Relative Abundance Survey of *Peromyscus* and *Microtus* along Mission Creek Riparian Habitat on the National Bison Range

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Abstract

In my survey, I sought to estimate the relative abundance of small mammals (especially *Peromyscus* and *Microtus* spp.) focusing on water as a limiting factor influencing their distribution and numbers along the riverine habitat of Mission Creek on the National Bison Range in Moiese, Montana. Sixteen transects were divided into three targeted trapping areas [1] dense riparian vegetation, [2] sparse riparian vegetation, and [3] riparian grassland located throughout the research area and were each surveyed for seven consecutive trapping nights. Spacing distances were a function of habitat complexity, with traps placed closer together in complex riparian habitat areas. In 15 trap nights, 448 individuals of six small mammalian species were trapped: *Peromyscus maniculatus* accounted for 66% of all individuals trapped; *Microtus pennsylvanicus* comprised 32%; and four remaining species combined accounted for 2%. *Microtus pennsylvanicus* were more often found in wet shrub abundant, grassy habitat and *P. maniculatus* more often in a drier shrub habitat. Significant relationships between both *P. maniculatus* and *M. pennsylvanicus* mass and relative abundance were found with distance to water (*P. maniculatus*; n =279, R^2 =0.027, P =0.006 and *M. pennsylvanics*; n =279, R^2 =0.027, *P* =0.029). There was a statistically significant relationship between the distance-from-water by individual trap transect percentage success with higher capture numbers of individuals found closer to the water (n =448, R^2 =0.409, P =0.0001). I also found significantly higher total small mammal capture success closer to the water (n =76, R^2 =0.056, P = 0.040). These data serve as a baseline to the archiving and distribution of small mammals at the National Bison Range for Mission Creek riparian habitat and possibly serve as a reference towards establishing guide lines to manage the small mammal communities as an important food web base for target predatory species of the riparian habitat.

Key Words**:** *Peromyscus*, *Microtus*, small mammal, relative abundance, riparian, National Bison Range.

1. Introduction

Murdiae is the largest family of mammals containing 281 genera and 1,326 species that includes members of the genera *Peromyscus* (deer mice) and *Microtus* (voles) (Wilson *et al*. 1999). Deer mice and voles, along with other small mammals, have important supporting ecological roles along riparian areas such as the Mission Creek riverine system on the National Bison Range in central Montana. For example, species in the genera *Peromyscus* and *Microtus* perform various functions that sustain ecological balance in riverine habitats, such as, dispersing plant seeds and mycorrhizal spores through herbivory and seed predation by tearing nuts, leaves, organic matter, and litter into smaller pieces. This increases the surface area to volume ratio which allows a faster decomposition rate. Also, soil composition is mixed and aerated by their burrowing (Pearson 1999).

1.1 *Background on the Genus Peromyscus spp. maniculatus*

The deer mouse *Peromyscus maniculatus* was the sole representative of the genus *Peromyscus* found in this survey. It is the most variable morphologically and ecologically of any North American mouse. It is an opportunist eating, insects, other animal matter, seeds, nuts, berries, fruit or various types of fungus and hordes what it is unable to eat in one sitting. It is nocturnal rarely leaving its nest during daylight hours unless disturbed (Wilson *et al*.1999).

Depending on resource distribution availability, the home ranges of deer mice vary from a few hundred square meters to a hectare or more. Males usually have larger home ranges than females and may stay briefly with females after mating. They are typically solitary, except for in the winter, when as many as a dozen deer mice may huddle together for warmth (Wilson *et al*.1999).

Females are often territorial during the breeding season and often breed year round producing 2-4 litters per year, on average and possibly more in warmer climates. In late summer, there may be as many as 15 or more individuals per 1.2 hectares. Due to its abundance and widespread disruption, the deer mouse is one of North America’s most important small mammal prey species. It is a primary prey of numerous species of owls, and mammalian predators including weasels, coyotes (*Canis latrans*) and bobcats *(Lynx rufus)* (Wilson *et al*.1999).

