UK bathing waters: a success story, but… 'There may be trouble ahead…'

Keith Jones

Pressure groups believe that sewage entering the sea is dangerous to the health of bathers and to the marine environment. Keith Jones explains the current measures to protect water quality and describes some problems that may prove difficult to solve.

The EC Bathing Water Quality Directive (76/160/EEC) has been around for 25 years and in that time UK coastal bathing waters have improved their compliance from 57 % in 1988/90 to 97 % in 2001. In the north-west the clean up has been nothing short of spectacular. In 1994 all the bathing waters from the Ribble estuary to the northern end of Morecambe Bay failed the Directive. By 2001, they had all passed, even those at Blackpool. This success story can be put down largely to the water companies building new sewage treatment works, ceasing the discharge of untreated sewage into estuaries and coastal waters, replacing the sewer infrastructure, replacing short sea outfalls with long sea outfalls and, more recently, tertiary treatment of effluents with UV radiation.

What caused it?

The pressure for this enormous expenditure of finance and engineering has come from unelected groups, such as Surfers Against Sewage (www.sas.org.uk) and the Marine Conservation Society (www.mcsuk.org), a pretty hostile media and above all the EU, which has threatened the UK Government with daily fines if standards are not met. The cost, around £10 billion, has been largely borne by the customers of the privatized water companies.

Not just the UK

It is not just a UK problem. St-Tropez lost its Blue Flag award in 2000 and in the US the Natural Resources Defence Council closed 13,410 beaches in 2001, up 19% on 2000 (http://www.nrdc.org/water/oceans/nttw.asp).

BELOW: Fig. 1. Gulls from a waste tip foraging on an estuary. COURTESY K. JONES

The tests

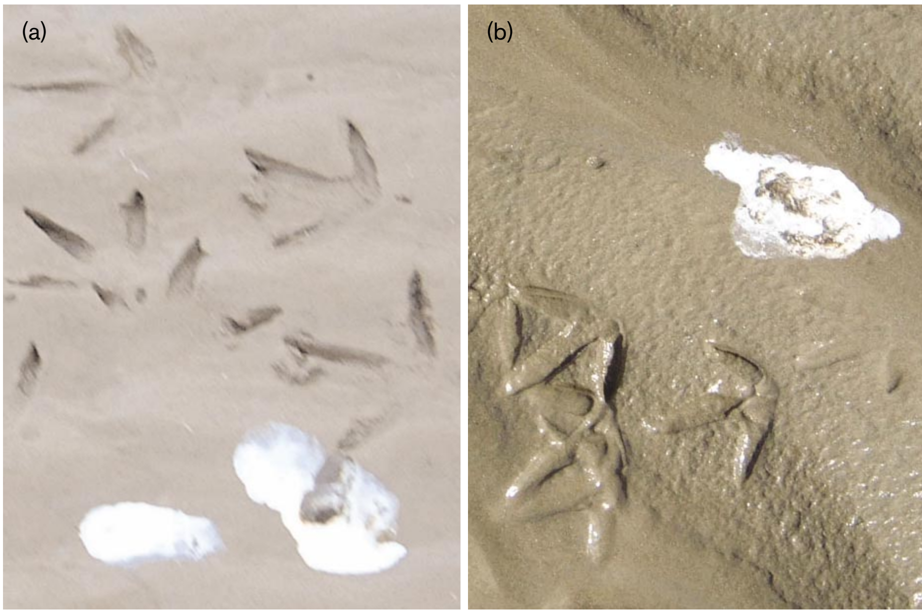
The testing of the UK's 433 bathing waters is under the remit of the Environment Agency. Twenty water samples, roughly one per week, are taken during the bathing season, which runs from 15 May to 30 September. Each sample is analysed for the density of faecal indicators (representative of the animal gut) which should not exceed 10,000 total coliforms per 100 ml and 2,000 faecal coliforms per 100 ml of water. To comply with the EC Directive, 95 % of the samples (at least 19 out of 20) must meet these standards.

The standards are set to change

The EC is, at this very moment, revising and updating its legislation on bathing waters to take into account changes in science, technology and a perceived risk to health. This will almost certainly result in a much tighter bathing water quality standard [a minimum of 200 faecal streptococci (intestinal enterococci) per 100 ml water and 500 *Escherichia coli* per 100 ml water compliance is proposed]. It has been estimated (DEFRA) that this will entail a fall in compliance in the UK from 97 % to 67 %. Considerable further expense will be necessary to meet the new standards. However, it remains to be seen whether tangible benefits to health accrue and if the expense is justifiable in anything other than aesthetics.

