ATTACHMENT E

Minnesota Department of Natural Resources

Marsh Lake Ecosystem Restoration Project

Lower Pomme de Terre River Channel Restoration

Pre-Project Mussel Surveys (2007 and 2010)

Lower Pomme de Terre River Channel Restoration – Pre-project Mussel Surveys, 2007 and 2010

Introduction

Currently, the channelized lower Pomme de Terre River flows into Marsh Lake flowing a short distance to the overflow spillway at Marsh Lake Dam. Bed sediment has been depositing a delta in Marsh Lake, and the suspended sediment flows into the Minnesota River and on into Lac qui Parle. Rerouting the lower Pomme de Terre River to its former channel and floodplain at the confluence with the Minnesota River downstream of Marsh Lake Dam (Figure 1) would restore natural floodplain processes. Sediment would be deposited overbank in the floodplain during higher discharge events. The Pomme de Terre River would be re-routed into its former channel in a meander loop upstream of Marsh Lake Dam and into the longer former channel downstream of the Marsh Lake Dam by constructing earthen cut-off dikes (Figure 1).

Pomme de Terre Realignment

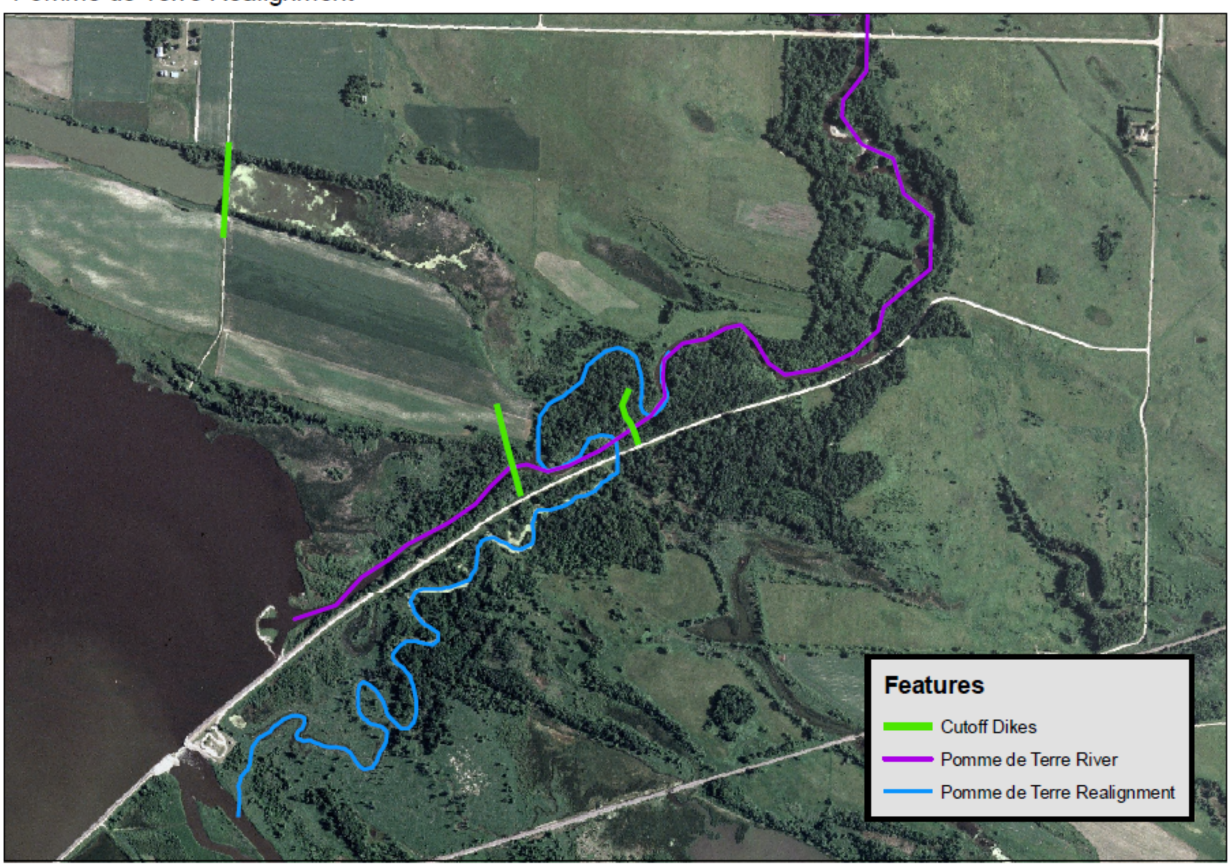


Figure 1. Lower Pomme de Terre River showing the current channelized reach cutoff dikes and proposed realignment with the historic channel.

