2nd INTERNATIONAL SYMPOSIUM ON BAT ECHOLOCATION RESEARCH

ACOUSTIC MONITORING HANDBOOK
DRAFT OUTLINE

HANDBOOK OVERVIEW

CHAPTER 1: INTRODUCTION

- Outline the purpose of the handbook
- Describe some echolocation basics (i.e. How do bats use echolocation, how do we visualize echolocation calls that we record, what characteristics do we use to identify calls as belonging to one species or another – this section will be brief)

CHAPTER 2: ACOUSTIC SURVEY DESIGN

- What questions are you asking and what data are you trying to obtain?
    - Presence/absence, occupancy (*Gorreson et al. 2008; Loeb et al. 2015)*
    - Activity level/abundance (*Silvis et al. 2016; Grider et al. 2016*)
    - Feeding activity (*Heim et al. 2016)*
    - Migratory activity (*Furmankiewicz and Kucharska 2009; Rydell et al. 2014)*
    - Behavior

- Importance of controls
    - To detect changes in bat activity over time and space. (*Dzal et al. 2009; Baerwald and Barclay 2009)*
    - To detect changes in the activity/abundance of a species or group of species. (*Dzal et al. 2011)*

- What approaches to use?
    - Active/passive (*Coleman et al. 2014)*
    - Transects – driving, walking, biking (*Roche et al. 2011; Loeb et al. 2015; Whitby et al. 2014; Walsh and Harris 1995)*
    - Citizen science (*Barlow et al. 2015)*

- How many detectors and where to put them?
    - Selecting sampling locations (*Rodhouse et al. 2011)*
    - Detector deployment (habitat, orientation, recording time) (*Britzke et al. 2010; Skalak et al. 2012)*
    - Considering sound detection spaces (*Darras et al. 2016; O'keefe et al. 2014; MacKenzie et al. 2002)*

- How long to deploy detectors?
    - Temporal vs. spatial replication (*Bailey et al. 2007)*
    - Absent or undetected? Understanding detectability and its relationship to survey effort (*Gu and Swihart 2004)*
    - General advice on allocating survey effort (*Mackenzie and Royle 2005, Law et al. 2015)*
    - Power analysis when species detections are <1 *(Guillera-Arroita and Lahoz-Monfort 2012)*
    - But what can we do with a single survey? *(Lele et al. 2012)*
    - Estimating true absence *(Wintel et al. 2012)*

CHAPTER 3: BAT DETECTOR CHOICE

- Describe some of the basic concepts and terminology related to making acoustic recordings of bat echolocation calls (e.g. heterodyne vs. full spectrum vs. zero-crossing, signal:noise ratio, etc.)

- Best practices for deployment (e.g. height, directionality, strategies for power and data storage).

- Discussion of relative costs of bat detector features, as well as tradeoffs of different specifications.

- Describe currently available detector models, including their general characteristics, and suitability for addressing different kinds of research questions. Perhaps categorize detectors into high/medium/low cost options. Present in a table (like consumer report).
    - NOTE: The Handbook editors plan to first obtain basic information on detector specs directly from the relevant companies via a standardized form and will add to the table based on conference discussions.

CHAPTER 4: ECHOLOCATION CALL IDENTIFICATION

- Intraspecific variation in echolocation
    - Briefly summarize reasons for variation (habitat, geography, presence of conspecifics or ambient noise, individual/colony) (*Murray et al. 2001; Broders et al. 2004; Gillam and McCracken 2006; Veselka et al. 2013)*
    - Provide examples (*Molossus* as an example of a group that is highly flexible in its echolocation call structures*;* perhaps also include variable calls from a few species that are geographically widespread, thereby providing "local" examples for as many Handbook users as possible. North American examples that would be good include *M. lucifugus, E. fuscus, L. noctivagans, L. cinereus*)

- Discussion of manual vs. automated call ID
    - Need for both (automated ID practices are necessary to deal with large volumes of data and provide standardization; manual ID practices may (or may not) be more accurate and can provide users an opportunity to validate auto ID results and become more familiar with their data set). (*Jennings et al. 2008; Russo and Voigt 2016; Britzke et al. 2013)*
    - Understanding the potential for bias in manual ID *(Fritsch and Bruckner 2014)*
    - Effects of filters *(Clement et al. 2014)*
    - Methods of manual ID
        - Heterodyning (*Limpens 2004)*
        - Examining digital recordings (*Fritsch and Bruckner 2014)*
        - Combination of heterodyning and software analysis. (*Barataud et al. 2015)*

