Trash Monitoring Conceptual Modeling Workshop Summary Notes and Outcomes

Abstract

The following document summarizes the outcomes of the April 18-19, 2017 workshop to develop scientific monitoring questions for trash pollution and start the process of developing a conceptual model to inform trash monitoring in receiving waters. This document has been developed for Regional Water Quality Control Board Staffs and permittees who will be developing receiving waters monitoring programs. The design of any trash monitoring program depends on the kind of management question the monitoring is aiming to address. A number of management questions were developed at this workshop that fell into five broad categories:

1. How much trash is out there?
2. At what rate is it changing?
3. What are the sources of trash (and how much or what portion does each source contribute)?
4. What are the most effective management actions?
5. What is the effect or cost of trash impacts?

These categories of management questions were used to identify scientific monitoring questions, which could then be used to develop a monitoring program. A number of common themes emerged as the scientific monitoring questions were identified, including the widespread use of comparing standing stock measurements to detect change, and the need to have comparable monitoring methodologies across different types of habitats.

Despite outreach efforts, the workshop did not include representation from all areas of the State. Receiving input from Regional Board staff and permittees throughout the state would add value to future methods validation efforts. Further outreach to other regions of the state will occur to address this issue and get a broader sense of the range of habitats where receiving waters monitoring is needed.

Overview

On April 18-19, 2017 the California Ocean Protection Council and the State Water Resources Control Board (Water Board) hosted a workshop to develop scientific monitoring questions for trash and start the process of developing a conceptual model that would inform trash monitoring efforts in receiving waters and habitats[1]. The objectives of the workshop were to identify the key and unresolved issues surrounding trash monitoring, develop a mechanism to translate management questions into scientific monitoring questions, and provide considerations and recommendations for future field testing efforts.

[1] The question of whether monitoring in habitats or receiving waters could be used to determine compliance with the trash amendments was controversial. The focus of this workshop was on receiving waters monitoring, rather than compliance assessment.

The workshop also included presentations from experts in trash monitoring, which are available online here: http://www.opc.ca.gov/programs-summary/land-based-impacts/trash-monitoring-projects/. This document is intended to provide a high-level summary of the workshop outcomes, rather than an accounting of the workshop process. Additional notes on a variety of topics from this workshop are available in Attachment 2.

High-Level Outcomes

As mentioned above, the workshop had three key objectives: identify key and unresolved issues surrounding trash monitoring, develop a mechanism to translate management questions into scientific monitoring questions, and provide recommendations for future field testing efforts. The outcomes of these objectives are summarized below.

Key Issues Surrounding Trash Monitoring

The most important issue identified in this workshop surrounding trash monitoring is that the design of any trash monitoring program depends on the kind of management question the monitoring is aiming to address. For instance, a monitoring program to assess how much trash is in waterways would be different than a monitoring program to assess whether a bag ban reduced the number of bags found along a local creek. To start scoping what broadly-applicable parameters trash monitoring programs should address, workshop participants identified a number of trash management questions of interest. These questions fell into five broad categories:

1. How much trash is out there?
2. At what rate is it changing?
3. What are the sources of trash (and how much or what portion does each source contribute)?
4. What are the most effective management actions?
5. What is the effect or cost of trash impacts?

These broad categories of management questions could lead to a number of different scientific monitoring questions, and workshop participants brainstormed a suite of monitoring questions that addressed the first four broad management questions listed above.[2]

The monitoring questions were developed as examples of what a permittee could monitor to address broader management questions, rather than as the monitoring questions that should be pursued moving forward. The list of the monitoring questions that were developed at this workshop is available in Attachment 1.