The lower Pomme de Terre River supports an abundant and diverse mussel community. Mussels in the lower reach of the channelized Pomme de Terre River below the lower cut-off dike would no longer be in a flowing river and would probably die eventually. Mussels in the locations of the cut-off dikes would be buried. Mussels are expected to recolonize the reconnected segments of the old channel over time. Mussel surveys were designed to allow for monitoring the impact to mussels in the proposed cut off areas, the ongoing status of mussels in a reference area upstream of the channel realignments, and colonization of the reconnected channel segments that presently do not support mussels.

<u>Methods – timed searches</u>

In 2007 and 2010, timed searches for mussels were done at five sites within the area of channel to be cutoff during the project and five within a reference reach upstream of the proposed channel realignment (Figure 2).

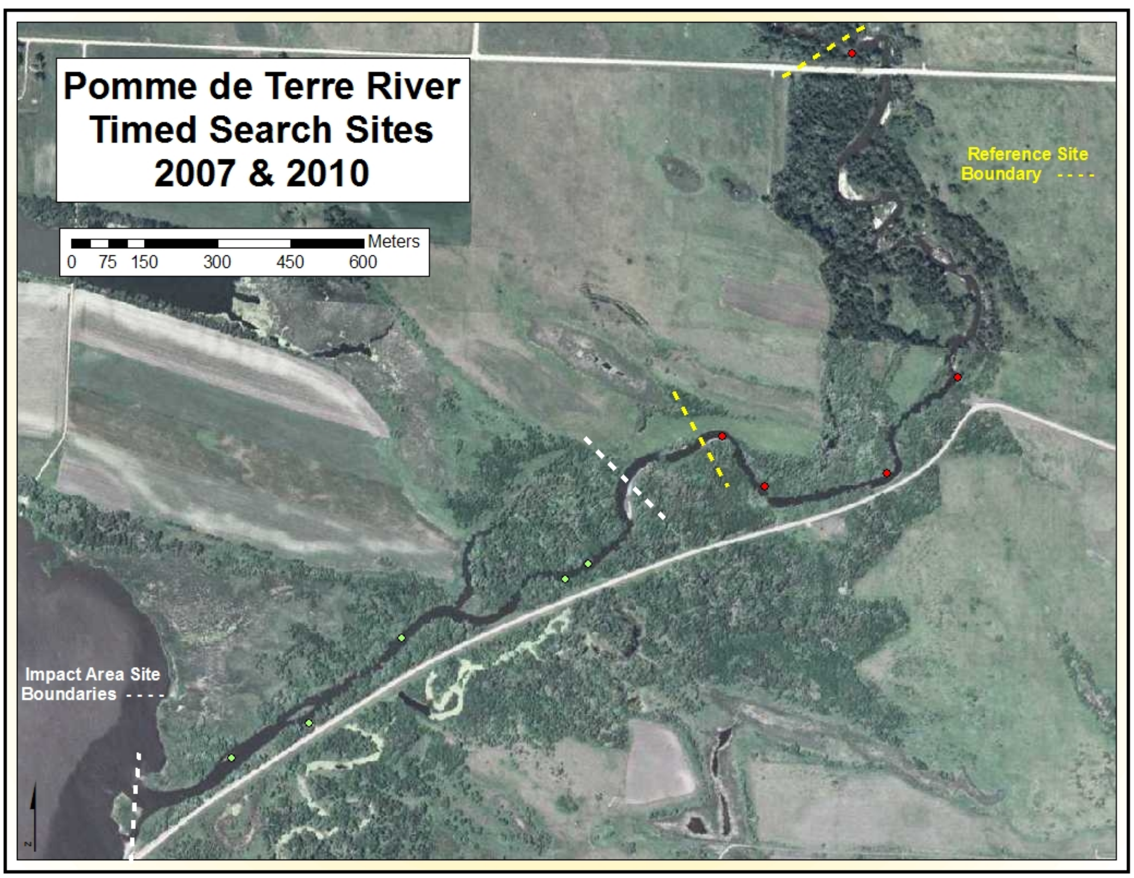


Figure 2. Timed search sample sites in the lower Pomme de Terre River.

Timed searches were conducted by wading, snorkeling or SCUBA diving. In turbid water like we encountered in the Pomme de Terre, searching is mostly by feel with the searcher sweeping the bottom surface and digging into the substrate a few centimeters to find mussels. After a period of time, usually 20-30 minutes for each person searching, all live mussels and empty shells collected are brought to shore and sorted and enumerated by species. Catch Per Unit Effort (CPUE) is calculated for each site by dividing the number of live mussels collected by the time spent searching. Each species is then sorted into two age categories; ≤5 years and >5 years. For each species collected the minimum and maximum lengths represented in each age category is recorded. Species collected only as empty shells were recorded as fresh dead, weathered dead, or in sub-fossil condition. All live mussels were returned to the river by scattering them within the collection area.

