UNIVERSITY OF LEEDS

Aeroecology: Exploring Biodiversity with Radar

Glossary

Abundance: The number of organisms in a location. Abundance may relate to a single species or a group of species.

Aeroecology: Aeroecology is the branch of ecology that studies species and their interactions within the air. This can involve insects flying a few metres above the ground or birds flying at thousands of metres of elevation alongside aeroplanes.

Air column: When we think about animals in the air, we often think about the body of air that sits above a given location. We sometimes refer to this defined volume of air as the “air column” above that location.

Biodiversity: Biodiversity is a complex term, but the definition we will use in this course comes from the United Nations Convention on Biological Diversity: "*the variability among living organisms from all sources, including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems*".

Biological scatterers: When a radar pulse (an electromagnetic wave emitted from the radar) strikes an object, that pulse is scattered in all directions. An object capable of scattering a pulse is known as a “scatterer” and if the return signal back to the radar receiver is strong enough then that scatterer will register in the radar data. Scatterers can be of several broad types and when a scatterer is of biological origin (an animal, leaves, etc) we call that a “biological scatterer”, which may be abbreviated to a “bioscatterer”.

Biomass: The weight of organisms in a location. Biomass may relate to a single species or a group of species.

Citizen science: Citizen science comprises a broad range of techniques for conducting scientific research that might be as simple as a non-expert collecting data. A good example might be pollinator surveys where little background knowledge is needed to report broad insect groups. At the other end of the scale, citizen science projects can be complex community-led projects where local people design the study, collect the data, analyse the data, and help with interpretation in collaboration with a scientist. Note that while the term “citizen science” is used in this course, there is a discussion about alternative terms to welcome participants regardless of citizenship status. You can read more about that debate here.

Dielectric constant: The way in which a scatterer reflects radar pulses is dependent not only on its shape but also the substance of which it is composed. The dielectric constant is a measure of how fast a radar pulse will travel through a substance compared to through air. Water has a relatively high dielectric constant of 80, while insects (which are mostly, but not entirely, water) tend to have a dielectric constant of closer to 35 when considering radar pulse frequencies. The dielectric constant is important for modelling how different types of scatterers might appear in the radar data.

Diversity: Sometimes used interchangeably with “biodiversity”, “diversity” in a biological context usually refers to the range of different types of a phenomenon (e.g. shapes, colours, species).

Ecosystem services: Ecosystem services are those benefits that people experience from the natural world. Examples might include pollination, clean water, and edible plants.

Environmental DNA: When an organism is present in a medium (soil, air, water), it will shed particles into that medium. Those particles may contain small traces of DNA. By collecting a lot of the medium (e.g. a large volume of lake water) and filtering the particles out, we can use genetic sequencing to look for genetic “barcodes” (sequences of DNA that are almost unique to different species) to build a list of the species that are present in that medium. The DNA fragments in the medium are called “environmental DNA”.

Genetic diversity: One dimension of biodiversity, describing the range of different genetic material within an environment. Genetic diversity might relate both to the range of genotypes that code for particular phenotypes, as well as the genetic material that does not code directly for proteins but may play another, more complex role in species evolution.

Genotype: A genotype is the sequence of genetic information (DNA) that an organism contains. More specifically, it is usually used to refer to the particular DNA that codes for a particular trait (see also “phenotype”).

Habitat: A habitat is the geographical space that provides all the essential requirements for an organism, such as nutrients, shelter, and reproduction.

Invasive species: An invasive species is a species that has arrived in a location outside of its natural range, established a growing population, and is causing damage to local ecosystems. Cane toads in Australia are a good example.

Morphology: In a general sense, morphology is the study of shapes. When used in biology, we usually mean the shape and size of an organism.

Organism: an individual life form (e.g. animal, plant, bacterium).

Phenotype: A phenotype is an observable trait that results from a combination of an organism’s genes and the environment. While genes (see also “genotype”) are a code that translates into certain biochemical processes, the phenotype is the result of those processes as they occur within a given environment. For example, blue eye colour in humans is a phenotype that is

genetically determined, but pink feather colour in flamingos is a phenotype that is determined by their diet rather than genes.

Precautionary principle: In conservation biology, we may be uncertain about how a particular problem will affect the natural world. In the absence of evidence, we might assume that an outcome would be negative and so try to mitigate that problem. For example, a new chemical pesticide might have been shown to be safe in limited laboratory trials but not have been tested in the field. Until we have good evidence for its safety, we would not allow it to be used widely. We call this approach "the precautionary principle".

Radar: A device used to emit electromagnetic pulses and detect their reflection from objects (known as "scatterers"). Originally, "radar" was a contraction of "radio detection and ranging", due to its ability to detect and estimate the distance to objects. Modern radars can make detailed inferences about the nature of the scatterers in the beam based on the way that the beam is scattered back to the radar.

Reflectivity: A radar variable that measures the amount of radar beam that is reflected back to the radar receiver. Reflectivity is greater when there are more and/or larger objects in the scanning volume.

Rewilding: The process by which land that has been modified by humans is restored to some form of "natural" state.

Taxonomy: The process of naming groups (e.g. species) of biological organisms. "Taxonomy" is also used to refer to the names themselves.

Taxonomic diversity: The diversity of species that are present in a location. Note that there are different measures of taxonomic diversity that might take into account simple counts of species richness or the evenness of a community (as opposed to communities where one species dominates).

Taxonomic resolution: The level of detail at which we study biological organisms. For example, we might look at "birds" (low resolution), "waterbirds" (medium resolution), or "Canada goose" (high resolution). Radar is often limited in the taxonomic resolution at which it can work because the differences between species cannot be distinguished in radar data.

Validation (data): The process by which one dataset is checked by comparing it against another dataset that should measure the same phenomenon in a different way. In the case of radar data, we need to validate radar measures of biodiversity or biomass by comparing them against other measures derived from other ecological techniques or citizen science.

Vertical-looking radar: A type of radar that emits pulses directly upward in a narrow cone. Vertical looking radars (VLRs) tend to have a high level of taxonomic resolution within a very limited scanning volume.