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HOME ON THE PRAIRIE: A STUDY OF AMERICAN MARTEN (*Martes americana*) DISTRIBUTION AND HABITAT FRAGMENTATION IN THE TURTLE MOUNTAINS OF NORTH DAKOTA

A Thesis in

Geography

by

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ABSTRACT

The North Dakotan Turtle Mountains are an island of primarily forested habitat home to the American marten, *Martes americana*, a meso-carnivore in the mustelid, or weasel, family. American marten populations disappeared around 1940, but recently reappeared in this region; however, both their distribution and the effects of habitat fragmentation on their distribution are unknown. Historically, American martens have been located in the Turtle Mountains; yet current descriptions of favorable marten habitat do not match any North Dakotan habitats. I used track plates and camera traps to determine the presence/absence of martens. I determined that American martens were present. To model probabilities of marten presence/absence in the Turtle Mountains, I used these data in conjunction with landscape metrics such as amount of water, developed land, and agriculture, as well as various indices of forest fragmentation. This isolated landscape in North Dakota allowed me to ultimately verify American marten range expansion. Concerning habitat fragmentation, the way the forest patches are distributed appears to be more important to marten habitat than interior forest area, although the latter is important as well. Water is a significant predictor (p-values <0.05) of martens at both local and landscape scales, whereas developed land is significant (p-values <0.05) only at larger scales. This research will allow local and state policy makers to make informed decisions about the management of areas vital to the survival of the American marten.

Keywords: American marten, mustelid, habitat fragmentation, North Dakota, Turtle Mountains, island biogeography

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Chapter 1: Introduction

Physical Description

The American marten (*Martes americana*) is a carnivorous mammal in the *Mustelidae*, or weasel, family, the largest of the seven carnivore families (Kruuk 1995). Markley and Basset (1942) describe martens as having thick, reddish brown, attractive fur in the winter that changes to a lighter, rougher pelt in the summer. Martens have a distinct amber-colored patch on their necks that easily distinguishes them from their cousin, the fisher (*Martes pennanti*), which has a generally dark brown to blackish colored pelt and rounded ears with whitish tips (Powell 1993). The marten has an elongated body typical of species in the mustelid family.

Diet

Martens are generalists, although some experts suggest that they are specialists by season (Zielinski, Spencer, and Barrett 1983). Martens prey on abundant populations of rodents such as voles (*Microtus spp.*) and deer mice (*Peromyscus spp.*). They have been documented consuming salmon when either living close to water or when rodent populations declined (Ben-David, Flynn, and Schell 1997). Several studies have shown martens to consume primarily voles (Koehler and Hornocker 1977; Murie 1961; Weckwerth and Hawley 1962); however, martens also are known to feast on huckleberries (*Vaccinium spp.*), strawberries (*Fragaria spp.*), and pikas (*Ochotona spp.*) (Murie 1961; Weckwerth and Hawley 1962).

Mating

Martens mate in July, sometimes into August, with the mating season lasting anywhere from 24-46 days (Markley and Bassett 1942). Male martens are polygamous, evidenced by multiple individual female home ranges that normally fall within a single male home range (Powell 1994). Martens first mate anywhere between 15-39 months of age (Mead 1994).

Reproduction

Delayed implantation of the blastocyst is characteristic of all mustelids (Vaughan 1986). Wright (1942) demonstrated this to be the case when females trapped during the winter showed signs of pregnancy yet the testes of the trapped males were not "in breeding condition." Jonkel and Weckwerth (1963) noted that martens exhibited delayed implantation for approximately 7.5 – 8 months after the mating season, with possibly one individual for up to 9.5 months. Recent research suggests that delayed implantation is characteristic of mammals in seasonal climates (Thom, Johnson, and MacDonald 2004).

Size

Martens exhibit sexual dimorphism. Holmes and Powell (1994) concluded that sexual dimorphism leads to resource partitioning rather than vice versa. One study found mainland martens to be smaller than isolated martens as well as a more prominent trend of dimorphism on islands (Nagorsen 1994). Males weigh, on average, 628g (1.38lb), and females weigh an average of 404g (0.89lb) (Strickland and Douglas 1987).

Home Range

Male martens have larger home ranges than their female counterparts (Powell 1994; Buskirk and McDonald 1989; Hawley and Newby 1957) and display intrasexual terroriality. Although the data vary widely (Table 1), Powell (1994) calculates an average home range of $8.1 km^2$ and $2.3 km^2$ for male and female martens, respectively. Powell also noted that a positive relationship exists between home range and body size.

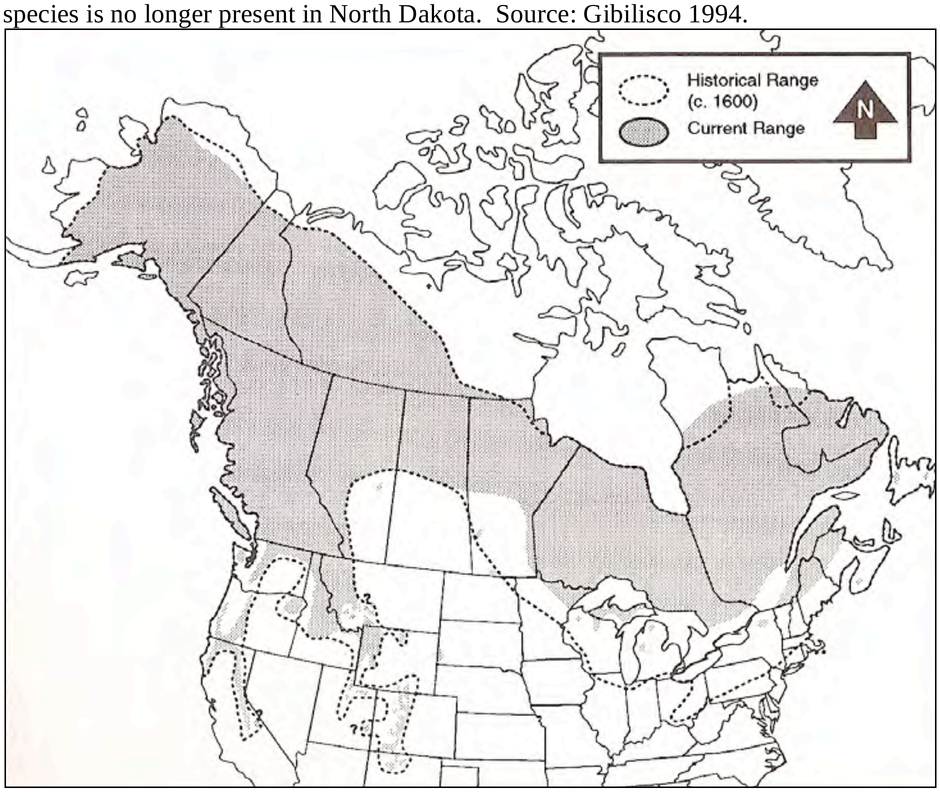
Table 1. Home range of male and female American marten in km^2. Empty cells indicate the information was not available. Source: Powell 2004

Male		Female		
Mean	SD	Mean	SD	Location
7.1	1.5	5.6	2.8	Yukon
8.7		6.6	2	Yukon
4.8		2.3		Vancouver Island, B.C.
27		17		Newfoundland
4.6	1.9	2.4	1.4	New York State
2	2.6	0.6		Montana
7.1	2.9	7.9	8.9	Alaska
3.6	1.4	1.1	0.9	Ontario
10	9.1	4.3	2.8	Northwest Territories
6.1	5.9	1.9	1.8	Northwest Territories
8.2	2	1.7	0.8	Maine
16	5	4.3		Minnesota
3.4	0.7	1	0.2	Ontario
6.8	0.8	4.2	0.3	Ontario
5	1.1	3.1	0.6	Ontario
11	2	13	1	Ontario
10	0.7	12		Manitoba
3.9	1	3.2	1.7	California
5.6		2.9		Maine
8.1 = grand mean		2.3 = grand mean		

Distribution

The Laurentide ice sheet substantially influenced the distribution of martens in North America by pushing populations south during the Pleistocene and inducing retreat to the north upon melting in the Holocene (Graham and Graham 1994). In the early 1990s, Charles Gibilisco (1994) surveyed various governmental agencies on the status of fisher and American marten, combining his data with that of others to produce a distribution map of martens (Figure 1). Marten have disappeared from many of their former ranges in California, Oregon, and Washington (Zielinski et al. 2001) as well as in the Mid-Atlantic (Gibilisco 1994) due to suitable habitat removal and trapping. Figure 1 reveals that although martens were once located in the northeastern tip of North Dakota, their populations no longer remain anywhere in the state.

Figure 1. Current and historic distribution of American marten in North America. Note the species is no longer present in North Dakota. Source: Gibilisco 1994.



The Turtle Mountains in northern North Dakota are located near the border of the marten's historic home range (Figure 1). Although martens were extirpated from the Turtle Mountains in the 1940s, the Canadian Wildlife Service reintroduced 59 martens between 1989 and 1990 in the Manitoba portion of the Turtle Mountains (Armstrong 2007, pers. comm.). The reintroduced population was comprised of an almost equal sex ratio, but was skewed toward juveniles (about 80%). The individuals were taken from the Duck Mountains and the forests of the Porcupine Hills, both located in southwestern Manitoba, although the Porcupine Hills sit on the border between Manitoba and Saskatchewan. Trapping was not allowed for five years following the reintroduction until the populations proved healthy enough to permit harvesting.

Habitat

The range of American marten once covered a large portion of North America (Graham and Graham 1994), with populations extending as far south as Colorado. Upon the recession of the Laurentide ice sheet, suitable *Martes* habitat began to retreat north, leaving isolated patches of forest for the remaining *Martes* populations in the northern United States (Graham and Graham 1994) (Appendix A). Since then, marten populations have diminished further from excessive trapping and decreased suitable habitat primarily caused by forest clear-cutting (Buskirk and Ruggiero 1994; Hodgman et al. 1994; Snyder and Bissonette 1987; Soutiere 1979; Steventon and Major 1982).

Primary habitat for martens has been thought to include mesic, coniferous or mixed conifer-deciduous, contiguous, closed canopy, mature forests north of 35° latitude (Spencer, Barrett, and Zielinski 1983; Buskirk and Powell 1994; Proulx et al. 2005);

however, some studies have observed otherwise (Payer and Harrison 2003). In Maine, martens selected against stands < 24 yr of age and instead used older stands of deciduous, conifer, and mixed forest (Fuller and Harrison 2005; Soutiere 1979). In Newfoundland, higher densities of martens were documented in old growth forests with larger interior forest area compared to regenerating logged stands (Bissonette, Fredrickson, and Tucker 1989). Trees with large diameters provide sizeable boles for denning and resting (Flynn and Schumacher 1999) and old growth forests offer more trees that meet this criteria. Thompson and Harestad (1994) suggest sufficient forest maturity at a minimum of 80 yr old boreal conifer and mixed stands, 100 yr old lodgepole pine (*Pinus contorta*) stands, and 60 yr old temperate rain forest stands.

Fragmented and isolated forests hinder marten populations. The proclivity of American martens to select contiguous closed canopy forests is well documented (Aubry and Houston 1992; Buskirk and Powell 1994; Hawley and Newby 1957; Steventon and Major 1982). Marshall (1951) hypothesized that clear-cuts provide greater opportunities for capturing prey. Martens have been thought to rarely venture far, if at all, into open terrain, but they have been known to hunt more on forest edges (Spencer, Barrett, and Zielinski 1983). However, a study conducted by Hargis et al. (1999) lends no support for this claim. Even though clear-cuts may provide advantages of increased prey abundance, Steventon and Major (1982) found that martens preferred uncut, softwood islands and partially cut mixed stands, particularly for winter foraging as the forest structure near the ground provides subnivean access. Undoubtedly, cohesive forest stands are conducive to successful marten populations.

Several studies report on the various effects of forest fragmentation on marten populations. Chapin et al. (1998) found that the more isolated the patch of forest, the less likely martens were to be present. Their study also concluded that larger patches are necessary to maintain marten populations, regardless of whether clear-cuts are part of forest management practices. Hargis et al. (1999) speculate that forest patches <100 m wide may not allow martens to elude predators such as eagles, owls, or larger carnivores like the coyote. They also detected very few martens in areas with >25% non-forest cover, and recommend progressive clear-cutting rather small clusters of clear-cuts. Martens will inhabit partially harvested forests, but only those that provide sufficient closed canopies and more prey (Fuller and Harrison 2005).

Martens also use wetland habitats. Forests in Newfoundland are considered part of wetland habitat, such as bogs and streams, and seem to sustain marten populations (Bissonette, Fredrickson, and Tucker 1989). High quality marten habitat often includes riparian vegetation, such as lodgepole pine (*Pinus contorta*) located in mesic areas or herbaceous plants (Allen 1987; Buskirk and Powell 1994; Fecske 2003). Martens, like other mustelids such as the fisher, use these areas as migration and dispersal corridors (Allen 1987).

A variety of tree species contribute to suitable marten habitat depending on the geography of the area. In Newfoundland marten prefer mixed Balsam fir (*Abies balsamea*) and White Birch stands (*Betula papyrifera*) (Bateman 1986). Lodgepole pine (*Pinus contorta murrayana*), red fir (*Abies magnifica*), mountain hemlock (*Tsuga mertensiana*) and western white pine (*Pinus monticola*) are all species located in American marten habitat in California (Zielinski, Spencer, and Barrett 1983). They will inhabit boreal forests with mature stands of black spruce (*Picea mariana*), larch (*Larix spp.*), and paper birch (*Betula papyrifera*) (Douglas, Fisher, and Mair 1983). Martens generally prefer conifer-dominated stands (scientific names listed in study area), such as ponderosa pine (*Pinus ponderosa*) (Bull and Heater 2000).

Coarse woody debris (CWD) is another important element of suitable marten habitat. Martens use CWD to maneuver through heavy snow pack to seek shelter from predators (Buskirk and Powell 1994). Martens most likely expend more energy digging in the snow pack rather than taking advantage of the fine spaces provided by copious amounts of CWD (Hargis and McCullough 1984). Ample supplies of undecayed or moderately decayed snags are associated with increased marten activity in subnivean access sites (Corn and Raphael 1992). The removal of this debris, whether by fire or humans, decreases the structural diversity of the forest and thus reduces the habitat suitability (Aubry and Houston 1992).

Generally, suitable marten habitat contains mature contiguous forests with plenty of CWD in moderately mesic areas. Since martens were recently reintroduced into the Turtle Mountains, they are still evolving to refine their ecological niche in the area. Dispersal corridors and selective habitat characteristics are most likely not solidified as they continue to adapt to their environment.

Objective

North Dakota Fish and Game began receiving reports of fisher and marten sightings in 2004 and 2005. Thomas L. Serfass of Frostburg State University conducted preliminary surveys on fisher and marten sightings in the region to establish strategies for further investigation (T. Serfass, pers. comm.). First, my research sought to confirm marten presence in the Turtle Mountains. Second, I wanted to determine the current distribution of martens in the Turtle Mountains. Third, knowing that forests in this part of North Dakota are extremely fragmented, I wished to determine the effects of forest fragmentation on marten presence/absence provided they were confirmed to be present. I attempted to discern the threshold distance between forested islands that prevents martens from colonizing a new island. Other forest fragmentation effects of interest included the patch shape, size, and distribution. Finally, I wanted to determine what landscape variables would allow me to predict their locations, assuming that detection locations are a reliable indication of habitat use.

Chapter 2: METHODS

Study Area

The Turtle Mountains are a plateau that evenly shares 262,000 acres (106,000 ha) between North Dakota and Manitoba (Figure 2). This unique landscape is approximately 183 to 244 m higher in elevation than the surrounding grass-covered plains (Bluemle 2002). The average annual precipitation ranges from 406 to 432 mm. As a heavily forested region, the principal tree species is quaking aspen (*Populus tremuloides*), but the area also includes the following species: bur oak (*Quercus macrocarpa*), green ash (*Fraxinus pennsylvanica*), paper birch (*Betula papyrifera*), boxelder (*Acer negundo*), sumac (*Rhus glabra*), Saskatoon serviceberry (*Amelanchier alnifolia*), snowberry (*Symphoricarpos albus*), and balsam poplar (*Populus balsamifera*) (Bluemle 2002; Hagen, Isakson, and Hyke 2005; Stewart 1975). A few small conifer patches are scattered throughout the landscape; their presence, however, is due to human modification of the local environment. The woody component of the understory primarily consists of beaked hazelnut (*Corylus cornuta*), willows (*Salicaceae*), red raspberry (*Rubus idaeus*), prickly rose (*Rosa woodsii*), pin cherry (*Prunus pennyslvanica*), and highbush cranberry (*Viburnum edule*) (Bluemle 2002; Stewart 1975). Common herbaceous plants include starry false lily of the valley (*Maianthemum stellatum*), early meadow rue (*Thalictrum dioicum*), yellow avens (*Geum aleppicum*), pink wood violet (*Viola rugulosa*), wild sarsaprilla (*Aralia nudicaulis*), dwarf cornel (*Cornus canadensis*), pink wintergreen (*Pyrola asarifolia*), and arrowleaf aster (*Aster drummondii*) (Stewart 1975).

Figure 2. Map of North Dakota. The red box indicates the location of the Turtle Mountain region of Manitoba and North Dakota. Source: http://www.2pedal.com/USA/ND/

The Turtle Mountains are found in the prairie pothole region and thus, the landscape is scattered with hundreds of lakes. Typically, this region of high waterfowl productivity is dominated by prairie ecosystems, however, the Turtle Mountains are a uniquely forested component. These lakes are mainly a result of high precipitation during the late Wisconsonian (Bluemle 2002), a time when glaciation dominated the northern half of North America and subsequently carved out the hummocky terrain. The last vestiges of ice in this area melted approximately 10,000 years ago (Bluemle 2002), leaving behind what is now known as the Turtle Mountains, sometimes referred to as "hummocky collapsed glacial topography" or "dead-ice moraine" (Bluemle 2002).

Agricultural practices such as farming and cattle ranching fragment the terrain in addition to the natural fragmentation that results from the various bodies of water. Most of the land is privately owned, with approximately 200 km^2 belonging to the local Ojibwe tribe; some of the land, however, is designated as USFWS, Wildlife Management Area, State School, State Park, and Forest Service (Appendix B). The Peace Gardens, an international park, also is located in the center of the Turtle Mountains, straddling the North Dakota-Manitoba border.

Procedures

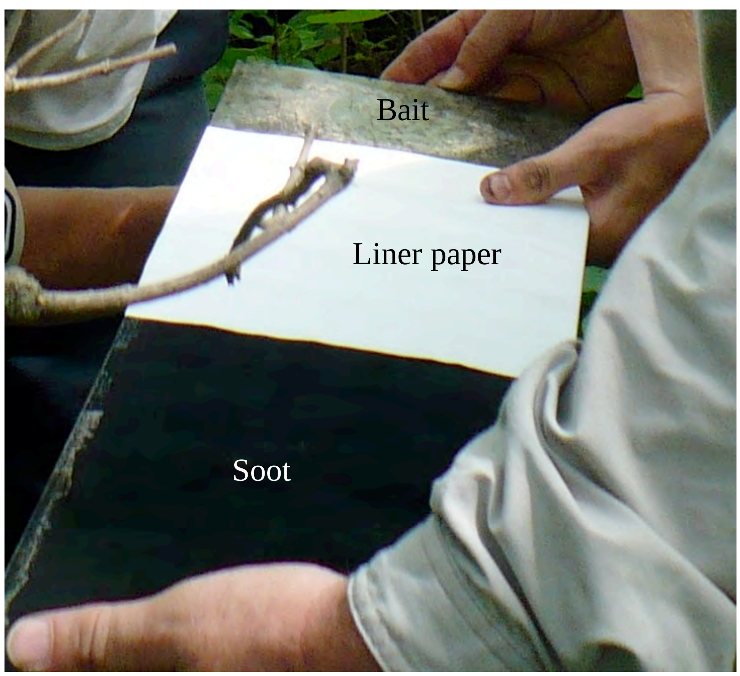
I used track plates and camera traps to detect martens at randomly selected sites in the Turtle Mountains. Each site contained track plates, camera traps, or both devices. I assumed that detection rates did not vary between sites with cameras versus those with track plates. I based this assumption on pilot methods in the study where, when both devices were placed at a site, rarely did a camera detect a marten when the track plate did not. Mammal track guides (Elbroch 2003; Zielinski and Kucera 1995) were used to determine animal tracks.

The primary means used to detect carnivores in wildlife studies, especially the targeted American marten, are track plates and cameras traps. These methods were recommended by Barrett (1983), Jones and Raphael (1993), and Zielinski and Kucera (1995). The track plate consists of a metal plate, a wooden baseboard, and a flat, flexible plastic rectangle (Figure 3). The metal plate was 0.25 m x 0.55 m; the wooden baseboard measured 0.3 m x 0.6 m; the plastic rectangle was 0.6 m x 1 m and 6.5 mm thick. The plastic rectangle snaps into the wooden base, creating a dome that provides a protective cover for the metal plate, particularly in inclement weather. I placed the track plate against a tree and blocked any openings between the plate and tree with surrounding snags to ensure both that animals could only enter one end and that the track plate would blend in with surrounding vegetation (Figure 4). I used an acetylene torch to create a layer of carbon soot on approximately half of one side of the metal plate component (Figure 5). I then placed white household shelf liner paper (adhesive side up) on the clean part of the plate, leaving a small amount of space for bait and scent lure. The plate now has two ends, the bait and tacky paper end, and the soot end. I positioned the metal plate inside the domed structure with the bait end adjacent to the tree and the soot end closest to the open entrance of the track plate.

Figure 3. Track plate components used in the North Dakotan Turtle Mountains study on American marten during the summer of 2007. The plastic rectangle bends into a dome and snaps into the grooves on each side of the wooden base.

Figure 4. Track plate site used to study American marten in the Turtle Mountains of North Dakota during the summer of 2007. I placed snags in the holes adjacent to the tree to ensure all species could enter only one end of the track plate.

Figure 5. Metal plate component of the track plate used in the American marten Turtle Mountains study during the summer of 2007. The dark end is covered with soot from an acetelyne torch. The white paper is household shelf liner paper placed sticky side up. The small length of metal showing at the end is where I placed the beaver meat and approximately 8 g of beaver castor.



Two brands of camera traps were used: Reconyx (Reconyx, LLP, Holmen, Wisconsin, www.reconyx.com) and Cuddeback (Cuddeback Digital, Park Falls, Wisconsin, cuddebackdigital.com). I used four Reconyx cameras that took infrared triggered, black and white photos at 2-sec intervals. I used three types of Cuddeback cameras that took color photos at 59-sec intervals: 20 Excite, 3 Expert, and 15 No-flash. The Excite cameras had a 2.0 megapixel digital camera and a strobe flash that could illuminate 40 feet in front of the device. The Expert cameras had a 3.0 megapixel digital camera and a strobe flash that could illuminate about 20 m (66 ft) in front of the device. The No-flash cameras use a 3.0 megapixel digital camera during the day and a 1.3 megapixel digital camera during the night. The No-flash cameras also have a 20 m (66 ft) flash range in front of the device. A total of 44 cameras were used. The date and time were programmed into each camera before setting it up at the sample site to obtain accurate information on species detected in the photos.

Each site consisted of a track plate, camera trap, or both, and a scent canister hung at approximately eye level. I assumed that the scent lure would not attract animals that were not already present within a few kilometers of the sample site (i.e., the lure would not attract animals that are not normally found in the local habitat). The scent canisters were film canisters with approximately eight 3-mm diameter holes drilled with a 2-mm (1/8 in) drill bit. I placed cotton swabs dipped in commercial scent lures inside the scent canisters. I used the following commercial scent lures: beaver castor, skunk essence, and GH-II. Each film canister contained equal proportions of beaver castor with either skunk essence or GH-II. The beaver castor was obtained from locally trapped beavers. The skunk essence and GH-II were purchased from Minnesota Trapline Products (Pennock, MN, www.minntrapprod.com) and a more local trapper supply shop, Dusty Hough's Fur Shed (Barnesville, MN). The GH-II primarily consisted of pure skunk essence.

The scent canisters were used to lure marten to the site after which the smell of beaver meat would most likely take over to bring the marten directly to the detection device. The beaver meat bait was provided by North Dakota Game and Fish and came from locally trapped beavers. Approximately 85 to 170 g (3 to 6 ounces) of beaver meat were placed on the bait end of the track plates. Sites with only a camera trap had beaver meat on a stick or log elevated approximately 0.3 m off the ground and placed 1 – 1.5 m away from the camera (Figure 6). Sites with both a track plate and a camera had the same bait setup as the track plate sites but with the camera facing the open end (or soot end) of the track plate (Figure 7). I located the largest tree with the flattest ground surface to place the track plates. Large trees, downed logs, or stumps covered the bait end opening of the track plate so as to ensure that any animal searching for the meat would enter the soot end opening. I ensured that the bait end was completely sealed off placing additional coarse woody debris around any remaining holes around the tree or stump. Grasses, shrubs, and small trees around the camera sites were cleared to decrease false triggers from wind as well as to secure a clear photo of any animal entering the site.

Figure 6. Camera site in the North Dakota Turtle Mountains study on American marten during the summer of 2007. The bait is approximately 1 - 1.5 m away from the camera, and elevated approximately 0.3 m from the ground. Some sites had large snags upon which I placed the meat. At these sites the meat was elevated 0.5 – 1 m off the ground.

Figure 7. Track plate and camera trap site in the North Dakota Turtle Mountains study on American marten during the summer of 2007. The cameras were placed at varying distances from the track plates but low enough and close enough to take photos of any animal entering the track plate.

I employed a stratified random sampling design. I divided the Turtle Mountains into 14 10 x 10 km cells (Appendix C). Each 10 x 10 km cell was further subdivided into 100 1 x 1 km cells. Using National Land Cover Data (NLCD) with 30-m resolution, I was able to determine the percentage of forest cover for each 1x1 km cell. I deemed a cell worthy of sampling if it had at least 50% forest cover, totaling 515 cells as candidates for sampling (Appendix D). I randomly sampled 11.7% of the candidate cells in each of the 100 km^2 units (Appendix E), excluding the majority of the two most southeastern 100 km^2 units, as this is the location of the local Native American Ojibwe tribe and I was unable to sample sites on the reservation. If a candidate cell was inaccessible, I then sampled the next randomly selected 1 x 1 km cell in the respective 100 km^2 unit. The proportional sampling within each 10 x 10 km allowed me to concentrate my detection efforts in areas with proportionally more forest cover and therefore, suitable marten habitat.

The fieldwork took place during the summer of 2007 in a series of four cycles beginning on June 19 and ending on August 13. I sampled 20 cells per cycle over the first three cycles for a total of 60 sampled cells. The 20 cells per cycle were also randomly chosen to prevent regional sampling bias (e.g., sampling only in the western 100 km^2 units). Thus, the 20 cells per cycle were located within a minimum of 10 of the (essentially) 12 100 km^2 units. I sampled three random sites in each of the 20 cells, totaling 60 actual sample sites per cycle.

Each cycle lasted 10-14 days. I set out track plates and camera traps for the first 4 to 5 days, then re-baited the track plates for the following 3 to 4 days. I replaced the shelf liner paper if any tracks were present upon revisiting the site to re-bait. Half of the camera-only stations also were re-baited in the first cycle to determine if re-baiting was necessary for the remaining cycles. I discovered that re-baiting the camera-only sites was unnecessary as animals seemed to be attracted to the scent lures without bait for the duration of the sampling at that site. I collected the track plates and cameras for the 4-5 days following the re-baiting. Then, I repeated the cycle. The fourth cycle was structured somewhat differently in that the sites and cells were not randomly chosen. Based on presence/absence information obtained in the first three cycles, I then strategically sampled smaller forested islands to determine the dispersal distance thresholds for martens. The fourth cycle was not included in the analysis.

GPS locations were collected at every site (Appendix F). I also ranked each site's understory density and percent canopy cover on a scale from 1-5. Understory was ranked as: 1) if only grass was present at heights of 2 to 5 cm, 3) if the vegetation was 1 m (chest height) or lower and moderately easy to traverse, and 5) if the vegetation was 1.25 m or higher and difficult to traverse. I did not have specific criteria for the rankings of canopy cover other than a categorical one where a "one" indicated no canopy cover whatsoever and a "five" indicates barely any sky visible. I also documented the distance to visible water sources and the presence of pre-existing animal trails, which includes whitetail deer and cattle trails.

Analysis

I analyzed data on 123 sampled sites. The first cycle of sampling was a pilot to determine the appropriate sampling methods (e.g., type of bait, if a site needed to be re-baited, type of scent lure). The fourth cycle was not randomly sampled; I strategically chose sites to sample based on the previous cycles. Data from the fourth cycle is not reported here. Although a total of 232 sites were sampled, the 123 were sampled most consistently over the second and third cycles of stratified random sampling (conducted from June 30th through July 27th) and thus, vary the least from each other. Cycle 3 had one 1 x 1 km cell whose sites had to be removed one day after setting them up. I immediately randomly selected another cell in the same 100km^2 sampling unit and set up three sample sites; thus, the total number sites sampled for cycles two and three equals 123 instead of 120.

I assessed the time elapsed from baiting the sites until a marten detection. I also examined the number of detections per cycle with each detection device. Multiple track plate detections were evaluated by observing marten tracks upon re-baiting, and subsequently observing a second set of tracks when I returned to take down the site. Any photos of the same species taken more than 30 min apart were considered multiple detections. There were no sites with both cameras and track plates where I could confirm multiple detections between cameras and track plates as there was no way to discern marten photos from tracks at the same site. Therefore, these detections are based on time stamps in the photos and observations made during site checks, with no overlap between both devices at one site. I classified the camera detections into six 4-hr time slots to group the detections by time of day: 00:01 – 04:00, 04:01 – 08:00, 08:01 – 12:00, 12:01 – 16:00, 16:01 – 20:00, and 20:01 – 00:00. Two time slots, 04:01 – 08:00 and 16:01 – 00:00, were classified as crepuscular since the photoperiod during the summer at 48°N is extensive. Three time slots, 08:01 – 12:00, 12:01 – 16:00, and 16:01 – 20:00, were classified as diurnal. The remaining time slot, 20:01 – 00:00, was classified as nocturnal.

I entered the GPS locations of the 123 sites into ArcGIS 9.2 (Environmental Sciences Research Institute, Redlands, California, www.esri.com) and created 5 buffer zones with the following radii around each site: 100 m, 250 m, 500 m, 1 km, and 2 km. I chose to analyze the data at 100 m to look for trends associated specifically with the sample sites. In order to get different interpretations of marten habitat selection near the sample sites, I incorporated the 250 m and 500 m buffers based on the scale of the remotely sensed data. The 1 km and 2 km scales were included to encompass the average home range of the female and male marten, respectively, to deduce landscape scale trends possibly associated with marten presence. I gathered information on several variables (Table 2) using both Patch Analyst 3.12 (Rempel 2007) for GIS, which incorporates FRAGSTATS, and the National Land Cover Dataset (NLCD) classifications with 30-m resolution. Any area within the buffer zone that occurred inside the Canadian border was removed from the buffer zone as GIS data from Canada was unavailable. Most of the variables were analyzed at all five scales; however, data at some scales were unattainable (Table 3).

