Freshwater Snails of South Dakota within the Middle Rockies, Western Corn Belt Plains, Northern Glaciated Plains and Lake Agassiz Plains Ecoregions

Bruce J. Stephen
Department of Biological Sciences
University of Nebraska Lincoln
Lincoln, Nebraska

Final Report
For the South Dakota Department of Fish, Game and Parks

January 2009

Author address:
Lincoln, NE 68510
bstephen@mac.com
Contents

Acknowledgements 3
Summary 4
Introduction 5
Methods 6
Results 7
Discussion 8
Literature Cited 10

Table 1. Site list with species richness, chemical and physical aspects 12
Table 2. Species abundances and Ecoregion locations. 13

Figure 1. Map of South Dakota showing sample sites. 14
Figure 2. Map of locations with Physa gyrina. 15
Figure 3. Map of locations with Gyralus deflectus. 15
Figure 4. Map of locations with Lymnaea elodes. 16
Figure 5. Map of locations with Helisoma trivolvis. 16
Figure 6. Map of locations with Lymnaea caperata. 17
Figure 7. Map of locations with Aplexa elongata. 17
Figure 8. Map of locations with Promenetus exacuous. 18
Figure 9. Map of locations with Helisoma aniceps. 18
Figure 10. Map of locations with Laevapex fuscus. 19
Figure 11. Map of locations with Campeloma decisum. 19
Figure 12. Map of locations with Lymnaea sp. 20
Figure 13. Map of locations with Physa sp A. 20

Appendix A. Detailed location and species listings for each sample site. 21
Acknowledgements

I would like to thank the following: Dan Fogell for advice on several aspects of this study. The State of South Dakota and more specifically the South Dakota Department of Game, Fish and Parks for funding, permits and generally being a great partner for studies within South Dakota. The National Forest Service for permits allowing collecting within The Black Hills National Forest.
Summary

Regions of South Dakota including the extreme northeast and southeast corners and the Black Hills were surveyed for freshwater snails during summer and fall of 2008. Aquatic habitats sampled included springs, marshes, ponds, lakes, roadside ditches and sections of three rivers in the eastern portion of the state. The survey was conducted using a modified weighted-effort method. Sampling is first done using a dip net along several areas of the shallow shoreline. The dip netting covers an area of approximately 2 square meters. Further searching is then done by hand, using hand nets, and dip nets, as well as a sieve to search bottom substrate. Sampling concentrated on shallow shoreline regions. The conditions linked to snail species richness including pH, conductivity, and bottom substrate were measured for each sample area. Specific latitude and longitude was recorded for each sample site using a GPS unit. To provide species richness comparisons of freshwater snail fauna found during this survey summary data from past surveys in 2005 and 2006 on other regions of South Dakota is used. In 2005 ten species of snail aquatic snail were found. In 2006 ten species were also found, two were species not found in 2005. In this study 12 species of aquatic snail were found, four of these were not found in previous years. The entire state of South Dakota provides a wide array of aquatic habitats and thus the entire state was expected to house a larger diversity of aquatic snail species than were discovered.
**Introduction**

This study provides biodiversity and abundance assessments of the freshwater snail fauna in regions of South Dakota not recently sampled including the level III and IV ecoregions (Bryce et al., 1996) of the Middle Rockies, Western Corn Belt Plains, Northern Glaciated Plains, Lake Agassiz Plains and a section of the Nebraska Sand Hills within Nebraska. This study along with studies done through the South Dakota Department of Game, Fish and Parks in 2005 (Stephen, 2006) and 2006 (Stephen, 2007) provide a recent set of baseline data for the entire state. Another goal of this survey was to note the presence of any non-indigenous species of snail, or the presence of uncommon, rare or endangered snail species. Water quality data on the two principal environmental parameters that affect the presence and abundance of snails are conductivity (calcium being the more critical cation) and pH (Dillon, 2000). These chemical parameters as well as physical factors such as shoreline vegetation and bottom substrate were recorded for each sample site.

