

# Draft staff report external scientific review

---

Review prepared by  
Prof Tamara Galloway  
College of Life and Environmental Sciences  
University of Exeter,  
Geoffrey Pope Building  
Stocker Road, Exeter UK  
tel 0-44-1392 263436  
email [t.s.galloway@exeter.ac.uk](mailto:t.s.galloway@exeter.ac.uk)

26<sup>th</sup> June 2014

## Proposed amendments to stateside water quality control plans for trash

This document constitutes an external scientific review of the Draft Amendments to Stateside Water Quality Control Plans for Trash, prepared by the Division of Water Quality, State Water Resources Control Board, California Environmental Protection Board, May 2014

The question being addressed by the reviewer is:

Is the scientific portion of the proposed rule based upon sound scientific knowledge, methods and practise? This question is directed towards all aspects of the document, but in particular to the following scientific conclusions

1. Trash threatens public health and safety, reduces aesthetic appeal, degrades aquatic habitats and endangers wildlife in surface waters.
2. Different land uses have different rates of trash generation.

## Overview

The Draft Staff Report provides a detailed analysis of the need for a proposed Trash Amendment to the Stateside Water Quality Control Plans for Trash and also serves as the State Water Board's Substitute Environmental Document (SED) that is required to meet the needs of the California Environmental Quality Act. The report aims to present an analysis of why such an amendment is needed, centred on the achievement of the highest water quality consistent with maximum benefit to the people of the state. According to definitions provided by Porter-Cologne section 13050, beneficial uses requiring protection from pollution and nuisance involve both surface waters and ground waters. The Water Board is charged with protecting surface and ground waters, marshes and wetlands through a system of water quality objectives and discharge prohibitions. These are described in the document for the various basin plans and the ocean plan for the state.

The scientific rationale presented in the document provides a detailed analysis of the beneficial uses that can be affected by trash, associated with aquatic life and public health. It discusses the evidence linking land use with trash generation rates and provides an analysis of the various methods that might be implemented to achieve improved water quality through capturing trash. Here, the quality of that scientific evidence is reviewed, with an emphasis on the impacts of trash on aquatic life and public health.

## General comments

## Draft staff report external scientific review

---

The document is thoroughly researched and clearly presented. A wide range of scientific reports, government and organisational reports and publications from the international peer reviewed and publically available literature have been used to provide evidence for each section and conclusion and in general these are well placed within the text and accurately cited.

The following section of the review discusses the first conclusion 'Trash threatens public health and safety, reduces aesthetic appeal, degrades aquatic habitats and endangers wildlife in surface waters' and concentrates on the evidence presented in Appendix A Trash Background

### *Appendix A Trash background*

The first point to make about this section is in relation to its organisation. The conclusion being made from this evidence is that 'Trash threatens public health and safety, reduces aesthetic appeal, degrades aquatic habitats and endangers wildlife in surface waters', yet the emphasis of the Appendix and supporting documents is in the reverse order, with excellent emphasis given to aquatic life beneficial uses, wildlife, freshwater, estuarine and marine habitats and organisms and evidence for these effects, yet less attention given to providing evidence for the human health aspect.

### *'Trash threatens public health' pA-196*

The evidence presented to support the adverse effects of trash on public health presents a reasonable picture of the likely effects, yet is limited in the literature that is cited to support the claims being made. Only one reference is provided, an internal document from Los Angeles Water Board, 2010. Detailed inspection of this reference does not provide a good body of evidence supporting the influence of trash on human health, other than anecdotally. There exists, however, an extensive body of research covering this topic, exploring and describing the links between exposure to anthropogenic litter, human waste and adverse health effects. My recommendation would be that to maintain the high standard of scientific evidence supporting the document as a whole, some additional effort is put into strengthening the evidence here. There are a number of relevant documents that could be used to support this, and a couple of suggestions are listed below, or these could be replaced with a more USA focused example.

