RMP Microplastic Workgroup Meeting

Wednesday, May 22, 2019
9:30 AM – 4:30 PM

REMOTE ACCESS
Audio by Phone: (415) 594-5500, Access Code 943-326-397#
Slides: https://join.me/sfei-conf-cw1

AGENDA

1.	**Introductions and Goals for This Meeting** (Attachment) The goals for this meeting: • Present significant findings on monitoring to date; • Obtain feedback on findings and data interpretation; • Discuss draft microplastic strategy document and multi-year plan; and • Obtain recommendations on special study and SEP proposals for 2020 and ways to further refine proposals Meeting materials: 2018 MPWG minutes (See pages 1-9)	9:30 Melissa Foley
2.	**Information: Overview of Moore Microplastic Deliverables and Timeline** Brief overview of the Moore Microplastic project deliverables and schedule. Desired Outcome: Provide background for today's discussion Meeting materials: Slides	9:40 Meg Sedlak
3.	**Discussion of Pathways: Wastewater and Stormwater** An overview of key findings will be presented for microplastic pathways into the Bay. Desired outcome: Feedback from the group on the findings Meeting materials: Draft wastewater and stormwater chapters	10:00 Alicia Gilbreath and Meg Sedlak
4.	**Discussion: Surface Water and Small Fish** An overview of key findings will be presented from surface water and small fish sampling. Desired outcome: Feedback from the group on the findings Meeting materials: Draft fish and surface water chapters	10:50 Carolynn Box and Diana Lin

5.	**Discussion: Identification of Source Contribution** Presentation of the findings from Alice Zhu's Master's Thesis on modeling potential sources of microplastic to the Bay. Desired outcome: Informational purposes only Materials: Slides	11:45 Chelsea Rochman / Alice Zhu
	Lunch (to be brought in)	12:30
6.	**Update from Stakeholders** Update on Ocean Protection Council microplastic work, on-going activities associated with Heirs to Our Ocean, and highlights from the recent Microplastic Workshop at SCCWRP.	1:00 Holly Wyer, Cambria Bartlett, Shelly Moore, Anna-Marie Cook
7.	**Discussion: Modeling Results to Date** A short update on the status of the Bay and open ocean models will be presented. We are beginning to incorporate the field data into the models. A draft chapter should be available for workgroup review in June. Desired outcome: Update workgroup on status of the model Meeting materials: Slides	1:15 Rusty Holleman
8.	**Discussion: Policy Issues and Communications** One of the goals of the Moore project is to generate resources that inform and educate stakeholders and the public. Desired outcome: Input on how to refine communication documents Meeting materials: Draft policy report	1:35 Carolynn Box
	Short Break	2:25
9.	**Discussion: Microplastic Strategy and Multi-Year Plan** The Updated Strategy document and multi-year plan will be presented. Desired outcome: Gather feedback on Strategy and scientific needs for the workgroup Meeting materials: Updated Strategy document and multi-year plan	2:40 Meg Sedlak
10.	**Discussion: Microplastic Proposals for 2020** Proposal for special study ideas for 2020 will be presented. The workgroup will ask questions, discuss, and provide feedback. 2020 Special Study Proposals include: ● Microplastic strategy funding ● Monitoring in sportfish (analyze archive samples) ● SEP proposal for a stormwater water conceptual model	3:20 Meg Sedlak, Alicia Gilbreath

	Desired outcome: Gather feedback on the merits of each proposal and how they can be improved Meeting materials: MPWG Special Study Proposals **(See pages 10-23)**	
11.	**Closed Session - Decision: Recommendations for 2020 Special Studies Funding** RMP Special Studies are identified and funded through a three-step process. Workgroups recommend studies for funding to the Technical Review Committee (TRC). The TRC weighs input from all the workgroups and then recommends a slate of studies to the Steering Committee. The Steering Committee makes the final funding decision. For this agenda item, the MPWG is expected to decide (by consensus) on a prioritized list of which studies to recommend to the TRC. To avoid an actual or perceived conflict of interest, the Principal Investigators for proposed special studies are expected to leave the room during this agenda item. Desired Outcome: Recommendations from the MPWG to the TRC regarding which special studies should be funded in 2020 and their order of priority.	4:00 Karin North
	Report out on Recommendations	4:20
	Adjourn	4:30

FINAL

REGIONAL MONITORING PROGRAM FOR WATER QUALITY IN SAN FRANCISCO BAY
sfei.org/rmp

Bay RMP Microplastic Workgroup Meeting

May 15, 2018
San Francisco Estuary Institute
4911 Central Avenue, Richmond, CA

Meeting Summary

Attendees

Science Advisor	Affiliation	Present
Kara Lavender Law	Sea Education Association	Yes
Chelsea Rochman	University of Toronto	Yes
Anna-Marie Cook	Environmental Protection Agency	Yes

Others Present

Carolynn Box	5 Gyres	Eunha Lee	HORIBA
Anna Cummins	5 Gyres	Andrew Whitley	HORIBA
Barbara Baginska	RWQCB	Alexander Black	Cabot Wellington Foundation Microfiber Solution
Luisa Valiella	USEPA	Emily Bartlett	Heirs to Our Ocean
Steph Karba	Patagonia	Cambria Bartlett	Heirs to Our Ocean
Nirmela Arsem	EBMUD	Amy Franz	SFEI
David Williams	BACWA	Becky Sutton	SFEI
Lorien Fono	BACWA	Diana Lin	SFEI
Jim Wan	CCCSD	Don Yee	SFEI
Karin North	Palo Alto	Jay Davis	SFEI
Julie Weiss	Palo Alto	Meg Sedlak	SFEI
Eric Dunlavey	San Jose	Phil Trowbridge	SFEI
Simret Yigzaw	San Jose	Rusty Holleman	SFEI
Autumn Cleave	SFPUC	Stacy Cullison	SFEI
June-Soo Park	DTSC	Warner Chabot	SFEI
Francisco Sanchez	DTSC		
Reinhard Hohlwein	CalRecycle		
Holly Wyer	Ocean Protection Council		
Sherry Lippiatt	NOAA		
Rachel Strader	Moore		
Sienna Courter	Baykeeper		

The last page of this document has information about the RMP and the purpose of this document.