Table 2. Variables used in data analysis for marten habitat in the North Dakota Turtle Mountains American marten study during the summer of 2007. For a more in depth description of these variables, see Appendix G.

Variable	Description
WATER	hectares of water
DEVELOPED	hectares of developed land
FOREST	hectares of forest (any kind)
GRASS	hectares of grassland
AG	hectares of agricultural land
WETLAND	hectares of wetlands
MPS	mean patch size
ED	edge density
MPFD	mean patch fractal dimension
AWMPFD	area weighted mean patch fractal dimension
MNN	mean nearest neighbor
IJI	interspersion and juxtaposition index
STRM_DEN	stream density in meters per hectare
ROAD_DEN	road density in meters per hectare
UD	understory density
CC	canopy cover
NUMP	number of patches
MSI	mean shape index
AWMSI	area weighted mean shape index

Table 3. Variables used for analysis at each buffer in marten habitat in the North Dakota Turtle Mountains American marten study during the summer of 2007. Note that not all variables were useful or available at each scale. CC and UD were only used at the 100 m because I assigned the values at each site and thus they are not applicable at larger scales.

Variable	100m	250m	500m	1km	2km
WATER	x	x	x	x	x
DEVELOPED	x	x	x	x	x
FOREST	x	x	x	x	x
GRASS	x	x	x	x	x
AG	x	x	x	x	x
WETLAND	x	x	x	x	x
MPS	x	x	x	x	x
ED	x	x	x	x	x
MPFD	x	x	x	x	x
AWMPFD	x	x	x	x	x
MNN	x	x	x	x	x
IJI	x	x	x	x	x
STRM_DEN	x	x	x	x	x
ROAD_DEN	x	x	x	x	x
UD	x				
CC	x				
NUMP		x	x	x	x
MSI			x		x
AWMSI		x	x		x

I performed correlation analysis on all variables using Minitab version 14. I used the statistical software package R version 2.6.1 (The R Foundation for Statistical Computing, www.r-project.org) for the remainder of the analysis. I conducted univariate logistic regression on each variable to determine how well the variables independently explained the presence or absence of marten. I calculated the mean and standard deviation of each variable for detection and non-detection sites. The data were not normally distributed, however, so I used the nonparametric Kruskal-Wallis test to determine if a significant difference existed between detection and non-detection sites.

All variables that were not significant at the 0.25 level (Zielinski et al. 2004) in the univariate logistic regression models were removed. If any remaining variables were correlated (>│.70│) (Payer and Harrison 2003), I kept those with the smaller p-value and AIC value.

The remaining variables were placed in a logistic regression model. P-values and AIC values were used to assess the significance of each variable. These two indexes in addition to the le Cessie-van Houwelingen goodness-of-fit test (Hosmer et al. 1997; le Cessie and van Houwelingen 1991) were used to assess the predictive capability of each subset model at the five buffer levels. Variables with borderline significance (p-value ~ 0.10), but that likely were ecologically important to martens, were kept unless they proved highly insignificant (p-value >0.25) in the best subset models. Variables were considered significant at the 0.05 alpha level (Payer and Harrison 2003; Ruggiero, Pearson, and Henry 1998). I also tested all two-way interactions between the variables that were significant in the univariate logistic regression models. Models with p-values >0.10 were considered to fit the data well. All final models were compared to AIC stepwise regression to crosscheck the chosen variables for each model. A complete table of the data used in my analysis is in Appendix H.

Chapter 3: RESULTS

The track plates were deployed for an average of 5 trap nights (± 0.15 nights). The average time until a marten detection was 5.5 trap nights ($\sigma = 1.87$). The shortest time period between setting (or re-baiting) the track plates and marten detections was two days; the longest time period was eight days. The camera traps were out for an average of 9.78 nights (± 0.24). The average time until a marten detection was 3.95 trap nights ($\sigma = 2.76$). I recorded marten detections the same day I set out the camera traps, making the shortest time until detection less than 12 hr. The longest elapsed time between setting the camera traps and detecting a marten was 9 days.

Out of 123 sampled sites, 26 (21.1%) had confirmed marten detections (Appendix I). I detected martens on track plates at 6 of 31 (19.4%) of the sites with track plates in the second cycle and 5 of 34 (14.7%) in the third cycle. There were two marten detections on track plates at 1 of 31 (3.2%) of the sites with track plates in cycle two, and at 2 of 34 (5.9%) in cycle three. I detected multiple martens in photos at 9 of 39 (23.1%) of the sites with cameras in cycle two, and 11 of 43 (25.6%) in cycle three. There were 13 distinct marten detections from the 39 cameras traps set during the second cycle, and 21 distinct detections from the 43 cameras set during the third cycle. Overall, 13 of 26 (50%) of the sites with confirmed marten detections had multiple marten detections.

Most (46%) of the detections in cycle two were diurnal (Figure 8). However, 42.9% of the detections in cycle three were crepuscular (Figure 9), as the onset of twilight did not begin until after 20:00 in the summer time. Overall, most (26.5%) of marten activity was crepuscular (Figure 10).

Figure 8. Frequency of marten activity in the Turtle Mountains of North Dakota study of American marten, during cycle two, from June 30 – July 12. This graph is specific to the distinct camera trap detections. Photos more than 30 min apart were considered separate detections.

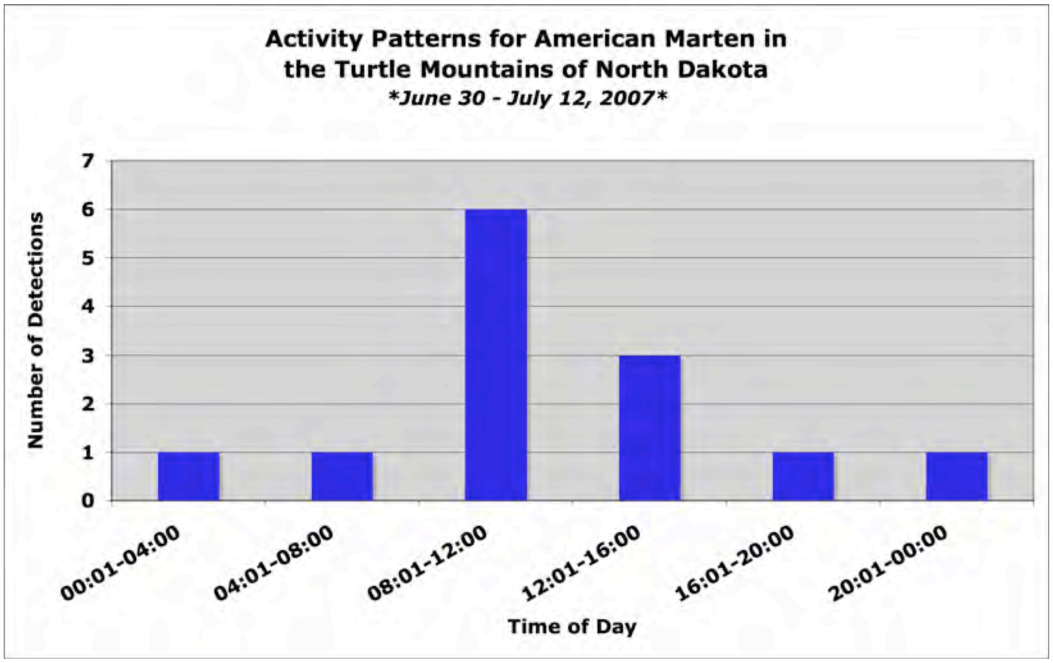


Figure 9. Frequency of marten activity in the Turtle Mountains of North Dakota study of American marten, during cycle three, from July 14 – July 27. This graph is specific to the distinct camera trap detections. Photos more than 30 min apart were considered separate detections.

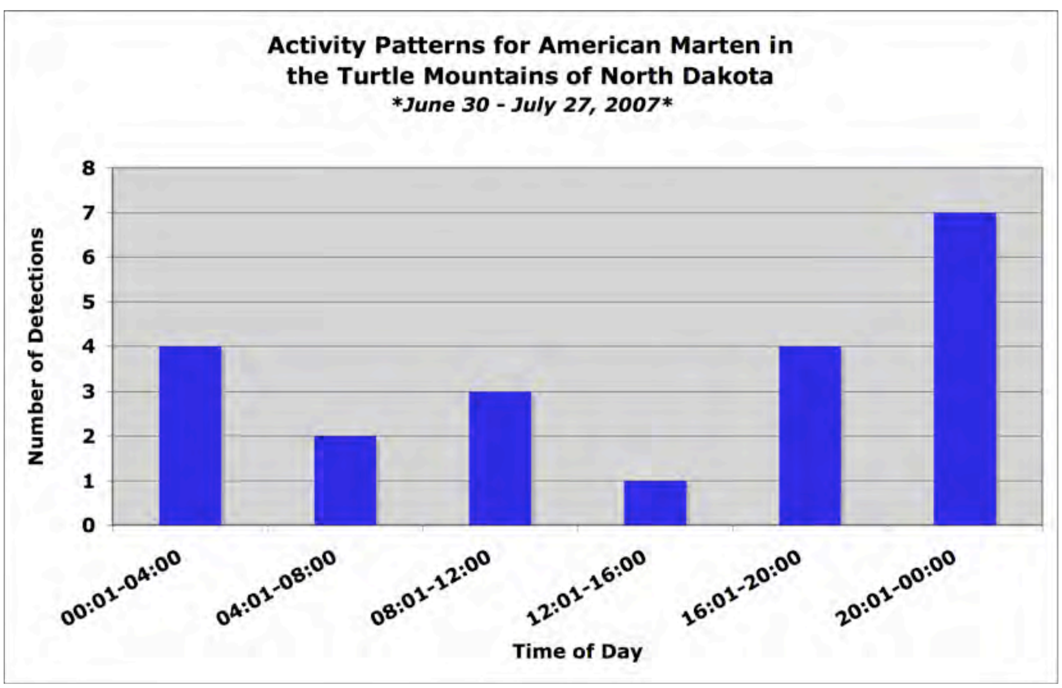
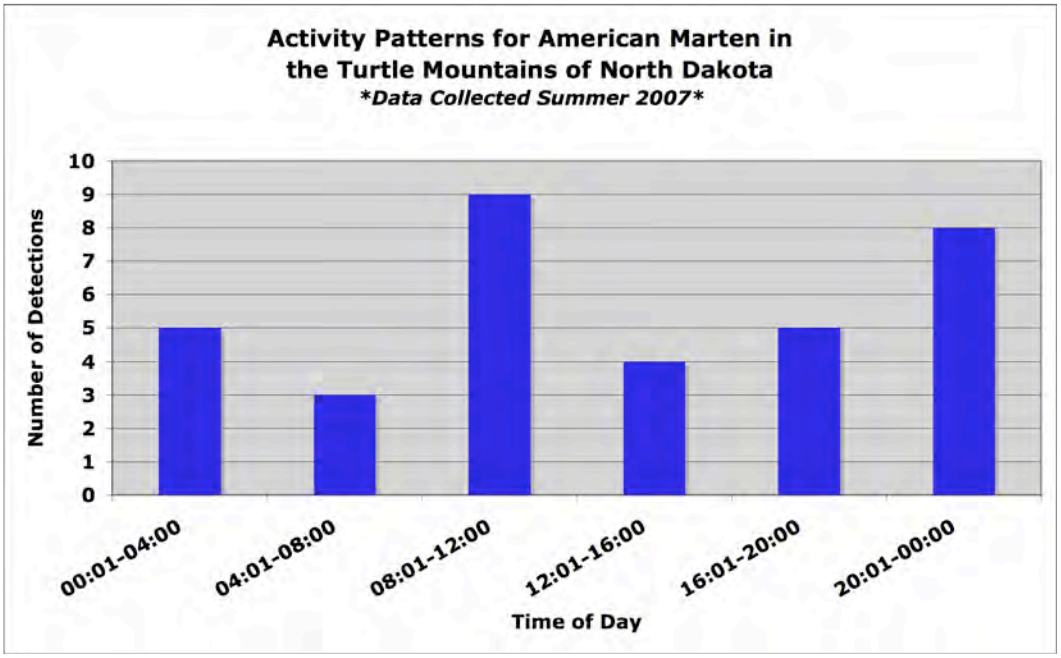


Figure 10. Frequency of marten activity in the Turtle Mountains of North Dakota study of American marten during June 30 to July 27, 2007. This graph is specific to the distinct camera trap detections. Photos more than 30 min apart were considered separate detections.



Although sightings of fisher had been reported in the Turtle Mountains, I did not detect any fishers. I did, however, detect several other species, such as coyote, striped skunk, mink, and ground squirrel. Appendix J lists the species (with scientific names) detected during my study and the sites at which they were detected.

The fragmentation variables were those with the highest correlations ($> |.70|$) (Appendix K), although the variables that measured water were also correlated at most scales. The variables most often correlated at the five buffer scales were: WATER and STRM_DEN, MPS and NUMP, MPFD and MSI, AWMPFD and AWMSI, AWMPFD and MPFD, and AWMSI and MPFD.

Univariate Analysis

The remaining uncorrelated ($< |.70|$) variables were assessed individually using univariate logistic regression (Table 4). FOREST, MNN, and ED consistently had the highest p-values at each buffer scale.

Table 4. P-values for univariate logistic regression on variables assessed for significance in suitable marten habitat in the American marten study in the Turtle Mountains of North Dakota during the summer of 2007. P-values <0.25 were considered significant.

Variable	100 m	250 m	500 m	1 km	2 km
WATER	0.144	0.095	0.102	0.016	0.003
DEVELOPED	0.487	0.299	0.025	0.024	0.018
FOREST	0.861	0.547	0.861	0.894	0.438
GRASS	0.184	0.483	0.362	0.153	0.225
AG	0.550	0.457	0.131	0.086	0.043
WETLAND	0.218	0.404	0.757	0.954	0.517
MPS	0.066	0.737	0.629	0.662	0.616
ED	0.994	0.356	0.734	0.848	0.689
MPFD	0.686	0.250	0.909	0.845	0.049
AWMPFD	0.584	0.129	0.293	0.009	0.101
MNN	0.117	0.397	0.963	0.943	0.796
IJI	0.975	0.028	0.128	0.161	0.235
STRM_DEN	0.729	0.262	0.076	0.031	0.006
ROAD_DEN	0.540	0.916	0.123	0.027	0.008
UD	0.090	-	-	-	
CC	0.393	-	-	-	
NUMP	-	0.802	0.450	0.930	0.059
MSI	-	-	0.821	-	0.028
AWMSI	-	0.073	0.145	-	0.068

I also calculated the mean, $\bar{x}$, and the standard deviation, σ, for each variable at both detection and non-detection sites (Appendix L); however, the data were not normally distributed, so I assessed the differences between detection and non-detection sites for each variable using the nonparametric Kruskal-Wallis test (Table 5). The following variables consistently had the lowest p-values across all scales at which I assessed them: WATER, DEVELOPED, AG, AWMPFD, IJI, STRM_DEN, and ROAD_DEN.

Table 5. P-values for nonparametric Kruskal-Wallis test on variables assessed for significance in suitable marten habitat in the American marten study in the Turtle Mountains of North Dakota during the summer of 2007. P-values <0.05 denote a significant difference between detection and non-detection sites.

Variable	100 m	250 m	500 m	1 km	2 km
WATER	0.037	0.071	0.116	0.015	0.007
DEVELOPED	0.690	0.256	0.099	0.002	0.012
FOREST	0.825	0.541	0.850	0.993	0.285
GRASS	0.273	0.921	0.487	0.155	0.656
AG	0.402	0.330	0.210	0.076	0.019
WETLAND	0.160	0.843	0.744	0.819	0.396
MPS	0.077	0.859	0.629	0.905	0.156
ED	0.283	0.249	0.441	0.912	0.285
MPFD	0.855	0.269	0.719	0.813	0.045
AWMPFD	0.780	0.129	0.257	0.003	0.095
MNN	0.102	0.528	0.298	0.929	0.364
IJI	0.952	0.092	0.114	0.103	0.115
STRM_DEN	0.514	0.241	0.125	0.115	0.032
ROAD_DEN	0.720	0.703	0.230	0.038	0.006
UD	0.071	-	-	-	-
CC	0.392	-	-	-	-
NUMP	-	0.898	0.557	0.939	0.055
MSI	-	-	0.845	-	0.010
AWMSI	-	0.078	0.181	-	0.055

Buffer Models

Below are the final models for each buffer level. Each variable coefficient, β, is given as the natural log (*ln*) of the point estimate in the equation.

100 m Buffer Model

$$log\ (\pi_i / 1 - \pi_i) = -3.1903 + 1.0671\ WATER - 5.7447\ WETLAND + 0.7647\ MPS$$

	$e^{(\beta)}$	P-values	95% Wald CI for β	95% Wald CI for $e^{(\beta)}$
Intercept	0.41	0.001	(-5.004, -1.376)	(0.007, 0.253)
WATER	2.907	0.026	(0.129, 2.005)	(1.138, 7.426)
WETLAND	0.003	0.255	(-15.639, 4.149)	(0.000, 82.674)
MPS	2.148	0.024	(0.100, 1.430)	(1.105, 4.178)

The AIC = 124.56 and the le Cessie-van Houwelingen (CH) goodness of fit statistic = 0.64. I analyzed four different models until I arrived at this model. No interaction terms were significant. I chose to keep WETLAND in the model because the study area is located in the prairie pothole region and thus, wetlands are a significant factor in this landscape that influence the vegetation and movement of martens (Bissonette, Fredrickson, and Tucker 1989). The intercept odds ratio, 0.410, indicates that one is 59% less likely to see a marten in the 100 m buffer zone without accounting for any variables. The odds ratios for the variables in the model indicate an increase or decrease in the odds of finding a marten for every one unit increase in the variable.

250 m Buffer Model

$$log\ (\pi_i / 1 - \pi_i) = -0.0885 + 0.1165\ WATER - 1.8848\ AWMSI + 0.0234\ IJI$$

	$e^{(\beta)}$	P-values	95% Wald CI for β	95% Wald CI for $e^{(\beta)}$
Intercept	-0.915	0.946	(-2.671, 2.494)	(0.069, 12.110)
WATER	1.124	0.119	(-0.030, 0.263)	(0.970, 1.301)
AWMSI	0.152	0.013	(-3.370, -0.400)	(0.034, 0.670)
IJI	1.024	0.012	(0.005, 0.042)	(1.005, 1.043)

The AIC = 122.2 and the CH statistic = 0.77. I analyzed two different models until I arrived at this model. No interaction terms were significant nor created a better fit of the model. Although WATER has a p-value higher than 0.05, its value is not very far from this cutoff. Water is an important resource to martens and thus, was left in the model. The intercept odds ratio, 0.915, indicates that one is 8.5% less likely to find a marten in the 250 m buffer zone without accounting for any other variables. The odds ratios for the variables in the model indicate an increase or decrease in the odds of finding a marten for every one unit increase in the variable.

500 m Buffer Model

$$log\ (\pi_i\ /\ 1 - \pi_i) = -4.1579 + 0.0158\ DEVELOPED + 0.0211\ IJI + 0.0372\ STRM\_DEN$$

	$e^{(\beta)}$	P-values	95% Wald CI for β	95% Wald CI for $e^{(\beta)}$
Intercept	0.016	0.002	(-6.765, -1.551)	(0.001, 0.212)
DEVELOPED	1.016	0.007	(-0.100, 0.131)	(0.905, 1.140)
IJI	1.021	0.164	(-0.009, 0.051)	(0.991, 1.052)
STRM_DEN	1.038	0.043	(0.001, 0.073)	(1.001, 1.076)

The AIC = 125.09 and the CH statistic = 0.97. I analyzed four models until I arrived at this model. None of the interaction terms augmented the model. The IJI p-value is higher than 0.05 but I chose to keep the variable in the model because the unique forest mosaic of the Turtle Mountains undoubtedly has some effect on martens that is represented in this landscape metric. The intercept value of 0.016 means that one is 98.4% less likely to detect a marten in the 500 m buffer zone without accounting for any other variables. The other variables represent the odds of detecting martens given a one unit increase in the variable. For example, for every hectare of developed land in the buffer zone, the odds of detecting a marten increase by 1.6%.

1 km Buffer Model

$$log\ (\pi_i\ /\ 1 - \pi_i) = -6.6969 + 0.0253\ WATER + 0.0714\ DEVELOPED + 0.0373\ IJI$$

	$e^{(\beta)}$	P-values	95% Wald CI for β	95% Wald CI for $e^{(\beta)}$
Intercept	0.001	0.006	(-11.495, -1.899)	(0.000, 0.150)
WATER	1.023	0.007	(0.007, 0.044)	(1.007, 1.045)
DEVELOPED	1.074	0.001	(0.028, 0.115)	(1.028, 1.122)
IJI	1.038	0.151	(-0.014, 0.088)	(0.986, 1.092)

The AIC = 118.23 and the CH statistic = .52. I analyzed 5 models until I arrived at this final model. Interaction terms did not prove useful to the model so I only fitted the main effects of the significant variables. I kept IJI in the model because it represents the forest mosaic, and in a landscape with such a distinct and unique distribution of forest, I believe this variable is important to the model. The odds of finding a marten without accounting for any additional variables are extremely low – 99.9% that one will not detect a marten in the 1 km buffer zone. The variables in the model represent the odds of detecting a marten for every one unit increase in the variable.

2 km Buffer Model

$$\log(\pi_i / 1 - \pi_i) = -3.2082 + 0.0118\ WATER + 0.0324\ DEVELOPED - 0.3296\ AWMSI$$

	$e^{(\beta)}$	P-values	95% Wald CI for β	95% Wald CI for $e^{(\beta)}$
Intercept	0.040	0.015	(-5.791, 0.626)	(0.003, 1.870)
WATER	1.012	0.000	(0.006, 0.018)	(1.006, 1.018)
DEVELOPED	1.033	0.004	(0.010, 0.054)	(1.010, 1.055)
AWMSI	0.719	0.067	(-0.685, 0.025)	(0.504, 1.025)

The AIC = 110.8 and the CH statistic = 0.59. Interaction terms did not augment the model and thus were not included in the final model. I analyzed nine models before arriving at this final model. Although the AWMSI p-value is higher than 0.05, I chose to keep this variable in the model because both it is very close to 0.05 and it represents the effects of differently shaped forest patches on martens. These effects have been useful in other studies (Bissonette, Fredrickson, and Tucker 1989; Hargis, Bissonette, and Turner 1999), and were significant in the 250 m buffer model as well. The intercept reveals that the odds of detecting a marten in the 2 km buffer, without accounting for any other variables, are low. One is 96% less likely to detect a marten in this buffer zone.

Chapter 4: DISCUSSION

Univariate Analyses

The univariate analysis illustrates the importance of water at all five scales. Both the average hectares of water and the average stream density increase at every scale in accordance with marten detections, and, the Kruskal-Wallis p-values for hectares of water are significant (<0.05) at most scales. Martens select habitat with abundant water resources not only to meet their basic mammalian needs, but also because these lakes, streams, and wetland areas provide riparian vegetation that facilitates dispersal and migration in an otherwise grassy physiographic province (Bissonette, Fredrickson, and Tucker 1989). The significance of water illustrated by the analysis here underscores the importance of conserving this valuable resource in the Turtle Mountains.

In addition to copious amounts of water bodies typical of this glaciated region, the Turtle Mountains have some developed areas, although most is low intensity residential. Interestingly, even though marten detections are associated with an increased average amount of developed land at every scale and an increased average road density at four of the five scales, developed land was inconsequential to marten detections at the smaller scales and road density was significant only at the 1 km and 2 km scales. This suggests that significant amounts of development were mostly in the periphery of the buffer, the area furthest away from the central points of marten detection. The statistical significance of developed areas at the larger scales could mean that martens are actually selecting forested habitat located far from these altered environments. If this is the case, development is a positive predictor of the distance martens will travel to avoid man-made structures or open areas in general (Buskirk and Powell 1994; Hargis and McCullough 1984; Spencer, Barrett, and Zielinski 1983).

Another possibility of what is most likely open or low intensity development is increased prey densities along the forest edge or in fields (Spencer, Barrett, and Zielinski 1983). Martens may find it easier to forage in unforested areas due to increased visibility and less obstructions from CWD and other dense vegetation. However, marten diet in the Turtle Mountains is unknown, including the abundance of prey, and thus, more research is needed to test this hypothesis.

Forest patch shape (as indicated by AWMSI) is another significant variable, or close to being significant, at the 250 m, 500 m, and 2 km scales. Although not significant at the 1 km scale, a similar index, (AWMPFD), was significant. The average of these indices decreased with marten detections, suggesting that less serpentine patches are associated with marten presence. Larger forested interior allows martens to conserve energy by not traveling as far to forage or to find resting or denning structures (Hargis, Bissonette, and Turner 1999). They have more habitat nearby to meet their needs rather than having to traverse more land to enter peninsular or other isolated forested areas.

Not only patch shape, but the arrangement of forest patches appears important to marten presence as well. The IJI index was almost significant (p-values near 0.10) at the four larger scales, with average values increasing in association with marten detections at these scales as well. This indicates that marten presence is more likely as forest patches become equally adjacent to each other (Chapin, Harrison, and Katnik 1998). The forest patches of the Turtle Mountains have substantial connectivity, giving martens the ability to easily move from one patch to another. The interspersion and juxtaposition of these patches favors martens by allowing them to move between forests without spending excessive time in open areas where they are more susceptible to predation.

The amount of agricultural land was another variable that varied significantly between detection and non-detection sites at the 1 km and 2 km scales. Martens were detected in areas where the average amount of agricultural land decreased. Less agriculture is commensurate with the preservation of the forests in the Turtle Mountains. Since I sampled in 1 km grid cells with at least 50% forested land cover, the probability of substantial amounts of agricultural land in the smaller buffers is low. Similar to developed land, martens could also be displaying a preference for forests away from agricultural land that occupies sizeable amounts of area on the periphery of the buffers. With the known hesitancy of martens to venture into unforested areas (Buskirk and Powell 1994; Hargis and McCullough 1984), agricultural land is probably not beneficial.

Buffer Models

Similar factors affected marten presence/absence in the forests of the Turtle Mountains of North Dakota at each of the scales analyzed in this study. The amount of water present was a significant variable at all scales, whether the water was located in lakes or streams. Studies of martens in wetlands are not anomalous (Zielinski, Spencer, and Barrett 1983; Bissonette, Fredrickson, and Tucker 1989). Buskirk and Powell (1994) noted marten preference for riparian habitat in the Rocky Mountains of Wyoming. Water resources create riparian corridors that are important for maintaining connectivity between isolated patches of forest (Bissonette, Fredrickson, and Tucker 1989). These corridors facilitate movement and successful dispersal of American martens. The significance of the amount of water as a predictor of marten presence/absence carried through the two levels of analysis reflect the basic biogeographic and biologic conditions necessary for survival of American martens.

Average patch shape, an indication of interior forest area, also surfaced as a significant marten presence/absence predictor at the 250 m and 2 km scales of analysis, similar to the significance displayed in the univariate analysis. The odds ratios at both scales indicate that the likelihood of detecting marten decreases with the loss of forested interior associated with increasingly convoluted patch shapes. Selection of larger forest stands is consistent with other studies (Flynn and Schumacher 1999; Hargis, Bissonette, and Turner 1999; Snyder and Bissonette 1987). As Potvin et al. (2000) observed, large forest interior is commensurate with larger home ranges. The 2 km buffer area encompasses the average, and larger, home range of the male marten, 8.1 km^2. Therefore, it's possible that male martens are selecting for forested interior more than female martens at this scale. The territorial tendencies of the male marten might explain this phenomenon. Sufficient forest interior allows male martens to maintain their home ranges in forested habitat rather than having to venture further to obtain food or find a mate. Although male martens do tend to be trapped more than females (Buskirk and Lindstedt 1989), further studies about sex and age ratios within the Turtle Mountain population are necessary to confirm this hypothesis. Larger forested interior is commensurate with less patchiness in the forest, and thus, martens could also be displaying a preference for less patchy habitat. Similarly, the significance of circular or square patch shapes for the 250 m buffer probably illustrates the need for patches large enough to provide shelter and foraging habitat.

Forest patch shape was not significant at the 500 m and 1 km buffer scales. Only developed land, forest patch interspersion and juxtaposition, and water were significant at these scales. It is possible that not enough developed land existed in the 250 m buffer and, therefore, was significant; however, once the buffer expanded to the 500 m and 1 km buffers, the influence of the amount of developed land overshadowed the potential impacts of forest patch shape. Upon reaching the 2 km scale, the amount of developed land was most likely negligible in comparison to the effects of forest patch shape.

The juxtaposition index seems to be a better predictor of marten presence/absence at the 500 m and 1 km scales, yet works in tandem with patch shape at the 250 m scale. The amount of forested interior appears less important than how forest patches are positioned around each other, although at the largest scale (2 km) forested interior is significant. At the 250 m, 500 m, and 1 km scales, the IJI odds ratios indicate that as forest patches become increasingly located near one another as well as adjacent to other land use types, the odds of detecting martens increase. Martens are rather hesitant to venture, at most, more than 5 – 6 km into unforested land (Hawley and Newby 1957; Powell, Buskirk, and Zielinski 2003; Robinson 1953). The increased juxtaposition allows martens to traverse less unforested land before reaching forested habitat. It is also possible that the more juxtaposed the landscape with forest patches, the more options martens have to find various prey associated with different forest structures (e.g., dense understory, disturbed habitat). More information on marten prey in this region is needed. Regardless, a trend showing the importance of forest patch arrangement is evident from the univariate analysis as well as the logistic regression models.

Interestingly, the amount of developed land became a positive predictor at the three largest buffer scales. Areas with at least 20% human-built structures constitute developed land. If marten densities are high in the Turtle Mountains, juveniles might be forced into less suitable habitat with more developed area. Since juvenile martens are less wary of predators and thus, more likely to be curious of trapping sites (Strickland 1994), it is likely that I detected more juvenile martens than adults. Although I did not take any tree measurements (such as basal area), I observed a few large diameter trees, large downed logs or stumps, and cavities for martens to use as denning or resting sites (Buskirk and Ruggiero 1994; Flynn and Schumacher 1999). Developed areas may offer structures suitable for denning or resting. Holyan et al. (1998) documented marten use of cabins in central Oregon. Similarly, martens were using cabins located within the nearby International Peace Gardens as dens and resting sites. Such developed areas may offer cover in a landscape where normal forest structures used for cover are scarce. Martens could also be taking advantage of higher prey densities along the edges of these developed areas as long as sufficient canopy cover exists (Douglas, Fisher, and Mair 1983; Fuller and Harrison 2005; Spencer, Barrett, and Zielinski 1983). However, since this variable is significant only at the larger scales in both the univariate and logistic regression analysis, martens might be selecting against larger tracts of developed land by spending more time at a distance from these open areas. The lack of closed canopy in more open developed land most likely precludes marten detections within these areas. Further investigation of this trend is necessary.