1. DG Europe (2011), Plastic Waste: Ecological and Human Health Impacts. Science for Environment Policy In-depth Report November 2011, available from <http://ec.europa.eu/environment/integration/research/newsalert/pdf/IR1.pdf>

This document provides an in depth analysis of the human and ecological health effects that might be predicted from plastic litter, with a lengthy section discussing human health effects.

2. Musmeci et al., 2010. The impact measurement of solid waste management on health: the hazard index. *Ann Ist Super Sanità* 46: 293-298

This document discussed various methods for assessing the risk to human health associated with exposure to emissions (chemical, physical, infectious) arising from solid waste disposal.

## Draft staff report external scientific review

---

Despite these limitations in the extent of scientific evidence and supporting documentation cited, the section is well laid out and the conclusions and content provide a plausible and convincing rationale for concluding that trash poses public health and safety hazards.

### *Beneficial uses impacted by trash A-188*

This section outlines the many beneficial uses specific to California that are listed in the basin plans for the regional water boards, and in the Ocean plan, that may be impacted by trash. It is reasonable to conclude, as this section does, that the trash related impacts to aquatic life beneficial uses are substantiated and that there is sufficient evidence documenting ingestion, entanglement, habitat alteration and degradation due to trash to lead to adverse effects on spawning, migration and survival of aquatic life including mammals, turtles, birds, fish, amphibians and invertebrates.

### *Effects of trash on aquatic habitats A-190*

In this section the potential impacts of trash on different aquatic habitats is reviewed, from the potential to impact on the function of the soft bottomed benthos to the presence of trash items in deep-sea canyons. The evidence to support the conclusion that trash can be found in these locations and has the potential to impact these habitats is strong.

The potential for trash to contribute to the wider distribution of invasive species is discussed (page A-191). This section is well written and discussed except for the discussion relating to the paper by Barnes (2002). The statement 'In fact, trash is found to more than double the rafting opportunities for biota' ... needs to be qualified with a bit more detail. What Barnes actually found was that when debris was examined from 30 remote island shores from across the globe, there was a relationship between the extent of rafting organisms and latitude. Anthropogenic litter had roughly doubled the propagation of fauna in the subtropics locations and this figure was even higher at higher latitudes. Hence floating litter increases the opportunities for alien invasions, as shown by this example. We don't yet know if this applies universally.

Whether trash can serve as a *transport medium for pollutants* is discussed in some detail (page A-192). Whilst there are some very recent additions to this literature that are not included, they do not change the overall conclusion made, which is that the extent to which plastic debris act as vectors for pollutants is likely to be strongly influenced by local conditions and by the nature of the contaminant and of the plastic. It is unlikely that microplastics (defined as plastic debris of <5mm in diameter) represent an important global reservoir of persistent organic pollutants, but they may well influence the movement and distribution of these pollutants in the wider environment.

The review of scientific evidence on the effects of trash ingestion on wildlife is thorough and provides relevant examples, especially for sea turtles, where a significant body of evidence has been assembled of the often fatal consequences of plastics ingestion and gut abrasion and blockage.

Regarding the propensity of plastics to act to transport toxic substances to organisms following ingestion, the evidence presented provides a good overview of current literature up until 2011. There are some more recent references that have since appeared in the literature, and a selection of the most recent is summarised briefly below. Their inclusion in the draft

## Draft staff report external scientific review

---

report would further strengthen the conclusions that have been made regarding the transport of toxic substances to organisms following ingestion.

1. Koelmans et al., (2014) Leaching of plastics additives to marine organisms, *Environmental Pollution* 187: p49-54.

This article explores the transfer of adhered plastics additives into the tissues of marine organisms, using lugworms and fish as exemplar species. The conclusions drawn are that plastics ingestion will make a negligible contribution to the transfer of the additives nonylphenol and bisphenol A to the animal's body tissues compared with other routes of exposure.

2. Velzeboer et al., 2014, Strong sorption of PCBs to nanoplastics, microplastics, carbon nanotubes and fullerenes, *Environmental Science and Technology*, 48: p4869-4876.

