FACTORS AFFECTING DISTRIBUTION AND DETECTION OF BOREAL CHORUS FROGS (*Pseudacris maculata)* AND WOOD FROGS (*Rana sylvatica)* AT CAPE CHURCHILL, MANITOBA

2006 Summary Report

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Abstract: In 2006, we repeatedly surveyed 57 potential anuran breeding locations in the tundra biome within Wapusk National Park, Manitoba, Canada. We examined habitat selection and associations of the wood frog (*Rana sylvatica*) and the boreal chorus frog (*Pseudacris maculata*) with regard to vegetation, water quality, and patches of vegetation affected by goose herbivory. We also examined plausible methods for surveying anurans in the tundra environment. Both the wood frog and the boreal chorus frog selected for sites where vegetation was taller and had a higher composition of sedge and willow. Both species also selected for sites with a lower pH. The wood frog and the boreal chorus frog also were found more commonly in sites with no goose herbivory.

Introduction

Amphibian populations are declining globally (Jennings and Hayes 1985, Beebee et al. 1990, Blaustein and Wake 1990). Disease, introduced predators, ultraviolet radiation, pollution, environmental change, and habitat loss and degradation have been suggested factors responsible for amphibian population declines (Jennings and Hayes 1985, Beebee et al. 1990, Laurance et al. 1996, Pounds et al. 2006). However, the relative importance of each potential factor is often unknown in specific cases. Because the processes that underlie amphibian declines are not well understood, collaborative efforts, such as the North American Amphibian Monitoring Program (NAAMP), have been developed to collect basic ecological data, and to systematically monitor amphibian population trends. Despite efforts such as the NAAMP, there are still many areas where amphibian surveys have not been conducted and little is known about local populations.

There are two species of anurans that inhabit the tundra region of Cape Churchill, Manitoba, the boreal chorus frog (*Pseudacris maculata)* and the wood frog (*Rana sylvatica)* (Andersen et al. 2005). These two species have large ranges that extend into the eastern portion of the United Stated and Canada and are generally associated with forested habitats (Conat and Collins 1991). However, in the tundra region of Cape Churchill, Manitoba, these two species breed over 5 km from the nearest forested area.

Currently, little published information exists regarding these two species in such an environment.

Tundra environments at Cape Churchill and elsewhere are experiencing changes resulting from both biological and physical factors. Among the changes is widespread habitat alteration from foraging by increasing numbers of mid-continent light geese [snow geese *(Chen caerulescens)* and Ross' geese (*Chen rossii*), e.g., Batt 1997, Jefferies and Rockwell 2002]. As goose populations continue to grow and the extent of vegetation change increases, the potential for impacts on other species and their habitat also increases. Global climate change, which has especially strong effects in cold climates (e.g., Flato and Boer 2001), is also a concern. Understanding habitat associations of anurans in tundra environments, and how their populations change with respect to changes in vegetation may indicate which habitat characteristics are most important and thus inform future management decisions.

We began anuran surveys at Cape Churchill during the summer of 2006 to: (1) evaluate associations between anuran occurrence and water body type, vegetative structure, and environmental conditions [pH, Total Dissolved Solids (TDS), and temperature], (2) evaluate the abundance of boreal chorus frogs and wood frogs within vegetation patches affected by lesser snow geese (*C.c. caerulescens*) and Ross' geese, (3) assess factors influencing anuran detections diurnally and across the breeding season, and (4) evaluate plausible methods for surveying anurans, including manual audile surveys, automated call recorders, and broadcasting breeding calls during surveys.

Methods

We collected data within a 12.6 km^2 study area in the tundra region of Cape Churchill, Manitoba. The circular study area began at the coast of the Hudson Bay and had a diameter of 4 km that extended inland. The study area encompassed a matrix of small upland ridges and lowland, sedge-dominated marshes. There was a mix of semi-permanent and permanent water bodies throughout. Vegetation surrounding the water bodies was mostly sedges with willows on the banks of the more permanent water bodies. Permafrost occurred near the substrate surface, rendering most water bodies very shallow. The study area size and location were selected to be representative of all regionally available habitats. Churchill, the nearest town, experiences winter temperatures as low as -50 C with an average of -26 C. Summer temperatures range from -10 to 35 C.

