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AS I SEE IT

Oil spills versus shifting baselines

J. M. Ruiz*

Depto. Biología Animal, Biología Vegetal y Ecología, Universidade da Coruña, Campus da Zapateira s/n, 15071 Coruña, Spain

The oil tanker 'Prestige' sank off Galicia (NW Spain) on 19 November 2002, 1 wk after having suffered an accident in the International Maritime Organisation's (IMO) Finisterre Traffic Separation Scheme (TSS). Some 63 000 t of heavy fuel oil were spilled, contaminating a large volume of water and long stretches of the coast over a period of several months (see http://otvm.uvigo.es). In Spain, and elsewhere, the oil spill caused strong reactions from every sector of society: governmental responses were therefore inevitable. Since then, 2 years have elapsed, and it is time to reflect on the governmental responses and the insights they may afford with regard to protection of the world's oceans in the long term.

Marine pollution: sporadic vs. daily

Whilst accidental spills from tankers can be spectacular, they account for only a minor fraction of all marine oil pollution (e.g. Clark 1997). Moreover, there are at least 2 other types of contamination from maritime traffic which are less obvious, but affect the marine environment constantly and insidiously: atmospheric emissions from ship fuel consumption, and toxicants leached into the water from antifouling paints on the hulls. Both have received IMO consideration for years (but, perhaps, not enough). The impacts of antifouling paint are of greatest concern in busy shipping areas, as can be shown for the Finisterre TSS, which is used by ~50 000 ships yr^{-1} (see Ruiz et al. 1998).

Ships' hulls are treated with antifouling paints containing components that leach into the water. Paints with tributyltin (TBT) as a biocide were introduced in the 1960s, and after gaining US EPA (United States Environmental Protection Agency) registration in 1978, they became dominant on the market, being used on up to 80 % of the world's commercial fleet (de Mora 1996). The environmental damage caused by TBT led to a partial ban on its use during the 1980s and 1990s, and from 2003 IMO has issued a total prohibition of its application; it is hoped that by 2008 no TBT-treated vessel will navigate the oceans (www.imo.org).

The amount of TBT leached by shipping across the Finisterre TSS can be approximated (ignoring emissions from fishing boats and in ports) using the model proposed by Isensee et al. (1994):

$$M = e \cdot \mathrm{OD} \cdot \mathrm{WS}$$

where M is the biocide mass, e is the leaching rate (µg cm^{-2} d^{-1}), OD is the sum of all ships' operation-days, and WS is the wetted surface of vessels. A value of 2 is usually assumed for e, and 4100 m^2 is the world average WS; as for OD, considering traffic density, TBT use and time required to traverse the TSS, then 20 000 OD is a reasonable assumption. Thus, ~1.64 t yr^{-1} are a conservative estimate of the TBT leached by shipping off NW Spain (i.e. M = 45 kg in 10 d). The toxicity of TBT (from the TSS and elsewhere) has affected the area for decades (see Ruiz et al. 1998 on gastropod imposex), and has also caused economic losses (at least in the Pacific oyster culture: J. M. Ruiz unpubl.). In addition, as Bryan & Gibbs (1991, p 352) stated, 'it is probable that *these* effects ... are far from being the only consequences of releasing TBT into the sea'.

Relative toxicity of the oil released by the 'Prestige'

The main chemical impact of oil and its derivatives is due to a family of natural compounds known as polycyclic aromatic hydrocarbons (PAHs). It was established by the Scientific Commission in charge of assessing the environmental effects of the 'Prestige' oil spill (www.ccaprestige.es) that the concentration of the 16 US EPA priority PAHs in 'Prestige' oil was 1264 mg kg^{-1}, with a toxicity equivalent (TE) index of 50. It is common practice to express the concentrations of individual PAHs as equivalents of benzo[*a*]pyrene (BaP)

*Email: jmruiz@udc.es

based on their relative carcinogenicity; values are then summed up to yield BaP equivalents (BaPE) which allow the comparison of potential effects of PAHs derived from oil spills and other sources (e.g. Law et al. 2002). In the worst-case scenario (if all the PAHs in the 63 000 t spill were removed from the matrix and leached into water during the first 10 d) the 'Prestige' will have spilled 3.15 t BaPE.