FINAL

1. Introductions and Goals for This Meeting

No changes

2. Information: Review of Sampling Conducted to Date

Meg Sedlak presented an overview of the San Francisco Bay and Adjacent National Marine Sanctuaries Microplastic project. All field sampling has been completed, except for a stormwater duplicate that was accidentally missed during the season's field sampling, and will be collected in the Fall of 2018. Meg emphasized that successful completion of the large field sampling effort was due to opportunities to leverage existing RMP efforts (e.g. stormwater sampling, margin sediment sampling) and the support of RMP stakeholders (e.g. wastewater facility staff participation in microplastic sample collection at facility).

3. Information: Method Development and Challenges

Dr. Chelsea Rochman summarized the successful development of laboratory methods for each field matrices and some analytical challenges (details are in Section 4 of Draft Progress Report). Chelsea also provided a timeline for completion of the laboratory analysis of all the samples, with all the samples analyzed by October 2018.

Surface water pump samples were filtered onto multiple filters which will be analyzed once the method has been developed. The plan is to sonicate each filter sample and combine filters from the same sample into one beaker, and sieving the sample through a 45 um and 25 um mesh. Larger particles fraction can be sorted by microscopy, while the smaller particle fraction can be separated by density separation using $CaCl_2$. After particles are counted and sorted, then they will be individually imaged, and analyzed via Raman or FTIR spectroscopy. An interesting finding that seems to be unique to one of the wastewater treatment plants is something that looks like Styrofoam, but was determined to be some sort of PVC lubricate, and not a particle.

Fibers are challenging to analyze via Raman spectroscopy. Alice Zhu, a graduate student at the University of Toronto, is developing a flow chart to match dye characteristics with polymer types to help identify the underlying polymer type of fibers that are difficult to match with Raman spectroscopy.

The most important discussion item Chelsea highlighted to the group is that field samples take significant amount of time to process in the laboratory, and the time-limiting step is the Raman spectroscopy. An FTIR is also in use now, and larger particles will be identified via FTIR, and smaller particles or ones that are more challenging to handle or identify via FTIR, will be taken to the Raman spectroscopy. Manta samples generally require a total of 40-55 person-hours per sample to complete laboratory analysis, while the wastewater effluent samples take 30 person-hours per sample. An approach to subsampling will need to be developed in order to complete analysis of all samples on time.

Discussion

Kara pointed out that it may not make sense to count particles that are smaller than the manta trawl net size (355 um) because the net is not meant to capture these smaller particles. If

smaller particles are captured, the capture efficiency is likely very low. Chelsea said smaller particles are being captured by becoming entraining with larger organic material. Don suggested that these could be considered minimum counts if capture efficiency is low for small particles. Kara also proposed that the need to identify every particle and obtain an accurate composition of polymer types depends on the goals of the study. If the goal is to obtain a baseline monitoring of contamination levels, then the manta trawl may not be a good quantitative sampling method for the smaller particles, and polymer distribution of the smaller particles may not be sufficiently quantitative. Becky clarified that the goal of polymer identification is source identification. Chelsea also clarified that the very small particles are mostly fibers, and also that the subsampling discussion is most applicable to fibers, which is a majority of the identified particles.

Kara said for the Semester at Sea project, they do not count fibers, and they identify all particles visually (without microscope), which generally means identified particles are >500 um. Also, post-cruise analysis found that most of the identified particles are polyethylene and polypropylene, and therefore individual spectroscopy for each type of samples is not necessary. Another question Kara proposed is how policy recommendations may be different based on different findings of the fiber breakdown (e.g. 1:4 ratio of synthetic fiber:natural fiber ratio versus a 4:1 ratio).

Chelsea shared two approaches to using spectroscopy for a subset of the particles. One is to use spectroscopy on 10-15% of all the particles, and use a random number generator to choose which particles are presented to spectroscopy. However, this is not a preferred option because this may not be sufficient to get a representative distribution of particle types in the field. A second preferred option is to use the following approach for each “particle category”.

- If particle count in category < 10, spectroscopy all 10
- If particle count in category is between 10 and 100, spectroscopy 10%
- If particle count is much greater than 100, then a smaller % may be used.

However, a decision is needed about how specific to define each particle category, whether it’s by morphological category (i.e. fiber, fragment, sphere, film) or color and category (red fibers, pink fibers, blue sphere, white spheres). Currently, the Rochman group is using the second approach, but this ends up to identifying by spectroscopy a large majority of the particles. This approach may be feasible for the wastewater effluent samples, but not for the Manta trawl samples which have a significantly greater diversity of particle types.

Don recommended that the subsampling size depends on what size is needed to get a stable distribution. One could keep subsampling until distribution starts to stabilize, and could do this computationally with a sample distribution that has already been completed. Andrew Whitley from HORIBA suggested that as we learn more about particle types and distribution, the subsampling strategy could change. Eric suggests rechecking periodically to see if subsampling sufficient. Karin suggested the option to store the fibers till later for spectroscopy analysis.

Dave Williams asked if subsampling distribution would be used to extrapolate results. Chelsea recommended presented the results as is, without extrapolating results to all wastewater treatment plants because there is a lot of particle diversity. However, Dave Williams pointed out that once the effluent particles distribution is presented, most people will take the data and extrapolate it to all wastewater treatment plants. Karin agreed that there is a consideration for how the data will be used

Chelsea emphasized that the sampling approach developed is part of the overall project goal to develop methods that can used by other researchers.

Staff from Horiba Instruments asked if there is an opportunity to change field sampling technique. Chelsea said based on the large number of particles in the Manta trawl that a much shorter trawl (e.g. 10 minutes instead of 30 minutes) would be sufficient; however, it was noted that all of the samples have been collected for this project.

Anna Cummins was interested about measurement of persistent organic pollutants (POPs) in identified microplastics in Bay samples. While analysis of POPs is not part of this project, Chelsea has students investigating this topic through other projects, which can be shared. Analysis of POPs could be conducted with the Manta samples which are not chemically digested.

Action Item

- Decision to form subgroup to discuss and determine subsampling approach. The group agreed that subsampling is necessary. Volunteers for the subgroup include Chelsea Rochman, Don Yee, Nirmela Arsem, and Eric Dunlavey.