Within the study area we randomly chose 57 potential anuran breeding locations, which we identified as a water body deeper than 10 cm that contained or obviously once contained vegetation. At each breeding location, we conducted 4 broadcast surveys between 30 May and 18 June. During each survey we randomly selected to broadcast 1 minute of either of the 2 anuran species, or not to broadcast any call. We recorded any anuran detections for 3 minutes before and after the broadcasting of anuran mating calls and weather and water conditions. We broadcasted anuran calls rotating a megaphone in a 360 ^{0} circle. We obtained the prerecorded anuran calls from the U.S. Geological Survey Amphibian Research and Monitoring Initiative [ARMI; U.S.G.S. Upper Midwest Environmental Science Center webpage (http://www.umesc.usgs.gov)]. Mating calls of wood frogs and the boreal chorus frogs were broadcast at an average of 67 and 78 dB and ranged from 64-71 and 71-80 dB, respectively. We used survey data to assess the local abundance of anurans.

We classified each potential breeding location according to vegetation present, water body type, and an index of goose foraging. At each randomly selected potential breeding location, we categorized the water body type as pond, sedge meadow, or open lake. We also visually noted and recorded all vegetation present. Within each site, we used a local coordinate system and a grid that encompassed the entire body of water and shoreline to identify random sample locations. We excluded large areas of open water from the grid (e.g., the center of a lake). At each sample location we dropped a 1 x 1 m quadrant at our feet and took a digital photo. Within the quadrant, we measured pH, water temperature, total dissolved solids (TDS), water depths at 2 diagonal corners of the quadrant, vegetation height at the 4 corners of the quadrant, and the tallest vegetation within the quadrant. We calculated for each breeding site an average pH, TDS, vegetation height, and tallest vegetation.

We estimated vegetation composition from the digital photos taken of all quadrants by placing a grid on each photo with 100 points of intersection. We identified every piece of vegetation under each intersection and recorded the number of times species occurred in each quadrant. We used these counts to estimate vegetation composition by percent cover.

When we detected anurans within 75 m of our potential breeding location, we attempted to triangulate their position using 2 observers, and used the quadrant method described above to measure vegetative composition, height of tallest vegetation, and average vegetation height at the anuran detection location. If we detected an anuran at a water body separate from the surveyed water body, we classified the water body in which the anuran was detected as discussed above, and repeated the quadrant sampling method at a random sample location within that body of water. We used these data to examine breeding site associations and within-site (hereafter, micro-site) habitat selection. We used 2-sample *t*-tests to compare characteristics between detection sites and non-detection sites, and characteristics between sites where both species of anurans were detected and sites where only boreal chorus frogs were detected. We also used *t*-tests to compare percent sedge and willow, tallest vegetation, and average vegetation height at each detection site within each breeding location to vegetation at randomly selected sites at each breeding location.

At each potential breeding location we recorded evidence of goose herbivory. When geese forage on tundra vegetation they often leave detectable evidence of their foraging (D.E. Andersen, personal communication). We used evidence of 2 different foraging habits to quantify the amount of foraging present in anuran breeding locations. Shoot pulling was evidenced by the presence of uprooted sedges with the base of the vegetation removed. This is caused when geese uproot the vegetation, eat the basal tissue, and leave the rest of the plant. Shoot pulling was segregated into 2 groups, recent and past shoot pulling, based on assessing the color and condition of the uprooted vegetation. We classified uprooted green vegetation as shoot pulling that occurred in 2006, whereas we classified brown, dry vegetation as past shoot pulling. We similarly assessed grubbing in the substrate, characterized by overturned small chunks of substrate, about the size of a goose bill. We visually surveyed all sampled anuran breeding locations for evidence of these 2 types of foraging. We used these data to examine any possible affect goose herbivory may have on local anuran breeding site selection. We used Fisher's Exact Test to determine if the number of sites with anuran detections and no evidence of goose herbivory was different from the number of sites with no anuran detections and no evidence of herbivory.