Why will compliance with the new regime be difficult?

There are fluctuating densities of faecal indicator bacteria in coastal waters which are unconnected with



sewage effluent. This is shown in the north-west by sporadic failures, each on different dates, during this year's bathing season at separate bathing waters: Southport, Morecambe North and Morecambe South. These failures are associated with two main problems, the same ones which will make compliance with the new more rigorous standards difficult.

Problem 1 – diffuse sources of pollution. Diffuse pollution is caused predominantly by agricultural run-off and flocks of birds. Agricultural run-off in wet weather can include faeces from grazing cattle and sheep, farm slurries and manures, and sewage sludge put to land. Animal faeces and farm wastes can contain large numbers of faecal indicators (Table 1).

David Kay's group at the Centre for Environment and Health in Wales has calculated the daily production of faecal coliforms by farm animals and compared them to *E. coli* equivalents from humans. Cattle are equivalent to 2·8 humans, pigs to 4·7 humans and sheep to 9·5 humans. Once on land faecal coliforms can survive for up to 8 weeks with a T_{90} (time for a log reduction in numbers) of 3·3 days in summer and 13·4 days in winter. Run-off can be minimized by farmers following DEFRA guidelines, but little can be done in wet weather.

The input from flocks of wild birds is even harder to prevent. Table 2 shows the levels of faecal coliforms excreted by wild birds on Morecambe Bay. As there are many thousands of wild birds on the Bay they have a considerable impact on indicator numbers and may be responsible for the sporadic failures during the bathing season and high densities of the bacteria in winter (Figs 1, 2 and 3).

There is an interesting situation in Blackpool, where there are roughly 125,000 starlings roosting nightly on the resort's piers. Kay's group have calculated that each starling is equal to one human in *E. coli* equivalents. However, they have also reasoned that, as bird faeces contribute directly to bathing waters and human faeces are subject to primary, secondary and tertiary treatment, which reduces the number of *E. coli* by a factor of 2–3 or 4 logs, the 125,000 starlings are equivalent to between 1,250,000 and 1,250,000,000 humans!

A huge research effort is underway globally to pinpoint the origins of pollution and to distinguish

ABOVE LEFT:
Fig. 2. Oystercatchers on Morecambe Bay.
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ABOVE:
Fig. 3. (a) Faecal sample from a bar-tailed godwit and footprints. (b) Gull faecal sample with gull footprints.
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Table 1. Faecal coliforms in livestock faeces, farm slurry and sewage sludge

Sample	Faecal coliforms per gram
Faeces – grazing sheep	$2{\cdot}8\times10^{9}$–$4{\cdot}5\times10^{12}$
Faeces – grazing cattle	$2{\cdot}3\times10^{5}$–$6{\cdot}7\times10^{9}$
Farm slurry put to land	$2{\cdot}2\times10^{4}$–$3{\cdot}2\times10^{6}$
Sewage sludge put to land	$1{\cdot}7\times10^{6}$–$2{\cdot}0\times10^{6}$

Table 2. Shedding of faecal indicator bacteria by wild birds on Morecambe Bay

Bird	Faecal coliforms (per gram faeces)
Bar-tailed godwit	$7{\cdot}1\times10^{11}$
Oystercatcher	$4{\cdot}7\times10^{11}$
Knot	$5{\cdot}3\times10^{5}$
Shellduck	$7{\cdot}4\times10^{8}$
Lapwing	$2{\cdot}6\times10^{5}$
Gulls (bay)	$1{\cdot}8\times10^{7}$
Gulls (waste tip)	$1{\cdot}0\times10^{10}$
Mallard	$7{\cdot}8\times10^{10}$