Besides the 2005 and 2006 studies little recent data exist on the freshwater gastropod fauna of South Dakota. Older studies suggest an array of up to 40 species of aquatic snails should be found in South Dakota (Over, 1915,1928; Henderson, 1927). Unfortunately species location data for these studies is often absent or not very specific. Some caveats should be considered when looking at these values. First of all several of the species listed are likely synonymous with other species and thus not true species. Recent work by several authors have begun to pare down the vast array species of aquatic snails (Dillon et al. 2002; Walther et al. 2006) spreading doubt on the actual number of species – once thought to be over 500 in North America (Burch and Tottenham, 1980). In South Carolina a reduction in species has been reported due to synonymy. Historically in South Carolina 43 species are reported but only 28, with still more suspect, appear to be valid (Dillon and Stewart, 2003). A similar reduction of the number of species housed in South Dakota may be loss of species due to habitat loss and land use. In a report of Iowa freshwater snails Stewart (2006) suspects several species historically found in the state have been extirpated due to human land use practices.

Aquatic snail species distributions and abundances have often been overlooked in North America even though they are an integral part of aquatic systems and may be under
dire threat. Threats to freshwater invertebrates diversity include non-indigenous species invasions and habitat loss. Freshwater mollusk populations may be one of the most threatened fauna worldwide (Lydeard, 2004). Since snails are an important food source for fishes and wetland birds (Swanson and Duebbert. 1989) and act as primary consumers and also non-specific detritivores (Dillon, 2000) their fate is the overall fate of the wetlands. In addition snails themselves, due to their importance in aquatic primary production, seem to be a major influence on wetland growth and destruction under changing environmental conditions (Silliman et. al, 2005).

This study provides current location data for several species of freshwater snail. In addition this project should aid in answering future questions about the degree of influence changing environmental conditions such as drought have on these aquatic habitats as well as the consequences non-indigenous species have on these habitats.
Methods

Regions of South Dakota were surveyed for freshwater snails during several periods. The first sampling was conducted in June 2008. A second round of sampling was conducted later the same year in August and September. The second sampling was designed to resample the same water bodies as the earlier sampling period but collect snails only if additional species were found. Aquatic habitats sampled included springs, marshes, ponds, lakes, roadside ditches and sections of three rivers in the eastern portion of the state: the Big Sioux, the James and the Vermillion. Due to the inability to find access to a water body within the Sand Hills region of South Dakota data from one Sand Hill’s lake in Nebraska is included here.

The sampling method used in this study was a modified weighted effort method. First a two-meter square area was swept with a dip net. In rivers sweeps of the net are done in one-meter segments every 3-5 meters. Sweeps were from 0.5 to 1 meters from the shoreline. Each sweep is collected and the materials washed through mesh. All snails within the swept area were collected. Then a weighted effort method is deployed. This entails additional searching by visual examination of shorelines, bottom substrate, vegetation, detritus and shallow water structures by hand and net. These searches took place in 20-minute intervals. Every 20 minutes it was determined if an additional species of snail was found, if so then the search continued. Whenever a search did not obtain an additional species the sampling was stopped.

Population densities were estimated using overall snail density, not divided by species, by simply counting the snails collected in the two-meter square netted area. Categories of density were high, medium and low. A high designation was earned if more than 50 snails of any species were found, low density was earned if fewer than ten snails were found, values in between were designated medium.

Clarification of species identification and sorting of all specimens was done after returning from the field. In some genera, for example Physa, dissection of soft tissue may be required for species confirmation. Shells were housed in jars while live specimens were preserved in 95% ethanol and stored in glass jars.
Conductivity and pH were determined using Extech Instruments Exstik II. Types of bottom substrate and shallow water and near shore vegetation were also recorded for each sample site.

