



BOSC

BOARD OF SCIENTIFIC COUNSELORS

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

RESPONSES TO CHARGE QUESTIONS

BOSC Safe and Sustainable Water Resources Subcommittee

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LIST OF ACRONYMS

BOSC	U.S. EPA Board of Scientific Counselors
CATME	Combustion Alternative Treatment for Microplastics in the Environment
COVID-19	Coronavirus Disease 2019
EPA	U.S. Environmental Protection Agency
FY	Fiscal Year
LIDAR	Light Detection and Ranging
NHD	National Hydrography Dataset
NOAA	National Oceanic and Atmospheric Administration
NWI	National Wetland Inventory
ORD	U.S. EPA Office of Research and Development
OW	U.S. EPA Office of Water
RARE	Regional Applied Research Efforts
SSWR	Safe and Sustainable Water Resources national research program
StRAP	Strategic Research Action Plan
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

INTRODUCTION

The U.S. Environmental Protection Agency (EPA's) Board of Scientific Counselors (BOSC) Safe and Sustainable Water Resources (SSWR) Subcommittee appreciates the opportunity to provide input on planned research products. The Subcommittee met October 28–29, 2020, November 17, 2020, and December 2, 2020 to review the initial progress on implementation of the fiscal years (FY) 2019–2022 SSWR Strategic Research Action Plan (StRAP). The Subcommittee understands that the products are at an early stage and recognizes the need for time and flexibility to carry out research during the Coronavirus Disease 2019 (COVID-19) pandemic. The Subcommittee appreciates the creative efforts to continue working to the extent possible from remote locations.

CHARGE QUESTIONS AND CONTEXT

The SSWR Subcommittee was charged with addressing a series of questions about the SSWR Research Program. Charge questions were as follows:

Q.1: Progress towards characterizing microplastics in the environment and uncertainties about their potential environmental health effects requires reliable and consistent methods. SSWR is conducting research to develop and standardize collection, extraction, identification and quantification methods for microplastics. Based on the progress and results to date, what suggestion(s) or recommendation(s) does the Subcommittee offer on research into addressing the uncertainties and challenges associated with the Agency's efforts to develop reliable and consistent microplastics analytical methods? [Research Area 1, Output 4]

Q.2: Existing geospatial datasets are often limited with respect to mapping rivers, streams, and wetlands with the degree of accuracy and at the resolution needed to support federal, state, tribal, and local water management decisions, including identifying "waters of the United States" subject to Clean Water Act jurisdiction. SSWR is leveraging existing interagency partnerships to improve the accuracy and application of geospatial data for mapping aquatic resources nationally. What suggestion(s) or recommendation(s) does the Subcommittee offer on further identifying emerging technologies, methodologies, and datasets to improve aquatic resource mapping tools and their application for federal, state and local water management decisions? [Research Area 2, Output 1]

Q.3: To help reduce health risks associated with exposure to fecal contaminants in recreational waters, SSWR is conducting research to strengthen the scientific basis of existing, and to advance new, fecal contaminant detection methods, source tracking, predictive tools, and health effects assessments that contribute to human health recreational water quality criteria programs. As the research progresses, what suggestion(s) or recommendation(s) does the Subcommittee offer on continuing to identify and conduct research of greatest importance to advancing human health protection from fecal contaminants in recreational waters? [Research Area 3, Output 1]

The responses of the SSWR Subcommittee to the charge questions are contained in the following section.