1.2 *Background on the Genus Microtus spp. pennsylvanicus*

The meadow vole *Microtus pennsylvanicus* was the sole representative of the genus *Microtus* found in this survey. Voles are primarily herbivores and eat most species of grasses and forbs. Although they are also opportunistic occasionally eating arthropods and animal remains. Voles also have intricate social structures. For example, *M. pennsylvanicus* has a social system in which females are territorial, averaging 70 square meters. However, males range freely commonly overlapping the home range of three females. Males patrol their ranges searching for receptive females with which to mate (Wilson *et al*.1999).

Meadow voles are the most prolific mammal on earth. For example, *M. pennsylvanicus* can breed about a month after birth (Wilson *et al*.1999). Their mean litter sizes range from 4.0 to 6.2, with extremes up to 11 young per litter (Hamilton 1941; Kott *et al*. 1963; Tamarin 1977). According to Hamilton (1941), weaning occurs between 12 and 14 days after birth. An average of 2.6 young per litter or 63% of the litter is successfully weaned (Morrison *et al.*1976). The great numbers of these small mammals put them at the prey base for numerous species of owls, hawks, falcons, snakes and mammalian predators, including weasels and coyotes (*Canis latrans*) (Wilson *et al*.1999).

1.3 *The resource distribution hypothesis*

From an ecological perspective, the distribution of resources needed by a species is a major factor in determining its diversity with respect to species richness and overall social structure. Therefore, the resource distribution hypothesis predicts that the size of a home range of an individual animal will depend primarily on two factors: (1) the resource needs of an individual, and (2) the distribution of resources in the environment (Pough *et al*. 2005). Based on this hypothesis and background information of *Peromyscus* and *Microtus* as R-selective generalists, I predicted that these targeted genera will be dispersed throughout the Mission Creek riverine habitat in varying riparian vegetative habitats.

1.4 *Significance*

The knowledge of the flow of matter and energy in an ecosystem is largely determined by predator-prey relations in natural systems. There is a hierarchy of predation, with small mammals such as species members of the genera *Peromyscus* and *Microtus* serving as secondary predators, by preying on arthropods, and in return are the prey bases supporting a wide range of tertiary and quaternary predators (Pearson 1999).

1.5 *Survey*

The goal of this survey was to ensure a relative species abundance count in a sufficient sampling space; it was not a census or general density study but a survey specific to a riparian community. Jones and Manning (1996) demonstrated that general habitat type (riparian, tall grass, and short grass) influenced species distribution of rodents more than either the presence or absence of particular species of plants. Therefore, specific plant communities were not characterized within the Mission Creek riparian zone. However, the amount of vegetative cover and general habitat type (size, shape, topography and connectivity of habitat patches) were taken into account in assessing where the locations of the various small mammal trap transects would be along both sides of Mission Creek. The trapping methods used in the relative abundance count were snap-traps, Shermans, and pit-fall traps. Snap-traps were used to aid in species relative abundance counts in assessing trap-shy species. Sherman live traps and pit-fall traps were small mammal live capture trapping methods (Pearson *et al.* 2003). By using a combination of traps, trap bias may have been reduced (Francl *et al*. 2002).

2. Materials and Methods

2.1 *Study area*

The research area was located along Mission Creek in Moiese Valley in central Montana on the northern edge of the National Bison Range (Figure 1). This survey was conducted from July 3 - 21, 2006. Habitat along Mission Creek distancing 2m to70m from the waters edge was selected to be large enough to contain a transect, be separated from another transect by at least five meters and be within 805m to a road.

In order to successfully survey the small mammal communities, portraying a description of their species compositions and relative abundances a large number of small plots were used for better accuracy (Neff 1968). Small plots were also more time efficient (Johnson 1977). Also taken into consideration were spacing distances being a function of habitat complexity, with trap transects placed closer in complex riparian habitat areas (Wilson *et al*. 1996).

2.2 Study design

This survey measured the relative number of individuals belonging to the genera *Peromyscus* and *Microtus* as well as identified members of other small mammalian species (other small mammals, defined here as any mammal small enough to fit inside a 7.6 x 8.9 x 22.9-cm Sherman live capture trap, or unable to escape a 16.5cm pitfall trap). The genera *Peromyscus* and *Microtus* were chosen as they include widespread, common species that live in riverine habitats in central Montana. They were assessed using multiple small mammal trapping techniques to estimate diversity with respect to species richness at different locations along both sides of Mission Creek (Wilson *et al*.1999). Specific locations were chosen to exemplify different subtypes of the riparian system (Figure 1). Sixteen transects consisting of 15 traps 5-10 meters apart were spread throughout the research area in three targeted trapping areas [1] dense riparian vegetation ($\geq$1.9 m high) , [2] sparse riparian vegetation ($\leq$ .95 m high), and [3] riparian grassland ($\leq$ .475 m high) and were trapped for seven consecutive nights each.

