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Understanding wetland responses to climate change in the Greater Yellowstone Area

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Abstract Wetlands in the Greater Yellowstone Area (GYA) support a high diversity of species. Increased temperatures associated with climate change are related to increased wetland drying in the GYA, potentially affecting the species using wetlands. The National Park Service Greater Yellowstone Inventory and Monitoring Network (GRYN) started monitoring wetlands in 2006, focusing on amphibian occupancy. Adding novel surveillance techniques to GRYN's existing, long-term monitoring program offers an opportunity to observe more species. This may help us better understand how wetland species diversity may be affected by climate change and provide additional information to managers. In 2017, I outfitted four permanent wetlands with equipment collecting photographs, acoustic recordings, and ultrasonic recordings for approximately five days in June/July. When the equipment was deployed, I collected environmental DNA (eDNA) samples. Data from wildlife cameras, acoustic recorders, ultrasonic recorders, and eDNA for cataloging the biological diversity of wetlands is still being analyzed. Acoustic data and eDNA samples require additional processing; however, preliminary data is available for photographic data and ultrasonic data. Cameras detected elk at all sites, whereas bat detection varied by site.

Introduction

Across Grand Teton and Yellowstone National Parks, depressional wetlands are poorly studied (Gould et al., 2012). Freshwater wetlands support a disproportionately high number of species relative to other ecosystems (Consolo-Murphy and Murphy, 1999; Dudgeon et al., 2006). Nearly 70% of Wyoming bird species (Nicholoff, 2003), all native amphibians in the region, and more than 40% of all plant species in Yellowstone are associated with wetlands (Elliott and Hektner, 2000). Yet, wetlands are affected by climate change (Matthews, 2010; Lee et al., 2015) because increasing temperatures and decreasing precipitation can lead to wetland drying (Burkett and Kusler, 2000; Brooks, 2004). It is estimated that over 40% of the isolated wetlands in the Greater Yellowstone Area (GYA) are dry when temperatures are higher than average and precipitation is reduced (Ray et al., 2015). Several years of drought have been associated with extensive wetland drying in the GYA (McMenamin et al., 2008; Ray et al., 2014; Schook and Cooper, 2014). This drying may affect the species associated with wetlands by altering abundance, distribution, and phenology (Quesnelle et al., 2013).

Current long-term monitoring of wetlands across the GYA has been focused on amphibian occupancy. The Greater Yellowstone Inventory and Monitoring Network (GRYN) completes amphibian surveys in 32 catchments across Yellowstone and Grand Teton national parks. To better understand how other species may be affected by accelerated drying, I added emerging technologies to the GRYN long-term monitoring effort. Specifically, I deployed wildlife cameras, acoustic recorders, ultrasonic recorders, and I collected eDNA samples at a subset of wetlands in the monitoring program.

Remotely-triggered wildlife cameras can document medium to large terrestrial mammals and birds that use Grand Teton NP wetlands. In brief, camera traps can be left unaided for multiple days, deployed at multiple locations simultaneously, and can record shy or suspicious animals that are otherwise difficult to detect. Acoustic and ultrasonic monitoring can be used to summarize animal diversity (e.g., bird and bat vocalizations as a proxy for bird and bat diversity). Environmental DNA (eDNA) monitoring enables efficient detection and quantification of organisms based on DNA present and collected in water samples. This novel approach supports documentation of rare or elusive taxonomic groups in addition to common species.

The initial phase of this project is focused on the utility of these methods; ultimately I hope to use these tools to examine patterns of biodiversity in wetlands. Specifically, how wetland hydroperiod (permanence) and isolation relate to species richness and community composition in the GYA.

Methods

One site in Grand Teton National Park was selected to pilot the use of wildlife cameras, and acoustic and ultrasonic monitoring equipment in the summer of 2016. Ultrasonic and photographic data expanded the surveyed species from four amphibians to roughly fifteen species across a range of taxanomic groups. Additionally, use of the equipment allowed us to survey a larger time frame (i.e. current methods only allow one hour of activity per year to be surveyed where the pilot effort allowed us to survey twenty-four hours of activity for four weeks).

In 2017, I expanded on the pilot effort by adding Stealth Cam PX18CMO trail cameras and Wildlife Acoustics SM3BAT recorders to four sites in Grand Teton National Park. SM2 acoustic recorders were added to eight additional wetlands, these data will be processed in 2018. All twelve wetlands represent a gradient of hydroperiod (permanence) and isolation. Wetlands representing four categories 1) permanent, isolated, 2) permanent, non-isolated, 3) seasonal, isolated, 4) seasonal, non-isolated were surveyed in 2017. For this report, I will focus on the four wetlands that received all technologies mentioned above. The four wetlands represent permanent wetlands across an isolation gradient. All permanent wetlands were randomly selected from GRYN long-term monitoring sites. Isolation was determined by the distance to nearest neighbor calculated from GRYN long-term monitoring data. Straight line distances were calculated from the center of the site to the center of all neighboring sites. Wetlands in this study are considered isolated if the distance to the nearest neighbor is greater than the median distance to nearest neighbor for all twelve sites and non-isolated if the distance was less than the median.