Methods – quantitative sampling

We used a systematic sampling approach with a random start for quantitative sampling. Systematic sample sites form a grid pattern that eliminates the potential for odd clustered groups of sample sites that are common with simple random sampling plans (Cochran 1977). When establishing a grid using ArcMap software it often will include sample sites that are not actually in the target area (a meandered river channel), these are eliminated from actual sampling as needed during the field work. Figure 3 shows the quantitative sampling sites on the Pomme de Terre River.

Samples are collected using a ¼ m^2 aluminum frame with a 6.35 mm square mesh bag attached. Each quadrat sample site is located by navigating with a GPS unit programmed with the systematic grid of sites to be sampled. Upon reaching the coordinates of a site the sample frame is dropped to the bottom and the material within the frame is scooped into the attached bag, excavation within the frame is to a depth of approximately 15 cm. When the excavation of bottom material is complete the frame and bag are rinsed in the water to remove material smaller than 6.35mm. Any remaining material is placed on a sorting platform where any mussels or shells are removed, species identified, aged by counting growth arrest rings (assumed to be annual), and total length recorded to the nearest millimeter using a caliper. Samples collected in this way are assumed to be free of the bias that samples collected by sight or touch would introduce, sometimes producing different results in terms of species relative abundance (small species may be under sampled when search methods depend on the collectors skills and experience) or size distributions within a species' population.

Data was collected from 97 quadrat samples within the impact area and 141 samples within the reference area (Figure 3). To estimate the surface area of the river in each area a polygon was created by tracing the shoreline in 2009 aerial photo using ArcMap to calculate the area in square meters.

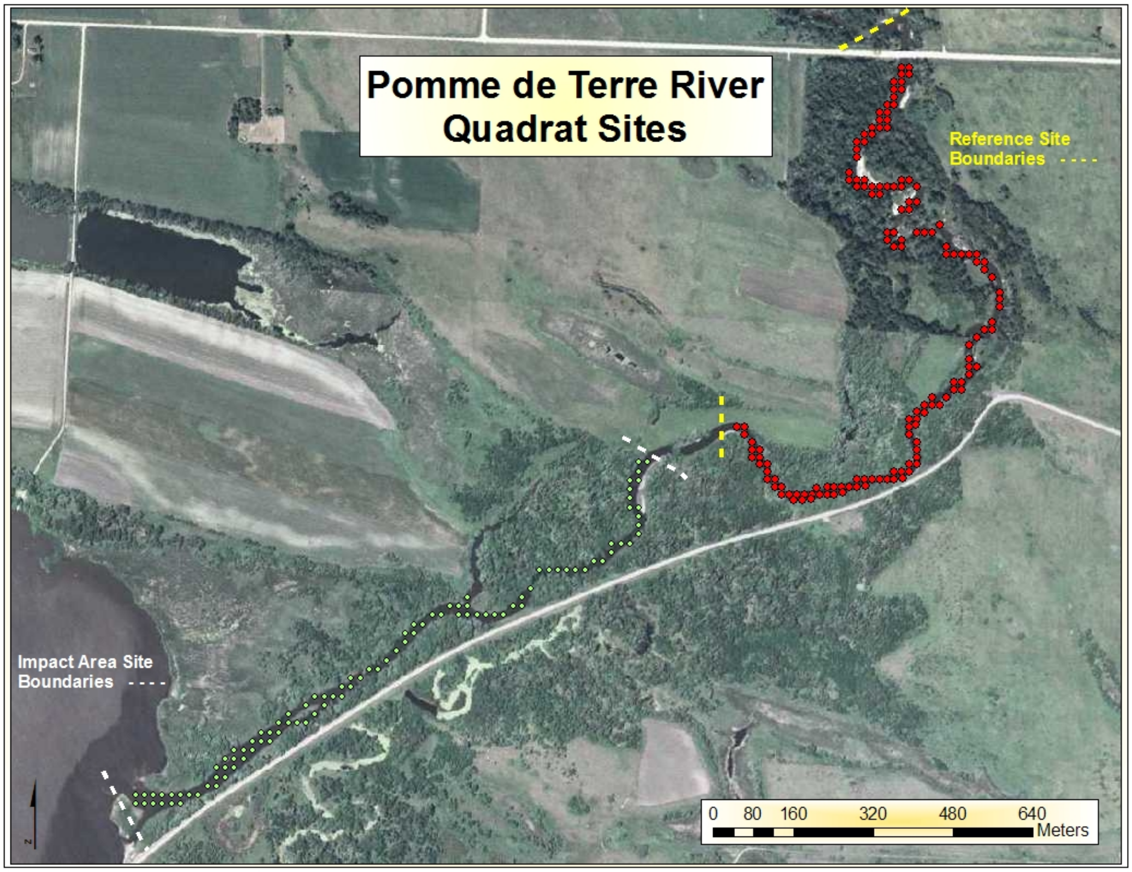


Figure 3. Quantitative sample sites in the lower Pomme de Terre River.

