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Review

Resolving conflicts in public health protection and ecosystem service provision at designated bathing waters

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ABSTRACT

Understanding and quantifying the trade-off between the requirement for clean safe bathing water and beaches and their wider ecosystem services is central to the aims of the European Union (EU) Marine Strategy Framework Directive (MSFD), and vital for the sustainability and economic viability of designated bathing waters. Uncertainty surrounding the impacts of ensuing bathing water policy transitions, e.g. the EU revised Bathing Waters Directive (rBWD), puts new urgency on our need to understand the importance of natural beach assets for human recreation, wildlife habitat and for protection from flooding and erosion. However, managing coastal zones solely in terms of public health could have potentially negative consequences on a range of other social and cultural ecosystem services, e.g. recreation. Improving our knowledge of how bathing waters, surrounding beach environments and local economies might respond to shifts in management decisions is critical in order to inform reliable decision-making, and to evaluate future implications for human health. In this paper we explore the conflicts and trade-offs that emerge at public beach environments, and propose the development of an evaluative framework of viable alternatives in environmental management whereby bathing waters are managed for their greatest utility, driven by identifying the optimal ecosystem service provision at any particular site.

1. Introduction

Levels of faecal indicator organisms (FIOs) such as *Escherichia coli* and intestinal enterococci are used as a measure of microbial pollution in recreational and shellfish harvesting waters around the world. The environmental sources contributing to microbial contamination of bathing waters and beaches can include both diffuse and point source inputs, e.g. sewage discharges and effluent from leaking septic tanks. Diffuse microbial pollution can occur following high precipitation, particularly storm events, if coincident with faecal loading and active hydrological pathways that connect FIO sources to receiving waters (Oliver et al., 2005). An important contributor to diffuse microbial pollution is agricultural run-off; this can result in the indirect contamination of waterways further down the catchment (Haack et al., 2013; Kay et al., 2010). Faecal loading by wild animals, and in particular gulls, waterfowl and birds roosting on bridges and piers, can also significantly contribute to the microbial pollution of recreational waters and beaches (Edge and Hill, 2007; Wither et al., 2005; Lévesque et al., 2000; Alderisio and DeLuca, 1999), which can have serious implications for public health (Graczyk et al., 2008).

Epidemiological studies have established that exposure to FIOs in bathing waters is significantly linked to a decrease in public health (Fewtrell and Kay, 2015; Wiedenmann et al., 2006; Wade et al., 2003). Maintaining and improving the microbial quality of EU bathing waters is regulated by the Bathing Water Directive (BWD; 76/160/EEC) and the revised Bathing Water Directive (rBWD; 2006/7/EC). The rBWD introduces more stringent standards for microbial water quality (Fig. 1) and will report against these standards for the first time at the end of the 2015 bathing season. A significant number of EU designated bathing waters that are currently achieving the 'mandatory' standard under the BWD (Table 1) are likely to fall below the legally enforceable 'sufficient' standard of the rBWD. This will result in these bathing waters being classified as 'poor' even though the actual level of microbial pollution may not have changed. Regulatory bodies have tried predicting which sites will fail, but projecting bathing water classifications under the rBWD using historical FIO classification

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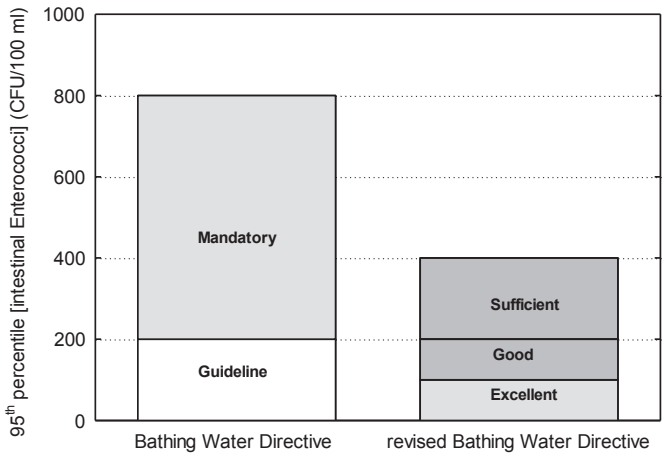