We placed 11 automated recorders at selected locations to evaluate patterns of anuran calling temporally and in response to weather conditions. We positioned automated recorders no closer than 200 m to each other at water bodies known to contain anurans. The recorders were programmed to record ambient sounds, including calling anurans, for 3 minutes before and after anuran call broadcasts. The broadcasts were the same ones used in the call broadcast surveys and recorders were programmed to record and broadcast at 1.5-hour intervals. Due to technical difficulties associated with battery function, most of the recorders failed. The technical difficulties are currently being remedied and all recorders will be ready for next season. Although the automated function of the recorders failed, we were able to manually turn on the recorder portion of the recorders and conduct simultaneous automated and manual surveys. We used these data and the number of detections before and after broadcast surveys to evaluate plausible methods for surveying anurans, including manual audile surveys, automated call recorders, and broadcasting breeding calls during surveys. We also evaluated associations between anuran calling and weather conditions. We assigned a one (call detected) or a zero (no call detected) to each survey from sites where ≥ 1 anuran was detected during any of the surveys from the potential breeding locations. We then used multiple linear regression to determine if any single or a combination of all weather conditions explained variation in either species' calling patterns.

Preliminary Results and Discussion

We surveyed 57 potential breeding locations 4 times. However, during the last round of surveys, 11 sites contained no standing water. We used only data from the first 3 surveys because drying of water bodies may have encouraged anuran movement from or between water bodies and for many of our analyses we assume no movements to or from surveyed sites. Therefore, the following results are based on 57 sites surveyed 3 times. Eighteen of the 57 breeding sites we surveyed contained wood frogs and 7 contained boreal chorus frogs; wood frogs were present at all sites where boreal chorus frogs were detected.

We used vegetation and detection data to determine habitat associations of wood frogs and boreal chorus frogs and the relationships between patches of vegetation affected by goose herbivory and use by both species of anurans. In the 57 sites surveyed, we identified 3 species of willow or their hybrids (*Salix planifolia, S. herbacea* and *S. brachycarpa*), 3 species of sedge (*Carex aquatilis*, *C. rupestris*, and *C. glacialis*), purple mountain saxifrage (*Saxifraga oppositifolia*), Lapland rosebay (*Rhododendron lapponicum*), a species of wintergreen (*Pyrola grandiflora*), and detected several species of mosses (Johnson 1987). We classified sites into groups according to what type of vegetation dominated the water body. We identified 4 major groups of vegetation; (1) sedge, which contained all *Carex*, (2) sedge and willow, which contained a mix of *Carex* and *Salix,* (3) peat or moss flats, which contained mostly peat or moss, and (4) upland, which contained *C. glacialis* and all other vegetation types.

Vegetation at sites where we detected wood frogs tended to be taller and have a higher composition of sedge and willow than sites where they were not detected; pH tended to be lower (Table 1). We detected similar patterns for sites where we found boreal chorus frogs (Table 1). We found no differences between sites where we found wood frogs and boreal chorus frogs and sites where we only found boreal chorus frogs (Table 1).

Table 1. Differences in environmental features and vegetation between detection locations and non-detection locations for wood frog and boreal chorus frog, Cape Churchill, Manitoba, 2005.

Variable	Wood Frog	Boreal Chorus Frog Average	Non-detection Average
Percent Composition of Sedge and Willow	64*	72*	47
pH	7.9 *	7.8*	8.2
TDS (Total Dissolved Solids)	175.3	155.5	231.7
Tallest Vegetation (cm)	30.4*	32.9*	21.5
Average Vegetation Height (cm)	8.7*	6.2*	2.8

* indicates values are significantly different from values of non-detection sites at the 0.05 alpha level; *t*-tests. # indicates values are significantly different between species at the 0.05 alpha level; *t*-tests.

We were able to collect micro-site selection data at 8 sites for wood frogs and 6 sites for boreal chorus frogs. We detected no statistical difference between detection locations and random sites for any variables (wood frog: average vegetation height; t = 0.828, P>0.25, tallest vegetation; t =1.471, P> 0.15 percent sedge and willow; t = 1.138, P>0.25; boreal chorus frog: average vegetation height; t =1.229 P>0.20, tallest vegetation; t =1.167, P> 0.20 percent sedge and willow; t = 1.389, P>0.15).

We categorized the 57 potential anuran breeding locations according to our index of goose herbiory and calculated the percent of the total of each category (Table 2). At 39% percent of the sites where we detected wood frogs, we also detected boreal chorus frogs.

