Biome Health Field Project

University College London, Centre for Biodiversity and Environment Research (CBER)

Dr Ben Collen, CBER, University College London, Gower Street, London, WC1E 6BT UK; e: b.collen@ucl.ac.uk

General description of the proposed research

The aim of the Biome Health Research Project is to develop a field-based study system that provides new evidence on how biodiversity responds to human pressures and how conservation interventions can be utilised to reduce the impacts of these pressures. In collaboration with national WWF offices and local partner organisations, we will develop and implement four complementary field research projects in four different biomes. Each biome differs in the pressures to biodiversity and in the species level responses to those pressures. By monitoring biome appropriate metrics of biodiversity (our measure of biome health) for each field project across a number of sites with varying levels of human pressure and where conservation efforts are underway, we will quantify the relationship between pressure, response and solution for each biome. While metrics of biodiversity vary between biomes the underlying design of each field project is the same – sampling biodiversity along a gradient of pressure and solutions. This design is highly flexible and conceptually can be reproduced for different biomes and response metrics, making the study scalable. The project will provide a unique and continuing resource for research and for the public communication of evidence-based solutions to help halt the loss of biodiversity.

Background

Only by improving our understanding of the mechanisms leading to biodiversity decline and by testing solutions and assessing their costs and benefits can we move away from merely documenting declines, and towards a new conservation paradigm with human actions to reverse the loss of wild places and species placed firmly at the centre. Most existing data, however, are correlational and not designed to compare across sites or among interventions. Here we outline a field study, explicitly designed to capture information on pressure, biodiversity status and response to conservation effort within a framework that allows robust comparisons to be made between sites, and allow inferences to be made that go beyond the scope of the individual study.

Conceptual design of field studies

Each field site will comprise a linked set of landscape-scale studies across a pressure gradient and/or a paired sampling scheme examining options for conservation intervention (Figure 1). For example, in temperate or tropical forests the pressure gradient may be increasing exposure to deforestation. As forest cover is lost through clearing or fragmentation, the response metric (mammal community abundance, as measured through occupancy) also declines (Figure 2). Through placing field sites along an identified gradient of forest loss, we can thus evaluate the shape of the relationship between forest loss and mammal community abundance – i.e. how much mammal occupancy declines for a quantified increase in deforestation. Multiple relationships may also be identified for different species and species groups within field studies. The relationships identified can provide good information for conservation management. For example, for groups of species which are currently in low pressure sites but which are absent from sites facing higher pressure in a trajectory that is quantified by the red line in Figure 2, there is great advantage in intervening early, for example prioritizing conservation at pristine/ low degradation sites before declines can occur. Across all field sites the completion of the first survey period in year one will enable a space-for-time (STS) approach to investigate the response of mammals to degradation (STS: a form of modelling used to infer past or future trajectories from contemporary spatial patterns, e.g. see (*4*) and (*5*)). Repeated surveys over an extended timeframe will subsequently enable quantification of temporal lags in response, as

well as scope for methodological developments in the rapidly progressing fields of camera trap and acoustic monitoring.

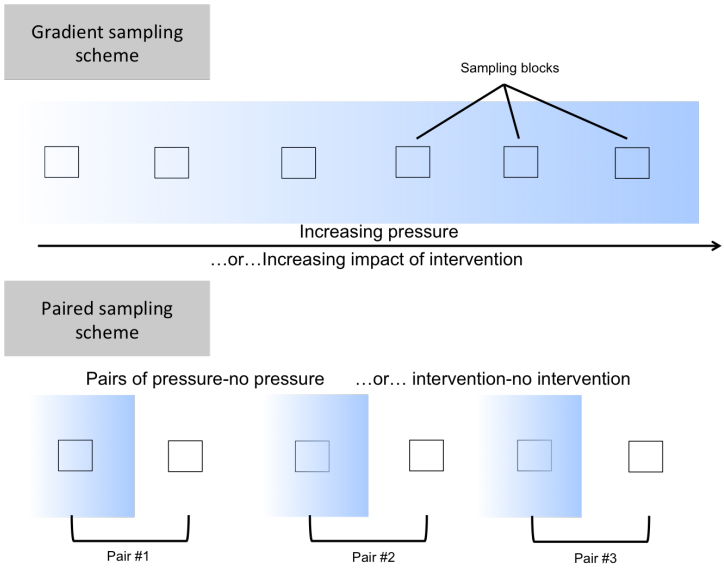

Figure 1. Conceptual design framework for field studies. Top panel: field sites/sampling blocks are placed along a gradient of increasing anthropogenic pressure (e.g. increasing level of deforestation) and identical measures are taken at each site for comparison (all other variables being held equal). Bottom panel: samples taken in a paired format simultaneously capturing data from 2 sites and comparing – similar to a control and treatment in a laboratory setting.

