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Do humans count in ecology? Quantitative methods can link socio-economics and ecology

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Scientists of all kinds are increasingly encouraged to think more broadly about their science, and engage in policy debates surrounding the implications of their work. Ecologists are no exception: in our work we are particularly aware of the consequences of changing patterns of human activity on biodiversity, ecosystem health and climate. When these changes endanger the health of ecosystems, or the survival of species we must think broadly about how proposed solutions will affect the people involved, and how they are likely to behave in response. One way forward is to explicitly include humans in our studies and models. For example, Watkinson et al. (2000) modelled the impact of genetically modified (GM) crop technology on arable weeds and farmland birds. The important issue was if farmers with weedy fields were more likely to adopt GM technology (because they would have greatest benefit) or more unlikely to adopt (for example, because they are organic farmers or are slow to adopt the latest technology). The interaction between an ecological variable (field weed population) and a social one (attitude to GM crops) was therefore crucial to the outcome.

There are many areas in ecology that may benefit from incorporating human behaviour, especially in ecosystems that are explicitly managed such as agricultural land. In the UK, the ‘entry level’ agri-environment scheme consists of a suite of management options for farmers, each of which contributes a number of points. In return for financial compensation, farmers must attain a total of 30 points per ha of land in the scheme. It is still too early to determine the effectiveness of the scheme as a whole, but there is clear evidence that some options are heavily-used by wildlife and therefore likely to provide benefit. Unfortunately, the uptake of options known to benefit wildlife, such as skylark plots and overwintered stubble, has been low with most farmers preferring to focus on boundary management. A simple economic assessment reveals the problem, which is that options within the scheme compete with each other for a farmer’s points total and if one is less costly to implement (even if only slightly) it will be favoured to the exclusion of others. As a consequence, certain options desired by ecologists may be virtually ignored by farmers even if they appear cost effective. In addition the diversity of options taken up is low. Policy alternatives such as caps on uptake of certain options, or a bidding system, might provide more ecologically satisfactory outcomes.

The dominant theoretical framework for making predictions about human behaviour, and for quantifying costs and benefits to humans is utility theory (see Cooke et al. 2009 and Brocas & Carillo 2004 for further details and alternatives). Utility is a tricky thing to quantify since it refers to human satisfaction or wellbeing, but in most contexts it is only the relative value that is important. While economists have traditionally focussed heavily on money as a proxy for utility, other much less concrete contributions to utility, such as satisfaction from living ‘close to nature’, can be important. Quantifying these non-monetary values is done in two basic ways: (i) by asking people how much they value something (stated preference), or (ii) by inferring value based on observations of what people do (revealed preference). For example, in valuing the recreational benefits from a natural area one might ask survey respondents how much they would be willing to pay to prevent its loss, or one could quantify the recreational value indirectly by observing the amount of money people actually spend travelling to the area for recreation. Although stated preference studies have known biases (Venkatachalam 2004) they are often used because appropriate observations to make a revealed preference estimate are difficult to obtain. Using these techniques, a utility model quantifying the value of alternative management options can be parameterised. From this, behaviour can be predicted (based on individuals choosing their own optimal utility) and the difference in utility scores can be used to weigh up costs and benefits (e.g. van Calker et al. 2006).

Ecologists who decide to model human behaviour will need to learn the terminology and concepts of social science, if not to build models themselves, then to communicate effectively with collaborators. The good news is that some core concepts have ecological equivalents. For example, predicting human behaviour based on utility optimisation is similar to predicting animal behaviour based on optimal foraging. Many statistical techniques used in social science and economics are also used by ecologists, but there are differences in emphasis (for example economists make greater use of extreme-value and multinomial distributions).

There are two challenges for social scientists and ecologists in the integration of their models. The main issue is the quantification of uncertainty in models of human behaviour. While this is true of all science, there is a particular imperative on modelling work that engages with public policy to uphold a high standard of transparency in this regard. Furthermore, models of human behaviour are peculiar in that they frequently become sufficiently complex as to prevent fitting to empirical data. In such cases an empirical basis must nevertheless be established via comparison between model outputs and observed behaviour. If these two issues can be adequately addressed, integrating human behaviour with ecological studies has the potential to greatly improve the contribution that ecologists are making to public policy.

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FURTHER READING

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Replacing the Pie Chart, and other Graphical Grouses

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The importance of clear and effective graphs cannot be overstated so I entirely agree with Tom Webb (Methods in Statistical Graphics, ***Bulletin*** 40(4), 53–54) that graphs for publication should be drawn, revised and edited just as much as text. Personally I follow Cleveland (1993, 1994) rather than Tufte, and these gurus are united in disparaging pie charts. Despite this, pie charts still occur in respectable scientific publications, perhaps because alternative graph formats are not well known. Below I compare a pie chart with the Cleveland dot plot but first to reply to a few points about Tuftism on scatter graphs, and the influence of computer packages.

I agree with Cleveland (1994) that right and top axes should be drawn (they are *not* "wasted ink"), all joined together to make a box enclosing the data rectangle. In this way, any far-flung point top right will not be overlooked, and with tick marks along every axis the x and y values of any point can be estimated more easily. Open symbols are often precise enough and particularly useful if there are some overlapping points; coincident points will need some other method to distinguish them, such as Cleveland's sunflowers with as many rays as coincident values. And (personal hobby-horse; don't blame Cleveland), if it makes sense to have the numerical values along the y-axis written horizontally, so it does for the label of the y-axis; move the box to the right to make space, or if desperate for maximum data rectangle write the y-axis label above the top left corner. The Tufte modifications of axes, or of the histogram, look fine for one's own data