

Nocturnal Acoustic Monitoring of Amphibians and Birds on the
Niobrara Delta and the 59 Mile Reach of the Missouri River

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Jacob Kerby, Ph.D., University of South Dakota
Kirsten Wert, M.S. University of South Dakota

INTRODUCTION

Both the Niobrara Delta and the 59 mile reach of the Missouri River contain potential habitat for important species of several taxa, including amphibians and birds. In 2010, we received a Wildlife Action Plan grant from South Dakota Game Fish and Parks (SDGFP) to determine what wildlife species are using habitat on the Niobrara Delta. A major goal of the South Dakota Wildlife Action Plan is to monitor species of greatest conservation need so they can be better protected. The Niobrara Delta provides potential habitat for many of these species, but had so far not been surveyed for wildlife habitat use other than fish and freshwater mussels. Sites at the Niobrara delta were surveyed by various means for multiple taxa in the summer of 2010, 2011 and 2012. However, another important monitoring method involves call surveying, particularly at night. Many amphibian species frequently call nocturnally (Kiesow, A. 2006), as do several species of marsh birds (Tallman, D., Swanson, D., Palmer, J. 2002; Poole, A. Ed. 2005). Most of our Niobrara Delta survey sites were impossible to manually survey in the dark because they are only accessible by boat. Navigating in the dark on the Missouri River, especially in the Niobrara Delta, would have been too dangerous to be practical. SongMeter audio recorders solve the problem of night-time inaccessibility because they can be programmed to record through the night and deployed in the afternoon. During all three years, the National Park Service agreed to allow us the use of their two SongMeter audio recorders, and in 2011 this grant funded the purchase of three additional recorders. These additional SongMeters allowed us to record nocturnal wildlife audio data at all 15 sites on Niobrara Delta (Figure 1) in May 2011, 15 off-river marsh sites (Figure 2) in June 2011, and all 15 sites on the Niobrara Delta in May, June and July of 2012. This allowed us to gain a more complete picture of what species are

present and actively calling over the entire delta, at different time periods in the summer. In addition, the purchase of a SongScope software license for the University of South Dakota allowed us to efficiently analyze a large amount of wildlife audio data in our lab.

METHODS

Due to several constraints, it was only logistically reasonable to conduct surveys on the delta for 4-5 consecutive days in May, June and July. In 2010 we had only two SongMeters available and were only able to gather acoustic data for 6 out of 15 sampling sites each month. We changed the sites where we deployed the SongMeters each sampling week hoping to cover an adequate range of sites over the course of the summer. However, different amphibian species call during different time periods over the summer, causing possible sampling bias problems. This issue arose in 2011 as well. We could only survey the delta in May of 2011 due to extreme flooding, but decided to survey 15 off-river marsh sites northeast of Vermillion, South Dakota in June for comparison to Niobrara Delta wildlife habitat use. However this meant that we were comparing species calling in May on the Niobrara Delta to species calling in June at off-river sites. Ideally data would be gathered at every survey site during every month. Finally, in 2012 we have been able to accomplish this, however this year's data has not yet been analyzed using SongScope software. At all sites, SongMeters were programmed to begin recording at 1900 and stop recording at 0300. They were attached to stakes, deployed in the afternoon and retrieved the next day.

At one to four sites each year, SongMeters malfunctioned or did not record due to user error. User error included incorrect programming or microphones that had not been attached at

deployment. In other cases, batteries had come loose during or between deployments, preventing recording. Moisture may have been an issue for certain recorders but this has since been rectified with the use of desiccant packets inside the recorder boxes. Overall the recording success rate has been satisfactory.

Data Analysis

Audio data was analyzed with SongScope Bioacoustics software. This software allows the user to generate recognizers by annotating example calls of the species they wish to detect. Recognizers were successfully generated for two of the amphibian species regularly calling at our survey sites: Northern Leopard Frog and Boreal Chorus Frog. Recognizers are able to scan one hour of audio data in roughly one minute and can scan multiple audio files at once (Waddle et al., 2009). However, recognizers were much more difficult and took longer to develop than had been anticipated. Several sound parameters must be adjusted to obtain a filter with the right level of discrimination to accurately detect only the calls of the target species (Acevedo, 2009). This was not difficult. However, the SongScope website explains that results may vary depending on a number of factors, and we found this to be true. The number of high quality training calls needed to develop a satisfactory recognizer is not always clear. We used roughly 20 example calls per species but the number of calls needed varies in different cases. Too many example calls can be just as harmful as too few. In addition, only clear target calls that don't overlap with other sounds are viable for use as training data. The open nature of delta habitat allows wind, wave action and background noise such as local traffic to carry far enough to interfere with the target calls being used for annotations. These factors made finding quality training calls a time-intensive process, and there was much time-consuming trial and error needed to generate a recognizer with a high success rate. For bird species, SongScope

recognizers proved even more difficult to construct, therefore we have focused on amphibian species so far.