SUBCOMMITTEE RESPONSES TO CHARGE QUESTIONS

Charge Question 1

Q.1: Progress towards characterizing microplastics in the environment and uncertainties about their potential environmental health effects requires reliable and consistent methods. SSWR is conducting research to develop and standardize collection, extraction, identification and quantification methods for microplastics. Based on the progress and results to date, what suggestion(s) or recommendation(s) does the Subcommittee offer on research into addressing the uncertainties and challenges associated with the Agency's efforts to develop reliable and consistent microplastics analytical methods? [Research Area 1, Output 4]

Narrative

Numerous recent studies have documented the pervasiveness of microplastics, which EPA's Office of Research and Development (ORD) defines as particles 5mm–1 nm¹, in the environment that may lead to human exposure through inhalation and ingestion. Researchers throughout the world are working to build a foundational understanding of the sources, transport routes, overall fate, and health impacts of microplastics. Science professionals worldwide commend SSWR for entering this field, but EPA is late to start researching and their investments must be selective to ensure they complement, rather than duplicate, the research that other institutions are already undertaking. The research SSWR is conducting achieves that goal.

SSWR's initial strategy focuses on measurements, which the Subcommittee believes is well-advised. Current limitations in method harmonization, and quality assurance of those methods, will prevent or hinder progress in understanding the effects of microplastics in the environment.

While there are several international efforts to achieve microplastic method standardization, SSWR has appropriately identified three niches that are relatively understudied, and for which they can effectively address gaps in the field. The first of those is measurement methods for microplastics in sediments. Most ongoing work is focused on measurements in aqueous media. Sediments present a challenge because of the additional step needed to separate plastics from the sediment before researchers can perform the measurements. This is a particularly appropriate activity for SSWR because EPA runs the National Coastal Condition Assessment, a national program that assesses that ecological condition of coastal aquatic resources, including sediments. This provides a natural implementation outlet for this product.

The second methodological research area is nanoplastics, which is another wise choice. Unlike microplastic measurements, which have many investigators, there are few groups working on nanoplastics measurement methods, despite increasing research that point to the toxicological nature of these smaller particles. ORD is scientifically well-positioned to implement this research, given their history in assessing non-plastic nanotechnology.

The third research area is exploring cheaper methods that can serve as a prescreening tool to determine whether or not implementing more expensive methods yielding information on shape and chemical composition is warranted. In particular, their proposal to investigate the combustion alternative treatment for microplastics in the environment (CATME) method for rapid determination of total plastics in sediments shows great promise. Such prescreening techniques, if successful, will have many applications. For instance, more frequent, cost-effective screening of drinking water would help

management groups focus and prioritize geographies or water sources that need additional treatment. Simplified methods would also allow volunteer groups to contribute to the knowledge base. This is another part of the measurement field that is relatively understudied, and to which SSWR could make a substantial contribution.

Measurement methods to characterize microplastics is the appropriate starting point. SSWR should begin work now towards developing a strategy for incorporating both environmental and human health effects into the next StRAP. Health and toxicological effects can vary by particle size, shape, and composition, as well as potential pathways of exposure. Consequently, developing a research framework on those micro or nanoplastics that have the greatest potential for adverse environmental and health outcomes is critical in tandem with methodological development.

Strengths

SSWR has identified measurement method niches which are understudied and for which they have competencies that make them the right group to pursue those research lines.

BOSC commends SSWR for forming partnerships to achieve this mission. In particular, their work through the Regional Applied Research Effort (RARE), a program that responds to the high-priority research needs of EPA regional offices, has helped connect them with the State of California, which is scheduled to become the first state to begin requiring routine monitoring of microplastics. Moreover, their partnership with the American Society for Testing and Materials facilitates collaboration with other researchers who are working to standardize measurement methods.

Suggestions

Continue investment in the three measurement niches as proposed. These are well-thought out and will make valuable contributions to the field. SSWR's capacity-building investments to focus on producing quality assurance and laboratory accreditation guidelines impressed the Subcommittee.

Recommendations

The Subcommittee offers the following recommendation to support the relevant Agency priorities:

Recommendation 1.1: Measurement methods to characterize microplastics is the appropriate starting point. SSWR should begin work now towards developing a strategy for incorporating both environmental and human health effects into the next StRAP.

