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Status of Freshwater Unionid Populations at Pictured Rocks National Lakeshore- 1999-2000

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INTRODUCTION

Unionid mussels (freshwater clams) are the most endangered group of animals in North American (Williams et al. 1993). North America has the largest diversity of unionids in the world (Metcalfe-Smith et al. 1998), and most of these are located in the Midwestern region of the United States**.** When compared to historical populations, many streams in eastern North America now possess depauperate mussel fauna. Williams et al. (1993) listed 297 species of native freshwater mussels in the United States and Canada. Of these, 213 species (71.7%) are considered endangered, threatened, or of special concern. Many of these species, 51 in the United States, are listed as endangered, and more are under review.

Unionid populations are declining due to a number of factors relating to habitat alteration and human interference. Problems stem from changes in physical habitat such as increased siltation, sedimentation and channelization; changes in water quality due to increased pollution such as heavy metals, radionucleides, pesticides, human and feed lot wastes, mining wastes, acid runoff; and harvesting for shell and pearls (Turner and Rabalais 1994, Schloesser et al. 1996). The increased spread of exotic species (i.e., the zebra mussel), have placed additional stress on fragile populations, causing major extirpations of all unionid species in many regions (Schloesser and Nalepa 1994, Strayer and Smith 1996). Perturbations of communities have caused resource managers to recognize the need for a transition from management of individual species to community management approaches (Christie et al. 1987; Evans and Waring 1987; Steedman and Regier 1987). Holistic management of communities has been hampered by lack of information on community structure, which is particularly scarce for unionid mussels. Managing mussel communities in any habitat requires describing each community, defining objectives for the structure of each community, and developing a means of measuring progress toward achievement of these goals. The goal of this project is to determine the population structure (distribution and diversity) and current status of native unionid mussel species at a number of national parks along the Great Lakes, beginning with Picture Rocks National Lakeshore.

Objectives:

1. What unionid and other easily identified species of bivalves are present in the lakes and streams of PIRO?
2. At all sites sampled, what is the abundance classification of each species (rare, common, or very abundant)?
3. At these same sites, which species fall into quickly ascertainable age classifications (i.e., juvenile, adult) based on size? Which species are actively recruiting?
4. What is the overall status of the population- stable, marginal, or at-risk?
5. With certain caveats, at these same sites, which of the unionid and other bivalve species fall into classifications such as native, non-native, pollution/disturbance tolerant or intolerant, rare, ecological sentinel species, or undesirable species?
6. What are the key environmental variables at each habitat sampled and are specific unionid communities associated with certain variables? Variables to be considered will be such things as which fish and other aquatic organisms are present in the same area, type of substrate, dissolved oxygen, total calcium, pH, secchi depth, water depth, and water velocity.
7. What is the quantity of each species present based on randomized quadrats or transects?
8. What is the annual incremental increase in shell length, or growth rate, for each species (based on dead shell- may not be possible for all species or for any endangered species)?
9. What proportion of the population sampled is composed of individual unionids <5years of age?
10. What is the amount and type of chemical contaminant present per gm of soft body tissue for each species sampled? This will be a limited survey designed to locate impacted areas where further study would be warranted.

11. Management, regulatory, or additional study decisions or potential actions that might hinge on the results of the study include deciding:

1) Are unionid and other bivalve populations in various PIRO lakes in good shape, under stress, or at risk based on current status?
2) What type of long term monitoring of unionids and other bivalves is needed (if any) to keep an eye on trends?
3) Should we try to eradicate or otherwise manage non-native bivalve species, hosts, or other biota that might be threatening native bivalve species?

METHODS

The sampling program in PIRO included initial visual scouting of rivers and lakes in order to determine where unionids are presently located, followed by intensive sampling by SCUBA divers in waters where unionids are found. This intensive sampling involved qualitative and quantitative components using both stratified selection of sampling stations and totally randomly selection of sampling areas for comparison purposes. Details of the sampling regime can be found in the attached QAPP (Appendix 1). Table 1 presents the streams and lakes that were cursorily surveyed visually by scout team to find unionid locations.

Table 1. Bivalve distribution at the sites surveyed by scout team in Pictured Rocks National Lakeshore, 1999-2000.

SITE	UNIONIDS	SPHAERIDS[1]	EXOTICS[2]
Big Beaver Lake*	present	present	none
Chapel Lake*	present	not determined	none
Grand Sable Lake*	present	none	none
Kingston Lake*	present	present	none
Little Beaver Lake*	present	present	none
Miner's Lake	none	present	none
Sevenmile Lake	none	none	none
Trapper's Lake	present	present	none
Beaver Creek	none	none	none
Hurricane River	none	none	none
Miner's Creek	none	none	none
Sable Creek	none	present	none
Sevenmile Creek	none	none	none

*Sites where clam density estimates were made (quantitatively sampled). [1] Sphaerid (fingernail clams) presence or absence provided as reference only- no further identifications were made. [2] Exotic bivalves = zebra mussels (*Dreissena polymorpha*), quagga mussels (*Dreissena bugensis*), or Asian clams (*Corbicula fluminea*).

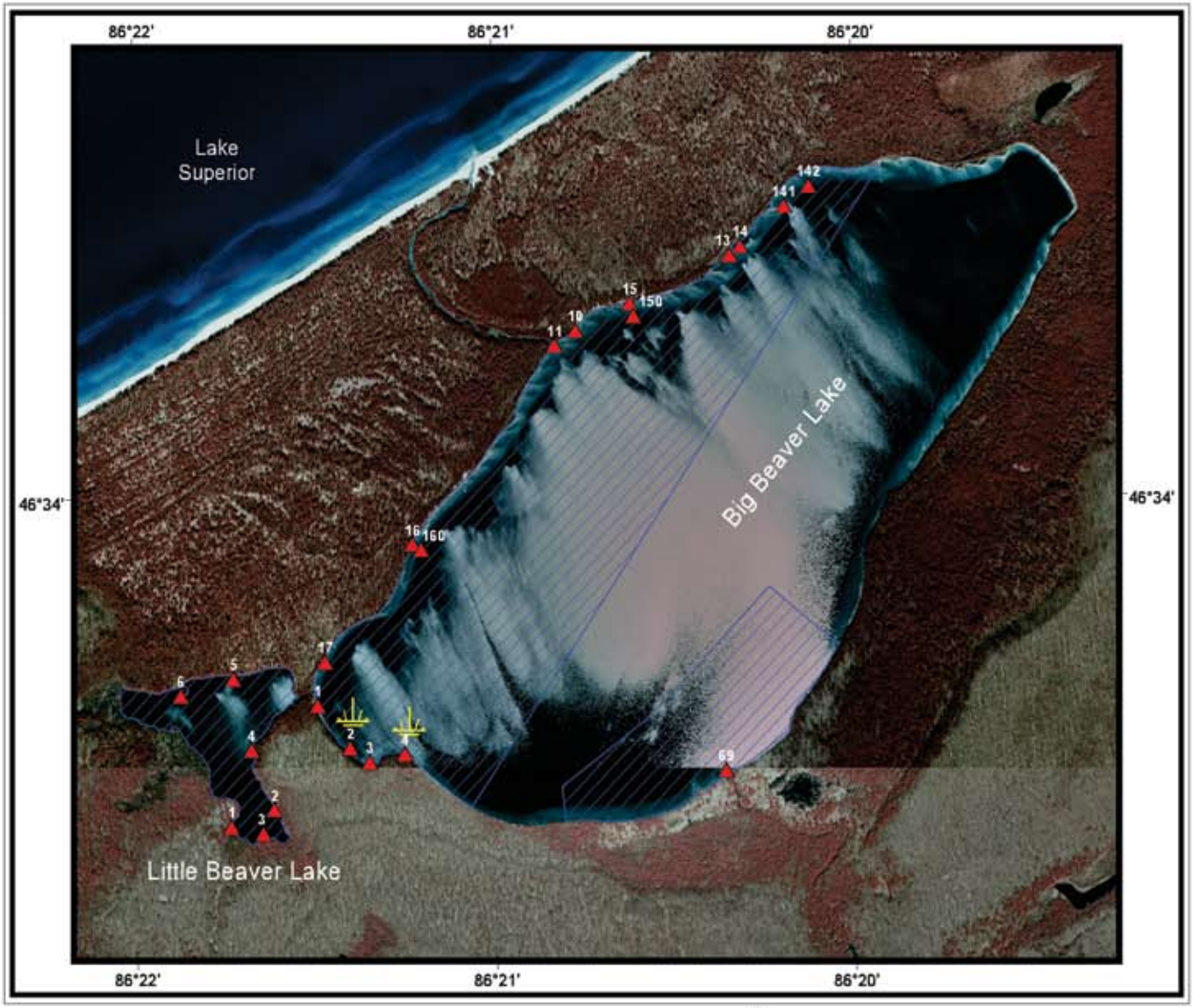
The location of quantitative samples, associated GPS coordinates, and further intensive diver surveys of unionid areas are presented in Figures 1-4. Polygon maps representing the surface area of each lake were constructed using "Arc/Info" (ESRI, Inc) Geographic Information Systems (GIS) software. Geospatially referenced, digital orthophotography images (US Geological Survey, Mid-Continent Mapping Center, 1992 and 1998) of each lake were obtained and used for digitizing of the shoreline, which provided whole lake areal calculations. GPS positions collected at each of the sample sites were then overlain on top of these surface area polygons. Based on interviews with the SCUBA divers, boundaries were then drawn on the surface polygon combining the sample point locations and the diver transects to determine the 'qualitative' survey areas. These boundaries were joined to the whole lake surface polygon to obtain the aerial calculations for the qualitative surveys and percent of the lake covered by these surveys.

The quantitative sampling involved testing several methods of selecting the site to be sampled by the SCUBA divers. In the first method, stratified sampling, sampling efforts (100 m^2 grids and the 0.25 m^2 excavated grids) were begun in areas where the divers had located existing clam populations and then in new stations based on habitat type, or set distance from starting point. In Chapel Lake we were forced to modify this technique because of the steep slope of the lake bottom. All transect locations were chosen randomly, and the grid size was reduced in order to maintain the entire grid inside the chosen depth zone. The grids used were 0.8m² and five were done within a 100m² area of substrate in each depth zone.

The second method, termed statistical sampling does not focus sampling efforts on known clam areas and removes any observational input from the divers. Random points were selected and the divers collected 1m^2 samples along transects off these points regardless of depth, thermocline, or clam location.

Site selection of sampling stations for the stratified samples relied on both distance and habitat. One-half of the sampling stations in each lake were selected based on distance- spaced either 10-minute (for smaller lakes) or 20-minute canoe journey apart. The second half of stations were selected based on different habitats to ensure that all habitat types present in each lake, (gravel, sand, emergent vegetation, submerged vegetation, creek outlets, etc.) were sampled. The number of stratified samples collected

Figure 1. Sample sites (1999) for Big and Little Beaver lakes, Pictured Rocks National Lakeshore



Legend

- Mussel sample location (Quantitative)
- Qualitative survey area (USGS - SCUBA)
- Large sponge location

Sample Location Information:

Sample Id#:	Latitude (N):	Longitude (W):
Big Beaver Lake:		
1	46° 33' 41.369"	86° 21' 29.691"
2	46° 33' 36.801"	86° 21' 24.329"
4	46° 33' 36.068"	86° 21' 15.241"
10	46° 34' 21.494"	86° 20' 46.247"
11	46° 34' 19.894"	86° 20' 49.758"
13	46° 34' 29.468"	86° 20' 20.419"
14	46° 34' 30.424"	86° 20' 18.670"
141	46° 34' 34.705"	86° 20' 11.348"
142	46° 34' 36.864"	86° 20' 7.195"
15	46° 34' 24.374"	86° 20' 37.151"
150	46° 34' 23.017"	86° 20' 36.526"
16	46° 33' 58.606"	86° 21' 13.705"
160	46° 33' 58.038"	86° 21' 12.310"
17	46° 33' 46.022"	86° 21' 28.445"
69	46° 33' 34.108"	86° 20' 21.537"
Little Beaver Lake:		
1	46° 33' 28.381"	86° 21' 44.250"
2	46° 33' 30.213"	86° 21' 37.040"
3	46° 33' 27.662"	86° 21' 38.918"
4	46° 33' 36.617"	86° 21' 40.848"
5	46° 33' 44.296"	86° 21' 43.751"
6	46° 33' 42.509"	86° 21' 52.551"

Digital Orthophotography data source:
US Geological Survey, Mid-Continent Mapping Center, 1998