Several common themes emerged once the monitoring questions were developed. Almost all of the monitoring questions developed involved a comparison of "standing stock" measurements in habitats where trash is deposited over a period of time. Comparability of methodologies across habitats and regions was important to effectively answer management questions at a broad scale, but was also

[2] Given the time and capacity constraints of the workshop, monitoring questions were not developed for management question five; regarding the effect or cost of trash impacts. Research to answer question five would likely involve combining a trash monitoring program with some other kind of analysis, like an economic study or toxicology study. Although question five was not pursued at this workshop, there was a lot of interest in the effects of trash pollution, and should be pursued in the future.

challenging. Generally, participants gravitated towards quantitative, rather than qualitative analysis, for trash monitoring questions, there was also an interested in translating qualitative methods to quantitative results. For example, there was an interest in the on-land visual assessment method, which is an existing qualitative method that is broadly applicable across urban areas, and how it could be translated to provide quantitative results, although these results would have some imprecision. Determining how precise monitoring should be was the most difficult aspect of developing monitoring questions. The precision needed for receiving waters trash monitoring may be a good area for the field testing project to explore.

Unresolved Issues Surrounding Trash Monitoring

The major concern surrounding receiving waters monitoring was cost, particularly the cost involved in developing a receiving waters monitoring program that could identify trash sources, including whether the trash came from a stormwater system or another source. Currently, a receiving waters monitoring program to identify sources of trash is too expensive to pursue. Moving forward, the field testing project will conduct methods validation and will investigate developing less expensive methods to achieve effective receiving waters trash monitoring.

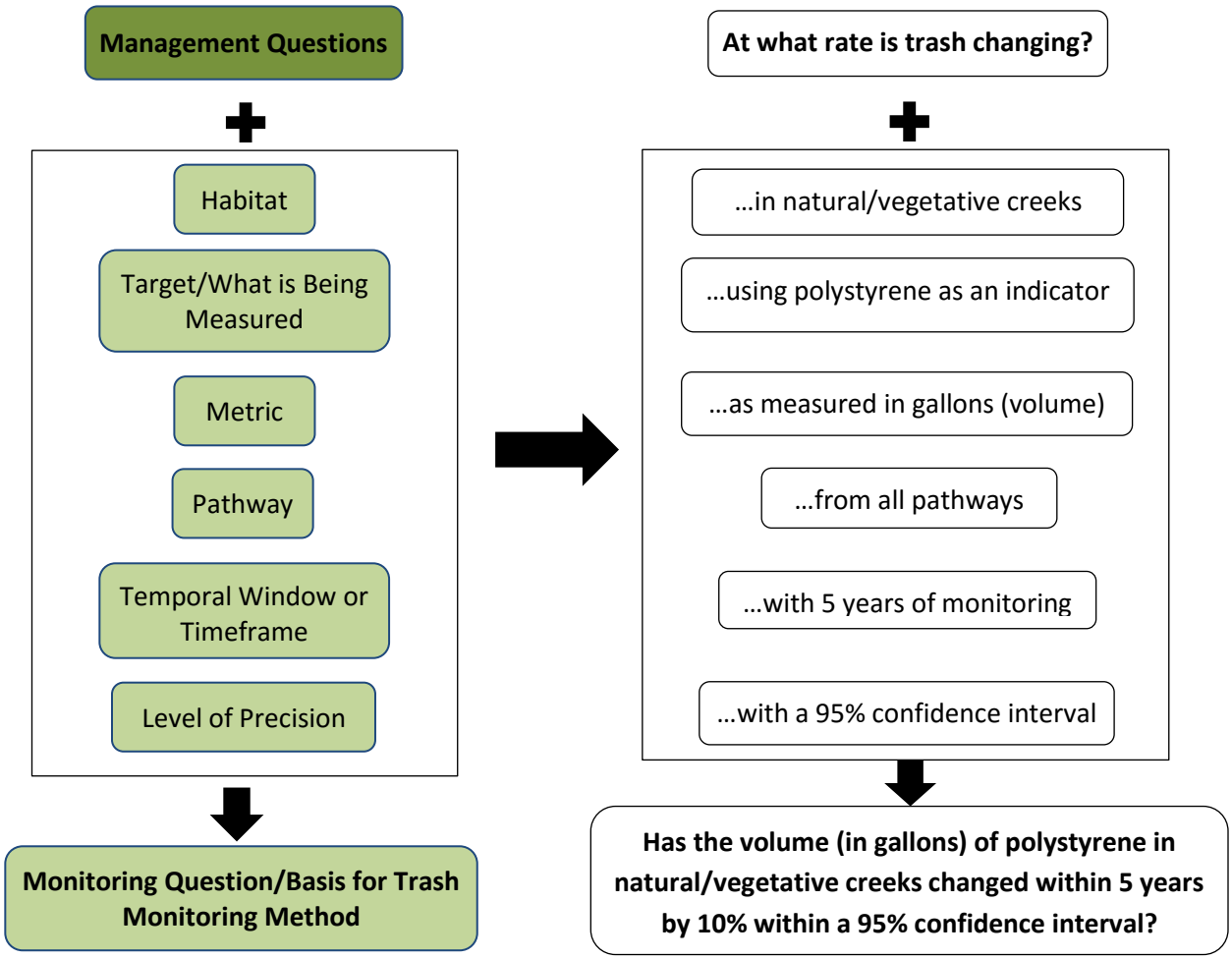
Despite outreach efforts, the workshop did not include representation from all areas of the state, so a lot of the discussion focused on issues in the San Francisco Bay Area and the San Diego Area. In particular, the regulatory concerns of the San Francisco Bay Regional Board were often foregrounded as a lens through which to view any emergent monitoring program. However, habitats, hydrology, trash generation patterns, and jurisdictional concerns vary greatly in California, and receiving input from Regional Board staff and permittees throughout the state would add value. Further outreach to other regions of the state should occur to address this issue and get a broader sense of the range of habitats where monitoring could occur and considerations for monitoring programs from other areas of the state.

