B O S C
Board of Scientific Counselors

REPORT OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY BOARD OF SCIENTIFIC COUNSELORS SAFE AND SUSTAINABLE WATER RESOURCES (SSWR) SUBCOMMITTEE

RESPONSES TO CHARGE QUESTIONS

Safe and Sustainable Water Resources Subcommittee

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CHARGE QUESTIONS AND CONTEXT

The SSWR Subcommittee was charged with six questions as follows:

> Q.1a: Does the research outlined for the 2019–2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?
>
> Q.1b: Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?
>
> Q.1c: Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019-2022 time frame.
>
> Q.1d: Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?
>
> Q.1e: What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS

Introductory paragraph that highlights any overarching responses.

Charge Question 1a

Q.1a. Does the research outlined for the 2019-2022 timeframe support the relevant Agency priorities as described in the EPA and ORD Strategic Plans?

Narrative

EPA's and ORD Strategic Plans for 2018-2022 each describe three Strategic Goals. EPA's three Strategic Goals are: 1) it's Core Mission to provide the Nation with clean air, land, and water, and to ensure chemical safety; 2) Cooperative Federalism for shared accountability, transparency, and participation with the public; and 3) the Rule of Law and Process to ensure compliance with the Law, create consistency and certainty, prioritize robust science, streamline and modernize permitting and reporting systems, and improve efficiency and effectiveness of its business processes. ORD's three Strategic Goals are: 1) advancing environmental science and technology; 2) Cooperative Federalism to inform and support federal, state, tribal and local decision-making; and 3) enhancing the ORD workforce and workplace. As described in the ORD Strategic Plan, ORD's strategic goals and objectives directly link to EPA's strategic goals and objectives, to ensure that ORD research outputs will assist EPA in achieving its goals and objectives.

To answer this charge question, the four research objectives[1], three research topics[2], and associated research areas and outputs[3] presented in the SSWR StRAP were evaluated against EPA's and ORD's stated strategic goals and objectives. For some EPA and ORD goals and objectives, this evaluation was not deemed relevant since they were not considered research oriented. These included improving EPA's business processes, modernizing EPA's permitting and reporting processes, and enhancing the ORD workforce and workplace.

Strengths

- The research objectives, topics, and areas described in the StRAP are aligned with the strategic goals identified by EPA and ORD. The associated research outputs are therefore expected to support EPA and ORD's strategic goals, especially EPA Strategic Goal 1 (Core Mission) and ORD Strategic Goal 1 (Advancing environmental science and technology).
- The stakeholder engagement described in the StRAP is aligned with and considered to support EPA's and ORD's Cooperative Federalism Strategic Goals.

Suggestions

- While the research objectives, topics, and areas outlined in the StRAP are aligned with EPA's and ORD's strategic goals, it is less clear how success in meeting those goals will be evaluated. ORD's strategic plan talks specifically about measures of progress (e.g., increase the number of research products meeting customer needs under each ORD goal). Where possible, we suggest that the StRAP similarly describe measures of success for the different research outputs.

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[1] The four research objectives identified in the SSWR StRAP are: 1) Improve Prediction and Early Accurate Detection of Contaminants; 2) Assess Potential Impacts; 3) Develop and Evaluate Approaches for Prevention and Mitigation; and 4) Translate and Communicate Research.

[2] The three research topics identified in the SSWR StRAP are: 1) Watersheds; 2) Nutrients and Harmful Algal Blooms; and 3) Water Treatment and Infrastructure.

[3] The three research topics identified in the SSWR StRAP each contain 3-4 research areas and a total of 31 research outputs, as summarized in Appendix 4 of the StRAP.

- The StRAP describes four research objectives1. However, the remainder of the StRAP is organized by three research topics with associated research areas and outputs as summarized in Appendix 4. Under the current format, it is not clear how the four research objectives relate to the three research topics and associated areas and outputs. This could be clarified under the Program Objectives section and potentially detailed through a revision of Appendix 4.
- There is clearly programmatic overlap between EPA, its federal and non-federal partners, and other stakeholders in many of the research areas described in the StRAP. Where possible, we suggest that EPA identify such overlap and describe existing or planned coordination activities to maximize research complementarity, minimize duplication, and provide efficient expenditures.

Recommendations

The Subcommittee offers this recommendation to ensure that the partner and stakeholder surveys support EPA's and ORD's Cooperative Federalism Strategic Goal.