Update to Action Item

- Subgroup met on Monday, June 4, 2018 and decided on the following approach. Attendees at the meeting were Nirmela Arsem, Eric Dunlavey, Chelsea Rochman, Carolynn Box, Don Yee, Rebecca Sutton, Meg Sedlak, and Diana Lin.
- The group agreed to use a similar strategy Chelsea had proposed at the workgroup meeting. Approximately 10 particles from each particle type (fiber, fragment, film, pellet, foam) will be identified via spectroscopy. The group decided this was a good strategy in order to complete sample analysis to meet project deadlines.
    - If particle count in category < 10, spectroscopy all 10
    - If particle count in category is between 10 and 200, spectroscopy 10% of particles
    - If particle count is greater than 200, spectroscopy 20
- The group also decided on the following strategy to streamline sample analysis and reduce the workload:
    - Prioritize a handful of pump samples in order to compare particles sizes and counts between pump samples and Manta trawl samples collected from the same site. Results from this comparison will be used to make decisions on prioritizing samples to analyze.
    - Deprioritize the Manta trawl samples that do not have pump samples associated with them. Depending on the results of the prior step, a decision will be made on whether to count fibers in these samples.
    - SFEI team will review sediment samples collected, and decide on which samples to prioritize to significantly reduce the number of sediment samples that will be analyzed for microplastics.

4. Discussion: Data Review

Becky Sutton presented of summary of the data review to date (Section 5 of the Draft Report). Becky summarized ongoing discussions about how to group identified particles into useful bins, which will be used to report data to CEDEN. Becky also showed results of one complete Manta trawl sample, and explained that the plastic particle distribution (mostly commonly polyethylene and polypropylene) is comparable to other open ocean studies. The core of the presentation focused on particle counts detected in the field blanks. Many field blanks were collected to support QA/QC of the data and promote best practices in a rapidly evolving field. Field blanks

are often not reported in the literature. Becky presented two approaches to managing field blanks:

- Subtract particles in field blanks from field samples
- Report field blank results alongside field samples and qualify field sample results that are not significantly different from blanks. *(Preferred method)*

Phil asked the experts what the industry standard is for handling field blanks, and the experts agreed that there is no industry standard, which is a big gap. Anna-Marie said the USEPA has a protocol for flagging outlier data. The group agreed that qualifying field results as presented in the second option is a good idea.

Anna Cummins asked if we can differentiate between wash-off beads affected by the state ban versus other beads not affected by the ban that would help inform policy decisions. However, most microbeads used in consumer applications are not spheres and difficult to differentiate from other fragment types.

5. Information: Updates from Advisors

Kara Lavendar Law gave a brief summary of her background of how she became involved in researching microplastics through SEA, which has decades of microplastic data from towing plankton nets in the open ocean.

Anna-Marie Cook provided an update on EPA's development of a standardized methodology for analyzing wastewater samples. The EPA held a microplastics workgroup, which identified developing standardized methodologies for microplastics as globally important. The EPA has a lot of experience developing methods for small particles (e.g. asbestos); however, microplastics is particularly challenging because there is no single characteristic that can be used for identification.

The California Department of Public Health has a method to extract microplastics from fish digestive tracts using pulsed ultrasonication. Method requires a clean room and ultrasonication equipment which is expensive and not necessarily feasible for commercial or municipal labs. The research group is working to develop a more accessible method.

The EPA has been collaborating with EBMUD and other wastewater agencies to develop method for analyzing wastewater influent. The heterogenous nature of influent (e.g. toilet paper and wipes) is challenging. The current approach is to use cellulase enzyme to break down cellulose in toilet paper, and digest with either KOH or H_2O_2. The goal of analyzing wastewater influent is to determine amount of microplastics transported through wastewater, and the removal efficiency of wastewater treatment plants. In contrast, method development for treated effluent is going well and Anna-Marie has more confidence on method development. The EPA will present method to the ASTM D19 committee at the end of June 2018 for review with a final standardized method likely available in December. Another challenge is the lack of reference standard sample that is representative of environmental microplastics and matrix to test method. Meg Sedlak noted that NIST (Jennifer Lynch) is interested in developing certified reference materials; Anna Marie indicated that she had been in touch with NIST. Steph Karba asked whether it could be helpful to get microplastic fibers from Patagonia mills which are generated during the cutting process and are collected for disposal. Chelsea expressed interest in obtaining samples.

6. Information: Presentation of the SFEP Rain Garden Project

Diana Lin gave a presentation on microplastic removal through a local bioretention rain garden in El Cerrito. The project is separate from the Moore and RMP funded projects, and was provided for informational purposes.

7. Discussion: Modeling Results to Date

Rusty Holleman provided on update on the development of a microplastic model that couples Bay and open ocean models. Rusty stated that deposition is not included in the model. He proposes to use the model to track transport plumes and evaluate areas in the Bay where there is potential for higher deposition of microplastics. Results also illustrate the importance of rainfall and freshwater inflows into the Bay on transport within the Bay. Kara was curious whether particles would be well mixed in a water column that is well mixed with sediment and if whether particle density separation will have a big influence in such waters.

8. Discussion: Policy Issues and Communication

Carolynn Box presented goals of the project to develop policy solutions based on the monitoring data. The project will convene a small group of experts to develop science-based recommendations, consider policy options, innovations in product design and household intervention, and identify data gaps and lessons learned. 5Gyres is also leading the education and outreach component of the project, and will develop factsheets and educational resources. 5Gyres has reached a significant number of people using social media, and advertised the use of the hashtag #SFBayMicroplastics on Instagram.

Karin North expressed interest to help with developing solutions and communicating message to the public about microplastics. However, it is important to have good solutions as part of the communication strategy. For example, if washing machine lint catchers are effective, then there are different strategies that can be pursued to encourage having these installed in machines by manufacturers or installed in homes. Chelsea mentioned that her research group found that the Lint LUV-R Washing Machine Discharge Filter was very effective in removing fibers >100 um.

Chelsea is also conducting a study to investigate potential harm to fish from ingesting microfibers, and will want fiber samples from Patagonia.

Holly Wyer stated that the state's Marine Debris Strategy includes prioritizing microplastics and will have funding to support standardizing methods and developing solutions research. The City of Palo Alto is piloting Rethinking Disposables program to encourage restaurants to reduce waste by minimizing disposable packaging items.

Dave Williams proposed that there is the need to show environmental harm before developing strategies to reduce pollution. Anna Cummins asked what is the balance between precautionary principle and showing beyond a doubt the potential for environmental harm. Ryan Hart stated the need for a package of solutions that are effective to capture microplastics, because right now it is hard to figure out what to recommend to the public.