Charge Question 2

Q.2: Existing geospatial datasets are often limited with respect to mapping rivers, streams, and wetlands with the degree of accuracy and at the resolution needed to support federal, state, tribal, and local water management decisions, including identifying "waters of the United States" subject to Clean Water Act jurisdiction. SSWR is leveraging existing interagency partnerships to improve the accuracy and application of geospatial data for mapping aquatic resources nationally. What suggestion(s) or recommendation(s) does the Subcommittee offer on further identifying emerging technologies, methodologies, and datasets to improve aquatic resource mapping tools

and their application for federal, state and local water management decisions? [Research Area 2, Output 1]

Narrative

SSWR is responding to the needs of EPA's Office of Water (OW) and the Army Corps of Engineers (USACE) to identify the jurisdictional Waters of the United States, particularly with respect to the challenges associated with identifying headwater streams (ephemeral and intermittent) and adjacent wetlands connected to jurisdictional rivers under "normal" flow (i.e., a typical year as defined in the Navigable Waters Protection Rule). The Agency is participating in an interagency collaboration with other partners, including USACE, the United States Geological Survey (USGS), and the United States Fish and Wildlife Service (USFWS) to discuss the uses, strengths and limitations of existing data such as the National Hydrography Datasets (NHD) and National Wetland Inventory (NWI) and to recommend possible improvements to those data sets. The goal of SSWR's research effort is to improve upon the classification of jurisdictional waters in areas that cannot be mapped accurately using existing data sources. This effort focuses on use of high-resolution imagery, topographic data, and various types of models distributed across multiple geographic areas that represent a particular challenge for mapping using existing tools. SSWR's effort is concentrated on case study watersheds with existing high-resolution data and modeling tools, with the expectation that tools, and approaches developed for these areas can be extrapolated to other regions.

Strengths

The Agency is to be commended for its participation in interagency efforts (e.g., with USACE, USFWS, and USGS) to identify strategies and tools for mapping jurisdictional waters, especially with a focus on filling gaps, and addressing known deficiencies in regional data sources such as NWI and NHD. In addition, the Agency has conducted a comprehensive literature review and data assessment to identify specific areas for which there is extensive high-resolution data (including satellite imagery, light detection and ranging [LIDAR]) as well as modeling tools (e.g., dynamic TOPMODEL). The group has identified a specific gap in modeling approaches that can be used to predict the probability of riverine flooding that will lead to overflow into adjacent wetlands.

Suggestions

The Agency is participating in interagency discussions regarding the use and enhancement of regional data sets that could prove useful in mapping a large percentage of the jurisdictional waters. SSWR's research effort seeks to fill the gap in areas that cannot be mapped using those existing data and tools. Additional resources that might be explored include use of the models WetLandscape or PHYLiSS (McKenna et al. 2018), which was developed in the Prairie Pothole Region to predict wetland water levels. For mapping adjacent wetlands under specific flow regimes, enhanced NWI (attributed with hydrogeomorphic characteristics) might be useful. In addition, the Restorable Wetland Index maps based on topographic and land cover characteristics (<https://data.nrri.umn.edu/data/dataset/minnesota-restorable-wetland-index>) may be another useful starting point for refining wetland connectivity maps.

The SSWR effort is currently addressing three difficult landscape settings where existing mapping tools are problematic. These efforts could be further focused and prioritized through more sustained participation of USACE practitioners to help define the most urgent mapping issues (i.e., utilizing a co-production model of research engagement).

Narrowly defined, Charge Question 2 focuses on emerging technologies, methods and data sets that might be used to refine estimates of locations of ephemeral and intermittent stream channels and to identify potentially connected wetlands adjacent to jurisdictional rivers and streams. Each of these represent distinct mapping challenges because they represent a gradient of conditions that are defined by the physical structure of the landscape, a dynamic hydrologic regime, and antecedent moisture conditions, creating difficulties in deriving a strict classification. Rather, the gradient of conditions that lead to channel formation and wetland connectivity are more appropriately defined using a probability approach (see Recommendation 2.1). The Subcommittee recognizes that translating the complex science based on probabilities into discrete classifications requires both science and policy perspectives.

