# Listening to biodiversity

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**Abstract**

The complex acoustic scenes produced in natural environments (e.g., a forest or a desert) can be used to assess biodiversity, that is the number of species present in these environments. For example, chirping birds in a wooded forest or croaking frogs in a marshy swamp offer specific acoustic information about the presence of the species. Ecologists and bioacousticians have recently developed efficient computational methods to assess levels of biodiversity in specific habitats, with metrics capable of estimating the biodiversity from sound recordings. This raises an interesting question of how human listeners might solve a similar problem of estimating biodiversity from the acoustic stimuli perceived in a natural environment. As a first assay to address this question, we employed a standard model of the early human auditory system to deconstruct an acoustic signal into representations thought to underlie human sound perception. We hypothesized that if the model representations differed with the number of species in the acoustic signal, this could be a cue human listeners use to estimate biodiversity. The model was composed of an auditory gammatone filterbank, followed by envelope extraction and compressive non-linearity and then a second filterbank operating on the envelopes. The model captured the frequency and amplitude modulation sensitivity and selectivity of the early auditory system. Similar to the eco-acoustic metrics, we computed the entropy on the output at different stages of the model. To evaluate the model, we used a curated, and previously published, set of natural sound recordings which included birds, amphibians and insects, that varied in the number for species from 1 species to 10 species. The model response varied across the recordings, increasing with each additional species. Additionally, we observed the model responses above 1.5kHz to be particularly indicative of the number of species. These preliminary modelling results suggest that human listeners should be able to estimate biodiversity from acoustic scenes and may rely on acoustic features present at mid-high audio frequencies.

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