After recognizers had been developed and used to determine whether Northern Leopard Frogs and Boreal Chorus Frogs were calling at all sites, we decided to switch to manual visual scanning of audio data to ensure that amphibian species presence data was obtained for each site in a timely fashion. Calls of specific species are readily recognizable to the human eye in the SongScope spectrograph, with distinct frequency and timing signatures for different call types. The four middle hours of each 6 hour recording period were visually scanned using SongScope's spectrogram display at a rate about 10-20 times more efficient than listening alone would have been.

In order to determine whether using SongMeters and SongScope substantially improved detection of amphibian species at all of our survey sites, we compared daytime visual encounter survey data with daytime and night-time detections combined, as well as data from nocturnal audio only (Figures 3 and 4). We also compared combined day and night detection percentages directly between the May 2011 Niobrara Delta surveys and the June 2011 off-river surveys (Figure 5).

Survey sites on the Niobrara Delta were grouped by apparent time since inundation using GIS map layers from various years from the 1950's through 2010 (Table 1). This allowed us to determine whether successional age of sites had an effect on species using habitat. Daytime detection data for difference species was arranged by site age class (Figure 6), and once all recordings had been analyzed, combined 2011 daytime and nocturnal amphibian detection data from the Niobrara Delta were also arranged by site age class (Figure 7).

RESULTS

COMPLETED OBJECTIVES

- We were able to successfully collect acoustic data for birds and amphibians at 50 different sites both along the Missouri River and in off river wetland areas.
- We use SongScope software to develop South Dakota specific recognizers for several amphibian species that were used to determine species presence in a timely manner. Unfortunately, generating the recognizers took a fair amount of time and with the large diversity of bird calls, we did not spend the time developing recognizers for them.
- The species presence data generated from this work at these 50 was submitted as a Masters thesis for Kirsten Wert. This thesis has been submitted to the South Dakota Fish, Game and Parks as the final report for the Wildlife Action Plan funding supporting that work.

Synopsis

While the details of all the species detected are highlighted in the thesis, this report will focus on comparing the data gained from the nocturnal sampling as compared to our daytime visual encounter surveys for amphibians. The amphibian species we were able to detect in 2010 - 2012 with night-time audio data on the Niobrara Delta included Bullfrogs (*Lithobates catesbeiana*), Northern Leopard Frogs (*Lithobates pipiens*), Plains Leopard Frogs (*Lithobates blairi*), Woodhouse's Toads (*Anaxyrus woodhousii*), Boreal Chorus Frogs (*Pseudacris maculata*), and Northern Cricket Frogs (*Acris crepitans*). At off-river marsh sites in 2011 we detected Northern and Plains Leopard Frogs, Northern Cricket Frogs, Boreal Chorus Frogs, Woodhouse's Toads, Great Plains Toad (*Anaxyrus cognatus*) and Cope's Gray Tree Frogs (*Hyla chrysoscelis*).

Prior to receiving this funding we had only two songmeter digital recorders available which severely limited our ability to properly sample sites in a timely manner. The resulting small sample size also prevented effective comparison of daytime and nighttime detection percentages.

Upon implementation of the new songmeters, we found dramatic improvements in detection rates when combining 2011 nocturnal detections with daytime detections for several species. As expected, the combination of daytime and night-time audio data produced the highest number of sites at which species were detected, substantially improving detection rates, particularly for Great Plains Toads, Boreal Chorus Frogs and Cope's Gray Tree Frogs. Certain species were detectable from nocturnal audio data that were not detected during shorter daytime surveys at all (Figures 3 and 4). Species also differed in the percentages of sites where they were detected between the Niobrara Delta and off-river sites (Figure 5).

There was no distinct pattern between percentages of survey site age classes for different amphibian species (Figures 6 and 7). Detections of species at different site age classes fell out in proportion to what would be expected if age class did not have an effect on species presence, when taking into account the numbers of sites per age class category (Figures 6 and 7, and Table 1).