Specific Suggestions:

- Because the existing regional datasets (e.g., NWI and NHD) are capable of accurately identifying a large percentage of the jurisdictional waters, it is critical that these data be updated and improved to the extent possible. Therefore, the Subcommittee encourages continued participation in interagency efforts to refine the national datasets.
- Prioritize development of high-resolution data and models that reduce uncertainty in estimates of stream channel origins and the extent/frequency of connectivity of adjacent wetlands in areas that represent the greatest need and threat, based on input from targeted end users (OW, USACE).
- The Subcommittee suggests that SSWR further engage USACE practitioners to better define gaps in specific knowledge and tools, identify any existing working USACE methodologies/guidance, and target case studies and methods development to problems that most urgently need solving. The Subcommittee also suggests expanding stakeholder engagement, where it makes sense to do so, with additional federal partners (e.g., the National Oceanic and Atmospheric Administration, or NOAA) as well as academic partners that may assist in the refinement of hydrologic models to predict probability of flooding in adjacent wetlands under a range of flow regimes. The Subcommittee also sees value in exploring partnership or knowledge-sharing through existing or new networks with non-U.S. partners (e.g., scientific developments in the European Union to support the new Water Framework and Floods Directives).
- The Agency's current focus on high resolution models to explore case studies is anticipated to provide valuable insight into site-specific hydrologic regimes. To make this information more relevant nationally, the Subcommittee suggests that the Agency document and publish methods and information needed for scaling the analytical processes to regional or national models for future applications.

Recommendations

The Subcommittee offers the following recommendation to support the relevant Agency priorities:

Recommendation 2.1: Hydrologic regimes are characterized by a continuum rather than discrete states. Therefore, the Subcommittee recommends the use of probabilistic metrics as a more accurate way to represent “real world” hydrological conditions to inform discrete classification approaches. The Subcommittee encourages the Agency to quantify uncertainties in both the underlying datasets as well as their applications. This will help with research prioritization and provide a more quantitative way to communicate success, progress, and key limitations among stakeholders.

Charge Question 3

Q.3: To help reduce health risks associated with exposure to fecal contaminants in recreational waters, SSWR is conducting research to strengthen the scientific basis of existing, and to advance new, fecal contaminant detection methods, source tracking, predictive tools, and health effects assessments that contribute to human health recreational water quality criteria programs. As the research progresses, what suggestion(s) or recommendation(s) does the Subcommittee offer on continuing to identify and conduct research of greatest importance to advancing human health protection from fecal contaminants in recreational waters? [Research Area 3, Output 1]

Narrative

Almost 100 million people swim in oceans, lakes, rivers, or streams each year, making it among the most popular recreational activities in the United States. When those waters are contaminated, particularly with human or animal feces, the associated pathogens are known to cause various health risks, including gastrointestinal, respiratory, ear, eye, and skin infections. EPA has broad responsibilities to protect water quality in recreational waters, and ORD has the charge to develop monitoring and assessment tools that allow OW to achieve those goals.

ORD has a long history of successfully executing that role. They have been instrumental over the last two decades in transitioning the Agency from the use of hundred-year-old culture-based measurement methods to more modern genetic-based methods. These genetic methods are more reliable and more rapid, shortening the time to measure from days to hours. They have also extended these molecular techniques to use genetic signatures as a means of source identification, allowing managers to differentiate whether the fecal contamination at a site originated from human or animal sources. Finally, ORD has conducted the epidemiological studies that produce health-risk relationships for these new methods, allowing the OW to set management guidelines that are appropriately protective of human health.