A total of 75 Sherman live, 8 snap and 9 pitfall traps were used for each riparian subtype for seven consecutive nights each (Total =525 Sherman trap nights, 56 snap trap nights, and 63 pitfall trap nights). Traps were placed along habitat features such as logs, trees, bushes, nesting sites, burrows and visible runways within one meter of the trap station flagging (Sutherland 1996). In more densely vegetated areas, traps were placed 5m apart, 10m apart when vegetation cover was less dense. Sherman and pitfall traps were baited with a dry mixture of molasses coated rolled oats and snap traps were baited with a mixture of peanut butter and rolled oats. The traps were baited every evening between 1800-2100 MDT and checked the following morning between 0700 -1000 MDT. The location of each small mammal capture in relation to the trap transect was noted along with other information, such as species, sex, weight, reproductive condition, recapture status (fur shaved on lower back) and date. The handling of the small mammals was performed according to IACUC standards (Wilson *et al*.1999). All Sherman live traps and snap traps were deactivated until the evening when they were re-baited.

2.3 *Data analysis*

To account for variability in trapping effort across sites, results were analyzed using captures per trap night (Francl *et al*. 2004). JMP IN Statistical software program was used for field data analysis. A one-way ANOVA was used to calculate distance from water by gender for both species, separately. Linear regressions examined trends (for both *P. maniculatus* and *M. pennsylvanicus*) in distance-from-water verses animal mass and total percentage capture success. A Chi-square logistic fit was used to test individual trap percentage success by distance from water. A linear regression was used to calculate vegetative height cover (m) by individual trap capture percentage success. A linear regression was used to test for relationships between the number of traps set per night that caught a re-capture animal.

3. Results

In 15 nights of trapping 75 Sherman, 8 snap and 9 pitfall traps were set per trap night, 448 individuals of six small mammal species were trapped. Overall small mammal trap success was 3.3%. *Peromyscus maniculatus* accounted for 66% of the individuals trapped and *M. pennsylvanicus* accounted for 32% of the species trapped. The remaining four species combined accounted for 2% (Table 1). *Microtus pennsylvanicus* were found more often found in wet shrub abundant and grassy habitat and *P. maniculatus* more often in a drier shrub habitat (Figure 2).

Gender for neither *P. maniculatus* (F =1.527, P =0.218) nor *M. pennsylvanicus* (F =0.158, P =0.692) differed significantly in their distance from water. However, statistically significant relationships were found between the distance-from-water by mass among both species separately, finding that heavier individuals of both species were found closer to water (*P. maniculatus*; n =279, R^2 =0.027, P =0.006 and *M. pennsylvanics*; n =279, R^2 =0.027, *P* =0.029). There was a statistically significant relationship between higher capture numbers of individuals found closer to the water and in riparian grasslands (n =448, df =1, R^2 =0.051, X^2 =114, P =0.0001). I also documented significantly higher total small mammal capture success closer to the water (n =76, R^2 =0.056, P = 0.040) (Figure 3). There were statistically significant relationship between vegetative height cover (m) and individual trap capture percentage success (with eight 50m outlier points: n =448, R^2 =0.011, P =0.027) (Figure 4), (without the eight 50m outlier points: n =440, R^2 =0.193, P =0.0001) (Figure 4.1). The number of re-captures per night increased significantly with progressive trap days (n =35, R^2 =0.179, P = 0. 012) (Figure 5).

4. Discussion

This study resulted in five statistically significant trends: (1) heavier individuals were found closer to the water; (2) individuals were trapped in higher percentages in the riparian grasslands and dense riparian vegetation locations. (3) there were higher total capture success rates closer to the water; (4) the majority of individuals trapped are in riparian vegetation that is between 0.2m – 2m tall; and (5) re-captures for both *P. maniculatus* and *M. pennsylvanicus* increased with each trap night.