Water body size was estimated visually and placed into one of three categories: Small (<0.5 ha), Medium (0.5-5 ha), Large (>5 ha). Substrate was recorded as organic mud, sand or small stone and the most prominent donated. Prominent shoreline vegetation was also recorded.
Results
In these widely separate areas of South Dakota sampled in this study 12 species of freshwater snail were collected from 23 sample sites making a total of 67 records. Additional sites were attempted but these produced no snails. The twelve species found were from five families; the limpet like Ancylidae (one species: *Laevapex fuscus*), the right-handed pond snails Lymnaeidae (three species: *Lymnaea caperata*, *Lymnaea elodes* and *Lymnaea* sp.), the left-handed pond snails Physidae (three species: *Aplexa elongata*, *Physa gyrina* and *Physa* species A), the Rams-horn snails Planorbidae (four species: *Gyraulus deflectus*, *Helisoma trivolvis*, *Helisoma anceps* and *Promenetus exacuous*) and the Viviparid snail *Campeloma decisum* also known as the river snail. Due to their small size two snail species could not be identified to the specific level and it is possible that these small specimens are of species already recorded.

Table 1 outlines site names and location, species richness, snail density, and physical and chemical attributes of each of 23 sample sites. In some areas snails were found in abundance. Designations of high, medium or low snail density were determined based on the number collected in the 2-meter square sweep. Density was high at four sites spanning three Ecoregions. Species richness varied from no species found (not included on table 1 but see appendix) to a maximum of six species. Cottonwood Slough had a species richness of six in one sample site. A second sample site in the same water body had a species richness of five, as did the sample site within the Fonder/Okeson WPA. These three high species rich sites were all within the Northern Glaciated Plains ecoregion. Chemical and physical analyses indicate alkaline pH values and relatively high conductivity values are common throughout the state. The lowest pH value found was 7.2 in the Middle Rockies region in the only cold-water spring sampled. This site also had the lowest conductivity value of 21.8 uS. Most sites had grasses as the prominent shoreline vegetation and organic (dead grasses and leaves) as bottom substrate.

Table 2 shows the occurrence of the twelve snail species throughout the ecoregions sampled. For comparison the species found in studies done in 2005 and 2006 in other parts of the state are included. The Northern Glaciated Plains and the Middle Rockies ecoregion were the most specious, each with seven species found, but they were more heavily sampled with five and seven sample sites respectively, than other regions.
The most common species overall was *Physa gyrina*. *P. gyrina* was found at 19 of 23 sites that housed snails. These sites include all regions sampled in this study. *Gyraulus deflectus* was the next most common snail found at 10 sites with *Lymnaea elodes* nearly as commonly found at 9 sites. Three species were each confined to a single site. *Campeloma decisum* was only found at one site along the Big Sioux River. The two species not able to be identified to the species level were also found at only one site each, one (the Lymnaeidae) in the James River and *Physa* species A in the cold-water spring within the Black Hills. Three snail species *Laevapex fuscus*, *Helisoma anceps* and *Physa* species A were only found in the Black Hills region. *Aplexa elongata* and *Promenetus exacuous* were only found in the NE part of the state.

Figure 1 is a Map showing the location of each sample site including sites where no snails were found. Figures 2-13 map the locations for each species. Appendix A is a more detailed look at each site and includes the number of each species collected as well a specific location information including the water body name, county and latitude and longitude.
Discussion

This survey of regions of South Dakota included several types of water bodies including rivers, marshes, ponds, larger lakes, and a cold-water spring. In total twelve species (Table 2) of freshwater snail in five families were discovered.

