# Report for 2004MT27B: Amphibian habitat distribution and the population structure of Columbia spotted frogs, Rana luteiventris, in western Montana watersheds

- Other Publications:
  - Project was extended. Publications forthcoming.

Report Follows

## Abstract

Wetlands are known for their valuable role in providing flood and erosion control, enhancing water quality and providing wildlife and fish habitat. Given the rate of loss and degradation of wetlands, it is important for us to understand the role that these systems play in the functioning of biotic communities. Given the large magnitude of wetland loss across Montana and the importance of wetland ecosystems to biota, it is not surprising that 60% of the threatened and endangered species in the state rely on wetlands to meet all or part of their seasonal needs (Montana Natural Resource Conservation 2001). Amphibian populations are one such species that are dependent upon small lentic habitat such as wetlands. One-third of all amphibian species in Montana are listed as species of special concern by the Montana National Heritage Foundation and Montana Department of Fish, Wildlife, and Parks. It is likely that changes in the availability of lentic habitat at the landscape and watershed scales are important to Montana's amphibian species. Historic loss of habitat has been demonstrated to have impacts on amphibian populations and communities in other systems. We are examining a large database of watersheds in western Montana to examine the quantity and distribution of amphibian habitat across western Montana. In addition, we are examining the genetic structure of amphibian populations within several watersheds to determine whether amphibians are functioning as panmictic populations, metapopulations, or isolated populations. An understanding of both the quantity and distribution of critical amphibian habitat as well as the functioning of these populations at the watershed and landscape scales are needed for the development of conservation and management plans.

## Introduction

Over the past decade amphibians have been the focus of increasing concern because of potential population declines. Although amphibian populations naturally undergo wide fluctuations in number (e.g., Pechmann et al. 1991) and there are many factors that are negatively affecting amphibian populations; habitat loss and fragmentation are often cited as key factors in imperiled amphibian populations (e.g., Blaustein et al. 1994). Although the question of whether current land use practices have been a major factor behind current losses is equivocal, impacts from the historic loss of habitat through both changing land use and management activities have been demonstrated (Hecnar and M'Closkey 1996, Knapp and Matthews 2000). Loss of amphibian diversity in temperate regions of North America have been tied to the historic draining of wetlands and clearing of forests (Hecnar and M'Closkey 1996), while the introduction of non-native fish in historically fishless lakes led to population declines of the mountain yellow-legged frog (Knapp and Matthews 2000).

Historically much of the lentic habitat in North America was created by beaver activity. More than 70% of the original riparian areas in the continental U.S. have been substantially altered by either removal of beaver or human developments (Megahan and King 1985). These areas play an important role in maintaining biodiversity; riparian areas occupy 1% of North America's landscapes but host 80% of our threatened and endangered species. Their role may be critical in the intermountain west, where alterations to the hydrology and nutrient flow of subalpine and mid-elevation valleys by beaver have been shown to be important for maintaining the characteristics of aquatic and riparian systems (e.g., Dahm and Sedell 1986). For many species of lentic breeding amphibians, beaver wetlands act as overwintering and breeding

habitat. Disruption of the temporal and spatial distribution of these critical habitats may fragment amphibian populations.

Although the changes in aquatic habitat on aquatic fauna have been examined in terms of species diversity, no one has examined how these changes alter the functioning of the populations. One group of organisms that historically may have relied heavily on beaver-created habitat is amphibians. Habitat destruction and fragmentation is thought to be one of the leading causes behind the current rash of amphibian extinctions (Blaustein et al. 1994). Beaver created wetlands (or more recently human stock ponds) and could be a major source of water bodies between the valley bottom and high elevation ponds in several regions in western Montana (Maxwell pers. comm.).

Although amphibians are frequently characterized as having limited dispersal, strong site fidelity, and spatially disconnected breeding habitats, very few tests of these metapopulation structure assumptions are tested in the literature (Smith and Green 2005). The few places where it has been examined, researchers find that frogs may function as metapopulations (Sjogren 1991, Hitching & Beebee 1997, Vos et al. 2001). If populations function as metapopulations, then factors that decrease dispersal rates and distances can result in population declines and increase susceptibility to loss (Soule 1987). However, the applicability of the metapopulation model to other species in the *Rana* genus and to the West may be problematic because of differences in the vagility and life history of the species, as well as the heterogeneity of the western landscape (Blaustein et al. 1994). Thus, understanding population structure and the relationship between population connectivity and landscape characteristics is an important component of management for this species.