DISCUSSION/IMPLICATIONS

Comparing daytime detections alone to daytime detections combined with nocturnal audio detections clearly demonstrates that deploying Songmeter recorders at night can substantially increase amphibian species detection capability. Every amphibian species except for Bullfrogs was detected at higher percentages of survey sites when night-time data was included (Figures 3 and 4). The reason Bullfrogs were not detected at higher rates at night was

most likely that this species does not become fully reproductively active until late June and August, after our survey period, which gave us low overall detection during both survey periods (Figure 8).

Amphibian species detected on the delta are typically found in backwaters, side-channels, islands, sandbars and river banks. These habitat types have been diminished by damming and channelization and are rare elsewhere on the river, so the presence of these amphibians indicates that the delta could be serving as important habitat. Differences in species detected at the Niobrara Delta and off-river were most likely due to habitat differences. Toad species such as Woodhouse's toad and Great Plains toad prefer dryer habitats and those that include bank area, which is not common on the delta. Gray tree frogs prefer habitat with trees, which are also not very common on the Niobrara Delta. In 2011, Niobrara Delta sites were surveyed from May 16-19, while off-river marsh sites were surveyed during the first and second weeks of June. This difference in survey timing would not have been large enough to cause differences in which species were detected at the delta or off-river.

Another benefit to using SongScope software is the ability to differentiate between Northern and Plains Leopard Frog calls. These two species are often indistinguishable from each other without close visual inspection, or listening to their call, and are notoriously difficult to catch during visual encounter surveys. They are often seen for just a second or two before escaping, which means they are often left classified simply as leopard frogs during daytime surveys. Our region is part of the hybridization zone for these two species, and future studies may be able to make use of Songscope in order to determine more precisely where these species' ranges overlap. We were able to make a Northern Leopard Frog recognizer and were in the process of developing a Plains Leopard Frog recognizer with less success when we made the

decision to switch to manual visual scanning. However, Plains Leopard Frog may be the logical next priority for work on an effective species recognizer.

Song Scope is only licensable for a single computer and a single username. Before purchasing a SongScope software license for the University of South Dakota, we were attempting to develop recognizers at the Yankton National Park Service Office because they could not temporarily transfer the license to us. The unfunded travel and logistical problems associated with this had been slowing our progress. Having the software available at USD has saved a great amount of time and travel expenses. Since the software allows extremely efficient analysis of audio data, funds used to pay an undergraduate technician to run the software and analyze the data were efficiently spent. Song Scope recognizers for two species were used to search through hundreds of data to detect calls specific to those species. Although manual visual scanning for the rest of the species took longer than using recognizers, it still allowed us to analyze an order of magnitude more audio data than manual audio surveys in the field, and was far more efficient than processing the data with no means of visualizing it. If biologists at USD continue to work on developing recognizers in the future, even recognizers with high error rates can reduce workload by selecting out likely matches, allowing quick searching for a specific species. The audio data gathered could also be used in future work to determine what bird species were calling at different sites.

Developing a web page hosting recognizer data turned out to be unnecessary, as the SongScope website provided a means to do this. The recognizers developed for Northern Leopard Frog and Boreal Chorus Frog have been uploaded to the SongScope online user forum recognizer library under the SongScope Bioacoustics Software section, which is accessible to anyone with a SongScope user license. In the future, the development of additional SongScope

recognizers could expand upon current projects in our laboratory and to other survey work being done by other researchers and agencies. Funding from SDGFP was renewed for a third year of surveys on the Niobrara Delta, and we have already collected audio data on the Niobrara Delta in May and June. We will soon collect data in July as well. Comparing species presence before and after the 2011 flooding should prove illuminating.

