fields promoted biodiversity, such that this practice had been implemented broadly. As a result, one-half of the original crop (control) areas were converted to set-asides. In this case, relying on the original experimental sample locations can lead either to suboptimal (unbalanced) design and smaller statistical power or to a biased control sample. Drawing a new random sample from the target population or replacing the converted locations would resolve this problem. Therefore, we argue that the key factors of repeatability in ecological field studies are not the exact sampling locations, but rather the definition of the statistical population and the sampling design.

Our second example focuses on Long Term Ecological Research (LTER) and monitoring systems designed to track ecological changes at large scales over long time periods in the face of changing human activities, natural disturbances, and climate (Haughland *et al.* 2010). The ability to accurately track change over time depends fundamentally on maintaining an unbiased and representative sample of the region of interest. If monitoring sites are permanently located, problems could arise if – by knowing the site location – managers can affect activities that occur there in the future. For example, suppose that a rare plant was discovered at certain monitoring sites. This could lead government officials to designate those sites as having some form of special management and/or protection, consequently rendering them unsuitable as part of an unbiased sample of the regional population in terms of human activities. In this way, accurate information on sampling location could in fact undermine the LTER goal of maintaining permanent unbiased survey locations. Similarly, LTER programs wishing to sample across a diversity of land uses may encounter property owners who are reluctant to provide access if the data can be traced back to their land (eg by identifying the location of an endangered species). Exclusion of this land-use stratum could bias the ecological sample, and thus represent another unintended consequence of making accurate location information widely available.

Such issues have been considered by the Alberta Biodiversity Monitoring Institute (ABMI; www.abmi.ca) in the context of its large-scale, long-term, cumulative effects monitoring program in Alberta, Canada. To ensure future access and representativeness of monitoring sites, the ABMI decided to "hide" their sampling locations by applying a relatively modest random offset to geographic coordinates released to the public. Precise coordinates are maintained in a secure location and may be retrieved by researchers following established guidelines. This compromise was designed to balance the need for accurate location data with the risk of inadvertently creating a suboptimal design and biased inference, as described in the above examples.

In conclusion, we feel that, where appropriate, accurate location information should be supplied for the sake of completeness, but that it is not necessary for the sake of repeatability or proper statistical design. We argue that location data are not the most important consideration for maintaining unbiased samples suitable for strong inference. The potential unintended consequences of releasing accurate location information, and the representativeness of a sample with respect to the experimental target population, should always be carefully considered.

Péter Sólymos[1*], Cole Burton[1], Jim Herbers[1], Stan Boutin[1,2], and Jim Schieck[1,3]

[1]Alberta Biodiversity Monitoring Institute, University of Alberta, Edmonton, Canada [*](solymos@ualberta.ca); [2]Department of Biological Sciences, University of Alberta, Edmonton, Canada; [3]Alberta Innovates – Technology Futures, Vegreville, Canada

Haughland DL, Hero J-M, Schieck J, *et al.* 2010. Planning forwards: biodiversity research and monitoring systems for better management. *Trends Ecol Evol* **25**: 199–200.

Kovács-Hostyánszki A, Kőrösi Á, Orci KM, *et al.* 2011. Set-aside promotes insect and plant diversity in a Central European country. *Agr Ecosyst Environ* **141**: 296–301.

doi:10.1890/13.WB.010

A reply to Sólymos *et al.*

In our letter (*Front Ecol Environ* 2012; **10[5]**: 235–236), we argued that applying open geospatial and location standards would link accurate geographical information to ecological studies, which may help improve experimental repeatability. We largely agree with Sólymos *et al.*'s arguments; their letter, however, highlights that our original message may not have been well articulated. Although we focused on the repeatability of ecological research, accurate location of samples has a much wider context, with applications that are useful beyond the narrow scope of the studies that we discussed. Here, we comment on several issues raised by Sólymos *et al.*

If an experimental treatment were applied in a temporally dynamic landscape and served as the focus of the study, then repeating the study should center on that treatment (instead of on the location) and would thus not require accurate spatial information. Nevertheless, satellite imagery and aerial photographs could help researchers choose sites with similar characteristics for conducting related research and substantially enhance our understanding of already published studies. For example, using Google Earth, the reader of a scientific article can "zoom in" on sample areas or points included in the study, thereby visualizing useful information such as the landscape context. This is especially important in regions characterized by habitat heterogeneity. Furthermore, because land use at a given study site may change over time, Google Earth can also assist in visualizing how a location has been altered.

Science – in terms of its techniques, questions, and approaches – is in a state of constant development. In an era of citizen science, ecoinformatics, and increasingly accessible databases, accurate location information should be a prerequisite for any field study. Information that may seem unnecessary now could be extremely important to researchers in the future. For instance, Kleijn and Raemakers (2008) analyzed the composition of pollen loads of bumble bees using museum specimens collected before 1950; it is unlikely that pre-1950 entomologists were aware that their collected bees would be used for such an analysis decades later. With this in mind, accurate location information should be provided for the benefit of current and future scientific studies.

Sometimes it may be better to "hide" the spatial coordinates of sensitive locations (eg imperiled species occurrences); if publically revealed, such information could lead to harm of an individual, population, or community. In such cases, access to location information should be restricted, but the information should still exist. Such data are extremely important for conservation (eg how to protect a metapopulation in order to enhance species survival). Finally, with regard to private property, researchers should certainly obtain permission from land owners before publishing coordinates.

We trust that these arguments make a convincing case that accurate locations are necessary in ecological studies, and hope that this will become a required part (with conditions) of ecology publications.

András Báldi[1*] and Julie Shapiro[2]

[1]*MTA Centre for Ecological Research, Institute of Ecology and Botany, Vácrátót, Hungary*

[*]*(baldi.andras@okologia.mta.hu);*

[2]*Universidade Federal do Mato Grosso do Sul, Department of Biology, Campo Grande, Brazil*

Kleijn D and Raemakers I. 2008. A retrospective analysis of pollen host plant use by stable and declining bumble bee species. *Ecology* **89**: 1811–23.

doi:10.1890/13.WB.011