Development of Management Questions into Scientific Monitoring Questions

The elements included as part of the scientific monitoring questions became more detailed as the workshop moved forward. The process to develop scientific monitoring questions used trash management questions as a broad starting point to generate many different monitoring questions. See Figure 1 for a depiction of translating trash management questions into scientific monitoring questions.[3]

[3] For our purposes at this workshop, the "habitat" box only referred to receiving waters habitats.

Figure 1: Translating Management Questions into Scientific Monitoring Questions



Considerations and Recommendations for Future Field Testing Efforts

Habitats and Temporal Considerations to Test

Over the course of the workshop, participants recommended that the future field testing project work to reduce bias from habitats in the trash samples collected and that the project should consider how trash composition changes depending on the habitats sampled. Participants also recommended coordinating the timing of trash sampling with weather, rather than with street sweeping activities; a combination of creek monitoring and storm drain monitoring around wet weather events would capture more of the pathways of trash to receiving waters. Overall, participants recommended field-testing monitoring methods at a lower number of sites more frequently, rather than at a higher number of sites less frequently.

Baseline

The field testing project should consider developing or validating monitoring methods that would reduce variability in baseline. Baseline monitoring is primarily influenced by funding, and determines how confident water quality managers are in future changes observed in receiving waters. There are a number of ways to reduce variability in baseline data collection, including:

- Collecting composite samples, such as sediment core samples and water column samples.
- Increasing the number of samples that are collected per site.
- Using a "coarse" metric for data collection, such as rating sites into categories A, B, C, and D, instead of collecting volumes or counts; ensuring that more than one staff is present to record the measurement will reduce the measurement error in classifying sites into A, B, C, and D.
- Ensuring that staff uses the same sampling time to collect all samples
- Choosing a method that is less vulnerable to storm variability.

