


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

Jill Deppe
Illinois Natural History Survey

Antonio Celis-Murillo
Michael Ward
David Enstrom



David Tcheng
National Center for Supercomputing Applications




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



Novel acoustic recording technologies are advancing our understanding in these ecological disciplines

Photo credit: Jill Deppe

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

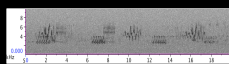




Photo credit: Michael Ward

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

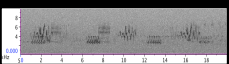




Photo credit: Michael Ward

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

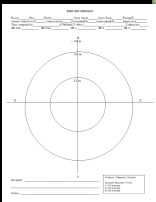








Photo credit: J. Deppe & A. Celis

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) Photo credit: Antonio Celis

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

W. Riverside Co, CA


Point counts vs. SRS counts

Celis Murillo et al. (Accepted, J. of Field Ornithology)

Photo credit: Antonio Celis

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



Celis Murillo et al. (Accepted, J. of Field Ornithology)

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

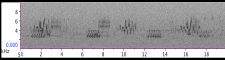




Photo credit: Michael Ward

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


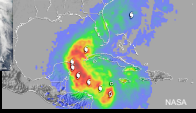





Photo credit: J. Deppe & A. Celis

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

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


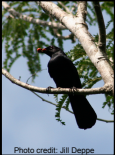

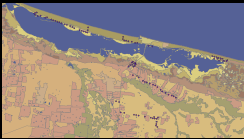





Photo credit: Jill Deppe

Photo credit: Michael Ward

Natural and human-modified habitats along coastal to interior gradient

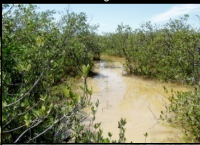








Photo credit: J. Deppe & A. Celis

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



Volunteer performing SRS survey

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

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

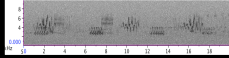




Photo credit: Michael Ward

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








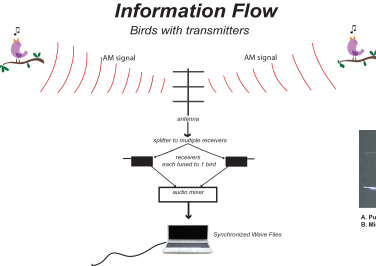


Photo credit: J. Deppe & A. Cells

Objective: characterize and quantify vocalizations of Northern Cardinals in IL

Microphone attached to radio transmitters D. Enstrom & M. Ward

Information Flow

Birds with transmitters

A. Pulsed Tracking Transmitter (Broadcasts CW band only)
B. Microphone Transmitter (Broadcasts in both CW and AM bands)

Photo/figure credits: David Enstrom

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


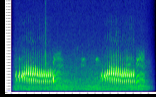


Photo credit: Tolly Cells

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



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

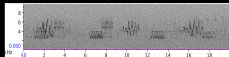





Photo credit: Michael Ward

Challenges, considerations & next steps



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

Machine learning approach

D. Tchong

Challenges, considerations & next steps

- Validation & calibration of hardware and software
 - Test effectiveness of microphone arrays at 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

Acknowledgements

- Michael Allen, John Rotenberry (UC Riverside)
- Jim Nichols (USGS Patuxent Wildlife Research Center)
- Western Riverside MSHCP