Projection: UTM
North American Datum, 1983

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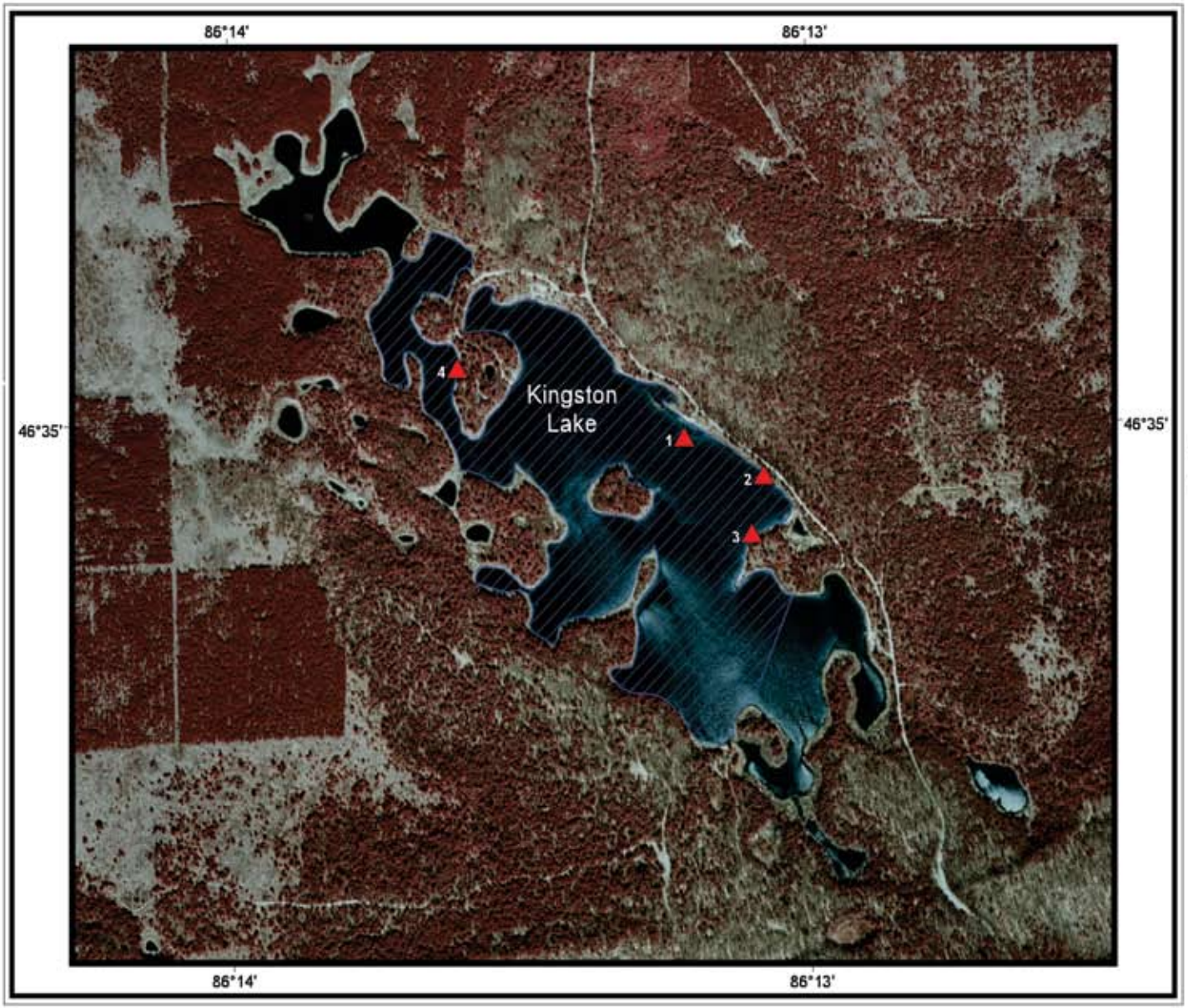
Figure 2. Sample Sites (1999) for Kingston Lake, Pictured Rocks National Lakeshore.



Legend

- Mussel sample location (Quantitative)
- Qualitative survey area (USGS - SCUBA)

Sample Location Information:

Sample ID#:	Latitude (N):	Longitude (W):
1	46° 35' 2.189"	86° 13' 12.292"
2	46° 34' 59.425"	86° 13' 3.489"
3	46° 34' 55.307"	86° 13' 4.872"
4	46° 35' 7.254"	86° 13' 37.448"

Digital Orthophotography data source:
US Geological Survey, Mid-Continent Mapping Center, 1998

Projection: UTM
North American Datum, 1983

0 0.25 0.5 0.75 1 Kilometers

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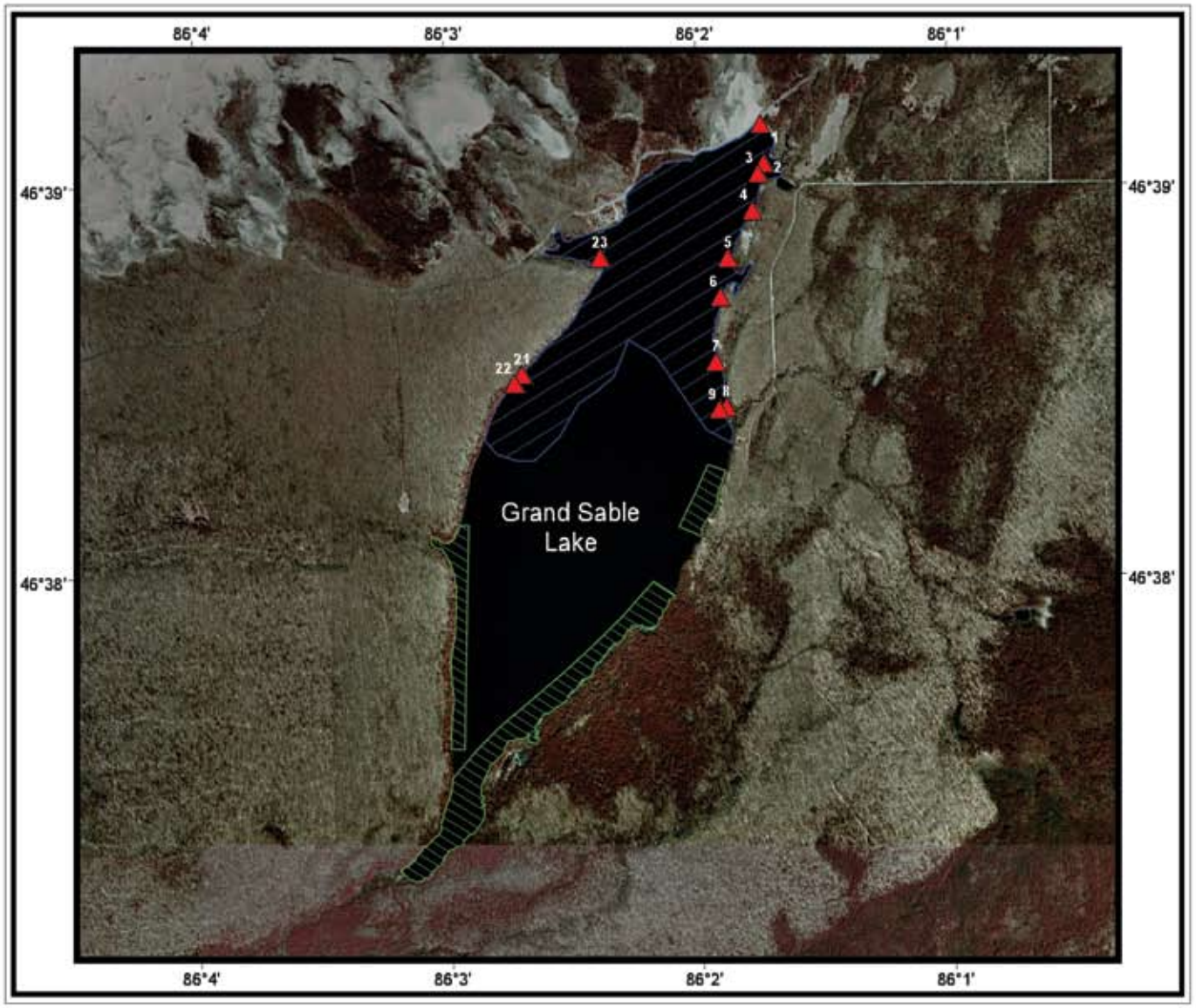
Figure 3. Sample Sites (1999) for Grand Sable Lake, Pictured Rocks National Lakeshore.



Legend

- Mussel sample location (Quantitative)
- Qualitative survey area (USGS - SCUBA)
- Qualitative survey area (Mr. Brian Carter)

Sample location information:

Sample ID#:	Latitude (N):	Longitude (W):
1	46° 39' 9.745"	86° 1' 44.553"
2	46° 39' 3.775"	86° 1' 43.988"
3	46° 39' 2.225"	86° 1' 45.348"
4	46° 38' 56.517"	86° 1' 46.674"
5	46° 38' 49.267"	86° 1' 52.733"
6	46° 38' 43.299"	86° 1' 54.627"
7	46° 38' 33.351"	86° 1' 55.849"
8	46° 38' 26.401"	86° 1' 53.463"
9	46° 38' 26.012"	86° 1' 55.222"
21	46° 38' 31.742"	86° 2' 42.200"
22	46° 38' 30.396"	86° 2' 43.982"
23	46° 38' 49.502"	86° 2' 23.263"

Digital Orthophoto image data source:
US Geological Survey, Mid-Continent Mapping Center, 1998

Projection: UTM
North American Datum, 1983

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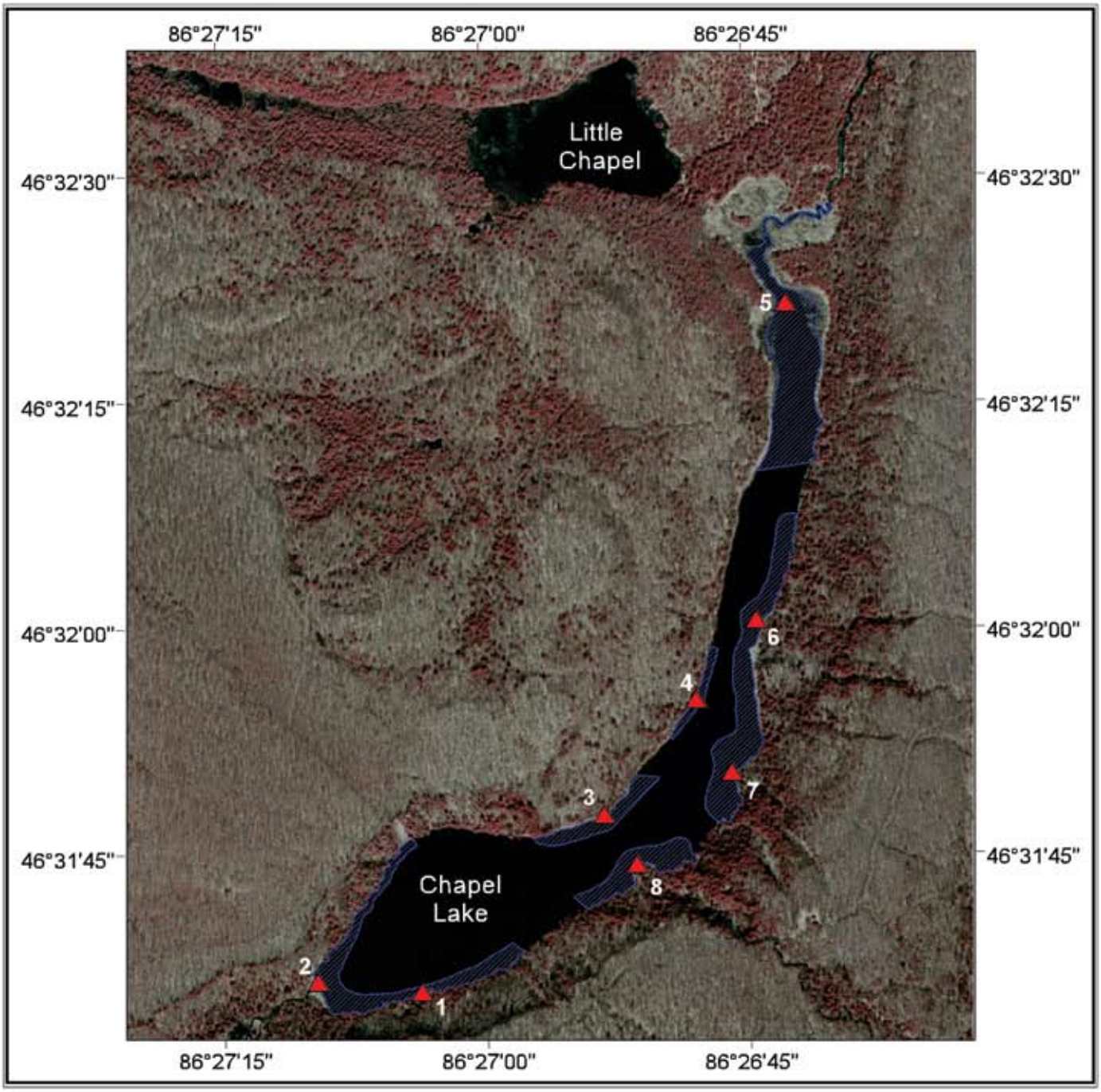
Figure 4. Sample Sites for Chapel Lake, Pictured Rocks National Lakeshore.



0 0.25 0.5 0.75 1 Kilometers

Legend

- Mussel sample location (Quantative)
- Qualitative survey area (USGS - SCUBA)

Sample Location Information:

Transect #:	Latitude (N):	Longitude (W):
1.	46° 31' 39.79"	86° 27' 08.35"
2..	46° 31' 40.44"	86° 27' 18.01"
3.	46° 31' 51.44"	86° 26' 51.39"
4.	46° 31' 59.10"	86° 26' 42.80"
5.	46° 32' 25.38"	86° 26' 34.27"
6.	46° 32' 04.37"	86° 26' 37.18"
7.	46° 31' 54.26"	86° 26' 39.54"
8.	46° 31' 48.18"	86° 26' 48.35"

Digital Orthography data source:
US Geological Survey, Mid-Continent Mapping Center, 2000

Projection: UTM (zone 16)
North American Datum, 1983

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in each lake varied in relation to lake morphometrics, habitat types, and unionid distribution. The numbers and locations of these samples are presented in Figures 1-4 and Table 3. Habitat descriptions of each sampling location are presented in Appendix 2. At each sample location, once the point along the shore was selected, the first 100 square meter grid was set. SCUBA divers searched the entire 100 square meter grid on a timed 15-minute/diver survey. The next 100 square meter grid was selected along a transect line leading from this point encompassing all depth gradients at 1.5 meter (5 ft.) intervals. All unionids found were collected and species type, shell length, sex (if shell dimorphic) gravidity, and any other characteristics noted for every animal. Except for a few representative animals, all unionids were returned to the substrate. In 10% of the grids, a few smaller, 0.25-m² areas were selected and excavated to a depth of 15 cm. Habitat information on features such as depth, fish, substrate type, vegetation, and temperature were recorded for each station and grid (Appendix 2)

The number and the location of the second series of stations and grids, referred to as 'statistical' samples are presented in Appendix 2, and Figures 1-4. This sampling protocol involved random selection of a compass heading, which was done by drawing a compass rose on the shore, and blindly tossing a pebble onto the rose and sampling off that heading. The divers followed this compass heading for 100 m regardless of depth. Quadrat (1 m^2) locations along this 100 m transect line were chosen every 30 kick-strokes (about every ten meters). Each quadrat (1 m^2) was fully excavated to a depth of at least 15 cm and all substrate material sieved. From three-five such transects per 90° on the compass rose were sampled. All unionids were handled as described above.