**Objectives of the project**

The purpose of this proposal is to (1) examine the quantity and distribution of critical amphibian habitat across western Montana, (2) examine the genetic structure of amphibian populations within several watersheds, and (3) examine whether either of the above are likely influenced by the presence of beaver activities. Specifically, we are assessing amphibian habitat by examining the number and distribution of potential breeding sites and the occurrence of beaver activity from an existing database for western Montana. Then using 6 focal watersheds, we will examine rates of change in quantity and distribution of this critical habitat in aerial photos over the last 70 years in watersheds with and without beaver. Finally, we plan to examine whether these amphibian populations are functioning as panmictic populations, metapopulations, or isolated populations and whether the landscape changes associated with beaver activity (through altering the distance between breeding populations) may affect the genetic structure of amphibian populations.

**Study Sites**

This study is being conducted in southwestern Montana. To examine the quantity and distribution of amphibian habitat, we have focused on selecting watersheds from two strata (4 and 6) in southwestern Montana from the statewide amphibian monitoring database (Maxell unpublished data). In addition, we collected samples of three paired watersheds (6 total watersheds) for aerial photo and genetics work. These three paired watersheds were relatively closed systems with similar geomorphology and hydrology but with different distances among

lentic sites and therefore different potential connectivity. One pair of watersheds were sampled in 2003 (Lower Wise River - HUC 995 and Pintler Creek – HUC 35). In 2004, all six watersheds were sampled (1) in the Pioneers (Alder Creek – HUC 24, Squaw Creek – HUC 57), (2) Lower Wise River - HUC 995 and Pintler Creek – HUC 35 and (3) in the Bitterroot Mountains (Cache Creek – HUC 11, and N. Fork of Fish Creek – HUC 19).

**Methods**

*Quantity and distribution of amphibian breeding habitat in western Montana today*

We have queried an existing database, developed for monitoring lentic amphibian presence/absence that consists of approximately 170 6$^{th}$ code hydrological unit code (HUC) watersheds that were randomly selected in southwestern Montana (Maxell unpubl. data). Bryce Maxell created the database collaboratively with multiple state and federal agencies (DEQ, NHP, MFWP, USFS). Western Montana was stratified by ecoregion, and within each stratum watersheds (6$^{th}$ code HUCs) containing at least 25% federal or state land were randomly selected. The number and total area of the watersheds chosen within each stratum was proportional to the area of each individual stratum relative to the total area for all strata. Within each 6$^{th}$ code HUC, field crews surveyed all standing water bodies on public lands (and some private lands) identified from topographic maps or aerial photos. Amphibians were surveyed using timed visual encounter and dip net sampling. In addition, habitat characteristics, associated with area, depth, type and area of emergent vegetation, substrate, fish presence, and water permanence were all recorded. Standing water bodies are classified as active breeding sites for frogs, possible breeding sites (no breeding observed but physical characteristics of sites would support breeding activity), and overwintering sites (physical characteristics of sites would support overwintering). Breeding was defined as the presence of amplexed pairs, egg masses or tadpoles. The physical characteristics for breeding include shallow water and emergent vegetation. The physical characteristics generally believed to be required for over wintering include permanent flowing water or depths greater than 2 m (Pilliod 2002; Turner 1960).

All surveyed watersheds within strata four and six, were extracted from the database. For any watershed with Columbia spotted frog breeding, we examined the type of site (glacial created, human created, beaver created, off river backwater). If more than one breeding site was present we collected elevation, type of site, and over land distance measures. In addition, we projected the data into ARCGIS and measured riparian distance among sites.