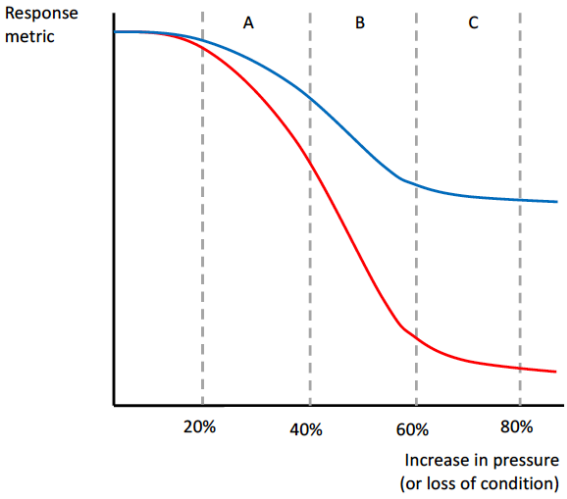

Figure 2. Hypothetical relationship between biodiversity response metric and habitat condition. Two example trajectories are shown - the red line declines rapidly in zone A, between 20% and 40% loss of condition, and accelerates into zone B, after which it flattens out (zone C). The blue line (which could represent a different functional group of animals, or different forest type) shows a smaller response, where the change in response metric between A and B is more linear in that phase

Field sites
Four field sites have been selected: Kenya, Philippines, Nepal and Borneo. Initial work has been carried out on experimental design, and relationships are being built with WWF national offices, as well as other potential research partners. Below is a brief explanation of the main question being posed in each field site.

Kenya
The dominant system drivers of grassland biomes are being impacted by altered fire regimes, increased grazing pressure and changing climate. This in turn alters ecosystem processes, causes loss of biodiversity and suppresses the dynamic nature of the system(*6*). North of the Masai Mara National Reserve, we will establish a monitoring scheme that enables the evaluation of ***the changing dynamics of mammal communities along a gradient of increasing human activity leading to degradation of the grassland savanna biome***. Mammals in the tropical grassland savanna biome face a range of threats, which compromise their important ecological roles and socioeconomic significance. But species in mammal communities do not respond equally to these landscape scale threats. We will therefore evaluate change in mammal dynamics using camera traps across this biome evaluating community responses at 5 sites along a gradient of pressure from human impacts. The design will enable us to quantify the influence of management (e.g. PAs, buffer zones, community management schemes–dependent on location) on individual species and to test whether there are generalities in response by group.

Philippines
We will establish a monitoring scheme that enables us to estimate ***the extent to which pressures across the reef system are mediated by Marine Protected Area*** (MPAs). We will evaluate community (benthic and macrofaunal) responses to a gradient of pressure from human impacts on reefs. The monitoring design will initially enable modelling of responses using space-for-time substitution (as described above). Repeated yearly surveys at those sites over time will enable quantification of temporal lags in community responses, as well as methodological tests (e.g. of the assumption that in STS–drivers of spatial gradients of community response also drive temporal changes in those communities). The ability to evaluate coral reef responses has been hindered by a lack of physical monitoring data required to estimate the relative and interactive effects of local stressors(*23*). This study will provide a substantial improvement on past efforts, which tend to suffer from very small sample sizes (e.g. a single surveyed reef) or problems related to non-random site selection. We will simultaneous monitoring of monitor 3 aspects of the reef system: Macrofauna, benthic and sessile organisms and environmental features

Nepal
We aim to establish a monitoring scheme that enables us to estimate ***the changing dynamics of mammal communities along a gradient of increasing human activity leading to deforestation and fragmentation of a temperate forest biome***. We will evaluate community responses to a gradient of pressure from human impacts on forests, using remote triggered camera traps. The monitoring design will enable hierarchical modelling of single species and community responses, and provides a method for assessing biodiversity while accounting for multiple sources of uncertainty (observation, detection, etc). The design will enable estimation of the influence of management (e.g. PAs, buffer zones, community forest schemes – dependent on location) on individual species and to test whether there are generalities in response by group. Repeated measures over time will enable quantification of temporal lags in response, as well as scope for methodological tests (e.g. can activity budgets be quantified consistently from camera images).

Borneo
We aim to investigate ***what are the impacts of forest loss and fragmentation due to the expansion of oil palm plantations on acoustic diversity, and to what extent do indices***

of acoustic features accurately reflect observed pressures and related biodiversity responses when benchmarked against traditional field methods? Biodiversity monitoring techniques are often highly resource intensive (requiring intensive and extensive human resources), focused on one or two species, and are carried out intermittently (1-2 surveys per year). Ecoacoustics, a new and rapidly developing field of science that studies natural and human-made sounds to tell us about ecological processes and drivers of environmental change, has the potential to undertake continuous sound recording which captures both pressures and responses in the environment (*37, 38*).

The development of acoustic indices is of particular interest for long-term biodiversity monitoring because they can facilitate the rapid assessment of biodiversity without identifying individual species. Acoustic monitoring techniques show early promise but require more focussed development to ensure they are able to provide robust data on biodiversity change and its drivers. We are working with SAFE (https://www.safeproject.net/) to establish a monitoring programme that will compare traditional (i.e. observer led sample surveys) and acoustic methods for monitoring pressures and responses within a gradient of land use intensity in a tropical forest where pressures and biodiversity responses are already known.