a request for 2016 GIT funding has been approved. This expert panel will commence in fall 2016 and be complete by fall 2017.

Panel Presentation: Midpoint Reviews – *Gary Shenk (USGS), Matt Johnston (UMD), and Peter Claggett (USGS)*

STAC is sponsoring a number of reviews to assist with the 2017 MPA. The three STAC reviews presented at this meeting all concern the overall modeling of the Chesapeake Bay watershed. The panelists described how these three reviews are related, background information, review status, and the specific questions for STAC reviewers.

Shenk reviewed the CBP Phase 6 CBWM, a management model with the purpose of giving understandable numbers to the management, which is being developed for the (MPA). Based on feedback from partners and earlier reviews by STAC, Phase 6 is simultaneously simple and complex by having a simple structure with inputs from other complex models. Shenk detailed the different parameters within the model structure, and explained how this steady state model can be used to calculate loads. The Phase 6 Model differs from Phase 5 in that the Chesapeake Assessment Scenario Tool (CAST), Scenario Builder, and CBWM are now one integrated piece of software. Shenk presented the review questions for STAC, and explained that answers to the questions on climate change and the Conowingo reservoir will be delayed until the model developers are finished with the work related to those questions. The review questions also do not address the following model sections: BMPs (which have a separate review process); WWTP and direct loads (which are decided by submitted data and a panel process, respectively); and nutrient inputs and land use (which are covered in their own STAC reviews).

Johnston explained that estimating the amount of manure and fertilizer applied to agricultural land in the Chesapeake Bay watershed is challenging because there is no observed data and survey results have many errors. Johnston overviewed the conceptual model for nutrient inputs in the Phase 6 CBWM, and detailed the underlying conceptual model used to estimate the total manure available for application to agricultural lands, as well as the new fertilizer estimation

method for Phase 6. Farmer-reported nutrient application rates are not available for the majority of agricultural acres throughout the calibration period (1984-2013), so the CBP developed "nutrient prescription" methods to distribute nutrient applications to crops, hay, and pasture.

Claggett presented the methodology for developing the 2013 land use/cover data set for the Phase 6 CBWM, creating an annual historical record from 1984 to 2013 for the purpose of model calibration, and incorporating the Census of Agriculture into the data. Claggett explained the difference between land cover data (i.e., impervious, herbaceous, water, etc.) and land use data (i.e., turf grass, cropland, pasture, fallow, forest, etc.). Claggett detailed the complex process of producing land use data for the Phase 6 Model from 1 meter resolution land cover data for the entire watershed and local parcel and land use data, and explained the methods for differentiating land uses. The new methodology for backcasting land uses annually from 2013 to 1984 uses the USGS' Continuous Change Detection and Classification (CCDC) data to identify every year of significant change then interpolating land cover/use change annually between years represented in the Chesapeake Bay Land Cover Data Series and the 2013 Phase 6 Land Use Dataset. Claggett updated STAC on peer reviews for these methods, and explained that the CBP Land Use Workgroup plans to produce land use forecasts out to 2070 with the Phase 6 Model.

Update on Reviews – *Rachel Dixon (CRC) and Bill Ball (CRC)*

Dixon and Ball updated STAC on the status, timelines, and panel members for the ongoing MPA reviews. Ball also asked STAC members to provide any suggested expertise needs and specific names/affiliations for the Generalized Additive Models (GAMs) review panel and to contact Dixon or Ball if interested in being on an upcoming review panel. Dixon will distribute a table outlining the status of the Midpoint Review panels and update STAC on a monthly basis.

ACTION: **STAC members** interested in becoming a STAC lead/reviewer on upcoming reviews should email Dixon at dixonra@si.edu or Ball at ballw@si.edu.

ACTION: **Dixon** will distribute a simplified spreadsheet of Midpoint Review panels that have formed to date. This document will be updated as needed. **UPDATE**: Dixon distributed the spreadsheet of Midpoint Review panelists and the status of reviews on 9/20/16.

Quarterly Meeting Report-Out and Next Steps

The meeting concluded with a discussion of next steps. Wainger asked if STAC should be offering clarity on the trade-offs of no-till. Kleinman suggested that the focus be broadened to nutrient management and conservation practices trade-offs, and that a STAC-led or separate effort investigate the long-term trends and the dissolved P concerns associated with agriculture in each watershed state - a STAC effort to provide spatial recommendations would be helpful. Rich Batiuk (EPA) recommended that STAC broaden the focus further to provide a collective sense of state of the science of P for stakeholders in the Bay watershed. Additional topics, such as advocating for using the concept of conservation systems to recommend suites of BMPs, clarifying the issues of soluble P and legacy P were also suggested. Kleinman offered to lead a STAC effort to investigate P trends and further discuss the state of the science and management recommendations on a physiographic basis. A workgroup, factsheet, or review were suggested activities. Wainger, Brosch, and Hirsch volunteered to help, with input from Glibert and Staver. STAC member Shirmohammadi recommended that STAC continue the conversation regarding

connections between climate change impacts on terrestrial lands and its impact on aquatic ecosystems at the December meeting. Wainger encouraged STAC members to email her or STAC staff with additional topics/suggestions for the December meeting. Since this was Hirsch's last quarterly meeting, STAC members applauded Hirsch, thanking him for his years on STAC.

ACTION: **Kleinman** will lead a STAC effort with the help of **Wainger**, **Brosch**, **Hirsch**, and potentially Glibert and Staver to capture the lessons learned about P trends and further discuss the state of the science/management through a workgroup, factsheet, or review. **UPDATE**: Kleinman will provide an update on this activity during the December 2016 quarterly meeting.

ACTION: **STAC members** should send agenda topics to STAC staff and Wainger for the December quarterly meeting.