The overall goal of this SSWR research area is to provide OW with information and tools needed for establishing and updating criteria – including recreational water quality criteria, future updates of human health criteria, and future revisions to aquatic life criteria. Charge Question 3 asked the Subcommittee to focus specifically on work with data and innovative tools to advance public health protection from microbial contaminants in surface waters. In their presentation to the Subcommittee, SSWR researchers described a strong portfolio of research, including studies to enhance the performance of molecular methods for existing indicators, development of new indicators, and expansion of microbial source

identification techniques. In addition, they described studies to assess the prevalence of antimicrobial resistance to evaluate whether that is an important area for EPA to focus, and new forecast modeling techniques that allow for predictions of water quality issues at a site even before the physical measurements are made. The Subcommittee endorses all these research areas as appropriate to ORD and of value to the nation.

Strengths

The Subcommittee is impressed by the research group that SSWR has assembled to address this topical area and their accomplishments to date. There is no other research group in the world that is ahead of them technically in this field. More importantly, they have successfully transitioned their work from the laboratory to practice, as OW has promulgated new water quality criteria and promoted new associated assessment techniques based on their research.

One of the key means SSWR has employed to achieve that success is through strategic partnerships, which they emphasized in their presentation, and for which they should be commended. Some of those partnerships are with other research institutions, particularly with academia, as they draw the best minds in the nation to help them address their research objectives. The success of those partnerships is reflected in the large number of collaborative publications with other institutions. However, their emphasis on partnership also extends to working closely with end-users, such as states and tribes. Ultimately, OW is more likely to make use of their products when there is consensus among the user community that these tools can be implementable by the typical practitioner and add real value to the management process. By working with the local community to employ those tools in demonstration programs in various geographies, SSWR has been successful in creating interest and an awareness of these state-of-the-art techniques.

The molecular tools that SSWR has developed have gained widespread traction in the user community. However, there does not yet exist an agreed-upon means for assessing whether the techniques are being properly utilized at the wide array of public and private laboratories that are now implementing them. As their use transitions from exploratory public health warning systems to regulatory applications, there is a need for programs, such as the National Environmental Laboratory Accreditation Program, to establish and implement laboratory accreditation protocols for genetic-based measurement methods. The development of a certified reference DNA material will be an important step in that direction. To the extent possible, SSWR is encouraged to support efforts by the National Institute of Standards and Technology or private organizations to create a certified reference DNA material.

While the Subcommittee feels that all of the research that SSWR has proposed is appropriate to the Agency, the Subcommittee concluded the research focus that has the most opportunity for impact is the further development of methods for the detection and quantification of coliphages as indicators of fecal contamination in surface waters. Coliphage has some potential advantages over current fecal indicator bacteria that are the focus of present water quality criteria. It may be less prone to false signals from regrowth in the environment and can more closely mimic the survival of some pathogenic viruses after disinfection. OW has suggested that they are interested in potentially adding coliphage as an additional water quality criteria indicator. This potential improvement in monitoring, and the renewed interest by OW, provides a tremendous opportunity for SSWR to impact the direction of the Agency's water quality criteria and, again, successfully transition from research to application.

Suggestions

One of the challenges with the use of genetic measurement techniques is that genetic fragments can persist in the water column long after the viability of the targets they represent has faded. Use of these tools would benefit from a better understanding of the relative survival of the pathogens and the genetic material that is now being quantified.

Regrowth in the environment of the indicators EPA uses can provide a false positive signal about the presence of fecal contamination. SSWR should help improve understanding of this regrowth process, such as what moisture, temperature and nutrients conditions cause such regrowth. Concern related to source(s) and causes of microbial blooms affecting recreational waters are explored and would complement other forensic details gathered when such events are investigated.

Recommendations

The Subcommittee offers the following recommendation to support the relevant Agency priorities:

Recommendation 3.1: The Subcommittee was charged with identifying the research of greatest importance to advancing human health protection from fecal contaminants in recreational waters, and it feels that while all of the research SSWR has proposed is appropriate, the research focus that has the most significant opportunity for impact and should be prioritized is the further development of methods for the detection and quantification of coliphages as indicators of fecal contamination in surface waters.

