Tracking mammalian communities in time and space in Borneo

Oliver R. Wearn[1,2]*, Robert M. Ewers[1], Chris Carbone[2], J. Marcus Rowcliffe[2]

1. Imperial College London, Silwood Park,
2. Institute of Zoology, Zoological Society of London

*Corresponding author: oliver.wearn08@imperial.ac.uk

The widespread invasion of digital technology into natural ecosystems across the globe is giving rise to a monumental data backlog. We currently do not have the software tools to catalogue, manage and analyse this data, which is a waste of time, effort and hard-fought grant money in a time of rapid biodiversity loss. Here, we show how large volumes of field data can be harnessed effectively.

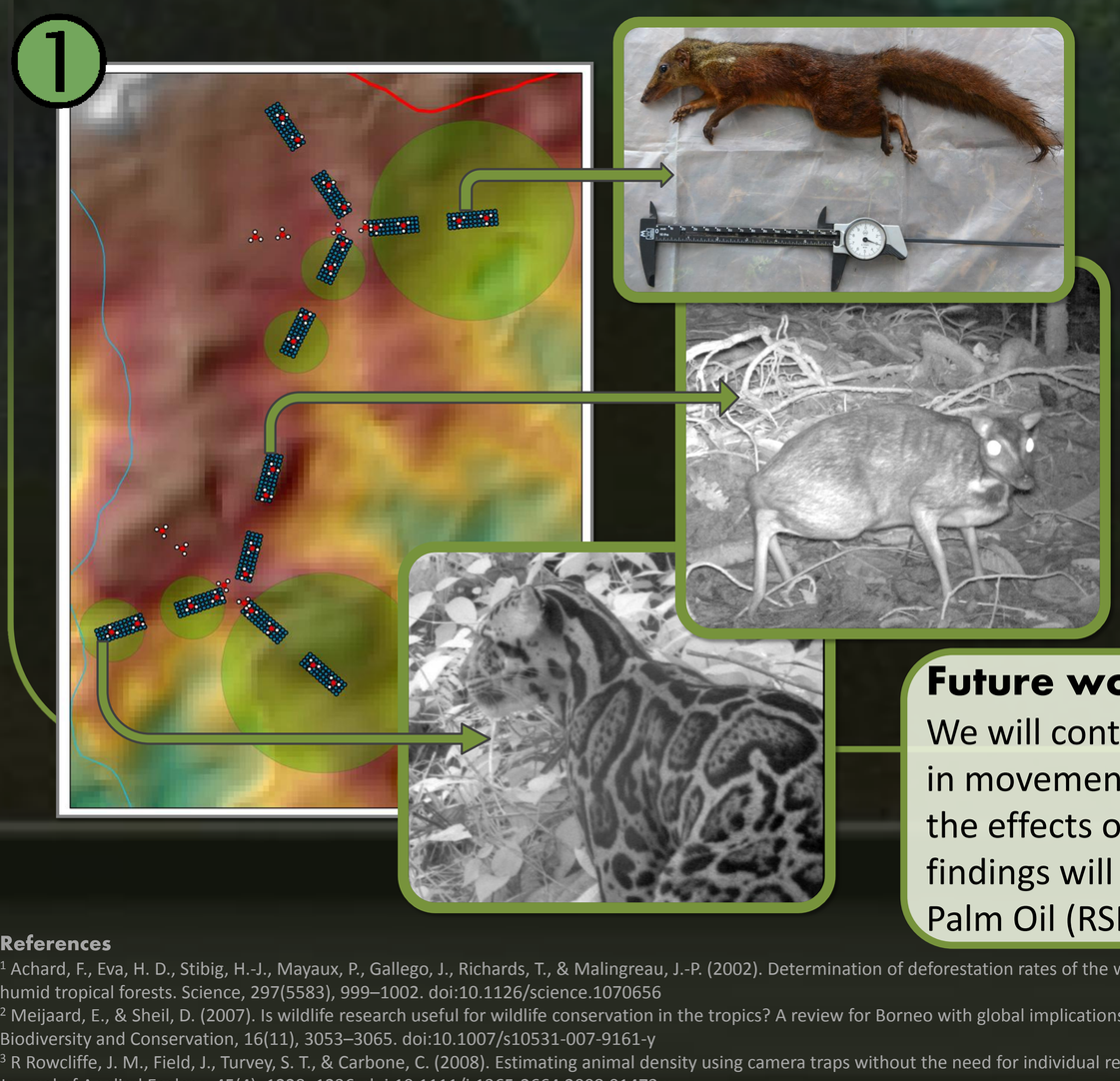
Background

In recent decades, Southeast Asia has undergone the fastest rate of deforestation of all the tropical regions[1]. Despite the popular "knowledge" on the impacts of forest loss and fragmentation in this region, especially vis-à-vis oil palm, the hard science is still largely missing, even for high-profile groups such as mammals. Wildlife research efforts in Borneo have thus far mostly been inappropriate for establishing the "bread-and-butter" conservation biology we urgently need to manage landscapes[2].

We are tracking mammalian communities – from the smallest mice to the largest elephants – across space and through time as a large-scale land-use change occurs in our study area during 2013. This will be one of the first systematic, long-term studies of land-use impacts on mammals, and **the first experimental study**, to be conducted in the region.

Methods