Products from the field testing project

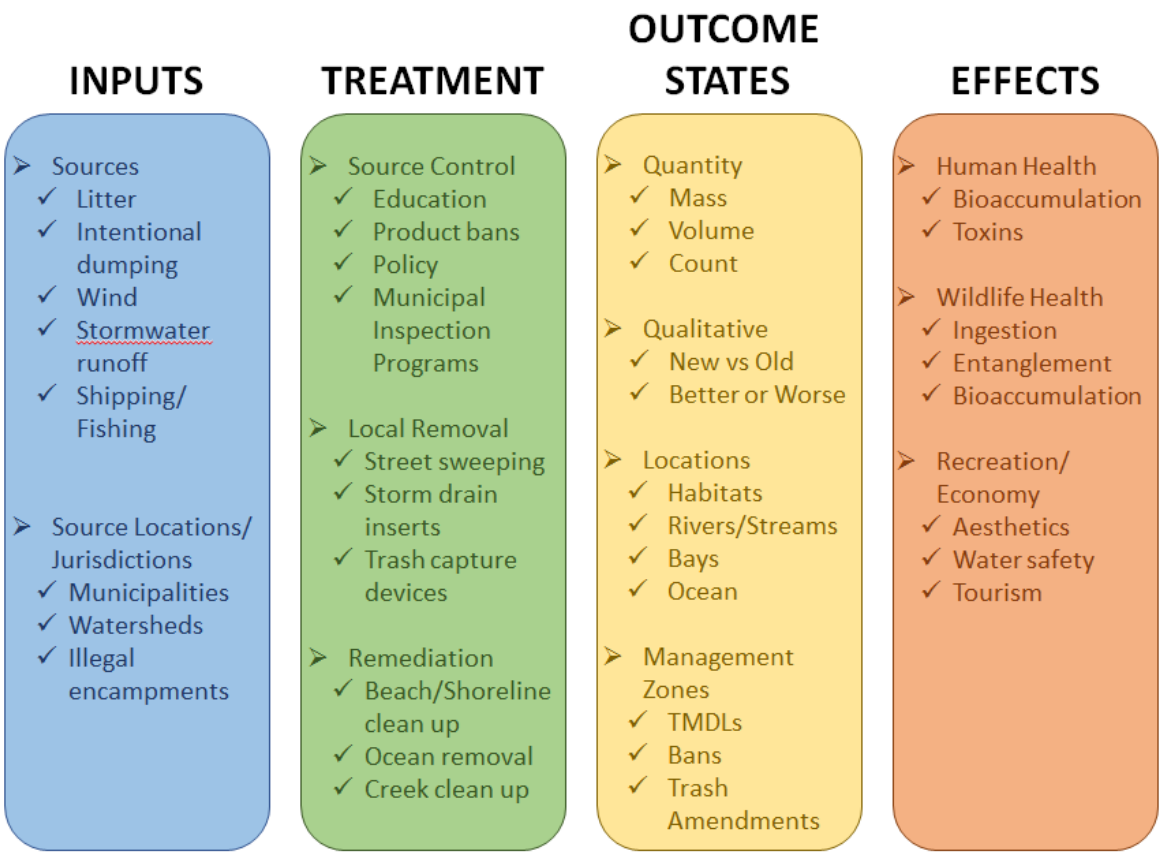
During the workshop, participants provided an outline of products coming out of the field testing project that would be helpful for permittees and Regional Board staff. Overall, a point of importance was that the work product from the field testing project could be "taken off the shelf and implemented," and would be applicable across the entire state. Suggested Field Testing Project deliverables included:

- A report with the trash monitoring protocols and clear instructions for data collection and analysis (on both the front and back end of data collection), including power of sampling design and other information for practitioners without a statistics background. Include the synopsis of the method, types of results, and how it might be used, particularly for engagement of citizen science groups.
- Staff training modules.
- Development of data management standards for monitoring entities, and encouraging adoption, perhaps by creating an open-source database.
- Development of tutorial materials and a "help desk" or clearinghouse for citizen science groups to participate in trash monitoring.
- Interim project updates for stakeholders, including the larger community beyond monitoring practitioners and permittees. These updates could include webinars and presentations from involved researchers or grad students.