Recommendation 1a.1: SSWR has clearly strengthened its partner and stakeholder engagement within the EPA organization, including EPA's regional offices. However, results from outreach to state agencies, professional organizations, and academia show room for improvement, both in number of participants that provide input and in the quality or relevance of the input received. With respect to the ERIS survey, it is recommended that:

- The survey should address structural issues to ensure reliable input is received on the basis of unbiased, non-leading questions.
- ORD should conduct the surveys separately for each of the six research areas and coordinate through ECOS to ensure state management is involved. Currently, ERIS operates through a designated "science contact" in each state that are not all in the same program area nor level of experience.
- The process and schedule for collecting input should be clearly documented in the StRAP so the participants, timeline, and expectations are known and transparent.

Charge Question 1b

> Q.1b. Each ORD research program undertook a rigorous engagement process to provide additional detail on specific EPA program and region, state, and tribal needs, the results of which are summarized in the StRAP objectives and explanations of research topics and areas. How well does the proposed research program respond to these partner-identified needs?

Narrative

The subcommittee was impressed by ORD's effort to solicit information about the needs of states, tribes, and regions, via surveys and meetings, and to align research activities with the needs identified by the partners.

Important concerns with the survey process were identified, however. The survey questions posed were very limited (11 questions, with "other" listed as question 12) and seemed biased towards specific research interests. For example, the question asking about the concern of "Toxics and Chemicals of Emerging Concern Including PFAS" led respondents to identify PFAs over other potential contaminants such as pesticides or pharmaceuticals.

Some research outputs identified by partners were not addressed in the StRAP, with insufficient explanation. For example, a partner in the NTWC spring 2018 survey identified the research need for a "hydraulic fracturing water reuse study for evaluating ecological impacts." In the StRAP, ORD's response was "this need will not be addressed," with no further justification. Additional items identified by partners that are listed as not being addressed include: a) Groundwater remediation: would be beneficial to see data from past in situ efforts and designs related to hydro technologies; b) Nutrient impact on wastewater reservoirs from water reuse; and c) Human health & ecological effect studies for large vessel ships - dumping sewage and gray water in international waters. The surveys also identified resiliency challenges that are not addressed. The subcommittee urges greater transparency in explaining why partner-identified requests like these were denied. For example, ORD could respond by saying that these concerns are being addressed elsewhere in the EPA, or by other agencies with some specifics.

Some research outputs listed in the StRAP did not align with the needs identified by the surveys. For example, sensors were identified by EPA as a research need. Our concern is that states don't necessarily need sensors and did not ask for sensors. Yet, it appeared that some research outputs were designed to satisfy the basic research interests of ORD scientists instead of addressing the needs of clients. However, the subcommittee recognizes that not all ORD research should be in response to client needs. For example, states are necessarily reactive: they identify problems and thus are in clean-up mode. EPA should be in preventative mode, and thus some research funding should be in response to solution-driven preventative needs.

In 2018 ITRC document, there is not a clear indication of what activities will be prioritized by the EPA. There should be a ranking criteria of the items that will be addressed for this 4 yr period. It is likely that research activity may not have been completed from the prior StRAP period that needs continuation.

Those uncompleted items should be mentioned, some of which may not have overlapped with current interests but still need continued attention. In addition, there should be clarification on why certain topics have been continued over topics that are no longer being addressed.

Strengths

- The subcommittee commends ORD for their effort to solicit information about the wide-ranging needs of states, tribes, and regions; and for their use of this information in guiding research program activities.
- The subcommittee commends ORD on the tangible research approaches that have been mapped out to address the key objectives identified by the partners. The research agenda outlined in the StRAP will further assist in providing solutions for safe and sustainable water resources in the states and regions, and to advance environmental protection.

Suggestions

- Justification should be provided for research needs identified by partners that will not be addressed by ORD. The subcommittee understands that research will not be performed for all the concerns suggested by stakeholders for a number of reasons. It is important to maintain as much transparency as possible with these stakeholders and describe why certain topics will and will not be addressed.
- Further consideration should be given to leveraging research expertise and maximizing the value of research expenditures through strategic partnerships. Given that ORD cannot perform all the potential research outlined either by stakeholders or through internal ORD researchers,

partnerships with other federal agencies and private foundations should be explored so that limited funds can be leveraged and provide opportunities for others (i.e., DOE, USGS, NOAA, AWWA, WRF) to champion important research topics.