Results – timed searches

Timed searches in the impact area produced 1,457 live mussels representing 11 species (Table 1), including *Ligumia recta* (black sandshell) a species of Special Concern in Minnesota that was collected at all 10 timed search sites. *Amblema plicata* (threeridge) was the species collected in greatest abundance. CPUE in the impact area ranged from a low of 0.8 mussels/minute to a high of 6.12 mussels/minute (Figure 4.).

Impact area

Species	Number

	Found Live
Threeridge	
Amblema plicata	938
Plain Pocketbook	
Lampsilis cardium	162
Deertoe	
Truncilla truncata	117
Fat Mucket	
Lampsilis siliquoidea	96
Pigtoe	
Fusconaia flava	51
Black Sandshell	
Ligumia recta	33
Pink Heelsplitter	
Potamilus alatus	21
White Heelsplitter	
Lasmigona complanata	18
Fragile Papershell	
Leptodea fragilis	16
Giant Floater	
Pyganodon grandis	3
Creeper	
Strophitus undulatus	2
Grand Total	**1,457**

Table 1. Relative abundance of mussel species collected during timed searches in the Lower Pomme de Terrre impact area.

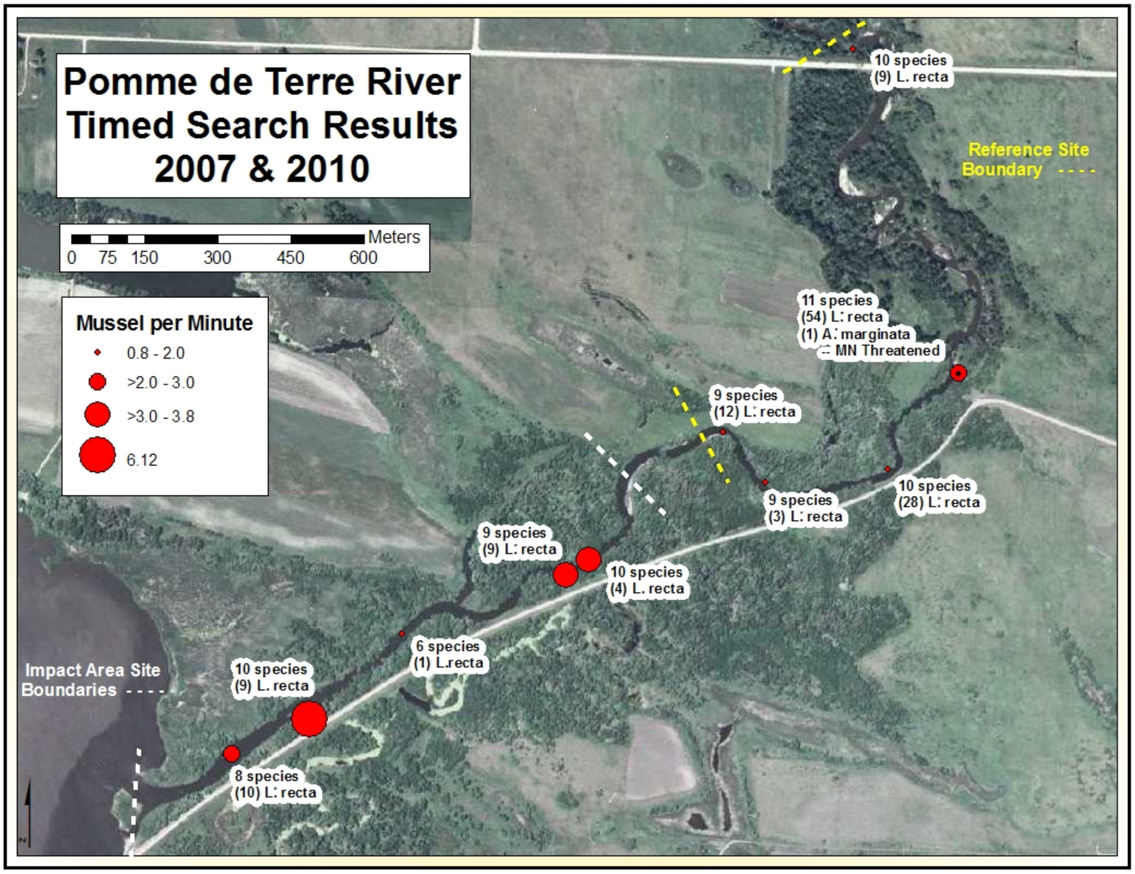


Figure 4. Timed search results in the Pomme de Terre River.