Kara asked if there is field evidence that would support foam band anecdotally. Becky and Meg confirmed that foam was detected frequently in Bay waters.

Karin mentioned that partnering with youth groups, such as Girl Scouts and Heirs to Our Oceans, can be a very effective way to get the message out.

9. Discussion: Microplastic Proposals for 2019

Meg presented two proposals for funding, a microplastic strategy update, and a study to evaluate microplastics in sport fish. The sportfish project would leverage the 2019 RMP sport fish monitoring effort which occurs every 5 years. The group agreed that conducting the sport fish study should be prioritized to leverage the RMP effort. The fish study also has the option to add tissue analysis and adding sample collection from a third site. When asked if there was a preference for which option to add on to support policy implications, Chelsea suggested that tissue analysis would be more relevant because this what people want to know about. However, there are very few other tissue data to compare to.

Steph mentioned that there are implications to a study on microplastics in fish tissue, because the media is likely to be very interested in reporting out these results. The group also discussed considering archiving the fish tissue for analysis pending results of the gut analyses. Fish with high digestive tracts microplastic counts could be prioritized for tissue analyses.

Chelsea mentioned that a fish field blank is not necessary; however, the fish can swallow material in the net if it is being trawled for a long period. Meg said that the capture method used has the fish in the net for a very short period.

Anna-Marie said that sport fish samples from the Great Lakes all showed microplastics in the gut, some of which were from previous ingestion of bait. She asked Chelsea if she thought fibers could be isolated from the fish tissue, and Chelsea confirmed that the literature reports other labs have been able to analyze fibers in fish tissue. The Great Lakes project is planning to analyze for plasticizers in the tissue, and not actual fibers.

Jay clarified that the details on who will be conducting the field sampling is still a work in progress.

Luisa asked about a reference site for fish analysis. Meg clarified that the group will know at the end of the year whether Tomales Bay is a good reference site based on prey fish samples from the Moore project. Barbara Baginska suggested that the Strategy proposal should include an evaluation of environmental risk of microplastics to provide a baseline to support interpreting the data planned for collection. A reference site can be called a minimal impact site. A literature review would be useful to understand the state of the science on environmental risk. Also, Chelsea is conducting a study feeding microplastics to fish, and the results of the study would be useful.

Karin expressed the need for a sampling method that can be used to by RMP Status and Trends to detect trends in microplastics data. Becky clarified that one of the goals of the Moore study is to find a matrix that would be a good for monitoring trends. Meg stated that the 2018 bivalve microplastic study is underway and that these samples will also be evaluated for possible trend indicators.

Nirmela pointed out that data can be compared within matrix, but not across different matrices (e.g. fish versus effluent data). Becky said we may be able to compare concentrations based on

actual particle sizes, instead of the operational sizes which are different between matrices due to sampling methodology.

Kara pointed out that the current monitoring data is a snapshot, and there is a need to consider whether results represent an average, and doing another round of sampling would also be useful

Luisa suggested that further data analysis with the collected data can be part of the RMP data analysis challenge. However, the study results may not be available in time.

10. Decision: Recommendations for 2019 Special Studies Funding

Study Name	Modified Budget	Priority	Comments
Microplastic Strategy	$15,000	1	The group also recommend the need for synthesis work in year 2020 for all microplastic data collected (from Moore, sport fish).
Sport Fish	$156,300 (with option to spread cost Y1-$75K and Y2 - $40K)	2	Definitely want to leverage sport fish sampling effort and collect all samples (gut and fillet tissue samples from 2 proposed site and additional third site). Second priority to add fillet analysis. Third priority analyze samples from third site, prefer San Pablo for North Bay comparison and archive whole fish for future analysis. Option to spread cost over 2 years by delaying Reporting and Data Services to second year and prioritizing laboratory analysis for first year (Y1-$75K, Y2 - $40K). Archived samples will make samples ready for any SEP funding available. Consider archiving 4th site to be available for analysis for SEP funding. Revised proposal needs to include cost for processing and archiving samples.

About the RMP

RMP ORIGIN AND PURPOSE

In 1992 the San Francisco Bay Regional Water Board passed Resolution No. 92-043 directing the Executive Officer to send a letter to regulated dischargers requiring them to implement a regional multi-media pollutant monitoring program for water quality (RMP) in San Francisco Bay. The Water Board's regulatory authority to require such a program comes from California Water Code Sections 13267, 13383, 13268 and 13385. The Water Board offered to suspend some effluent and local receiving water monitoring requirements for individual discharges to provide cost savings to implement baseline portions of the RMP, although they recognized that additional resources would be necessary. The Resolution also included a provision that the requirement for a RMP be included in discharger permits. The RMP began in 1993, and over ensuing years has been a successful and effective partnership of regulatory agencies and the regulated community.

The goal of the RMP is to collect data and communicate information about water quality in San Francisco Bay in support of management decisions.

This goal is achieved through a cooperative effort of a wide range of regulators, dischargers, scientists, and environmental advocates. This collaboration has fostered the development of a multifaceted, sophisticated, and efficient program that has demonstrated the capacity for considerable adaptation in response to changing management priorities and advances in scientific understanding.

RMP PLANNING

This collaboration and adaptation is achieved through the participation of stakeholders and scientists in frequent committee and workgroup meetings (see Organizational Chart, next page).

The annual planning cycle begins with a workshop in October in which the Steering Committee articulates general priorities among the information needs on water quality topics of concern. In the second quarter of the following year the workgroups and strategy teams forward recommendations for study plans to the Technical Review Committee (TRC). At their June meeting, the TRC combines all of this input into a study plan for the following year that is submitted to the Steering Committee. The Steering Committee then considers this recommendation and makes the final decision on the annual workplan.

In order to fulfill the overarching goal of the RMP, the Program has to be forward-thinking and anticipate what decisions are on the horizon, so that when their time comes, the scientific knowledge needed to inform the decisions is at hand. Consequently, each of the workgroups and teams develops five-year plans for studies to address the highest priority management questions for their subject area. Collectively, the efforts of all these groups represent a substantial body of deliberation and planning.

PURPOSE OF THIS DOCUMENT

The purpose of this document is to summarize the key discussion points and outcomes of a workgroup meeting.