Habitat

The Turtle Mountains are a unique habitat for martens as they contain primarily deciduous forest. Several studies claim that old growth coniferous or mixed forest is primary marten habitat (Bateman 1986; Bissonette, Fredrickson, and Tucker 1989; Buskirk and Ruggiero 1994; Strickland and Douglas 1987; Thompson 1991; Thompson and Harestad 1994). Raine (1983) conducted a study in Southeast Manitoba, near the Turtle Mountains, claiming that martens preferred conifer stands. Even Hénault and Renaud (1993) found that individual martens trapped in coniferous stands weighed more than martens caught in other forest types. Yet, Potvin et al. (2000) found that martens actually preferred deciduous or mixed forests with dense coniferous shrubs, and Payer (2003) noted the preference for deciduous forests over mixed forests due to increased prey in deciduous stands.

Thompson (1991) suggests multiple reasons for why marten would want to live in old forests: predator avoidance, prey availability, subnivean access, and natal dens in large diameter trees. He also claims that predominantly aspen forests are not suitable for marten populations. Thompson and Harestad (1994) argue that marten are unable to survive in primarily deciduous forests. However, I found evidence of several martens, albeit reintroduced, in the primarily deciduous forests of the Turtle Mountains. Referring to Thompson's reasoning for old forest preferences, the Turtle Mountains offer all but large diameter trees as denning structures. Several of my marten detection sites had high understory density, but low amounts of canopy cover. These understory densities ranged 1-2 m in height and were littered with a mix of coarse woody debris and thick herbaceous and woody plants, both of which are important to marten habitats (Corn and Raphael

1992; Spencer, Barrett, and Zielinski 1983). This complex understory provides sufficient protection from avian predators in the same way that dense canopy cover offers protection. Powell et al. (2003) mention that ample understory can substitute for canopy cover. The coarse woody debris in these areas also allows subnivean access in the winter. The forest structure of the Turtle Mountains appears to meet most of the habitat requirements for successful marten populations.

Although I do not have forest metrics to compare to other studies, I believe my research lends credibility to what seems to be an emerging consensus on the importance of forest structure rather than type. Payer (2003) concluded that structural complexity is imperative for martens to disperse and survive. Chapin et al. (1997) also found that vertical and horizontal structural complexity is more important than dense vegetation, coniferous forest, or old growth, as they detected no difference in use of coniferous, deciduous, or mixed forest stands. Allen (1987) agrees that conifers are important, but also emphasizes the significance of structural diversity. The Turtle Mountains offer plenty of structural diversity that allows martens to meet their foraging, protection, and denning requirements (Figures 11 and 12). This includes quaking aspen trees interspersed with paper birch and bur oak, pockets of dense shrubs such as hazel and willow, and copious amounts coarse woody debris. The complex understory also allows subnivean access during the winter for efficient hunting (Hargis and McCullough 1984) and protection from predators. Although it remains unclear where martens are denning, the fact that they have been surviving in the Turtle Mountains for probably more than a decade attests to their adaptive capability in forested habitats that fall outside the dominant habitat paradigm.

Figure 11. Example 1 of the understory density at a sample site in the Turtle Mountains, North Dakota study on American marten during the summer of 2007.

Figure 12. Example 2 of the understory density at a sample site in the Turtle Mountains, North Dakota study on American marten during the summer of 2007.

Chapter 5: Management Implications

This research has multiple management implications for martens in the Turtle Mountains. Water is an important resource and efforts should be made to conserve riparian habitat along wetlands, lake shores, and stream corridors to ensure successful movement and dispersal of American martens. Clear-cutting should be avoided to preserve the most forest interior possible, and the connection within areas with patches adjacent to one another should be protected. Understory density and structure also play vital roles in maintaining suitable marten habitat. Coarse woody debris and large downed trees or stumps should not be cleared in order to provide spaces for subnivean maneuvering and denning and resting sites. Efforts should be made to preserve large diameter deciduous (e.g., bur oak) and coniferous trees for denning and resting sites as well. The importance of deciduous forests should not be underestimated, as martens were found throughout the deciduous forests of the Turtle Mountains, and thus, this forest type should be preserved. Fur trapping should only be considered after further information on American marten demographics is obtained so that state agencies may implement sustainable harvest regulations capable of protecting this unique mustelid population.

Chapter 6: Conclusion

The objective of my study was to determine the presence/absence of American marten in the Turtle Mountains of North Dakota and ascertain landscape variables that influenced their presence at five scales. Ultimately, this study verifies marten range expansion in the Turtle Mountains, presumably from reintroductions in neighboring Manitoba. I found that water resources, developed land, forest patch shape, and the interspersion and juxtaposition of forest patches are all significant variables. Water is significant at all scales, whereas developed land is significant at larger scales. Forest patch shape and the interspersion and juxtaposition of forest patches were significant at various scales. Further research at finer stand scales is needed to assess the influence of these forest metrics as well as that of developed land. Although these variables do not drastically affect the probabilities of detecting marten presence, they do indicate some level of influence on the mammal. The results illustrate the importance of scale in habitat analysis and management. Despite the lack of some quantitative data in this study, I hypothesize that the complex structures of deciduous forests in the Turtle Mountains suggest a shift towards thinking of suitable marten habitat not as a particular forest type, but as one with diverse and complex forest structure, regardless of composition. Further research is needed on Turtle Mountain forest structure and marten population demographics to further explain and investigate the results of these findings.

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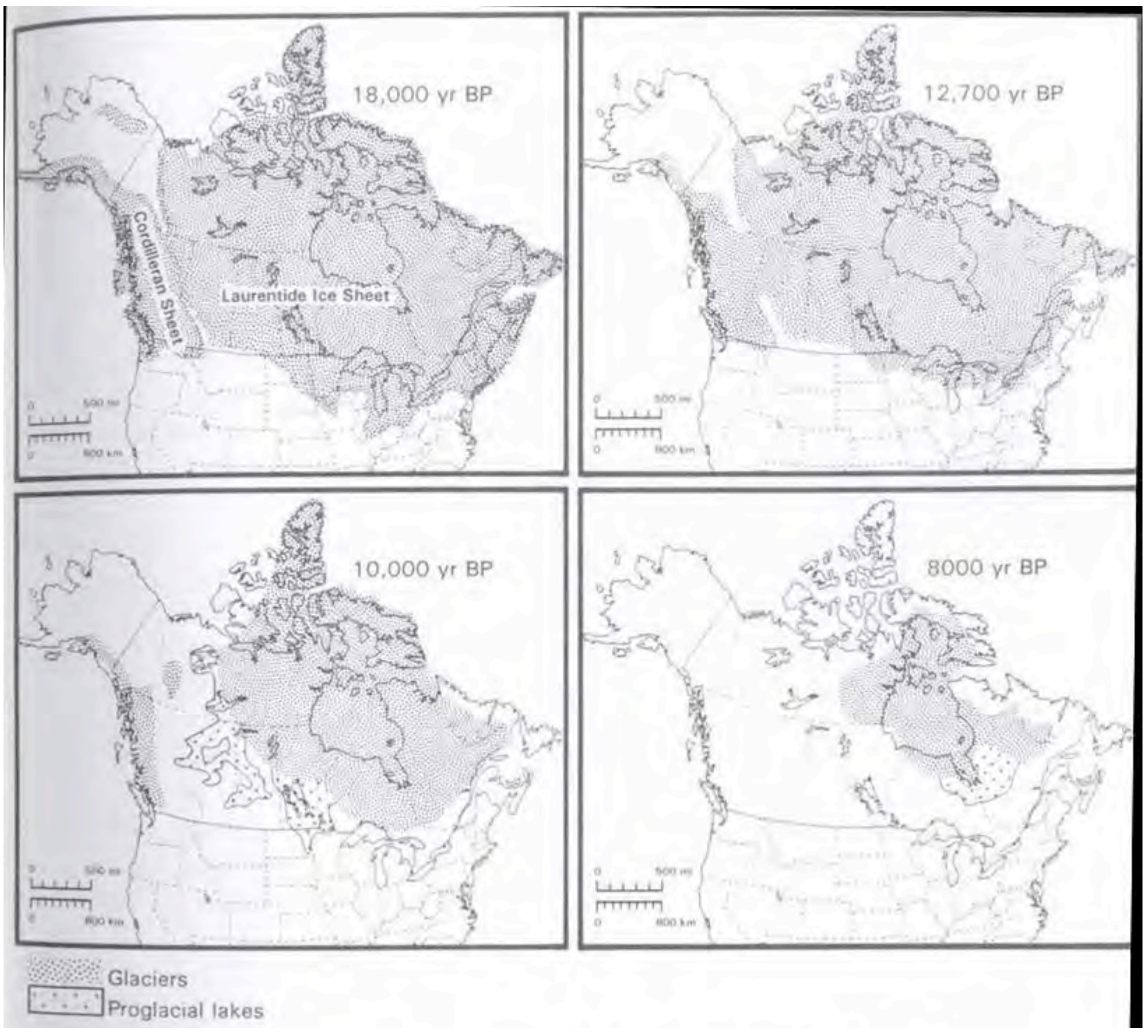
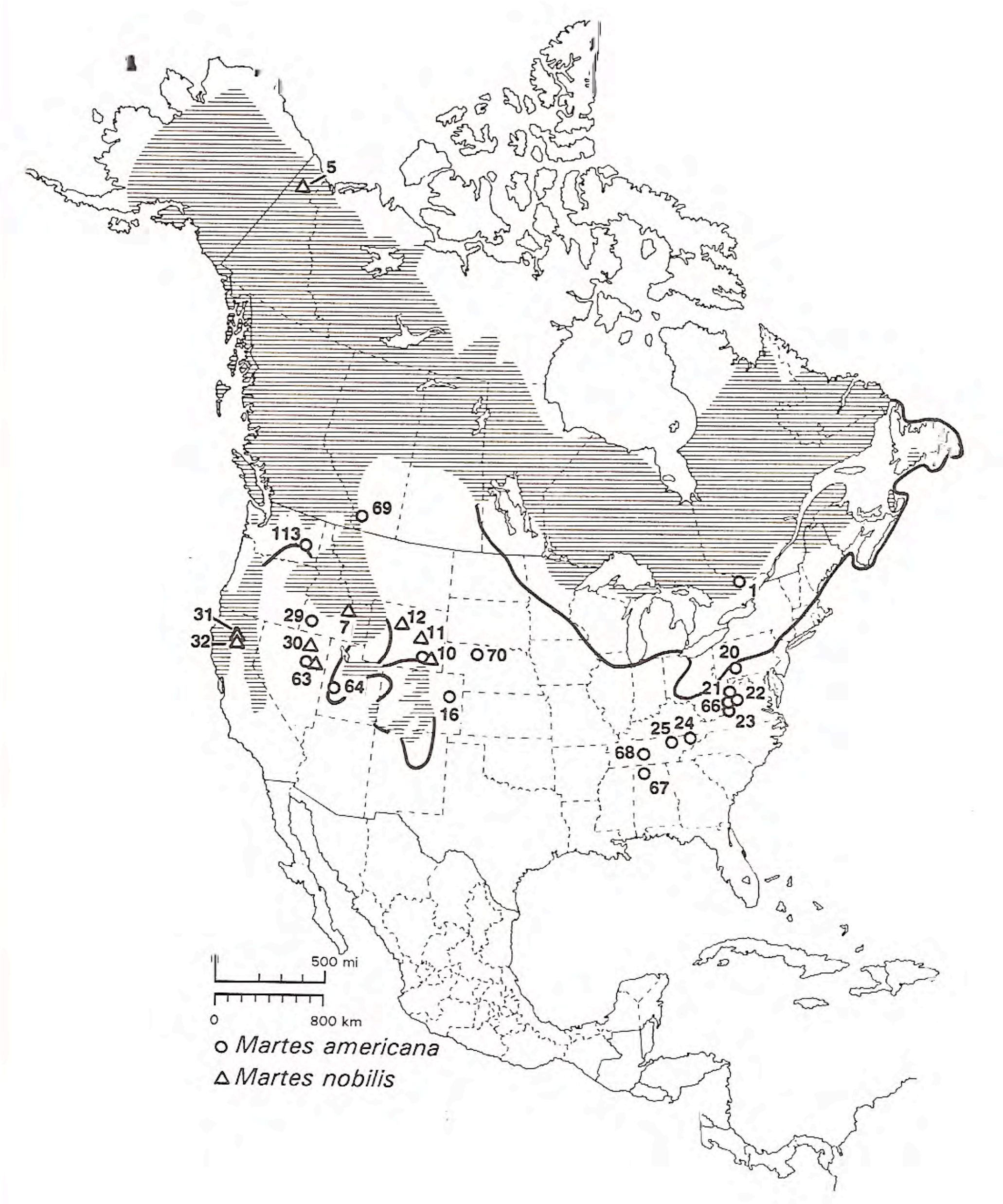
Appendix A: Changing Distribution of *Martes americana*

These are maps that illustrate the change in distribution of American marten from the late Pleistocene to the late Holocene. Source: Graham and Graham 2004.

Map 1. Advancement and subsequent retreat of the Laurentide ice sheet. The movement of this ice sheet affected the distribution of marten habitat by leaving isolated patches of forest behind after its retreat. Source: Graham and Graham 1994.

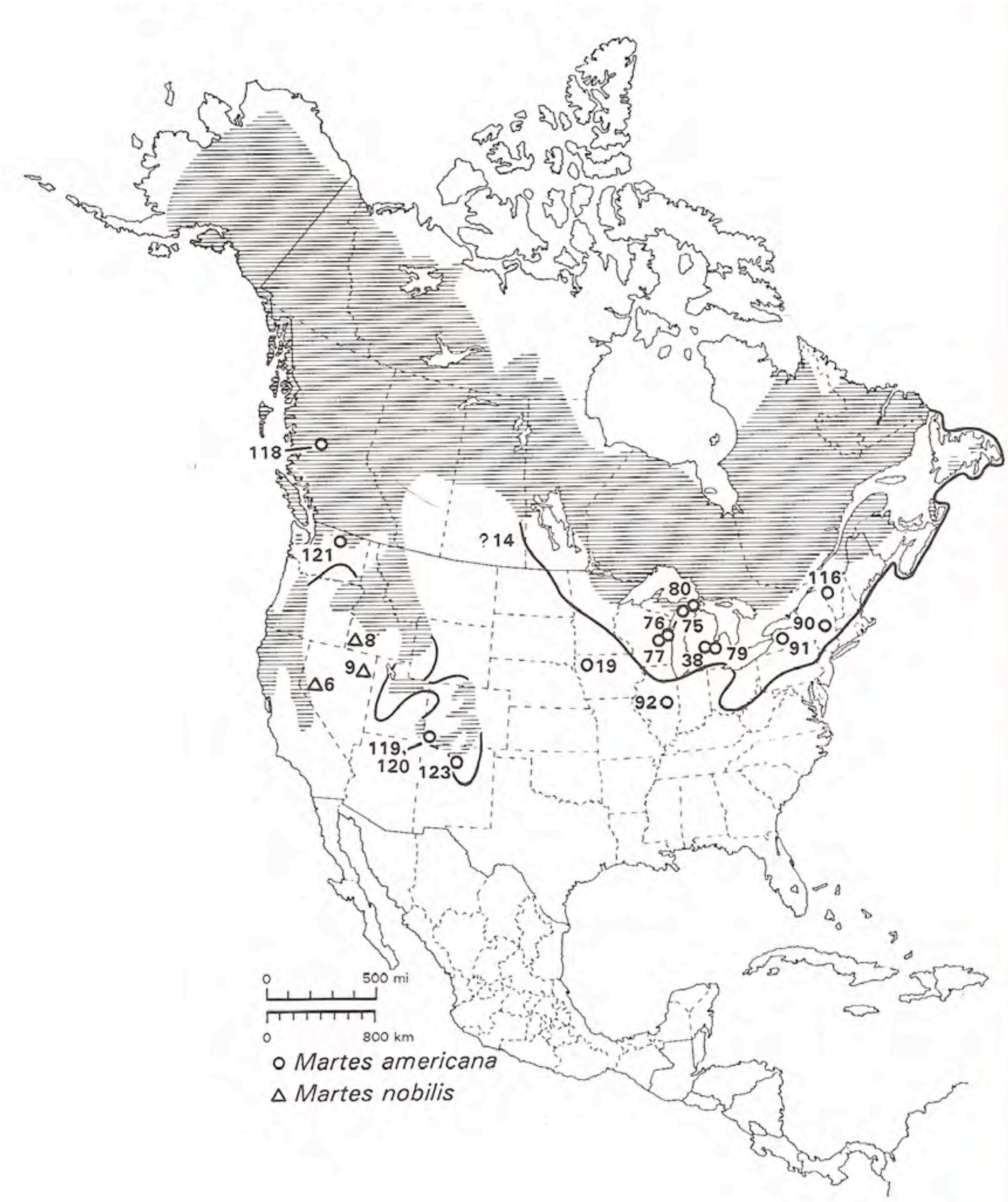


Map 2. Distribution of *Martes americana* during the late Pleistocene compared to current distribution. Shaded area represents current distribution and the solid line represents their historic distribution. Small circles represent historic fossil sites of marten. Source: Graham and Graham 1994.

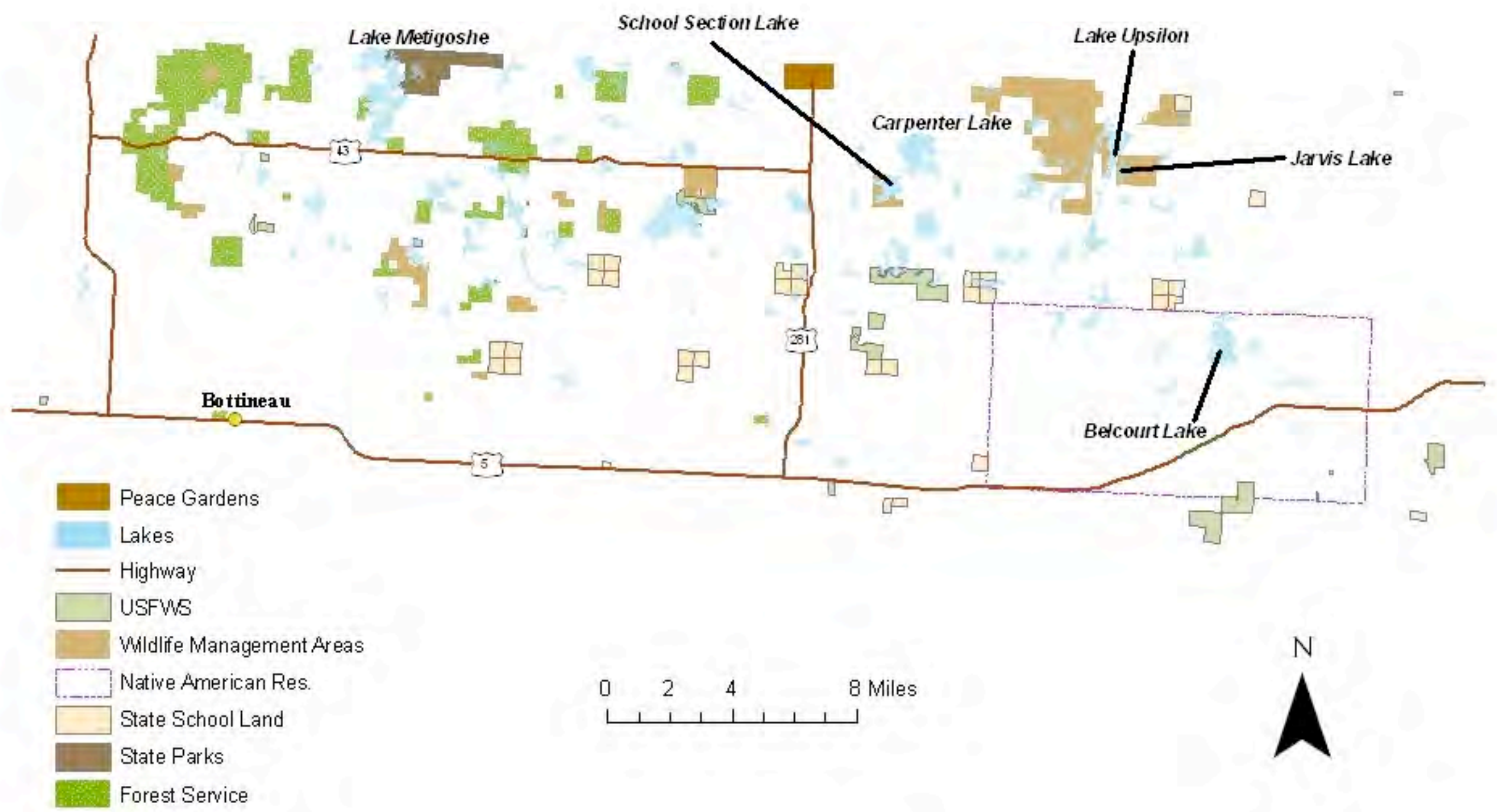


Map 3. *Martes americana* distribution during the early Holocene. Shaded area represents current distribution and solid line represents historic distribution. Small circles represent historic fossil sites of marten. Source: Graham and Graham 1994.

Map 4. *Martes americana* distribution during the late Holocene. Shaded area represents current distribution and solid line represents historic distribution. Small circles represent historic fossil sites of marten. Source: Graham and Graham 1994.

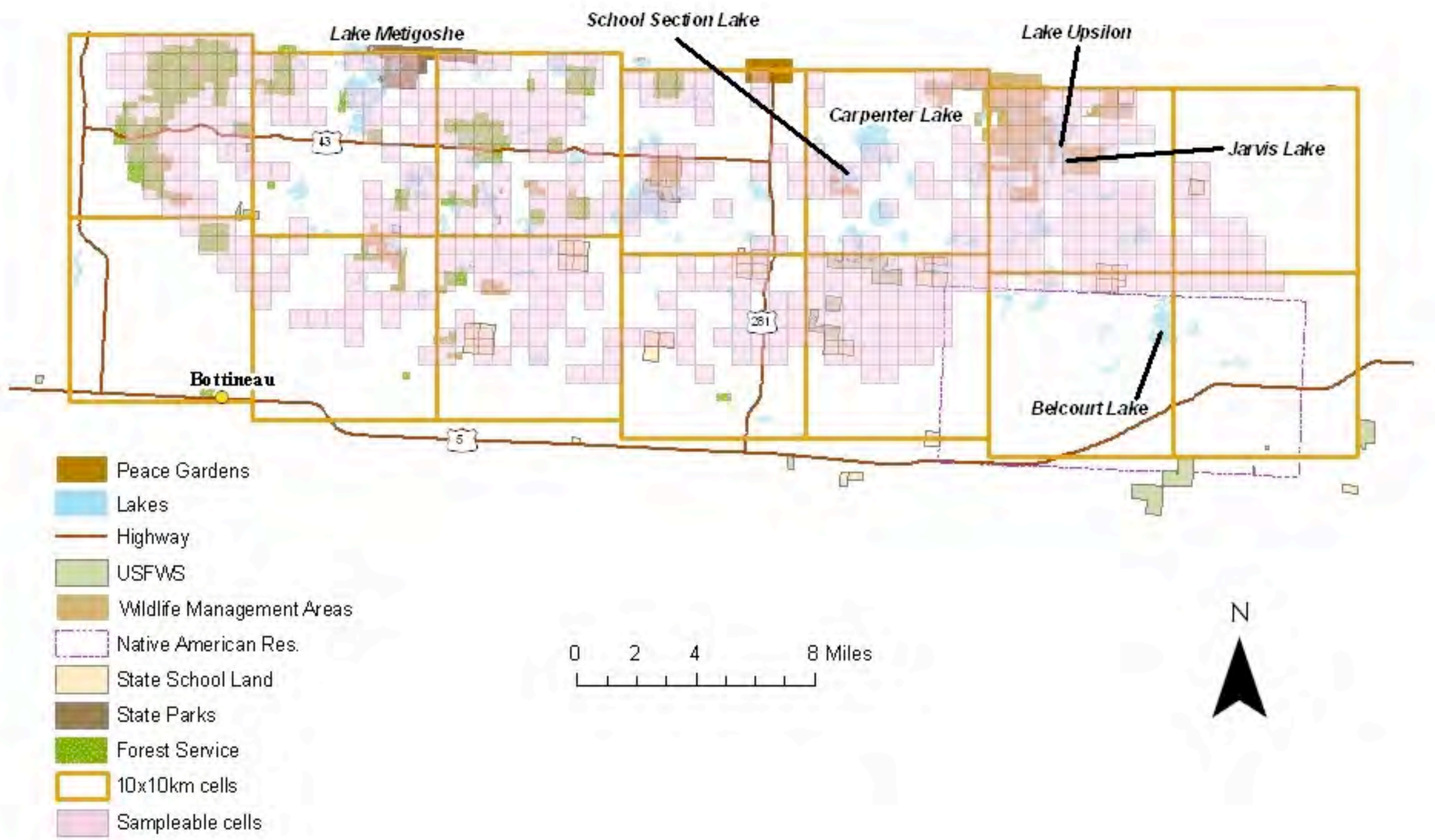


Appendix B: Map of the Turtle Mountains, North Dakota Showing Land Ownership Status



Appendix C: Map of 10 x 10 km Sampling Scheme for Martens in the Turtle Mountains

Appendix D: Map of Cells With at Least 50% Forested Land in the Turtle Mountains



Appendix E: Table of 1 x 1 km Cells Sampled in Each 10 x 10 km Cell

The 10 x 10 cells are numbered as the figure below illustrates:

7	6	5	4	3	2	1
8	9	10	11	12	13	14

The total number of cells sampled in cycles one through three is 61 because I had to remove sample sites from one cell at the landowner's request. I randomly sampled another cell in that 10 x 10 km cell.

10 x 10 cell	Number of Cells Sampled	Possible Number of Cells Sampled	% Sampled
1	2	18	11.1
2	10	80	12.5
3	4	37	10.8
4	4	33	12.1
5	8	63	12.7
6	5	46	10.9
7	7	61	11.5
8	1	9	11.1
9	4	24	16.7
10	5	46	10.9
11	4	32	12.5
12	6	52	11.5
13	1	8	12.5
14	0	6	0.0
Sum	61	515	11.8

Appendix F: GPS Locations for All Sites Sampled in the Turtle Mountains Study in North Dakota During the Summer of 2007

The cycle information is as follows:
Cycle 0: Preliminary field work where I piloted the study methods
Cycle 1: Random sample of 20 1 x 1 km cells, but also considered pilot work
Cycle 2: Random sample of 20 1 x 2 km cells
Cycle 3: Random sample of 20 1 x 2 km cells
Cycle 4: Strategically chosen sample sites (not cells) in forested islands near confirmed marten detections from previous cycles.

The FIELD ID is a label I gave to each site in the field. Generally, the first four-digit number is the number of that particular cell in the ArcGIS (except for a few cells in cycle one). The TP, CAM, or, CB label indicates a device at the site but does not indicate both a track plate or a camera trap if both were present at the site. An "I" in between the four-digit number indicates the site was sampled during the fourth cycle, and stands for "Island Biogeography" as I was attempting to investigate dispersal distance thresholds into islands of forested habitat.