Timed searches in the reference area produced a total of 1,037 live mussels representing 11 species including *Alasmidonta marginata* (elktoe) a state Threatened species and *Ligumia recta* (black sandshell) a state species of Special Concern (Table 2).

Reference Area

Species	**Number Found Live**
Plain Pocketbook	
Lampsilis cardium	412
Threeridge	
Amblema plicata	285
Black Sandshell	
Ligumia recta	106
Fat Mucket	
Lampsilis siliquoidea	88
Pigtoe	
Fusconaia flava	46

Deertoe	
Truncilla truncata	45
Pink Heelsplitter	
Potamilus alatus	20
Creeper	
Strophitus undulatus	13
Fragile Papershell	
Leptodea fragilis	13
White Heelsplitter	
Lasmigona complanata	8
Elktoe	
Alasmidonta marginata	1
Grand Total	**1037**

Table 2. Timed search results in the reference area, lower Pomme de Terre River.

CPUE at sites within the reference area were lower with a maximum of 3.76 mussels/minute (Figure 4).

Results – Quadrat sampling

Data were recorded from 97 ¼ M^2 quadrats within the impact area (Figure 3). Fifty-two live mussels representing 8 species were collected. *Truncilla truncata* (deertoe) was the most abundant species found in quadrat samples within the impact area (Table 3). A single specimen of the state Threatened elktoe mussel was collected during this sampling. Density in live mussels/M^2 is estimated by dividing the number of live mussels by the number of samples and dividing the result by the fraction of a square meter sampled (¼ $M^{2)}$. In this case (52 live mussels/97 samples)/(1/4 M^2 /sample) = 2.14 live mussels/M^2. Using the estimated area of the sampled river reach the mussel population can be estimated by multiplying the density by the area; in the impact area (2.14 live mussels/M^2)(33,330 M^2 impact area) = 71,470 live mussels/impact area (Table 4).

Impact Area	
Species	**Number Found Live**
Deertoe	
Truncilla truncata	27
Plain Pocketbook	
Lampsilis cardium	9
Threeridge	
Amblema plicata	7
Fragile Papershell	
Leptodea fragilis	2
Wabash Pigtoe	
Fusconaia flava	2
Creeper	
Strophitus undulatus	2
Fat Mucket	
Lampsilis siliquoidea	2
Elktoe (Threatened)	
Alasmidonta marginata	1
Grand Total	**52**

Table 3. Species abundance from quadrat results in impact area.

Impact Area		Population Estimate
Mean(no/m^2)	2.103093	70,096.1
SD	3.790021	
SE	0.384818	
95%UCL (Upper Confidence Limit)	2.857337	95,235.0
95%LCL (Lower Confidence Limit)	1.348849	44,957.1

Table 4. Population estimate for Impact Area.

Data were recorded from 141 ¼ M^2 quadrats within the reference area (Figure 3). Forty one live mussels were found representing 8 species including the state species of Special Concern black sandshell. Relative abundance of mussel species collected in the reference area differed from the impact area in that *Lampsilis cardium* (pocketbook) was the most abundant species. (Table 4).

Density of live mussels was (41 live mussels/141 samples)/(1/4 M^2 /sample) = 1.16/M^2 From the mussel density and estimated size of the reference area, the number of live mussels occupying the reference area is (1.16 live mussels/M^2)(34,030 M^2 impact area) = 39,581 live mussels (Table 5).

Reference Collection Area	
Species	**Number Found Live**
Plain Pocketbook	
Lampsilis cardium	16
Threeridge	
Amblema plicata	9
Deertoe	
Truncilla truncata	7
Black Sandshell (Special Concern)	
Ligumia recta	3
Wabash Pigtoe	
Fusconaia flava	2
Fat Mucket	
Lampsilis siliquoidea	2
Pink Heelsplitter	
Potamilus alatus	1
Fragile Papershell	
Leptodea fragilis	1
Grand Total	**41**

Table 5. Quadrat results from Reference area.