The question then is: how does the 'Prestige' BaPE pulse compare with the background presence of toxic compounds in the area? For practical reasons, let us first suppose that this background is defined only by TSS TBT, even if this is a very conservative assumption. Assessing the relevance of the pulse with respect to the background is a delicate matter, since the TE concept is accepted for some pollutant families, but there is no agreement on its application to mixtures containing diverse chemical classes (e.g. Gale et al. 2000). However, the need for ecological risk assessment of hundreds of chemicals leads to sensible, uncertainty-reducing approaches (e.g. Shephard 1998) where toxicity reference values are employed. These include US EPA Ambient Water Quality Criteria (AWQC, see http://epa.gov/waterscience/standards/), which show that natural polluting substances (e.g. metals and PAHs) are much less toxic than artificial biocides, i.e. xenobiotics that are purposely designed and produced to kill (e.g. DDT and TBT). Therefore, comparing the US EPA criteria to protect saltwater aquatic life from acute toxic effects, we realize that BaP is currently considered to be more than 700 times less toxic than TBT (i.e. 300 $\mu g\ l^{-1}$, compared to 0.42 $\mu g\ l^{-1}$).

It can be concluded that during those fatal 10 d in November 2002 the toxic substances introduced by shipping in the NW Spain TSS waters were equivalent to 110 % the amount of an ordinary period: 10 % is the pulse originated by PAHs in fuel oil, and 100 % is the background set by TBT. Thus, the spill may have contributed to overall toxicity in TSS waters on this temporal scale; however, if we consider that TBT input has occurred daily over the last few decades (and will occur for years to come), then we realise that the 'Prestige' spill is insignificant — a mere drop in a glass of water. And this precisely is the tragedy, that such a serious accident is actually irrelevant from an ecotoxicological point of view.

An oil spill a day shifts the baseline away

Many pollution studies have been designed to follow identifiable contaminant pulses, where baselines and reference sites are essential to analyse the impacts of the pulse (e.g. Wiens & Parker 1995). Their use has occasionally served to demonstrate cause-and-effect relationships. A recent example is the 'Exxon Valdez' oil spill in Alaska where some chronic toxicity has been demonstrated (see Peterson et al. 2003) by virtue of the pristine condition of the area (with no other potential impacts) and the unprecedented scope and duration of the follow-up research (see Kaiser 1999). Yet, even in this ideal scenario scientists found only limited evidence of impacts at the higher levels of the biological hierarchy (Paine et al. 1996), such as the otter–urchin–kelp trophic cascade (Peterson et al. 2003). This is proof that reductionistic science is inherently unable to fully grasp ecosystem complexity and to solve environmental problems (see Huesemann 2001 and references therein), although many scientists and decision-makers still believe that technology will provide solutions in due course. The issue is, however, that we are running out of time, 'ecology is a discipline with a time limit, because much of what we study, upon which society is dependent, is fast disappearing' (Bazzaz et al. 1998, p 87).

Time is a fundamental dimension; gradual environmental degradation usually remains unperceived, and society easily adapts to it, so that each succeeding generation has a different perception of what is natural and what is not. This concept was formulated as 'the shifting baseline syndrome' by fisheries biologist Pauly (1995), and it is now widely used to refer to the incremental lowering of standards with respect to Nature, chiefly with respect to the oceans (see www.shifting-baselines.org). Recognition of the actual shifting of baselines may be as elusive as is the comprehension of the consequences. In the quest for truth, society too often tends to follow the principle of the 'drunkard's search', i.e. it is inclined to search where it is easiest, not where it is most promising (see Kaplan 1964), prioritising the immediate but false reward, rather than the demanding but genuine treasure. Being part of society, science may likewise suffer from the same short-sightedness, particularly if self-interest (at the individual, institutional and socio-cultural scales; see Huesemann 2002) is spurred by extraordinary subsidies disbursed by politicians worried by public anger.