CYCLE	LATITUDE	LONGITUDE	ANALYSIS ID	FIELD ID
0	48.97688289	-99.88672184	173	PS1
0	48.97473536	-99.88647910	174	PS2
0	48.99349540	-99.85607550	175	PS3
0	48.98865142	-99.87450932	176	PS4
0	48.97745202	-99.88560596	235	BEAV4
0	48.96161534	-99.83408173	236	BEAV5
0	48.98804683	-99.89400102	241	NORTH1
0	48.99503248	-99.88313086	242	NORTH2
0	48.99466745	-99.87772135	243	NORTH3
0	48.99562189	-99.86763281	244	NORTH4
0	48.99373144	-99.85959196	245	NORTH5
0	48.96926324	-99.86716099	246	SKUNK3
0	48.97539326	-99.88680264	247	SKUNK4
0	48.96214818	-99.82454966	248	SKUNK5
0	48.98790962	-99.87675752	249	SOUTH1
0	48.99261849	-99.87645510	250	SOUTH2
0	48.95282473	-99.86393949	251	BEAV1
0	48.96992105	-99.87033773	252	BEAV3
1	48.99214441	-100.48283718	177	1263 CAM
1	48.99530497	-100.47757820	178	1263 TP1
1	48.99400486	-100.47872066	179	1263 TP2
1	48.99479971	-100.32782762	180	1443 CAM1
1	48.99425573	-100.33761567	181	1443 TP1
1	48.99109533	-100.33558181	182	1443 TP2
1	48.98009442	-100.41480697	184	1606 CAM1

CYCLE	LATITUDE	LONGITUDE	ANALYSIS ID	FIELD ID
1	48.98033959	-100.40900728	185	1606 TP1
1	48.97899371	-100.41388135	186	1606 TP2
1	48.98485400	-100.32927543	187	1612 CAM1
1	48.98380701	-100.32655181	188	1612 CAM2
1	48.98062927	-100.33165773	189	1612 TP1
1	48.99310020	-99.93070789	191	1642 CB14
1	48.99206453	-99.92215340	192	1642 TP1
1	48.99303767	-99.92342158	193	1642 TP2
1	48.98851370	-99.94129909	194	1810 CB01
1	48.98681168	-99.94077464	195	1810 CB07
1	48.98810752	-99.94009000	196	1810 TP1
1	48.99094219	-99.85723522	197	1816 CB25
1	48.98922566	-99.85830509	198	1816 CB9
1	48.98989219	-99.85552205	199	1816 TP1
1	48.98247806	-99.87919522	200	1984 CAM1
1	48.98013700	-99.87032658	201	1984 TP1
1	48.97521556	-99.86743969	202	1984 TP2
1	48.94253000	-100.50921000	203	2275 1481
1	48.93733992	-100.50074997	204	2275 1630
1	48.94801595	-100.26572158	205	2293 CB38
1	48.95042567	-100.26270032	206	2293 TP1
1	48.94453679	-100.25717178	207	2293 TP2
1	48.94595074	-100.12844310	208	2472 CB32
1	48.94703468	-100.12849214	209	2472 TP1
1	48.94439983	-100.12903562	210	2472 TP2
1	48.95309924	-99.82857389	211	2494 CAM1
1	48.95143527	-99.82990494	212	2494 TP1
1	48.95180315	-99.83733198	213	2494 TP2
1	48.93002621	-100.22077689	214	2634 CB05
1	48.93099063	-100.22472317	215	2634 CB13
1	48.93490414	-100.22588633	216	2634 TP1
1	48.93629964	-100.14432010	217	2640 CB10
1	48.93607358	-100.14352952	218	2640 CB2
1	48.93605238	-100.14250676	219	2640 TP1
1	48.92047352	-100.22168649	220	2803 CB16
1	48.92106185	-100.21673254	221	2803 TP1
1	48.92090024	-100.22442796	222	2803 TP2
1	48.89317492	-99.91973975	223	3501 TP2
1	48.88374100	-100.24555983	224	3477 CB11
1	48.88499443	-100.24674059	225	3477 CB12
1	48.88550565	-100.24880463	226	3477 TP1
1	48.89299496	-99.92269001	227	3501 CB4
1	48.89311859	-99.92453285	228	3501 TP1
1	48.88134487	-100.00397016	229	3664 CB29
1	48.88290239	-100.00725746	230	3664 TP1
1	48.88522737	-99.99686792	231	3664 TP2
1	48.85970808	-100.13594021	232	3992 CB31

CYCLE	LATITUDE	LONGITUDE	ANALYSIS ID	FIELD ID
1	48.86110090	-100.13694554	233	3992 TP1
1	48.85617862	-100.13720144	234	3992 TP2
1	48.94930509	-100.51638172	237	C2105 CAM
1	48.94562518	-100.52128002	238	C2105 TP1
1	48.95019718	-100.52214118	239	C2105 TP2
1	48.94189096	-100.50888788	240	CAM1 C2275
2	48.99592867	-100.25988911	1	1448 CB17
2	48.99498923	-100.26522076	2	1448 TP1
2	48.99209403	-100.26865650	3	1448 TP2
2	48.96720238	-100.45854734	4	1603 CB3
2	48.96768560	-100.45575206	5	1603 CB36
2	48.96624022	-100.45599229	6	1603 TP1
2	48.99059694	-100.06818577	10	1632 CB28
2	48.98880850	-100.06405341	14	1632 TP1
2	48.98710680	-100.06074289	15	1632 TP2
2	48.95673590	-100.31624517	33	2120 CB1
2	48.95761575	-100.32107072	34	2120 CB9
2	48.95164330	-100.32222139	37	2120 TP1
2	48.95798346	-100.29108848	38	2122 CB34
2	48.95859978	-100.28973799	39	2122 CB35
2	48.95430800	-100.29062186	40	2122 TP1
2	48.97012163	-99.79372060	42	2159 CB11
2	48.97084256	-99.79531668	43	2159 CB24
2	48.96947396	-99.79251545	52	2159 TP1
2	48.96909409	-99.77665588	53	2160 CB30
2	48.96798173	-99.77471715	54	2160 TP1
2	48.96825573	-99.77836294	55	2160 TP2
2	48.95205494	-99.94512166	62	2486 CB4
2	48.94867024	-99.93755875	63	2486 CB6
2	48.94622130	-99.93910102	73	2486 TP1
2	48.92567432	-100.18187882	83	2806 CB37
2	48.92326922	-100.17365224	84	2806 CB5
2	48.92424027	-100.17753691	85	2806 TP1
2	48.91066561	-100.33153033	95	2964 CB8
2	48.90925351	-100.32941289	102	2964 TP1
2	48.90763831	-100.33360016	103	2964 TP2
2	48.89686480	-100.39855965	112	3128 CB7
2	48.89612929	-100.39950966	113	3128 TP1
2	48.89676891	-100.39605305	114	3128 TP2
2	48.89599619	-100.20364830	118	3311 CB13
2	48.89829216	-100.21014755	119	3311 TP1
2	48.89445350	-100.20650393	120	3311 TP2
2	48.89930159	-100.15546024	121	3315 RX4
2	48.89980752	-100.14747899	122	3315 TP1
2	48.89953712	-100.15150306	123	3315 TP2
2	48.90258503	-99.99116379	127	3327 RXRED
2	48.90005319	-99.98497032	128	3327 TP1

CYCLE	LATITUDE	LONGITUDE	ANALYSIS ID	FIELD ID
2	48.90120998	-99.98915993	129	3327 TP2
2	48.89934903	-99.94579816	130	3330 CB29
2	48.90401683	-99.94403671	131	3330 TP1
2	48.90595472	-99.94422974	132	3330 TP2
2	48.90982565	-99.73364775	136	3346 CB9
2	48.91268162	-99.73725549	137	3346 TP1
2	48.90954620	-99.73782429	138	3346 TP2
2	48.87913071	-100.17567538	151	3651 CB25
2	48.87941334	-100.17340153	152	3651 CB33
2	48.87837038	-100.17373555	153	3651 TP1
2	48.86236204	-100.26982192	157	3813 CB38
2	48.86796325	-100.27226114	163	3813 TP1
2	48.86336233	-100.27285030	164	3813 TP2
2	48.86452616	-100.15341983	165	3991 CB12
2	48.86055591	-100.14943038	166	3991 CB32
2	48.86195962	-100.14493215	167	3991 TP1
2	48.86584656	-99.94323783	168	4006 CB10
2	48.86940292	-99.94288327	171	4006 RX3
2	48.86392283	-99.94601986	172	4006 TP1
3	48.98603811	-100.10356528	7	1629 CB29
3	48.99165055	-100.10064544	8	1629 TP1
3	48.98834607	-100.09833656	9	1629 TP2
3	48.97279831	-100.29343600	16	1784 CB1
3	48.97133793	-100.29646430	17	1784 CB25
3	48.97543408	-100.28758803	18	1784 TP1
3	48.98774391	-99.85146655	19	1812 RX3
3	48.98964543	-99.85301158	20	1812 TP1
3	48.98752816	-99.85272534	21	1812 TP2
3	48.96686610	-100.23732612	22	1957 CB5
3	48.96498310	-100.23861936	23	1957 TP1
3	48.96446150	-100.23108671	24	1957 TP2
3	48.95059900	-100.45219445	30	2110 CB37
3	48.94899697	-100.44714008	31	2110 TP1
3	48.95371472	-100.44847473	32	2110 TP2
3	48.95839719	-99.88477992	56	2321 CB18
3	48.96200879	-99.88897556	57	2321 CB35
3	48.96335056	-99.89041038	58	2321 TP1
3	48.93574116	-100.49284073	59	2445 CB10
3	48.93491345	-100.48949827	60	2445 CB32
3	48.92999042	-100.49439037	61	2445 TP1
3	48.95214094	-99.87781305	74	2491 CB3
3	48.95478677	-99.86529384	75	2491 TP1
3	48.95082624	-99.86507004	76	2491 TP2
3	48.92473639	-100.49386298	77	2613 CB26
3	48.92739421	-100.49222734	78	2613 TP1
3	48.92085423	-100.49237595	79	2613 TP2
3	48.94207461	-99.83703450	80	2662 CB23

CYCLE	LATITUDE	LONGITUDE	ANALYSIS ID	FIELD ID
3	48.94115780	-99.83758980	81	2662 CB31
3	48.93995390	-99.83779801	82	2662 TP1
3	48.92933613	-99.96146277	86	2822 CB24
3	48.92801715	-99.95993357	87	2822 CB4
3	48.92673564	-99.95946377	91	2822 TP1
3	48.93263399	-99.85755659	92	2830 CB17
3	48.93211372	-99.85959557	93	2830 CB28
3	48.93664808	-99.85490816	94	2830 TP1
3	48.90154031	-100.44743001	104	3124 CB12
3	48.89346108	-100.44711174	105	3124 CB13
3	48.89723897	-100.44878821	111	3124 TP1
3	48.88848323	-100.34649027	115	3300 RX2
3	48.88987312	-100.35581421	116	3300 TP1
3	48.88701699	-100.35223581	117	3300 TP2
3	48.89768422	-100.08382447	124	3320 CB20
3	48.89545606	-100.08746381	125	3320 TP1
3	48.89782478	-100.08809178	126	3320 TP2
3	48.91232313	-99.74322885	133	3345 CB9
3	48.90774393	-99.74575181	134	3345 TP1
3	48.91300156	-99.75388820	135	3345 TP2
3	48.89222349	-99.96465141	139	3498 CB2
3	48.89279287	-99.96723848	140	3498 TP1
3	48.89353660	-99.96358825	141	3498 TP2
3	48.89593977	-99.79015167	142	3511 CB11
3	48.89652475	-99.79341944	143	3511 CB15
3	48.89410908	-99.79140485	144	3511 TP1
3	48.86926839	-100.42475838	145	3633 CB5
3	48.86970568	-100.42153747	146	3633 TP1
3	48.87132154	-100.41662886	147	3633 TP2
3	48.86421452	-100.21627262	148	3648 RX4
3	48.86330861	-100.22018362	149	3648 RX8
3	48.86328891	-100.22300220	150	3648 TP1
3	48.86148663	-100.37525478	154	3805 CB33
3	48.86273654	-100.37587881	155	3805 CB7
3	48.86118187	-100.37748001	156	3805 TP1
4	48.98568640	-100.07046129	11	1632 I TP1
4	48.98617088	-100.08733666	12	1632 I TP2
4	48.96994771	-100.08308309	13	1632 ICB38
4	48.94910778	-100.52622409	25	2105 I TP1
4	48.94226370	-100.54073207	26	2105 I TP2
4	48.95865477	-100.56934814	27	2105 I TP3
4	48.93956029	-100.53375405	28	2105 ICB23
4	48.94855164	-100.53347175	29	2105 ICB35
4	48.94242346	-100.31569800	35	2120 I TP1
4	48.96743892	-100.31818726	36	2120 ICB34
4	48.95996008	-99.78127289	41	2159 I TP1
4	48.96281487	-99.76417649	44	2159 I TP2

CYCLE	LATITUDE	LONGITUDE	ANALYSIS ID	FIELD ID
4	48.96532022	-99.75884954	45	2159 I TP3
4	48.97509067	-99.76181111	46	2159 I TP4
4	48.97560499	-99.76798053	47	2159 I TP5
4	48.97307524	-99.73463254	48	2159 I TP6
4	48.97016999	-99.69861994	49	2159 I TP7
4	48.97732680	-99.68352313	50	2159 I TP8
4	48.97971950	-99.78040704	51	2159 I TP9
4	48.95565757	-99.99954242	64	2486 I CB5
4	48.98155128	-100.00522074	65	2486 I TP1
4	48.97069436	-99.95898256	66	2486 I TP3
4	48.95687110	-99.95033906	67	2486 I TP4
4	48.97081230	-99.94473861	68	2486 ICB26
4	48.98086580	-99.99856920	69	2486 ICB28
4	48.97807153	-99.97293826	70	2486 ICB3
4	48.94370874	-99.94110958	71	2486 ICB7
4	48.97642097	-99.98873924	72	2486 ITP2
4	48.93640182	-99.95692229	88	2822 I TP1
4	48.94388619	-99.97075830	89	2822 I TP2
4	48.93488528	-99.95631980	90	2822 ICB12
4	48.91055295	-100.36383871	96	2964 I CB1
4	48.90878672	-100.33313069	97	2964 I TP1
4	48.90587183	-100.35672189	98	2964 I TP2
4	48.89860388	-100.36943355	99	2964 I TP3
4	48.91534631	-100.38682071	100	2964 ICB11
4	48.90405161	-100.35849927	101	2964 ICB16
4	48.88558553	-100.44870104	106	3124 I TP1
4	48.89630422	-100.44713932	107	3124 I TP2
4	48.86889615	-100.44054100	108	3124 ICB17
4	48.87624641	-100.43766475	109	3124 ICB18
4	48.86699840	-100.42649486	110	3124 ICB6
4	48.84119698	-100.27044872	158	3813 I TP1
4	48.85506559	-100.27102699	159	3813 I TP2
4	48.83795335	-100.29039916	160	3813 ICB14
4	48.87633375	-100.24963226	161	3813 ICB24
4	48.83019875	-100.26785217	162	3813 ICB27
4	48.83713561	-99.95462280	169	4006 I TP1
4	48.86414470	-99.94628968	170	4006 I TP2

Appendix G: Description of Variables Used to Analyze Marten Data Collected in the Turtle Mountains, North Dakota

The land cover variables were calculated based on 30 m resolution data from the NLCD Zone 40 GIS data layer. The percentages of classification attributes (e.g. at least 30% vegetation cover) were used to determine the pixel classification. These percentages, since calculated at smaller scales, are applicable at the hectare scale, and thus hold for non-forest metric variables (e.g., WATER).

<u>WATER</u>
The number of hectares of water. This means areas with less than 25% cover, vegetation, or soil.

<u>DEVELOPED</u>
The number of hectares of land classified as developed in the NLCD GIS data layer. Developed land consists of hectares with at least 20% or greater human materials, such as asphalt, concrete, and buildings. This includes infrastructure (e.g., railroads), residential areas, and single family housing units. I did not divide the developed areas into low, high, and commercial/industrial intensity although the information exists in the data layer. For the purposes of this analysis developed land covers were aggregated to reclassify the low, medium, and high intensity development classes along with developed open into one Developed land cover class.

<u>FOREST</u>
The number of hectares of forested land. All types of forest (i.e. deciduous, coniferous, and mixed) were grouped into this variable. This includes trees greater than five meters tall that make up at least 20% of the vegetation.

<u>GRASS</u>
The number of hectares of grassland. This consists of hectares with at least 80% graminoid or perennial herbaceous vegetation.

<u>AG</u>
The number of hectares of agricultural land. The agriculture class is a reclassification of NLCD classes Pasture/Hay and Row Crops. This includes livestock grazing areas and crop production, both of which constitute at least 20% of the vegetation. Several Turtle Mountain farms grow canola oil plants, a major North Dakota export

<u>WETLAND</u>
This variable encompasses all classified wetland types, including: woody, palustrine forested, palustrine scrub/shrub, emergent herbaceous, palustrine emergent, and palustrine aquatic bed. This class is a reclassification of NLCD classes Woody and Emergent Wetlands. Varying percentages of wetland vegetation constitute each subclass. The wetland area unit is hectares.

MPS
The mean forest patch size in hectares.

ED
The forest edge density in meters per hectare. This is calculated by dividing the perimeter of the forest patches by the forest area and indicates the relative amount of forest edge in comparison to forest interior.

MPFD
The mean patch fractal dimension. This is an index with values between one and two. Values closer to one indicate forest patches with simple perimeters, such as circles or squares. Values closer to two indicate forest patches with more convoluted and complex perimeters. It is the average patch fractal dimension and is similar to the MSI index.

AWMPFD
The area-weighted mean patch fractal dimension. This is the same as MPFD but takes into account the size of the forest patch. It is the average patch fractal dimension for that weighs the larger patches more than the smaller patches.

MNN
The mean nearest neighbor, or forest patch distance, in meters. This is calculated from forest edge patch to forest edge patch.

IJI
The interspersion and juxtaposition index. This index ranges from 0 – 100. The index approaches zero when few forest patches are adjacent to each other and it approaches 100 when the forest patches are equally adjacent to each other. The IJI measures how the forest patches are interspersed and juxtaposed with one another.

STRM_DEN
An index for stream density. It is calculated via meters of stream length per hectare of land but has no units. The index relates to the likelihood of encountering a stream within a sample area. The higher the number, the higher the stream density.

ROAD_DEN
An index for road density. It is calculated via meters of road length per hectare of land but has no units. The index relates to the likelihood of encountering a road within a sample area. The higher the number, the higher the road density.

UD
The understory density ranking. The values range from 1 to 5 and were assigned at the sample sites. The understory was ranked as: 1) if only grass was present at heights of 2 to 5 cm, 3) if the vegetation was 1 m (chest height) or lower and moderately easy to traverse, and 5) if the vegetation was 1.25 m or higher and difficult to traverse. This variable was only applicable at the 100 m buffer.

CC
The canopy cover ranking. The values range from 1 to 5 and were assigned at the sample sites. I did not have specific criteria for the rankings of canopy cover other than a one indicates no canopy cover whatsoever, a five indicates barely any sky visible, and a two, three, or four indicates a ranking in between.

NUMP
The number of separate patches of forest. Patches of forest are comprised of adjacent groups of forest classed pixels from the NLCD layer.

MSI
The mean shape index. This index is closest to one when the forest patch is circular or square (i.e., more forested interior) and is greater than one when the forest patch shape is increasingly convoluted or uneven. MSI is similar to the MPFD index.

AWMSI
The area-weighted mean shape index. This index is the same as MSI but accounts for the larger the size of the forest patch. It is the forest patch shape index that weighs the larger patches more than the smaller patches.

Appendix H: Tables for Each Buffer to Assess Variable Capability to Predict Marten Locations in the Turtle Mountains

Below are the tables I used for analysis using the statistical software package R. Marten presence is indicated by a 1, and marten absence is indicated by a 0. The ID number is a unique number given to the

100m

ID	MARTENS	WATER	DEVELOPED	FOREST	GRASS
1	0	1.35	0	1.8	0
2	0	0.18	0	2.97	0
3	0	0.81	0	2.34	0
4	0	0.27	0	2.43	0
5	1	0.27	0.81	1.89	0.18
6	0	0	0.27	2.25	0.63
7	0	0.36	0	2.07	0.63
8	0	0	0	1.62	1.53
9	0	0	0	2.7	0.45
10	1	0	0	3.15	0
14	0	0	0.18	2.97	0
15	1	0	0.54	2.61	0
16	0	0.36	0	2.34	0.36
17	0	0	0	2.88	0
18	0	0	0	3.06	0.09
19	1	0	0.72	2.43	0
20	0	0	0.45	2.7	0
21	0	0	0.72	2.43	0
22	0	0	0	3.06	0
23	0	0	0.63	2.52	0
24	0	0	0.54	2.07	0
30	1	0.09	0.63	1.71	0.72
31	0	0	0.18	2.97	0
32	0	0.09	0.45	2.52	0
33	0	0	0	3.15	0
34	1	0.27	0	2.16	0.72
37	0	0	0.45	2.7	0
38	0	0	0.45	2.7	0
39	0	0	0	3.15	0
40	0	0.45	0	2.7	0
42	0	0	0	3.15	0
43	0	0	0	2.61	0
52	1	0	0	2.16	0
53	0	0	0	3.15	0
54	0	0.09	0	3.06	0
55	0	0	0	2.61	0
56	1	0	0	3.15	0

ID	MARTENS	WATER	DEVELOPED	FOREST	GRASS
57	1	0.9	0	2.25	0
58	0	0	0	3.15	0
59	0	0	0	3.15	0
60	0	0	0.63	2.07	0
61	0	2.61	0	0.54	0
62	0	0	0.09	0.18	0
63	0	0	0	2.97	0.18
73	1	0	0	3.15	0
74	1	0	0.36	2.79	0
75	1	0.09	0	3.06	0
76	0	0	0.9	2.25	0
77	0	0	0	3.15	0
78	0	0	0	3.15	0
79	0	0	0.45	2.7	0
80	1	0	0	2.61	0.54
81	1	0	0	3.15	0
82	1	0	0	3.15	0
83	0	0.36	0	2.79	0
84	0	0	0	3.15	0
85	0	0	0	3.15	0
86	0	0.72	0	2.43	0
87	0	1.8	0	1.35	0
91	1	1.98	0	0.54	0
92	0	0	0	3.15	0
93	0	0.09	0.54	1.98	0.18
94	1	1.08	0.72	1.35	0
95	1	0	0	2.25	0.81
102	0	2.07	0	0.09	0
103	0	0.72	0	2.43	0
104	0	1.26	0	1.89	0
105	0	0	0	2.61	0
111	1	0	0	3.15	0
112	0	0.27	0	2.34	0.09
113	0	0.27	0	1.98	0.36
114	0	0	0	2.97	0
115	0	0.63	0	1.71	0
116	0	0	0	1.89	0.45
117	0	0	0	3.15	0
118	0	0	0	2.43	0.72
119	0	0	0	2.07	0.27
120	0	0	0	0.9	1.44
121	0	0.18	0	1.71	0.18
122	0	0	0	3.15	0
123	0	0	0	2.16	0
124	0	0	0	3.15	0
125	0	0.09	0	3.06	0
126	0	1.26	0	1.89	0

ID	MARTENS	WATER	DEVELOPED	FOREST	GRASS
127	1	0.63	0	2.52	0
128	1	0.81	0	1.35	0
129	0	0	0	0.27	1.26
130	1	1.62	0	1.08	0.45
131	0	0.09	0	1.62	0.72
132	0	0	0.54	1.53	0
133	0	1.26	0.9	0.99	0
134	0	0	0.27	2.88	0
135	1	0.45	1.08	1.62	0
136	0	0	0	2.88	0
137	1	0.09	0	2.79	0.18
138	0	0	0	3.15	0
139	0	0	0	1.8	1.35
140	0	0	0	1.8	1.35
141	0	0	0	1.71	1.44
142	0	0	0	2.07	1.08
143	0	0	0	2.34	0.81
144	0	0	0	1.8	1.35
145	0	0	0.27	1.26	1.62
146	0	0	0.27	0.63	2.25
147	0	0	0	2.79	0.36
148	0	0.63	0.63	1.8	0
149	0	0.27	0.54	1.8	0.54
150	0	0	0.54	1.89	0.18
151	0	0	0	3.15	0
152	0	0.36	0	2.34	0.45
153	0	0.54	0.45	1.98	0.18
154	0	0	0	2.79	0.36
155	0	0	0	2.61	0.54
156	0	0	0	2.25	0.9
157	0	0	0.45	2.7	0
163	1	0.18	0	2.97	0
164	0	0	1.08	1.89	0
165	0	0	0	1.26	0.63
166	0	1.26	0	1.44	0.45
167	0	0	0	3.15	0
168	1	1.8	0.18	1.17	0
171	0	0.72	0.99	1.44	0
172	1	0.27	0	2.88	0

100m continued

ID	AG	WETLAND	MPS	ED	MPFD
1	0	0	1.8	342.86	1.14
2	0	0	2.97	247.62	1.02
3	0	0	2.34	247.62	1.05
4	0	0.45	2.43	400	1.14
5	0	0	2.25	247.62	1.05
6	0	0	1.03	323.81	1.05
7	0	0.09	1.62	209.52	1.05
8	0	0	2.7	247.62	1.03
9	0	0	3.15	266.67	1.03
10	0	0	3.15	266.67	1.03
14	0	0	2.97	266.67	1.04
15	0	0	2.61	266.67	1.05
16	0	0.09	2.34	247.62	1.05
17	0.27	0	2.88	266.67	1.04
18	0	0	3.06	266.67	1.04
19	0	0	2.43	400	1.14
20	0	0	1.35	304.76	1.03
21	0	0	1.22	285.71	1.02
22	0	0.09	3.06	266.67	1.04
23	0	0	1.26	342.86	1.05
24	0.54	0	1.03	323.81	1.06
30	0	0	1.71	209.52	1.05
31	0	0	2.97	247.62	1.02
32	0	0.09	1.26	266.67	1.01
33	0	0	3.15	266.67	1.03
34	0	0	2.16	247.62	1.06
37	0	0	1.35	285.71	1.02
38	0	0	1.35	304.76	1.03
39	0	0	3.15	266.67	1.03
40	0	0	2.7	247.62	1.03
42	0	0	3.15	266.67	1.03
43	0.54	0	2.61	285.71	1.07
52	0.99	0	3.15	266.67	1.03
53	0	0	3.06	266.67	1.04
54	0	0	2.61	285.71	1.07
55	0	0.54	3.15	266.67	1.03
56	0	0	2.25	247.62	1.05
57	0	0	3.15	266.67	1.03
58	0	0	3.15	266.67	1.03
59	0	0	2.07	380.95	1.15
60	0	0.45	0.54	114.29	1.05
61	0	0	0.09	76.19	1
62	2.43	0.45	2.97	247.62	1.02
63	0	0	2.97	247.62	1.02
73	0	0	2.79	247.62	1.03

ID	AG	WETLAND	MPS	ED	MPFD
74	0	0	3.06	266.67	1.04
75	0	0	1.12	266.67	1.02
76	0	0	3.15	266.67	1.03
77	0	0	3.15	266.67	1.03
78	0	0	2.7	380.95	1.12
79	0	0	2.61	304.76	1.08
80	0	0	3.15	266.67	1.03
81	0	0	3.15	266.67	1.03
82	0	0	2.79	247.62	1.03
83	0	0	3.15	266.67	1.03
84	0	0	3.15	266.67	1.03
85	0	0	2.43	247.62	1.04
86	0	0	1.35	209.52	1.07
87	0	0	1.17	152.38	1.02
91	0.63	0	3.15	266.67	1.03
92	0	0	0.99	323.81	1.06
93	0	0.36	0.68	228.57	1.03
94	0	0	2.25	266.67	1.07
95	0	0.09	2.79	266.67	1.04
102	0	0.99	0.09	38.1	1
103	0	0	2.43	247.62	1.04
104	0	0	1.89	266.67	1.09
105	0	0.54	2.61	285.71	1.07
111	0	0	3.15	266.67	1.03
112	0.45	0	2.34	285.71	1.08
113	0.36	0.18	1.98	266.67	1.08
114	0.18	0	2.97	266.67	1.04
115	0.81	0	1.71	209.52	1.05
116	0.81	0	1.89	266.67	1.09
117	0	0	3.15	266.67	1.03
118	0	0	2.43	228.57	1.03
119	0.81	0	2.07	228.57	1.05
120	0.81	0	0.9	152.38	1.05
121	0.27	0.81	1.71	304.76	1.12
122	0	0	3.15	266.67	1.03
123	0.99	0	2.16	361.9	1.13
124	0	0	3.15	266.67	1.03
125	0	0	3.06	266.67	1.04
126	0	0	1.89	323.81	1.13
127	0	0	2.52	266.67	1.06
128	0.99	0	1.35	228.57	1.09
129	1.53	0.09	0.14	114.29	1.05
130	0	0	1.08	228.57	1.12
131	0	0.72	1.62	228.57	1.07
132	1.08	0	0.76	228.57	1.02
133	0	0	0.99	152.38	1.04
134	0	0	2.88	266.67	1.04

ID	AG	WETLAND	MPS	ED	MPFD
135	0	0	0.54	285.71	1.02
136	0	0.27	2.88	304.76	1.07
137	0	0.09	2.79	247.62	1.03
138	0	0	3.15	266.67	1.03
139	0	0	1.8	190.48	1.02
140	0	0	1.8	247.62	1.08
141	0	0	1.71	190.48	1.03
142	0	0	2.07	266.67	1.08
143	0	0	2.34	228.57	1.03
144	0	0	1.8	266.67	1.09
145	0	0	1.26	266.67	1.13
146	0	0	0.31	152.38	1.02
147	0	0	2.79	266.67	1.04
148	0	0.09	0.9	266.67	1.04
149	0	0	0.9	285.71	1.04
150	0.54	0	0.94	323.81	1.06
151	0	0	3.15	266.67	1.03
152	0	0	2.34	323.81	1.1
153	0	0	0.99	342.86	1.06
154	0	0	2.79	266.67	1.04
155	0	0	1.3	304.76	1.03
156	0	0	1.12	304.76	1.04
157	0	0	1.35	304.76	1.03
163	0	0	2.97	266.67	1.04
164	0.18	0	1.89	209.52	1.04
165	1.26	0	1.26	266.67	1.13
166	0	0	1.44	228.57	1.08
167	0	0	3.15	266.67	1.03
168	0	0	1.17	209.52	1.09
171	0	0	1.44	304.76	1.14
172	0	0	2.88	266.67	1.04

100m continued

ID	AWMPFD	MNN	IJI	STRM_DEN	ROAD_DEN
1	1.14	0	0	36.933	0
2	1.02	0	0	116.624	0
3	1.05	0	0	63.93	0
4	1.14	0	76.42	0	28.528
5	1.05	0	0	0	38.404
6	1.09	30	68.54	0	48.399
7	1.05	0	0	37.833	0
8	1.03	0	0	0	0
9	1.03	0	0	0	0
10	1.03	0	0	0	72.326
14	1.04	0	0	0	24.773
15	1.05	0	0	0	36.993
16	1.05	0	90.57	36.987	0
17	1.04	0	0	0	0
18	1.04	0	0	0	0
19	1.14	0	0	0	64.066
20	1.03	30	0	0	57.58
21	1.05	30	0	0	55.104
22	1.04	0	0	0	0
23	1.04	30	0	0	62.614
24	1.05	30	96.41	0	60.471
30	1.05	0	48.22	0	50.453
31	1.02	0	0	0	33.766
32	1.03	30	77.25	0	84.785
33	1.03	0	0	95.331	0
34	1.06	0	97.1	54.787	0
37	1.04	30	0	0	59.56
38	1.03	30	0	0	29.273
39	1.03	0	0	0	0
40	1.03	0	0	55.927	0
42	1.03	0	0	0	0
43	1.07	0	0	0	0
52	1.03	0	0	0	0
53	1.04	0	0	0	0
54	1.07	0	0	26.075	0
55	1.03	0	0	0	0
56	1.05	0	0	0	0
57	1.03	0	0	57.912	65.879
58	1.03	0	0	25.851	78.451
59	1.15	0	95.87	0	58.484
60	1.05	0	0	0	47.533
61	1	42.43	63.09	66.171	42.511
62	1.02	0	0	0	124.744
63	1.02	0	0	0	0
73	1.03	0	0	0	0

ID	AWMPFD	MNN	IJI	STRM_DEN	ROAD_DEN
74	1.04	0	0	0	40.144
75	1.03	30	0	0	20.29
76	1.03	0	0	0	89.222
77	1.03	0	0	0	52.674
78	1.12	0	0	0	65.217
79	1.08	0	0	0	47.478
80	1.03	0	0	0	0
81	1.03	0	0	0	0
82	1.03	0	0	0	13.139
83	1.03	0	0	42.81	0
84	1.03	0	0	0	0
85	1.04	0	0	0	0
86	1.07	0	0	64.425	0
87	1.02	0	0	61.169	0
91	1.03	0	0	53.988	0
92	1.05	30	82.89	0	122.875
93	1.04	30	99.57	0	145.892
94	1.07	0	68.4	24.18	58.494
95	1.04	0	0	0	0
102	1	0	100	70.404	14.105
103	1.04	0	0	0	0
104	1.09	0	0	0	0
105	1.07	0	0	0	24.206
111	1.03	0	0	0	0
112	1.08	0	56.18	0	0
113	1.08	0	94.46	0	0
114	1.04	0	0	0	0
115	1.05	0	96.12	62.354	0
116	1.09	0	99.11	0	0
117	1.03	0	0	0	0
118	1.03	0	0	0	0
119	1.05	0	0	0	0
120	1.05	0	76.42	0	0
121	1.12	0	90.08	0	4.201
122	1.03	0	0	0	0
123	1.13	0	0	0	0
124	1.03	0	0	0	0
125	1.04	0	0	23.149	0
126	1.13	0	0	19.216	31.587
127	1.06	0	0	25.804	0
128	1.09	0	100	0	42.127
129	1.06	84.85	0	0	60.091
130	1.12	0	95.44	56.275	0
131	1.07	0	81.75	49.626	2.069
132	1.04	30	100	0	0
133	1.04	0	100	63.306	111.425
134	1.04	0	0	0	66.297

