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Sampling Considerations for Amphibian Surveys: Evaluating Risks of Committing Type I and Type II Errors

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SAMPLING CONSIDERATIONS FOR AMPHIBIAN SURVEYS: EVALUATING RISKS OF COMMITTING TYPE I AND TYPE II ERRORS

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ABSTRACT

Global amphibian declines pose a major threat to the world's biodiversity. We examined the observation bias associated with volunteer based anuran surveys, such as the North American Amphibian Monitoring Protocol (NAAMP). We followed NAAMP protocol to examine if variation in the persons (1-3) in an observer unit affected observer error. We hypothesized that observation units with multiple observers have less observer bias and would better report anuran assemblages compared to single observers. Larger observer units had fewer incidences of false positive observations. Additionally, we attempted to determine which sampling method for the eastern hellbender (*Cryptobranchus a. alleganiensis)* had the highest detection rate. We examined the detection probability of three methods: visual encounter surveys (VES), nocturnal spotlighting, and un-baited trapping. After 200 search hours and 300 trap nights, one hellbender was detected during a VES. Due to the small sample size we were unable to determine site occupancy and detection probabilit

CHAPTER 1

EVALUATING SAMPLING METHODS FOR THE EASTERN HELLBENDER (*CRYPTOBRANCHUS A. ALLEGANIENSIS*) IN THE OHIO RIVER WATERSHED

Introduction

Imperfect detection, the inability to correctly determine the presence of a species, is a logistical problem for many wildlife surveys (Bailey and Adams, 2005). When dealing with rare or endangered species, imperfect detection often skews population estimates (McKenzie et al., 2006). This is problematic because a species that is present at a location but undetected by the surveyor is recorded as absent (i.e., false negative). Thus, failing to detect a species can exaggerate rarity or suppress estimates of its abundance (McKenzie et al., 2006). Further, low detection rates can hamper species conservation when false negatives exclude a location from management efforts. Conversely, when a species is falsely recorded as present or is misidentified (i.e., false positive) population size and species' range can be overestimated. These inflated estimates can hamper proactive conservation strategies because they lead to false assumptions about a species distribution and abundance. Numerous occupancy models (e.g., single- and multiple-species models derived to fit a variety of data structures) have been developed to account for detection probabilities (McKenzie et al., 2006). These models provide an estimate of detection probability for a target species given a set of variables associated with a specific sampling event, such as time of day, temperature, and sampling method (McKenzie et al., 2006). Even the simplest applications of occupancy modeling provide valuable insight into both spatial correlations of species distributions and sampling covariates that influence the probability of detecting the species. Detection probability is often considered a nuisance variable that is used to increase the reliability of estimates for species occupancy, survival, and abundance (Christy et al., 2010); however, statistical models that incorporate detection probability can be used to develop survey protocols that maximize species detection. The Eastern hellbender is a declining, cryptic species and efforts for its conservation have suffered from its low detection probability, which makes populations difficult to survey.

Historically, the hellbender ranged from Southern New York to Mississippi with isolated populations in Missouri and Arkansas (Nickerson and Mays, 1973; Petranka 1998). Declining populations throughout its range have resulted in a near threatened classification by the ICUN red list of threatened species (IUCN, 2013). Despite the need for effective monitoring protocols, a thorough assessment of hellbender sampling techniques has not been conducted. Population declines have made the hellbender a management priority in many states; however, the development of successful management plans has been hindered by the hellbender's cryptic nature, which makes it difficult to detect.

Low detection rates have resulted in of a variety of sampling techniques with little agreement on the success of each method. Rock flipping is one of the most successful field sampling techniques (Santas et al., 2013). This method is disruptive to the stream habitat (e.g., den sites and benthic microhabitat) and potentially harmful to the hellbender (Burgmeier et al., 2011). Additionally lifting heavy rocks can cause observer fatigue and possible injury (Nickerson et al., 2003). Thus, the risk of sampling bias is high as the size of rocks sampled is dependent on the observers' physical ability. Electrofishing is a commonly used method with varied results. As it has the potential to harm the hellbender and negatively impact fecundity, it was not a recommended method by Browne et al. (2012). Additionally electroshocking requires use of costly equipment e.g., backpack voltage generator, submersible electrodes (Browne et. al., 2012) and increased observer training. In comparison, other less invasive, less destructive sampling techniques include: un-baited traps, visual encounter surveys (VES), and nocturnal spotlighting. The range of sampling methods has resulted in discrepancies in the time required to sample, sampling costs, and overall detection success. Not accounting for imperfect detection of hellbenders could potentially lead to erroneous conclusions about its occupancy.

The goal of this study was to use hellbender detection rates to evaluate three non-destructive sampling methods: visual encounter surveys, un-baited traps, and nocturnal spotlighting. These methods are the least likely to suffer from sampling biases because the search effort is not dependent on the observers' physical strength. These methods also are not dangerous to the hellbender, nor do they require a high degree of sampling expertise. Therefore, they potentially provide less biased data and are more likely to be acceptable in protected areas (e.g. national parks) or when concerning protected populations.