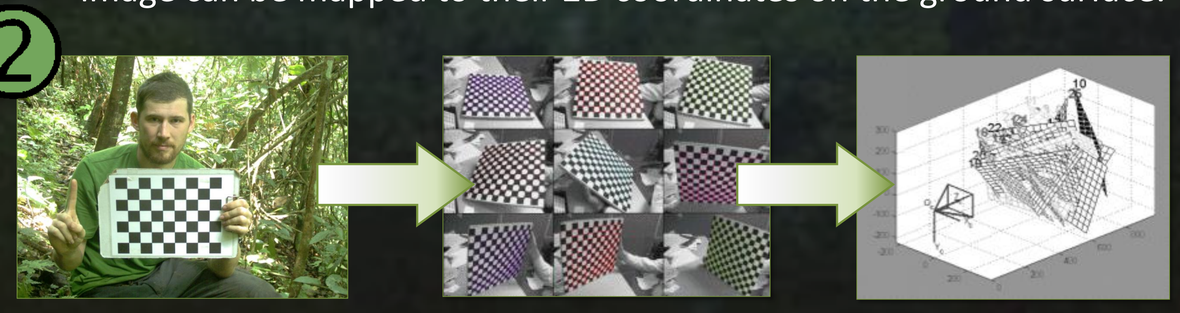
- Tropical forest mammals are cryptic, mobile and rare taxa, posing unique challenges for the collection of data in sufficient quantity and quality.
- We are circumventing these problems using both new and old technology – a network of remotely-operated digital cameras, as well as live-traps – deployed at random grid points within 1.75 ha plots (see blue points, Fig. 1).
- The landscape is currently continuous forest, but 80% of this will be cleared for an oil palm plantation. We have strategically located 28 of our plots in the landscape, stratified across future fragments of size 1, 10, 100 and 2,200 ha, and have already collected a substantial body of baseline data:



- ✓ 15,000 camera-trap nights and 16,000 live-trap nights conducted
- ✓ 62 non-volant mammal species so far recorded inside plots
- ✓ 370,000 near-video images recorded
- ✓ 3,350 live animal captures

New techniques for animal density estimation

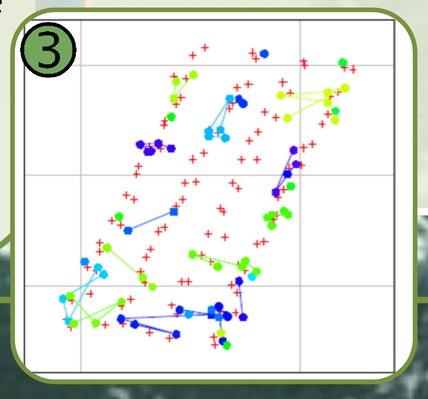
- The crucial state parameter for tracking species' responses to land-use change is density. This can be estimated from wildlife sensors by calibrating the random encounter model: $D = [C / t] * [\pi / vr(2 + \theta)]^3$, where C/t is the animal contact rate, r and ϑ define the sensor window and v is mean animal velocity.
- All of these parameters can be estimated from camera-traps which take rapid-fire images or video. The only requirement is that cameras are calibrated in the field (Fig. 2), so that an animal's 2D pixel location on an image can be mapped to their 2D coordinates on the ground surface.