Reference Area	Density	Population Estimate
Mean(no/m^2)	1.163120567	39,580.99291
SD	1.943355938	
SE	0.163660094	
95%UCL (Upper Confidence Limit)	1.483894351	50,496.92476
95%LCL (Lower Confidence Limit)	0.842346784	28,665.06105

Table 6. Population estimate for Reference Area

Twelve species of live mussels were collected by all sampling methods during these surveys and a single species was collected only as a weathered dead shell at a single site, *Anodontoides ferussacianus* (cylinder mussel), a species typically found in headwaters creeks.

Populations of the three most abundant mussel species (deertoe, pocketbook and threeridge) varied in age distribution by area (Figure 7). Most notably there was considerable evidence for ongoing recruitment of deertoe in the impact area but very little in the reference area and no evidence for recent recruitment of threeridge in the impact area.

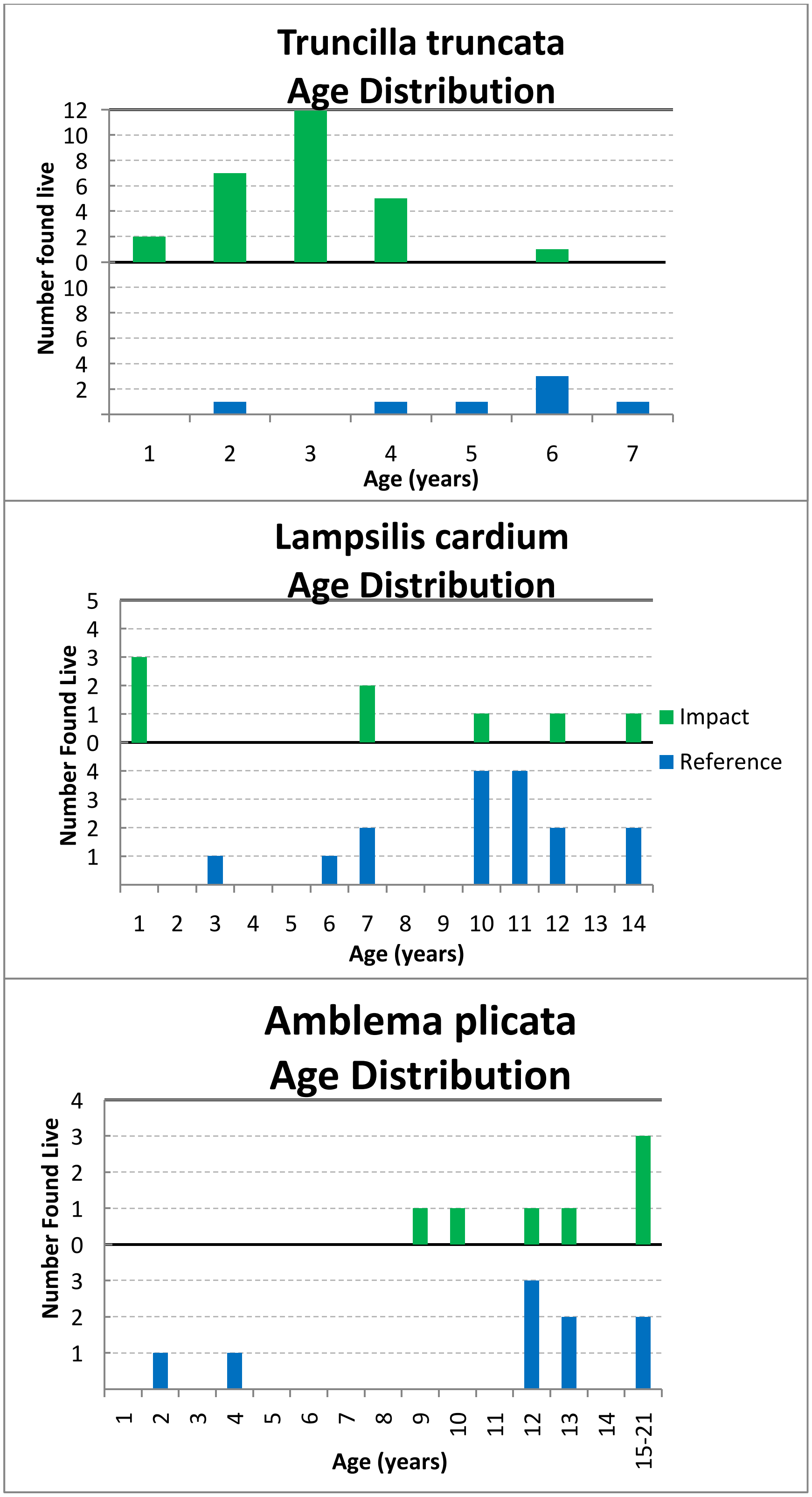


Figure 7. Age distribution of the three most abundant mussel species in the lower Pomme de Terre River from quadrat data.

