Special Study Proposal: Triclosan in Small Fish

Summary: The RMP classification of the widely used antibacterial ingredient triclosan as an emerging contaminant of low concern (Tier II) for San Francisco Bay is based on a relatively small amount of data. A recent study of a West Coast estuary suggests monitoring in small fish may be a more sensitive indicator of impact; these data are lacking for San Francisco Bay. Characterization of triclosan in whole fish composites of juvenile salmon from the Puget Sound indicates levels of potential concern, despite low concentrations in estuary waters. Food web transfer is suspected of leading to the higher concentrations observed in small fish. The proposed study would screen small Bay fish for triclosan and its metabolite, methyl triclosan, to determine whether levels may pose concerns. These data are essential to appropriately classify triclosan within the RMP's tiered risk framework for contaminants of emerging concern (CECs), and may influence ongoing efforts among stakeholders and local and state agencies aimed at reducing environmental contamination and ecological impacts of this antibacterial agent.

Estimated Cost: $41,300

Oversight Group: ECWG

Proposed by: Rebecca Sutton and Meg Sedlak (SFEI)

PROPOSED DELIVERABLES AND TIMELINE

Deliverable	***Due Date***
Task 1. Project Management (manage subcontracts, track budgets)	2017
Task 2. Develop detailed sampling plan	Spring 2017
Task 3. Field Sampling	Summer 2017
Task 4. Lab analysis	Fall 2017
Task 5. QA/QC and data management	Winter 2017
Task 6. Draft report	4/30/2018
Task 7. Final report	7/31/2018

Background

Triclosan is an antimicrobial chemical used widely in personal care products, such as liquid hand soaps, and many other consumer goods. Triclosan has been detected in Bay sediment and surface water (up to 68 ± 26 ng/L; Kerrigan et al. 2015), with observed concentrations below available aquatic toxicity thresholds (e.g., a predicted no effects concentration [PNEC] of 115 ng/L; EC 2012). Triclosan was not detected in mussels collected from the Bay in 2010 (< 33 ng/g wet weight; see 2013 Pulse of the Bay), though trace levels of the

metabolite methyl triclosan were identified in mussel tissue subjected to non-targeted analysis (Sutton and Kucklick 2015).

Based on the available data for the Bay, the RMP has classified triclosan as a low concern (Tier II) contaminant, according to the tiered risk and management action framework (Sutton et al. 2013). However, recent monitoring in Puget Sound found that though estuary water contained just 5.2 ng/L triclosan (Sinclair Inlet), levels in juvenile salmon averaged 24.4 ng/g (whole fish composites), suggesting considerable food web transfer (Meador et al. 2016).

To assess whether these observed tissue concentrations are a cause for concern, it would be best to compare them to a toxicity threshold that is also based on tissue concentrations, essentially comparing apples to apples. However, this sort of tissue-specific toxicity threshold is not available. Existing toxicological studies on fish provide toxicity endpoints tied to concentrations in water to which the fish are exposed in controlled laboratory environments (e.g., Schultz et al. 2012). Unlike the fish in Puget Sound, the fish in lab studies are exposed to triclosan only through water, and not through the food web. Using a bioaccumulation factor to account for the food-based exposure pathway, we can estimate the hypothetical water concentration that would lead to observed tissue levels in Puget Sound fish. Fish exposed in the lab to this hypothetical, calculated water concentration, and fed food free of triclosan, would be expected to contain the same level of triclosan in their tissues as seen in the Puget Sound fish exposed to triclosan via the food web.

The Puget Sound scientists calculated this hypothetical water exposure concentration to be 271 ng/L. This hypothetical water exposure concentration could then be compared directly to concentrations used in toxicology experiments involving fish raised in a controlled environment that are exposed to triclosan only through the water, not via the food web. The calculated water equivalent level, 271 ng/L of triclosan, is near a level of triclosan (560 ng/L) that has been shown to significantly increase aggressive behavior in fathead minnows when exposed in combination with another widely used antibacterial agent, triclocarban (179 ng/L; Schultz et al. 2012). These two compounds are known to co-occur in the environment, often at comparable levels (Halden and Paull 2005).

The RMP's previous review of triclosan noted data gaps regarding the potential for transfer through the food web to act as a source of additional exposure to wildlife (Klosterhaus et al. 2011). With new findings from the Puget Sound suggesting this may be occurring in a similar West Coast estuary (Meador et al. 2016), there is now stronger motivation to determine whether levels of triclosan in the Bay's small fish may be a potential concern. At present, the estimation method outlined above is the only way to account for the effects of food web transfer using existing toxicity data.

A notable strength of the present proposal is the evaluation of both triclosan and its metabolite, methyl triclosan, in tissue. Methyl triclosan is formed from biological methylation of triclosan. It is more likely to bioaccumulate than triclosan (Bedoux et al. 2012), and may be more toxic (Bedoux et al. 2012), yet it is rarely characterized in monitoring studies.