- Additional research expertise could be provided by ORD to further support needs of its state and federal partners. ORD has substantial expertise in synthetic data analysis, advanced measurements, and terrestrial and aquatic modeling that could be harnessed to provide specific answers to individual state and tribe needs. For example, ORD staff could work together with individual states to develop localized remediation plans, individual watershed TMDLs, and detailed numeric nutrient criteria; going beyond technical information or guidance toward providing new solutions that the states and tribes can use.

Recommendations

The Subcommittee offers these 2 recommendations to capitalize on [describe charge question]

Recommendation 1b.1: ORD should expand efforts to obtain information about partner needs by using surveys and other methods. The use of surveys to gather information from state and tribal partners a proper strategy. However, the survey questions were not general enough to solicit the range of stakeholder concerned issues. Survey questions to identify partner needs should not be leading questions but rather more open-ended. As briefly mentioned above, questions should be generic and not make any subtle suggestions to the respondent about what might be of interest to ORD. We recommend that survey questions be re-designed to better determine stakeholder priorities. In addition, survey questions should be designed with more participants in mind through strategic partnerships (i.e., NOAA, AWWA, WRF, etc). ORD should explore additional strategies to solicit detailed information about partner needs. If research needs identified by the partners are not funded or prioritized, more explanation should be offered.

Recommendation 1b.2: ORD should prioritize research activities. Given the budget constraints of EPA as well as the short 4-year time frame associated with developing outputs for StRAP, there needs to be a better articulation of the high level priorities that can be accomplished, and consideration of the other topics that could be accomplished with strategic partners such as other federal agencies, private research foundations, and academic institutions.

Charge Question 1c

> Q.1c. Does the StRAP, including the topics, research areas, and proposed outputs, clearly describe the strategic vision of the program? Given the environmental problems and research objectives articulated, please comment on the extent to which the StRAP provides a coherent structure toward making progress on these objectives in the 2019-2022 time frame.

Narrative

The StRAP describes four overarching Research Objectives and then identifies three closely related Topics under which the proposed research efforts are organized (watersheds, nutrients and harmful algal blooms, and water treatment and infrastructure). Presented under each Topic are the broad research areas and programs that are identified by Region, State, and Tribal needs. These lists identify specific research activities intended to be responsive to those needs. The process through which the proposed research will meet these needs are described in a series of 31 Outputs. The 31 Outputs collectively reflect

the direction proposed for the SSWR in FY 2019-2022. It is acknowledged that achieving these Outputs will depend upon budgetary appropriations.

The Subcommittee attempted to address this Charge Question by examining the proposed program as a whole. We examined whether the Research Objectives clearly reflect agency and ORD priorities, whether the Topics clearly provide understanding of the program's organizing framework, and whether the research areas and Outputs, taken together, provide a Vision that is both appropriate for EPA's mission and adequate to achieve the Research Objectives.

Strengths

- The StRAP provides a reasonably comprehensive examination of some the important challenges our country faces in providing safe and reliable water supplies within the context of EPA's mission. It also provides guidance on scientific, technological, and translational efforts required to respond to these particular challenges. At a broad level the StRAP communicates how these needed efforts will support the EPA's mission and its various Congressional mandates, to provide a relatively clear path forward for addressing the EPA's highest priority research objectives for safe and sustainable water resources.
- The needs of various stakeholders, as described in the StRAP have been given high priority in the proposed research program, and the 31 Outputs are generally satisfactory responses to those needs. The information, tools, and capabilities described in the Outputs, if delivered in efficient and understandable ways, should provide substantial support for those stated needs.
- At a technical level, the StRAP provides a relatively clear, albeit very broad, vision of the leading requirements for advancing the proposed research efforts. Of particular value is the emphasis on expanded analytical methodologies, continued environmental monitoring, and enhanced modeling capabilities. Moreover, the focus on delivering tools directly to stakeholders is rightly highlighted.
- Overall, the StRAP is a well-conceived and thoughtful guide to (for) addressing many of EPA's and their stakeholder's highest priority issues within the context of EPA's Safe and Sustainable Water Resources research program.