Table 2. Percent of potential anuran breeding sites occupied by wood frog and boreal chorus frog, and percent of sites that contained evidence of foraging by geese, Cape Churchill, Manitoba, 2006.

Classification	Percent of Total Sites	Percent of Sites Occupied by Wood Frog	Percent of Sites Occupied by Boreal Chorus Frog
Signs of Herbivory	77	61	43
New Shoot Pulling	63	56	29
Old Shoot Pulling	58	33	29
Grubbing	23	17	0
Sites With >1 Sign of Herbivory	53	33	14
No Signs of Herbivory	23	39	57

We found a significant difference between number of sites with anuran detections and evidence of goose herbivory and the number of sites with no anuran detections and evidence of herbivory (Fisher's Exact Test, $P > 0.0375$) (Table 3).

Table 3. Number of sites with and without anuran detections that contained evidence of foraging geese, Cape Churchill, Manitoba, 2006.

	Evidence of Geese Foraging	No Evidence of Geese Foraging
Anuran detections	11	7
No Anuran Detections	39	6

We assessed if weather conditions (e.g., wind, air temperature, humidity, and cloud cover) were related to calling patterns of either wood frogs or boreal chorus frogs. No weather variables explained a significant amount of calling pattern variation of either species at the 0.05 alpha level. (The wood frog model containing all variables; $R^2 = 0.032$, $P = 0.749$; the boreal chorus frog model containing all variables; $R^2 = 0.132$, $P = 0.515$)

We broadcasted mating calls of each species during each survey in an attempt to investigate the effectiveness of soliciting anuran responses. We conducted 75 surveys with a randomly selected broadcast treatment at sites where there was ≥1 anuran detection over the course of the 3 surveys. The effectiveness of the broadcast calls is being analyzed.

We will use data from the automated recorders combined with information on weather conditions to identify optimum weather conditions in which to conducts surveys. We also will compare the results obtained from the recorders and the simultaneously conducted manual surveys to assess the effectiveness of an automated recording device in the tundra environment. We were able to conduct 45 of the manual /automated surveys at 5 locations in 2006. These data are being analyzed.

Our preliminary analyses indicated that pH, vegetative composition, and average vegetation height were potentially relevant to anuran breeding site selection in Wapusk National Park. Both wood frogs and boreal chorus frogs appeared to be associated with a relatively high percent coverage of willow and sedge, tall vegetation, and high average vegetation height. Both species also were associated with pH values below 8.

The most immediate foreseeable potential threat to wood frogs and boreal chorus frogs in tundra landscapes in Wapusk National Park and elsewhere may be the loss and alteration of habitat resulting from goose foraging. Unfortunately, due to a small sample size we were unable to differentiate between the 2 species when we examined anuran site selection with regard to goose herbivory. However, our preliminary results indicated that when both species of anurans are combined, they selected against areas with evidence of goose foraging. Prolonged and heavy grazing by geese in single areas can significantly alter the structure and composition of the vegetative community (Jefferies and Rockwell 2002). Jefferies and Rockwell (2002) demonstrated that prolonged and heavy grazing by geese in salt marshes increased the percent bare sediment exposed, and altered the structure of the vegetative community. Our analysis indicated that both species of anurans in Wapusk National Park were associated with breeding sites that exhibited a specific vegetative structure and higher average vegetation height. Foraging by geese that alters vegetation structure and composition may negatively impact tundra anuran communities.

2007 Field Season Considerations

In 2007, we plan to increase sample sizes, which will increase resolution of our analyses. Specifically, we hope to gather information on more breeding sites, and create a habitat model for both species of anurans with program PRESENCE (MacKenzie 2002). Locating more breeding sites will involve possibly increasing the size of the study area and additional searching to gather information outside of the survey area. We also are remedying the technical difficulties we had with automated recorders. The recorders were designed to run on solar panels with a back-up battery pack. The solar panels we used were too small and larger ones will be employed next year.

There is also new technology that allows attachment of radio transmitters to wood frogs, which was previously untenable because of their small size. This technology was not available last year and could not be implemented into the study design. If we are able to acquire funds to purchase transmitters, it would be possible to radio track a small sample of wood frogs to their wintering location. Characteristics of wintering habitat of wood frogs are not well known even in more temperate portions of their breeding range. There are currently no data regarding the wintering habitat of wood frogs in a tundra environment.

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