Methods

2.1 Study Area. The Monongahela National Forest (MNF) is located in the Allegheny Mountains of eastern West Virginia, USA. The forest encompasses 372,715 ha, with elevations ranging from approximately 305 - 1482 meters above sea level. The headwaters of seven rivers (Monongahela, the Elk, the Tygart Valley, the Cheat, the Greenbrier, the Potomac and the Gauley) are located within the forest boundary. Logging and mining, as well as livestock grazing, are still common within the forest boundary. The MNF is home to a variety of species, including nine federally listed threatened and endangered species.

2.2 Sampling protocol. I sampled 25 sites in or near the Monongahela National Forest from June to October 2013 (Figure 1.1). Five sites were selected in each of five river systems: the Elk, Tygart Valley River, Shavers fork of the Cheat River and the East and West fork of the Greenbrier River. I selected these rivers because records from the West Virginia Biological Survey Museum (WVBM) indicated that hellbenders were historically present. I used ArcGIS 10.1 (ESRI, Redlands, CA) to randomly select river access points from road crossings. All sites were spaced at least 500m apart to ensure independence and located at least 100m from a bridge.

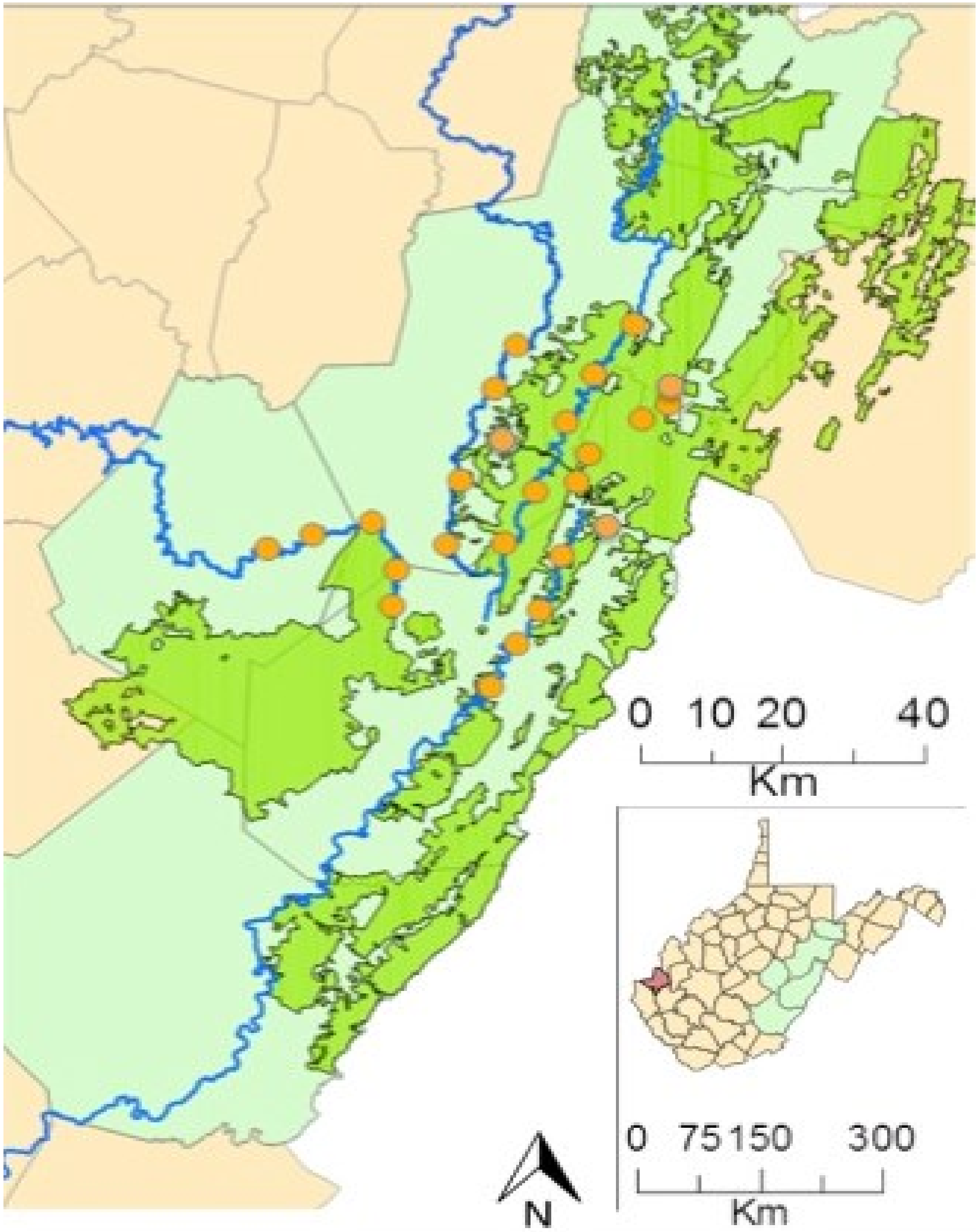

Figure 1.1: Location of hellbender sampling sites in the Monongahela National Forest, WV, 2013.