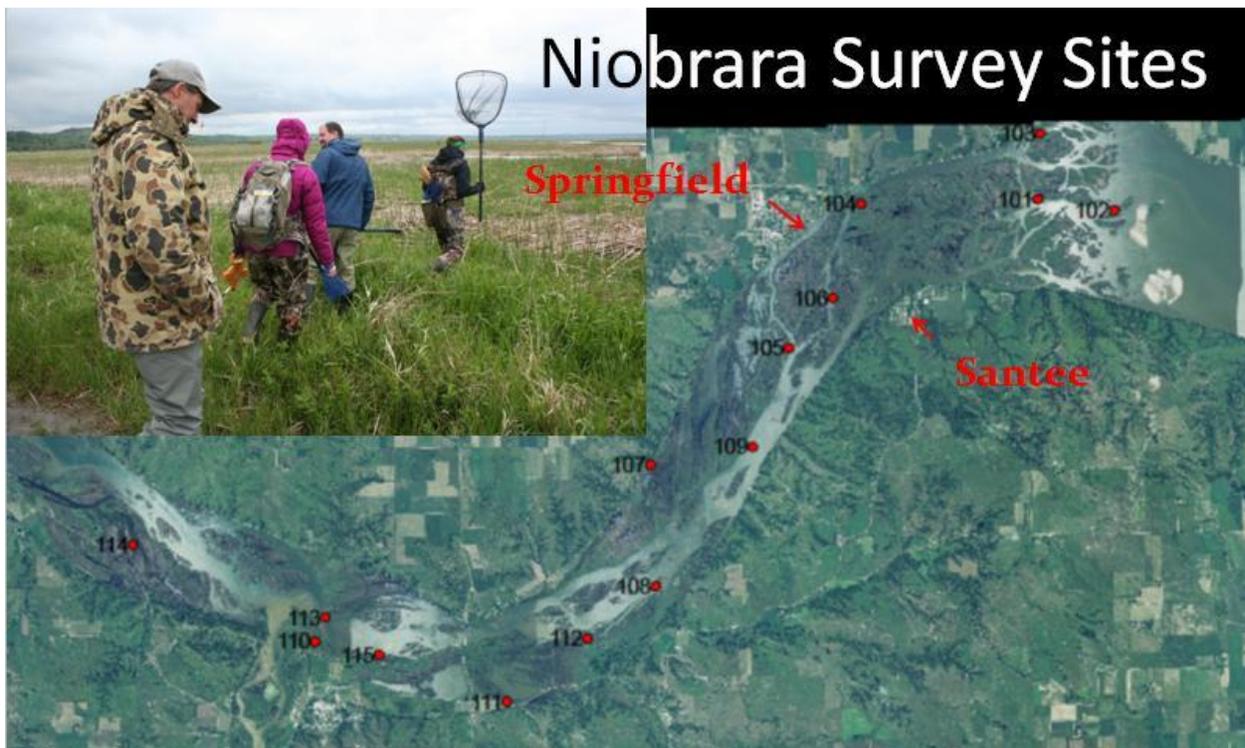


Figure 1. Niobrara Delta survey sites

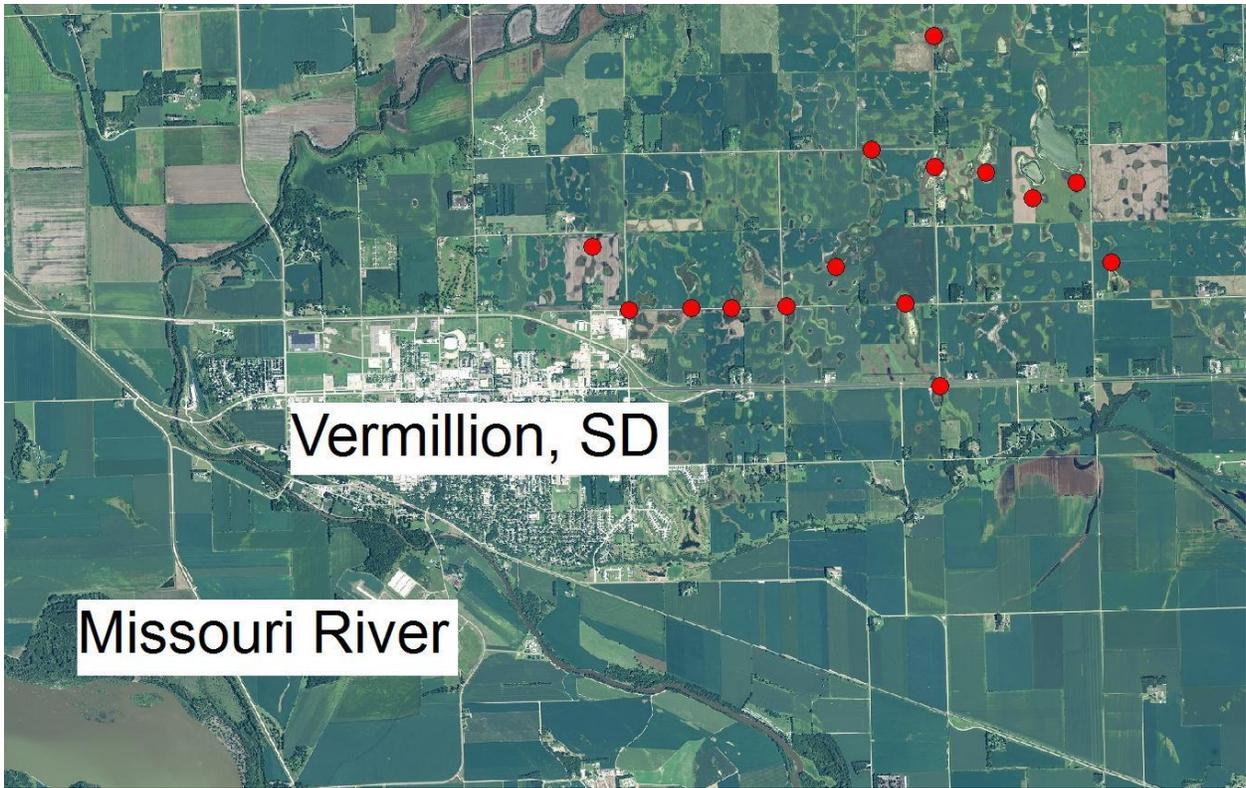


FIGURE 2. Off-river marsh survey sites

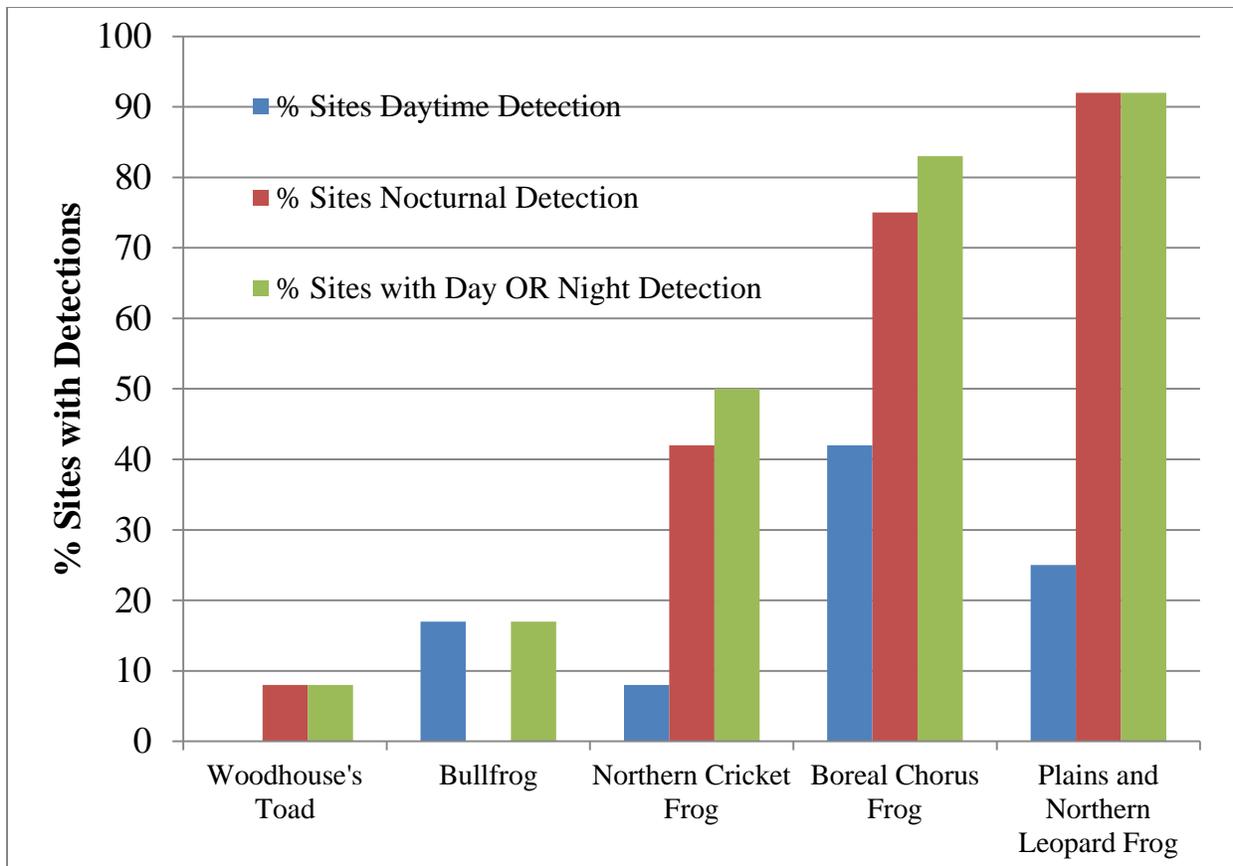


FIGURE 3. Comparing overall percentage of sites where different species were detected at Niobrara Delta sites in 2011 using daytime and night-time survey techniques