Suggestions

- The Subcommittee believes the StRAP could be improved to provide better understanding of its stated and implied strategic vision.
- Consider introducing some sense of program priorities.
  Are the 31 Outputs all of equal importance? Is there a difference between Outputs that are intended to apply nationally and those that are to apply locally? It is perhaps not critical to identify specific priorities, but a discussion of the topic would be useful as the planning effort moves ahead to identify more specific research undertakings. Some guidance on priorities will support these objectives, as well as development of future budget documents.
- Consider introducing some discussion of how success over the 2019 - 2022 planning horizon will be measured and reported. A plan that does not include an approach for assessment of success of the overall program would seem to be deficient. The StRAP now contains a roadmap for progress but no plan for allowing stakeholders to understand whether objectives are being achieved in a timely manner.
- Consider reorganizing Topics and providing clearer objectives for each of the tasks.
  The three Topics convey quite different messages about how the overall research program is organized, which adversely affects communication of the overall vision. While "Treatment and Infrastructure" reflects the research content clearly, "Watersheds" seems a "force-fit" for its

content; "Nutrient and Algal Blooms" is an entirely different category of activities. There is, no doubt, a need for some type of categorization of research areas, but the current Topics impede efforts by not articulating exactly what the SSWR is trying to achieve. Further, the relation between the four Research Objectives and the Topics is difficult to track.

- Consider improving consistency in the wording of Outputs.
  Some Outputs are fairly specific in what is to be expected from the research (e.g. Outputs 1 and 20); some are very broad and less clear (Outputs 5 and 23), and some are in between (Outputs 13 and 29). Not enough effort has gone into communicating specific expected Outputs, and the program vision is somewhat blurred as a result.
- Consider accounting for unanticipated changes in scientific advances and consumer market demands that may require modifying targeted CEC lists. For example, over-the-counter and prescription sales volume or demands of popular pharmaceuticals may quickly or unexpectedly change when newer classes of similar drugs are approved, or observed to have unexpected environmental effects. The StRAP responsiveness may be improved by giving thought to such issues. This would ensurie the agency remains nimble and adaptable when priorities or changes to the threat landscape occurs.
- Consider uncertainties in capturing information on stakeholder needs. The StRAP responds well to the described stakeholder needs, but there is uncertainty regarding the methods used to capture and understand those needs. The StRAP should consider elaborating further on this issue and pointing to efforts needed to improve understanding of these needs in the future.
- Consider identifying unmet needs. The StRAP provides little sense of what is not captured in its research program. A discussion of this matter would not suggest the SSWR program is deficient, but would reflect how well the program is in touch with future challenges. No research program is expected to be complete, but a program should reflect an awareness of the challenges that lie ahead.

Recommendations

The Subcommittee offers these [number] recommendations to capitalize on [describe charge question]

Recommendation 1c.1: Research Objective 4 (Translate and Communicate Research) is partially met in the StRAP. The Outputs clearly and appropriately emphasize communication of results (data, tools, models) to stakeholders, and this is clearly essential to the SSWR program's success. There is, however, no mention of how to communicate information on risks to public health and the environment when discovered as a result of agency research. Risk communication is far more complex than is communication of a strictly technical nature. Ineffective or unclear communication concerning human health or negative environmental impacts can have many adverse consequences, including distrust of agency results. The SSWR should review the role of risk communication in its general communication efforts, its value to stakeholders, and of the significant guidance that is available from authoritative sources on appropriate strategies for communicating risk.

Charge Question 1d

> Q.1d: Recognizing ORD's focus on addressing identified partner research needs, in the presence of reduced scientific staff and resources, are there any other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?

Narrative

As the nation's pre-eminent research organization devoted to addressing and solving environmental problems associated with water, ORD has the difficult task of balancing its programmatic needs between meeting the immediate and pressing needs of its clients, and maintaining capabilities and capacities to meet the nation's emerging threats and challenges. The current SSWR StRAP reflects the extensive effort that was invested in communicating with its clients about their needs. However, given the increasing threats to the nation's water resources and supplies (i.e., changing environmental conditions due to climate change, aging infrastructure, increased nutrient and contaminant loading, decreased water quantity and quality), and the potential for unknown threats and stressors resulting from genetic mutations, newly manufactured drugs and chemicals, and novel interactions resulting from extreme climatic events and warming, ORD must develop a parallel strategy for identifying *new and emerging* issues of concern and developing practical and cost-effective solutions. Thus, we have three distinct recommendations, the first which pertains to ORD as a whole, and the next two pertain to SSWR specifically.