Special Study Proposal: Microplastic Strategy

Summary: In late 2019, SFEI will complete a major three-year project on microplastic monitoring, modeling, and policy guidance, which was primarily funded by the Gordon and Betty Moore Foundation with generous added contributions from the RMP and others. To continue to provide strategic support on this issue to the San Francisco Bay Regional Water Board and other RMP stakeholders, strategy funding is recommended for 2020.

Core tasks include tracking new information regarding microplastic occurrence and toxicity; responding to requests for information from the Water Board and other stakeholders; and, in collaboration with the Workgroup, identifying any essential data gaps for San Francisco Bay that could be filled by the RMP or others. Strategy funding also allows for important leveraging activities such as the coordination of *pro bono* analyses by partners.

Estimated Cost: $10,000

Oversight Group: Microplastic Workgroup

Proposed by: Rebecca Sutton, Diana Lin, and Meg Sedlak (SFEI)

Time sensitive: Yes. Without this funding, we are unable to track and management microplastic work, leverage funds, respond to requests, and identify new area of pro bono collaboration

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	Due Date
Task 1. Information gathering from a variety of sources throughout the year, including presentations at scientific conferences	Year-round
Task 2. Respond to information requests from the Water Board and other RMP stakeholders	Year-round
Task 3. Coordinate *pro bono* studies with analytical partners	Year-round
Task 4. Update the multi-year plan at Spring Workgroup meeting	May 2020

Background

The science and management of microplastics is an area of dynamic development. The RMP has taken a leadership role on this issue, first by developing a Microplastic Monitoring and Science Strategy for San Francisco Bay (Sutton and Sedlak 2017), and then by co-funding and participating in a three-year project to monitor and model microplastic contamination in the Bay and adjacent Marine Sanctuaries, leveraging significant external funding from the Moore Foundation.

In late 2019, the project with the Moore Foundation will be completed. As this was a special project between program areas, there will be no additional funding available from this Foundation. To assure the RMP receives reliable and up-to-date science guidance on this rapidly evolving field, ongoing support for microplastic strategy development is recommended. Microplastic strategy funding is needed to review new methods and data in this rapidly changing field, track research approaches in other geographies, and keep stakeholders apprised of findings. The strategy budget will also enable us to coordinate *pro bono* analyses that contribute to our understanding of microplastics and add value to RMP-supported research in the Bay. Perhaps most important, funding could be used to provide relevant, objective science to inform the growing number of science and policy actions related to plastic and microplastic pollution. As an example, in the fall of 2018, the California State Legislators tasked the Ocean Protection Council with developing a state-wide microplastic strategy. Having completed an RMP microplastic strategy for the Bay, it will be important for SFEI staff to provide input and ensure coordination with the state-wide process.

Study Objectives and Applicable RMP Management Questions

Table 1: Study objectives and questions relevant to RMP Microplastic Workgroup management questions

Management Question	Study Objective	Example Information Application
1) How much microplastic pollution is there in the Bay?	Compare existing Bay occurrence data with levels reported elsewhere in the scientific literature to provide context for Bay observations. Track new and evolving methods for microplastic sample collection and analysis to ensure RMP studies use appropriate methods.	Does the latest science suggest Bay contamination levels are typical of urban areas? Are there any unique aspects to observations in the Bay? Are newly developed methods for sample collection and analysis good candidates for use in the Bay? How do measurements made with new methods compare to those made with methods previously used to characterize the Bay?
2) What are the health risks?	Review the scientific literature for toxicity thresholds as they emerge. Evaluate future monitoring needs and toxicity data gaps.	Do levels of microplastic in the Bay exceed available toxicity thresholds? Can microplastic occurrence be linked to the presence of plastic additive CECs in the Bay?

3) What are the sources, pathways, loadings, and processes leading to microplastic pollution in the Bay?	Evaluate new knowledge regarding sources, pathways, loadings, and processes for microplastic in the context of a comprehensive conceptual model to allow prioritization of data gaps the RMP can fill. Compare model predictions to monitoring results; assess potential reasons for differences between predicted and measured values.	What are the key sources, pathways, and processes that affect concentrations of microplastic in the Bay? Are relative levels of microplastic in different matrices or subembayments consistent with our expectations?
4) Have the concentrations of microplastic in the Bay increased or decreased?	N/A	
5) Which management actions may be effective in reducing microplastic pollution?	Evaluate available data on the impacts of existing and proposed management actions in the Bay Area and elsewhere. Evaluate the expected impacts of changes to population, climate, affluence, and other factors.	How might existing or proposed management actions impact levels of different types of microplastic particles in the Bay? What are the possible effects of changes to population, climate, and affluence on concentrations of microplastic and associated risk?

Approach

Funding for this task will allow us to think strategically about the latest science around microplastic monitoring and management so the RMP can continue to generate the information water quality managers need to effectively address microplastic contamination in the Bay. As the Moore Foundation project concludes in late 2019, it will be essential for the RMP to establish priorities for future work and seek opportunities to leverage external funding and scientific efforts.

Microplastic strategy funding would support the review of key information sources throughout the year. These sources include:

- Abstracts and newly published articles in key peer-reviewed journals (e.g., Environmental Health Perspectives, Environmental Science and Technology, Environmental Toxicology and Chemistry, Marine Pollution Bulletin, Science of the Total Environment)
- Documents produced by other programs (e.g., USEPA, NOAA Marine Debris Program, Australia's CSIRO Research Program, Woods Hole Oceanographic Institute, Environment and Climate Change Canada, European Chemicals Agency, Great Lakes CEC Program)

- Abstracts and proceedings from relevant conferences (e.g., Society of Environmental Toxicology and Chemistry, International Marine Debris Conference)

In addition, strategy funding allows staff to provide additional services, such as:

- Updating the multi-year plan for microplastics
- Presentations, briefings, and stakeholder interactions
- Scientific assistance to the Water Board
- Scientific assistance to stakeholders engaged in microplastic-related policy
- Coordination of *pro bono* analyses

The proposed deliverables table on the first page of this proposal lists the specific tasks to be completed and their due dates.

Budget

Table 2. 2020 Microplastic Strategy budget

Deliverables	**Budget**
Tasks 1-4: (1) Information gathering from a variety of sources throughout the year, including presentations at scientific conferences; (2) Respond to information requests from the Water Board and other RMP stakeholders; (3) Coordinate *pro bono* studies with analytical partners; and (4) Present recent findings to the workgroup.	$10,000

Budget Justification

This budget represents 10 hours of staff time for information requests; 10 hours for presentations and coordination of *pro bono* studies; and 40 hours for information gathering and reviewing literature.