Fig. 1. Comparison of the compliance classifications for the Bathing Water Directive (76/160/EEC) and the more stringent revised Bathing Water Directive (2006/7/EC) for intestinal Enterococci. Water quality that does not achieve at least the 'sufficient' compliance under the rBWD is classified as 'poor' (based on a four year dataset).

datasets is often inaccurate due to annual classifications being so intrinsically affected by the weather. However, although the impact of climate change and the increased risk of flooding and storm surges will further intensify uncertainty for future bathing water quality predictions (Arnell et al., 2015), projected classifications could provide an indication of which beaches are likely to require significant investment of resources under the rBWD.

Environmental management of designated bathing waters is almost entirely driven by the rBWD and the regulation of human exposure to potential microbial pollutants in bathing water. Designated bathing waters in the EU can be de-designated where the local authority identifies either grounds for concerns about public safety or low levels of usage by the public. Abandoning the designation of a bathing water site can have an immediately negative impact on local communities, as tourism revenue will be lost, together with longer term consequences such as a reduction in water quality following the removal of active beach management. In this paper we explore the conflicts and trade-offs that emerge at public beach environments, and propose the development of an evaluative framework of viable alternatives in environmental management whereby bathing waters are managed for their greatest utility, driven by identifying the optimal ecosystem service provision at any particular site.

2. Ecosystem services and public health at designated bathing waters

Designated bathing waters and beaches can provide a wide range of additional ecosystem services, such as sediment storage and transport, nutrient mineralisation, and through wave dissipation can contribute to protection from coastal inundation and sea-level rises (Guerry et al., 2012; Schlacher et al., 2008). Moreover, sandy beaches are listed under the EU Habitat Directive as internationally important habitats for wildlife such as birds and can contribute to cultural and social ecosystem services such as biodiversity conservation and recreation. The ecosystem services that beaches deliver depend on two main factors: beach management and environmental change including climate and land use change. The scale and variety of challenges along our coasts are increasing and their dynamic and interconnected nature requires an integrated response from local communities, local authorities and government (Atkins et al., 2011). Understanding the response of both biodiversity and microbial reservoirs to beach management and environmental change (together with any subsequent socio-behavioural changes from beach users) is therefore vital in order to inform decision-making and to evaluate future benefits and risks to human health and wellbeing. The rBWD promotes pro-active management of the beach environment through the production of a bathing water profile (BWP) for all designated bathing waters, which is intended to provide a qualitative appraisal of potential pollutant sources linked to physical, geographical and hydrological

Table 1
Bathing water quality classifications (%) for 2013 under the current Bathing Water Directive for European member states (only countries with marine coastlines have been included).

	Guideline	Mandatory	Not compliant	De-designated	No classification[a]
Albania	51	41	8	0	0
Belgium	62	33	4	0	2
Bulgaria	66	33	1	0	0
Croatia	95	3	0	0	2
Cyprus	100	0	0	0	0
Denmark	77	20	2	0	1
Estonia	64	26	6	2	2
Finland	76	10	1	0	13
France	72	19	3	0	5
Germany	90	7	1	0	2
Greece	93	6	0	0	1
Ireland	84	13	3	0	0
Italy	87	8	3	0	3
Latvia	55	33	0	0	12
Lithuania	84	13	0	1	2
Malta	99	1	0	0	0
Netherlands	69	23	5	0	3
Poland	67	31	0	1	0
Portugal	86	9	0	0	4
Romania	34	66	0	0	0
Slovenia	74	26	0	0	0
Spain	83	12	3	0	1
Sweden	59	21	2	0	19
UK	79	19	1	0	0

[a] Includes bathing waters that have been insufficiently sampled, or new bathing waters or bathing waters with changed circumstances. Data compiled from the European Environment Agency (http://www.eea.europa.eu/).