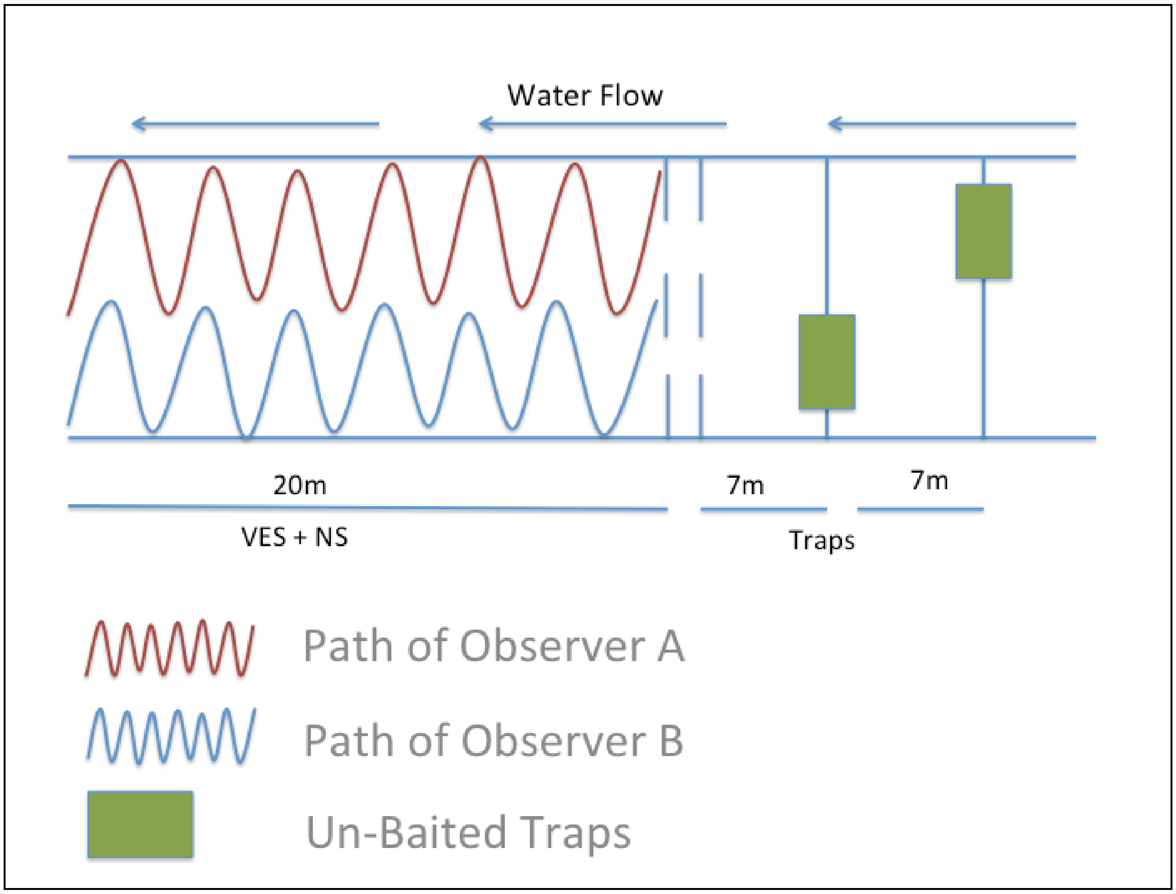

Figure 1.2: Site arrangement and sampling pattern.

2.3 Visual Encounter Surveys. I conducted diurnal visual encounter surveys (VES) along each 20m stream transect. Two observers sampled the stream while wearing polarized sunglasses (Spiderwire brand) and standing in shallow water to minimize sun glare. We used a mask and snorkel in water deeper than 0.5 meters to improve visibility. We sampled transects by moving upstream with each observer searching a lateral half of the stream. We walked a zig-zag pattern (Figure 1.2) to maximize the amount of stream searched without disturbing the habitat upstream.

2.4 Nocturnal Spotlighting. We conducted nocturnal spotlighting on the evening following the VES. Both observers used a high-powered spotlight (Waypoint model 44910) with a sweeping motion and moved upstream while searching the stream bottom.

2.5 Unbaited Traps. We set un-baited traps either 24 hours before or 12 hours after the completion of the nocturnal survey. We based this decision solely on scheduling logistics. We placed traps at 7 and 14 meters upstream from the end of the 20-m transect (Figure 1.2).

The traps were not in the stream during either the VES or nocturnal spotlighting to maintain sampling method independence. Traps were deployed for approximately 24 hours (range 22 – 26 hrs.) with the trap entrance positioned upstream and randomly located along transects.