UPPER RIGHT:
Fig. 4. Pie chart showing the monthly distribution of sunshine in the north-west UK.
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LOWER RIGHT:
Fig. 5. Compliance with the faecal coliform standard of bathing waters sampled in the morning (■) and afternoon (■).
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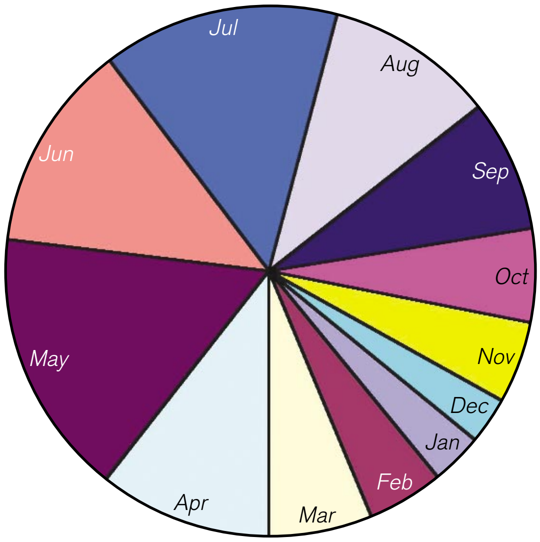
between faecal pollution caused by humans and by livestock and birds. At Lancaster, for example, we are using DNA fingerprinting to match genotypes of *E. coli* isolated during routine analysis of bathing waters with different animal sources.

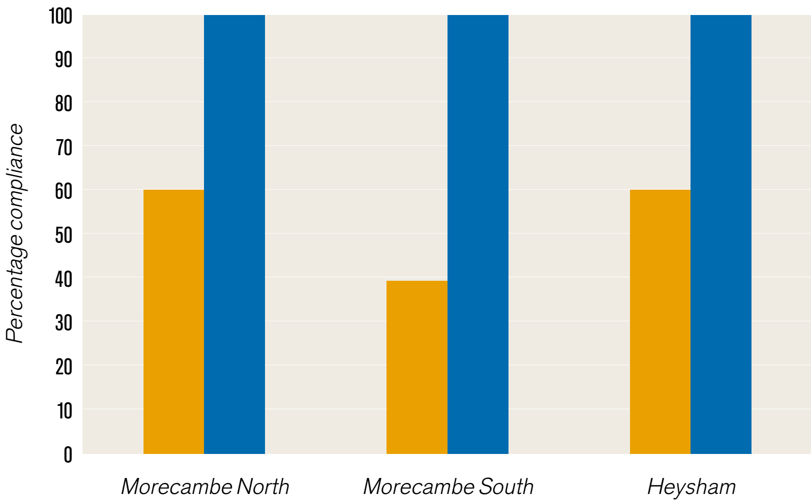
Since the clean up of sewage discharges the contribution which diffuse pollution makes to bathing waters has increased.

Problem 2 – the weather. Whatever their source, the survival of indicator bacteria in water is controlled by the weather, and nothing can be done about this. For example, at Morecambe the construction of a sewage treatment plant and the replacement of a short sea outfall with a long one resulted in a 76 % reduction in faecal coliforms during the bathing season, but had no effect during the non-bathing season. This is because of increased diffuse pollution in the non-bathing season and the influence of weather. Temperature and light are the main bactericides in bathing waters. Faecal indicators die off much faster in warm water than in cold. For example, faecal coliforms in sewage effluent survive for 2 weeks in sterile Morecambe Bay seawater at 37 °C in comparison to 7 weeks at 10 °C (in the dark). In sunlight, survival is measured in hours and minutes, not weeks. At Lancaster latitudes, the T_{90} for *E. coli* in seawater is only 30 minutes in June, but is not even reached during day-long sunshine in the winter. It is quite surprising to realize that almost half the annual amount of sunshine that occurs in the north-west UK occurs in just 3 months: May, June and July (Fig. 4).

In 1997 we showed that during the bathing season all three of Morecambe's bathing waters failed the Bathing Water Quality Directive when sampled in the early morning, but passed in the late afternoon (Fig. 5). The difference is attributed to the indicator bacteria from sewage and diffuse pollution surviving during darkness and being killed by UVB during daylight. Indeed we proposed that all bathing waters throughout the EU should be sampled in the early morning to allow for the worst case scenario.

Overall, failure to comply with the EU Bathing Water Quality Directive is more likely on cold, cloudy and windy wet days sampled in the early morning than on warm, sunny still days sampled in the late afternoon.





'There may be trouble ahead…'

Why do I think this? Well, it is going to be difficult to reduce further the background level of faecal indicators in bathing waters where there is substantial agricultural run-off or flocks of wild birds. In the south of the EU, where bathing waters are warm and clear and exposed to intense sunlight, the problem may be minor. However, in the north-west of the UK, where the water is cold and turbid and where there is much less sunshine, compliance with any new standards will be difficult and may not be possible.

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Further reading

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