Soundscapes to Landscapes (S2L)

Monitoring Animal Diversity from Space Using Citizen Scientists

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Essential Biodiversity Variables

- Genetic composition
  - Co-ancestry
  - Allelic diversity
  - Population genetic differentiation
  - Breed and variety diversity

- Species populations
  - Species distribution
  - Population abundance
  - Population structure

- Species traits
  - Phenology
  - Body mass
  - Natal dispersion distance
  - Migratory behavior
  - Demographic traits
  - Physiological traits

- Community composition
  - Species richness
  - Species interactions

- Ecosystem function
  - Net primary productivity
  - Secondary productivity
  - Nutrient retention
  - Disturbance regime

- Ecosystem structure
  - Habitat structure
  - Ecosystem extent and fragmentation
  - Ecosystem composition by functional type

Satellite-based

**Tracking Biodiversity**

*Ten variables*

- Species populations
  - Species occurrence

- Species traits
  - Plant traits (such as specific leaf area and leaf nitrogen content)

- Ecosystem structure
  - Ecosystem distribution
  - Fragmentation and heterogeneity
  - Land cover
  - Vegetation height

- Ecosystem function
  - Fire occurrence
  - Vegetation phenology (variability)
  - Primary productivity and leaf area index
  - Inundation

Skidmore et al., Nature, 2015
Next Generation Species Distribution Modeling

Modeling framework of current Species Distribution Models (SDMs), which include coarse abiotic predictors and model outputs.

“Next Generation” SDMs that include finer-scale remote sensing predictors and model output (species probability of occupancy, richness).

Adapted from He et al., 2015
Soundscape Spectrogram

Sugarloaf State Park
Progressive effects of drought 2004 - 2015

Bernie Krause, 2015

https://youtu.be/N2z54euleGU
Soundscapes to Landscapes

A science-based project that seeks to advance animal biodiversity monitoring from the next generation of Earth-observing satellites.

Initial focus is on birds.
Citizen scientists

• Types
  • Birders (Audubon, others)
  • Undergraduate students
  • Landowners

• Main tasks
  • Bird observations
  • Place/retrieve sound recorders
  • Bird call identification in web-based system
1-minute recording every 10 minutes
3-4 days in the field
Sonoma County
60 mi north of San Francisco

Prototype Phase

Lidar vegetation height (ft)

Pepperwood Preserve
Porter - Mark West Creek Watershed

Sonoma County Vegetation Mapping and LiDAR Consortium, NASA, University of Maryland, Watershed Sciences, Inc., Tukman Geospatial LLC
Dark-eyed junco
(*Junco hyemalis*)
Dark-eyed junco (*Junco hyemalis*)
Imaging spectroscopy (HyspIRI, simulated)

Chemistry

Lidar (GEDI, simulated)
SAR (Sentinel-1, PALSAR)

3D Structure
AVIRIS data availability

spring, summer, fall

2016
summer
Global Ecosystem Dynamics Investigation (GEDI)

Global spatial sampling, repeat coverage, track change

Simulated GEDI
Acoustic space vs. species richness

Pearson $r: 0.91, p<0.001$

Serna, 2016