ID	AWMPFD	MNN	IJI	STRM_DEN	ROAD_DEN
135	1.05	34.14	83.66	0	71.814
136	1.07	0	0	0	24.561
137	1.03	0	100	0	74.194
138	1.03	0	0	0	57.253
139	1.02	0	0	0	70.43
140	1.08	0	0	0	51.716
141	1.03	0	0	0	64.105
142	1.08	0	0	0	0
143	1.03	0	0	0	25.454
144	1.09	0	0	0	11.253
145	1.13	0	0	0	60.998
146	1.02	67.08	54.36	0	73.628
147	1.04	0	0	0	37.117
148	1.04	30	78.28	0	60.361
149	1.07	30	96.54	0	59.32
150	1.07	30	78.97	0	49.437
151	1.03	0	0	0	0
152	1.1	0	94.03	0	0
153	1.11	30	73.12	0	61.49
154	1.04	0	0	0	63.091
155	1.05	30	0	0	51.967
156	1.05	30	0	0	0
157	1.03	30	0	0	46.845
163	1.04	0	0	0	0
164	1.04	0	0	0	93.055
165	1.13	0	81.13	0	0
166	1.08	0	96.12	37.699	0
167	1.03	0	0	0	0
168	1.09	0	72.19	60.495	0
171	1.14	0	93.41	34.943	41.379
172	1.04	0	0	21.781	0

100m continued

ID	UD	CC
1	1.2	2.2
2	2.7	1.8
3	3.8	1.5
4	1	3.7
5	1	2.9
6	1	2.8
7	4.9	1.3
8	5	1.2
9	1	2.5
10	1.9	2
14	2.5	2
15	2.5	1.9
16	1.5	1.9
17	1.9	1.5
18	2	2.7
19	2	1.3
20	1.7	2
21	2	3.8
22	2.5	2.5
23	5	2.3
24	4	1.9
30	4	3
31	2.8	2.6
32	4.9	1.2
33	2.1	2
34	1.7	3
37	4	2
38	1.5	2
39	2.8	2
40	2.5	2
42	2.3	2.6
43	4.5	1.7
52	3.8	1.8
53	5	1.2
54	3.9	2.7
55	2.7	3
56	3.3	2
57	4.1	1.5
58	4.9	1.4
59	3	2.5
60	2.3	2.2
61	1.1	1.8
62	1	3
63	2	3.1
73	3.2	2.5

ID	UD	CC
74	4	1.9
75	3.2	2
76	4.4	2.6
77	1.3	2.6
78	3.8	1.5
79	1.5	2.2
80	4.3	1.6
81	4.1	1.7
82	4.5	1.4
83	3.9	2.3
84	3.8	2.8
85	3.8	1.9
86	3.4	2
87	2	1.7
91	4.4	2.8
92	3.3	2
93	2.8	2.8
94	4.5	1.2
95	1.3	2.7
102	2	2.3
103	3.6	1.9
104	3.8	2.7
105	2	2
111	4.5	1.5
112	5	2.8
113	3.7	3
114	3	2.8
115	5	1.5
116	5	1.2
117	2	2
118	4.3	2.7
119	1.8	2.5
120	3.7	4
121	1.1	1.8
122	2	3.2
123	1.6	1.5
124	4.9	1.6
125	3.9	1.5
126	4.6	1.9
127	3.9	1.9
128	4	1.8
129	2	1.8
130	3.3	3
131	3	3
132	3.9	2.5
133	4.5	1.2
134	3.9	2

ID	UD	CC
135	4.1	1.9
136	3.9	2.5
137	3.7	3
138	4	3
139	4.5	1.9
140	4.4	2
141	4	1.6
142	2	2.1
143	3.5	1.8
144	3	2.8
145	3.5	1.4
146	1.2	2.6
147	2.5	2.6
148	4.4	1.4
149	2.6	1.9
150	1.9	2
151	2.5	2.6
152	2	3
153	1.1	2
154	2.9	1.9
155	2	2.7
156	3	2
157	2.3	3.8
163	3.8	2.4
164	3.9	1.7
165	3.9	2
166	3.8	2
167	3.8	2
168	4.2	2
171	4	2.7
172	4.7	2

250m

ID	MARTENS	WATER	DEVELOPED	FOREST	GRASS
1	0	10.26	0	9.54	0
2	0	6.48	0.63	12.69	0
3	0	9	0.81	9.99	0
4	0	0.81	1.98	14.22	1.35
5	1	1.17	2.7	14.04	1.26
6	0	1.53	3.51	12.78	1.53
7	0	4.5	0	13.95	0.72
8	0	0	0	9.09	5.4
9	0	0	0	12.87	1.53
10	1	1.44	1.08	17.19	0
14	0	0.27	2.61	16.92	0
15	1	0	3.51	16.02	0
16	0	2.25	0	11.88	2.16
17	0	0	0	16.38	0.27
18	0	1.71	0	14.13	1.8
19	1	1.8	1.53	13.23	2.88
20	0	1.98	1.62	14.76	0.99
21	0	4.86	1.44	12.06	1.44
22	0	0.36	0.81	12.87	0.54
23	0	0	1.53	10.98	1.89
24	0	0	1.53	12.6	0
30	1	1.26	3.15	13.59	1.8
31	0	0.81	2.61	14.94	0.63
32	0	4.23	1.44	13.59	0
33	0	3.24	0	14.58	0.54
34	1	6.21	0	10.8	2.7
37	0	0	4.77	12.78	0
38	0	0.45	1.89	17.46	0
39	0	0	1.26	18.54	0
40	0	3.69	1.35	13.86	0.54
42	0	0	0	13.32	0
43	0	0	0	13.23	0.45
52	1	0	0	10.35	0.18
53	0	0.45	0	18.27	0
54	0	2.52	0	14.31	2.16
55	0	0.27	0	17.1	0.09
56	1	5.85	0.27	10.71	2.43
57	1	6.03	0	13.32	0
58	0	2.07	0.45	16.56	0
59	0	0.72	0.54	17.73	0
60	0	0	1.98	16.56	0
61	0	10.62	0	9.18	0
62	0	0	3.24	5.13	0.45
63	0	0	2.43	13.23	2.52
73	1	0	0.45	17.73	1.62

ID	MARTENS	WATER	DEVELOPED	FOREST	GRASS
74	1	0	3.06	15.12	1.62
75	1	6.66	1.35	11.16	0
76	0	3.6	5.04	10.08	1.08
77	0	0	0	19.8	0
78	0	0	0.72	19.08	0
79	0	0	1.62	17.91	0.27
80	1	1.98	0	14.58	0.81
81	1	0.36	0	18.36	0.81
82	1	0	0	19.08	0.36
83	0	7.92	0	11.7	0
84	0	0	0	18.27	0
85	0	2.7	0	17.1	0
86	0	8.01	0	11.79	0
87	0	8.82	0	9.09	0
91	1	9.99	0	3.96	0
92	0	0.9	0.99	17.01	0.27
93	0	2.52	0.99	11.88	1.53
94	1	3.24	2.52	12.15	0.45
95	1	1.53	1.08	8.1	6.12
102	0	9.54	0.45	6.66	0.81
103	0	5.4	0.09	12.78	1.53
104	0	3.69	1.35	13.5	1.26
105	0	0.9	1.71	14.22	1.62
111	1	0	0.9	18.27	0.63
112	0	3.15	0	10.35	1.71
113	0	2.97	0	11.43	1.71
114	0	2.43	0	11.34	1.71
115	0	8.19	0	4.05	0
116	0	0	0	15.57	0.45
117	0	0	0	16.11	0
118	0	0	0	11.79	5.67
119	0	1.89	0	7.38	2.79
120	0	0	0	6.03	7.2
121	0	2.88	0	7.47	0.63
122	0	0.9	0	15.75	0
123	0	0.27	0	13.23	1.08
124	0	3.96	0	15.84	0
125	0	3.24	0	16.56	0
126	0	4.77	0	15.03	0
127	1	6.84	0	10.71	0.99
128	1	5.49	0	7.56	0.09
129	0	2.07	0	7.74	2.61
130	1	7.56	0	6.75	5.13
131	0	4.14	1.53	8.28	2.34
132	0	0	2.34	5.76	2.97
133	0	11.97	3.24	4.05	0.36
134	0	2.43	2.16	14.76	0.36

ID	MARTENS	WATER	DEVELOPED	FOREST	GRASS
135	1	5.58	1.98	10.8	0
136	0	1.08	0	17.01	0
137	1	2.34	1.62	8.73	2.34
138	0	2.43	0	16.38	0.99
139	0	0.72	0	11.88	7.02
140	0	1.26	0	12.6	5.31
141	0	1.8	0	10.26	5.94
142	0	0	0	11.25	8.01
143	0	0	0	12.87	6.93
144	0	0	1.35	10.8	6.3
145	0	0	1.26	8.37	10.17
146	0	0	0.9	7.2	11.7
147	0	0	0	15.84	3.96
148	0	2.34	1.53	15.3	0
149	0	5.22	1.53	9.9	2.07
150	0	0.63	1.62	9.45	2.97
151	0	0.54	1.26	12.87	2.16
152	0	0.54	1.26	15.3	2.25
153	0	0.54	1.44	14.58	3.06
154	0	0	0	17.01	2.79
155	0	0	0	18.36	1.44
156	0	0	0	14.58	5.13
157	0	0	2.79	16.83	0
163	1	3.33	1.26	8.64	4.5
164	0	1.08	5.49	8.82	0
165	0	2.7	0.81	6.12	1.53
166	0	7.47	0	6.57	5.58
167	0	5.49	1.26	9.09	1.44
168	1	7.65	5.04	7.11	0
171	0	5.85	4.05	9.27	0
172	1	5.58	0.81	13.41	0

250m continued

ID	AG	WETLAND	NUMP	MPS	ED
1	0	0	2	4.77	151.52
2	0	0	1	12.69	151.52
3	0	0	3	3.33	142.42
4	0	1.44	2	7.11	203.03
5	0	0.63	3	4.26	227.27
6	0	0.45	1	13.95	178.79
7	0	0.63	1	9.09	142.42
8	2.16	3.15	2	6.43	157.58
9	4.68	0.72	1	17.19	136.36
10	0	0.09	1	17.19	136.36
14	0	0	1	16.92	145.45
15	0	0.27	2	8.01	127.27
16	0.72	2.79	2	5.94	166.67
17	3.15	0	1	16.38	130.3
18	0	2.16	2	7.07	172.73
19	0	0.36	2	6.61	166.67
20	0	0.45	1	14.76	166.67
21	0	0	1	12.06	175.76
22	3.6	1.62	2	6.43	163.64
23	3.42	1.98	4	2.74	187.88
24	5.67	0	2	6.3	154.55
30	0	0	4	3.4	181.82
31	0	0.81	2	7.47	133.33
32	0	0.54	2	6.8	178.79
33	1.44	0	1	14.58	148.48
34	0	0.09	2	5.4	139.39
37	2.25	0	5	2.56	166.67
38	0	0	1	17.46	163.64
39	0	0	3	6.18	130.3
40	0	0.36	3	4.62	200
42	6.48	0	1	13.32	90.91
43	6.12	0	1	13.23	96.97
52	9.27	0	1	18.27	118.18
53	0	1.08	2	7.16	124.24
54	0	0.81	1	17.1	154.55
55	0.63	1.71	2	5.36	96.97
56	0	0.54	1	13.32	115.15
57	0	0.45	1	16.56	139.39
58	0	0.72	2	8.86	136.36
59	0	0.81	2	8.28	196.97
60	0	1.26	3	3.06	136.36
61	0	0	2	2.57	115.15
62	10.53	0.45	2	6.61	100
63	1.62	0	2	6.75	115.15
73	0	0	2	7.56	148.48

ID	AG	WETLAND	NUMP	MPS	ED
74	0	0	1	11.16	151.52
75	0	0.63	4	2.52	196.97
76	0	0	1	19.8	103.03
77	0	0	2	9.54	112.12
78	0	0	1	17.91	157.58
79	0	0	1	14.58	136.36
80	1.53	0.9	1	18.36	124.24
81	0	0.27	1	19.08	103.03
82	0	0.36	1	11.7	130.3
83	0	0.18	1	18.27	103.03
84	1.44	0.09	1	17.1	112.12
85	0	0	1	11.79	90.91
86	0	0	1	9.09	96.97
87	1.89	0	2	3.19	112.12
91	5.85	0	3	5.67	139.39
92	0	0.63	4	2.97	172.73
93	0	2.88	3	4.05	196.97
94	1.08	0.36	4	2.03	178.79
95	0	2.97	1	9.9	93.94
102	0	2.34	2	3.33	136.36
103	0	0	4	3.19	124.24
104	0	0	3	4.5	187.88
105	0	1.35	3	4.74	203.03
111	0	0	1	18.27	106.06
112	2.79	1.8	2	5.18	154.55
113	2.61	1.08	1	11.43	145.45
114	4.23	0.09	1	11.34	106.06
115	7.56	0	2	2.03	103.03
116	3.78	0	1	15.57	157.58
117	3.69	0	1	16.11	103.03
118	1.26	1.08	1	11.79	115.15
119	7.2	0.54	1	7.38	96.97
120	6.57	0	2	3.02	78.79
121	6.21	2.61	3	2.49	175.76
122	3.15	0	2	7.88	127.27
123	5.22	0	3	4.41	163.64
124	0	0	1	15.84	115.15
125	0	0	1	16.56	118.18
126	0	0	1	15.03	121.21
127	1.26	0	2	5.36	106.06
128	6.21	0.45	2	3.78	109.09
129	6.84	0.54	2	3.87	127.27
130	0	0.36	3	2.25	109.09
131	1.98	1.53	3	2.76	142.42
132	7.47	1.26	3	1.92	106.06
133	0	0.18	2	2.03	84.85
134	0	0.09	2	7.38	133.33

ID	AG	WETLAND	NUMP	MPS	ED
135	0	1.44	2	5.4	142.42
136	0	1.71	1	17.01	145.45
137	3.24	1.53	3	2.91	127.27
138	0	0	1	16.38	127.27
139	0	0.18	3	3.96	163.64
140	0	0.63	1	12.6	166.67
141	0	1.8	3	3.42	196.97
142	0	0.54	1	11.25	178.79
143	0	0	3	4.29	133.33
144	0	1.35	2	5.4	166.67
145	0	0	4	2.09	157.58
146	0	0	5	1.44	160.61
147	0	0	2	7.92	169.7
148	0	0.63	1	15.3	169.7
149	0.27	0.81	4	2.47	181.82
150	4.68	0.45	3	3.15	181.82
151	2.97	0	2	6.43	142.42
152	0.45	0	2	7.65	172.73
153	0.18	0	3	4.86	181.82
154	0	0	2	8.51	178.79
155	0	0	1	18.36	133.33
156	0	0.09	3	4.86	209.09
157	0	0.18	2	8.41	148.48
163	2.07	0	4	2.16	157.58
164	3.24	1.17	5	1.76	136.36
165	8.64	0	2	3.06	151.52
166	0	0.18	2	3.29	121.21
167	0	2.52	5	1.82	136.36
168	0	0	4	1.78	157.58
171	0	0.63	3	3.09	175.76
172	0	0	1	13.41	112.12

250m continued

ID	AWMSI	MPFD	AWMPFD	MNN	IJI
1	2	1.12	1.12	30	0
2	2.11	1.13	1.13	0	88.74
3	1.95	1.05	1.12	50.64	88.9
4	2.2	1.12	1.14	60	97.31
5	1.98	1.11	1.12	30	84.05
6	2.37	1.15	1.15	0	97.09
7	2.34	1.15	1.15	0	57.62
8	2.09	1.06	1.13	67.08	93.28
9	1.63	1.08	1.08	0	70.72
10	1.63	1.08	1.08	0	70.72
14	1.75	1.09	1.09	0	44.65
15	1.47	1.04	1.06	30	65
16	2.05	1.08	1.12	60	96.34
17	1.59	1.08	1.08	0	63.74
18	2.01	1.1	1.12	30	95.94
19	2.19	1.07	1.13	60	75.26
20	2.15	1.13	1.13	0	85.34
21	2.51	1.16	1.16	0	94.58
22	1.98	1.1	1.12	30	79.96
23	1.82	1.06	1.1	30	99.09
24	1.51	1.08	1.07	30	98.19
30	1.56	1.05	1.08	37.5	98.51
31	1.24	1.04	1.04	30	91.15
32	2.02	1.09	1.12	30	95.12
33	1.92	1.11	1.11	0	68.74
34	1.71	1.1	1.09	42.43	66.32
37	1.2	1.06	1.03	30	89.05
38	1.94	1.11	1.11	0	63.43
39	1.12	1.04	1.02	30	0
40	2.42	1.08	1.15	30	81.89
42	1.23	1.04	1.04	0	0
43	1.32	1.05	1.05	0	67.69
52	1.37	1.05	1.05	0	62.92
53	1.48	1.05	1.07	60	95.67
54	1.85	1.1	1.1	0	63.6
55	1.3	1.02	1.04	60	60.51
56	1.56	1.08	1.08	0	82.56
57	1.7	1.09	1.09	0	99.11
58	1.53	1.04	1.07	30	99.92
59	2.21	1.08	1.13	30	95.97
60	1.74	1.06	1.1	68.28	0
61	1.97	1.13	1.13	60	41.78
62	1.28	1.02	1.04	90	38.18
63	1.33	1.03	1.05	60	0
73	1.36	1.06	1.05	30	94.14

ID	AWMSI	MPFD	AWMPFD	MNN	IJI
74	2.25	1.14	1.14	0	85.83
75	1.73	1.09	1.1	30	82.62
76	1.15	1.02	1.02	0	0
77	1.14	1.03	1.02	30	0
78	1.84	1.1	1.1	0	35.91
79	1.77	1.1	1.1	0	96.46
80	1.44	1.06	1.06	0	85.39
81	1.17	1.03	1.03	0	97.99
82	1.89	1.11	1.11	0	33.73
83	1.19	1.03	1.03	0	50.33
84	1.34	1.05	1.05	0	0
85	1.31	1.05	1.05	0	0
86	1.59	1.08	1.08	0	94.57
87	1.56	1.09	1.09	90	88.65
91	1.25	1.05	1.04	30	88.32
92	1.45	1.08	1.07	33.11	98.8
93	1.88	1.08	1.11	30	79
94	1.99	1.1	1.13	58.71	74.56
95	1.48	1.07	1.07	0	57.23
102	1.87	1.12	1.12	30	89.56
103	1.44	1.02	1.06	39.27	59.1
104	1.96	1.09	1.12	40	82.29
105	2.02	1.07	1.12	40	94.81
111	1.23	1.03	1.03	0	99.75
112	1.84	1.13	1.11	60	92.18
113	2.13	1.13	1.13	0	88.54
114	1.56	1.08	1.08	0	63.1
115	2.38	1.08	1.16	84.85	96.47
116	1.98	1.11	1.11	0	40.79
117	1.27	1.04	1.04	0	0
118	1.66	1.09	1.09	0	87.68
119	1.77	1.1	1.1	0	86.94
120	1.47	1.04	1.07	216.33	96.12
121	2.65	1.1	1.17	48.28	84.77
122	1.38	1.06	1.05	30	77.93
123	1.58	1.09	1.08	40	67.71
124	1.43	1.06	1.06	0	0
125	1.44	1.06	1.06	0	0
126	1.55	1.07	1.07	0	0
127	1.39	1.04	1.06	30	77.3
128	1.52	1.07	1.08	30	49.94
129	1.67	1.1	1.1	30	66.36
130	1.51	1.07	1.08	99.3	71.3
131	1.86	1.07	1.11	68.28	96.48
132	1.54	1.07	1.08	40	94.61
133	1.7	1.12	1.1	150	75.98
134	1.25	1.06	1.04	30	73.59

ID	AWMSI	MPFD	AWMPFD	MNN	IJI
135	1.52	1.08	1.08	30	98.95
136	1.75	1.09	1.09	0	70.46
137	1.88	1.04	1.11	48.28	65.73
138	1.56	1.07	1.07	0	99.68
139	2.01	1.06	1.12	40	39.64
140	2.32	1.14	1.14	0	65.38
141	2.16	1.1	1.14	48.28	83.55
142	2.64	1.17	1.17	0	76.42
143	1.56	1.04	1.08	85.95	0
144	2.42	1.08	1.15	90	78.23
145	2.01	1.07	1.12	48.54	17.38
146	1.47	1.06	1.07	49.42	17.38
147	1.96	1.08	1.11	30	0
148	2.15	1.13	1.13	0	91.2
149	1.64	1.07	1.09	30	93.13
150	1.85	1.09	1.11	30	87.62
151	1.52	1.09	1.07	30	95.26
152	1.83	1.08	1.1	30	87.57
153	1.65	1.06	1.09	40	80.06
154	1.91	1.1	1.11	30	0
155	1.54	1.07	1.07	0	0
156	1.87	1.08	1.11	30	15.94
157	1.3	1.04	1.05	30	0
163	1.73	1.08	1.1	40.61	96.63
164	1.32	1.03	1.05	36	79.09
165	2.71	1.11	1.18	60	63.16
166	2.22	1.07	1.14	189.74	62.16
167	1.54	1.05	1.08	32.49	92.3
168	1.85	1.08	1.12	73.71	91.32
171	2.09	1.08	1.13	40	78.68
172	1.52	1.07	1.07	0	94.57

250m continued

ID	STRM_DEN	ROAD_DEN
1	26.129	0
2	43.232	18.609
3	48.747	19.002
4	0	41.335
5	0	36.347
6	0	42.99
7	25.574	14.542
8	12.621	0
9	0	2.387
10	0	52.713
14	0	37.508
15	0	34.165
16	25.45	0
17	0	0
18	22.173	0
19	25.575	27.225
20	24.205	26.68
21	36.174	24.485
22	0	10.657
23	0	25.499
24	0	25.297
30	0	32.863
31	13.685	33.006
32	26.285	37.179
33	59.389	0
34	53.811	0
37	0	47.688
38	0	23.842
39	0	16.551
40	31.492	22.885
42	0	0
43	3.984	0
52	0	0
53	13.913	0
54	40.536	0
55	16.074	1.035
56	43.958	14.945
57	31.47	26.274
58	20.315	40.794
59	0	25.499
60	0	46.211
61	40.535	16.681
62	0	75.455
63	0	24.109
73	0	11.331

ID	STRM_DEN	ROAD_DEN
74	0	23.819
75	27.519	22.105
76	16.369	73.484
77	0	24.855
78	0	30.793
79	0	39.703
80	28.83	0
81	10.554	3.427
82	0	10.421
83	55.646	0
84	0	0
85	5.818	0
86	26.292	0
87	25.598	0
91	24.54	0
92	2.527	92.517
93	13.583	79.744
94	28.1	41.725
95	4.422	24.894
102	34.811	13.097
103	5.419	9.228
104	12.421	27.909
105	0	27.143
111	0	29.363
112	23.531	0
113	24.133	0
114	0	0
115	30.489	0
116	0	0
117	0	0
118	0	0
119	7.359	1.682
120	0	0
121	23.117	18.919
122	0	0
123	0	31.817
124	25.074	2.717
125	22.421	12.791
126	18.657	22.594
127	25.049	13.608
128	0	33.959
129	13.783	27.424
130	26.752	6.06
131	30.757	25.998
132	0	26.047
133	70.249	56.106
134	25.529	30.033

ID	STRM_DEN	ROAD_DEN
135	35.43	31.159
136	8.966	11.826
137	0	49.517
138	16.858	24.753
139	0	48.212
140	0	30.572
141	15.517	59.311
142	0	0
143	0	33.122
144	0	32.995
145	0	41.536
146	0	40.995
147	0	25.06
148	8.109	36.623
149	19.384	25.564
150	0	25.42
151	0	23.408
152	0	21.13
153	0	25.394
154	19.455	25.459
155	11.758	20.094
156	0	34.506
157	0	30.01
163	11.234	22.445
164	6.23	46.861
165	17.633	17.946
166	46.241	0
167	20.736	20.676
168	51.614	30.52
171	23.159	24.313
172	33.18	0

500m

ID	MARTENS	WATER	DEVELOPED	FOREST	GRASS
1	0	28.53	0	41.22	0
2	0	20.79	1.44	54.27	0
3	0	23.49	2.79	47.07	0
4	0	7.92	8.1	55.26	3.87
5	1	7.29	6.66	57.87	2.52
6	0	8.28	6.03	58.68	2.97
7	0	11.07	0	49.41	3.33
8	0	0.09	0	32.94	6.48
9	0	10.17	0.81	38.97	8.55
10	1	1.62	14.4	51.03	0.72
14	0	1.62	13.86	60.12	0
15	1	0	22.05	54.36	0
16	0	13.14	0.63	41.49	2.43
17	0	7.02	0.36	45.54	2.97
18	0	13.59	0.63	43.74	6.84
19	1	19.17	2.97	34.56	17.82
20	0	15.3	3.33	43.29	12.87
21	0	23.22	3.15	34.11	14.13
22	0	5.31	2.7	38.88	2.61
23	0	0.9	2.97	36.99	6.48
24	0	2.07	2.97	45.81	0.54
30	1	5.49	8.46	54.45	4.59
31	0	8.82	8.28	50.31	9.63
32	0	22.32	9.36	38.97	3.96
33	0	4.5	0	54.63	12.6
34	1	15.3	0.54	45.99	8.64
37	0	4.77	8.19	36.36	8.64
38	0	9.63	3.51	62.28	0.99
39	0	6.39	3.42	64.17	1.44
40	0	7.29	6.48	57.51	6.12
42	0	0.09	2.79	38.07	8.73
43	0	0.27	3.51	43.56	7.02
52	1	0	1.62	33.57	9.9
53	0	2.61	0	53.91	13.23
54	0	2.61	1.62	47.61	19.62
55	0	2.61	1.62	49.95	8.28
56	1	30.6	1.35	27.36	14.85
57	1	27.72	1.17	47.16	0
58	0	22.95	1.08	51.21	0
59	0	10.44	3.96	62.28	0
60	0	5.49	5.49	64.35	0.9
61	0	15.48	4.23	57.6	0.54
62	0	1.08	8.91	17.82	8.46
63	0	0	8.55	42.03	8.19
73	1	1.26	6.12	57.96	6.3

ID	MARTENS	WATER	DEVELOPED	FOREST	GRASS
74	1	9.54	7.47	45.72	14.31
75	1	40.5	3.06	32.85	0
76	0	21.6	10.08	38.7	5.76
77	0	0	3.15	74.52	0.18
78	0	9.54	2.61	65.61	0.09
79	0	0	3.51	67.23	5.94
80	1	8.1	0	55.53	1.8
81	1	6.3	0	57.51	3.69
82	1	6.39	0	59.13	4.5
83	0	19.62	0.45	56.88	0
84	0	5.67	0.45	48.15	4.68
85	0	19.44	0	51.48	1.44
86	0	39.6	0	33.3	0
87	0	31.23	0	31.59	0
91	1	30.78	0	27.72	0
92	0	24.39	4.41	40.32	2.61
93	0	24.75	3.51	35.82	3.06
94	1	22.32	5.85	40.14	0.81
95	1	20.52	3.69	34.29	13.23
102	0	29.79	1.35	32.85	9.63
103	0	29.88	2.7	33.12	9.63
104	0	7.83	3.24	61.2	4.05
105	0	1.35	3.6	63.18	7.56
111	1	0.99	3.6	67.95	4.41
112	0	8.1	0	45.36	3.33
113	0	6.3	0	43.47	3.24
114	0	12.42	0	36.45	3.96
115	0	28.89	0	23.04	0
116	0	1.8	0.9	50.4	0.54
117	0	5.13	1.53	45.09	1.08
118	0	0	0.09	43.92	10.53
119	0	19.62	0.72	20.34	14.04
120	0	1.08	0	34.65	13.95
121	0	7.2	0	35.91	3.42
122	0	1.44	0.72	39.96	3.51
123	0	4.86	0	41.76	3.15
124	0	22.05	0	51.48	0.18
125	0	15.75	0.81	55.98	1.44
126	0	26.91	1.8	48.6	0
127	1	23.49	0	39.6	3.51
128	1	14.31	0	38.7	4.95
129	0	19.17	0	35.01	4.68
130	1	25.11	3.51	34.29	12.6
131	0	14.49	5.94	30.24	5.4
132	0	6.3	6.21	19.35	5.49
133	0	31.68	6.3	33.3	2.43
134	0	26.55	6.48	38.97	4.68

ID	MARTENS	WATER	DEVELOPED	FOREST	GRASS
135	1	18.27	3.96	50.76	0
136	0	9.63	1.89	56.97	4.86
137	1	15.75	3.51	38.7	4.14
138	0	21.69	1.26	46.98	4.59
139	0	13.14	0	35.82	20.97
140	0	8.19	0.18	48.6	13.77
141	0	14.85	0	38.7	17.91
142	0	0	2.52	50.31	17.73
143	0	0	0.9	54.99	20.52
144	0	0	5.85	49.77	18.09
145	0	0	2.61	30.06	45
146	0	0	1.71	37.62	38.52
147	0	0	0.27	54.81	22.77
148	0	15.84	3.15	51.93	3.69
149	0	11.79	3.6	48.33	3.06
150	0	13.59	4.68	38.7	2.97
151	0	2.88	3.51	38.16	10.62
152	0	3.42	2.79	39.69	9.63
153	0	2.88	2.97	39.51	7.83
154	0	0	0	65.79	11.43
155	0	0	0	66.6	9.36
156	0	0	0	57.6	17.73
157	0	7.83	9.18	54.45	0
163	1	12.69	6.75	30.33	10.98
164	0	14.76	9.99	34.65	2.97
165	0	12.6	2.43	31.41	5.67
166	0	18.72	1.53	37.62	16.11
167	0	16.65	5.13	35.37	11.25
168	1	15.48	12.69	46.44	2.61
171	0	15.93	9.45	50.76	0.81
172	1	12.96	10.53	51.39	2.52

500m continued

ID	AG	WETLAND	NUMP	MPS	ED
1	0	1.89	3	13.74	109.44
2	0.09	0.54	2	27.14	101.73
3	4.05	0.45	2	23.53	122.54
4	0	2.7	2	27.63	158.77
5	0	3.51	2	29.34	142.58
6	0	1.89	2	24.7	123.31
7	4.68	9.36	6	5.49	125.63
8	27.09	11.25	5	7.79	147.98
9	9.63	9.72	3	17.01	108.67
10	8.37	1.71	3	17.01	108.67
14	0.09	2.16	2	30.06	107.9
15	0	1.44	3	18.12	110.21
16	9.63	10.53	3	13.83	120.23
17	16.11	5.85	4	11.39	110.21
18	3.78	9.27	6	7.29	131.79
19	0	3.33	3	11.52	112.52
20	0	3.06	6	7.22	135.65
21	0	3.24	6	5.68	117.15
22	24.75	3.6	4	9.72	127.17
23	27.9	2.61	5	7.4	124.86
24	24.3	2.16	3	15.27	110.21
30	0.09	4.77	4	13.61	141.04
31	0	0.81	5	10.06	131.02
32	0	3.24	5	7.79	137.96
33	5.58	0.54	3	18.21	86.32
34	6.84	0.54	3	15.33	93.26
37	19.35	0.54	5	7.27	112.52
38	0.81	0.63	1	62.28	115.61
39	1.98	0.45	1	64.17	117.92
40	0	0.45	4	14.38	124.08
42	27.27	0.9	6	6.34	93.26
43	22.41	1.08	6	7.26	95.57
52	32.04	0.72	1	53.91	100.19
53	4.32	3.78	1	47.61	85.55
54	3.6	2.79	3	16.65	109.44
55	11.79	3.6	4	6.84	71.68
56	2.43	1.26	4	11.79	96.34
57	0	1.8	2	25.6	93.26
58	0	2.61	1	62.28	110.98
59	0	1.17	2	32.17	117.92
60	0	1.62	3	19.2	120.23
61	0	0	8	2.23	96.34
62	33.75	7.83	6	7.01	87.86
63	17.73	1.35	7	3.9	79.38
73	1.71	4.5	4	11.43	95.57