The most widespread species in this study was Physa gyrina, being found in 19 of 23 sites with snails. P. gyrina is common in much of North America and is often considered “weedy” inhabiting many water body types and qualities. This species was not found in Club House Lake, in the Lake Agassiz Plain ecoregion (the most NE site). P. gyrina was also absent in some river sites but present in others. This absence is not particularly telling due to the limitation on river sampling, which was sporadic and dictated by bridge access. These access sites often were low in shoreline and emergent vegetation. In many areas including South Dakota the rams-horn snail Helisoma trivolvis is found in abundance. This species was found at only seven sites in this study. The lower than expected presence of H. trivolvis may be due a species replacement within the Black Hills. In Black Hills the planorbid snail Helisoma anceps was found but none of the usually more prevalent Helisoma trivolvis were discovered. These two species are similar in size and appearance and likely have the same or overlapping niches. Surveys from other states typically do not find these species in the same water body (Jokinen, 1983; Jokinen, 1992) and thus it appears that in the Black Hills region H. anceps takes the position where H. trivolvis is found in other regions.

The occurrence of a member of the Physidae found in a spring is of interest. This snail, designated Physa species A, was found in a cold-water spring (Cascade Spring) within the Black Hills region. It was the only snail species discovered in the spring and adjacent stream. A similar snail was found in a cold-water spring in Nebraska (Stephen per. obs.). Though the small size and the small number of specimens found make species identification uncertain it’s likely that this is the same species and it may be found restricted to these cold-water spring habitats.

Two snails often thought of as northern species, Aplexa elongata and Promenetus exacuous, follow that same pattern in this study being found only in the northeast part of the state with one exception. The exception was the one out of state sample site included
here. On this site, within the Nebraska Sand Hills just south of the South Dakota border, several *Aplexa elongata* were found.

South Dakota has a wide variety of aquatic habitats. Many of these are good quality habitats for snail fauna having alkaline pH and high conductivity values. Given these parameters it was expected that more species of freshwater snail would have been discovered in the state. The Black Hills region, with its widely different elevations and habitats, in particularly was expected to provide a multitude of additional species. Though the Black Hills region did not produce as large a number of species as suspected, three species *Laevapex fuscus*, *Helisoma anceps* and *Physa* species A were only found within this region. This region was relatively species rich with seven species found. This matches the richness of the Northern Glaciated Plains region though more sites were sampled within the Black Hills.

Historically studies have found up to 40 species of aquatic snail in South Dakota (Over, 1915,1928; Henderson, 1927). These numbers are likely greater than the current number of species in the state. First off several species are likely synonyms. Several authors have recently begun to tackle the overwhelming array of North American freshwater snail species and have reduced the recognized number (Dillon et al, 2002; Walther et al. 2006). Taking studies done on other states such as South Carolina gives us an idea of how many species may be synonyms. In South Carolina Dillon and Stewart, (2003) have reduced the number of actual species found historically from 43 to 28 with several more suspect due to synonymy. In addition some species historically present may have been lost. Iowa encompasses ecoregions that historically have housed at least 40 species of aquatic snail (Stewart, 2006). However, due to changing land use and water use patterns, the author suspects that seven of these are extirpated from Iowa and eleven more have only rare reports and thus are in danger of being extirpated.

In this study no species suspected of being extirpated from nearby states were discovered. No non-indigenous species known to be encroaching in the overall region were discovered: Of recent concern are the New Zealand Mudsnaill, now found in Colorado and Montana (Kerns et al. 2005; MSU, 2005); and the Faucet Snail and Banded Mystery Snail found in Michigan and Minnesota both of which house parasites.
responsible for massive die-offs of water fowl (Minn DNR, 2007; USGS, 2007; La Crosse Tribune, 2007).

A full analysis of the historical species to the current species is not be done in this report but due to the findings in other states it is suspected that the current aquatic snail species in South Dakota is, at most, in the high 20’s.
Literature Cited


Over, W.H. 1915 Mollusca of South Dakota. 29(7): 79-81
Over, W.H. 1915 Mollusca of South Dakota (continued). 29(8): 90–95


Table 1. Snail species richness, physical and chemical parameters from 23 aquatic sites sampled throughout several ecoregions of South Dakota. Site sampling was done between Spring 2008 through Fall 2008 with the exception of site R7 (the most southern site sampled on the Big Sioux river), which was sampled in Fall 2007. One sample site from Nebraska (C11) is included here to provide some species distribution detail with the Nebraska Sand Hill ecoregion that encroaches into South Dakota in the southwest counties of Bennett and Todd.