2.6 Sampling Covariates. Sampling covariates were measured at the beginning of each 20-m transect and prior to nocturnal spotlighting and VES sampling. We recorded pH using the Oakton Double Junction model 10. Conductivity, temperature and dissolved Oxygen were measured using a YSI (model 556). We measured water depth at 2m, 6m, and 10m from the bank to monitor change in water level throughout the sampling season. We measured surface flow by recording the time (seconds) it took a Ping-Pong ball (Franklin brand) to travel 8m downstream in the swiftest portion of the river. Due to an equipment malfunction we were unable to measure conductivity in the field for the September sampling event, so we collected water samples in a 0.5 L plastic bottle and tested the water for conductivity in the laboratory using a YSI conductivity meter.

Table 1.1: Sampling covariates of hellbender detection

Sampling covariates	**Impact on detection**
Water condition	Preferred hellbender habitat is fast flowing, highly oxygenated streams. Water temperature is usually a cool 20 C (Dundee 1971; Petranka 1998).
Sampling time of day	Hellbenders are primarily nocturnal often hiding under rocks during the day (Nickerson and Mays, 1973).
Weather	Diurnal foraging activity has been known to occur on overcast days (Nickerson and Mays 1973; Humphries 2007).

2.7 Site Covariates. Site covariates were recorded once. We measured canopy cover in July using a GRS densitometer; we walked the center of the river taking a reading at every meter within the 20m transects. We calculated percent canopy cover by dividing the number of positive canopy cover measurements by total number of readings. We performed a complete habitat assessment using the United States Environmental Protection Agency's (EPA) Wadeable Stream Rapid Assessment. We evaluated the following habitat perimeters: Epifaunal Substrate Cover, Sediment Disposition, Embeddedness and Velocity/Depth Regime, based on visual characteristics ranging from optimal to poor. We collected these measurements to rapidly evaluate the physical habitat characteristics of our sites.

Table 1.2: Site covariates of hellbender detection.

Site Covariate	Impact on Detection
Canopy Cover	Removal of forest canopy can contribute to increased water temperature which negatively impact hellbenders (Hutchinson et al., 1976).
Substrate	Habitat Selection positively correlated to cobble boulder substratum relative to finer substrate (Bodinof et al., 2012).
Hydrology	Hellbender sensitive to disturbances in hydrology (Quinn et. al, 2013).

2.8 Analysis. I developed 33 candidate models to determine if site and sampling covariates affected detection probability. I used single-season, single-species occupancy models (Mackenzie et. al, 2006) to examine the utility of three sampling methods in program PRESENCE. The default model included occupancy and detection probability as constants (ψ(.), p (.)). Models with a delta AIC≤ 2.00 were considered to have support, and were used for inference.

Results

I conducted four sampling events from June to Oct 2013. Two hundred trap nights and 200-person hours yielded one hellbender detection in September 2013. I detected a single, sexually mature male hellbender in the east branch of the Greenbrier River during a visual encounter survey.

Discussion

I detected one hellbender, and thus I was unable to run the planned analysis. Given the effort of my study—200 search hours and 200 trap nights—I expected higher detection success. Our low detection rate could be explained by: a) poor performance of chosen sampling methods or b) a decline in hellbender population potentially causing extirpation in some streams. Poor stream conditions including high flow and turbidity potentially impacted my detection success. Historically hellbenders have been well sampled in West Virginia. Humphries and Pauley (2005) detected 44 hellbenders using both diurnal flip and search and nocturnal surveys in a similar portion of the Monongahela National Forest. Hellbender density within that region varied from 0.8 to 1.2 individuals per 100 m2 (Humphries and Pauley, 2005). Given the success of Humphries and Pauley's nocturnal surveys we conclude that nocturnal spotlighting is an effective technique for this region.

Visual Encounter Surveys are beneficial because they have little impact on the habitat or study animal. Additionally, minimal equipment or observer training is required. Thus, VES surveys are cost effective and easily reproducible. However, this method is heavily dependent upon ideal sampling conditions. I suspect that high flow and increased turbidity negatively impacted my results limiting detection success. Therefore, I recommend this method be used in combination with other methods.

Little is known about hellbender detection success of un-baited traps. However, as hellbenders rely on chemoreception to detect prey (Townsend, 1882; Nickerson and Mays, 1973; Nickerson et al., 2003) the success of trapping using various baits is well studied. Trapping success widely depends on the type of bait used. Fresh Gizzard Shad

(*Dorosoma cepedianum*) has a high rate of detection; however, chicken liver, crayfish, and carp have also been used (Browne et al, 2011). Baiting traps increases the risk of introducing a foreign species or disease into the stream. I used baitless traps as hellbenders have been detected in West Virginia using this method (Thomas K. Pauley, personal communication). Secondly, if baitless trapping were a reliable method it would reduce the risk of “bait-bucket “introductions. However, given lack of success I do not recommend the use of unbaited traps as a reliable detection method.

As hellbenders can live up to 29 years, it is reasonable to assume continued site occupancy 15 years following initial sampling. I concluded that hellbender populations are in decline and extirpation has potentially occurred at one or more of my sites. I suspect that although VES and unbaited traps are not the best methods of detection, nocturnal spotlight is still an effective sampling technique. Therefore, I suspect that if hellbenders occupied my sites in sizable numbers we would have detected them using nocturnal spotlighting. The methodology of my study was sound; however, adjustments need to be made for future attempts at hellbender occupancy studies. Additionally, I suspected that above average precipitation resulting in high water levels, and increased turbidity reduced visibility impacting my detection success.