Next Steps

On the last day of the workshop, the beginnings of a draft conceptual model identifying how trash moves through the environment, and what affects it was developed, and is available below in Figure 2. To address some of the gaps and unresolved issues identified above, the Southern California Coastal Water Research Project will be holding a second workshop to build on the work done so far and develop a final, documented, conceptual model in the fall of 2017.

Figure 2: Draft Conceptual Model of the Fate and Transport of Trash and its Effects



Attachment 1: Monitoring Questions Developed at the Workshop

Below is a list of the broad management questions that workshop participants prioritized, with more detailed management questions below them, and scientific monitoring questions listed by the square bullets. The monitoring questions were examples that workshop participants developed as part of their testing of the conceptual model framework, and do not represent the monitoring questions that are preferred or recommended by the group, rather, they are a starting point to consider when refining and developing monitoring questions and monitoring programs that are broadly applicable across the state.

- How much trash is out there?
    - What is the spatial distribution of trash?
        - What is the volume of trash (> 5mm) deposited on banks and visible on surface waters in streams under base flow between reference areas and non-reference areas? (with a precision of +/- 20%)
        - How do volumes of trash (>5 mm) in surface waters, water column, sediment, and shorelines/banks compare between estuary and creeks/channels? (with a precision of +/- 20%)
    - What are the most prevalent trash types?
        - What is the condition of trash (>5 mm) deposited on banks and visible on surface waters in streams after a significant flow event? (with a precision of +/- 20%)
        - How does the composition of trash (>5mm) deposited on banks and visible on surface waters in streams compare between reference areas and non-reference areas,, including trash by material, item, type, and brand? (with a precision of +/- 20%)
- At what rate is it changing?
    - At what rate is trash changing, including quantity, types, and sources?
        - Has the volume of polystyrene in natural/vegetative creeks changed within 5 years by 10% within a 95% confidence interval?
        - Has the count per area of plastic bags (full or partial) changed by 20% in riparian habitat post-storm (of a specified size) over a specified number of years from baseline with an 80% confidence interval?
        - Has the visual assessment score of all visible trash > 5 mm changed by 1 score in tidal creeks/rivers on a seasonal basis (e.g. wet season timed w/storms vs. dry season)? With a confidence interval of 95%?
        - Has the volume of plastic discharged in small, medium and large storm outfalls into creeks changed by 30% with a 95% confidence interval as compared to baseline?
- What are the sources of trash (and how much/what portion does each source contribute)?
    - What are the relative contributions of MS4 and non-MS4 sources?
        - What is the relative contribution and/or significant movement of trash within CalTrans jurisdiction that moves (windblown) off their jurisdiction?

        - Can we measure a signal in receiving waters after there are Styrofoam foodware bans?
        - What is the contributing trash load from illegal encampments compared to MS4s in a given creek system?
- What are the most effective management actions?
    - What is the effectiveness of product bans?
        - Are we 95% certain that we have a decline of at least 50% in volume of glass in rivers and creeks after an increase in glass CRV, as measured one week after labor day?
        - Are we 95% confident that we have a 50% decline in count of cigarette butts found in capture devices after a 48 hour/0.1 inch “first flush” event?
        - Are we 95% confident that there is a 50% decline in the volume of polystyrene found in rivers and creeks 48 hours after a 0.1 inch storm (take measurements both before and after implementation).
        - Are we 95% certain that there is a decline of at least 30% in food packaging volume in the rivers and creeks before and two years after roll out of a reusable container exchange program in commercial districts measured 48 hours after >0.1 inch rainfall?
- What is the effect or cost of trash impacts?
    - What is the effect of trash on biota?
    - What is the cost of trash impacts on aesthetics, economic activity, and recreation?
    - What is the effect of trash impacts on human safety?

Attachment 2: Additional Notes

Participants in the workshop provided feedback on a wide array of issues relating to trash monitoring, not all of which was able to be included in the body of the workshop summary. Additional notes on topics covered are included below.