Undoubtedly, there will be more oil spills: they are yet another illustration of the 'tragedy of the commons' (see Hardin 1998). If society is led to believe that the marine environment is without problems — as long as there is no oil spill, then governments will be reinforced in their Pavlovian behaviour: the apparent risk merits major attention, the unnoticed one deserves little or none. As I see it, whilst this situation remains, we ecologists will have failed to demonstrate that serious menaces are posed by pervasive phenomena, such as climate change, overfishing, eutrophication, biological invasions, coastal development, chemical pollution, etc.

LITERATURE CITED

Bazzaz F, Ceballos G, Davis M, Dirzo R and 15 others (1998) Ecological science and the human predicament. Science 282:879

Bryan GW, Gibbs PE (1991) Impact of low concentrations of tributyltin (TBT) on marine organisms: a review. In: Newman MC, McIntosh AW (eds) Metal ecotoxicology: concepts and applications. Lewis Publishers, Ann Arbor, MI, p 323–361

Clark RB (1997) Marine pollution, 4th edn. Oxford University Press, Oxford

de Mora SJ (1996) Tributyltin: case study of an environmental contaminant. Cambridge University Press, Cambridge

Gale RW, Long ER, Schwartz TR, Tillitt DE (2000) Evaluation of planar halogenated and polycyclic aromatic hydrocarbons in estuarine sediments using ethoxyresorufin-O-deethylase induction of H4IIE cells. Environ Toxicol Chem 19:1348–1359

Hardin G (1998) Extensions of 'The Tragedy of the Commons'. Science 280:682–683

Huesemann MH (2001) Can pollution problems be effectively solved by environmental science and technology? An analysis of critical limitations. Ecol Econ 37:271–287

Huesemann MH (2002) The inherent biases in environmental research and their effects on public policy. Futures 34: 621–633

Isensee J, Watermann B, Berger HD (1994) Emissions of antifouling-biocides into the North Sea: an estimation. Germ J Hydrogr 46:355–365

Kaiser J (1999) Ecology: the *Exxon Valdez*'s scientific gold rush. Science 284:247–249

Kaplan A (1964) The conduct of inquiry: methodology for behavioral science. Chandler, San Francisco

Law RJ, Kelly C, Baker K, Jones J, McIntosh AD, Moffat CF (2002) Toxic equivalency factors for PAH and their applicability in shellfish pollution monitoring studies. J Environ Monit 4:383–388

Paine RT, Ruesink JL, Sun A, Soulanille EL, Wonham MJ, Harley CDG, Brumbaugh DR, Secord DL (1996) Trouble on oiled waters: lessons from the *Exxon Valdez* oil spill. Annu Rev Ecol Syst 27:197–235

Pauly D (1995) Anecdotes and the shifting baseline syndrome. Trends Ecol Evol 10:430

Peterson CH, Rice SD, Short JW, Esler D, Bodkin JL, Ballachey BE, Irons DB (2003) Long-term ecosystem response to the *Exxon Valdez* oil spill. Science 302:2082–2086

Ruiz JM, Quintela M, Barreiro R (1998) Ubiquitous imposex and organotin bioaccumulation in gastropods *Nucella lapillus* (L.) from Galicia (NW Spain): a possible effect of nearshore shipping. Mar Ecol Prog Ser 164:237–244

Shephard BK (1998) Quantification of ecological risks to aquatic biota from bioaccumulated chemicals. Natl Sediment Bioaccumulation Conf Proc. EPA/823/R-98/002, US Environmental Protection Agency, Office of Water, Washington, DC

Wiens JA, Parker KR (1995) Analyzing the effects of accidental environmental impacts — approaches and assumptions. Ecol Appl 5:1069–1083

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