CHAPTER 2

EXAMINING THE RISK OF OBSERVER BIAS IN ANURAN MONITORING PROGRAMS

INTRODUCTION

The use of nonscientists in the collection of ecological data (citizen science) has become increasingly important in species conservation (Tulloch et al., 2013). Citizen science provides an opportunity to collect data previously considered logistically impossible due to temporal and financial limitations (Dickinson et al., 2010). Therefore, the use of volunteer-based surveys provides researchers with the ability to discern large-scale biodiversity patterns (Bird et al., 2013), such as population trends and abundance. Despite the benefits of citizen science, there is concern over the utility of volunteer-based data in the scientific community (Bird et al., 2013). Critics of citizen science note decreased precision in species identification and abundance due to varying observer skill and commitment (Bird et al., 2013). Crall et al., (2011) warned of biased data due to underrepresentation of species and nonrandom distribution of observer effort. However, volunteer-based surveys are common monitoring strategies in avian and anuran monitoring programs.

In response to global anuran declines, the North American Amphibian Monitoring Program (NAAMP) was created to monitor the distributions and relative abundance of amphibian populations in North America (Weir and Mossman, 2005). The NAAMP protocol uses road-based observer surveys as a method to monitor trends in amphibian populations (Scott and Woodward, 1994; Lotz and Allen, 2007). Standardized volunteer listener surveys, such as NAAMP, are often cost effective, and repeatable. Additionally, volunteer based programs foster public interest in amphibian conservation and they can be applied across several geographic regions (Shearin et al., 2012).

Observer biases associated with citizen scientist-based call surveys have not been well documented in anuran studies (Lotz and Allan, 2007). However, observer bias in bird density surveys frequently occurs (Bart and Schoultz, 1984; Sauer et al., 1994; McLaren and Cadman, 1999). Observer error can result in an inaccurate assessment of anuran populations and trends as observers have the potential to: falsely include a species not actually present (false positive), fail to detect a species that is present (false negative), or incorrectly identify species (Lotz and Allen, 2007). While many previous anuran call studies mention error in the form of a potential bias (Kolozsvary and Swihart, 1999; Lehtinen et al., 1999; Pope et al., 2000; Zampella and Bunnell, 2000; Crouch and Paton, 2002; Lotz and Allen, 2007), other studies fail to mention the potential risk of observer bias and therefor fail to document it (Vandewalle et al., 1996; Stevens et al, 2002; Lotz and Allen, 2007).

Inter-observer variability is a major problem with citizen science frog call survey data (Hemesath, 1998). Inter-observer differences in detecting and identifying species is a primary source of variation, and therefore bias, in call surveys (Droege and Eagel, 2005). Recent studies have concluded that there are little differences among observer agreement during presence/absences anuran call surveys (Bishop et al., 1997; Shirose et al., 1997; Hemesath, 1998; Genet and Sargent, 2003). However, inter-observer agreement varies based on the frog species calling (Bishop et al., 1997; Shirose et al., 1997; Genet and Sargent, 2003; Pierce and Gutzwiller, 2007), potentially reflecting differences in chorus size and call volume (Pierce and Gutzwiller, 2007). The goal of this study was to examine how observer group size (1-3 persons) affected the accuracy of anuran auditory surveys using a group consensus approach. Furthermore, our goal was to examine how species richness affected data accuracy. We hypothesized that larger observer groups would have less observation error and would provide more accurate results. Additionally, we hypothesized that observer error would be positively associated with species richness. The results of our study will help researchers account for citizen scientist participation and better design auditory survey sampling protocols.

Methods

2.1 Study Area. The James W. Webb Wildlife Center and Management Area is a 2374 ha property managed by the South Carolina Department of Natural Resources for wildlife management. The area is located in Hampton County, SC, in the Coastal Plain, a region that has one of the highest diversity of anurans in the United States (Reid and Kilpatrick, 2013). The area is characterized by a range of upland and lowland communities that include longleaf pine (*Pinus palustris*) flatwoods, bottomland hardwood forests, and mixed pine hardwood forests. Land management practices include high-frequency prescribed fire (spring and summer fires) to maintain pine savannas and woodlands (Waldron et al., 2006). Upland isolated wetlands are abundant in the upland pine communities, ranging in size from 0.25-0.75 ha.

2.2 Field Sampling. In March 2013, we conducted field surveys to examine observer biases associated with volunteer-based anuran call surveys. We used the NAAMP frog call quiz (Weir, 2009) to ensure that all observers were proficient at identifying anuran species indigenous to the region.

