Benefit:risk characterization and assessment for microbial bio-control programs

John Mumford
Centre for Environmental Policy, Imperial College London,
Silwood Park, Ascot SL5 7PY, United Kingdom
j.mumford@imperial.ac.uk

There are three key questions I address in regard to public issues/concerns in benefit:risk characterization and assessment of microbial biocontrol:

What is the risk paradigm? This was established in the Australian Biological Control Act 1984 as [Allow biological control of a target if…] *(i) the control…would not cause any significant harm to any person or to the environment; or(ii) any harm caused to persons or to the environment by the control…would be significantly less than the harm caused, or likely to be caused, by failure to control…* This could be extended to the general form in which the risk is defined as: the harm caused by bio-control would be greater than the harm caused by not using it (including using alternative conventional control). This formulation of the risk problem has been used in Australia recently for the approval of field trials of *Wolbachia*-infected *Aedes aegypti* for control of dengue under the Agriculture and Veterinary Chemicals Code 1994 (Murphy et al., 2010). [Murphy et al figure] A hazard-based approach to bio-control, as for pesticides now in the EU in Regulation (EC) No 1107/2009, would not give a balanced evaluation of net social value, and may focus public attention on negative aspects, to the exclusion of positive aspects.

How to consistently and simply determine harm from alternative controls? It is necessary to have a consistent means of assessing the "harm" done by alternatives to microbial bio-control, particularly conventional pesticides. An example of this has been presented by Leach and Mumford (2008; 2011) and Leach et al. (2008) applied to control of Desert locust in Senegal in the context of applications of *Metarhizium* compared to conventional pesticides over the course of an outbreak campaign. [Leach et al figure]

How to consistently capture and communicate subjective assessments of risk and benefits? Where risks and benefits are assessed for a range of microbial products it is important to have a consistent assessment approach, such as applied in Great Britain for invasive species risks (Mumford et al., 2011). This risk assessment scheme has a standard template of questions covering four key components of invasive species risk: entry, establishment, spread, impact. Together these measure likelihood and magnitude to give overall risk. Clearly defined scores are given by assessors, along with a measure of confidence in each score. Confidence values allow Monte Carlo simulation of score values to provide a cumulative distribution of outcomes for the risk. Within each of the four high level risk components additional questions must be answered by assessors (with scores and confidence) that relate to various dimensions of the risk components. It would be difficult to put a weight on each of these scores because the various dimensions or properties may have different importance in relation to different species. But each score and confidence value is documented in the risk assessment template with evidence gathered by the assessor to justify their score/confidence. The responses and justification for the specific questions within each risk component are used in a peer review process to validate subjective assessments and to provide inputs into risk management decisions. While this scheme focuses on risks, the concept can extend to risks and benefits together. This gives graphical presentations of risk which can be used to inform the public. [Leach and Mumford figures]

References

Leach, A.W., Mullie, W.C., Mumford, J.D., Waibel, H. (2008). Spatial and historical analysis of pesticide externalities in locust control in Senegal. FAO, Rome, Italy. 91pp.

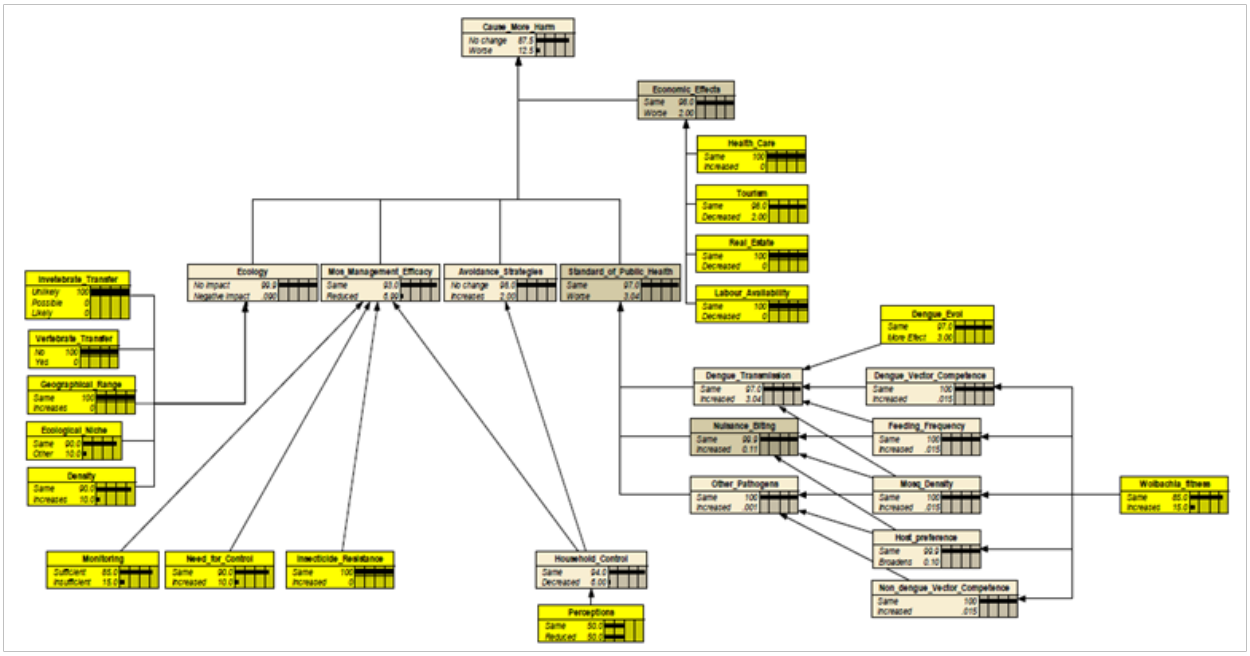
Leach, A.W. , Mumford, J.D. (2008) Pesticide Environmental Accounting: A method for assessing the external costs of individual pesticide applications. *Environmental Pollution*, 151:139-147.