Population statistics included descriptive statistics (mean, median, quartile, range, etc.) as well as *t* tests, moving averages, and other statistical methods to analyze the abundance data (number of mussels/taxon/transect), comparisons between populations within a water body and water bodies and potential relationships to habitats. In addition to the basic statistics described above, we used ANCOVA, moving average (5-year grouping), and multivariate statistical methods to analyze abundance data (number of mussels/taxon/transect/grid).

Species identification was based on live shell and collected dead shell. Shell was taken to the mollusk departments at the University of Michigan, Ann Arbor, MI, and

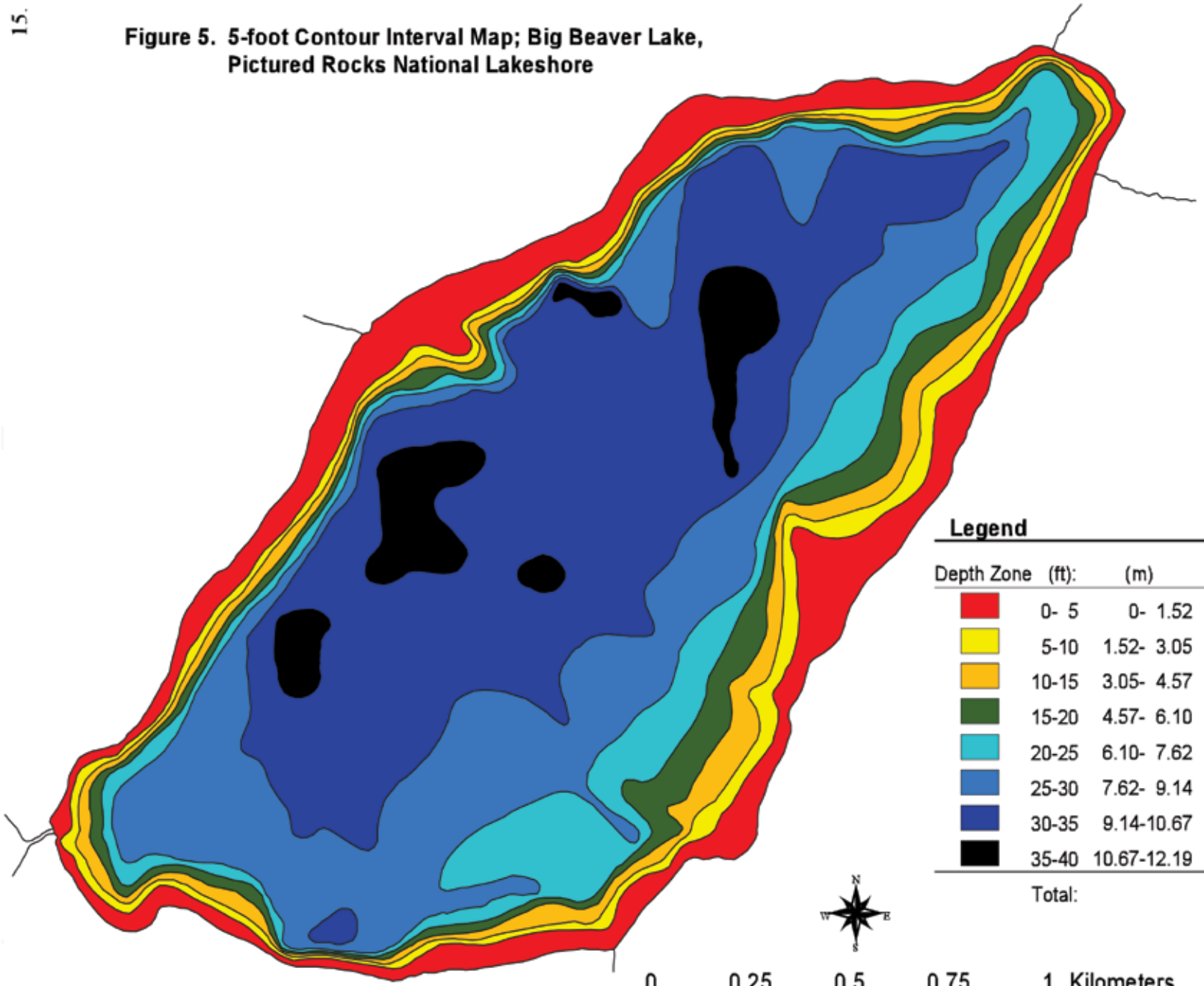
University of Ohio, Columbus Ohio, for verification of identification. Voucher specimens for each type of live shell found have been collected and will be submitted separately.

Estimates of age and growth rates for representative clams from each site were determined by examination of external annuli and by sectioning the shell on a line from the umbo to the ventral margin of the shell. The cut sections were sanded using a series of fine grade emery papers, followed by polishing with a felt wheel and jewelers rouge. The shell sections were then examined under a microscope. Internal annular rings were determined using techniques described in Tevesz and Carter (1980). Length and age frequencies were then plotted using a curvilinear regression. Comparisons between internal and external annuli (examination for non-annular external rings) were done according to the techniques described in Downing et al. (1992).

The amount and type of chemical contaminant present per gm of soft body tissue for each species sampled was determined for clams from each water body sampled. Individual clams were collected, placed on ice as quickly as possible and sent to the Great Lakes Science Center. There, soft tissues from each individual were removed from the shell and frozen at –40°F. The following contaminant array will be surveyed: pesticides including hexachlorobenzene, pentachlorobenzene, octachlorostryene, α- and γ-BHC, aldrin, dieldrin, endrin, α- and β-heptachlor epoxide, cis- and trans- nonachlors, p,p'- (DDE, DDD, and DDT), mirex (including 8-monohydro mirex), α- and γ-chlordanes, oxychlordane, toxaphenes (Cl 6 to Cl 10), dacthal, and pentachlorophenyl methyl ether; PCBs (80 congeners, including most of the planar dangerous ones) and mercury. Analysis techniques and QA/QC protocols are described in Schmidt (1997), Schmidt and Hesselberg (1992), and Wilford et al. (1973). Bathymetric data was used to track unionid distribution and these maps are presented in Figures 5-8.

Bathymetric maps, where available, were obtained as non-georeferenced paper maps. No bathymetric data is available for Kingston Lake. These maps were mostly based upon surveys conduced in the 1940's and 50's (MI DNR). Geo-referencing of these maps was accomplished by comparing significant, recognizable features such as stream/creek inlets, points, and bays to the digital orthophotography images of the corresponding lakes and extracting georeferenced data

Figure 5. 5-foot Contour Interval Map; Big Beaver Lake, Pictured Rocks National Lakeshore



Legend

Depth Zone	(ft):	(m)	Acres:	Hectares:
	0- 5	0- 1.52	102.59	41.52
	5-10	1.52- 3.05	38.44	15.56
	10-15	3.05- 4.57	43.68	17.68
	15-20	4.57- 6.10	47.27	19.13
	20-25	6.10- 7.62	79.84	32.31
	25-30	7.62- 9.14	172.64	69.86
	30-35	9.14-10.67	242.27	98.05
	35-40	10.67-12.19	36.22	14.66
	Total:		762.96	308.77

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0 0.25 0.5 0.75 1 Kilometers

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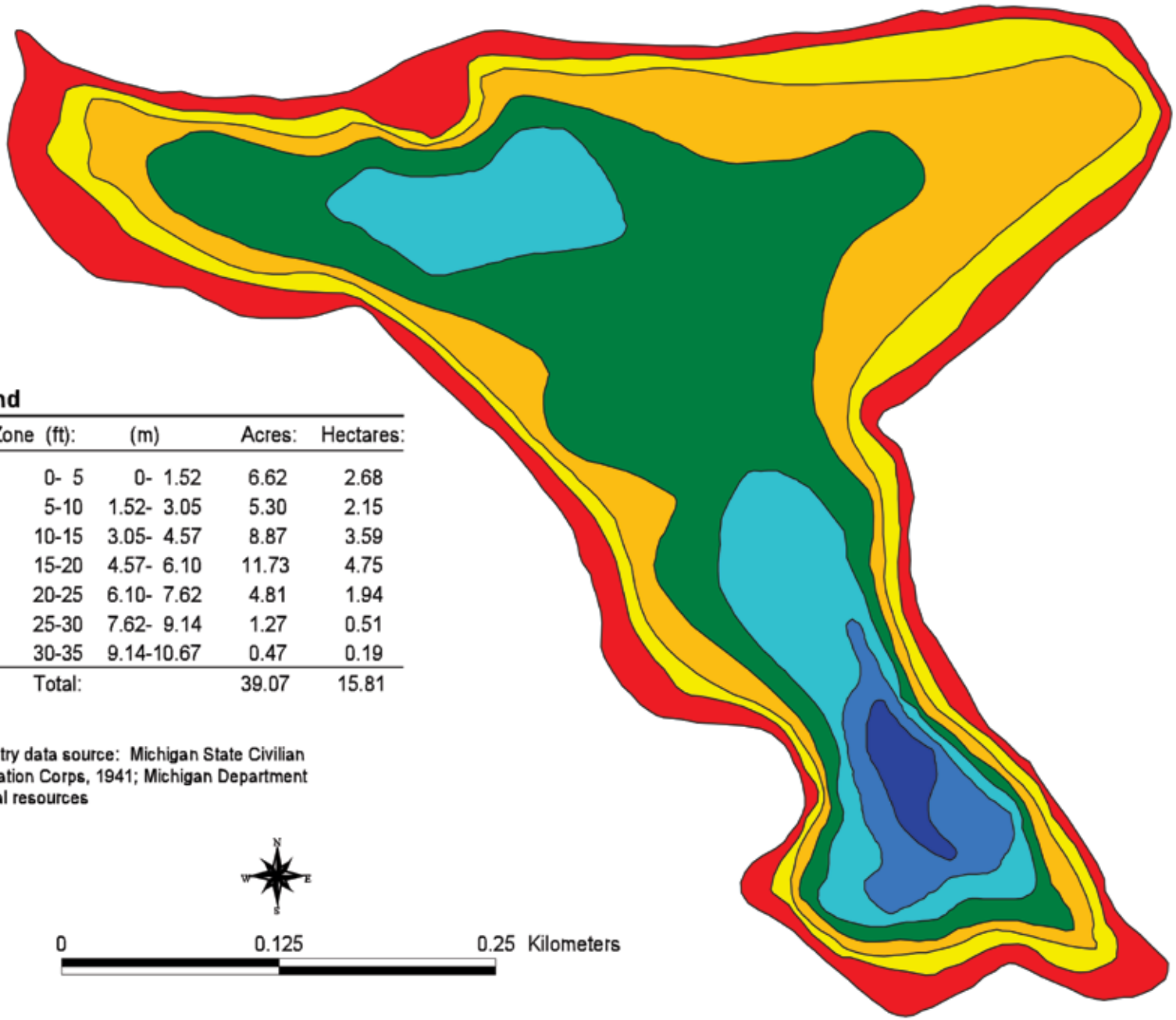
Bathymetry data source: Michigan State Civilian Concervation Corps, 1941; Michigan Department of Natural resources.

Figure 6. 5-foot Contour Interval Map; Little Beaver Lake, Pictured Rocks National Lakeshore



Legend

Depth Zone (ft):	(m)	Acres:	Hectares:
0- 5	0- 1.52	6.62	2.68
5-10	1.52- 3.05	5.30	2.15
10-15	3.05- 4.57	8.87	3.59
15-20	4.57- 6.10	11.73	4.75
20-25	6.10- 7.62	4.81	1.94
25-30	7.62- 9.14	1.27	0.51
30-35	9.14-10.67	0.47	0.19
Total:		39.07	15.81

Bathymetry data source: Michigan State Civilian Concervation Corps, 1941; Michigan Department of Natural resources

N W E S

0 0.125 0.25 Kilometers

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Figure 7. 5-foot Contour Interval Map; Grand Sable Lake, Pictured Rock National Lakeshore

Legend

Depth Zone (ft):	(m)	Acres:	Hectares:
0- 5	0- 1.52	53.22	21.54
5-10	1.52- 3.05	56.48	22.86
10-15	3.05- 4.57	63.63	25.75
15-20	4.57- 6.10	37.50	15.18
20-25	6.10- 7.62	27.23	11.02
25-30	7.62- 9.14	39.76	16.09
30-35	9.14-10.67	34.53	13.97
35-40	10.67-12.19	36.96	14.96
> 40 *	> 12.19	325.94	131.91
Total:		675.27	273.27

* Includes area with water depths from 40' - 89' (max depth)

Bathymetry data source: MECW, 1937;
Michigan Department of Natural Resources.