1. Find balance between meeting the immediate needs of customers and anticipating emerging issues by **developing a formal process for conducting "horizon scanning" exercises** that will: a) identify threats that are known to be coming; and 2) anticipate the "unknown-unknown" threats by identifying the necessary skillsets, data and information required to identify actionable issues. To meet new and emerging threats in a proactive, rather than reactive manner that is cost effective and efficient, ORD as a whole must maintain its capacity to anticipate and innovate. Two historic examples of EPA investments that have paid substantial dividends and were transformative to their disciplines include: 1) the development of the field of computational toxicology, which revolutionized the practice of chemical testing, and 2) EMAP, which fundamentally changed approaches for conducting environmental monitoring. Investments such as these do not need to consume large portions of the budget, but when chosen wisely, can result in cost-effective problem-solving of future threats and challenges.
2. Invest resources in addressing two different areas: a) developing solutions to address the ramifications of changing climate and b) investing in the next generation of environmental monitoring and assessment tools and technologies.

We recognize that EPA is not a climate change management organization; however, it must consider the ramifications of extreme events and long-term changing climate patterns in all of its water-based programs. In particular we feel the following areas merit further investment, (if not a mention of current activity in the current StRAP):

- Stressor interactions of intense storms / warming on:
  - Ocean acidification
  - HAB toxicity (economic and environmental impacts on drinking water and recreation)
  - Hypoxia
  - Water quality characteristics, esp. with respect to nutrients and chemical contamination

- Impacts of changing hydrologic regimes on:
  - balance between water reuse and biological responses
  - stormflow intensity and water quality characteristics
  - Ecological, economic, and social impacts of diminished water availability

    - Groundwater-surface water interactions

- Changing patterns of biota:
    - Invasive species impacts
    - Pathogens (redistribution: new and emerging)
    - HAB distribution and toxicity patterns
    - Impacts on biotic metric (e.g., Index of Biotic Integrity) responsiveness and effectiveness

In addition, ORD must continue to invest in the next-generation environmental monitoring and assessment tools and technologies. This includes new investments, as well as making better use of existing tools and technologies within and across EPA and ORD, as well as other agencies and programs across government, academia, and the private sector. For example, increased connectivity and interoperability across data and tools can enhance data and information delivery to researchers and end users. An evaluation of the best uses for community-engaged science, including use of Traditional Ecological Knowledge, could provide a cost-effective means to expand the geographic and topical scope of data for assessing status and trends of environmental conditions. Additional areas of enhancement include:

- Genomics (and other "omics")
    - Microbiology:
        - Faster methods for detection and risk identification (e.g., new pathogen detection; level of pathogenicity)
        - Source identification
    - Genetic barcoding
        - Method standardization
        - Expansion to extracellular DNA
        - Indicator development and benchmark setting
    - Other Diagnostic Tools ("Omics"-based)

- Technologies for detecting, analyzing, and remediating chemical of emerging concern
    - Beyond PFAS
    - Pharmaceutical monitoring and assessment / remediation
    - Scanning methods for monitoring and remediating chemicals of emerging concern

- Automated Monitoring Technology Development
    - Unmanned drones for characterization and sample collection
    - Sensor development – all cost points
    - Big Data analysis and visualization

Strengths

The panel noted many strengths of the StRAP. The first was the obvious and extensive communication with clients including OWOW, Regions, States, and Tribes. The panel also noted that several very high-profile areas have received a lot of attention in the Watershed and HAB programs to identify important technology needs, and to integrate and leverage existing innovative technologies including remote sensing, and (unspecified) use of "omics". Also noted were efforts to develop guidelines for the development of safe cyanotoxin levels in drinking and recreational waters. The panel was also encouraged by the focus on lower food webs dynamics, which can provide an "early warning system" for identifying human and environmental health threats. Further, the research emphasis on nano/microplastics is noted;

however, in addition to evaluating potential health effects, there is an urgent need to identify standardized methods for sampling and characterizing these particles. This plastics program presents an opportunity for collaboration across multiple ORD programs (e.g., SHC, HSRP, CSS). Finally, the panel noted the comprehensive and ambitious set of outputs. We encourage the scientists and communication staff to consider multiple methods for disseminating research results with a focus on both peer-reviewed as well as social media venues.