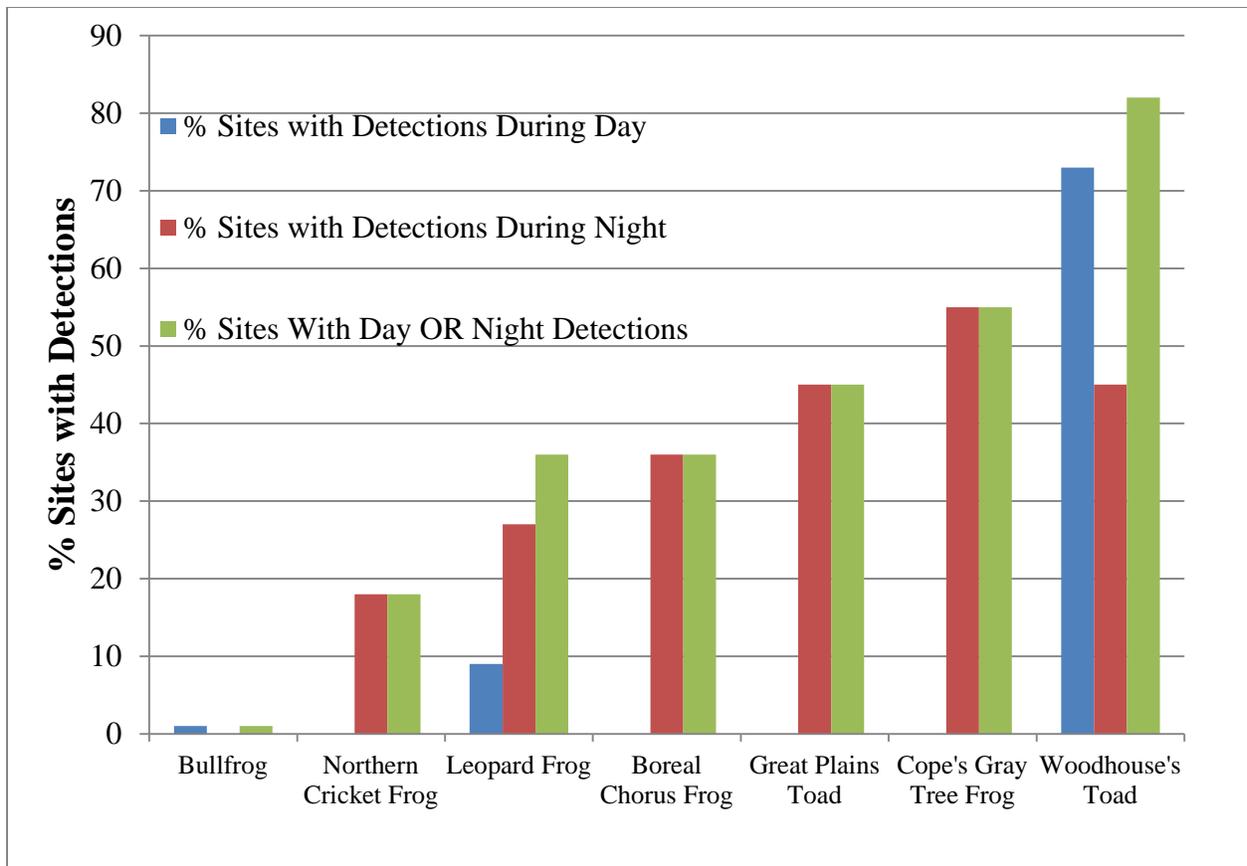


FIGURE 4. Comparing percentage of sites where different species were detected at off-river sites in 2011 using daytime and night-time survey techniques.