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Site No</th>
<th>Level III Ecoregion</th>
<th>Species Richness</th>
<th>Species Density</th>
<th>Conductivity (uS)</th>
<th>pH</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Elevation (ft)</th>
<th>Most Prominent vegetation</th>
<th>Most Prominent Substrate</th>
<th>waterbody size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horseshoe Lake</td>
<td>C1</td>
<td>Western Cornbelt Plains</td>
<td>3 Medium</td>
<td>Medium</td>
<td>271</td>
<td>8.4</td>
<td>42.63391</td>
<td>96.53231</td>
<td>1106</td>
<td>Grasses</td>
<td>Mud</td>
<td>Large</td>
</tr>
<tr>
<td>Lake Lakota</td>
<td>C2</td>
<td>Western Cornbelt Plains</td>
<td>4 High</td>
<td>High</td>
<td>828</td>
<td>7.5</td>
<td>43.20537</td>
<td>96.56003</td>
<td>1321</td>
<td>Grasses</td>
<td>Organic</td>
<td>Large</td>
</tr>
<tr>
<td>Burbank Lake</td>
<td>C3</td>
<td>Northern Glaciated Plains</td>
<td>2 Low</td>
<td>Low</td>
<td>865</td>
<td>7.5</td>
<td>42.72545</td>
<td>96.86050</td>
<td>1033</td>
<td>Grasses</td>
<td>Organic</td>
<td>Large</td>
</tr>
<tr>
<td>LaBolt Lake</td>
<td>C4</td>
<td>Northern Glaciated Plains</td>
<td>3 Low</td>
<td>Low</td>
<td>875</td>
<td>7.6</td>
<td>45.05418</td>
<td>96.69033</td>
<td>1373</td>
<td>Grasses</td>
<td>Organic</td>
<td>Large</td>
</tr>
<tr>
<td>Kaufman WPA Roadside ditch,</td>
<td>C5</td>
<td>Northern Glaciated Plains</td>
<td>4 High</td>
<td>High</td>
<td>2120</td>
<td>7.6</td>
<td>45.09316</td>
<td>96.47524</td>
<td>1114</td>
<td>Grasses</td>
<td>Organic</td>
<td>Large</td>
</tr>
<tr>
<td>Fonder/Okeson WPA</td>
<td>C6</td>
<td>Northern Glaciated Plains</td>
<td>5 Medium</td>
<td>Medium</td>
<td>1372</td>
<td>7.8</td>
<td>45.60176</td>
<td>96.97878</td>
<td>1198</td>
<td>Cattails</td>
<td>Organic</td>
<td>Small</td>
</tr>
<tr>
<td>Cottonwood Slough 1</td>
<td>C8</td>
<td>Northern Glaciated Plains</td>
<td>6 High</td>
<td>High</td>
<td>1223</td>
<td>7.7</td>
<td>45.74679</td>
<td>96.88036</td>
<td>1035</td>
<td>Cattails</td>
<td>Organic</td>
<td>Large</td>
</tr>
<tr>
<td>Cottonwood Slough 2 Clubhouse</td>
<td>C9</td>
<td>Northern Glaciated Plains</td>
<td>5 Medium</td>
<td>Medium</td>
<td>857</td>
<td>7.5</td>
<td>45.78852</td>
<td>96.82112</td>
<td>1045</td>
<td>Cattails</td>
<td>Organic</td>
<td>Large</td>
</tr>
<tr>
<td>Lake Agassiz</td>
<td>C10</td>
<td>Nebraska Sandhill Plains Middle</td>
<td>3 High</td>
<td>High</td>
<td>1285</td>
<td>7.6</td>
<td>45.89290</td>
<td>96.61885</td>
<td>992</td>
<td>Cattails</td>
<td>Organic</td>
<td>Large</td>
</tr>
<tr>
<td>Liberal Slough</td>
<td>C11</td>