Reporting

Presentation at RMP Microplastic Workgroup meeting, Technical Review Committee and/or Annual Meeting.

References

Sutton R, Sedlak M. 2017. Microplastic Monitoring and Science Strategy for San Francisco Bay. SFEI Contribution 798. San Francisco Estuary Institute, Richmond, CA.

Special Study Proposal: Microplastic in San Francisco Bay Sport Fish

Summary: In the fall of 2019, SFEI will complete a three-year project to characterize microplastic in San Francisco Bay, funded by the Gordon and Betty Moore Foundation and others. The project provides information to address many of the management questions articulated in the RMP Microplastic Strategy. A key element not included in the Moore project was the characterization of microplastic in sport fish. Sport fish are an important food source to humans and Bay wildlife and are integrators of contaminants present in Bay water, sediment, and prey fish. In summer 2019, as part of RMP Status and Trends monitoring, sport fish will be collected and analyzed for a suite of contaminants. In 2018, the Steering Committee approved funding to collect and archive sport fish for microplastic analysis. This proposal is to fund the analysis of the archived samples for microplastic.

Estimated Cost: $78,400

Oversight Group: Microplastic Workgroup

Proposed by: Chelsea Rochman (University of Toronto), Meg Sedlak, Diana Lin, and Rebecca Sutton (SFEI)

Time sensitive: No. The samples will be archived in the freezer; however, the sportfish complement the existing work with the Moore project and may provide valuable insight into foodweb uptake. Waiting too long to analyze these samples run the risk of not being to build off the momentum of the Moore project and may jeopardize being able to have the samples analyzed in a timely manner because of capacity issues with the laboratory.

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	***Due Date***
Task 1. Field collection (funded through 2019 project)	Summer 2019
Task 2. Laboratory analysis	Spring/Summer 2020
Task 3. Review of data	Fall 2020
Task 4. Manuscript	Spring 2021

Background

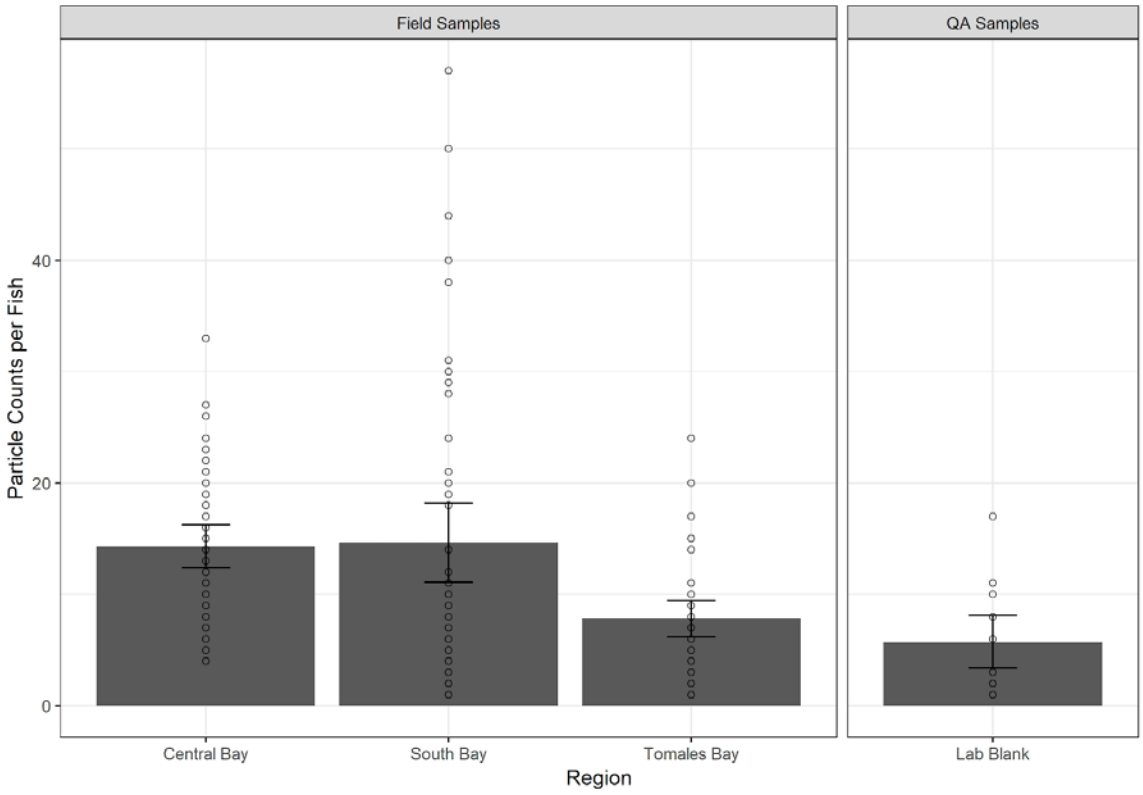
Plastic is ubiquitous in modern life. Global plastic production was estimated to be 299 million tons in 2013 (Gourmelon 2015); nearly a third of plastic production is used for plastic packaging, including single-use items (Andrady and Neal 2009) that are discarded after use. For the last two decades, society has focused on macroplastic in the ocean, such as the Pacific Ocean Garbage Patch, but recently attention has turned to the plastic particles < 5 mm in diameter, referred to as microplastic.

Based on a small screening study that identified microparticles in Bay surface water and effluent, the RMP developed a RMP Microplastic Strategy (Sutton and Sedlak 2017). Many elements of the first two years of the Strategy are currently being addressed through the San

Francisco Bay Microplastics project (primarily funded by the Gordon and Betty Moore Foundation), including surface water, sediment, prey fish and pathways to the Bay. A high priority for the Strategy is to assess the extent to which microplastic is taken up into biota.

The San Francisco Bay Microplastics project is evaluating the presence of microplastic in two important prey fish species, northern anchovy and topsmelt. Microparticles—including microplastic—have been identified in both species at all six of the Bay Area sites sampled (ten fish of each species were analyzed at each site). Microparticles were ubiquitous, and detected in all but two fish samples out of 150. Average concentration of microparticles from topsmelt and anchovies from San Francisco Bay was 14.5 particles/fish, and ranged up to 57 microplarticles/fish. Fibers represented 85% of microparticles in sampled fish from San Francisco Bay. Not all microparticles are plastic; chemical analyses conducted on these samples found that many are anthropogenic fibers for which a polymer identification could not be made due to spectral interferences from the dye. Plastic type identified included polyester, acrylic and polypropylene. San Francisco Bay fish were found to be statistically significantly different from the reference fish collected from two sites in Tomales Bay and the laboratory blanks (Figure 1).