SUMMARY LIST OF RECOMMENDATIONS

Charge Question 1: Progress towards characterizing microplastics in the environment and uncertainties about their potential environmental health effects requires reliable and consistent methods. SSWR is conducting research to develop and standardize collection, extraction, identification and quantification methods for microplastics. Based on the progress and results to date, what suggestion(s) or recommendation(s) does the Subcommittee offer on research into addressing the uncertainties and challenges associated with the Agency's efforts to develop reliable and consistent microplastics analytical methods? [Research Area 1, Output 4]

- **Recommendation 1.1:** Measurement methods to characterize microplastics is the appropriate starting point. SSWR should begin work now towards developing a strategy for incorporating both environmental and human health effects into the next StRAP.

Charge Question 2: Existing geospatial datasets are often limited with respect to mapping rivers, streams, and wetlands with the degree of accuracy and at the resolution needed to support federal, state, tribal, and local water management decisions, including identifying "waters of the United States" subject to Clean Water Act jurisdiction. SSWR is leveraging existing interagency partnerships to improve the accuracy and application of geospatial data for mapping aquatic resources nationally. What suggestion(s) or recommendation(s) does the Subcommittee offer on further identifying emerging technologies, methodologies, and datasets to improve aquatic resource mapping tools and their application for federal, state and local water management decisions? [Research Area 2, Output 1]

- **Recommendation 2.1:** Hydrologic regimes are characterized by a continuum rather than discrete states. Therefore, the Subcommittee recommends the use of probabilistic metrics as a more

accurate way to represent “real world” hydrological conditions, to inform discrete classification approaches. The Subcommittee encourages the Agency to quantify uncertainties in both the underlying datasets as well as their applications. This will help with research prioritization and provide a more quantitative way to communicate success, progress, and key limitations among stakeholders.

Charge Question 3: To help reduce health risks associated with exposure to fecal contaminants in recreational waters, SSWR is conducting research to strengthen the scientific basis of existing, and to advance new, fecal contaminant detection methods, source tracking, predictive tools, and health effects assessments that contribute to human health recreational water quality criteria programs. As the research progresses, what suggestion(s) or recommendation(s) does the Subcommittee offer on continuing to identify and conduct research of greatest importance to advancing human health protection from fecal contaminants in recreational waters? [Research Area 3, Output 1]

- **Recommendation 3.1:** The Subcommittee was charged with identifying the research of greatest importance to advancing human health protection from fecal contaminants in recreational waters, and it feels that while all of the research SSWR has proposed is appropriate, the research focus that has the most significant opportunity for impact and should be prioritized is the further development of methods for the detection and quantification of coliphages as indicators of fecal contamination in surface waters.