<td>Nebraska Sandhill Plains Middle</td>
<td>2 Medium</td>
<td>Medium</td>
<td>872</td>
<td>7.4</td>
<td>42.99417</td>
<td>101.25108</td>
<td>958</td>
<td>Cattails</td>
<td>Organic</td>
<td>Medium</td>
</tr>
<tr>
<td>Spring Cold Brook Reservoir</td>
<td>C12</td>
<td>Rockies</td>
<td>1 Low</td>
<td>Low</td>
<td>21.8</td>
<td>7.2</td>
<td>43.33470</td>
<td>103.55172</td>
<td>3480</td>
<td>Grasses</td>
<td>Stone</td>
<td>Small</td>
</tr>
<tr>
<td>Gates Park Lake</td>
<td>C14</td>
<td>Rockies</td>
<td>2 Low</td>
<td>Low</td>
<td>825</td>
<td>8.3</td>
<td>43.45817</td>
<td>103.49040</td>
<td>3618</td>
<td>Grasses</td>
<td>Organic</td>
<td>Medium</td>
</tr>
<tr>
<td>Sunday Gulch GPA pond</td>
<td>C15</td>
<td>Rockies</td>
<td>3 Low</td>
<td>Low</td>
<td>562</td>
<td>8.1</td>
<td>43.75818</td>
<td>103.62600</td>
<td>5368</td>
<td>Cattails</td>
<td>Organic</td>
<td>Medium</td>
</tr>
<tr>
<td>Sheridan Lake</td>
<td>C16</td>
<td>Rockies</td>
<td>4 Low</td>
<td>Low</td>
<td>150</td>
<td>7.4</td>
<td>43.88966</td>
<td>103.58655</td>
<td>5217</td>
<td>Cattails</td>
<td>Organic</td>
<td>Small</td>
</tr>
<tr>
<td>Pactola Reservoir Strawberry</td>
<td>C17</td>
<td>Rockies</td>
<td>3 Medium</td>
<td>Medium</td>
<td>NA NA</td>
<td>43.96933</td>
<td>103.47921</td>
<td>4755</td>
<td>Cattails</td>
<td>Organic</td>
<td>Large</td>
<td></td>
</tr>
<tr>
<td>Picnic grounds pond</td>
<td>C18</td>
<td>Rockies</td>
<td>1 Low</td>
<td>Low</td>
<td>399</td>
<td>7.8</td>
<td>44.07331</td>
<td>103.48472</td>
<td>4441</td>
<td>Grasses</td>
<td>Stone</td>
<td>Large</td>
</tr>
<tr>
<td>James River</td>
<td>R1</td>
<td>River</td>
<td>2 Low</td>
<td>Low</td>
<td>1677</td>
<td>7.5</td>
<td>44.59867</td>
<td>98.23964</td>
<td>1245</td>
<td>Grasses</td>
<td>Gravel</td>
<td>River</td>
</tr>
<tr>
<td>Big Sioux River</td>
<td>R2</td>
<td>River</td>
<td>2 Low</td>
<td>Low</td>
<td>935</td>
<td>8.0</td>
<td>44.33007</td>
<td>96.88813</td>
<td>1609</td>
<td>Grasses</td>
<td>Mud</td>
<td>River</td>
</tr>
<tr>
<td>W F Vermillion River</td>
<td>R3</td>
<td>River</td>
<td>1 Low</td>
<td>Low</td>
<td>979</td>
<td>8.1</td>
<td>43.91527</td>
<td>96.66822</td>
<td>1403</td>
<td>Grasses</td>
<td>Mud</td>
<td>River</td>
</tr>
<tr>
<td>James River</td>
<td>R4</td>
<td>River</td>
<td>2 Medium</td>
<td>Medium</td>
<td>1246</td>
<td>8.1</td>
<td>43.55783</td>
<td>97.37034</td>
<td>1342</td>
<td>Grasses</td>
<td>Mud</td>
<td>River</td>
</tr>
<tr>
<td>Big Sioux River</td>
<td>R5</td>
<td>River</td>
<td>3 Low</td>
<td>Low</td>
<td>1494</td>
<td>7.8</td>
<td>43.05183</td>
<td>97.40756</td>
<td>1152</td>
<td>Grasses</td>
<td>Mud</td>
<td>River</td>
</tr>