Discussion

Physical habitat within the two areas differed in that the impact area appeared to be more stable as the river neared Marsh Lake and the river's delta. Stability and the predominance of firm sandy substrate (Figure 6) may favor the establishment of mussel populations. In the reference area the channel appeared to be quite unstable, with actively eroding outside bends, and had recently abandoned some channel segments while forming new channels though the floodplain forest. Many trees were in the process of being washed into the river often making it difficult to traverse. Substrate in the reference area appeared to be unstable and freshly deposited, even gravel and cobble deposits were soft and easily penetrated when traversed on foot. Quantitative data on the hydrogeomorphic characteristics of these two areas were not available for comparison at the time of this report.

Mussels were considerably more abundant in the impact area than in the reference area (density of 2.12 vs. 1.16). Relative abundance of the top three species collected during surveys also differed with deertoe mussels the most abundant in the impact area and pocketbook mussels most abundant in the reference area (Figure 5). It is likely that the estimated 70,000 mussels in the impact area will be adversely affected by the channel rerouting that will cut off Pomme de Terre River flows. These affects will depend on the final restoration plan but could result in the loss of most or all of the existing mussel population in the cutoff channels. Options for mitigating the loss of existing mussels could range from no action and accepting loss to translocation of some mussels, or provision of a minimum flow into the cutoff channels through the cutoff dikes. It is hypothesized that the reconnected former river channel will be colonized by mussels recruited from upstream and from the Minnesota River below the Marsh Lake Dam, replacing any loss of mussels from the impact area over time.

Future surveys within the impact area will document any changes that occur in the existing mussel population. Reference area sampling in the future will serve as an index to changes in the mussels that may be unrelated to this project. Sampling within the reconnected channel will be done in years following project completion and accomplished using comparable methods to determine the rate of mussel recolonization.

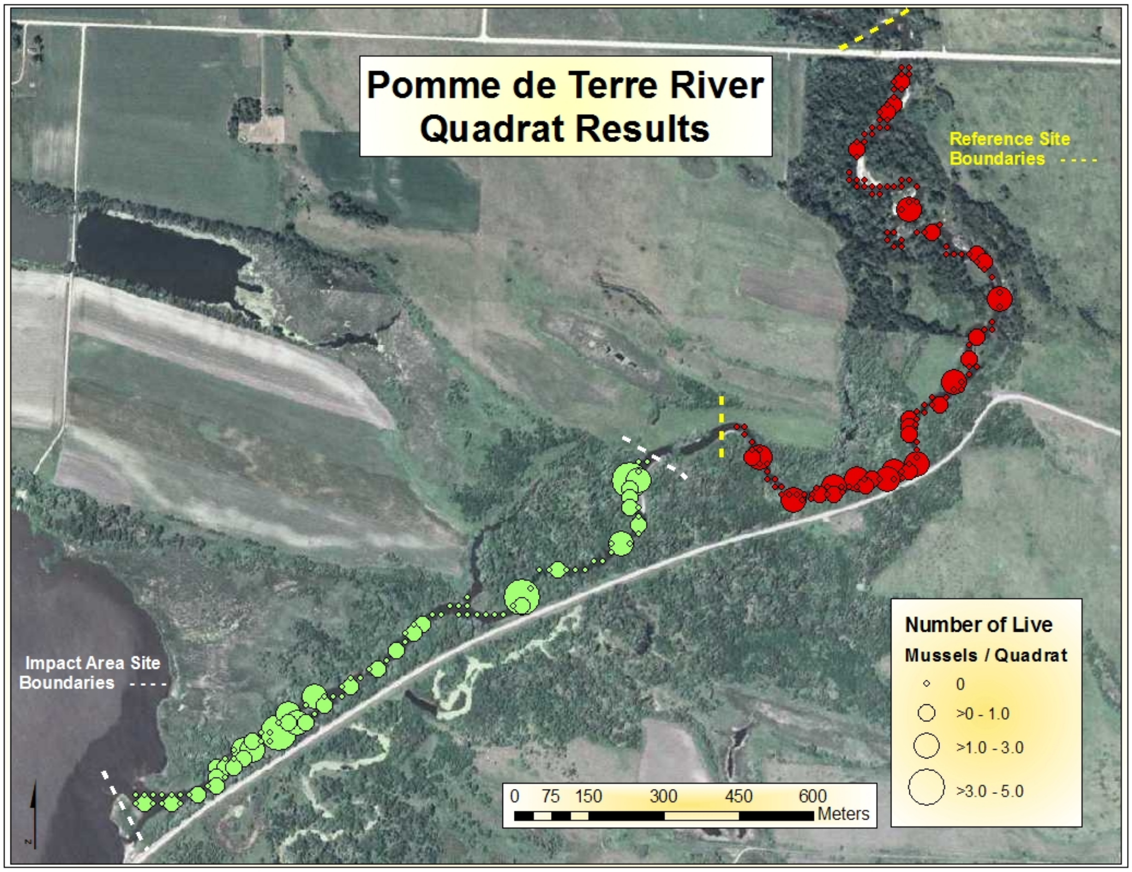
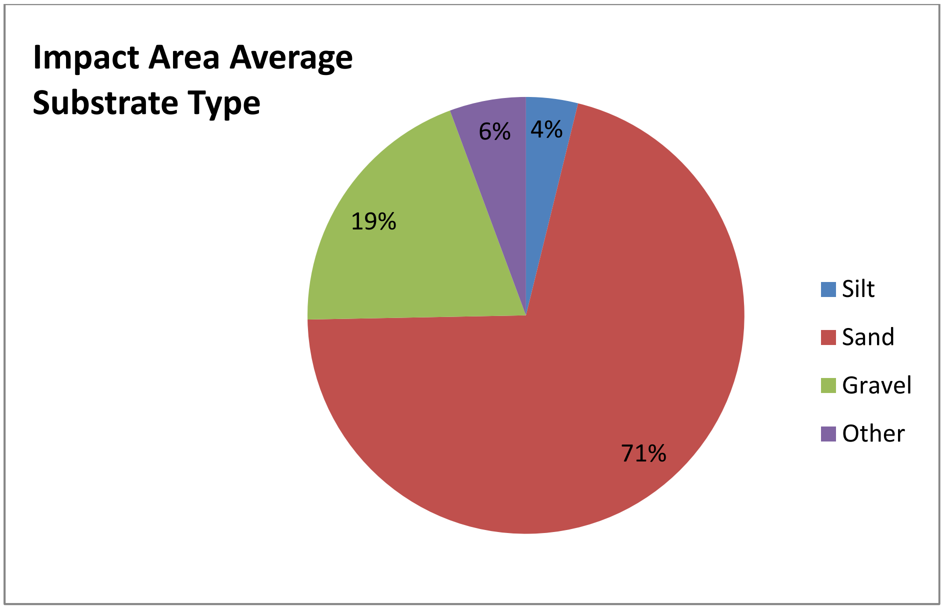