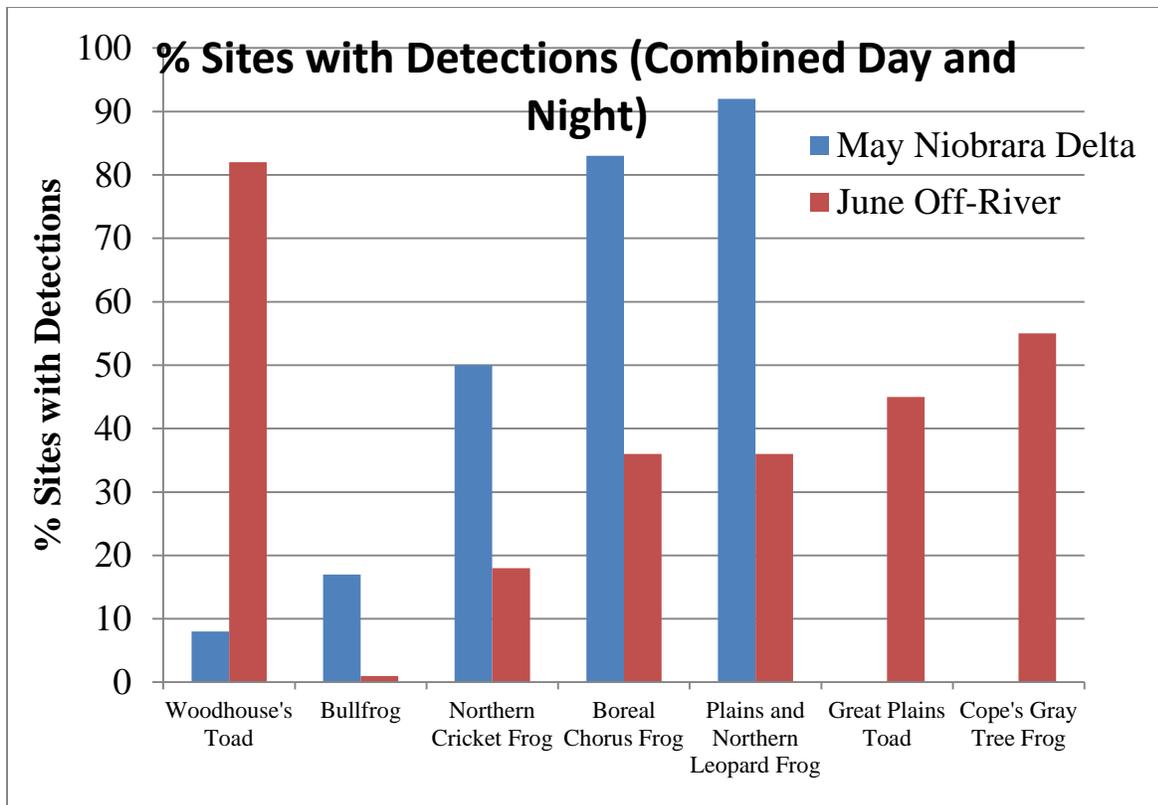


FIGURE 5. Direct comparison of percentages of sites with detections of different species between Niobrara Delta sites in May and off-river marsh sites in June 2011.

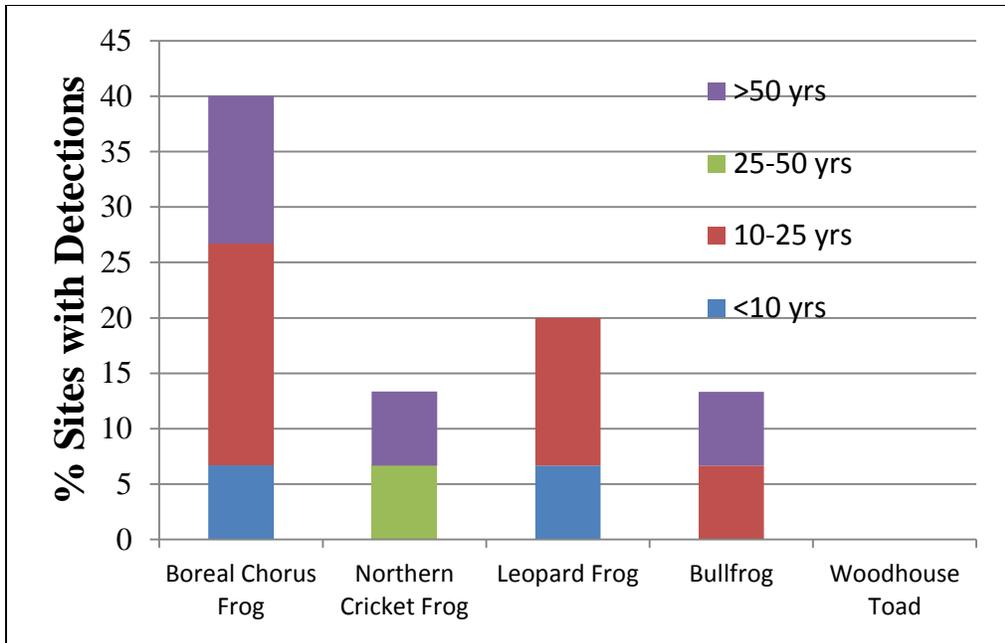


FIGURE 6. 2011 daytime Niobrara Delta amphibian species detection data.