All five trends supported the resource distribution hypothesis that the home ranges of individuals should be smaller in a rich environment than in one where resources are scarce. *Peromyscus maniculatus* and *M. pennsylvanicus* are R-selected species, and as generalists, they overlap in microhabitat. However, field data collected and analyzed supported the prediction that *P. maniculatus* and *M. pennsylvanicus* would occupy distinct habitats as *Microtus pennsylvanicus* were found more often found in wet shrub abundant and grassy habitat and *P. maniculatus* more often in a drier shrub habitat (Figure 2). Pregnant and lactating females were trapped in the same locations which indicated they were territorial primarily during their breeding season.

Trejo (2003) suggested that *P. maniculatus* and *M. pennsylvanicus* use dense vegetation cover as a defense mechanism to hide from aerial predators. Graham (1968) suggested that the time of major activity depends on the amount of vegetative cover present. Dense cover activity will promote more diurnal activity, whereas under sparse cover, activity will be mostly crepuscular (Graham 1968). This suggests that *P. maniculatus* and *M. pennsylvanicus* would actively forage nocturnally in the denser riparian habitat although this study did not prove that as they were consistently trapped in vegetation heights from 0.2 m – 2 m tall.

Value in an animal's home range lies within the familiarity of an individual with the locations of food and shelter as they employ a type of foraging known as trap lining, in which they move over a regular route and visit specific places where food might be available (Pough *et al*. 2005) which supported the fifth trend in re-capture percentage success increasing with progressive trapping days. A trend was seen in the field that at about the fifth trapping night in each riparian subtype the amount re-captured small mammals caught equaled and often exceeded the numbers of individuals caught for the first time.

The western jumping mouse *Zapius princeps* was found towards the end of the trapping period suggesting that they are more active in mid July vs. early July. These small, long-tailed jumping mice are frequently found in riparian areas and are semi-aquatic as they may dive and swim to escape predators (Wilson *et al*.1999).

The shrews *Sorex cinereus* and *Sorex monticolus* were found in transects close to the waters edge which indicates their preferential habitats are associated with water. These long tailed shrews are found in moist habitats probably due to their small body size, susceptibility to high temperatures and evaporative water loss because of their high activity level (Wilson *et al*.1999).

Mustela frenata has generally low densities throughout its range and is listed as endangered, threatened, or rare. The capture location of *M. frenata* was along a transect in the second trapping effort 10m from the waters edge. These data supported the existing body of knowledge on *M. frenata* habitat preferences; being near water, grasslands along creeks and lakes, swamps, cattail marshes and brush land (Wilson *et al*.1999). Their dens are stationed in dense brushy vegetation in or around dry creeks and drainage ravines and they use waterways as an avenue for travel (Wilson *et al*.1999).

Notably, this survey is bias towards nocturnal small mammal species. Precaution of deactivating Sherman live traps were taken to have reduced the possible mortality of small mammals that might die inside during the 29.5˚C mid-day temperatures characteristic of the month of July in central Montana. Therefore, *P. maniculatus* and *M. pennsylvanicus* may not be the sole representatives of their respective genera along Mission Creek. For example, *Microtus pennsylvanicus* is known to occur in overlapping geographical areas with other *Microtus* species, white footed mice (*Peromyscus leucopus)*, deer mice (*P.maniculatus)*, cotton rats (*Sigmodon hispidus)*, and jumping mice (*Zapus hudsonius)* to name a few (Wilson *et al*.1999).

Moon phases were also considered as a limiting factor in determining the numbers of individuals trapped per night. However, no real comparisons or statistically significant results were determined due to the condensed timing of this survey. I recommend that future studies take moon phases into account in determining their trap nights as small mammals are known to be less active during a full moon due to a higher predation rate.

4.1 ***Significance of data***

The field data collection from this survey will serve as a baseline to the archiving and distribution of small mammal data at the National Bison Range for Mission Creek riverine habitat and possibly serve as a reference towards establishing guide lines to manage the small mammal communities as an important food web base for target predatory species of the riverine habitat for the future.