ID	AG	WETLAND	NUMP	MPS	ED
74	0	0.81	4	8.21	120.23
75	0	1.44	3	12.9	149.52
76	0	1.71	1	74.52	79.38
77	0	0	1	65.61	76.3
78	0	0	1	67.23	100.96
79	0	1.17	4	13.88	94.8
80	6.93	5.49	3	19.17	95.57
81	4.32	6.03	1	59.13	97.88
82	2.34	5.49	2	28.44	103.28
83	0.09	0.81	3	16.05	96.34
84	17.91	0.99	3	17.16	103.28
85	4.95	0.54	2	16.65	43.16
86	4.95	0	2	15.8	52.41
87	15.03	0	5	5.67	71.68
91	19.35	0	8	5.04	101.73
92	0.45	5.67	7	5.12	111.75
93	2.7	8.01	9	4.46	133.33
94	6.57	2.16	5	6.86	142.58
95	0.72	5.4	3	7.29	75.53
102	0	4.23	4	8.21	122.54
103	0.18	2.34	5	6.62	114.07
104	0.9	0.63	3	20.4	118.69
105	0	2.16	2	31.59	113.29
111	0	0.9	5	13.59	90.17
112	17.46	3.6	1	45.36	93.26
113	20.97	3.87	1	43.47	98.65
114	21.6	3.42	3	12.15	97.11
115	25.47	0.45	5	4.61	108.67
116	24.03	0.18	3	16.8	94.8
117	24.75	0.27	1	45.09	90.94
118	18.27	5.04	2	21.96	90.17
119	22.41	0.72	6	3.39	82.47
120	26.19	1.98	6	5.78	99.42
121	26.46	4.86	4	8.98	156.45
122	31.86	0.36	3	13.32	87.09
123	25.02	3.06	2	20.88	116.38
124	2.88	1.26	1	51.48	95.57
125	1.62	2.25	1	55.98	110.98
126	0	0.54	1	48.6	104.05
127	10.53	0.72	2	19.8	78.61
128	18.27	1.62	2	19.35	94.8
129	17.91	1.08	4	8.75	77.84
130	0	2.34	7	4.9	119.46
131	18.36	3.42	5	6.05	83.24
132	34.56	5.94	5	3.87	68.59
133	2.7	1.44	5	6.66	107.9
134	0	1.17	6	6.49	84.78
135	0	4.86	3	16.92	106.36

ID	AG	WETLAND	NUMP	MPS	ED
136	0.36	4.14	3	18.99	109.44
137	11.43	4.32	5	7.74	110.98
138	0	3.33	2	23.49	103.28
139	0	7.92	6	5.97	123.31
140	0	7.11	2	24.3	121.77
141	0	6.39	3	12.9	117.15
142	0.36	6.93	2	25.16	134.87
143	0	1.44	1	54.99	128.71
144	0	4.14	5	9.95	141.04
145	0.18	0	11	2.73	134.1
146	0	0	7	5.37	168.79
147	0	0	4	13.7	134.87
148	0.99	2.25	4	12.98	138.73
149	8.82	2.25	1	48.33	134.1
150	15.75	2.16	5	7.74	137.19
151	19.98	2.7	5	7.63	117.92
152	20.16	2.16	8	4.96	119.46
153	21.69	2.97	9	4.39	127.17
154	0	0.63	4	16.45	120.23
155	0.09	1.8	2	33.3	104.82
156	0	2.52	4	14.4	137.96
157	5.22	1.17	4	13.61	109.44
163	15.21	1.89	6	5.05	115.61
164	14.31	1.17	6	5.78	106.36
165	24.84	0.9	9	3.49	110.21
166	3.42	0.45	4	9.4	115.61
167	3.42	6.03	6	5.89	128.71
168	0	0.63	2	23.22	136.42
171	0	0.9	2	25.38	114.84
172	0	0.45	5	10.28	105.59

500m continued

ID	MSI	AWMSI	MPFD	AWMPFD	MNN
1	2.07	2.5	1.13	1.14	42.36
2	1.93	2.27	1.1	1.13	94.87
3	2.45	3.28	1.14	1.18	30
4	2.82	3.18	1.16	1.18	30
5	2.53	2.6	1.14	1.15	30
6	2.51	3.27	1.16	1.18	30
7	1.78	3.01	1.1	1.18	45.32
8	1.94	3.92	1.1	1.21	32.49
9	1.77	2.24	1.09	1.13	30
10	1.77	2.24	1.09	1.13	30
14	2.23	2.37	1.14	1.13	30
15	1.96	2.03	1.12	1.11	30
16	2.02	3.39	1.11	1.19	121.23
17	1.61	2.43	1.07	1.14	30
18	1.66	2.93	1.09	1.16	48.03
19	2.07	2.66	1.12	1.15	60
20	1.63	3.28	1.08	1.18	40
21	1.59	2.73	1.07	1.16	54.14
22	2.17	3.28	1.14	1.19	30
23	1.7	3.21	1.07	1.18	37.42
24	1.96	2.93	1.12	1.16	60
30	1.94	2.43	1.11	1.14	30
31	1.71	1.94	1.08	1.11	48
32	1.85	2.8	1.1	1.16	36
33	1.52	1.95	1.07	1.1	68.28
34	1.67	2.05	1.08	1.11	42.43
37	1.81	1.99	1.11	1.12	38.49
38	2.85	2.85	1.16	1.16	0
39	2.86	2.86	1.16	1.16	0
40	1.63	2.77	1.07	1.15	37.5
42	1.5	1.96	1.08	1.11	35
43	1.34	1.74	1.05	1.09	30
52	2.66	2.66	1.15	1.15	0
53	2.41	2.41	1.13	1.13	0
54	1.76	2.78	1.09	1.16	50
55	1.63	2.05	1.09	1.12	45
56	1.48	2.49	1.06	1.14	71.04
57	1.77	2.47	1.08	1.14	30
58	2.74	2.74	1.15	1.15	0
59	2.03	2.71	1.11	1.15	30
60	1.82	2.77	1.09	1.15	30
61	1.59	2.24	1.08	1.14	74.32
62	1.52	1.39	1.08	1.05	36.18
63	1.5	1.47	1.08	1.07	36.06
73	1.53	1.73	1.08	1.09	30

ID	MSI	AWMSI	MPFD	AWMPFD	MNN
74	2.04	3.04	1.12	1.17	83.03
75	2.57	3.07	1.15	1.18	30
76	1.79	1.79	1.09	1.09	0
77	1.83	1.83	1.09	1.09	0
78	2.4	2.4	1.13	1.13	0
79	1.69	1.93	1.1	1.1	33.11
80	1.76	2.2	1.11	1.12	40
81	2.48	2.48	1.14	1.14	0
82	1.89	2.55	1.09	1.14	67.08
83	1.75	2.11	1.1	1.12	30
84	1.79	2.45	1.1	1.14	42.36
85	1.22	1.38	1.03	1.05	67.08
86	1.65	1.59	1.1	1.07	90
87	1.36	1.54	1.05	1.07	90
91	1.34	1.62	1.06	1.08	37.5
92	1.62	1.93	1.09	1.11	44.63
93	1.48	1.91	1.07	1.11	30
94	2.12	2.58	1.13	1.16	54
95	1.76	2.62	1.09	1.16	62.43
102	2.03	2.72	1.11	1.16	48.54
103	1.66	3.03	1.07	1.17	46.97
104	2.14	1.88	1.13	1.1	30
105	1.91	2.04	1.1	1.11	60
111	1.21	1.45	1.03	1.06	38.49
112	2.69	2.69	1.15	1.15	0
113	2.91	2.91	1.16	1.16	0
114	1.77	2.86	1.08	1.16	30
115	2.06	2.38	1.13	1.15	64.97
116	1.61	2.39	1.07	1.13	50
117	2.64	2.64	1.15	1.15	0
118	1.88	2.51	1.1	1.14	216.33
119	1.58	2.21	1.08	1.14	83.54
120	1.53	1.92	1.08	1.11	72.48
121	2.2	4.48	1.11	1.23	30
122	1.63	2.35	1.08	1.13	30
123	2.51	3.3	1.15	1.18	30
124	2.59	2.59	1.14	1.14	0
125	2.89	2.89	1.16	1.16	0
126	2.9	2.9	1.16	1.16	0
127	1.8	1.9	1.1	1.1	30
128	2.28	2.44	1.14	1.14	30
129	1.42	1.6	1.06	1.08	37.5
130	1.51	2.3	1.07	1.13	51.43
131	1.54	1.62	1.08	1.08	30
132	1.52	1.73	1.08	1.09	60
133	1.73	1.9	1.1	1.11	40.97
134	1.39	1.7	1.06	1.09	83.64

ID	MSI	AWMSI	MPFD	AWMPFD	MNN
135	1.75	1.81	1.09	1.09	40
136	1.64	2.68	1.07	1.15	48.28
137	1.78	2.3	1.11	1.13	58.97
138	2.24	2.66	1.14	1.15	192.09
139	1.59	3.21	1.07	1.18	55
140	2.31	3.27	1.13	1.18	60
141	1.98	3.42	1.1	1.19	70
142	2.5	3.55	1.14	1.19	60
143	3.38	3.38	1.18	1.18	0
144	1.7	2.81	1.08	1.15	36
145	1.42	2.32	1.06	1.13	38.83
146	1.82	3.01	1.09	1.17	43.87
147	1.83	2.87	1.1	1.16	39.27
148	1.68	3.46	1.06	1.19	33.11
149	3.75	3.75	1.2	1.2	0
150	1.84	2.55	1.09	1.15	42
151	1.79	2.37	1.1	1.14	56.83
152	1.39	2.18	1.05	1.12	31.55
153	1.47	2.06	1.07	1.12	36.67
154	1.62	2.39	1.08	1.13	36.21
155	1.97	2.24	1.11	1.12	30
156	1.81	2.9	1.1	1.16	33.11
157	1.75	2.39	1.1	1.13	33.11
163	1.71	2.22	1.09	1.14	44.95
164	1.61	1.87	1.08	1.11	47.69
165	1.51	2.41	1.07	1.14	41.92
166	1.83	2.6	1.1	1.15	30
167	1.71	1.8	1.09	1.1	30
168	2.77	2.82	1.17	1.17	60
171	2.18	2.29	1.12	1.13	60
172	1.42	2.41	1.05	1.13	62.83

500m continued

ID	IJI	STRM_DEN	ROAD_DEN
1	64.73	39.632	1.675
2	55.71	33.472	8.201
3	83.86	35.55	12.481
4	92.22	4.698	28.634
5	93.65	0	23.988
6	95.26	9.118	24.279
7	76.16	23.045	7.009
8	86.76	13.608	5.572
9	59.71	12.62	9.225
10	59.71	1.432	57.009
14	55.6	0	44.555
15	49.29	0	52.234
16	91.23	27.957	1.881
17	84.01	15.159	0.676
18	85.55	26.559	1.519
19	93.8	39.296	22.975
20	87.89	36.593	13.935
21	93.62	42.221	18.393
22	95.27	0	11.379
23	88.5	0	12.76
24	74.94	7.457	12.731
30	86.86	5.066	26.912
31	85.24	15.333	30.016
32	92.32	23.836	31.234
33	78.4	22.238	1.025
34	73.79	33.09	2.605
37	80.35	5.922	21.447
38	78.01	14.297	12.508
39	84.76	7.483	11.737
40	88.38	15.604	21.154
42	67.64	6.964	13.545
43	79.66	9.059	19.182
52	94.18	4.422	11.759
53	85.92	10.134	2.756
54	88.03	10.134	10.894
55	63.01	10.134	17.846
56	79.92	39.738	11.108
57	82.63	35.613	18.989
58	88.95	28.34	20.445
59	78.76	7.781	19.81
60	75.75	10.266	25.076
61	82.35	23.107	17.175
62	88.87	4.755	45.892
63	26.29	0	26.23
73	89.95	1.594	21.392

ID	IJI	STRM_DEN	ROAD_DEN
74	76	21.365	15.943
75	92.27	49.234	13.272
76	28.12	25.208	52.309
77	65.92	0	24.075
78	87.66	12.255	17.275
79	95.46	0	25.852
80	96.43	18.98	7.29
81	94.24	19.19	9.726
82	48.37	21.486	14.367
83	67.09	28.024	0
84	67.67	5.041	6.49
85	89.71	25.349	0
86	99.59	15.522	0
87	36.45	13.297	0
91	86.99	12.93	0
92	89.53	25.366	55.575
93	85.79	31.467	53.265
94	78.65	42.444	47.588
95	51.46	10.619	10.273
102	85.85	19.293	6.763
103	67.45	17.111	7.829
104	84.82	17.733	19.779
105	82.27	2.822	23.324
111	86.7	5.174	36.465
112	84.28	15.005	0
113	82.82	14.597	0
114	81.29	15.342	0.311
115	70.81	36.315	0
116	57.32	0	3.859
117	62.18	10.438	6.741
118	73.76	0	0
119	87.72	11.127	3.613
120	75.94	2.839	0
121	81.88	19.377	15.099
122	40.7	0	17.914
123	76.84	5.721	19.821
124	54.82	32.425	4.237
125	66.66	16.15	7.215
126	44.8	36.17	9.708
127	61.38	22.876	25.78
128	77.27	8.285	20.2
129	65.31	12.183	20.894
130	87.87	31.167	12.435
131	98.35	18.667	17.235
132	98.01	9.915	19.887
133	74.97	52.171	33.025
134	88.15	34.606	26.037

ID	IJI	STRM_DEN	ROAD_DEN
135	97.75	34.476	17.651
136	75.05	15.893	16.473
137	88.97	25.109	33.476
138	82.87	24.667	15.891
139	90.51	13.218	30.617
140	77.55	10.434	30.501
141	93.2	20.798	28.326
142	61.99	0	23.345
143	45.94	0	17.925
144	87.16	0	27.405
145	19.14	0	24.09
146	8.91	4.624	28.9
147	3.69	16.73	16.757
148	82.68	19.117	18.894
149	92.49	10.122	20.629
150	92.9	9.686	21.293
151	83.01	0	16.859
152	84.32	0	14.377
153	86.42	0	15.454
154	35.6	15.176	20.897
155	40.75	15.166	15.328
156	40.27	8.128	31.435
157	78.88	10.462	20.724
163	96.79	11.935	21.617
164	85.21	16.607	23.295
165	54.58	19.387	10.454
166	64.33	23.569	7.989
167	93.48	26.071	19.434
168	76.48	21.722	16.396
171	64.95	17.63	16.805
172	73.44	15.83	13.89

1km

ID	MARTENS	WATER	DEVELOPED	FOREST
1	0	63.81	1.71	122.67
2	0	54	3.87	147.06
3	0	53.82	6.93	157.77
4	0	56.43	16.11	195.66
5	1	48.6	16.11	200.43
6	0	49.95	17.55	191.7
7	0	48.42	1.26	189.45
8	0	28.35	1.35	164.07
9	0	27.99	2.52	149.94
10	1	13.05	58.23	137.79
14	0	12.96	71.91	166.59
15	1	5.4	81.9	186.75
16	0	65.43	10.89	150.75
17	0	69.84	11.52	141.39
18	0	40.5	9.72	151.2
19	1	43.74	11.25	171.09
20	0	40.05	8.55	175.41
21	0	47.16	11.43	174.78
22	0	25.47	9.09	186.75
23	0	35.55	9.63	181.44
24	0	57.6	6.03	167.4
30	1	57.51	19.53	162.18
31	0	49.05	22.68	190.98
32	0	51.3	22.41	182.52
33	0	45.63	16.56	166.32
34	1	26.28	14.67	156.69
37	0	26.01	17.19	148.68
38	0	48.78	19.17	176.49
39	0	49.77	18.45	177.03
40	0	60.48	18.36	175.23
42	0	12.06	12.06	153.36
43	0	13.5	12.78	161.82
52	1	10.98	10.53	144.09
53	0	3.69	5.22	122.94
54	0	3.24	5.85	116.82
55	0	3.69	6.12	121.95
56	1	85.95	16.2	153.63
57	1	86.49	6.39	142.02
58	0	76.32	5.58	142.11
59	0	35.19	12.15	254.52
60	0	30.51	12.69	255.51
61	0	20.16	12.24	266.58
62	0	23.58	22.05	93.87
63	0	20.43	18.45	137.97
73	1	33.03	19.08	161.55

ID	MARTENS	WATER	DEVELOPED	FOREST
74	1	111.6	16.47	137.43
75	1	91.53	20.07	174.06
76	0	89.37	21.06	177.21
77	0	17.19	11.79	241.29
78	0	22.5	12.33	258.12
79	0	4.23	7.92	232.11
80	1	55.44	13.95	182.43
81	1	58.41	11.25	179.64
82	1	57.33	8.37	180.63
83	0	32.76	2.07	217.26
84	0	56.34	7.83	156.87
85	0	35.19	6.66	188.64
86	0	123.12	4.14	79.2
87	0	115.29	6.03	79.65
91	1	109.53	7.56	80.19
92	0	99.63	12.69	140.4
93	0	96.21	10.62	146.88
94	1	89.37	13.95	156.24
95	1	70.92	7.02	179.01
102	0	82.71	5.58	168.75
103	0	78.3	6.84	191.43
104	0	13.95	10.26	243.63
105	0	9.9	8.64	216.72
111	1	11.43	7.83	246.51
112	0	29.97	4.86	145.71
113	0	28.89	4.41	146.07
114	0	30.6	6.3	136.26
115	0	72.36	2.88	159.21
116	0	30.06	5.04	127.08
117	0	60.57	5.85	141.12
118	0	35.91	2.16	191.52
119	0	44.73	5.85	168.93
120	0	35.64	1.62	179.37
121	0	17.28	8.28	117.18
122	0	12.33	13.95	88.47
123	0	15.48	11.43	107.37
124	0	80.28	6.57	165.06
125	0	88.02	10.89	157.23
126	0	79.2	12.42	155.25
127	1	90.09	8.64	156.78
128	1	56.79	8.37	177.3
129	0	74.61	11.07	170.82
130	1	67.86	13.32	163.08
131	0	50.13	12.24	109.17
132	0	44.73	12.42	86.85
133	0	70.11	13.86	171.54
134	0	74.07	13.95	189.45

ID	MARTENS	WATER	DEVELOPED	FOREST
135	1	55.62	14.31	179.37
136	0	71.64	13.77	176.13
137	1	82.8	13.77	161.64
138	0	75.15	14.22	172.53
139	0	58.14	0.72	196.92
140	0	53.37	1.71	197.55
141	0	60.03	0.72	191.34
142	0	7.38	14.67	198.54
143	0	6.21	12.06	217.62
144	0	9.99	16.11	207.9
145	0	0	14.4	127.8
146	0	0.45	15.39	153.9
147	0	0.9	14.67	180.63
148	0	43.47	7.74	184.86
149	0	44.91	9.36	184.95
150	0	45.54	10.62	184.23
151	0	8.91	11.34	151.92
152	0	13.23	12.69	140.67
153	0	9.45	12.33	141.66
154	0	3.78	1.71	196.29
155	0	5.04	1.17	203.22
156	0	3.06	1.89	185.58
157	0	40.5	19.17	171.99
163	1	35.1	20.61	128.52
164	0	50.49	22.23	152.46
165	0	42.39	5.4	159.57
166	0	39.24	9.63	163.17
167	0	42.66	11.25	147.33
168	1	46.8	21.6	225.09
171	0	57.24	23.58	202.41
172	1	42.12	19.71	233.28

1km continued

ID	GRASS	AG	WETLAND	NUMP	MPS
1	2.52	35.37	3.06	4	30.67
2	2.7	34.02	6.84	3	49.02
3	5.85	57.42	13.59	5	31.55
4	13.68	13.32	17.01	2	97.83
5	16.2	12.33	18.54	4	50.11
6	23.67	11.07	18.27	3	63.9
7	14.13	42.57	16.38	5	37.89
8	9.99	76.14	20.97	7	23.44
9	14.22	100.71	16.83	9	16.66
10	17.46	76.14	7.29	11	12.53
14	17.01	37.17	6.57	9	18.51
15	8.55	24.3	5.31	6	31.12
16	18.36	50.67	16.11	16	9.42
17	17.37	55.8	16.29	18	7.86
18	33.48	54.27	23.04	17	8.89
19	67.41	0.18	18.54	9	19.01
20	68.13	0	20.07	6	29.24
21	61.47	0	17.37	8	21.85
22	6.66	68.58	15.66	8	23.34
23	6.48	66.51	12.6	9	20.16
24	9.63	65.52	6.03	10	16.74
30	31.23	29.97	11.79	11	14.74
31	34.38	1.17	13.95	9	21.22
32	34.02	11.97	9.99	10	18.25
33	42.21	39.6	1.89	12	13.86
34	42.57	68.49	3.51	11	14.24
37	31.41	86.76	2.16	11	13.52
38	22.23	38.16	7.38	16	11.03
39	19.62	39.69	7.65	13	13.62
40	29.52	23.4	5.22	10	17.52
42	56.88	64.62	13.23	9	17.04
43	54.18	55.35	14.58	9	17.98
52	58.86	75.15	12.6	8	18.01
53	96.66	79.47	4.23	11	11.18
54	93.24	87.93	5.13	14	8.34
55	94.95	81.18	4.32	13	9.38
56	39.78	10.44	6.21	11	13.97
57	46.8	17.01	13.5	10	14.2
58	35.82	38.16	14.22	11	12.92
59	6.39	0	3.96	1	254.52
60	11.43	0	2.07	2	127.75
61	10.44	0	2.79	1	266.58
62	24.57	128.88	19.26	10	9.39
63	15.3	98.64	21.42	10	13.8
73	16.74	66.69	15.12	9	17.95

ID	GRASS	AG	WETLAND	NUMP	MPS
74	32.4	2.97	11.34	12	11.45
75	17.1	0	9.45	7	24.87
76	14.22	0	10.35	11	16.11
77	40.23	0	1.71	5	48.26
78	16.29	0	2.97	3	86.04
79	66.24	0	1.71	3	77.37
80	15.21	28.8	16.38	14	13.03
81	13.77	32.58	16.56	15	11.98
82	11.07	38.07	16.74	14	12.9
83	10.62	45.09	4.41	8	27.16
84	18.27	63.09	9.81	11	14.26
85	17.37	58.77	5.58	10	18.86
86	0.9	103.05	1.8	5	15.84
87	4.95	103.95	2.34	5	15.93
91	9.9	102.87	2.16	5	16.04
92	17.01	26.19	16.29	16	8.77
93	22.41	19.71	16.38	15	9.79
94	13.5	22.59	16.56	12	13.02
95	18.9	27.99	8.37	5	35.8
102	18.9	27.45	8.82	8	21.09
103	17.55	11.79	6.3	6	31.91
104	29.52	9.36	5.49	5	48.73
105	67.41	4.68	4.86	9	24.08
111	38.16	2.79	5.49	4	61.63
112	26.01	94.68	10.98	7	20.82
113	23.04	98.28	11.52	7	20.87
114	34.11	95.22	9.72	10	13.63
115	1.89	72.09	3.78	3	53.07
116	36.63	111.78	1.62	9	14.12
117	18.63	84.24	1.8	7	20.16
118	19.71	43.65	19.26	8	23.94
119	35.28	36.27	21.15	15	11.26
120	25.2	55.08	15.3	6	29.9
121	17.01	135.63	16.83	14	8.37
122	14.13	174.51	8.82	12	7.37
123	14.85	150.03	13.05	14	7.67
124	11.61	39.96	8.73	8	20.63
125	8.01	39.06	9	11	14.29
126	9.27	46.08	9.99	8	19.41
127	13.68	36.27	6.75	7	22.4
128	6.03	56.52	7.2	5	35.46
129	7.2	43.56	4.95	5	34.16
130	33.12	24.93	9.9	9	18.12
131	48.15	75.51	17.01	12	9.1
132	51.66	99.72	16.83	12	7.24
133	16.83	29.7	10.17	7	24.51
134	23.58	3.06	8.1	7	27.06

ID	GRASS	AG	WETLAND	NUMP	MPS
135	14.4	36.45	12.06	11	16.31
136	20.7	16.11	13.86	11	16.01
137	17.28	26.46	10.26	13	12.43
138	21.33	17.28	11.7	9	19.17
139	37.17	3.06	16.2	6	32.82
140	33.84	7.56	18.18	6	32.92
141	41.94	1.62	16.56	4	47.83
142	45.81	20.61	25.2	11	18.05
143	40.95	14.13	21.24	7	31.09
144	44.73	8.91	24.57	8	25.99
145	135	32.22	2.79	10	12.78
146	123.75	16.56	2.16	8	19.24
147	91.53	23.76	0.72	14	12.9
148	18.36	53.73	4.05	11	16.81
149	23.67	44.64	4.68	8	23.12
150	20.25	43.47	8.1	8	23.03
151	24.66	110.07	5.31	17	8.94
152	26.91	111.78	6.93	19	7.4
153	27.63	114.3	6.84	17	8.33
154	63.81	36.63	9.99	10	19.63
155	52.29	40.41	10.08	7	29.03
156	79.83	31.77	10.08	8	23.2
157	30.42	47.25	2.88	7	24.57
163	20.88	101.61	5.49	16	8.03
164	35.37	48.69	2.97	13	11.73
165	47.07	50.67	7.11	16	9.97
166	42.03	48.78	9.36	13	12.55
167	56.07	43.47	11.43	16	9.21
168	15.48	0	3.24	5	45.02
171	25.11	0	3.87	5	40.48
172	15.48	0	1.62	2	116.64

1km continued

ID	ED	MPFD	AWMPFD	MNN	IJI
1	64.19	1.12	1.19	58.71	74.23
2	78.22	1.14	1.21	34.14	85.34
3	101.47	1.1	1.25	67.42	87.98
4	126.07	1.19	1.26	30	90.33
5	127.61	1.09	1.26	52.5	91.74
6	132.22	1.17	1.27	30	92.74
7	92.25	1.11	1.21	51.46	84.04
8	100.32	1.1	1.23	34.29	75.58
9	94.36	1.09	1.22	66.89	81.2
10	74.18	1.1	1.14	53.12	65.43
14	84.75	1.11	1.15	69.38	62.91
15	87.44	1.11	1.15	47.07	59.81
16	114.54	1.09	1.21	61.41	94.65
17	118.57	1.1	1.2	43.4	93.73
18	118.57	1.09	1.21	57.35	95.87
19	116.27	1.09	1.21	36.67	78.11
20	128.18	1.15	1.23	30	90.99
21	115.69	1.12	1.21	35.3	91.61
22	104.16	1.12	1.2	33.75	92.84
23	104.16	1.11	1.2	54.04	92.8
24	110.69	1.1	1.23	30	87.11
30	116.84	1.1	1.18	32.73	96.28
31	118.77	1.12	1.17	34.71	86.79
32	111.66	1.11	1.19	30	92.55
33	85.71	1.09	1.17	34.13	89.67
34	83.98	1.09	1.15	41.57	88.34
37	88.79	1.1	1.15	75.74	83.65
38	113.19	1.1	1.21	43.12	95.55
39	110.69	1.11	1.21	35.57	95.29
40	111.46	1.12	1.19	42.73	90.87
42	87.06	1.09	1.19	30	88.11
43	91.86	1.1	1.19	30	90.04
52	84.75	1.09	1.2	37.5	85.69
53	81.48	1.09	1.2	64.99	74.46
54	81.87	1.09	1.18	67.24	73.62
55	80.14	1.08	1.2	40.19	74.5
56	103.01	1.1	1.18	53.77	87.66
57	80.91	1.09	1.2	77.21	90.67
58	79.56	1.09	1.2	74.46	95.01
59	93.4	1.21	1.21	0	87.04
60	84.75	1.1	1.19	60	86.79
61	80.91	1.18	1.18	0	89.75
62	70.15	1.12	1.12	64.1	89.06
63	60.73	1.09	1.08	101.04	84.59
73	68.8	1.1	1.08	53.25	93.32

ID	ED	MPFD	AWMPFD	MNN	IJI
74	102.82	1.13	1.14	45.41	78.93
75	113.39	1.12	1.19	30	93.92
76	110.5	1.1	1.17	55.19	94.32
77	84.37	1.09	1.18	36	81.95
78	85.33	1.09	1.19	30	89.54
79	83.98	1.12	1.19	70	60.85
80	97.05	1.1	1.17	40.98	98.76
81	99.16	1.1	1.18	37.77	97.56
82	96.09	1.09	1.17	43.12	95.73
83	89.75	1.11	1.19	45.07	80.29
84	97.05	1.09	1.19	57.33	87.43
85	93.01	1.09	1.19	55.3	85.28
86	33.63	1.07	1.12	180	55.62
87	34.21	1.07	1.12	130.25	57.59
91	34.78	1.09	1.11	167.57	64.53
92	104.55	1.1	1.14	33.43	95.43
93	101.66	1.1	1.14	34.13	94.97
94	108.39	1.1	1.15	40	95.8
95	108.58	1.1	1.22	40.97	94.2
102	104.93	1.11	1.2	40.61	90.77
103	88.59	1.1	1.17	39.14	91.33
104	83.98	1.09	1.13	42	91.41
105	98.78	1.09	1.16	31.38	67.48
111	95.13	1.14	1.16	30	77.48
112	76.87	1.09	1.19	47.84	82.49
113	76.68	1.09	1.19	50.43	82.7
114	72.26	1.07	1.19	58.9	88.05
115	91.48	1.1	1.23	30	70.02
116	70.34	1.09	1.19	123	79.41
117	79.75	1.1	1.19	50.69	79.65
118	103.97	1.07	1.22	41.25	89.12
119	111.46	1.08	1.19	38	96.03
120	105.51	1.06	1.25	45	85.54
121	102.43	1.09	1.23	34.29	72.19
122	79.75	1.09	1.22	57.68	66.01
123	98.78	1.09	1.24	51.04	71.7
124	87.63	1.07	1.22	59.08	82.57
125	98.4	1.08	1.22	46.88	83.24
126	91.67	1.09	1.21	45.91	83.24
127	75.33	1.08	1.16	38.57	76.56
128	80.33	1.09	1.17	60.39	82.64
129	75.33	1.1	1.16	42	77.14
130	89.56	1.08	1.16	40	86.52
131	75.14	1.09	1.13	60	87.32
132	67.07	1.1	1.13	109.4	89.26
133	88.79	1.13	1.14	48.92	91.53
134	84.56	1.09	1.14	42.12	79.97