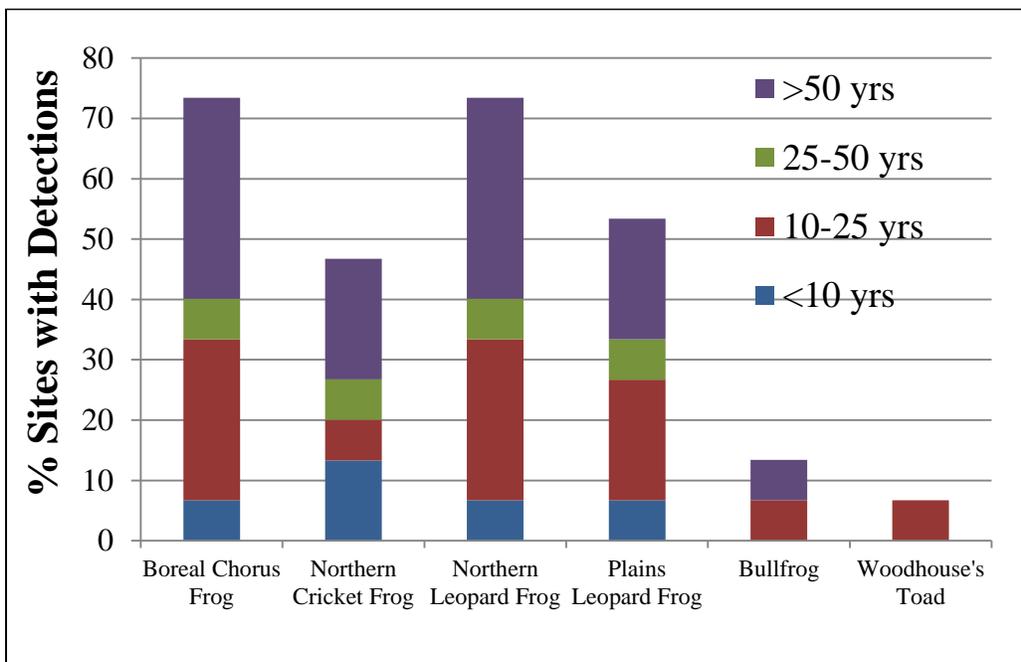


FIGURE 7. 2011 combined nocturnal and daytime Niobrara Delta amphibian species detection data.

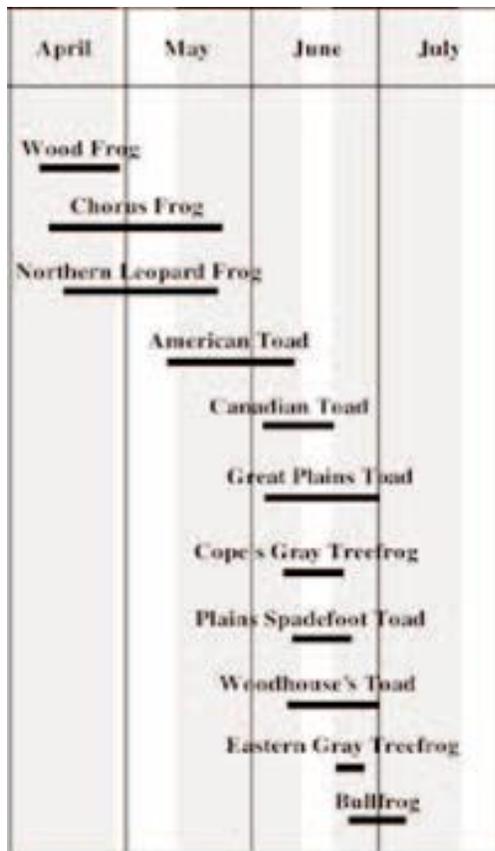


FIGURE 8. Amphibian species call timing chart (Fisher *et. al.* 1999).

TABLE 1

Age Class	Sites
<10 yrs	108, 109
10-25 yrs	101, 102, 103, 106
25-50 yrs	104, 110, 115
>50 yrs	105, 107, 111, 112, 113, 114

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