At each site, the deployment location was selected to minimize sound interference with nearby vegetation and maximize the amount of the site visible to the wildlife camera. A rebar was placed fifteen centimeters into the ground leaving fifteen centimeters above ground. An approximately two meter long aluminum conduit was placed on the rebar. One wildlife acoustic ultrasonic microphone was placed at the top of the conduit (approximately two meters high). One wildlife acoustics audible microphone was placed one meter above the ground. A wildlife camera was placed below the audible microphone and secured with tape. The SM3BAT units were set to record in audible range thirty minutes before sunrise until thirty minutes after sunset. Then, the units switched to ultrasonic recordings in the evening. Frequencies were set to capture species in Grand Teton National Park. These recordings were processed using Sonobat 4.1 with Western Wyoming classifiers.

Methods for analyzing the relationship between wetland hydroperiod and isolation to species richness are still in development at the time of writing this report.

Preliminary Results

Acoustic recordings and eDNA samples will be processed in early 2018. Cameras detected the following

Site	Dates	Myyu	Myca	Myci	Myvo	Mylu	Myev	Anpa	Epfu	Lano	Laci
3726	6/22/17-6/29/17	0	0	0	0	38	2	0	8	15	24
4783	6/23/17-6/26/17	3	0	0	3	107	7	1	13*	65*	38
3504	7/1/17-7/7/17	3	22	26	24	2931	116	1	8*	105*	4
4817	7/1/17-7/5/17	0	0	0	0	12	1	0	0	0	0

* Further identification is needed to distinguish *Lasionycteris noctivagans* from *Eptesicus fuscus*

Table 1. Preliminary results from Sonobat 4.1 with Western WY classifiers show the number of each species counted during the sampling period. Myyu = *Myotis yumanensis*, Myca = *Myotis californicus*, Myci = *Myotis ciliolabrum*, Myvo = *Myotis volans*, Mylu = *Myotis lucifugus*, Myev = *Myotis evotis*, Anpa = *Antrozous pallidus*, Epfu = *Eptesicus fuscus*, Lano = *Lasionycteris noctivagans*, Laci = *Lasiurus cinereus*

species at each wetland site: site 4783 (non-isolated) two elk and one Sandhill crane, site 3726 (isolated) one elk, site 3504 (isolated) one elk, site 4817 (non-isolated) three elk. Bat species detected are represented in Table 1.

Conclusions

Preliminary data is still being processed and analyzed for the 2017 field effort. Conclusions will depend on the full analysis of the data; however, the available information helps us assess the use of these novel technologies. Currently, GRYN is able to monitor four species with the use of amphibian visual surveys alone. Ultrasonic recorders allowed us to survey ten additional species with roughly the same field effort. Two additional species were captured by the wildlife cameras. Automated equipment did not seriously impact the field effort necessary to complete amphibian visual surveys and has the potential to greatly improve survey efforts. However, processing time increased with the automated equipment. Both of these methods require a large amount of processing after returning from the field. Also, the cost of processing eDNA samples and acoustic recordings may be prohibitive. Because I am still in the processing phase for both of these methods (e.g. subsampling acoustic recordings, generating spectrograms, extracting DNA, etc.), I am as yet unable to make any conclusions about the utility of these methods for this study.

Future Work

Data collected in 2017 needs to be further analyzed. Next generation sequencing (NGS) techniques will be used to document all organisms detected in the eDNA samples using a DNA barcoding approach. Acoustic recordings will likely be processed using available software. I plan to compare the benefits and challenges of the different surveillance tools by assessing the time investment of each method with the species detected. Additional comparisons will be made based on comments from GRYN staff.

This project will continue in 2018 with a larger set of wetlands. Work will again be completed in watersheds in Grand Teton NP where long-term monitoring has been conducted for over a decade by GRYN and the Northern Rockies Conservation Cooperative. Wetlands spanning a hydrologic gradient of permanent to seasonal and isolation gradient will be studied. I will survey biodiversity at theses wetlands using methods discussed here. I will compare the species richness (number of species surveyed) across wetland types to see if there is a pattern associated with wetland drying and species diversity. I will also compare community composition to see if species sort along these wetland gradients by a number of species traits (e.g., mobility).

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