Of note, while fish can be exposed to higher levels of triclosan from their surroundings, algae and invertebrates are often considered more sensitive (Chalew and Halden 2009). A

number of different aquatic toxicity thresholds for triclosan are available in the literature. Colgate-Palmolive scientists used an unconventional method to develop a PNEC of 1,550 ng/L (Capdevielle et al. 2008). In contrast, a more traditional and conservative method based on acute algal toxicity has led to use of a PNEC of 4.7 ng/L (e.g., von der Ohe et al. 2012). Should the latter threshold be considered more appropriate for San Francisco Bay, the few recent ambient Bay surface water measurements available (up to 68 ± 26 ng/L; Kerrigan et al. 2015) may suggest cause for concern. However, existing data are too few to trigger reclassification of triclosan within the RMP's CEC risk and management action framework (Sutton et al. 2013; Sutton and Sedlak 2015). Until more data are generated, triclosan may remain classified as a low concern (Tier II) for San Francisco Bay.

Study Objectives and Applicable RMP Management Questions

This study will provide data essential to determining the appropriate placement of triclosan in the RMP's tiered risk framework, which guides monitoring and management actions on emerging contaminants in San Francisco Bay (Sutton et al. 2013; Sutton and Sedlak 2015). Existing data on triclosan have led to classification as a low concern (Tier II) contaminant (along with other pharmaceutical and personal care product chemicals monitored; Sutton et al. 2013), but a recent study of Puget Sound suggests small fish may be a more sensitive indicator of exposure and potential concern (Meador et al. 2016). Management questions to be addressed by this study are the same as those of the overall RMP program, as shown in Table 1.

Table 1. Study objectives and questions relevant to RMP management questions.

Management Question	Study Objective	Example Information Application
1) Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?	Compare measured concentrations to toxicity thresholds (back-calculated to account for food web magnification).	Do findings suggest triclosan is appropriately classified as a low concern for San Francisco Bay? Do data indicate a need for management actions?
2) What are the concentrations and masses of contaminants in the Estuary and its segments? 2.1 Are there particular regions of concern?		
3) What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary? 3.1. Which sources, pathways, etc. contribute most to impacts?		

4) Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased? 4.1. What are the effects of management actions on concentrations and mass?		
5) What are the projected concentrations, masses, and associated impacts of contaminants in the Estuary?	Review results alongside available projections of use and potential control actions under consideration by local, state and federal agencies and organizations.	Which anticipated changes or actions are likely to have the greatest impact on triclosan pollution? Are additional/different actions needed?

This monitoring effort would most directly address question 1, determining whether contaminant levels exceed a toxicity threshold. Inferences regarding future pollution could involve interpretation of the data within the context of use information and potential changes in use or regulation of this antimicrobial pesticide, all of which may play a role in addressing question 5.

In addition, the study will address the established emerging contaminants priority question: What emerging contaminants have the potential to adversely impact beneficial uses of the Bay? The RMP's tiered risk and management action framework currently lists pharmaceuticals and personal care products including triclosan as a low concern (Tier II) for San Francisco Bay; findings would be used to update this classification based on a more sensitive indicator.

Approach

Ambient Bay Small Fish Sampling

Small fish will be collected through a strategic collaboration with an existing sampling effort in the Lower South Bay, the region of the Bay with the greatest likelihood for organism exposure to wastewater-derived chemicals. Dr. James Hobbs (UC Davis), the principal investigator of this on-going effort, has expressed willingness to collaborate.

Mississippi silversides are expected to be an appropriate sentinel species for this study, though others may be considered. Small fish will be shipped whole to AXYS Analytical (or a comparable laboratory) for preparation as whole-fish composites (4-10 individuals per composite, depending on species and size). A total of up to 17 composite samples will be tested, along with one field replicate, one field tissue blank, and a reference sample. Minimum sample size is 2.5 g.

Analytical Methods

Samples will be analyzed by AXYS Analytical or a comparable laboratory. AXYS will soon release a new method to determine both triclosan and methyl triclosan in tissue. The

instrument detection limit for triclosan is expected to be 1 ng/g, while for methyl triclosan it is expected to be in the range of 1-5 ng/g. Per sample analytical costs are estimated to be $440 for AXYS, which includes preparation of composites and lipid analysis as well as chemical analysis.

Budget

The following budget represents estimated costs for this proposed special study (Table 2). Efforts and costs can be scaled back by reducing the number of composites sampled.

Table 2. Proposed Budget.

Expense	Estimated Hours	Estimated Cost
Labor		
Project Staff	168	24,000
Senior Management Review	6	1,300
Project Management		0*
Contract Management		0*
Data Technical Services		4,000
GIS Services		0
Creative Services	6	500
IT Services		0
Communications		0
Operations		0
Subcontracts		
Name of contractor		
AXYS or comparable lab		8,800
Direct Costs		
Equipment		1,000
Travel		500
Printing		0
Shipping		1,200
Other		0
Grand Total		41,300

*services included in the base RMP funding

Budget Justification

Field Costs
Field costs are minimized through sample collection in collaboration with an existing monitoring effort.

Laboratory Costs
Analytical costs per sample are estimated to be $440. For up to 20 samples, including one field replicate, a field blank, and a reference specimen, the total analytical costs will be $8,800.

Data Management Costs
Standard data management procedures and costs will be used for this project. Data will not be uploaded to CEDEN at this time.

Reporting

Results will be provided to the RMP committees in the form of a report. A draft will be provided for review by 4/30/18. Comments will be incorporated into the final report published by 7/31/18.

References

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