Figure 5. Abundance of live mussels collected in quadrat sample s in the impact and reference areas.



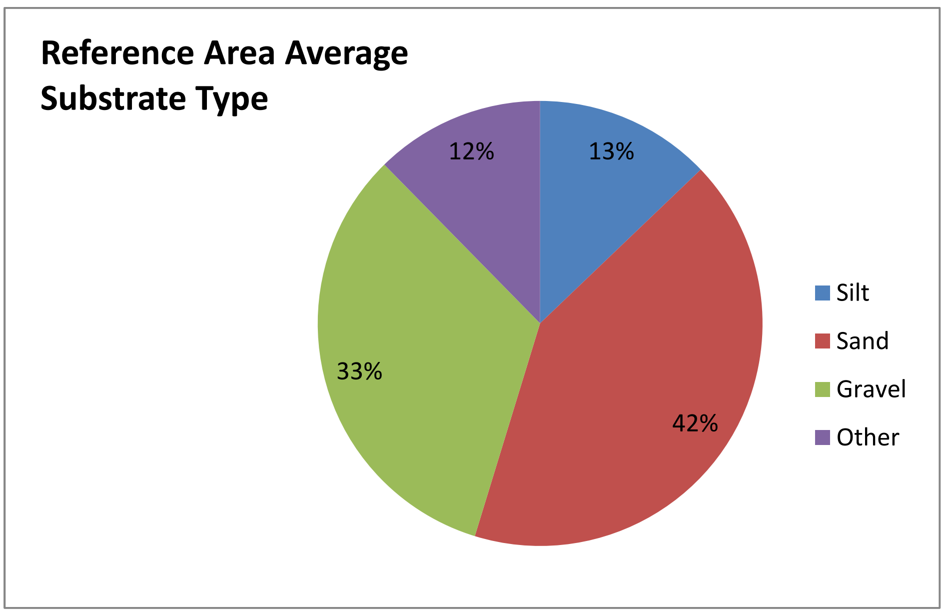


Figure 6. Distribution of substrate types estimated at quadrat sites.

References: Cochran W.G. 1977. *Sampling Techniques. Wiley series in probability and mathematical statistics-applied. John Wiley and Sons. New York.*