0 0.25 0.5 0.75 1 Kilometers

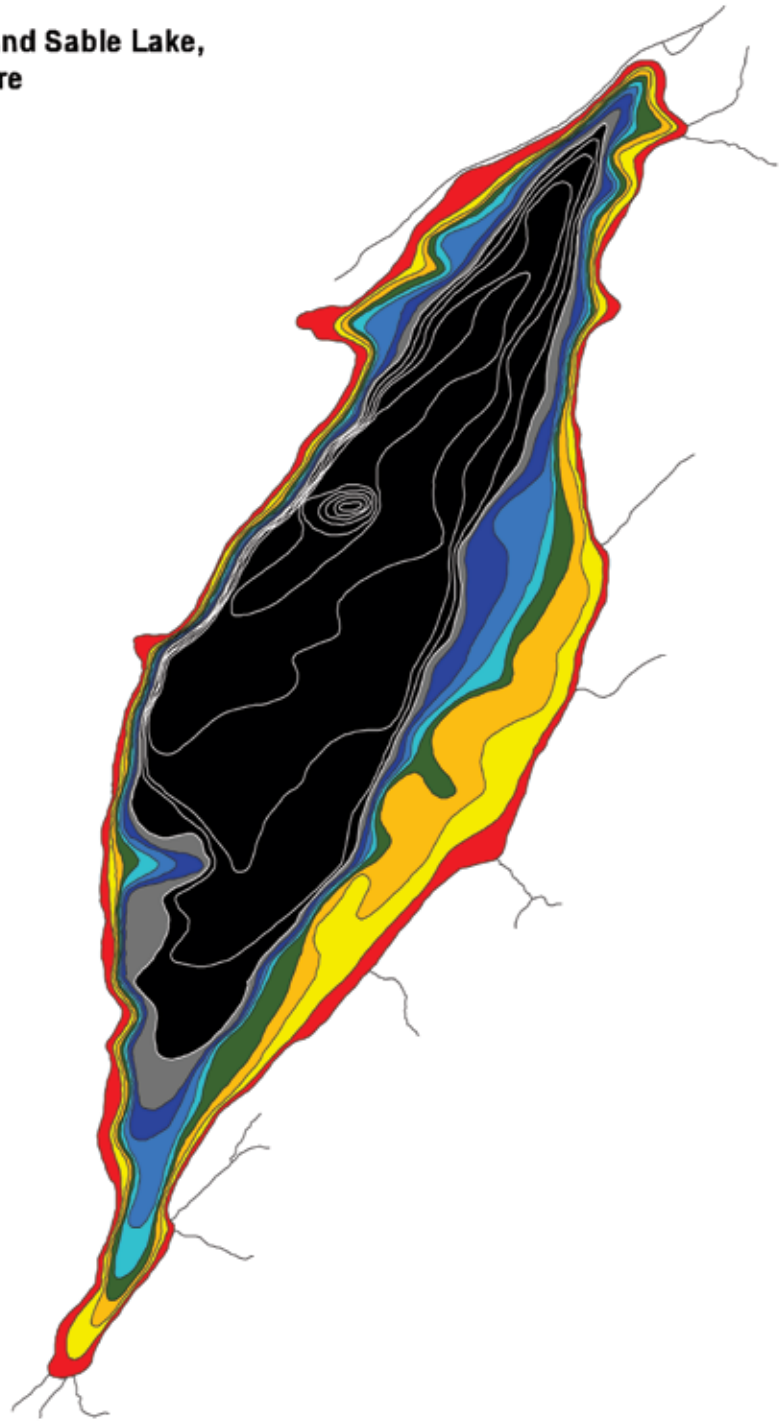

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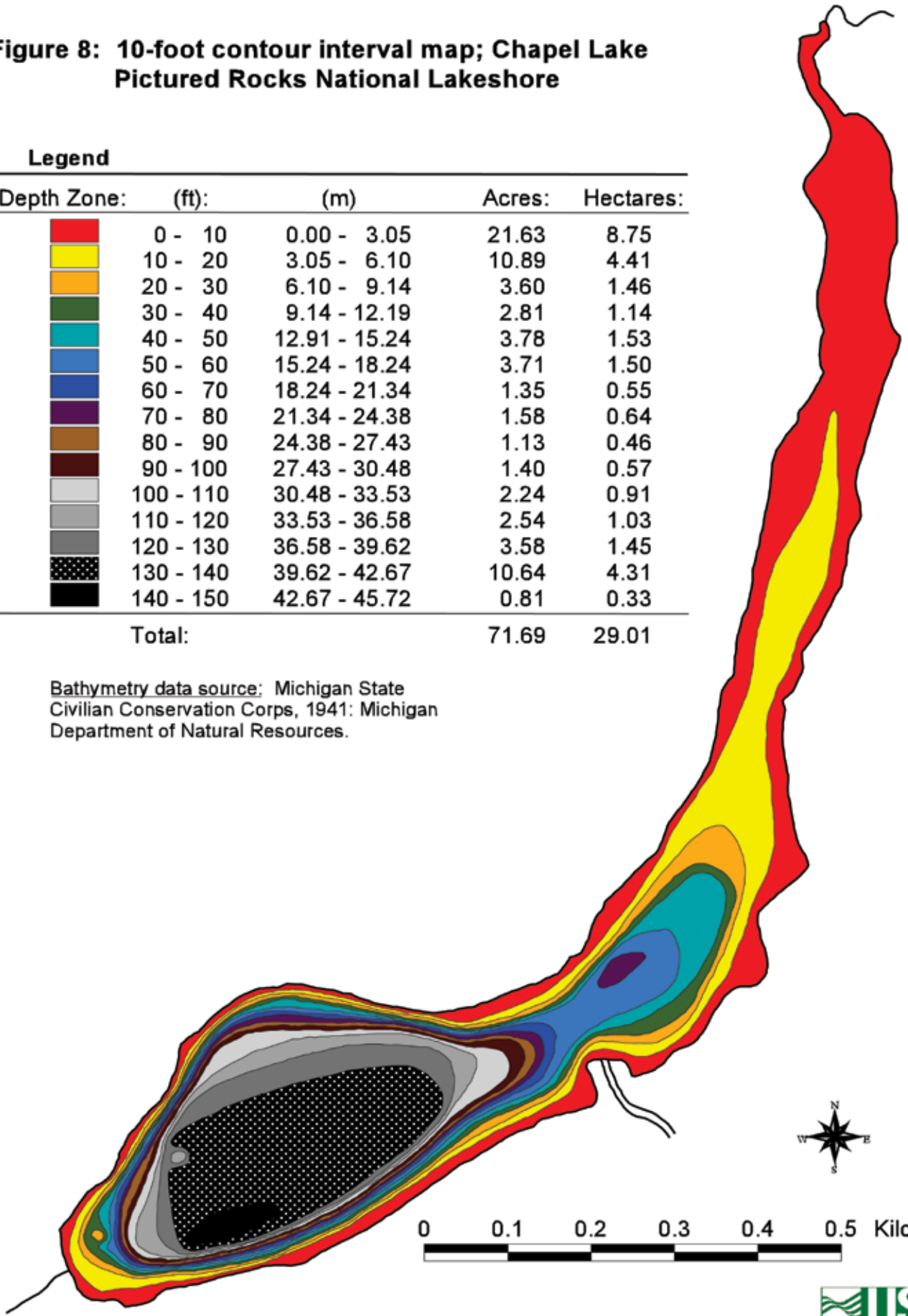
Figure 8: 10-foot contour interval map; Chapel Lake Pictured Rocks National Lakeshore

Legend

Depth Zone:	(ft):	(m)	Acres:	Hectares:
	0 - 10	0.00 - 3.05	21.63	8.75
	10 - 20	3.05 - 6.10	10.89	4.41
	20 - 30	6.10 - 9.14	3.60	1.46
	30 - 40	9.14 - 12.19	2.81	1.14
	40 - 50	12.91 - 15.24	3.78	1.53
	50 - 60	15.24 - 18.24	3.71	1.50
	60 - 70	18.24 - 21.34	1.35	0.55
	70 - 80	21.34 - 24.38	1.58	0.64
	80 - 90	24.38 - 27.43	1.13	0.46
	90 - 100	27.43 - 30.48	1.40	0.57
	100 - 110	30.48 - 33.53	2.24	0.91
	110 - 120	33.53 - 36.58	2.54	1.03
	120 - 130	36.58 - 39.62	3.58	1.45
	130 - 140	39.62 - 42.67	10.64	4.31
	140 - 150	42.67 - 45.72	0.81	0.33
	Total:		71.69	29.01

Bathymetry data source: Michigan State Civilian Conservation Corps, 1941: Michigan Department of Natural Resources.



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for that feature. The more distinct the feature, the better the georeferenced data could be obtained. Once a minimum of 4 georeferenced positions were obtained, the paper contour maps were digitized and transformed into real-world coordinates using 'Arc/Info'. After the paper maps were digitized, polygons representing each contour interval were constructed. A comparison of the whole lake polygon map produced from the orthophotography images was made to the digitized bathymetric polygon maps. This comparison showed that the shoreline of the bathymetric maps were not accurate enough to overlay onto the digital orthophotography images, but the aerial calculations were sufficiently close (+/- 5%) to use on their own (e.g., %of each depth zone relative to the whole lake, and relative coverage of each depth zone as compared to the entire lake, etc.). Depth data is presented in feet, per original data provided by NPS, and in metric conversion.

RESULTS

In 1999 and 2000, we surveyed seven lakes and five streams in PIRO: Lakes= Big Beaver, Grand Sable, Kingston, Little Beaver, Miners, Sevenmile, and Trappers. Creeks surveyed = Beaver, Miners, Sable, Sevenmile, and Hurricane River. Six of the eight lakes contained unionids, and none of the five streams (Table 1). No exotic bivalves (zebra mussels or Asian clams) were found.

In 2001 we quantitatively surveyed Chapel Lake and scouted Chapel Creek. Unlike the other streams in the park, Chapel Creek did contain unionids. We did not see very many, and only one species was found

Taxonomic Identifications

Figure 9 shows the major morphological features of unionids, it is included to aid in deciphering descriptions. To date, four unionid genera have been identified in Pictured Rocks, *Elliptio*, *Lampsilis*, *Potamilus*, and *Pyganadon* (Figure 10), with seven species designated. None of these genera or species are considered endangered, threatened, or species-of-concern either at the state or federal level. Species identifications and pictures

are provided in Figures 11-17, with locality distributions presented in Table 2. Grand Sable Lake had the highest number of genera and species of unionids.

Table 2. The distribution of unionid species found in Pictured Rocks National Lakeshore. X= present. O= absent.

Genus	Species	Grand Sable	Kingston	Big Beaver	Little Beaver	Trappers	Chapel
Elliptio	***complanata* (eastern elliptio)**	X	O	O	O	O	O
Elliptio	***dilatata* (spike)**	X	O	O	O	O	O
Lampsilis	***luteola* (fatmucket)**	X	X	X	X	O	X
Lampsilis	***radiata* (fatmucket)**	X	X	X	X	O	X
Potamilus	***alatus* (pink heelsplitter)**	X	O	O	O	O	O
Pyganadon	***grandis* (giant floater)**	X	X	X	X	X	O
Pyganadon	***grandis/ cataracta* Intergrades**	X	O	X	X	O	O
Pyganadon	***cataracta* (eastern floater)**	X	X	X	X	O	X

Taxonomic Authority

The genera designations are not in taxonomic dispute, and are easily identified in the field (Figure 10). However, the species identifications for the *Lampsilis* group and the *Pyganadon* group are in major taxonomic dispute, and have undergone many name changes during the last 50 years, with more changes likely in the future, until this issue is resolved. Furthermore, the two main taxonomic authorities for the Midwest, the Ohio State University Museum of Biological Diversity, The Bivalve Mollusk Collection (OSU), Drs. Stansbury and Watters, and the University of Michigan Mollusk Collection (UM) Dr. Burch, R. Sherman, D. Graf, do not agree on species designations for these genera. Since we expect the names to shift in the next decade, and because it is easier to combine data, than to try to split past collections and reports, we have chosen to use the OSU nomenclature (splitters rather than clumpers). Thus, for this report, we are using the following names:

1. *Lampsilis*

There are two visually distinct forms of *Lampsilis* at PIRO that can be readily identified in the field (Figures 11 and 12). For this reason, we used the OSU system, and have divided the *Lampsilis* into two species, *L. radiata* and *L. luteola.* At the University of Michigan Mollusk Collection (Dan Graf and Renée Sherman) all these animals would be lumped together and called *Lampsilis siliquoidea*. Some taxonomists list *L. radiata* and *L. luteola* as sub-species of *L. siliquoidea*.

The shell of *L. luteola* is light colored (tan), usually with visible greenish stripes, and the shell hinge tooth, the pseudocardinal tooth, is broad with strong secondary crenellations (see Figures 11 and 12)(listed in raw data sheets as Lamp A). The shell of the second species, *L. radiata* is usually dark colored (dark red brown) and with faint stripes, if any (listed in raw data sheets as Lamp B). Overall, the shell is more angular in appearance (front to back) and has a thick, heavy robust hinge line. The pseudocardinal tooth is narrower, more triangular, with minimal secondary crenellations.

Both species of *Lampsilis* have identical distribution patterns, and were found in the same lakes, in the same grids, coexisting side-by-side, with no differences related to sex or age. No obvious hybrid forms were found. *Lampsilis* are one of the few genera of unionids whose shells are sexually dimorphic. Figure 13 shows how to sex these clams externally.

2. *Pyganadon* (*Anodonta*)

Identification of *Pyganadon* species is difficult not only due to poor taxonomic revision, extensive shell variability within the different species, natural erosion of key shell characteristics, and the observation that hybridization between species is a common occurrence. We have identified two species, *P. grandis*, and *P. cataracta*, plus intergrades or hybrids (Figure 14). These species and hybrids are not as readily differentiated in the field, as are the *Lampsilis* species. Identifications are based on shell shape, which is often subjective, and the whorls located on the umbo of the shell (beak structure), which are often eroded even in very young animals (Figure 15). The hybrids are so designated because they combine the shell shape and/or beak structure of both

species. We also found animals in Chapel Lake that we classified as *P. cataracta*, which fit the description of *P. lacustris*; these were separated in our notes, but combined for analysis (as were all *Pyganadon* forms). If the distinction becomes accepted in the future we can easily separate the species and reanalyze the data.

3. *Elliptio*

Elliptio spp. are thick shelled, slow-growing mussels (Figure 16). Both species found at PIRO are very similar in habit and appearance (Figure 16). The shells are dark brown in color, with no distinguishing stripes or rays and very elongated in shape. *Elliptio complanata*, the eastern elliptio, differs in that the internal shell lining, the nacre, is usually white or light pink and the shell ventral margin is usually straight. *Elliptio dilatata*, the spike or lady finger has dark purple nacre, and full adults have a indentation on the ventral margin. Young spikes (< 6 cm) tend to be lighter brown in color, with a strong posterior wing, while older animals become very dark brown. We saw *Elliptio complanata* in the lake, but did not collect any in the sampling grids.