This article highlights the influence of salinity on sorption of contaminants, especially to polymers. The authors note that polychlorinated biphenols, which are priority organic pollutants in the marine environment with many adverse human and ecological health effects, bind exceptionally strongly to all particles tested.

3. Bakir et al., 2014. Transport of persistent organic pollutants by microplastics in estuarine conditions, *Estuarine Coastal and Shelf Science*, 140: 14-21.

This paper confirms that transport and movement of contaminants by plastic particles in the aquatic environment are greatly influenced by local conditions. The likely direction of transport for the organochlorine pesticide DDT and the polyaromatic hydrocarbon phenanthrene, both common aquatic pollutants, is predicted to be from freshwater and estuarine to fully marine conditions.

Collectively, these articles confirm the overall conclusion made in the draft staff report that the uptake and bioaccumulation of toxic substances from plastics has been shown to occur, but that it is not yet possible to fully describe the extent to which this is significant in comparison with other modes of toxicant transfer (via atmosphere or ocean currents) in the environment.

*The effects of trash entanglement (A-193)* are well discussed and illustrated with relevant recent examples, supporting the conclusions made in the report that trash entanglement can lead to fatalities for many different species.

Different land uses have different rates of trash generation.

The second conclusion to be addressed in this review is that different land uses have different rates of trash generation (A-198).

Scientific evidence is presented to document the composition of trash collected from beaches, inland waterways, coastal waters and subsurface waters. The data on which these descriptions are based is extensive (>850K pieces of litter collected in 2012 alone), and it is comparable to similar data

## Draft staff report external scientific review

---

assembled for other global sites by organisations, academics and government funded studies. These support the top ten items of trash collected from coastal clean-up sites to be: cigarette butts, bags, food wrappers and containers, caps and lids, crockery and cutlery, glass beverage bottles, plastic beverage bottles, beverage cans and building materials. This dominance of consumer products associated with food consumption is useful since it helps in directing remedial efforts towards the most pollution sites and activities.

The factors influencing the movement of trash in the environment in a downstream direction are well reviewed and supported with data (A-199), allowing for identification of five primary transport mechanisms: littering, storm events, wind-blown trash, illegal dumping and direct disposal into water bodies. Credible and detailed studies are presented documenting assessments of the types of trash items found in different water bodies, and highlighting affected areas (high foot and car transport

areas, transition points, special sports and entertainment events, fast food and shopping outlets). This evidence supports the conclusion that different rates of trash generation are associated with different land uses.

A useful additional section deals in detail with outfall and storm drain monitoring. A key aspect of the successful implementation of the amendment will be in applying a system of monitoring to judge compliance and success in remediating water quality. The information presented is in agreement with California State's position as a leader in implementing local ordinances with goals of reducing trash, and specifically plastics, including single-use disposable items: expanded polystyrene foam and single use plastic bags.

Again, there are recent peer reviewed references that support these conclusions, but which are based on studies of waters in the UK and Europe. This highlights the global nature of the problems being addressed.

1. Lechner et al., 2014. The Danube so colourful, a potpourri of plastic litter outnumbers fish larvae in Europe's second largest river. *Environmental pollution*, 188: p1770181.

This 2 year survey of the Austrian Danube reported a net flow rate of 4.2 tonnes per day, with industrial raw materials (flakes, spheres and pellets) accounting for >70% the reported items

2. Sadri et al., 2014. On the quantity and composition of floating plastic debris entering and leaving the Tamar estuary, Southwest England. *Marine Pollution Bulletin*, 81: 55-60.

This paper confirmed the net movement of land based litter and debris into marine waters. A study of the effects of tide noted that spring tides were associated with larger plastics items than were neap tides. The estuary could not be identified as either a net source or sink of litter.

Collectively, these additional references reinforce the conclusion made in the draft staff report that a major proportion of marine litter originates on land and that different land based uses lead to the generation of different rates of trash generation.

end