Notes on Metrics

Generally, volume is a better metric to use for trash monitoring than weight. Trash is a very diverse pollutant, and is made up of many kinds of materials including, glass, plastics, paper, and metals. If a heavier material, like metal, is collected in a sample, it can greatly affect the sample's weight, but doesn't necessarily mean that more trash was collected. Due to the diversity of materials present in trash, some materials may absorb water much better than others, and will be heavier in "wet weight" measurements, and, again, would affect the sample's weight, but may not actually indicate that more trash is present. If using weight as a metric, specifying whether you're using dry or wet weight is critical. Using counts of specific types of items may be appropriate when monitoring for the efficacy of product bans, but is not preferred when conducting general trash monitoring. Monitoring using counts would also need to include protocols for how to count partial pieces of trash (e.g. does half of a bottle equal one bottle when counting? Does a quarter of a bottle equal one bottle when counting?). There may be value added by converting to trash counts from other methods, particularly for microplastics monitoring and comparability with beach cleanup data.

Notes on Qualitative Trash Monitoring Methods and Qualitative Data

In some cases, qualitative information may be enough to make a management decision; for example, it may not be necessary at this point to develop a monitoring program to determine what the relative contribution of trash to a given creek system from illegal encampments and stormwater systems, because presently both are significant and both need to be addressed.

Trash monitoring may be done using quantitative or qualitative methods. Finding a good balance of where or when each type of method is appropriate would be valuable for stakeholders in the future. Generally, whether to use quantitative or qualitative sampling depends on the scale of monitoring and the variability or difficulty of sampling a particular kind of habitat. When spatial deposition of trash is variable, it may be worthwhile to consider a less quantitative method, or use a qualitative method.

Notes on Future Field Testing Recommendations

Habitats and Temporal Considerations

There are a number of ways to go about monitoring habitats, including comparing a habitat in a reference site to the same habitat in an impaired site, and or sampling the same habitat before and after storm flows. When monitoring for changes in trash composition due to a management action, ideally monitoring would follow a Before-After-Control-Impact design, which would involve monitoring habitats in both reference sites and impacted sites before and after a management action. This design was a preferred way to monitor the efficacy of specific product bans.

Trash monitoring programs should also consider the timing of when reporting requirements are due to policymakers and regulators.

Technical Advisory Committee

The Technical Advisory Committee (TAC) for the field testing project should be structured to cover a range of expertise. The TAC will be convened in the fall of 2017, and will remain in place for the 3-year field-testing project duration. Workshop participants made suggestions of entities to consider as part of the TAC including:

- Advisors with expertise in on-the-ground trash monitoring (consider for ~4 seats on the TAC)
    - Include practitioners with expertise in both Northern and Southern California, as well as monitoring in a variety of habitats
- Remote Sensing Experts
- Advisors in methods development with experience applying methods in permits and developing end products
- Advisors with expertise in specific types of habitats (e.g. creeks and streams)
- Advisors with expertise in mechanical engineering

Additionally, participants also provided a list of organizations to consider when forming the TAC. The suggested organizations are listed below.

- California Department of Transportation
- United States Department of Agriculture (they have expertise in drone use)
- United States Geological Survey
- Space and Naval Warfare Systems Command
- University of California, Davis – specifically the Coastal Marine Science Institute
- University of California Water Security and Sustainability Research Initiative
- California Council on Science and Technology
- Sacramento State University Water Programs
- California State University Council on Ocean Affairs, Science, and Technology
- The Nature Conservancy
- ESRI
- Marine Applied Research and Exploration

Stakeholder Outreach

Workshop participants provided recommendations on both areas of expertise to consider when reaching out to stakeholders, as well as organizations. The areas of expertise discussed included stakeholders with legislative expertise as well as experts in the social and environmental justice aspects of trash pollution. The organizations suggested by participants are listed below:

- California Department of Transportation (different staff may participate in the stakeholder group and the TAC)
- California Coastkeepers
- 5 Gyres
- Center for Ocean Solutions

The State Water Board indicated that it could host a stakeholder kickoff event for the field testing project.