4.2 ***Management Options***

The deer mouse is highly significant epidemiologically. In nature it is the primary host of the very virulent hantavirus that causes Hantaviral Pulmonary Syndrome (HPS), a serious disease of humans found most often in the western United States (Wilson *et al*.1999). Therefore, disease testing on *P. maniculatus* found in the Mission Creek riverine habitat could be a valuable undertaking.

Another important project to pursue could be the monitoring of small mammal biodiversity along the Mission Creek riverine habitat for consecutive years for the purpose of drawing inference about change. It is recommended that the timing and frequency of sampling should be planned to ensure that short-term seasonal variations do not obscure any long-term differences that are being investigated (Wilson *et al*.1999).

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Table 1. – The total number of individuals captured for each species and the trap success percentage per trap- night for each species.

Scientific Name	Common Name	No. Captured	Percentage of all Captured
Target Species			
Peromyscus maniculatus	deer mouse	296	66.071
Microtus pennsylvanicus	meadow vole	142	31.696
Non-target Species			
Mustela frenata	long-tailed weasel	1	0.223
Sorex cinereus	masked shrew	3	0.670
Sorex monticolus	montane shrew	1	0.223
Zapius princes	western jumping mouse	5	1.116
Total		448	100

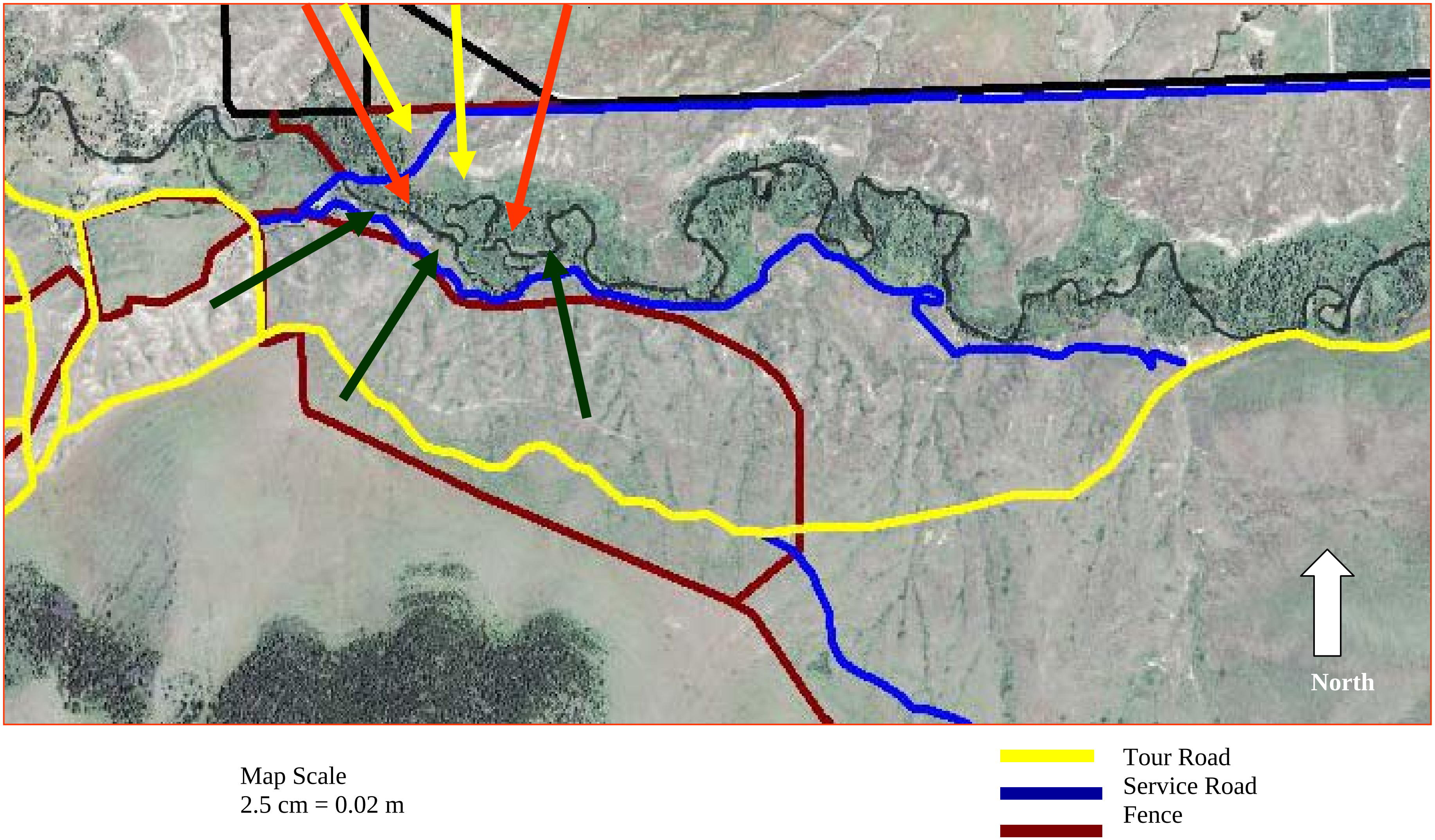


Figure 1: Map of Mission Creek in Moiese Valley in central Montana on the northern edge of the National Bison Range: arrows point towards trapping locations; red arrows point towards dense riparian vegetation; dark green arrows point towards the sparse riparian vegetation; and yellow arrows point towards the riparian grassland.