Leach, A.W., Mumford, J.D. (2011) Pesticide Environmental Accounting: A decision-making tool estimating external costs of pesticides. *Journal of Consumer Protection and Food Safety*, (in press)

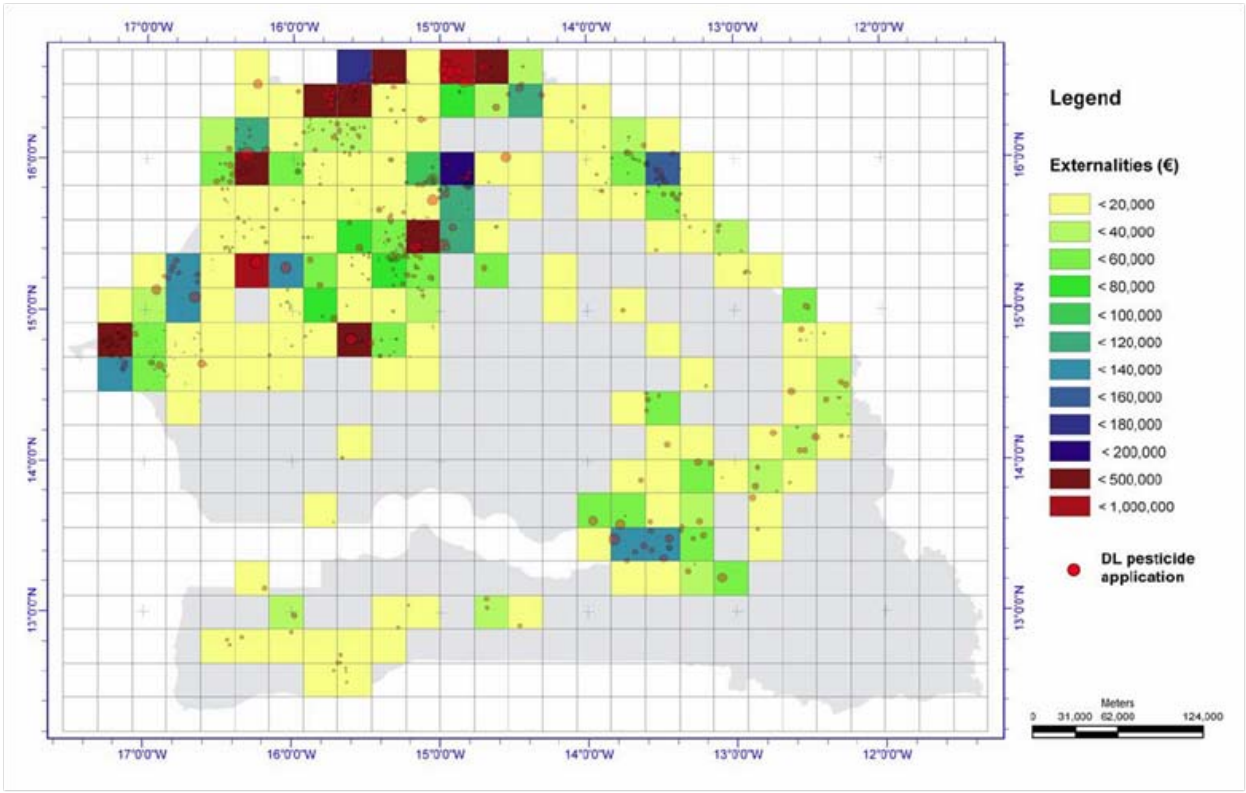
Mumford, J.D., Booy, O., Baker, R.H.A., Rees, M., Copp, G.H., Black, K., Holt, J., Leach, A.W., Hartley, M. (2010) Invasive species risk assessment in Great Britain. *Aspects of Applied Biology*, 104: (in press)