4. *Potamilus*

Potamilus alatus, or the pink heelsplitter, is thick shelled, slow growing species (Figure 17). The shell is dark brown in color, with pink nacre. (In taxonomic keys from about ten years ago, this animal was called *Proptera alata*). Its presence in Grand Sable is unexpected. This mussel has not been reported from Lake Superior, although it is found in the Red and Winnipeg rivers in Canada. Our hypothesis is that these mussels were accidentally introduced into the lake. The only known fish host is the fresh water drum, which does not occur in Grand Sable, though glochidia-infected drum may have been accidentally stocked with some of the game fish. Appendix 3 shows the known fish hosts for these unionids.

Fig. 9
Unionid shell Morphology

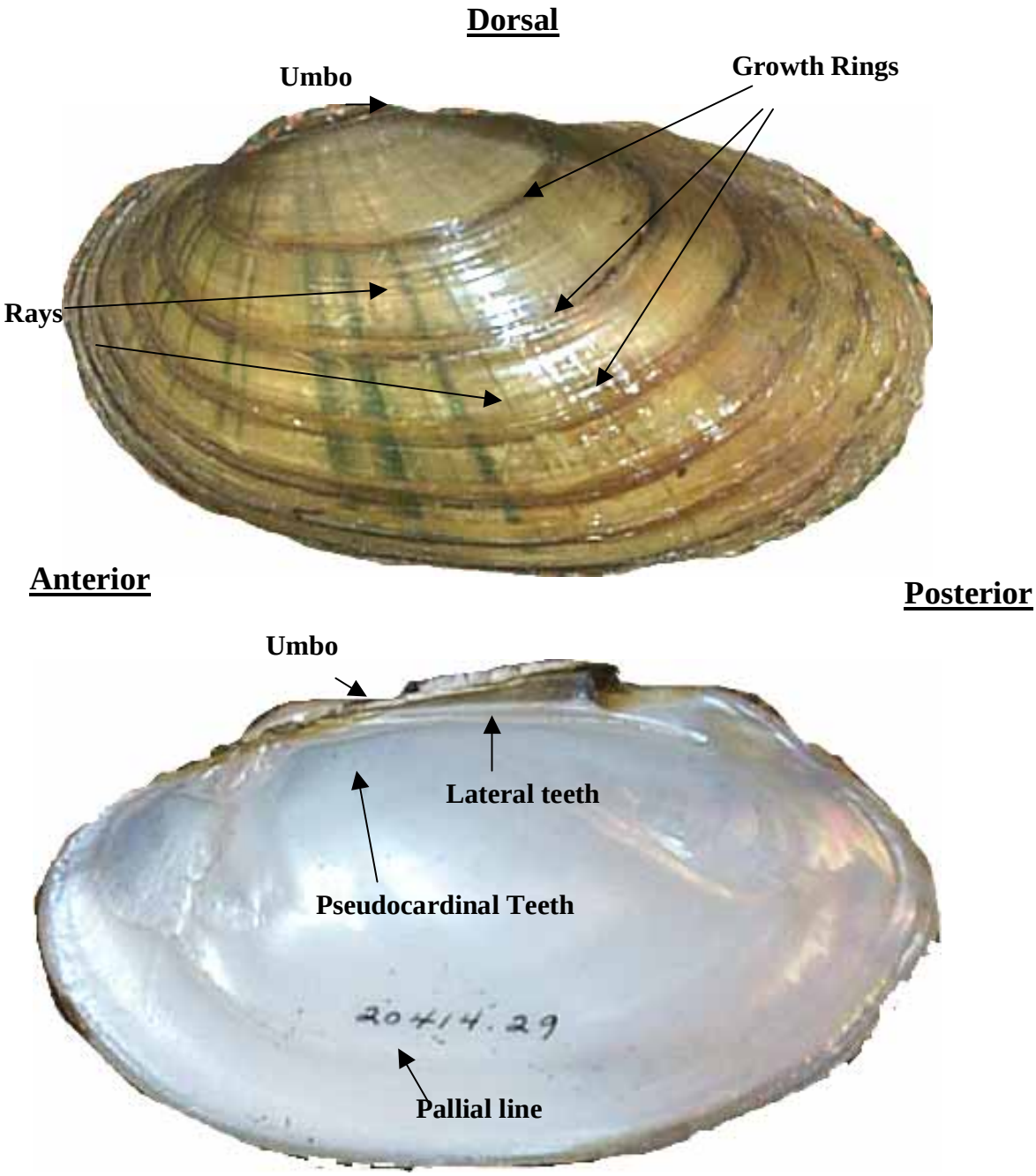
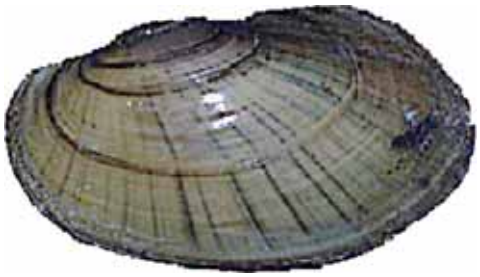


Figure 10
Unionid Genera found in Pictured Rocks National Lakeshore

Pyganadon spp.

Lampsilis spp.



Elliptio spp.

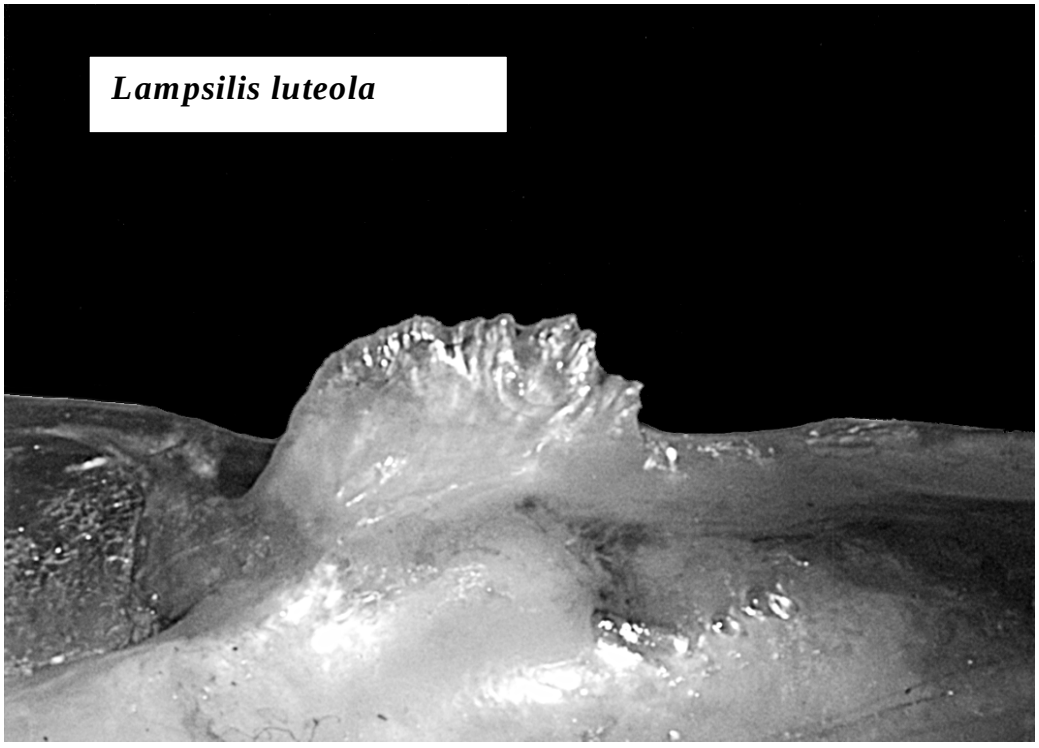
Potamilus spp.

Figure 11. ***Lampsilis spp.*** **found in Pictured Rocks National Lakeshore**

Lampsilis luteola

Lampsilis radiata

Figure 12. Shell tooth types found in *Lampsilis luteola* and *L. radiata* from Pictured Rocks National Lakeshore, 1999



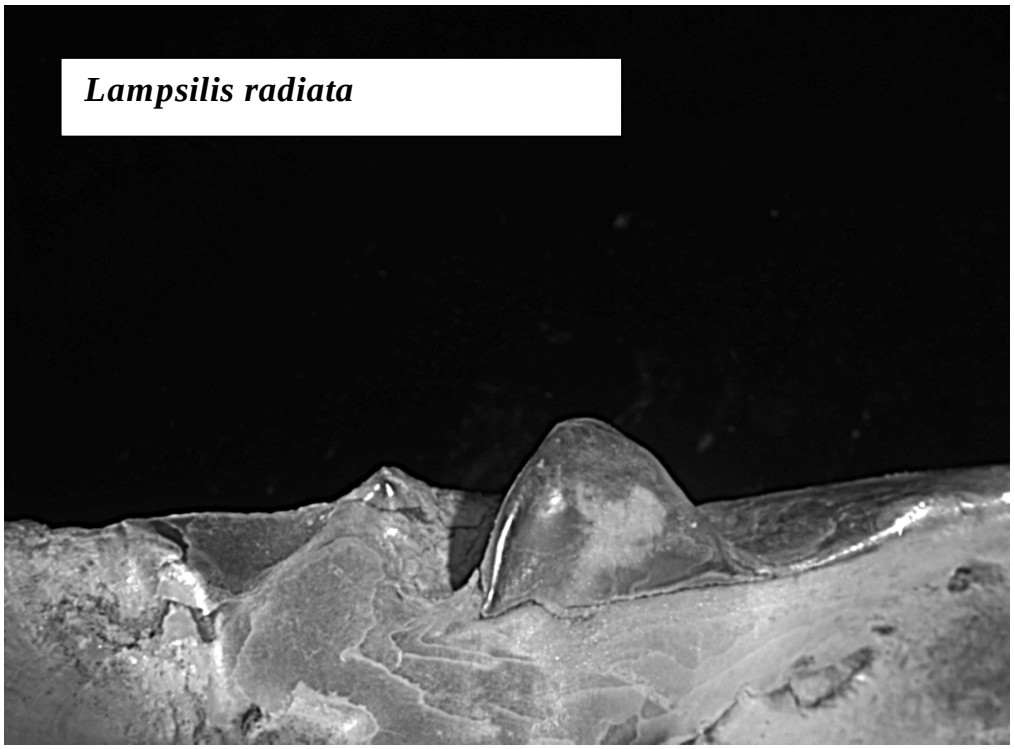


Figure 13. *Lampsilis spp.* Sexual Dimorphism

Female

Male

Figure 14. *Pyganadon spp.* collected in Pictured Rocks National Lakeshore, 1999.

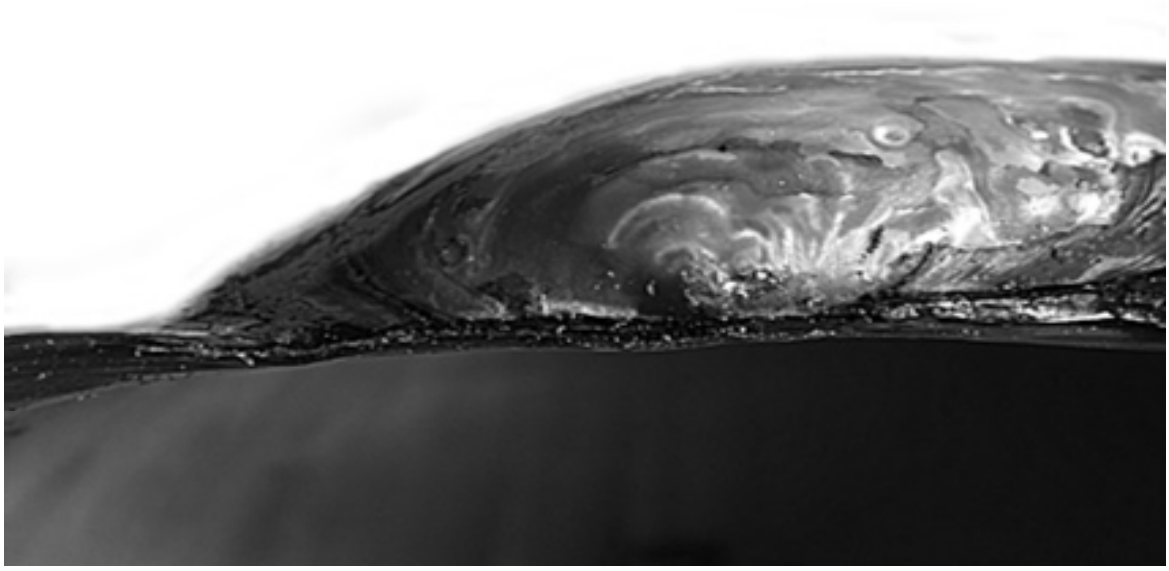
Pyganadon grandis

P. grandis* x *cataracta

P. cataracta

Figure 15. Beak structure in *Pyganadon spp.* Collected in Pictured Rocks National Lakeshore, 1999.