Figure 1 Preliminary results of microparticle analyses in prey fish (Points represent individual particle counts per fish; bars represent average number of particles for all fish from the same region and error bars represent two times the standard error.)



The Moore microplastic project did not evaluate larger sport fish that are consumed by humans and wildlife. Microplastic has been detected in sport fish (Rochman et al. 2015;

Collard et al. 2017; Neves et al. 2015; Compa et al. 2018); however, to date, no study has measured microplastic in Bay sport fish. This is important because microplastic can be an important vector for transferring chemicals, such as flame retardants and plasticizers present in the plastic to the fish (Rochman et al. 2013). There are also likely human health risks associated with ingestion of plastic and contaminant exposures from fish consumption.

The presence of microplastic in fish may have adverse effects. Recent research suggests that the presence of microplastic particles (< 300 microns) may result in reduced growth and body condition of fish (Critchell and Hoogenboom 2018). Rochman et al. (2013) identified an increase in liver toxicity in fish associated with the presence of microplastic.

Microplastic accumulates in the digestive organs of fish; however, recent research on fish suggests that microplastic particles may translocate from the gut to other organ systems (Collard et al. 2017). This finding is important because it suggests the potential for human exposure to microplastic as well as the contaminants that may be present in the microplastic. In a laboratory feeding study of fish, Rochman and colleagues demonstrated the bioaccumulation of PBDEs in fish from a dietary intake of microplastic coated with contaminants (Rochman et al. 2013).

It is important to assess uptake of microplastic into sport fish for four reasons. First, assuming microplastic is detected and the RMP continues to monitor sport fish for microplastic over time, this study may provide a baseline for an important trend indicator. This may allow us to see the efficacy of management actions such as microbead, plastic bag, and polystyrene foam bans. Second, because this project is targeting sport fish that have multiple foraging behaviors, this project will help us understand whether microplastic accumulation is limited to fish that maintain a high site fidelity in the margins of the Bay and consume benthic invertebrates, or whether it is also present in piscivorous Bay fish that forage more widely. Third, this project will complement the existing work being conducted on the Moore project in the Bay margins assessing microplastic in prey fish and sediment. A comparison among sediment, prey fish, and sport fish may provide insight on the potential for food web transfer of microplastic and contaminants that may be adsorbed to the surface of microplastic or present in the microplastic as an additive (e.g., plasticizers or flame retardants). Lastly, evaluating the concentration of microplastic in Bay sport fish will help us understand the potential health risk to humans and other animals that consume sport fish.

The urgency of monitoring sport fish has increased with the ubiquitous detection of microplastic in Bay prey fish and the observation that microplastics can translocate from the gut to liver tissue of fish (Collard et al. 2017). It is important to understand the uptake of microplastic in higher trophic level fish both for implications for human health, as well as the health of larger predators such as cormorants and harbor seals.

Study Objectives and Applicable RMP Management Questions

The purpose of this study is to monitor sport fish gut contents for the abundance of microplastic and explore whether concentrations and patterns vary by habitat and fish species. We will also collect data to evaluate the correlation between microplastic in sediment and microplastic in prey fish and sport fish.

Table 1. Study objectives and questions relevant to RMP Microplastic Strategy management questions (Sutton and Sedlak 2017).

Management Question	Study Objective	Example Information Application
1) How much microplastic pollution is there in the Bay?	Assess concentration in an important upper trophic organism.	Assess the potential for uptake of microplastic into the food web. Use this information to update the conceptual model for microplastic in the Bay.
2) What are the health risks?	Compare concentrations in Bay sport fish to published toxicity studies.	Assess magnitude of potential impact on fish and higher trophic level organisms.
3) What are the sources, pathways, loadings, & processes leading to microplastic pollution in the Bay?	Compare different species that forage in the margins vs open bay.	Assess variation among species and sites to gain insight into the importance of local sources.
4) Have the concentrations of microplastic in the Bay increased or decreased?	Establish a baseline for future trend analyses.	Assess change in microplastic concentration in fish in future years based on the baseline established with this study.
5) Which management actions may be effective in reducing microplastic pollution?	Characterize chemical composition and particle type of microplastic present in sport fish.	Understanding the type and composition of microplastic accumulating in biota will be important for prioritizing appropriate management actions.

Approach

The 2019 RMP Status and Trends sport fish collections present an opportunity to measure microplastic particles in sport fish. The RMP monitors sport fish every five years at five popular fishing locations in the Bay. We propose to collect two species of sport fish at three sites in the Bay. One species will be shiner surfperch (*Cymatogaster aggregata*), an abundant and popular sport fish that feeds on invertebrates in the benthic zone and exhibits high site fidelity, useful for assessing regional differences in contaminants. The other species will be striped bass (*Morone saxatilis*), another popular sport fish species that is higher in the food chain than shiners and provides an integrated signal for the Bay as a whole as a result of its wide foraging behavior and opportunistic consumption of lower trophic level fish. As part of the RMP Status and Trends Program, striped bass samples will be collected at two sites in the Bay, targeting popular fishing sites in the Lower South Bay (near Artesian Slough) and Central Bay. Shiner surfperch will be collected at two popular fish locations in the Bay (Central Bay and San Leandro Bay).

It is not possible to collect both fish species at every site. For this study, we will collect approximately 10 fish of each species at the Central Bay site; and then ten of one species at the remaining two sites. Fish gut samples will be analyzed for microplastic. The samples will be shipped to University of Toronto for micoplastic analyses. After receipt in the laboratory,

the fish are thawed, weighed and measured. They are then dissected to remove gut and gut contents for digestion, consistent with previously published protocols (Dehaut et al. 2016; Foekema et al. 2013; Corcoran 2015). The guts are individually weighed and the contents are placed in a jar filled with a 20% KOH solution. The amount of KOH added is typically three times the volume of biological tissue. The material is left at room temperature for up to 14 days to facilitate the digestion. The jars are not stirred to avoid damage to plastic from hard materials such as rocks and shells. After digestion, the samples are filtered through a 10-micron polycarbonate filter. Samples are then analyzed under a microscope and particles are picked out of the samples. Raman and/or FTIR spectroscopy is used to identify the chemical composition of each of the particles and particle sizes.