We sampled ten isolated, upland wetlands that were randomly selected in the study area and separated by at least 300m. Each night prior to sampling, we randomly assigned observers (n=7) into one of two travel groups. One travel group included four individuals and the other group included three individuals. Each travel group was then divided into a single observer-sampling unit and a multiple-observer consensus-sampling unit. Specifically, the three-member travel group included a single observer and a two-observer consensus-sampling unit, and the four-member travel group included a single observer and a three-observer consensus-sampling unit. At each wetland, a different individual occupied the single-observer unit, and we randomized the order in which individuals rotated through the single-observer unit. Therefore, on each night, each individual occupied the single observer unit on at least two sampling occasions in the four-member travel group and at least three sampling occasions in the three-member travel group.

Prior to sampling, we placed acoustic data loggers (Wildlife Acoustics Song Meter SM2+) in each wetland to record anuran vocalizations during the study. Data loggers were synchronized to digital watches before the start of the study. Each night, both travel groups sampled the same sampling route, but were separated by approximately 45 minutes. We followed NAAMP guidelines for sampling (Weir and Mossman, 2005). We started the survey at least 30 minutes after dark and the route was completed no later than 1:00 am. After arriving at a site, the groups waited in silence for 90 seconds before the start of a five-minute listening period, allowing anurans to recover from potential disturbances associated with surveyor arrival. The single-observer unit was separated from the consensus-sampling unit by at least five meters and prohibited from communicating with the other observer-unit. The multiple-observer sampling unit used a consensus (i.e., majority agreement) approach to recording the anuran species heard at the wetland. We recorded all anurans detected in the target wetland. After the completion of the 5-minute listening period, we recorded air temperature using a hand held thermometer and wind speed was recorded using the Beaufort Wind Code (World Meteorological Organization, 1970).

2.3 Data Analysis. Two individuals independently reviewed data collected from acoustic data loggers using Raven Pro 1.4 bioacoustics software (Bioacoustics Research Program, 2011). Both listeners had to agree on the species that called during the five minute listening period before we compared it to the observations made in the field by the observer units. Following agreement of results, acoustic logger data were used as the reference for assessing observer error. We labeled field observations that reported a species that was not observed on the data loggers as type I errors (false positive), whereas species heard on the data loggers that were not recorded by the observer units were labeled as type II errors (false negative). For statistical analysis, we used multinomial logistic regression in the GLIMMIX procedure in SAS 9.3. Our data were coded so that the response variable included three levels that quantified the type of observer error (i.e., Type one error = 1, type 2 error = 2 and 0 = no errors were committed). We examined four models that included size and richness as predictors, error as the response, and travel group as the random effect. We used the Laplace Approximation (Raudenbush et al., 2000) to evaluate model likelihoods, and we identified top performing models using AICc model selection (Burnham and Anderson, 2002).

Results

We detected seven species throughout the course of the study: *Pseduacris nigrita, P. ornata, P. brimleyi, P. crucifer, P. ocularis, Lithobates sphenocephalus,* and *Acris crepitans*. Data logger observations from two wetlands were lost due to a technical error and thus not included in the analysis. We analyzed 66 observer unit observations. The top-performing model included species richness and observer group size as predictors. Type I error (false positive) was negatively associated with observer unit size (estimate = -1.3497 ± 0.6500; t_{54} = =2.08; Figure 2.1). We failed to detect an effect of observer group size on type II error (estimate 0.0186 ± 0.3619; t_{54} = 0.30; P = 0.7653). Species richness was positively associated with type II error (estimate = 2.2617 ± 0.6319; t_{54} = 3.58; P = 0.007; Figure 2.2). We failed to detect an effect of species richness on type I error. Richness was not associated with committing a type I error (P =0.4795, t=-0.71, SE=0.6338, DF=54; estimate=-0.4514 ± SE).