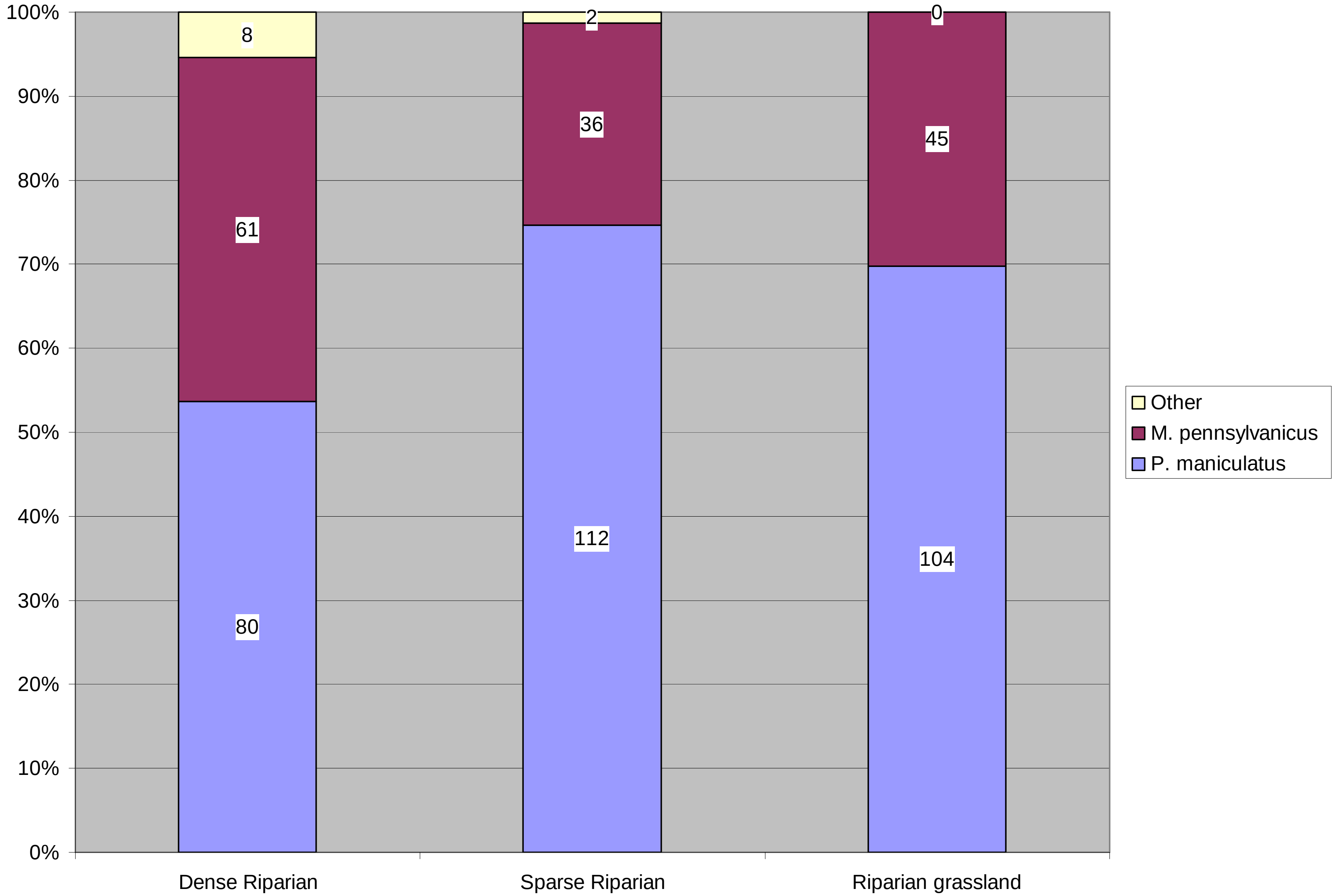
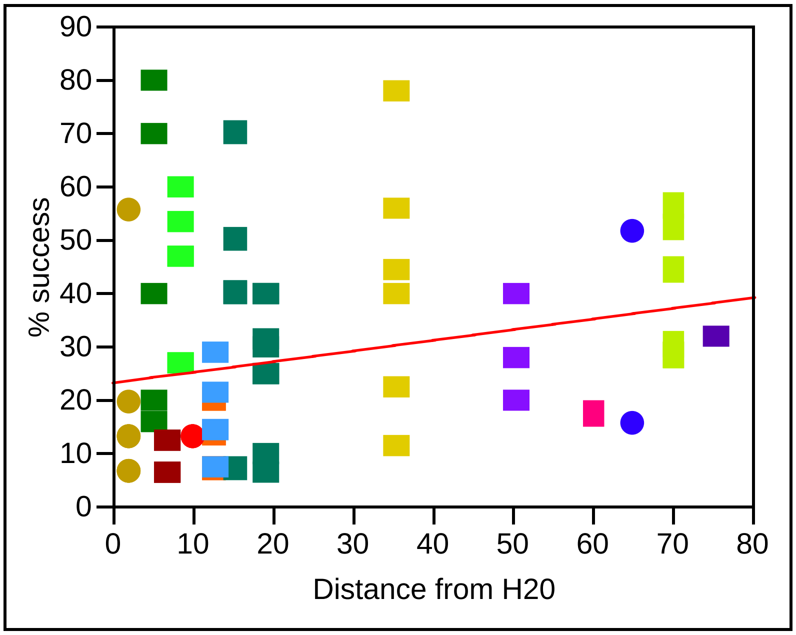
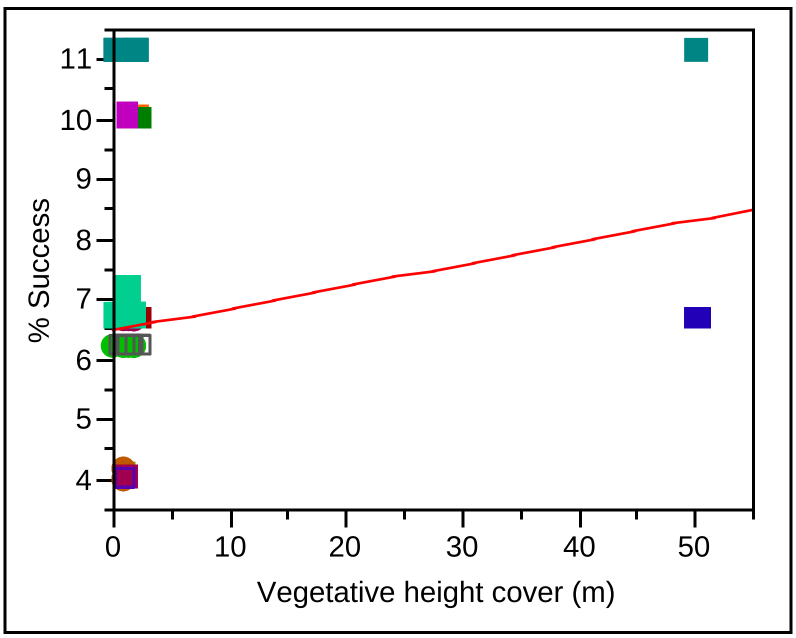


Figure 2: Distribution of targeted species (*P. maniculatus* and *M. pennsylvanics*) along with non-targeted species (grouped as, other) in each riparian trapping location.