This project will benefit from additional chemical analyses of similar sport fish from the same locations. In addition, this project will leverage the findings from the Moore Microplastic project by comparing microplastic analyses in sediment and prey fish such as anchovy and topsmelt to sport fish to assess food web uptake as well as spatial distribution of microplastic. The data will be subjected to rigorous quality assurance-quality control review before being uploaded to CEDEN and CD3.

The final deliverable will be a manuscript prepared by University of Toronto with assistance from SFEI. A draft of the manuscript will be provided for Workgroup and TRC review.

Budget

The following budget represents estimated costs for this proposed special study (Table 2).

Table 2. Proposed Budget.

Expense	Estimated Hours	Estimated Budget
Labor		
Data review & report writing	76	$11,000
Senior review /input	3	$400
Data Management	86	$11,000
Subcontract		$56,000
University of Toronto Microplastic Analyses		
Total		**$78,400**

Budget Justification

Data Management and QA Costs
The data will be reviewed by RMP staff and uploaded into CD3 using existing CEDEN formats. Based on our experience with the Moore data sets, it is fairly labor-intensive to review the microplastic data.

Reporting Costs
The contracting laboratory will prepare a manuscript summarizing the findings of this work. RMP staff will assist in writing the manuscript.

Laboratory Costs
SFEI is currently working with the University of Toronto on the Moore project. The Rochman Laboratory uses state of the art instrumentation to conduct microplastic analyses and is recognized as a pioneer in the field of microplastic research. The cost to analyze each sample is $1,000 due to the labor intensive nature of the extraction process, identification, enumeration, and analysis associated with spectroscopy. We will include laboratory blanks in our analyses (approximately 10 percent of the samples collected). The collection of ten fish of each species at each site will provide information on the variation observed in field samples.

Reporting

The results of this project will be summarized in a manuscript prepared by the University of Toronto with assistance from SFEI. A draft of the manuscript will be provided for Workgroup and TRC review.

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Study Description for Supplemental Environmental Project (SEP) Fund for the Regional Monitoring Program for Water Quality in San Francisco Bay

This is for use in documenting how a specific San Francisco Bay Regional Monitoring Program study by the San Francisco Estuary Institute (SFEI) complies with the State Water Resources Control Board Policy on Supplemental Environmental Projects (SEP) (http://www.waterboards.ca.gov/water_issues/programs/enforcement/#policy).

Basic Information

Study Name: Development of a Stormwater Conceptual Model for Microplastic

Study Budget, Total: $30,000

SFEI Contacts:

- Technical – Alicia Gilbreath, Alicia@sfei.org (510) 746-7308
- Financial – Jennifer Hunt, jhunt@sfei.org, (510) 746-7347

Study Description

Provide a concise description of the study, including the goal(s) of the study.

As part of the San Francisco Bay Microplastics Project, 12 tributaries comprising 11% of the watershed drainage area to San Francisco Bay (i.e., 763 sq. km out of a total of 6,725 sq. km) and 6% of the total flow to the Bay via small tributaries were sampled during storms WY2017, WY 2018, and WY2019 to estimate concentration of microparticles. Geographically distributed throughout the Bay Area, these tributaries were selected based on watershed size, watershed characteristics (e.g., impervious surfaces), land use characteristics (e.g., commercial, industrial, rural, etc.) and whether the tributary had been previously identified as a trash hotspot (i.e., macrodebris greater than 5 mm).

Microparticles and microplastic were identified in stormwater from all 12 tributaries, discharging between 1.3 and 30 microparticles per liter, with a mean 9.2 particles per liter. Correlations between stormwater microparticle concentrations and watershed land use, as well as calibration of the Regional Watershed Spreadsheet Model, suggested that industrial land use may be associated with greater discharges of microparticles and microplastic.

We propose to develop a conceptual model that describes sources of microparticles and microplastic to stormwater, and identifies land uses

and/or landscape attributes that could be linked to higher levels of discharge. A review of Bay data in the context of the scientific literature may suggest industrial land use, impervious surfaces generally, or proximity to roadways as key factors that may explain higher levels of discharge, and should be evaluated in future monitoring studies. Evaluating possible factors influencing microparticle and microplastic loads is important to identify potential sources, to better understand areas of uncertainty, and to identify key attributes that influence the generation of microparticles in stormwater.

Compliance with SEP Criteria

This study complies with the following SEP criteria:

- It supports development and implementation of a monitoring program and/or study of surface water quality or quantity and/or the beneficial uses of the water.
- Its nexus to violation(s) is that is located within the same Water Board region in which violation(s) occurred.

This study goes above and beyond applicable obligations of dischargers because of the following:

- This project is a study (or studies) and associated product (or projects) above and beyond what is required in permits or orders issued by the Regional Water Board or what can be accomplished with dischargers' required monetary contributions to the Regional Monitoring Program for Water Quality in San Francisco Bay.

Study Milestones and Performance Measures

Provide a projected date for when the study results will be available, and describe where or how the results will be made available. Public availability of study results will constitute successful completion of the study.

A draft conceptual model of microplastic will be presented to the RMP Microplastic Workgroup in the Spring of 2020. After incorporation of stakeholder comments on the draft report, the final document will be posted on the RMP website.

Study Budget and Reports to Water Board

Pursuant to the October 2015 Supplement to the Memorandum of Understanding (MOU) between SFEI and the Regional Water Board, SFEI is responsible for identifying in each annual work plan and annual budget for the RMP those studies or elements, or portions of a study or element, that are to be funded by SEP funds. SFEI will keep a copy of accounting records of SEP fund contributions and expenditures separately from regular RMP funds. In its annual and quarterly financial reports to the Regional Water

Board, SFEI will separately itemize SEP fund contributions and expenditures by each SEP funder.

SFEI will provide notice to the Regional Water Board within one month after receiving funds from a discharger for the SEP and the notice will state SFEI's agreement to use the funds received as described herein.

Publicity

Pursuant to the 2015 MOU, SFEI will indicate on its Regional Monitoring Program website, and annual and other reports, that funding for the study is the result of settlement of "San Francisco Bay Water Board" enforcement actions.