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.

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.