Pyganadon grandis



Pyganadon cataracta

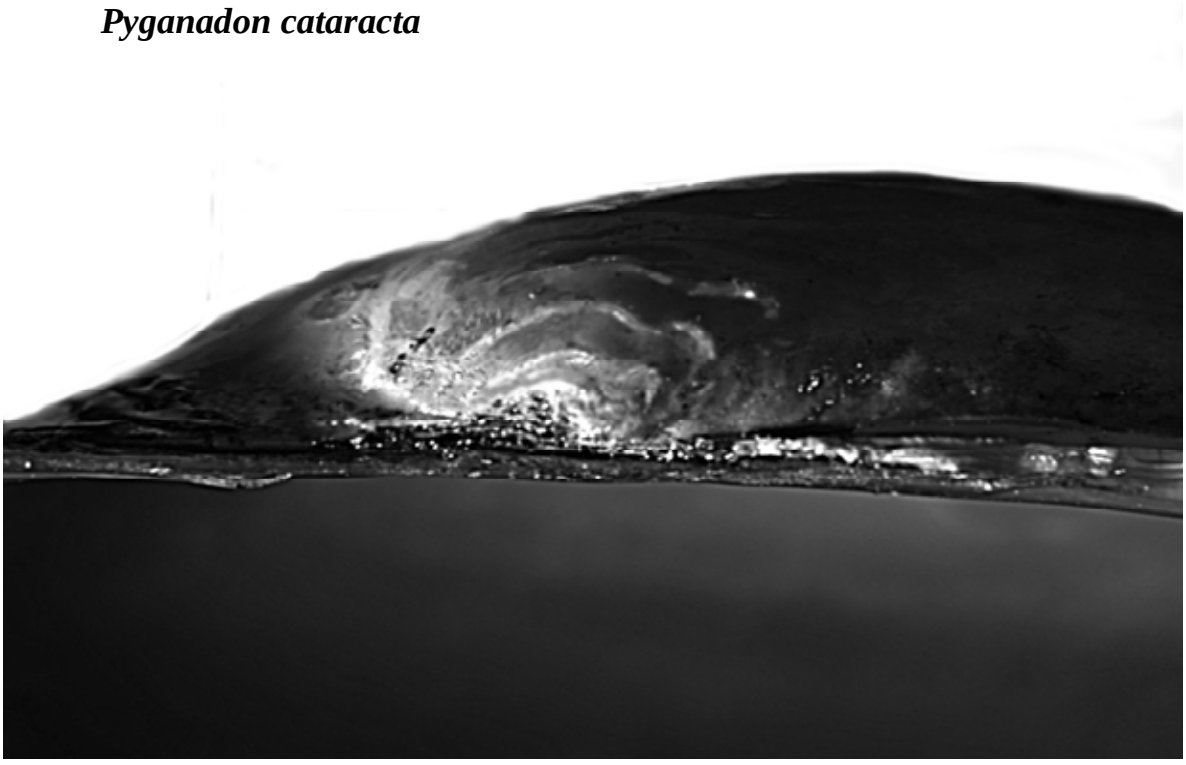


Figure 16. ***Elliptio spp.***

Elliptio complanata

Elliptio dillatata

Figure17. ***Potamilus alatus***

Potamilus alatus

Population Densities

Lampsilis luteola was the most dominant unionid collected (by number of live animals) in all the lakes surveyed, except Grand Sable, followed by *Lampsilis radiata,* and *Pyganadon grandis* (see Tables 3 and 4). Grand Sable was dominated by *P. grandis*. Appendix 3 contains all raw data files and Appendix 4 contains the basic stats, the mean/median/quartiles, etc, of the raw data.

Table 3. Total number of live individuals of each species collected from each lake.

Genus	***Species***	**Grand Sable**	**Kingston**	**Big Beaver**	**Little Beaver**	**Chapel**
Total area searched (m^2)		3000	800	2600	600	2800*
Elliptio	***complanata*** **(eastern elliptio)**	0[1]	0	0	0	0
Elliptio	***dilatata*** **(spike)**	6	0	0	0	0
Lampsilis	***luteola*** **(fatmucket)**	4	93	226	91	4
Lampsilis	***radiata*** **(fatmucket)**	1	4	90	25	54
Potamilus	***alatus*** **(pink heelsplitter)**	0[1]	0	0	0	
Pyganadon	***grandis*** **(giant floater)**	7	1	38	83	0
Pyganadon	***grandis x cataracta*** **intergrades**	0	0	17	33	0
Pyganadon	***cataracta*** **(lake floater)**	1	1	36	45	9
All Species Combined		19	99	407	277	68

1 Found in lake but not in sampling grids

* 112-m^2 sub sample of actual grid area within 2800m^2 of depth zones searched

Table 4. Unionid densities (all species combined) found in the grids. Depth zone limited to the preferred habitat area of 0-10ft for purposes of comparison.

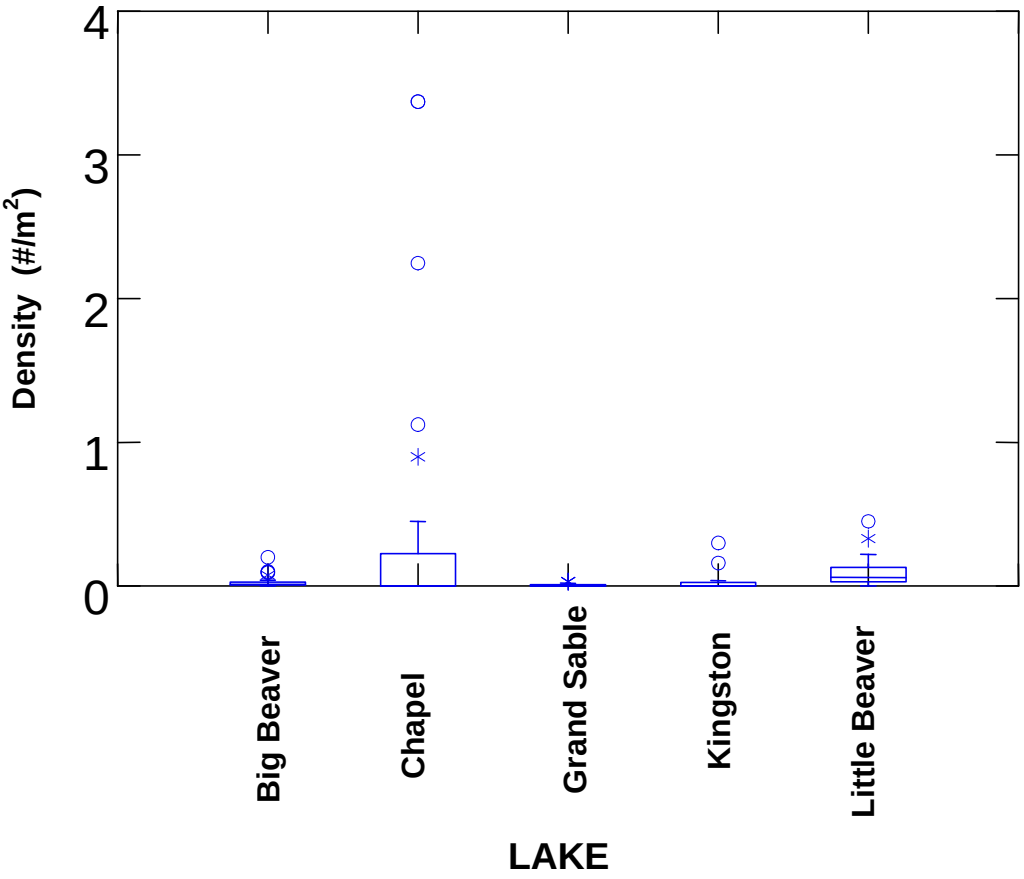
Lake	Total collected in the 0-10' depth zone	Average #/ m^2
Big Beaver Lake	335	0.299
Little Beaver Lake	277	0.46
Kingston Lake	80	0.10
Grand Sable Lake	19	0.0079
Chapel Lake	64	1.143

Overall, Chapel Lake had the highest density of unionids per square meter and Grand Sable the lowest ($p \leq 0.05$). Based on #/m^2, all species combined. Chapel Lake, had the highest densities, averaging 0.255/m^2, with a maximum of 3.37/m^2 (Table 5, Figure 18).

Table 5. Kolmogorov-Smirnov Two Sample Test comparison of native clam populations (#/m^2) of five water bodies associated with Pictured Rocks National Lakeshore, USA. Common letters indicate no statistical difference ($p \leq 0.05$) in mean clam population density between water bodies.

	Grand Sable	Kingston	Chapel	Little Beaver	Big Beaver
Minimum/m^2	0.000	0.000	0.000	0.000	0.000
Maximum/m^2	0.030	0.300	3.371	0.450	0.200
Median/m^2	0.000	0.002	0.000	0.060	0.012
Mean/m^2	0.006	0.043	0.255	0.092	0.029
Standard Deviation	0.010	0.093	0.680	0.100	0.044
		a	a	a	

Figure 18. Quartiles: Box-plots representing clam densities for each lake.



The overall size of the unionid population in each lake is not just based on number /m^2 but also on amount of habitat available for colonization. Unionids were more likely to colonize waters less than 10 ft deep in most of the lakes (see discussion below). Contour interval maps (Figures 5-8) for each of the lakes for which bathymetric data are available (data not available for Kingston) show the number of hectares of each depth zone present. In Table 6, we estimate the size of the unionid population in each lake. This calculation is based on the assumption that unionid distribution follows the pattern seen in the sampling grids, and is limited mainly to the 0-10 ft. depth contour.

Table 6. Estimate of the size of the unionid population for each lake in PIRO, based on all species combined, based on primary habitat area in the 0-10 ft depth contour.

Lake	# Hectares 0-10ft	% of lake area	Mean #/m^2	Estimated total # clams in lake
Big Beaver Lake	57.08	18.49	0.299	170,669
Little Beaver Lake	4.83	30.55	0.46	22,218
Chapel Lake:	8.753	30.17	1.143	100,047
Grand Sable Lake	44.4	16.25	0.0079	3,508

This depth contour contains the majority of the clams, but not all, so our population size estimates are possibly low. Big Beaver Lake was the only lake where unionids were consistently found at other depth contours. Considering total habitat availability, Big Beaver Lake contains the largest clam population. Grand Sable Lake may be the largest lake, but this habitat is not utilized by unionids.

The 0.25-m^2 excavated grids were designed to detect young clams that normally remain burrowed in the substrate and could easily be overlooked in the larger grids. Of the seventy 0.25 m^2 grids sampled throughout the park, only 1 grid, in Little Beaver Lake, contained a young clam, a 20-mm *P. grandis,* buried in the substrate that was not collected during the initial sampling. (These small grids were sampled inside of the 100 m^2 grids and sampled after the larger grid was completed). Based on 6 excavated 0.25 m^2 grids in Little Beaver, this sampling method estimated a population density of 1.5 young clams/m^2.

The transects taken on compass headings were not effective at collecting or detecting clams in areas where clams densities were low (Appendix 4). Of the 12 transects (54x 1m^2 grids) in Grand Sable, none contained clams. If we had based our population work on this transect type of sampling protocol in this lake, we would have assumed no unionids were present. Furthermore, these samples required 5 hours to

complete (3 divers=15 total person hours) to sample a total of 54 square meters. There were several reasons that made this sampling regime so time consuming. The long transects covered deep waters in the lake. Deeper water samples required more time because of the low water temperatures and length of time forced the divers to return for fresh air tanks and to warm up. A regular 100 m^2 grid could be completed in less than 30 minutes start-to-finish where the sediment was firm, vegetation was minimal and clam densities were low. In a lake with a higher density of clams, this sampling system, of statistical transects taken on compass headings, was successful at detecting clams. However, sample variance was high, and density estimates as compared to the stratified sampling regime was low. In Big Beaver Lake, two out of the sixty $1m^2$ grids contained clams (station #16). This provides a population estimate of $0.03/m^2$ and a total estimate (5-10 ft) of 4668 clams in the 5-10 ft depth zone of the lake. This population estimate is much lower than that provided by using the stratified sampling regime, an estimated 42012 clams. More samples would likely drop the variance and improve the population estimate, but once again, these statistical transects proved very time consuming, requiring about 1.4 hours of bottom time to complete a total survey of a mere 60 square meters of substrate.

In 2001 we introduced a new sampling methodology in Chapel Lake. The number of transects was determined using an equation that factored in the shoreline perimeter of the lake and the overall area of the lake available as unionid habitat (based on depth and thermocline). Each transect was divided into five foot depth zones, and a minimum of five 0.8 m² grids were randomly placed and searched in each depth zone per. . The substrate type, vegetation % cover and species composition was recorded for each grid along with the number of unionids, their species composition, and size data. Subsamples of animals from each grid were aged in the field and shells were brought back to the lab for analysis of internal annuli.

Population Distribution

The unionids were not randomly distributed within the lakes. Depth, and by inference thermocline, appears to be the main habitat feature controlling distribution within each lake in PIRO. All unionids were located above the thermocline.