*Changes in the quantity and distribution of amphibian breeding habitat in watersheds with and without beaver over the last 70 years*

Each of the six focal watersheds have historic aerial photos periodically from the 1940s through the present. Using aerial photos and maps from the last ~70 years we are assessing the number and location of lentic sites for at least 3 different time periods (~1940, ~1970, and ~1990). GIS layers are being created using scanned and ortho-rectified photos for each watershed. Using similar methods as Johnston and Naiman (1990) and Snodgrass (1997), we are able to determine the rate of creation and loss of lentic sites within watersheds with and without beaver activity over the last 70 years. Georectified orthophotos have been downloaded from the Montana Natural Resource Information System (NRIS). The historical photos and maps of each watershed are being examined, water bodies are located, scanned, ortho rectified, and compared

with previous years. The final result of this effort will allow us to examine the creation and loss of lentic sites over time and the distance among sites over time within our focal watersheds.

*Population structure of amphibian populations in western Montana*

To understand the functioning of these populations, we have chosen genetic tools. Dispersal rates of these species are difficult to measure as the majority of dispersers are likely metamorphs that are too small to tag with a transmitter, but have very high mortality rates (very low mark-recapture rates) to estimate dispersal. Genetics provides a tool that allows us to estimate the amount of gene flow between breeding populations. Within our six focal watersheds, approximately 30 Columbia spotted frog tadpoles at each breeding site were collected. We sampled all breeding sites within each watershed. Techniques for DNA extraction, PCR amplification, and allele separation and scoring have followed the procedures outlined in Funk et al. (2005). Pure Gene ® kites (Gentra) were used to extract the DNA according to manufacturer's instructions. Samples are being run using standard PCR and gel electrophoresis techniques for 6 microsatellites previously established for Columbia spotted frogs (Funk et al. 2005). $F_{ST}$, allelic richness, and a Mantel's test of genetic and geographic distance will allow us to determine the amount of gene flow between breeding populations and whether the frogs within beaver and non-beaver watersheds are functioning as one mixed (panmictic) population, as metapopulations, or as isolated populations.

**Results and Continuing Work**

*Quantity and distribution of amphibian breeding habitat in western Montana today*

We first ran a nonparametric multivariate test (Non metric multidimensional scaling) with the dataset (# lentic sites, # breeding sites, site type, distance among sites, elevation) to examine whether there are patterns or biases in the data set associated with sampling regime (% of private, unsampled land in the watershed) and geographic location (stratum and range). There were no patterns in the data set (strata four and six) associated with these factors so we analyzed the entire data set as one. Overall there were 109 watersheds ($6^{th}$ code HUCs) in strata four and six where Columbia spotted frogs were detected. Of those watersheds where Columbia spotted frogs were present, 83.5% were watersheds with beaver present. Beaver watersheds had significantly higher numbers of lentic sites and breeding sites. In addition, most of the breeding sites were beaver created sites. Our expectations that beaver sites would make up the majority of mid-elevation sites and that watersheds with beaver would have shorter distances among breeding sites was not demonstrated in our data. Contrary to our expectations, watersheds with beaver had on average longer distances among breeding sites.

*Changes in the quantity and distribution of amphibian breeding habitat in watersheds with and without beaver over the last 70 years*

The paired focal watersheds for each site have historic aerial photos from either the 1960s or early 1970s. We have begun to evaluate the historic photos to determine the rates of creation and loss of potential breeding sites in watersheds with and without beaver activity over the last 70 years. GIS layers are being created using scanned and ortho-rectified photos for each watershed. Historic photos have been evaluated for two of the sites and photos are being collected for the other four sites. In the one pair of watersheds in the Bitterroot Mountains that have been examined, the beaver watershed had a higher turnover rate with 16 different sites

created over the 62 years. Once other paired watersheds have been completed we will determine whether the increase in turnover rate of lentic sites in beaver watersheds is the same across our different study areas.

*Population structure of amphibian populations in western Montana*

All 2003 samples have been run using standard PCR and gel electrophoresis techniques for 6 microsatellites previously established for Columbia spotted frogs (Chris Funk, pers. comm.). We have checked our allelic diversity and heterozygosity to ensure we have reasonable estimates using tadpole samples (versus adults as other studies have done (Funk 2005)). Overall, we see high $F_{ST}$ values among sites, similar to the values that have been seen among mountain ranges in previous work (Funk 2005). As expected closer sites appear to have greater genetic connectivity. We are currently running 2004 samples. Once the 2004 genetic samples are complete we will run analyses to examine how genetic connectivity is related to riparian and overland distance, as well as, continue our formal analyses to look at isolation by distance, and the scale of population in these contrasting watersheds through assignment tests.

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