APPENDIX A: MEETING AGENDA

Day 1: Wednesday October 28, 2020, Eastern Daylight Time

Time (EDT)	Topic	Presenter
11:45-12:00	Sign on & Technology Check	
12:00-12:15	Welcome and Opening Remarks	Tom Tracy (DFO) Joseph Rodricks (BOSC SSWR Chair) Robert Blanz (BOSC SSWR Vice Chair)
12:15-12:30	ORD Welcome	Jennifer Orme-Zavaleta (ORD Principal DAA for Science)
12:30-12:40	SSWR Overview and Charge Questions	Suzanne van Drunick (SSWR NPD)
12:40-1:00	ORD Overview – Centers	Tim Watkins (Director, CEMM) Wayne Cascio (Director, CPHEA)
1:00-1:10	Watersheds Introduction	Rick Greene (Watersheds Topic Lead)
1:10-2:10	Overview of Research Area 1: <i>Assessment, Monitoring and Management of Aquatic Resources</i> <ul style="list-style-type: none"> • Output 1: National Aquatic Resource Survey (NARS) Support • Output 2: NARS Extension • Output 3: Biological Indicators • Output 5: Water Quality Benefits • Output 6: San Juan Watershed Support 	Brenda Rashleigh (ACD, CPHEA) Steve Paulsen (CPHEA) Peg Pelletier (CEMM) Susan Yee (CEMM) Matt Heberling (CEMM) Kate Sullivan (CEMM)
2:10-2:30	BOSC questions on Research Area 1, Outputs 1-3 and 5-6	Joe Rodricks, Robert Blanz (BOSC Chairs)
2:30-2:45	Break	
2:45-3:15	Research Area 1, continued <ul style="list-style-type: none"> • Output 4: Microplastics 	Kay Ho (CEMM)
3:15-3:30	EPA's international efforts on plastics in marine litter	Jane Nishida (Principal Deputy AA, OITA)
3:30-4:15	BOSC questions on Research Area 1, Output 4, Charge Question 1	Joe Rodricks, Robert Blanz (BOSC Chairs)
4:15-4:30	Public Comments	Tom Tracy (DFO)
4:30-5:00	BOSC Discussion	Joe Rodricks, Robert Blanz (BOSC Chairs)
5:00-5:15	Wrap up	Joe Rodricks, Robert Blanz (BOSC Chairs)
5:15	Adjourn	

Day Two: Thursday October 29, 2020, Eastern Daylight Time

Time (EDT)	Topic	Presenter
11:50-12:00	Sign on & Technology Check	
12:00-12:10	Welcome – Day 2	Tom Tracy (DFO) Joseph Rodricks (BOSC SSWR Chair) Robert Blanz (BOSC SSWR Vice Chair)
12:10-12:30	ORD Overview – Centers	Rusty Thomas (Director, CCTE) Greg Sayles (Director, CESER)
12:30-1:00	Overview of Research Area 2: <i>Improved Aquatic Resource Mapping</i> <ul style="list-style-type: none"> • Output 1: Improved Accuracy and Application of Geospatially Explicit Aquatic Resource Data 	Brenda Rashleigh (ACD, CPHEA) Jay Christensen (CEMM)
1:00-1:45	BOSC questions on Research Area 2, Charge Question 2	Joe Rodricks, Robert Blanz (BOSC Chairs)
1:45-2:00	GEMMD Virtual Lab Tour	
2:00-2:15	Break	
2:15-2:35	Overview of Research Area 3: <i>Human Health and Aquatic Life Criteria</i> <ul style="list-style-type: none"> • Output 2: Human Health and Chemical Contaminants • Output 3: Aquatic Life Criteria 	Ann Grimm (ACD, CEMM) Adam Biales (CCTE) Russ Erickson (CCTE)
2:35-2:50	BOSC questions on Research Area 3, Outputs 2 and 3	Joe Rodricks, Robert Blanz (BOSC Chairs)
2:50-3:20	Research Area 3, continued <ul style="list-style-type: none"> • Output 1: Human Health and Recreational Water Quality 	Orin Shanks (CEMM)
3:20-4:15	BOSC questions on Research Area 3, Charge Question 3	Joe Rodricks, Robert Blanz (BOSC Chairs)
4:15-4:30	Public Comments	Tom Tracy (DFO)
4:30-5:15	Charge Question Break-out Groups (committee members will be preassigned to specific charge questions)	Joe Rodricks, Robert Blanz (BOSC Chairs)
5:15-5:30	BOSC Discussion/Next Steps	Joe Rodricks, Robert Blanz (BOSC Chairs) Suzanne van Drunick (NPD) Tom Tracy (DFO)
5:30	Adjourn	

APPENDIX B: MATERIALS

Material Provided in Advance of the Meeting

Materials to Support the Charge Questions

- Agenda
- Charge questions
- SSWR Draft StRAP FY 2019–2022

Informational Materials

- Virtual Participation Guide
- Research Area 1 Overview Presentation
- Research Area 1.4 Presentation
- Research Area 2 Overview Presentation
- Research Area 3 Overview Presentation
- Research Area 3.4 Presentation