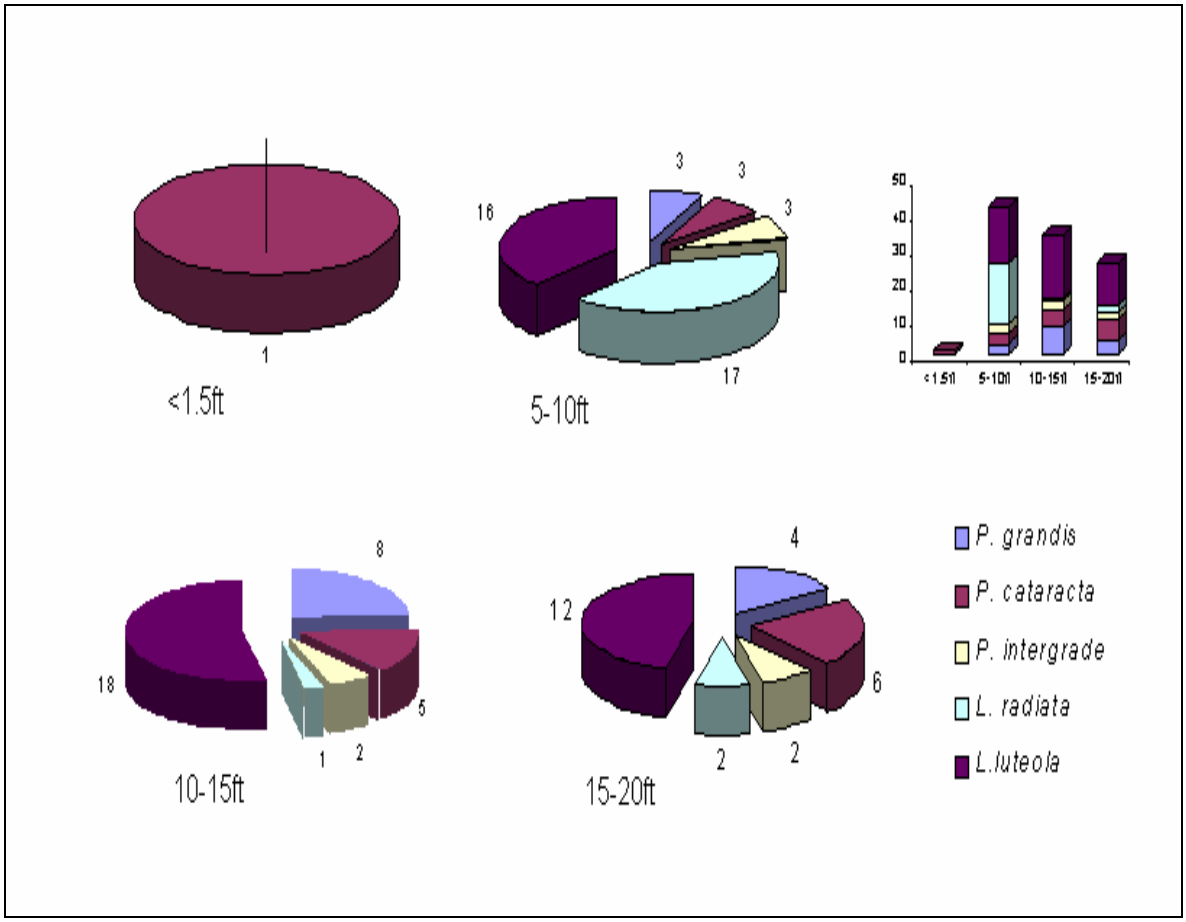
Thermocline depth was determined by measurements collected by divers during sampling and these depths are presented in Appendix 2. In Grand Sable, Kingston, and Little Beaver lakes, the thermocline is fairly shallow, at about 12 –13 ft, with unionid distribution concentrated in shallower waters and thus close to shore. In Big Beaver, the thermocline develops around 21-22 ft. (7 m) and unionids colonize areas down to 20 ft in depth.

Unionid distribution above the thermocline was also not random, but showed further significant differences based mainly on depth, with most of the animals occupying the 0-10 ft. depth contour. These results did vary by lake as a result of the bathymetric profile and the degree of overlap in depth contours in the sampling grids. Paired *t*-tests showed that no significant difference ($p \leq 0.05$) in depth distribution could be detected at Kinston or Little Beaver lakes. Neither lake was deep, and sampling grids tended to cover 0-10 ft depth zones. Significant difference in depth distribution was seen in the deeper Grand Sable Lake, with the greatest number of unionids being found in the 0-10ft depth contour. No depth gradient difference could be detected in Big Beaver Lake, but substantial differences between specific sampling stations did occur.

Homogeneity between sampling stations did vary in two out of the four lakes sampled. Paired sample *t*-tests were not able to detect a significant difference in clam densities between sampling stations neither within Kingston Lake nor within Grand Sable. This is taking stations as a whole, across all depth contours and indicated clam distribution was not significantly different between stations sampled. Significant differences were detected between sampling stations in Little Beaver and Big Beaver lakes.

The only difference noted by the field crews between these stations in both Beaver Lakes was substrate. Those stations with the highest densities were rock/cobble areas. Big Beaver is also different from the other lakes sampled in that unionids colonize areas down past 15 ft (5 m), even though their numbers are higher in the 5-10 ft zone (2.5-3.5m). Figure 19 shows an example of this depth preference in Big Beaver Lake.

Figure 19. Depth distribution of unionids in Grid 4, Big Beaver Lake, 1999.

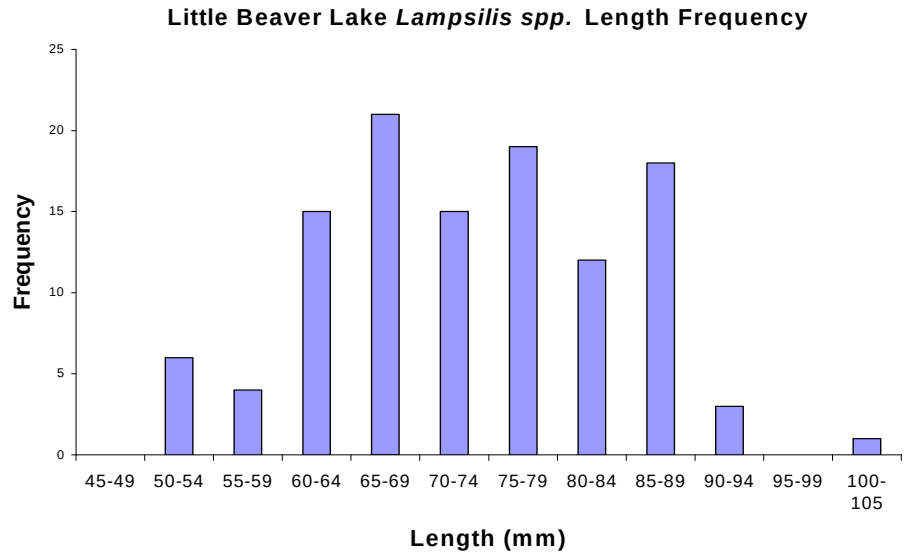


Population Age Structure

With the exception of Grand Sable Lake, unionid populations showed signs of consistent recruitment and long-term survival. A number of gravid female unionids were seen during sampling, indicating conditions are suitable for reproductive efforts to be initiated (Appendix 2). Second, several different length classes of animals were found in these lakes indicating successful recruitment has been occurring over the years (Figure 20). There was no significant difference in length frequency between species, lakes, or depths ($p \leq 0.05$).

Grand Sable Lake had so few unionids that population dynamic data was difficult to obtain. Based on available data and field observation, several age classes of *Pyganadon* and *Lampsilis spp.* were present. However, only 2 age groups of *Elliptio spp.* were found, and none less than 25 years of age (Figure 21).

Figure 20. Examples of length/frequency of various unionid species at different stations in Pictured Rocks National Lakeshore, 1999. Based on maximum shell length.



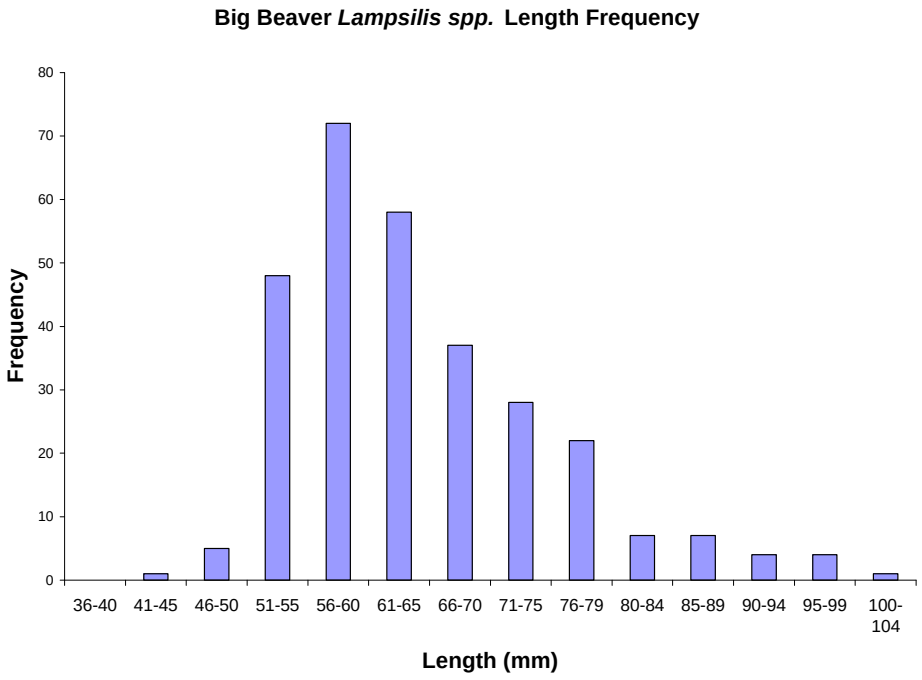
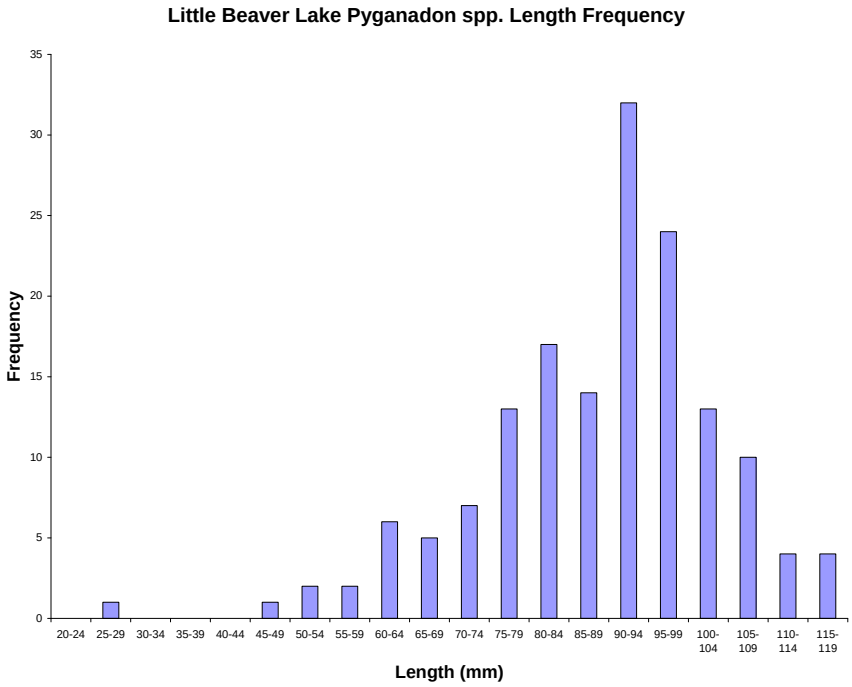


Figure 20 (cont.). Examples of length/frequency of various unionid species at different stations in Pictured Rocks National Lakeshore, 1999. Based maximum shell length.



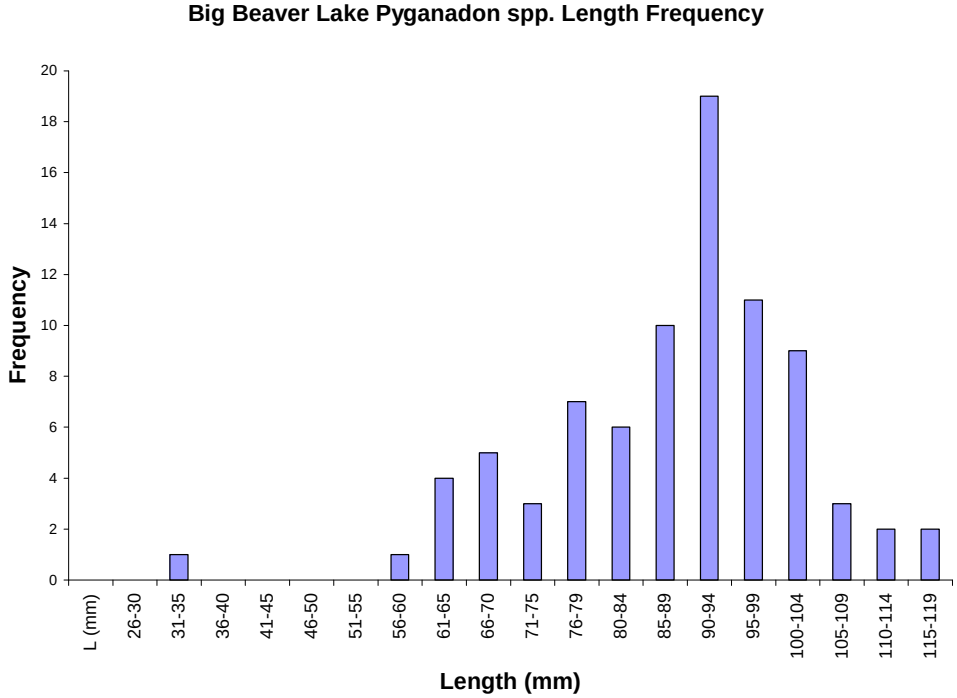
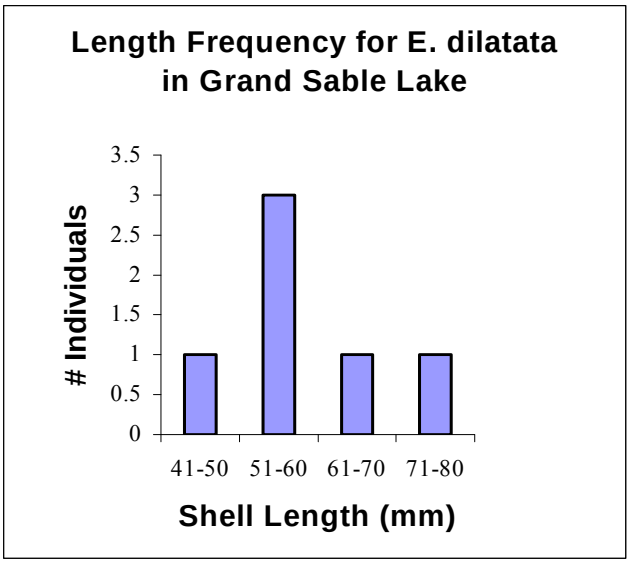
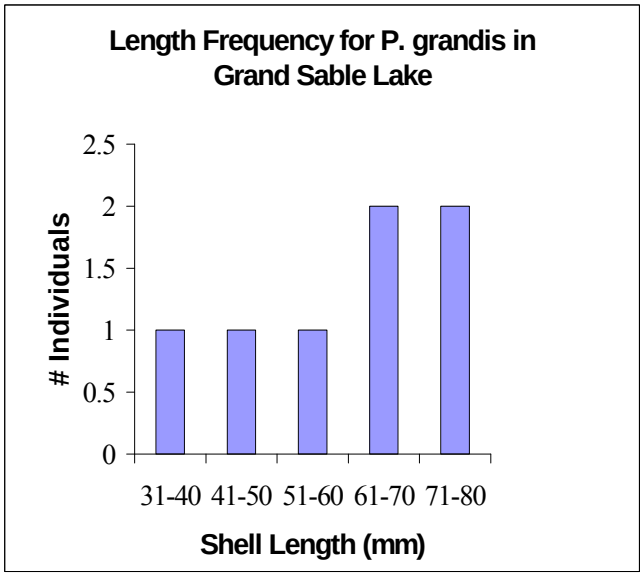