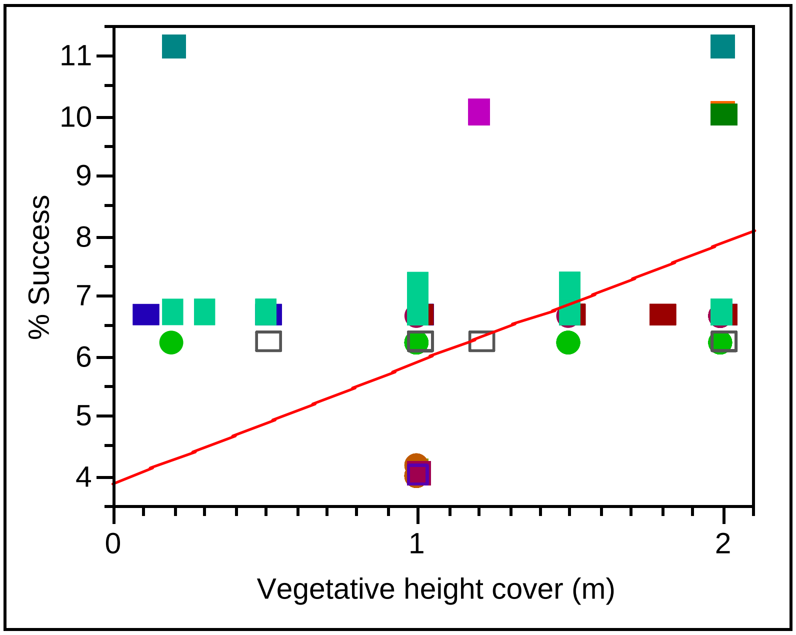
(n =76, R^2 =0.056, P = 0.040)

Figure 3: Depicts higher overall trapping success closer to the water. (Data points are grouped as all animals trapped at each transect per night = % success)



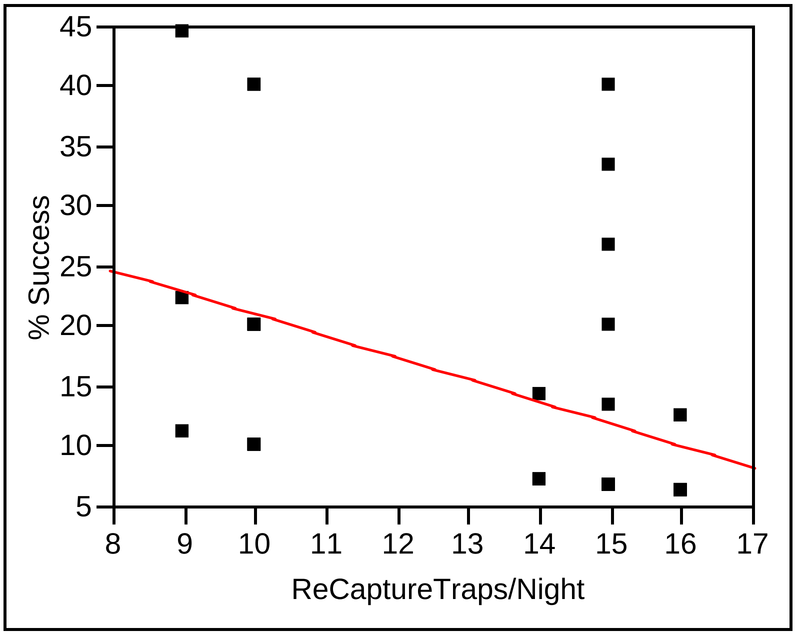
(n =448, R^2 =0.011, P =0.027)

Figure 4: Depicts a relationship between captures per night and vegetation cover (50m outliers represent transects with trees).



(n =440, R^2 =0.193, P =0.0001)

Figure 4.1: Depicts a relationship between captures per night and vegetation cover (excluded 50m outlier trees from this figure) showing that the majority of individuals trapped are in riparian vegetation that is between 0.2m – 2m tall.



(n =35, R^2 =0.179, P = 0. 012)

Figure 5: The number of re-captures per night increased significantly with progressive trap days eventually reaching equilibrium at each trapping location with the re-capture number equaling non-recaptures.