ID	ED	MPFD	AWMPFD	MNN	IJI
135	86.29	1.09	1.15	51.82	95.96
136	87.83	1.09	1.17	42.7	84.52
137	92.44	1.09	1.13	45.76	86.27
138	89.17	1.11	1.15	46.09	82.8
139	96.67	1.1	1.21	45	76.95
140	93.4	1.1	1.21	41.18	87.26
141	105.12	1.13	1.24	37.5	74.18
142	97.82	1.08	1.15	39.31	81.65
143	91.67	1.1	1.16	33.55	78.92
144	95.13	1.11	1.13	41.25	77.22
145	83.21	1.09	1.18	51.71	38.77
146	86.1	1.07	1.21	63.54	33.99
147	96.09	1.06	1.2	41.22	45.25
148	107.62	1.08	1.23	59.92	86.92
149	104.74	1.09	1.21	43.69	88.29
150	109.16	1.11	1.2	39.05	90.23
151	103.2	1.09	1.14	31.76	77
152	105.51	1.09	1.15	57.9	78.15
153	105.31	1.09	1.15	45.63	77.11
154	93.59	1.09	1.2	36.19	63.53
155	94.36	1.09	1.21	45.64	66.15
156	87.63	1.1	1.2	39.94	59.75
157	84.17	1.1	1.19	50.69	93
163	89.94	1.09	1.14	53.28	90.26
164	93.59	1.1	1.18	48.72	92.2
165	110.89	1.09	1.18	34.2	84.46
166	103.58	1.08	1.19	37.88	90.21
167	92.63	1.06	1.15	60.06	92.29
168	96.86	1.1	1.18	36	85.13
171	96.86	1.12	1.19	60.97	85.19
172	93.21	1.18	1.18	60	80.77

1 km continued

ID	STRM_DEN	ROAD_DEN
1	20.267	2.467
2	23.182	4.209
3	24.007	8.462
4	16.234	19.726
5	14.513	18.276
6	16.12	19.305
7	23.931	3.316
8	15.559	3.439
9	14.874	4.598
10	10.329	41.797
14	9.455	49.751
15	3.78	48.412
16	24.591	8.994
17	25.87	8.884
18	19.416	16.346
19	22.136	23.063
20	21.302	20.373
21	24.226	21.71
22	4.581	9.778
23	10.201	10.893
24	15.877	7.841
30	17.518	16.059
31	13.669	19.954
32	17.461	17.121
33	20.947	13.161
34	16.07	12.281
37	11.32	12.189
38	20.849	13.548
39	21.695	12.435
40	24.649	13.026
42	7.855	19.242
43	8.113	19.463
52	7.586	18.508
53	2.534	10.189
54	2.534	10.887
55	2.534	11.286
56	30.037	15.63
57	27.646	15.602
58	25.604	17.388
59	8.816	20.788
60	10.057	22.458
61	12.733	23.954
62	4.831	25.552
63	3.871	17.972
73	7.26	19.718
74	38.498	14.095
75	32.027	25.904
76	30.45	25.949

ID	STRM_DEN	ROAD_DEN
77	15.4	19.41
78	15.459	21.549
79	8.063	18.992
80	20.24	21.864
81	21.188	20.56
82	21.062	17.56
83	11.486	3.336
84	14.887	8.799
85	11.733	7.62
86	10.081	2.683
87	8.755	4.455
91	8.299	6.204
92	29.166	28.792
93	29.556	24.893
94	29.13	31.912
95	10.798	6.435
102	11.134	4.731
103	11.7	4.115
104	9.871	25.045
105	9.422	17.823
111	8.617	19.926
112	15.449	3.638
113	15.204	4.296
114	14.839	5.972
115	17.282	2.767
116	9.155	7.118
117	16.129	6.632
118	7.181	2.316
119	13.818	5.605
120	7.238	1.755
121	11.048	18.95
122	5.051	23.822
123	9.184	22.106
124	23.931	6.358
125	24.072	10.365
126	26.863	12.37
127	25.152	16.184
128	13.942	18.826
129	18.676	17.553
130	22.207	8.955
131	16.145	12.645
132	14.29	13.631
133	28.2	23.763
134	25.463	22.394
135	23.815	23.908
136	28.604	17.952
137	33.03	20.462
138	29.683	20.655
139	16.593	16.711
140	16.081	18.275
141	16.643	16.717

ID	STRM_DEN	ROAD_DEN
142	1.235	15.404
143	2.685	14.269
144	1.15	16.618
145	8.243	30.623
146	11.116	32.328
147	11.351	30.517
148	12.761	10.959
149	11.462	12.824
150	11.555	13.737
151	0	20.67
152	0	21.194
153	0	21.173
154	10.475	15.399
155	9.701	14.572
156	8.177	15.678
157	11.074	11.757
163	10.95	14.349
164	14.531	12.382
165	12.814	5.965
166	17.045	12.366
167	21.796	13.287
168	10.31	9.109
171	14.089	11.395
172	6.649	8.624

2km

ID	MARTENS	WATER	DEVELOPED	FOREST	GRASS	AG
1	0	111.51	23.31	349.56	32.58	218.34
2	0	101.79	21.87	382.86	40.59	232.47
3	0	107.73	22.32	448.38	53.19	261.72
4	0	177.21	63	746.37	60.75	148.59
5	1	172.62	62.55	745.65	62.73	151.38
6	0	171.81	65.07	738.09	67.32	153.54
7	0	89.01	15.12	537.66	45.81	412.47
8	0	76.41	11.97	466.56	31.59	322.02
9	0	85.41	22.23	502.65	43.47	376.38
10	1	15.75	156.69	318.6	52.11	427.41
14	0	13.68	162.63	332.19	57.33	468.63
15	1	14.22	168.93	359.1	61.56	493.29
16	0	195.57	37.71	605.88	93.6	276.12
17	0	201.78	37.08	632.07	95.49	244.8
18	0	176.67	39.06	624.15	90.72	267.84
19	1	180.9	28.35	641.88	131.85	47.34
20	0	164.07	27.99	601.65	132.48	40.77
21	0	189.45	28.98	646.02	132.21	43.38
22	0	216.36	45.45	723.51	32.94	179.91
23	0	231.57	48.51	696.06	37.26	186.57
24	0	184.05	51.66	729.63	47.16	191.34
30	1	144.36	79.92	677.16	164.79	141.12
31	0	177.75	72.99	640.62	167.31	145.8
32	0	150.3	82.08	673.11	156.06	140.85
33	0	162.99	51.75	606.69	81.72	330.48
34	1	163.08	57.6	580.59	86.58	341.73
37	0	155.79	54.36	549.27	94.68	375.03
38	0	255.51	49.14	655.11	70.47	180.18
39	0	272.07	47.52	657.27	69.84	163.35
40	0	279.36	51.93	642.42	63.36	179.64
42	0	69.57	31.95	605.43	224.73	279.9
43	0	70.65	31.77	627.12	211.86	269.82
52	1	68.49	32.13	584.73	231.66	295.2
53	0	24.48	42.75	382.86	281.25	493.92
54	0	22.23	41.4	362.43	288.18	510.75
55	0	42.39	42.84	397.35	276.66	464.4
56	1	340.38	41.67	597.24	91.44	107.28
57	1	302.58	34.29	613.8	93.69	137.34
58	0	286.47	36.99	604.35	95.04	159.21
59	0	90.54	51.12	867.24	146.61	77.58
60	0	100.89	44.55	854.1	123.03	107.55
61	0	81.18	38.52	798.39	245.7	72.09
62	0	104.31	52.74	413.1	64.98	589.14
63	0	50.76	53.55	475.74	64.53	563.85

ID	MARTENS	WATER	DEVELOPED	FOREST	GRASS	AG
73	1	56.43	55.8	474.03	65.34	554.4
74	1	358.56	51.93	679.14	83.79	10.71
75	1	401.94	50.04	673.65	68.85	7.56
76	0	375.84	55.98	684	74.79	14.85
77	0	51.75	41.4	749.7	321.66	73.98
78	0	72.36	39.87	785.25	262.08	77.22
79	0	40.41	46.53	686.07	349.65	118.17
80	1	289.98	53.46	674.01	102.96	80.28
81	1	288.36	52.92	674.64	104.76	79.02
82	1	287.91	50.58	670.5	112.59	78.3
83	0	163.26	19.44	623.16	80.55	310.77
84	0	256.23	27.54	585.36	91.44	249.84
85	0	219.96	25.56	594.36	85.86	272.88
86	0	219.6	44.19	258.84	117.54	595.71
87	0	216.18	40.5	255.69	117.36	605.88
91	1	212.58	39.24	248.04	117.81	613.62
92	0	322.56	30.42	701.37	81	65.61
93	0	331.38	25.38	703.26	76.95	63.27
94	1	321.75	45.54	680.85	75.78	70.2
95	1	181.08	49.23	666.45	65.88	253.89
102	0	200.61	50.31	672.12	56.97	234.81
103	0	202.23	48.69	651.96	63.27	249.66
104	0	56.34	32.4	723.15	281.79	123.75
105	0	31.41	45.54	632.16	282.24	238.32
111	1	40.59	37.62	673.83	291.87	178.47
112	0	109.17	54.18	483.84	147.6	392.22
113	0	106.56	53.55	489.51	147.96	388.89
114	0	113.94	52.38	482.85	141.48	395.37
115	0	148.77	37.17	568.35	54.45	427.23
116	0	115.56	41.76	496.89	86.49	490.59
117	0	118.44	37.44	508.23	71.28	497.61
118	0	128.7	29.61	793.62	47.79	193.32
119	0	170.73	19.62	781.47	62.82	152.28
120	0	140.94	30.51	832.41	49.77	143.82
121	0	74.52	41.13	407.34	64.08	619.83
122	0	99.36	40.32	365.94	83.79	609.3
123	0	96.48	40.68	394.83	67.95	604.62
124	0	224.55	23.22	566.46	138.24	257.04
125	0	226.44	22.41	567.45	162.45	231.03
126	0	225.72	24.48	542.7	141.39	278.28
127	1	286.11	35.1	660.15	87.48	143.91
128	1	305.82	34.92	673.2	78.39	110.61
129	0	294.39	34.74	664.47	76.5	134.73
130	1	280.26	35.46	515.52	183.87	179.01
131	0	248.49	42.75	423.27	179.28	306.81
132	0	230.85	44.64	394.2	171.27	362.97
133	0	203.04	34.29	693.18	81.36	183.78

ID	MARTENS	WATER	DEVELOPED	FOREST	GRASS	AG
134	0	181.35	46.53	720.63	110.07	140.31
135	1	170.28	39.87	665.55	95.4	238.05
136	0	238.32	31.77	776.52	80.28	71.28
137	1	232.11	30.15	729.72	76.59	126.81
138	0	224.37	36	746.91	90.45	96.93
139	0	226.08	49.23	706.86	121.77	92.07
140	0	221.58	45.18	710.01	119.07	102.06
141	0	228.96	48.69	688.59	121.32	104.22
142	0	100.26	38.43	837.36	128.07	57.24
143	0	91.89	38.61	858.33	109.98	62.01
144	0	99.72	44.28	838.08	131.76	46.8
145	0	12.51	65.43	377.82	430.02	349.2
146	0	13.77	67.41	415.8	425.97	309.33
147	0	19.44	62.73	489.33	405.54	247.77
148	0	153.81	32.13	640.44	94.95	300.51
149	0	170.82	32.04	594.09	108.9	309.69
150	0	164.7	36.27	576.18	130.05	304.38
151	0	65.16	33.21	530.28	61.56	513.54
152	0	60.12	33.93	523.44	66.96	517.86
153	0	63.09	33.75	512.46	67.41	526.05
154	0	32.4	35.1	496.62	319.86	333.54
155	0	34.2	36.81	499.59	318.06	327.69
156	0	33.03	37.53	468.9	332.01	346.77
157	0	119.07	58.41	556.29	151.11	335.97
163	1	152.01	55.26	517.23	99.81	395.91
164	0	127.98	61.2	555.21	134.28	343.62
165	0	109.17	34.47	491.94	157.41	414.18
166	0	127.89	32.76	507.15	169.92	368.64
167	0	125.55	35.01	487.17	179.1	371.07
168	1	167.22	79.02	811.35	135.63	33.39
171	0	185.22	72.72	833.85	117.54	16.38
172	1	151.11	71.64	811.98	156.06	34.2

2 km continued

ID	WETLAND	NUMP	MPS	ED	MSI	AWMSI
1	33.48	27	12.95	60.26	1.9	4.87
2	31.23	26	14.73	60.45	1.9	4.85
3	35.19	32	14.01	71.26	1.88	4.75
4	53.64	17	43.9	101.51	2.19	8.6
5	54.63	16	46.6	100.79	2.15	9.32
6	53.73	18	41.01	101.17	2.15	8.53
7	44.01	16	33.6	71.21	1.97	8.07
8	37.35	14	33.33	54.74	1.92	6.4
9	46.17	14	35.9	66.31	2.13	7.13
10	23.4	27	11.8	48.5	1.78	2.71
14	16.11	30	11.07	52.29	1.88	2.78
15	15.93	29	12.38	54.5	1.88	2.79
16	40.68	38	15.94	98.1	1.85	6.95
17	38.34	32	19.75	96.42	1.96	5.95
18	51.12	37	16.87	103.57	1.99	6.49
19	57.51	14	45.85	89.26	2.32	6.73
20	53.46	17	35.39	85.76	2.08	7
21	58.14	18	35.89	90.94	2.1	6.86
22	51.39	23	31.46	102.04	1.99	9.8
23	49.59	31	22.45	102.85	1.83	9.49
24	45.72	30	24.32	96.61	1.95	7.56
30	42.21	31	21.84	100.16	1.93	5.14
31	45.09	32	20.02	95.36	1.91	4.88
32	47.16	33	20.4	103.81	1.95	5.75
33	15.93	28	21.67	87.92	1.97	4.4
34	19.98	40	14.51	87.82	1.81	3.81
37	20.43	29	18.94	85.33	1.95	4.28
38	39.15	28	23.4	95.07	1.98	6.61
39	39.51	25	26.29	96.71	2.15	6.84
40	32.85	28	22.94	93.68	2.02	5.61
42	37.98	32	18.92	68.28	1.69	5.36
43	38.34	27	23.23	68.9	1.78	5.42
52	37.35	30	19.49	67.9	1.77	5.27
53	24.3	47	8.15	61.99	1.64	4.46
54	24.57	50	7.25	62.28	1.67	3.28
55	25.92	44	9.03	63.24	1.7	4.52
56	71.55	28	21.33	89.55	2	5.64
57	67.86	27	22.73	85.81	1.88	6.21
58	67.5	34	17.77	85.71	1.77	6.28
59	16.47	15	57.82	76.11	1.87	6.91
60	19.44	14	61.01	74.23	1.94	7.13
61	13.68	14	57.03	72.17	1.92	7.27
62	25.29	33	12.52	60.26	1.9	2.42
63	41.13	30	15.86	57.24	1.81	2.73
73	43.56	26	18.23	59.64	1.96	2.94

ID	WETLAND	NUMP	MPS	ED	MSI	AWMSI
74	65.43	26	26.12	92.86	1.94	5.16
75	47.52	27	24.95	96.99	2.01	6.11
76	44.1	29	23.59	94.69	1.89	5.29
77	10.08	11	68.15	68.33	2.07	7.25
78	12.78	14	56.09	71.88	1.96	7.25
79	7.74	12	57.17	66.98	2.04	7.17
80	48.87	36	18.72	92.29	1.85	4.59
81	49.86	33	20.44	90.99	1.89	4.79
82	49.68	32	20.95	90.94	1.9	4.85
83	52.38	34	18.33	86.05	1.84	7.35
84	39.15	35	16.72	75.19	1.73	6.09
85	50.94	36	16.51	79.32	1.75	6.82
86	13.68	31	8.35	46.53	1.83	2.25
87	13.95	27	9.47	45.18	1.92	2.29
91	18.27	27	9.19	44.37	1.88	2.44
92	48.6	25	28.05	88.64	1.95	5.04
93	49.32	18	39.07	88.69	2.1	6.2
94	55.44	29	23.48	91.04	1.93	4.87
95	33.03	19	35.08	81.15	2.14	4.36
102	34.74	19	35.37	83.55	2.16	4.64
103	33.75	23	28.35	82.78	2.05	4.68
104	32.13	27	26.78	86.29	1.97	4.79
105	19.44	22	28.73	69.91	1.76	5.12
111	26.01	24	28.08	77.98	1.97	4.84
112	62.55	45	10.75	78.32	1.69	5.76
113	63.09	53	9.24	79.28	1.61	5.59
114	63.54	45	10.73	76.73	1.65	5.66
115	13.59	40	14.21	77.98	1.74	5.62
116	18.27	41	12.12	74.28	1.78	4.5
117	16.56	50	10.16	79.9	1.74	4.54
118	56.52	28	28.34	85.61	1.94	6.52
119	62.64	23	33.98	86.14	1.88	6.71
120	52.11	25	33.3	83.89	1.88	6.95
121	42.66	48	8.49	78.65	1.77	4.46
122	50.85	61	6	78.27	1.73	3.64
123	45	47	8.4	77.12	1.82	4.23
124	40.05	30	18.88	77.69	1.92	5.35
125	39.78	27	21.02	79.76	1.97	5.21
126	36.99	38	14.28	80.91	1.84	5
127	36.81	18	36.67	74.14	1.99	5.46
128	46.62	15	44.88	78.41	2.09	6.06
129	44.73	18	36.92	75.63	1.91	5.76
130	55.44	30	17.18	82.88	1.92	5.19
131	48.96	34	12.45	73.95	1.84	4.53
132	45.63	32	12.32	68.23	1.8	4.69
133	53.91	30	23.11	78.46	1.82	3.95
134	50.67	28	25.74	81.77	1.88	4.24

ID	WETLAND	NUMP	MPS	ED	MSI	AWMSI
135	40.41	24	27.73	75.24	1.95	3.93
136	51.39	17	45.68	81.53	2.14	5.11
137	54.18	22	33.17	81.72	2.06	4.49
138	54.9	25	29.88	80	1.89	4.59
139	53.55	25	28.27	90.08	1.79	7.47
140	51.66	29	24.48	90.18	1.7	7.58
141	57.78	28	24.59	89.6	1.7	7.62
142	88.2	18	46.52	86.43	2.01	5.33
143	88.74	11	78.03	84.56	2.45	5.36
144	88.92	17	49.3	85.28	2.02	5.04
145	11.79	39	9.69	62.42	1.72	4.94
146	14.49	40	10.4	70.06	1.77	4.82
147	21.96	42	11.65	76.83	1.71	4.71
148	27.72	36	17.79	98.67	1.95	6.79
149	34.02	42	14.15	99.15	1.9	6.73
150	37.98	41	14.05	99.01	1.97	6.46
151	45.81	59	8.99	88.3	1.76	2.94
152	47.25	57	9.18	89.5	1.82	2.92
153	46.8	61	8.4	89.07	1.75	2.91
154	32.04	33	15.05	74.71	1.81	6.2
155	33.21	38	13.15	78.65	1.78	6.25
156	31.32	31	15.13	74.91	1.86	6.53
157	28.71	42	13.24	85.13	1.89	4.96
163	29.34	44	11.76	89.36	1.93	4.52
164	27.27	42	13.22	87.15	1.9	5.01
165	42.39	53	9.28	86.96	1.77	4.39
166	43.2	52	9.75	87.63	1.77	4.56
167	51.66	52	9.37	88.93	1.83	4.4
168	22.95	22	36.88	90.7	2.03	5.72
171	23.85	14	59.56	88.3	2.25	5.57
172	24.57	23	35.3	94.31	1.99	5.87

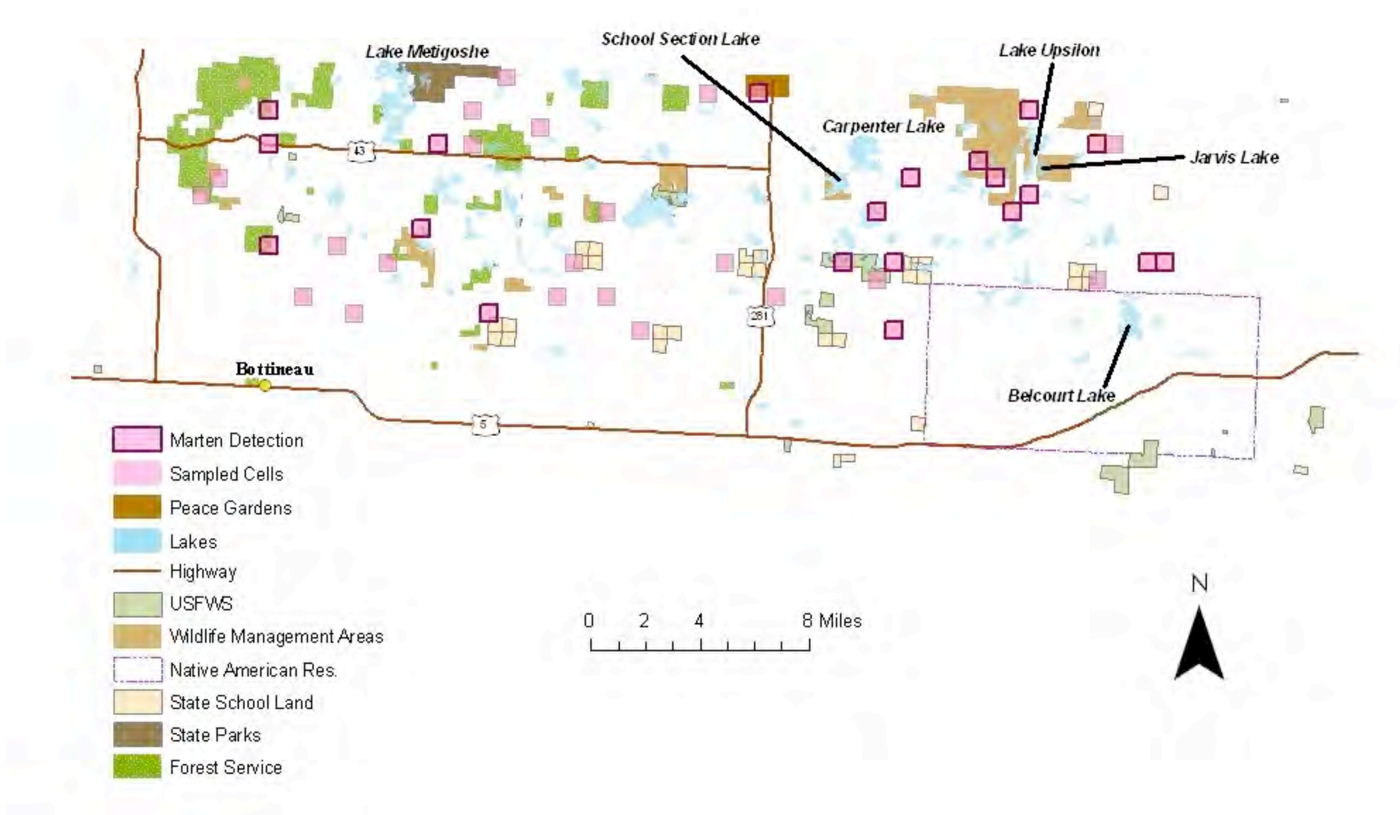
2 km continued

ID	MPFD	AWMPFD	MNN	IJI	STRM_DEN	ROAD_DEN
1	1.1	1.21	48.38	87.44	12.688	7.271
2	1.1	1.21	48.34	86.49	12.243	7.247
3	1.1	1.2	43.92	85.07	13.28	9.015
4	1.1	1.27	37.09	97.86	16.683	14.918
5	1.1	1.27	39.52	97.68	17.003	15.21
6	1.11	1.26	37.68	98.27	16.231	15.729
7	1.1	1.27	106.85	78.04	13.978	5.144
8	1.1	1.24	75.39	83.51	11.878	3.94
9	1.11	1.25	82.32	84.21	13.875	5.242
10	1.09	1.15	95.6	77.91	4.719	23.848
14	1.11	1.15	109.56	71.12	4.763	24.322
15	1.11	1.15	109.37	68.99	4.402	24.891
16	1.09	1.25	57.24	94	19.258	11.631
17	1.1	1.23	55.45	94.53	19.637	11.271
18	1.11	1.24	45.86	94.17	19.105	12.108
19	1.1	1.25	48.38	85.86	18.39	16.311
20	1.09	1.26	45.14	85.57	16.594	15.044
21	1.09	1.25	44.7	85.43	18.996	16.477
22	1.1	1.28	34.43	92.62	15.967	11.061
23	1.09	1.28	37.33	92.06	16.994	11.141
24	1.11	1.25	39.58	93.64	12.805	12.694
30	1.09	1.22	43.16	97.42	16.457	19.411
31	1.09	1.21	43.8	97.48	17.49	19.016
32	1.1	1.23	52.6	97.78	16.051	20.768
33	1.1	1.2	38.2	87.51	15.063	10.924
34	1.09	1.18	35.3	88.38	15.939	12.212
37	1.1	1.2	36.89	87.93	14.86	12.215
38	1.1	1.24	39.92	92.27	23.866	9.21
39	1.12	1.24	39.42	91.58	24.858	8.977
40	1.1	1.22	36.27	90	22.035	10.108
42	1.09	1.21	65.26	91.07	8.535	11.214
43	1.1	1.21	49.09	91.42	8.459	11.229
52	1.1	1.21	76.51	90.35	8.293	10.837
53	1.09	1.2	84.73	80.79	4.399	14.995
54	1.09	1.16	86.91	77.67	5.12	14.284
55	1.09	1.2	70.12	82.92	5.347	14.681
56	1.11	1.22	49.75	93.08	29.627	14.706
57	1.09	1.22	48.27	95.01	25.045	12.044
58	1.09	1.22	56.92	96.12	24.078	12.876
59	1.09	1.24	62.24	87.79	9.677	16.159
60	1.1	1.25	80.15	91.01	11.345	15.694
61	1.09	1.25	64.89	82.93	9.467	17.412
62	1.11	1.13	54.95	75.8	5.196	14.247
63	1.1	1.14	73.63	80.25	2.722	15.076
73	1.11	1.15	60.72	81.83	2.961	16.138

ID	MPFD	AWMPFD	MNN	IJI	STRM_DEN	ROAD_DEN
74	1.09	1.22	44.27	82.57	31.456	15.976
75	1.1	1.23	43.34	78.92	35.177	17.47
76	1.09	1.22	49.21	83.13	32.793	19.891
77	1.1	1.25	50.98	68.89	10.738	19.742
78	1.1	1.25	57.2	81.52	10.248	18.436
79	1.1	1.25	52.34	67.48	12.122	21.812
80	1.1	1.2	35.26	96.06	25.158	21.942
81	1.1	1.21	39.96	95.96	25.16	22.35
82	1.1	1.21	43.57	95.48	24.936	22.149
83	1.1	1.25	63.04	86.83	9.886	8.222
84	1.09	1.23	54.33	89.82	11.166	9.828
85	1.09	1.24	62.83	90.16	11.259	9.081
86	1.11	1.13	89.37	72.87	8.57	11.761
87	1.11	1.13	84.06	71.61	7.866	11.226
91	1.11	1.14	82.57	71.14	7.527	10.591
92	1.1	1.22	44.07	92.23	24.889	18.361
93	1.1	1.24	36.77	91.51	25.077	17.665
94	1.1	1.21	39.18	95.16	24.926	21.335
95	1.11	1.2	57	93.93	10.336	12.583
102	1.11	1.21	48.87	93.7	12.156	12.802
103	1.11	1.21	46.7	92.87	11.065	12.53
104	1.11	1.21	40.73	78.93	12.037	19.259
105	1.08	1.22	63.42	68.09	9.676	22.948
111	1.11	1.21	49.17	68.21	11.038	20.856
112	1.09	1.23	68.07	93.42	17.331	13.411
113	1.08	1.22	65.94	93.17	17.011	13.384
114	1.08	1.22	68.16	93.68	17.486	13.008
115	1.09	1.22	51.61	81.49	10.217	10.517
116	1.09	1.2	49.72	80.37	9.669	13.523
117	1.09	1.2	41.03	77.92	8.72	11.844
118	1.11	1.24	41.78	92.67	7.663	10.847
119	1.09	1.24	43.56	92.37	9.254	4.781
120	1.1	1.24	39.59	94.27	7.663	10.251
121	1.09	1.2	57.02	68.44	7.95	15.846
122	1.09	1.17	56.84	71.34	9.386	16.039
123	1.1	1.19	70.66	69.23	9.33	15.997
124	1.1	1.22	48.98	88.11	15.03	11.916
125	1.1	1.22	47.88	87.2	15.14	11.822
126	1.1	1.21	50.08	87.14	14.399	11.844
127	1.1	1.23	60.02	94.68	20.432	13.054
128	1.1	1.24	59.79	94.34	22.352	14.392
129	1.09	1.23	62.27	94.6	21.251	13.996
130	1.1	1.22	53.14	86.52	20.859	13.278
131	1.1	1.2	61.58	89.34	17.877	14.053
132	1.09	1.2	62.03	91.09	17.058	13.792
133	1.09	1.19	43.19	93.88	19.139	19.666
134	1.1	1.2	41.6	93.91	18.938	21.814

ID	MPFD	AWMPFD	MNN	IJI	STRM_DEN	ROAD_DEN
135	1.1	1.18	43.84	97.31	15.396	21.65
136	1.11	1.21	49.22	85.29	21.648	16.713
137	1.11	1.2	42.36	89.66	20.929	17.198
138	1.1	1.2	63.03	89.51	21.313	18.292
139	1.08	1.25	42.08	91.53	16.453	16.362
140	1.08	1.25	43.51	92.28	15.862	15.842
141	1.07	1.25	41.85	91.59	16.965	15.182
142	1.09	1.22	35	93.06	9.167	12.283
143	1.11	1.22	32.73	94.33	7.416	12.05
144	1.09	1.21	45.58	92.35	9.405	13.316
145	1.09	1.21	69.03	55.25	8.21	27.452
146	1.09	1.21	69.56	58.12	7.818	27.17
147	1.09	1.21	53.08	61.95	7.685	23.798
148	1.11	1.25	37.56	89.08	12.129	8.911
149	1.11	1.25	49.37	89.89	13.189	9.086
150	1.11	1.25	44.91	91.22	12.442	10.141
151	1.09	1.16	42.59	77.16	1.984	16.088
152	1.1	1.16	44.33	75.87	2.814	16.738
153	1.09	1.16	42.13	75.89	2.443	16.537
154	1.1	1.24	47.87	81.59	8.16	15.269
155	1.09	1.24	41.51	82.03	8.103	16.122
156	1.1	1.24	47.09	80.66	8.108	15.792
157	1.1	1.21	59.02	94.44	5.749	9.813
163	1.11	1.21	46.59	90.87	9.845	10.094
164	1.11	1.21	51.7	94.29	7.24	9.454
165	1.1	1.2	57.69	82.41	10.504	11.302
166	1.1	1.2	51.51	85.54	12.182	10.081
167	1.1	1.2	49.37	85.83	12.433	10.186
168	1.11	1.23	39.88	85.25	7.582	14.41
171	1.1	1.23	36.06	83.19	10.073	12.463
172	1.09	1.23	37.15	84.36	6.145	14.738

Appendix I: Map of Marten Detection and Non-detection Sites in the Turtle Mountains of North Dakota



Appendix J: Species Detected at Sample Sites in Each Sampling Cycle in the Turtle Mountains