- Generalized discussion about the principles of automated ID
    - Basics of how automated ID works
    - Importance of filters
    - Classification methods – parametric or nonparametric, does it matter? *(Britzke et al. 2011)*
    - Bias and consistency
    - Estimating likelihood of misidentification (*Britzke et al. 2002)*
        - Classification accuracy tables
        - MLE values
        - Why low species accuracy may matter (marginally) less than you think
        - Why file/pass level disagreement may matter less than you think *(Britzke et al. 2002; Lemen et al. 2015)*

- Summary of call identification software currently available, being careful to avoid including information that will not age well (e.g. price)
    - NOTE: As with the information about bat detectors, the Handbook editors plan to first obtain basic information on software specs directly from the relevant companies via a standardized form and will add to the table based on conference discussions.

- Summary of existing and publicly available call libraries
    - *Walters et al.(2013) contains a table with a list at the time of publication – can be used as a starting point.*

CHAPTER 5: DATA, ANALYSIS, AND INFERENCE

- Strategies for organizing, manipulating and storing enormous quantities of data. Include some examples of the quantity of data that a surveyor could expect.
    - Databases
        - Why and how
        - Current limitations
            - Workarounds
        - Archiving standards
        - Community standards

        - NPS
        - NABat
        - European equivalent?
    - What to database
        - Detector settings
        - Call files
        - Call file data parameters
        - Software version and settings
        - Site data
        - Personnel data
        - Dates – deploy, retrieve, *working*

- Provide a general purpose or existing database that readers could use to manage call-associated data (perhaps with help from Tom Rodhouse).
    - Community review and discussion of NPS database as starter
    - Modification of NPS database

- Summary of current widespread statistical techniques and the inferences they provide
    - Null hypothesis, information theoretic, or Bayesian (many, but will select only a few)
    - Occupancy analysis *(Bailey et al. 2007, Welsh et al. 2013)*
        - Logistic regression (mostly why not; *MacKenzie 2005*)
        - Single visit occupancy (*Lele et al. 2012*)
        - Single season
        - Dynamic (*MacKenzie et al. 2003)*
        - Abundance (with caveats*; Royle and Nichols 2003, Royle 2004*)
        - False-positive *(Royle and Link 2006, Miller et al. 2011, Clement et al. 2014)*
    - Activity levels
        - Generalized linear models and generalized linear mixed models
            - Determining need for hierarchical effects *(Bolker et al. 2009)*
                - Random intercept
                - Random slope
                    - Pooling species
            - Link functions
                - Poisson
                - Negative binomial
        - Zero-inflation *(Sileshi et al. 2009)*
            - Function
            - Theoretical considerations
        - Generalized additive models
            - Smoothers vs polynomials
            - When to consider
    - Community structure
        - Ordination

        - NMDS
        - CCA and RDA
        - PCA and CA
    - Structural equation models and Bayesian belief networks
        - Limited as this could get very hairy very quickly
    - Autocorrelation
        - Spatial
        - Temporal

- Appropriate and inappropriate ways to analyze results and draw conclusions, with regard to
    - Sampling design
    - Collection method
    - Analysis method
    - Uncertainty
    - *A priori* considerations
    - Incorporating other data types and sources, and prior information

CHAPTER 6: CASE STUDIES

- Four or five one-page descriptions of well-designed and -executed acoustic surveys. Ideally, this section will provide concrete examples of the concepts discussed in chapters 1 through 5 and will represent a diversity of research questions, detector and call ID software choices, and geographical areas. Case studies may illustrate examples of high and low activity, as well as comparisons of data sets from pre- and post-WNS scenarios.
    - NOTE: The Handbook editors will request examples of research projects to use as case studies from conference participants and will select four or five that best meet the needs of the handbook. Please see the associated e-mail attachment for details on this request.
    - We will summarize the remaining examples in a table of citations to be at the end of the chapter and ordered by project type. This will alert handbook readers to a variety of studies on given topics.
    - All case studies should have associated publications that readers can access for more information (and perhaps should be open-access).

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