Suggestions

The panel noted a number of areas where new issues could be considered or improvements could be made to the StRAP. As noted in our recommendations, the panel is very concerned that ORD must maintain its capacity to identify future and emerging issues of concern. While it is undeniably a critical function of EPA as a whole to meet to the needs of its end users and clients**, there is no other single organization in the government or the private sector that has the capacity to proactively address new and emerging issues that could threaten human and / or environmental health**. A specific strategy for conducting such 'horizon scanning' activities must be implemented for EPA, and ORD in particular. In addition, sufficient institutional and human resources must be maintained to quickly and cost-effectively deal with the 'unknown-unknown' threats when they appear. The agency cannot only rely on scientists attending professional conferences and keeping up with the literature to provide the necessary intelligence to identify new and emerging threats and stressors. Thus, **we recommend that a specific strategy be developed to identify sources of data and information required to: identify issues in advance of their becoming a threat, or identify when an existing issue will become a serious problem.**

Other suggestions offered by the panel focused on the StRAP document and its focus. These include: 1) there is a clear need to identify the link between Technical Support and Research, and the criteria used to elevate a request for support to the level of a research question and program. It is not clear to the panel that the survey was a particularly effective tool for identifying the key research questions that would best serve the Regions, States and Tribes. 2) Several pressing environmental problems were noted (pages 3-5), but were not further addressed within the Program Descriptions. These include Stormwater; Diminished Water Availability; and Wetlands (arguably not a problem, in and of themselves). 3) Nano/micro plastics are noted in the Watershed program, but are not listed as a category of environmental problems. 4) The topic of Resiliency is discussed in the Integration section, but not addressed elsewhere. 5) The Integration section does not address the potential for use of the USGS's new NHD products in the Watershed Program. Furthermore, the panel is unsure whether this list of topics for integration represent the full potential to maximize and leverage resources across programs. 6) The San Juan River Watershed program is an "odd duck" within the Watershed Program; its specific nature is an anomaly and the report would benefit from some additional contextual information. 7) Description of the Communication Strategy seems to rely heavily on traditional media and methods, e.g., peer reviewed papers, workshops for dissemination of results. Younger audiences require different communication strategies centered on social media. In addition, tools such as the EnviroAtlas appeal to a broad audience and could be used more widely to provide a platform for disseminating research results. A secondary benefit would be that its user base would in turn be enhanced by increasing interoperability with other analytical and information-delivery tools. 8) Both benthic and pelagic algal blooms are important, but the report largely ignores activities that address the benthic component.

From a programmatic perspective, this team also identified some additional opportunities and comments. First, the panel suggests that there is a need for a strategy to address other classes of chemicals than PFAS, PFOAs. PFAS are an obvious problem, but there are other families of chemicals for which the threat is clear (e.g. pharmaceuticals) or for which there is insufficient data to determine the exposure risk. Second,

given the clear cost-effective nature of preventative measures compared to remediation followed by restoration, could ORD identify particular threats for which the agency could collaborate with conservation and management agencies and organizations to: 1) prioritize the types and locations of threats for which prevention measures might produce the greatest cost-benefit, and 2) identify the most effective protection practices and strategies for given stressors.

- WRITING TEAM: I also have on my list: Opportunities open to address impacts on lower and upper food web dynamics. I don't know what to say about this, as up above, we state that we are pleased that they are addressing lower food web dynamics. Please help.

Recommendations

The Subcommittee offers these recommendations to identify other critical emerging environmental needs or fields of expertise and/or new research methods where this program should consider investing resources?]

Recommendation 1d.1: Develop a deliberate process for identifying emerging stressors and problems.

Recommendation 1d.2: Invest further resources in:

- developing solutions to address the ramifications of changing climate (Extreme Events and Warming);
- developing/refining next generation environmental monitoring and assessment tools and technologies.

Charge Question 1e

> Q.1e. What are some specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems?

Narrative

We interpret market based approaches and prizes or challenges as targeting two distinct audiences: industry, and secondary education institutions. In either case, to create successful incentives, it's important to engage and promote end user participation to develop the structure for incentives. We suggest working together with industry associations (e.g. American Society of Civil Engineers, American Water Works Association, and State Water Environment Associations) for a "finger on the pulse" of practitioners.

Regarding educational institutions, we suggest targeting specific populations, but consider that undergraduate engineering programs have very little flexibility and high demands on student time for course work, whereas graduate student schedules are more flexible. High school opportunities are entirely different. To encourage participation, we suggest giving the competition structure support, and give greater recognition to faculty and teachers behind the student teams. Opportunities to engage corporations to partner may raise their corporate profile as good stewards and promote education amongst these stakeholders.

