Perspectives from a field researcher: How bioacoustic technology can provide answers to ecological questions

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Many fundamental questions in ecology involve bioacoustics

Population & community ecology
- Species distributions
- Species abundance or density
- Composition
- # of species

Behavioral ecology
- Animal communication
- Mating behavior
- Territory defense/competitive interactions

Outline

Population & community ecology
- Evaluation of an acoustic recording system for quantifying population and community patterns
- Spatio-temporal bird patterns in disturbed environments

Behavioral ecology
- Quantifying species’ vocalization repertoires

Challenges, considerations & next steps

Point counts are the most frequently used method for surveying bird communities

...but this method has limitations
- observer differences in detection & species ID
- observer effects on bird behavior
- logistical limitations

Acoustic recording surveys provide solutions
- reduce biases
- provide permanent records
- capitalize on inexperienced observers

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Soundscape recording system (SRS)
4-channel microphone array (SRS)
Records sounds in 360°
Quadraphonic playback system
Simulates 3-D soundscape

Advantages over mono- and possibly stereo systems
Flexible design, capitalizes on commercial components

Celis-Murillo et al. (Accepted, J of Field Ornithology)
Objective: test effectiveness of soundscape recording system for estimating population & community parameters relative to a trained observer conducting a point count in the field.

Compared:
1. Species abundance (probability of detecting individuals)
2. Species richness (probability of detecting species)
3. Composition

Riparian breeding birds

SRS performed as well or better than point counts for surveying bird populations & communities.

- Recordings:
  - Higher detection probabilities
  - Better fit to assumptions of time of detection model for estimating abundance
  - More reliable abundance estimates
- Recordings & field counts: similar ability to detect species and estimate # of species
- 60% overlap in species composition between methods

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Challenges, considerations & next steps

Natural and human-modified habitats along coastal to interior gradient

- 160 monitoring locations in NE Yucatan Peninsula
- 5 habitat types
- Locations visited every 3 months over 1.5 yrs
- SRS surveys

How do bird communities respond to large-scale natural disturbances in a human modified landscape?

Objective: quantify spatio-temporal patterns in bird populations & communities following Hurricane Wilma

PIs: A. Celis, J. Deppe, M. Allen

Photo credit: J. Deppe & A. Celis

Photo credit: J. Deppe & A. Celis

Photo credit: Antonio Celis

Celis Murillo et al. (Accepted, J. of Field Ornithology)
Acoustic recording surveys enabled us to deal with several design & logistical issues

1. Inter-observer biases eliminated
2. Intra-observer biases reduced
3. Enhanced species identification
4. Satisfied personnel requirements by using inexperienced field technicians
5. Completed project on limited budget

Additional advantage: Recordings generated source pool of sounds for developing song id algorithms

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Traditional approach: directional microphones

Biases:
- Sampling is non-random
- Difficulty following birds
- Limited duration of recordings
- Observers may influence behavior/vocalizations
- Low amplitude vocalizations may be missed

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Objective: characterize and quantify vocalizations of Northern Cardinals in IL

Microphone attached to radio transmitters

Advances in bioacoustics provide better answers to questions regarding vocalization structure and function

- # syllables increases with recording duration (males & females)
- Detect more rare syllables
- Unbiased sampling of vocalizations

Can also use to look at activity budgets & individual variation in vocalizations

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Easy to accumulate large libraries of sound recordings
- No $ to maintain or generate collections
- Need to analyze recordings!!

Automated processing of recordings needed:
- Presence/absence and abundance
- Single & multiple species

D. Tcheng

Challenges, considerations & next steps

• Validation & calibration of hardware and software
  - Test effectiveness of microphone arrays in estimating parameter(s) of interest
  - E.g., Hobson et al. (2002) calibrated their microphone system so that its detection distance was comparable to that of field observers
  - Playbacks to quantify detection distance
  - Performance index of software (e.g., 95% accuracy)

• Standardization of metadata
  - Necessary for comparison of data collected using different recording systems

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