Below is a comprehensive list of all species that were detected at the sites sampled in the two cycles used for analysis.
Note: asterisk in "Analysis ID" column denotes marten detection site

Cycle 1

	Martes americana	*Procyon lotor*	*Mephitis mephitis*	*Odocoileus virginianus*
Analysis ID	Marten	Racoon	Skunk	White Tail Deer
177				
178				
179			1	
180				1
181				
182				
184				1
185				
186				
187				1
188				1
189				
191				
192				
193		1		
194				1
195		1		1
196				
197				
198			1	
199				
200		1		1
201				
202				
203				
204				
205				

	Martes americana	*Procyon lotor*	*Mephitis mephitis*	*Odocoileus virginianus*
Analysis ID	Marten	Racoon	Skunk	White Tail Deer
206				
207*	1			
208				
209				
210				
211				1
212				
213				
214		1		
215				
216				
217				
218				1
219				
220				
221			1	
222				
223			1	
224				
225				
226		1		
227				
228			1	
229		1		1
230				
231				
232				
233				
234				
237				1
238				
239*	1			
240				1

	Tamias striatus	*Tamiasciurus hudsonicus*	*Canis latrans*	*Mustela vison*
Analysis ID	Chipmunk	Squirrel	Coyote	Mink
177				
178				
179	1			
180				
181		1		
182				
184				
185				
186				
187				
188				
189				
191				
192				
193				
194				
195				
196				
197				
198				
199				
200				
201				
202				
203				
204				
205				
206				
207*				
208				
209				
210				
211				
212				
213				
214				
215				
216				
217				

	Tamias striatus	*Tamiasciurus hudsonicus*	*Canis latrans*	*Mustela vison*
Analysis ID	Chipmunk	Squirrel	Coyote	Mink
218				
219	1			
220				
221				
222				
223				
224				
225				
226				
227				
228				
229			1	
230				
231				
232				
233				
234				
237				
238				
239*				
240				

	Rana sylvatica	*Peromyscus spp.*	*Marmota monax*	*Felix sylvestris*
Analysis ID	Frog	Mouse	Woodchuck	House cat
177				
178		1		
179		1		
180				
181				
182				
184				
185				
186	1			
187				
188				
189				1
191				
192	1			
193				
194				
195				
196				
197				
198				
199				
200				
201				
202				
203				
204				
205				
206				
207*				
208				
209				
210				
211				
212				
213				
214				
215				
216		1		
217				

	Rana sylvatica	*Peromyscus spp.*	*Marmota monax*	*Felix sylvestris*
Analysis ID	Frog	Mouse	Woodchuck	House cat
218				
219				
220				
221				
222				
223				
224				
225				
226				
227				
228	1			
229				
230				
231				
232				
233				
234				
237				
238				
239*				
240				

	Canis lupus familiarus	*Erythizon dorsatum*	*Alces alces*	*Lepus americanus*	*Sus scrofa*
Analysis ID	House dog	Porcupine	Moose	Rabbit	Feral Pigs
177					
178					
179		1			
180					
181					
182					
184					
185					
186					
187					
188					
189					
191					
192					
193					
194					
195					
196					
197					
198					
199					
200					
201					
202					
203					
204					
205					
206					
207*					
208					
209					
210					
211			1	1	
212					
213					
214					
215					
216					
217					

	Canis lupus familiarus	*Erythizon dorsatum*	*Alces alces*	*Lepus americanus*	*Sus scrofa*
Analysis ID	House dog	Porcupine	Moose	Rabbit	Feral Pigs
218					
219					
220					
221					
222					
223					
224					
225					
226					
227					
228					
229					
230					
231					
232					
233					
234					
237					
238					
239*					
240			1	1	

Cycle 2

	Martes americana	*Procyon lotor*	*Mephitis mephitis*	*Odocoileus virginianus*
Analysis ID	Marten	**Raccoon**	**Skunk**	**White Tail Deer**
1		1	1	1
2				1
3		1	1	1
4				
5*	1			1
6				1
7		1		
8				1
9		1		1
10*	1	1		1
14				1
15*	1			
16				1
17				
18				1
19*	1	1		1
20				
21				
22		1		1
23				
24				1
30*	1	1		
31				
32		1	1	
33				1
34*	1	1		
37				
38				1
39				
40				
42				
43				
52*	1	1		
53				1
54				1
55		1		1
56*	1			
57*	1		1	
58				
59		1		
60				
61				

	Martes americana	*Procyon lotor*	*Mephitis mephitis*	*Odocoileus virginianus*
Analysis ID	Marten	**Raccoon**	**Skunk**	**White Tail Deer**
62				
63				
73*	1			
74*	1			
75*	1	1		1
76				
77				
78		1	1	1
79				
80*	1			
81*	1			1
82*	1			1
83		1		
84				
85				
86		1		1
87				
91*	1			1

	Tamias striatus	*Tamiasciurus hudsonicus*	*Canis latrans*	*Mustela vison*
Analysis ID	**Chipmunk**	**Squirrel**	**Coyote**	**Mink**
1				
2				
3				
4				
5*				
6				
7				
8				
9		1		
10*	1			
14				
15*				
16	1	1		
17				
18				
19*		1		
20		1		
21				1
22		1		
23				
24				
30*				
31				
32		1	1	
33				
34*				
37				
38				
39				
40				
42				
43				
52*				
53				
54				
55				
56*				
57*				
58				
59	1			
60				
61				
62				
63				
73*				

	Tamias striatus	*Tamiasciurus hudsonicus*	*Canis latrans*	*Mustela vison*
Analysis ID	**Chipmunk**	**Squirrel**	**Coyote**	**Mink**
74*				
75*				
76				
77				
78				
79				
80*				
81*				
82*				
83	1	1		
84				
85		1		
86	1	1		
87				
91*	1	1		

	Rana sylvatica	*Peromyscus spp.*	*Marmota monax*	*Felix sylvestris*
Analysis ID	**Frog**	**Mouse**	**Woodchuck**	**House Cat**
1				
2				
3				
4		1		
5*				
6		1		
7				
8		1		
9				
10*			1	
14				
15*				
16		1		
17				
18				
19*				
20				
21				
22				
23				
24				
30*				
31	1			
32				
33		1		
34*				
37				
38				
39	1			
40				
42				
43				
52*				
53				
54				
55				
56*				
57*	1			
58				
59				
60				
61				
62				
63				
73*				

	Rana sylvatica	*Peromyscus spp.*	*Marmota monax*	*Felix sylvestris*
Analysis ID	**Frog**	**Mouse**	**Woodchuck**	**House Cat**
74*				
75*			1	
76				
77				
78				
79				
80*				
81*				
82*				
83				
84				
85				
86	1	1	1	
87		1		
91*				

	Canis lupus familiaris	*Erythizon dorsatum*	*Alces alces*	*Lepus americanus*	*Sus scrofa*
Analysis ID	**House Dog**	Porcupine	Moose	Rabbit	Feral Pigs
1		1			
2					
3			1		
4					
5*					
6					
7					
8				1	
9					
10*		1			
14					
15*		1			
16		1			
17					
18					
19*					
20					
21					
22					
23					
24					
30*					
31					
32					
33					
34*					
37					
38					
39					
40					
42					
43					
52*					
53					
54					
55					
56*					
57*					
58					
59		1		1	
60					
61					
62					
63					
73*					

	Canis lupus familiaris	*Erythizon dorsatum*	*Alces alces*	*Lepus americanus*	*Sus scrofa*
Analysis ID	**House Dog**	Porcupine	Moose	Rabbit	Feral Pigs
74*					
75*					
76					
77					
78					
79					
80*					
81*					
82*					
83					
84					
85					
86					
87					
91*					

Cycle 3

	Martes americana	*Procyon lotor*	*Mephitis mephitis*	*Odocoileus virginianus*
Analysis ID	Marten	**Raccoon**	**Skunk**	**White Tail Deer**
92		1	1	1
93		1		1
94*	1	1		
95*	1	1		
102				
103				
104		1		1
105		1		
111*	1			1
112				
113				
114				
115				1
116				
117				
118		1		
119				
120		1		1
121				
122				1
123				
124		1		1
125		1		
126				
127*	1			
128*	1	1		
129		1		
130*	1			
131		1		
132		1		
133		1		1
134		1		1
135*	1	1		
136			1	
137*	1	1		
138		1		
139		1	1	
140				
141		1		
142				1
143				
144		1	1	1

	Martes americana	*Procyon lotor*	*Mephitis mephitis*	*Odocoileus virginianus*
Analysis ID	Marten	**Raccoon**	**Skunk**	**White Tail Deer**
145				
146		1		
147				1
148		1		
149		1		
150				1
151				
152			1	1
153		1		
154		1		
155				
156			1	1
157				
163*	1			1
164		1		
165				
166				
167		1		
168*	1		1	
171			1	
172*	1	1		

	Tamias striatus	*Tamiasciurus hudsonicus*	*Canis latrans*	*Mustela vison*
Analysis ID	**Chipmunk**	**Squirrel**	**Coyote**	**Mink**
92				
93				
94*		1		
95*				
102				
103				
104				
105				
111*				
112				
113				
114				
115			1	
116			1	
117				
118				
119				
120	1	1		1
121				
122				
123				
124				
125				
126				
127*		1		
128*				
129		1		
130*				
131				
132	1	1		
133	1	1		1
134	1	1		
135*	1			
136	1			
137*				
138		1		
139				
140				
141	1			
142		1		
143				
144				
145				
146	1	1		
147				

	Tamias striatus	*Tamiasciurus hudsonicus*	*Canis latrans*	*Mustela vison*
Analysis ID	**Chipmunk**	**Squirrel**	**Coyote**	**Mink**
148				
149	1	1		
150		1		
151				
152		1		
153				
154	1			
155		1		
156		1		
157		1		
163*				
164				
165				
166		1		
167	1	1		
168*				
171				
172*		1		

	Rana sylvatica	*Peromyscus sp.*	*Marmota monax*	*Felix sylvestris*
Analysis ID	**Frog**	**Mouse**	**Woodchuck**	**House Cat**
92				
93				
94*				
95*				
102				
103				
104				
105				1
111*				
112				
113				
114				
115				
116				
117				
118				1
119		1		1
120				
121				
122				
123				
124				
125	1			
126				
127*				
128*				
129		1		
130*				
131				
132				
133		1		
134		1		
135*				
136				
137*				
138				
139				
140				
141				
142				
143				
144				
145			1	
146				
147				

	Rana sylvatica	*Peromyscus sp.*	*Marmota monax*	*Felix sylvestris*
Analysis ID	**Frog**	**Mouse**	**Woodchuck**	**House Cat**
148				
149				
150			1	
151				
152				
153				
154				
155				
156				
157		1		
163*				
164				
165				
166		1		
167				
168*				
171				
172*		1		

	Canis lupus familiaris	*Erythizon dorsatum*	*Alces alces*	*Lepus americanus*	*Sus scrofa*
Analysis ID	**House Dog**	Porcupine	Moose	Rabbit	Feral Pigs
92					
93					
94*				1	
95*					
102					
103					
104				1	
105				1	
111*					
112					
113					
114					
115					
116					
117					
118					
119					
120					
121					
122					
123					
124					
125		1			
126					
127*					
128*					
129					
130*					
131					
132					
133					
134				1	1
135*					
136					
137*					
138					
139					
140					
141					
142					
143					
144					
145					
146				1	

	Canis lupus familiaris	*Erythizon dorsatum*	*Alces alces*	*Lepus americanus*	*Sus scrofa*
Analysis ID	**House Dog**	Porcupine	Moose	Rabbit	Feral Pigs
147		1			
148					
149					
150		1			
151					
152					
153					
154					
155					
156					
157					
163*					
164					
165					
166				1	
167					
168*					
171					
172*					

Cycle 4

	Martes americana	*Procyon lotor*	*Mephitis mephitis*	*Odocoileus virginianus*
Analysis ID	Marten	Raccoon	Skunk	White Tail Deer
11*	1			1
12				
13		1		
25				
26				
27				
28				1
29				
35		1		1
36				1
41				
44				
45				
46				
47			1	
48				
49		1		
50				
51				
64		1		1
65*	1			
66*	1			
67				
68				1
69			1	1
70		1		1
71		1		1
72				
88				
89		1	1	
90				
96				1
97		1		
98				
99			1	
100				1

	Martes americana	*Procyon lotor*	*Mephitis mephitis*	*Odocoileus virginianus*
Analysis ID	Marten	Raccoon	Skunk	White Tail Deer
101				
106				
107				
108				
109			1	1
110*	1			1
158				
159		1		
160				
161				
162				
169				
170*	1			

	Tamias striatus	*Tamiasciurus hudsonicus*	*Canis latrans*	*Mustela vison*
Analysis ID	Chipmunk	Squirrel	Coyote	Mink
11*	1	1		
12	1			
13				
25		1		
26				
27	1			
28				
29				
35	1			
36				
41				
44				
45				
46				
47				
48				
49			1	
50				
51				
64	1	1		
65*				
66*				
67		1		
68				
69				
70				
71				
72				
88				
89	1			
90				
96	1	1		
97	1			
98				
99	1	1		
100				
101				

	Tamias striatus	*Tamiasciurus hudsonicus*	*Canis latrans*	*Mustela vison*
Analysis ID	Chipmunk	Squirrel	Coyote	Mink
106				
107	1	1		
108				
109		1		
110*		1	1	1
158	1			
159				
160			1	
161				
162			1	
169			1	
170*				

	Rana sylvatica	*Peromyscus spp.*	*Marmota monax*	*Felix sylvestris*
Analysis ID	Frog	Mouse	Woodchuck	House cat
11*				
12				
13		1		
25		1		
26				
27		1		
28				
29				
35				
36				
41				
44				
45		1		
46				
47				
48		1		
49		1		
50				
51				
64				
65*				
66*				
67				
68				
69				
70				1
71				
72				
88				
89				
90				
96		1		
97		1		
98		1		
99		1		1
100				
101				

	Rana sylvatica	*Peromyscus spp.*	*Marmota monax*	*Felix sylvestris*
Analysis ID	Frog	Mouse	Woodchuck	House cat
106				
107				
108				
109		1		1
110*		1		
158		1		
159				
160				
161				
162				
169				1
170*				

	Canis lupus familiarus	*Erythizon dorsatum*	*Alces alces*	*Lepus americanus*	*Sus scrofa*
Analysis ID	House dog	Porcupine	Moose	Rabbit	Feral Pigs
11*					
12					
13				1	
25					
26		1			
27					
28					
29					
35					
36					
41					
44					
45					
46					
47					
48					
49					
50					
51					
64				1	
65*					
66*					
67					
68					
69					
70					
71					
72					
88					
89					
90					
96					
97		1		1	
98					
99					
100					
101					

	Canis lupus familiarus	*Erythizon dorsatum*	*Alces alces*	*Lepus americanus*	*Sus scrofa*
Analysis ID	House dog	Porcupine	Moose	Rabbit	Feral Pigs
106					
107		1			
108		1			
109	1				
110*				1	
158					
159					
160					
161		1			
162					
169	1				
170*					

Appendix K: Correlation Analysis for Each Buffer Zone Performed on Variables Assessed for Their Prediction Capability of Martens in the Turtle Mountains

Variables with Pearson correlation values > │.70│ are in bold font and n = 123.

100 m

	WATER	DEVELOPED	FOREST	GRASS	AG
DEVELOPED	-0.019				
FOREST	-0.559	-0.227			
GRASS	-0.179	-0.138	-0.426		
AG	-0.064	-0.077	-0.461	0.046	
WETLAND	0.089	-0.068	-0.269	-0.050	0.089
MPS	-0.337	-0.385	0.655	-0.307	-0.136
ED	-0.363	0.065	0.484	-0.277	-0.109
MPFD	0.117	-0.015	-0.176	0.071	0.100
AWMPFD	0.108	0.064	-0.203	0.083	0.100
MNN	-0.033	0.322	-0.271	0.207	0.134
IJI	0.304	0.223	-0.466	0.069	0.170
STRM_DEN	0.630	-0.126	-0.264	-0.145	-0.103
ROAD_DEN	-0.095	0.561	-0.195	0.037	0.040
UD	0.042	0.029	0.043	-0.031	-0.022
CC	-0.094	-0.024	-0.015	0.069	0.021

	WETLAND	MPS	ED	MPFD	AWMPFD
DEVELOPED					
FOREST					
GRASS					
AG					
WETLAND					
MPS	-0.158				
ED	-0.202	0.312			
MPFD	0.051	-0.142	0.474		
AWMPFD	0.039	-0.236	0.508	**0.968**	
MNN	-0.062	-0.655	-0.072	-0.231	-0.111
IJI	0.237	-0.551	-0.083	0.278	0.332
STRM_DEN	0.075	-0.096	-0.341	-0.026	-0.060
ROAD_DEN	0.042	-0.331	0.033	-0.075	-0.024
UD	-0.244	0.092	-0.065	-0.021	-0.067
CC	0.170	0.009	0.044	-0.006	0.010

	MNN	IJI	STRM_DEN	ROAD_DEN	UD
DEVELOPED					
FOREST					
GRASS					
AG					
WETLAND					
MPS					
ED					
MPFD					
AWMPFD					
MNN					
IJI	0.209				
STRM_DEN	-0.153	0.162			
ROAD_DEN	0.405	0.188	-0.199		
UD	-0.201	0.030	0.036	-0.016	
CC	0.013	0.091	-0.149	-0.060	-0.364

250 m

	WATER	DEVELOPED	FOREST	GRASS	AG
DEVELOPED	-0.065				
FOREST	-0.518	-0.122			
GRASS	-0.235	-0.155	-0.347		
AG	-0.142	-0.101	-0.464	-0.062	
WETLAND	-0.058	-0.027	-0.213	0.125	-0.018
NUMP	0.069	0.381	-0.353	0.239	-0.011
MPS	-0.243	-0.221	0.564	-0.284	-0.121
ED	-0.176	0.217	0.122	0.147	-0.289
AWMSI	0.108	-0.044	-0.203	0.235	-0.086
MPFD	0.176	-0.084	-0.082	0.061	-0.123
AWMPFD	0.176	-0.040	-0.273	0.249	-0.081
MNN	0.212	0.108	-0.503	0.322	0.135
IJI	0.173	0.135	-0.252	-0.068	0.070
STRM_DEN	0.795	-0.072	-0.338	-0.201	-0.226
ROAD_DEN	-0.156	0.588	-0.023	0.064	-0.160

	WETLAND	NUMP	MPS	ED	AWMSI
DEVELOPED					
FOREST					
GRASS					
AG					
WETLAND					
NUMP	0.170				
MPS	-0.247	-0.810			
ED	0.212	0.402	-0.269		
AWMSI	0.238	-0.025	-0.185	0.589	
MPFD	0.075	-0.253	0.047	0.437	0.746
AWMPFD	0.257	0.035	-0.268	0.581	0.984
MNN	0.096	0.432	-0.665	-0.055	0.106
IJI	0.324	0.138	-0.213	0.250	0.265
STRM_DEN	0.027	-0.057	-0.071	-0.113	0.163
ROAD_DEN	0.066	0.390	-0.240	0.337	0.032

	MPFD	AWMPFD	MNN	IJI	STRM_DEN
DEVELOPED					
FOREST					
GRASS					
AG					
WETLAND					
NUMP					
MPS					
ED					
AWMSI					
MPFD					
AWMPFD	0.762				
MNN	-0.169	0.160			
IJI	0.257	0.295	0.104		
STRM_DEN	0.204	0.203	0.176	0.199	
ROAD_DEN	-0.044	0.042	0.105	0.000	-0.199

500 m

	WATER	DEVELOPED	FOREST	GRASS	AG
DEVELOPED	-0.115				
FOREST	-0.402	0.076			
GRASS	-0.293	-0.164	-0.231		
AG	-0.267	-0.179	-0.539	-0.117	
WETLAND	-0.093	-0.144	-0.182	0.067	0.057
NUMP	0.037	0.107	-0.492	0.355	0.203
MPS	-0.110	-0.080	0.512	-0.244	-0.221
ED	-0.128	0.150	0.061	0.267	-0.238
MSI	-0.030	-0.039	0.274	-0.172	-0.136
AWMSI	-0.090	-0.203	0.070	0.148	-0.089
MPFD	-0.020	0.020	0.233	-0.202	-0.109
AWMPFD	-0.049	-0.175	0.024	0.156	-0.090
MNN	0.161	-0.069	-0.225	0.121	0.001
IJI	0.191	0.031	-0.114	-0.323	0.088
STRM_DEN	0.772	-0.158	-0.214	-0.196	-0.338
ROAD_DEN	-0.132	0.629	0.092	0.062	-0.254

	WETLAND	NUMP	MPS	ED	MSI
DEVELOPED					
FOREST					
GRASS					
AG					
WETLAND					
NUMP	0.084				
MPS	-0.157	-0.769			
ED	0.215	0.192	-0.125		
MSI	-0.017	-0.678	0.710	0.297	
AWMSI	0.280	-0.262	0.168	0.653	0.564
MPFD	0.003	-0.639	0.614	0.278	0.952
AWMPFD	0.263	-0.205	0.116	0.680	0.549
MNN	0.130	0.190	-0.454	-0.127	-0.355
IJI	0.302	0.001	-0.092	0.036	0.040
STRM_DEN	0.027	0.003	-0.071	0.014	-0.003
ROAD_DEN	0.057	0.168	-0.051	0.237	-0.077

	AWMSI	MPFD	AWMPFD	MNN	IJI	STRM_DEN
DEVELOPED						
FOREST						
GRASS						
AG						
WETLAND						
NUMP						
MPS						
ED						
MSI						
AWMSI						
MPFD	0.491					
AWMPFD	0.975	0.500				
MNN	-0.080	0.281	-0.050			
IJI	0.043	0.053	0.049	0.058		
STRM_DEN	0.029	0.014	0.065	0.106	0.144	
ROAD_DEN	-0.142	-0.031	-0.142	-0.144	-0.075	-0.105

1 km

	WATER	DEVELOPED	FOREST	GRASS	AG
DEVELOPED	-0.140				
FOREST	-0.229	0.032			
GRASS	-0.495	-0.097	-0.073		
AG	-0.202	-0.106	-0.734	-0.115	
WETLAND	0.030	-0.109	-0.060	-0.057	-0.035
NUMP	-0.049	0.065	-0.464	0.186	0.374
MPS	-0.104	-0.009	0.609	-0.182	-0.378
ED	-0.039	0.026	0.381	0.027	-0.393
MPFD	0.024	0.153	0.398	-0.203	-0.367
AWMPFD	-0.099	-0.300	0.210	0.044	-0.122
MNN	0.253	-0.026	-0.562	-0.059	0.437
IJI	0.329	-0.101	0.183	-0.435	-0.173
STRM_DEN	0.714	-0.067	-0.034	-0.235	-0.397
ROAD_DEN	-0.244	0.692	0.135	0.185	-0.224

	WETLAND	NUMP	MPS	ED	MPFD
DEVELOPED					
FOREST					
GRASS					
AG					
WETLAND					
NUMP	0.202				
MPS	-0.213	-0.610			
ED	0.373	0.227	0.001		
MPFD	0.014	-0.457	0.678	0.253	
AWMPFD	0.101	-0.220	0.172	0.543	0.154
MNN	-0.173	-0.004	-0.288	-0.641	-0.331
IJI	0.377	0.163	0.040	0.417	0.195
STRM_DEN	0.149	0.099	-0.113	0.235	0.058
ROAD_DEN	0.033	0.105	0.081	0.097	0.150

	AWMPFD	MNN	IJI	STRM_DEN
DEVELOPED				
FOREST				
GRASS				
AG				
WETLAND				
NUMP				
MPS				
ED				
MPFD				
AWMPFD				
MNN	-0.341			
IJI	0.053	-0.302		
STRM_DEN	0.073	-0.133	0.388	
ROAD_DEN	-0.260	-0.194	-0.210	0.013

2 km

	WATER	DEVELOPED	FOREST	GRASS	AG
DEVELOPED	-0.201				
FOREST	0.320	-0.149			
GRASS	-0.468	0.002	-0.120		
AG	-0.492	0.096	-0.826	-0.014	
WETLAND	0.399	-0.266	0.340	-0.360	-0.349
NUMP	-0.222	0.004	-0.552	0.094	0.642
MPS	0.099	-0.094	0.772	-0.016	-0.690
ED	0.461	-0.122	0.621	-0.229	-0.526
MSI	0.282	-0.021	0.508	-0.269	-0.512
AWMSI	0.199	-0.252	0.572	-0.013	-0.563
MPFD	0.069	0.040	0.006	-0.220	0.058
AWMPFD	0.222	-0.298	0.606	0.049	-0.537
MNN	-0.381	0.319	-0.583	0.128	0.525
IJI	0.529	-0.173	0.518	-0.461	-0.475
STRM_DEN	0.842	-0.158	0.336	-0.261	-0.600
ROAD_DEN	-0.123	0.520	0.046	0.420	-0.168

	WETLAND	NUMP	MPS	ED	MSI
DEVELOPED					
FOREST					
GRASS					
AG					
WETLAND					
NUMP	-0.051				
MPS	0.142	-0.824			
ED	0.456	0.050	0.171		
MSI	0.181	-0.708	0.712	0.305	
AWMSI	0.246	-0.422	0.500	0.517	0.288
MPFD	-0.146	-0.232	0.144	-0.022	0.577
AWMPFD	0.246	-0.409	0.506	0.570	0.319
MNN	-0.338	0.061	-0.232	-0.741	-0.329
IJI	0.544	-0.216	0.224	0.554	0.262
STRM_DEN	0.430	-0.256	0.154	0.490	0.264
ROAD_DEN	-0.155	-0.022	0.053	-0.071	-0.078

	AWMSI	MPFD	AWMPFD	MNN	IJI	STRM_DEN
DEVELOPED						
FOREST						
GRASS						
AG						
WETLAND						
NUMP						
MPS						
ED						
MSI						
AWMSI						
MPFD	-0.126					
AWMPFD	0.962	-0.130				
MNN	-0.317	0.010	-0.378			
IJI	0.388	0.038	0.404	-0.439		
STRM_DEN	0.316	-0.032	0.369	-0.345	0.466	
ROAD_DEN	-0.246	-0.170	-0.224	0.067	-0.352	0.073

Appendix L: Means and Standard Deviations for Detection and Non-Detection Variables at Each Buffer Scale

There were 96 non-detection sites and 27 detection sites.

100 m

	No Martens		Martens	
Variable	$\bar{x}$	σ	$\bar{x}$	σ
WATER	0.22	0.48	0.39	0.59
DEVELOPED	0.14	0.27	0.19	0.33
FOREST	2.31	0.75	2.34	0.76
GRASS	0.26	0.48	0.13	0.26
AG	0.14	0.38	0.10	0.28
WETLAND	0.07	0.18	0.01	0.02
MPS	2.07	0.89	2.16	0.78
ED	261.11	58.82	261.02	33.33
MPFD	1.05	0.03	1.05	0.03
AWMPFD	1.05	0.03	1.05	0.03
MNN	7.65	15.92	2.38	8.58
IJI	24.90	29.68	24.63	38.89
STRM_DEN	11.36	24.28	13.16	22.49
ROAD_DEN	28.51	35.09	24.01	28.79
UD	3.04	1.21	3.48	1.06
CC	2.21	0.62	2.10	0.57

250 m

	No Martens		Martens	
Variable	$\bar{x}$	σ	$\bar{x}$	σ
WATER	2.31	2.91	3.40	3.02
DEVELOPED	0.91	1.24	1.20	1.36
FOREST	12.77	3.72	12.28	3.99
GRASS	1.71	2.39	1.36	1.69
AG	1.53	2.49	1.13	2.35
WETLAND	0.57	0.80	0.43	0.65
MPS	8.35	5.33	8.75	6.03
NUMP	2.05	1.07	2.11	1.15
ED	145.01	31.26	138.72	31.54
MPFD	1.08	0.03	1.08	0.03
AWMPFD	1.10	0.04	1.08	0.03
MNN	32.57	37.92	25.95	26.71
IJI	62.89	35.70	79.62	16.92
STRM_DEN	13.11	15.91	17.11	17.72
ROAD_DEN	21.88	19.98	21.44	15.63
AWMSI	1.77	0.38	1.63	0.28

500 m

	No Martens		Martens	
Variable	$\bar{x}$	σ	$\bar{x}$	σ
WATER	10.92	9.69	14.52	10.72
DEVELOPED	2.88	3.05	4.81	5.26
FOREST	45.44	11.51	45.01	11.09
GRASS	6.98	7.69	5.53	5.32
AG	8.85	10.68	5.45	7.96
WETLAND	2.69	2.64	2.52	1.90
MPS	19.38	17.74	17.61	13.17
NUMP	3.86	2.20	3.52	1.72
ED	110.39	21.96	108.81	19.51
MPFD	1.10	0.03	1.10	0.03
AWMPFD	1.14	0.04	1.13	0.03
MNN	42.07	33.70	42.38	19.66
IJI	74.06	20.17	80.55	14.95
STRM_DEN	14.92	11.51	19.74	14.46
ROAD_DEN	16.62	12.22	20.94	14.04
MSI	1.93	0.48	1.91	0.41
AWMSI	2.52	0.61	2.34	0.40

1 km

	No Martens		Martens	
Variable	$\bar{x}$	σ	$\bar{x}$	σ
WATER	41.62	27.71	57.18	29.82
DEVELOPED	10.82	8.55	17.80	16.08
FOREST	167.73	38.09	168.79	33.43
GRASS	31.81	25.96	24.15	15.77
AG	48.26	38.65	34.13	30.31
WETLAND	10.15	6.36	10.07	5.18
MPS	28.68	39.17	25.22	22.55
NUMP	9.19	4.11	9.11	3.78
ED	93.41	16.70	92.71	18.27
MPFD	1.10	0.02	1.10	0.02
AWMPFD	1.19	0.03	1.17	0.04
MNN	49.51	23.87	49.89	25.78
IJI	82.17	12.21	85.85	10.45
STRM_DEN	14.32	7.68	18.25	9.48
ROAD_DEN	14.65	8.24	19.04	9.64

2 km

	No Martens		Martens	
Variable	$\bar{x}$	σ	$\bar{x}$	σ
WATER	145.4	81.63	206.91	108.12
DEVELOPED	42.29	18.14	56.66	33.62
FOREST	591.45	144.7	615.50	135.59
GRASS	133.57	93.41	110.34	55.21
AG	271.9	161.55	197.42	170.28
WETLAND	39.81	16.99	42.16	15.82
MPS	23.8	15.48	25.38	10.70
NUMP	31.39	12.21	26.63	7.08
ED	80.66	12.96	81.83	15.12
MPFD	1.1	0.01	1.10	0.01
AWMPFD	1.22	0.03	1.21	0.03
MNN	53.63	15.35	52.73	18.44
IJI	85.67	9.15	88.03	8.84
STRM_DEN	12.84	5.82	17.11	9.01
ROAD_DEN	13.87	4.59	16.65	4.38
MSI	1.89	0.15	1.96	0.12
AWMSI	5.57	1.54	4.96	1.42