<tr>
<td>Big Sioux River</td>
<td>R7</td>
<td>River</td>
<td>3 Low</td>
<td>Low</td>
<td>40.80647</td>
<td></td>
<td>96.67112</td>
<td></td>
<td></td>
<td>Grasses</td>
<td>Mud</td>
<td>River</td>
</tr>
</tbody>
</table>
Table 2. Occurrences of each species of aquatic snail found in a survey of several ecoregions of South Dakota in 2008. Comparisons of species richness are included for each region and additional comparisons of species found in other regions in surveys conducted in 2005 and 2006 are listed.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of sites found</th>
<th>Regions in which species were found</th>
<th>2005 study</th>
<th>2006 study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physa gyrina</td>
<td>19</td>
<td>Cornbelt NGP Agassiz Plains Middle Rockies Neb. Sandhills Rivers</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Gyraulus deflectus</td>
<td>10</td>
<td>Cornbelt NGP Agassiz Plains Middle Rockies Neb. Sandhills Rivers</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Lymnaea elodes</td>
<td>9</td>
<td>Cornbelt NGP Agassiz Plains Middle Rockies Neb. Sandhills Rivers</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Helisoma trivolvis</td>
<td>7</td>
<td>Cornbelt NGP Agassiz Plains Middle Rockies Neb. Sandhills Rivers</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Lymnaea caperata</td>
<td>6</td>
<td>Cornbelt NGP Agassiz Plains Middle Rockies Neb. Sandhills Rivers</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Aplexa elongata</td>
<td>6</td>
<td>Cornbelt NGP Agassiz Plains Middle Rockies Neb. Sandhills Rivers</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Promenetus exacuous</td>
<td>3</td>
<td>Cornbelt NGP Agassiz Plains Middle Rockies Neb. Sandhills Rivers</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Helisoma anceps</td>
<td>2</td>
<td>Cornbelt NGP Agassiz Plains Middle Rockies Neb. Sandhills Rivers</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Laevapex fuscus</td>
<td>2</td>
<td>Cornbelt NGP Agassiz Plains Middle Rockies Neb. Sandhills Rivers</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Campeloma decisum</td>
<td>1</td>
<td>Cornbelt NGP Agassiz Plains Middle Rockies Neb. Sandhills Rivers</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Lymnaea sp.</td>
<td>1</td>
<td>Cornbelt NGP Agassiz Plains Middle Rockies Neb. Sandhills Rivers</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Physa sp. A</td>
<td>1</td>
<td>Cornbelt NGP Agassiz Plains Middle Rockies Neb. Sandhills Rivers</td>
<td>✓ ✓ ✓ ✓ ✓ ✓</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
</tbody>
</table>