In considering a plan for developing new incentives or challenges, it would be useful to understand the success of previous efforts. To date, how has EPA measured the success of incentives or challenges? These represent substantial investments in time and volunteer work (e.g., for judging, etc). What evidence is there of a connection between an incentive or challenge to change the broader community's behavior supporting EPA's objectives under the CWA and SDWA?. For example, has EPA compiled information on previous competitions or incentives and their long-term impacts? If so, can this be used for public interest/good PR? We consider communicating success stories important.

We are aware of several tertiary education sector challenges. Does EPA have any activities directed to high school audiences?

Strengths

- Partnerships with NIH, USDA, USGS.
- Partnerships with tertiary education institutions such as Campus RainWorks Challenge.
- Programs such as National Municipal Stormwater and Green Infrastructure Awards Program.
- Challenges such as: Nutrient Sensor Action, Advanced Septic Nitrogen Sensor and Arsenic Sensor.

Suggestions

- Have regional EPA offices partner with state regulatory counterparts; in particular, the state regional basin coordinators who are responsible for assuring that the regulated community develops and implements TMDLs in their respective basins or watersheds. The goal of this partnership is to reinforce the implicit rewards that a given sector of the regulated community can realize if they meet the TMDL goals of improved water quality.
  For example, if a wastewater treatment plant with known levels of mercury in its discharge, and the receiving stream is water quality limited for mercury, can develop and implement a mercury minimization plan to effectively reduce the concentration in its discharge, then the state may be able to reduce or lift restrictions on fish consumption.
  A secondary benefit may be that after word of this success story spreads, more anglers will come into the area, boosting the local economy, and providing a safer environment for those who like to eat what they catch.
- Provide incentives for market based approaches such as streamlined or reduced permitting requirements, grants to assist with initial development, or industry recognition to encourage innovative development to reduce nutrients. Methods such as algal harvesting have a great amount of potential.
- Work with innovation incubators and investors to better understand the emerging innovation economy, and better understand where market based incentives might best be targeted.
- Pursue opportunities for EPA staff to serve as visiting instructors. Teachers are more prone to include new material if they do not have to create it all themselves. A co-benefit to EPA staff is to stay current on topics at hand.
- Explore technologies for harvesting and reusing materials captured in stormwater treatment practices (aka stormwater control measures or best management practices). Heavy metals might be more of an economic incentive, whereas there is generally more data on nutrient capture.
- Develop programs to encourage extracting nitrogen and phosphorus from the soil profile or runoff. N and P are currently inexpensive, thus it is easier for farmers to continue applying more, rather than harvesting what is already building up in the soil. Successful examples from Southern California nurseries who are harvesting and reapplying their own irrigation water, thus substantially reducing

application of new N and P. Programs should be developed to collaborate with Regions, USDA and/or state extension services.

- Create incentives for using agricultural byproducts that would otherwise contribute to nutrient loading and generating electricity. An existing example emerges from a power company that seeks converting methane from hog waste digestion to electricity.
- Create partnerships to address reducing sediment loads from construction, which is not currently mentioned in the StRAP. Construction sediment loading is a significant issue for watershed management, especially in highly developed urban areas.
- Create partnership/incentive for water conservation such as a Fit Bit for domestic water use. What would drive/encourage people to continue conservation after droughts and mandatory conservation ends?
- Conduct a detailed literature search of the hundreds of case studies that provide insights on how to introduce more market related incentives for environmental protection, such as *Economic Valuation of River Systems*.

Recommendations

The Subcommittee offers these recommendations to capitalize on specific ideas for innovation (including prizes/challenges) and market-based approaches that the program could use to advance solutions to existing and emerging environmental problems

Recommendation 1e.1: Paradigm shift to reduce enforcement penalties (not eliminate) and to increase incentives.

SUMMARY LIST OF RECOMMENDATIONS

Add just the list of recommendations, if this is helpful.

CONCLUSIONS

Add brief text that summarizes main findings.

APPENDIX A: MEETING AGENDA

APPENDIX B: MATERIALS

Material Provided in Advance of the Meeting

Materials to Support the Charge Questions

- Bulleted list

Informational Materials

- Bulleted list

Additional Material Provided During the Meeting

- Bulleted list