Murphy BD, Jansen C, Murray J, De Barro P (2010) Risk analysis on the Australian release of *Aedes aegypti* (L.) (Diptera: Culicidae) containing *Wolbachia*. CSIRO report. http://www.eliminatedengue.org/LinkClick.aspx?fileticket=nMtZNaIayzw%3dandtabid=3911

Murphy et al figure:



Leach et al figure:



Leach and Mumford Figures:

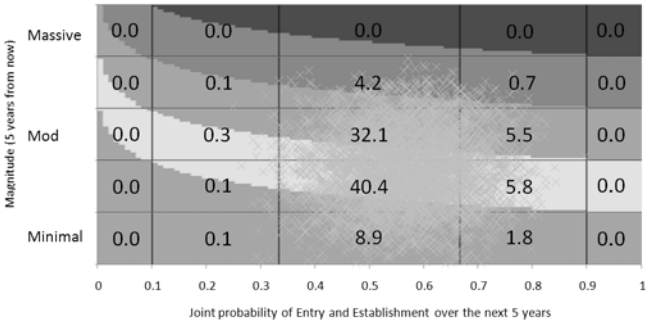
Invasive Risk Impact Simulator

Species: **Example Mammal**

See Histograms

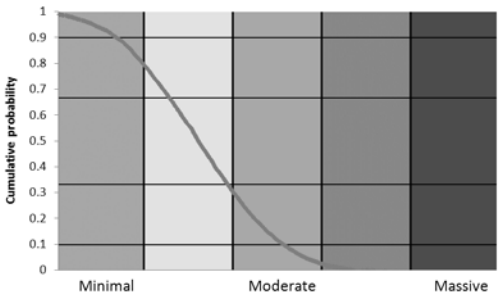
Subjective assessment by stage		Assessment	Score	Confidence assessment	Parameters for Beta distribution Alpha	Beta
Probability	P entry	**Likely**	4	High	16.50	5.37
	P establishment	**Likely**	4	High	16.50	5.37
Magnitude	Spread	**Minor**	2	High	5.37	16.50
	Impacts	**Moderate**	3	Medium	5.82	5.82

Probability and Magnitude of Example Mammal Risk



X denote cases from 5000 realisations of assessed scores and confidence

Cumulative Distribution of Risk for Example Mammal over 5 years



NNRAP - Risk Assessment Visualiser

Dr Adrian Leach, Professor John Mumford and Dr John Holt

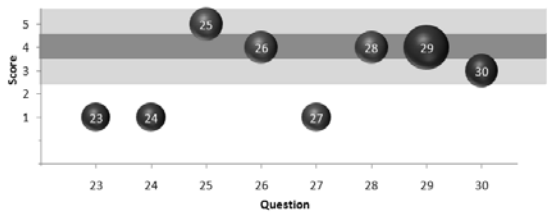
Centre for Environmental Policy - Imperial College London

Example Mammal - Cross channel by vehicle

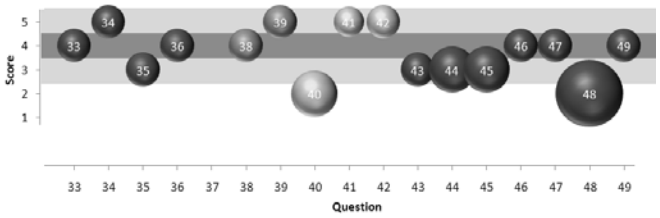
Visualisation types to show on subsequent sheets:

- Histograms ☐
- Bar with Error ☐
- Error bars only ☐
- Bubbles ☑

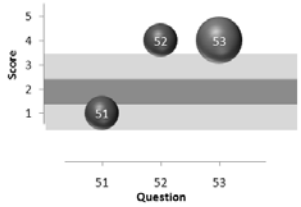
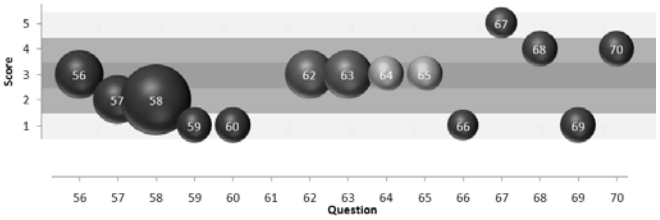
ENTRY Key



ESTABLISHMENT Key



SPREAD Key



IMPACT Key