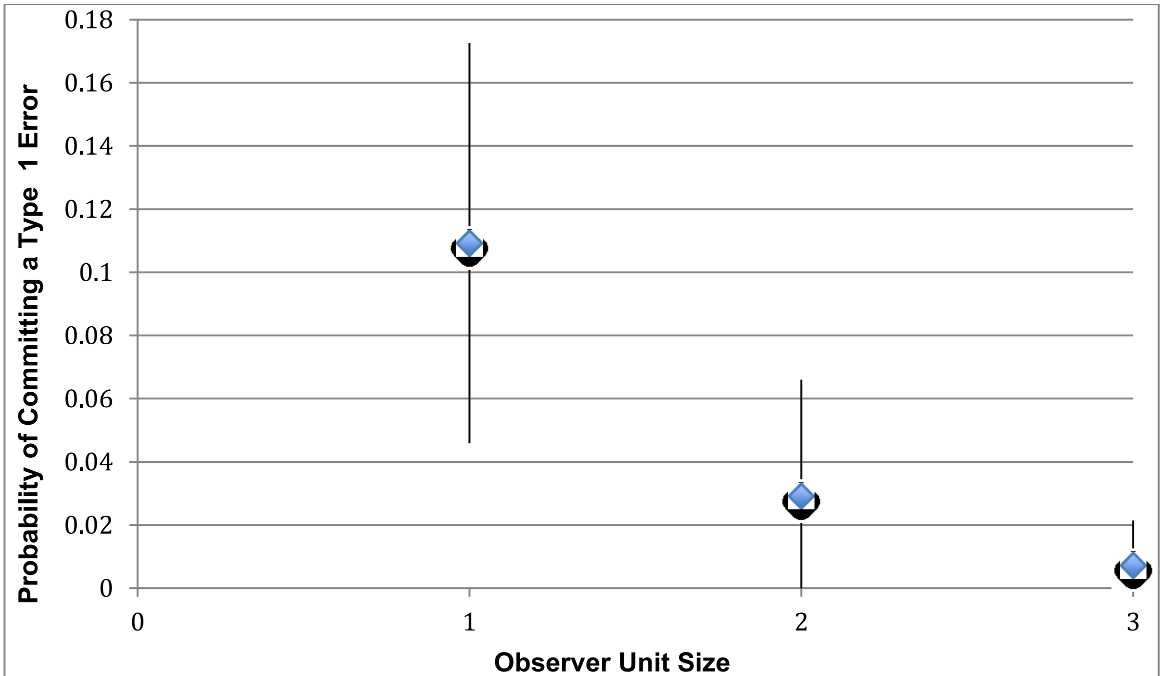

Figure 2.1: Effect of Group Size on Type 1 Error with Standard Error

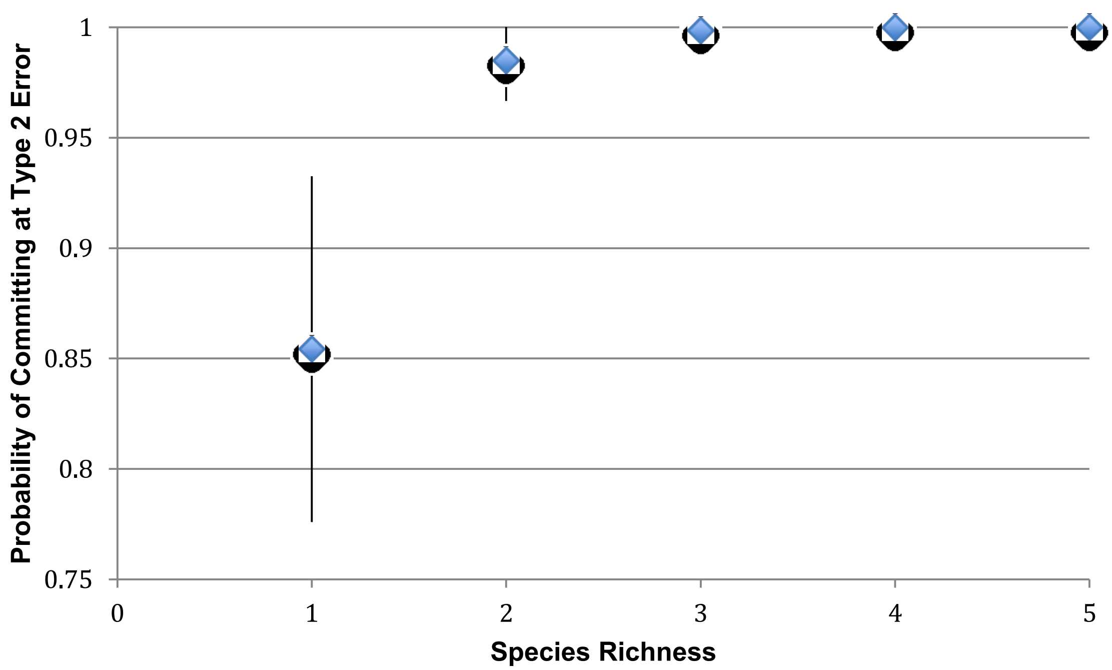

Figure 2.2: Effect of Species Richness on Type II Error with Standard Error

Discussion

The results of our study support our hypothesis that consensus sampling reduces the risk of observer error, improving the accuracy of citizen science based monitoring programs. The risk of committing a type I error (false positive) decreased as the number of observers increased (Figure 2.1). We suspect multiple-observer units yielded more accurate results because they were able to discuss questionable detections. Specifically, anurans that were not detected by every observer may have been disregarded in favor of a more conservative result. The current NAAMP protocol requires that observations are made independently of other observers (Weir and Mossman, 2005). However, we suggest that the occurrence of type I error would decrease if the protocol allowed for consensus sampling, which supports recommendations by Nichols et al., 2000, Grant et al., 2005, Lotz and Allen, 2007, who suggest that bias could be minimized by adopting two-person observation teams.

Inclusion of type I errors in a dataset can obscure anuran trends in long-term management projects (Lotz and Allen, 2007; McClintock et al., 2010). Furthermore, imperfect detection of anurans can result in biased estimates of abundance and species richness, (Tanadini and Schmidt, 2011). In the case of false positives, overestimation of species range and/or abundance can occur, leading to false conclusions about a species population status and abundance. Consequently, our results did not support an association between observer unit size and type II errors (false negative).