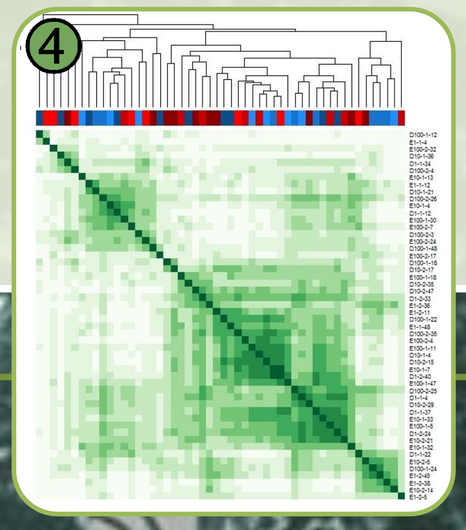


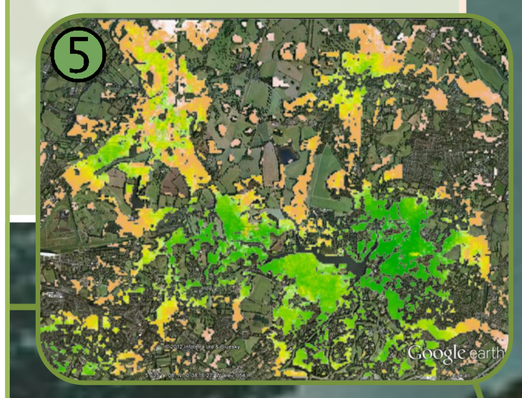
CAMTRAPPER: An R package for the analysis of camera-, video- and sound-trap data

We are currently developing a statistical toolbox for the batch analysis of complex multimedia data, such as those generated by camera-traps and other wildlife sensors. This package of functions will run various analyses at the cutting edge of conservation science with basic user input:

- ✓Summary outputs of survey effort, sensor malfunction rates, data collection rates and species-accumulation curves
- ✓Construction of **species-abundance matrices**, including flexible time thresholds for the definition of "independent" capture events
- ✓Partitioning of **ß-diversity** at multiple scales
- ✓Species and site **clustering** (Fig. 4), including constrained trees by multivariate regression tree (MRT) analysis
- ✓**Redundancy analysis** and forward selection of significant environmental and spatial variables
- ✓Modelling of individual species using Poisson generalised linear mixed models, occupancy or **spatially-explicit capture-recapture** (Fig. 3)
- ✓**Random encounter modelling** (REM) of density
- ✓**Predictive surfaces** output as .kml files for import into Google Earth (Fig. 5)







Future work

We will continue to monitor species across the forest fragmentation horizon, quantifying changes in movement, ranging, occupancy and density. This will provide a robust and defensible account of the effects of oil palm and land-use change on mammals. Through our strong links to industry, our findings will feed into ongoing efforts to revise best practices via the Roundtable for Sustainable Palm Oil (RSPO) and High Conservation Value (HCV) assessment routes.

References

[1] Achard, F., Eva, H. D., Stibig, H.-J., Mayaux, P., Gallego, J., Richards, T., & Malingreau, J.-P. (2002). Determination of deforestation rates of the world's humid tropical forests. Science, 297(5583), 999–1002. doi:10.1126/science.1070656

[2] Meijaard, E., & Sheil, D. (2007). Is wildlife research useful for wildlife conservation in the tropics? A review for Borneo with global implications. Biodiversity and Conservation, 16(11), 3053–3065. doi:10.1007/s10531-007-9161-y

[3] R Rowcliffe, J. M., Field, J., Turvey, S. T., & Carbone, C. (2008). Estimating animal density using camera traps without the need for individual recognition. Journal of Applied Ecology, 45(4), 1228–1236. doi:10.1111/j.1365-2664.2008.01473.x