Total species by region: 5 7 3 7 2 6 8 8

Additional Species found in 2005 and 2006:
- P. acuta
- V. tricarinata
- L. stagnalis
- A. limosa
Figure 1. Circles represent survey locations within South Dakota. Filled circles (●) denote sites where snails were found, open circles (○) are sample sites where no snails were discovered. The survey concentrated on ecoregions not recently sampled and included the Western Cornbelt Plains, the Lake Agassiz Basin, the Nebraska Sand Hills and the Middle Rockies (Black Hills) ecoregions as well as three larger areas on the eastern side of the state: the Vermillion, the Big Sioux and the James. The approximate boundaries of the Cornbelt (SE corner), and the lower elevations of the Northern Glaciated Plains which bleed into the Agassiz Basin (NE corner) and Black Hills (West) ecoregions are shown with shading.
Figure 2. Filled circles (●) donate survey locations within South Dakota where *Physa gyrina* was found. The approximate boundaries of the sample areas, the Cornbelt (SE corner), and the lower elevations of The Northern Glaciated Plains which bleed into the Agassiz Basin (NE corner) and Black Hills (West) ecoregions, are shown with shading.

Figure 3. Filled circles (●) donate locations within South Dakota where *Gyraulus deflectus* was found. The approximate boundaries of the sample areas, the Cornbelt (SE corner), and the lower elevations of The Northern Glaciated Plains which bleed into the Agassiz Basin (NE corner) and Black Hills (West) ecoregions, are shown with shading.
Figure 4. Filled circles (●) donate survey locations within South Dakota where Lymnaea elodes was found. The approximate boundaries of the sample areas, the Cornbelt (SE corner), and the lower elevations of The Northern Glaciated Plains which bleed into the Agassiz Basin (NE corner) and Black Hills (West) ecoregions, are shown with shading.

Figure 5. Filled circles (●) donate survey locations within South Dakota where Helisoma trivolvis was found. The approximate boundaries of the sample areas, the Cornbelt (SE corner), and the lower elevations of The Northern Glaciated Plains which bleed into the Agassiz Basin (NE corner) and Black Hills (West) ecoregions, are shown with shading.
Figure 6. Filled circles (●) donate survey locations within South Dakota where Lymnaea caperata was found. The approximate boundaries of the sample areas, Cornbelt (SE corner), and the lower elevations of The Northern Glaciated Plains which bleed into the Agassiz Basin (NE corner) and Black Hills (West) ecoregions, are shown with shading.

Figure 7. Filled circles (●) donate survey locations within South Dakota where Aplexa elongata was found. The approximate boundaries of the sample areas, Cornbelt (SE corner), and the lower elevations of The Northern Glaciated Plains which bleed into the Agassiz Basin (NE corner) and Black Hills (West) ecoregions, are shown with shading.
Figure 8. Filled circles (●) donate survey locations within South Dakota where *Promenetus exacuous* was found. The approximate boundaries of the Cornbelt (SE corner), and the lower elevations of The Northern Glaciated Plains which bleed into the Agassiz Basin (NE corner) and Black Hills (West) ecoregions are shown with shading.

Figure 9. Filled circles (●) donate survey locations within South Dakota where *Helisoma anceps* was found. The approximate boundaries of the sample areas, the Cornbelt (SE corner), and the lower elevations of The Northern Glaciated Plains which bleed into the Agassiz Basin (NE corner) and Black Hills (West) ecoregions are shown with shading.
Figure 10. Filled circles (●) donate survey locations within South Dakota where *Leavesper fuscus* was found. The approximate boundaries of the sample areas, Cornbelt (SE corner), and the lower elevations of The Northern Glaciated Plains which bleed into the Agassiz Basin (NE corner) and Black Hills (West) ecoregions, are shown with shading.

Figure 11. Filled circles (●) donate survey locations within South Dakota where *Campeloma descisum* was found. The approximate boundaries of the sample areas, Cornbelt (SE corner), and the lower elevations of The Northern Glaciated Plains which bleed into the Agassiz Basin (NE corner) and Black Hills (West) ecoregions, are shown with shading.
Figure 12. Filled circles (●) donate survey locations within South Dakota where Lymnaea sp. was found. The approximate boundaries of the Cornbelt (SE corner), and the lower elevations of The Northern Glaciated Plains which bleed into the Agassiz Basin (NE corner) and Black Hills (West) ecoregions are shown with shading.

Figure 13. Filled circles (●) donate survey locations within South Dakota where Physa species A. was found. The approximate boundaries of the sample areas, the Cornbelt (SE corner), and the lower elevations of The Northern Glaciated Plains which bleed into the Agassiz Basin (NE corner) and Black Hills (West) ecoregions, are shown with shading.