Our results indicated that consensus sampling did not reduce the occurrence of type II errors, which were found to be positively associated with species richness. It is possible that anuran calls are harder to detect in a multi-species chorus. Species with distinct calls such as Spring Peepers (*P. crucifer*) and Southern Chorus Frogs (*P. feriarum*) were often present in large numbers that made less conspicuous calls i.e., Brimleys Chorus Frogs (*P.brimleyi*) and Cricket Frogs (*Acris Spp*.), harder to detect. Observer experience can impact anuran detection during call surveys (Weir et al., 2005); however, we assume that observer experience had no effect on our study because all observers completed the NAAMP frog quiz prior to our study. As our study was conducted early in the breeding season we detected fewer species than past anuran studies (Burton et al., 2006; Pierce and Gutzwiller, 2007; Weir et al., 2005) .Yet, despite the limited diversity encountered, we conclude that call surveys at ponds with greater species richness are more likely to suffer from type II error regardless of the number of observers.

Citizen science based monitoring programs are beneficial as they a) allow for the data collection that would otherwise be financially unattainable and b) encourage public participation in ecological studies (Dickinson et al., 2010). However, our results indicate that consensus sampling does not reduce type II errors in ponds with high species richness. Therefore, we suggest that acoustic data loggers are the best option for sites with high species diversity as call data can be reviewed multiple times. Additionally, we recommend that citizen science based call surveys such as NAAMP are amended to include consensus sampling, as multiple observers are effective at reducing type I error.

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Animal Resource Facility

DATE:	April 30, 2013
TO:	Jayme Waldron, Ph.D.
FROM:	Marshall University IACUC
IACUC #:	538
PROJECT TITLE:	[443898-2] Evaluating the effectiveness of sampling methods for the eastern hellbender (Cryptobranchus a. alleganiensis) in the Ohio River watershed
SUBMISSION TYPE:	Revision
ACTION:	APPROVED
APPROVAL DATE:	April 30, 2013
EXPIRATION DATE:	December 1, 2013
REVIEW TYPE:	Designated Member Review

Thank you for your submission of Revision materials for this research project. The Marshall University IACUC has APPROVED your submission. All research must be conducted in accordance with this approved submission.

This submission has received Full Committee Review of original application (443898-1) and Designated Member Review of the revised application (443898-2).

Please note that any revision to previously approved materials must be approved by this committee prior to initiation. Please use the appropriate revision forms for this procedure.

Please report all NON-COMPLIANCE issues regarding this project to this committee.

This project requires Continuing Review by this office on an annual basis. Please use the appropriate renewal forms for this procedure.

If you have any questions, please contact Monica Valentovic at (304) 696-7332 or valentov@marshall.edu. Please include your project title and reference number in all correspondence with this committee.

Monica A. Valentovic, Ph.D.
Chairperson, IACUC

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Master of Science- Biological Science
Advisor: Dr. Jayme Waldron
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Bachelors of Science, *cum laude*-Biological Science
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Professional and Academic Positions:

2013: **Graduate Research Fellow:**
Department of Biological Sciences, Marshall University
Duties Included: Design and implement research project, supervise fist year graduate students in field sites, sample for aquatic amphibians using multiple detection techniques, take stream measurements, analyze data, author manuscript

2012-2014: Graduate Teaching Assistant:
Department of Biological Sciences, Marshall University.
Duties Included: Lecturing to undergraduate students on information needed for laboratory experiment, supervising experiments, grading laboratory worksheets, and tutoring students on lab and lecture material.

2011: Aquatic Biology Technician
Natural Resources Department, Cleveland Metroparks.
Duties Included: Assist in the assessment of low order streams systems using Ohio FWEPA protocol, identify amphibians, fish, and invertebrates to species, aid in removal of nuisance fish species from inland lakes, stock game fish in park lakes

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Research Experience:

2014: **Evaluating the Risk of Observer Bias in Citizen Science Surveys**
Department of Biological Science, Marshall University.
Attempted to assess the risk of observer bias and false positive detection when using the Current NAAMP (North American Amphibian Monitoring Program) frog call survey protocol.

2013-2014: **Morphological differences of *Diadophis spp.* in West Virginia**
Department of Biological Science, Marshall University.
Assisted Dr. Thomas Pauley in a corporative effort with the Pennsylvania DNA examining morphological and gonadal difference in Ringneck snakes (*Diadophis punctatus*)

2013-2014: **Evaluating the Effectiveness of Sampling Methods for the Eastern Hellbender**
Department of Biological Science, Marshall University
Identified which non-invasive sampling techniques have the highest incidence of detection for the E. hellbender (*Cryptobranchus a. alleganiensis*) in the Ohio River watershed.

2013: **South Carolina Snake Occupancy**
Department of Biological Science, Marshall University.
Assisted Dr. Jayme Waldron in her research on the Eastern Diamondback Rattlesnake (*Crotalus adamanteus*).

2009- 2010: **The Effects the Invasive Earthworm Amynthas Spp. on *Plethodon cinereus***
Department of Biological Science, Cleveland State University.
Assisted Dr. B. Michael Walton in his research identifying a potential relationship between *Plethodon cinereus* and *Amynthas Spp*

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