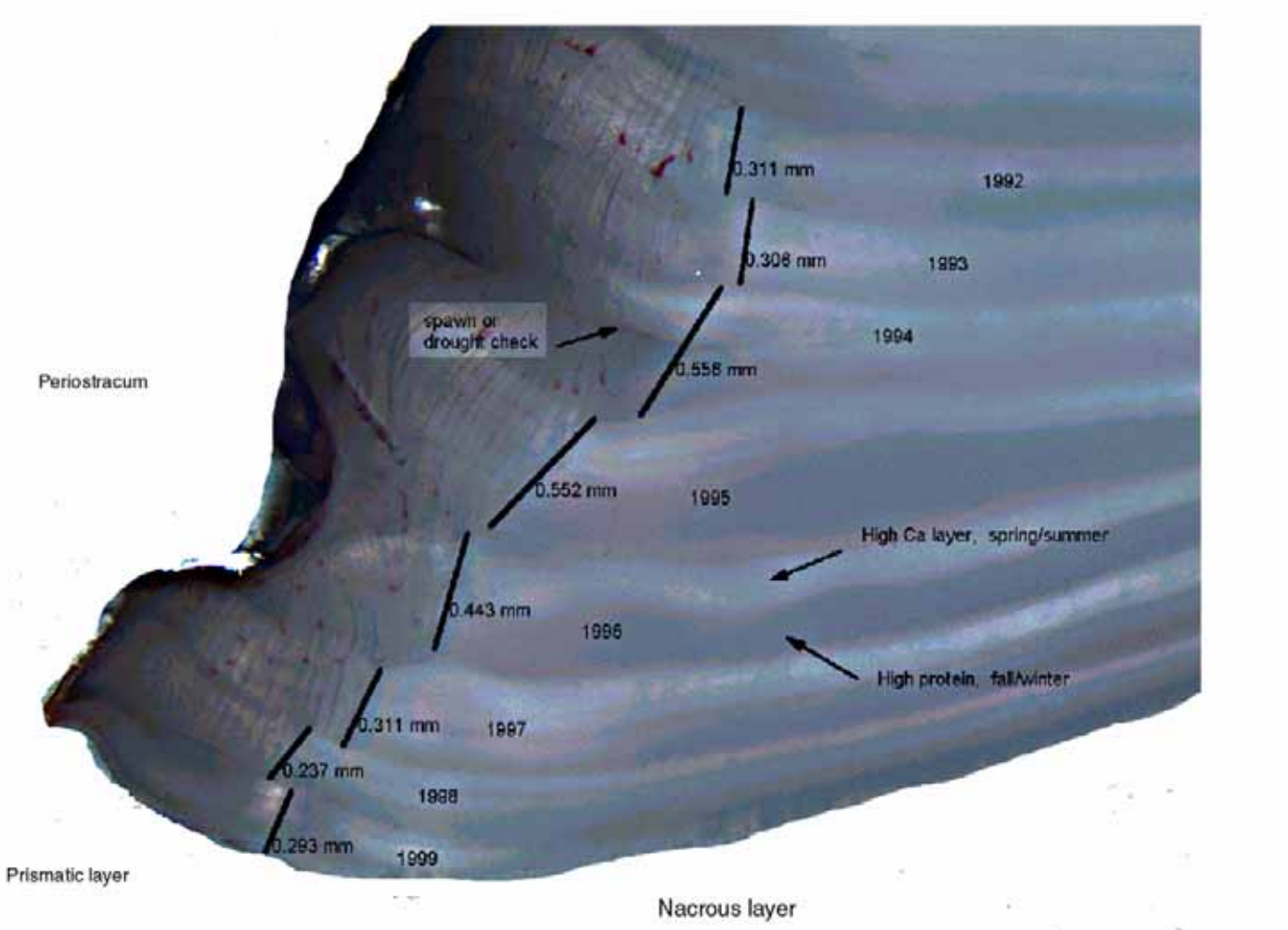
Figure 21. Examples of length/frequency in Grand Sable Lake.





Length and age are not necessarily directly related in unionids, and although the exterior of most shells is marked with visible growth bands (annuli), these are not necessarily accurate representations of years.lived. To determine age, we first had to determine the relationship between external annuli on the outside of the shell (see Figure 9) and a more accurate estimation of age as based on internal annuli (Figure 22). Using external annuli, if comparable, would give us a larger data set, since use of internal annuli requires the killing of the animal. Shell cross-sections show that internal and external annuli are identical in *Pyganadon spp.*, but not in *Elliptio spp.* or *Lampsilis spp.* Therefore, with *Pyganadon spp.*, field recorded notes on external annuli could be used to measure growth rates and age. Internal and external annuli are in agreement up to about age 5 in *Lampsilis spp* .in all the lakes at PIRO except for Chapel Lake where the relationship remained constant. After this age, which is probably the age of sexual maturity for the animals from this region, external annuli underrepresented age (internal annuli).

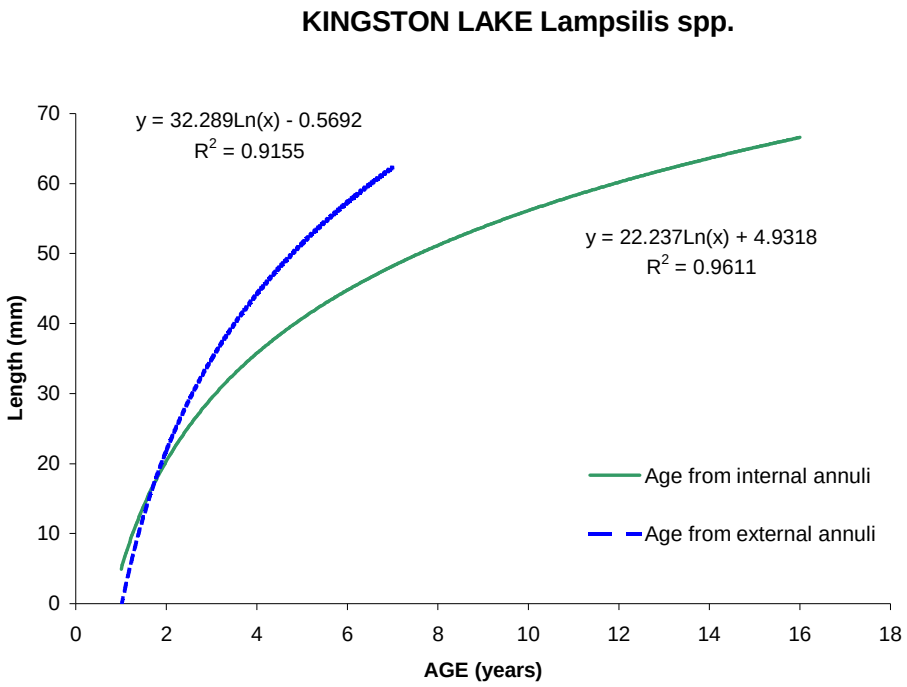
Figure 22. Labeled shell section photo of an *Elliptio dilatata* from Grand Sable Lake



With *Elliptio spp.*, the shell is so dark that external annuli are often hidden, and so few animals and shell were collected, that little data on growth and sexual maturity is available.

The regression formulas presented in Figures 23-25 can be used to calculate an estimated age for unionids that were not killed and shelled-sectioned, so long as specific species and lake formulas are used.

Figure 23. Regression of the age estimates obtained using external and internal annuli from *Lampsilis spp.* in Kingston Lake, 1999. Internal annuli are considered more accurate at age determination.



Based on these linear regressions, the oldest unionids in the lakes seen during our study were: a *Lampsilis radiata* with an estimated age of 141 years (100 mm long) born in 1850, from Little Beaver Lake; an *Elliptio dilatata* at 41 years old (75 mm) born in 1958,

from Grand Sable Lake; and, a *Pyganadon cataracta* at 23 years old (117 mm) born in 1976, from Big Beaver Lake (Figures 23-25). These animals were replaced unharmed in the lakes. *Pyganadon spp.*, being a fast-growing, thin-shelled species, is known to be relatively short lived. Twenty-three years of age is a comparatively old *Pyganadon*.

Figure 24. *Lampsilis spp.* Age/Length Regression for Four Lakes in PIRO.

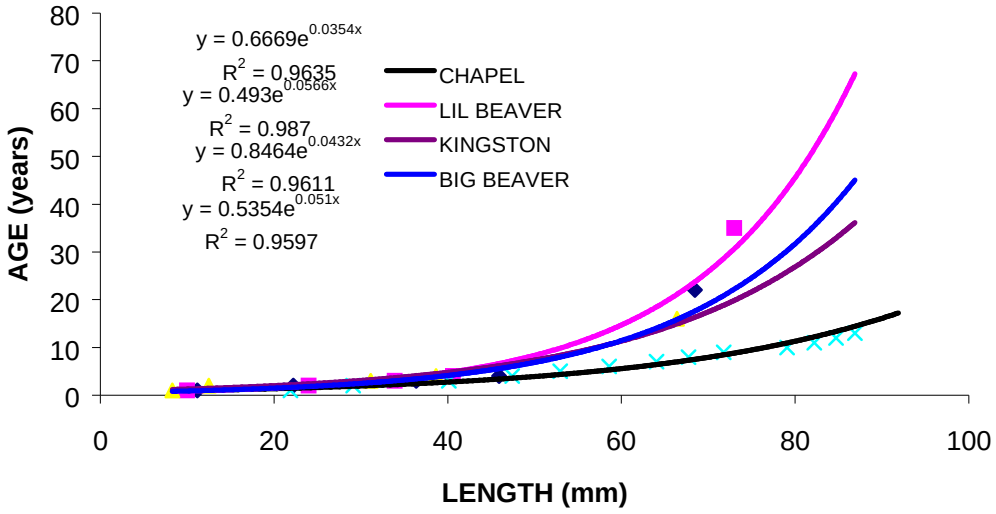
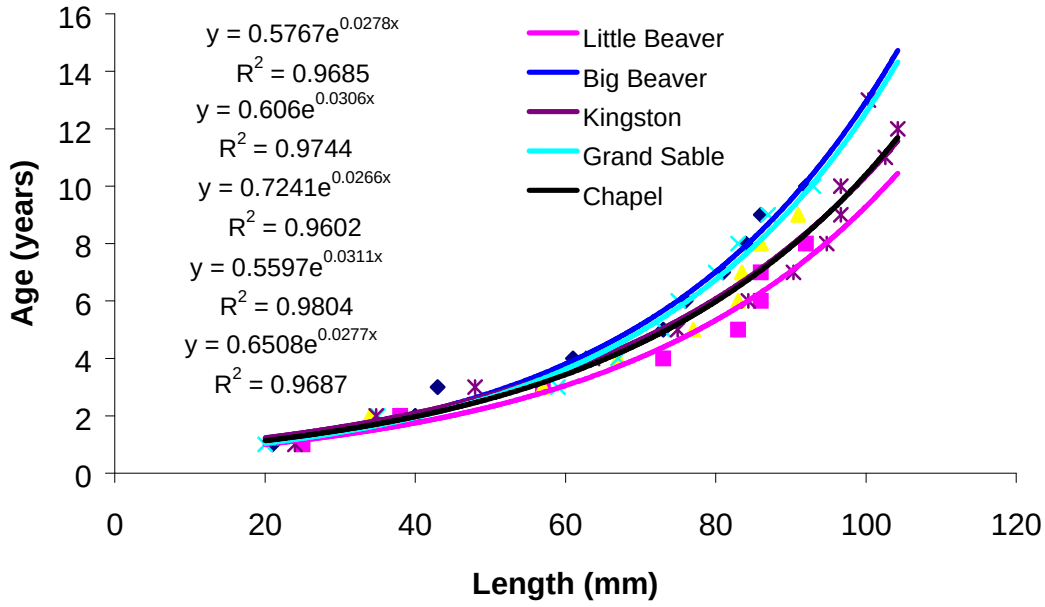


Figure 25. *Pyganadon spp.* Age/Length Regression from Four Lakes in PIRO.



Age estimations based on field measurements of length, or external annuli and not on shell sections, should be used with caution, as such calculations may not reflect the actual age of a particular animal. Growth rates of individual unionids, as with all bivalves, can vary substantially, even among siblings living side-by-side. Age calculations provide an average of the estimated age of animals of a specific size class for a particular species in each lake. Actual age determinations must rely on shell sections and must consider local conditions. Age estimates rely on annuli formation, which depending on temperature, food supply, and many still unknown variables, may not be annually deposited. For the purposes of this study, considering winter temperatures and detailed examinations of the shell matrix, we have assumed that internal annuli, consisting of dark proteinaceous bands alternating with light highly mineralized bands are being formed on an annual basis, with the proteinaceous bands indicating the winter season (Figure 22). Spawning checks and other disruptions or cuts through the matrix do occur, but patterns of band periodicity and disruption of the shell matrix are visually quite different. We have also assumed that shell readsorption (reduction in shell length) is minimal, even in old animals.

We used ANCOVA to test if the differences in regression slopes were significantly different. The tests showed no significant difference ($p \leq 0.05$) in growth rates of either *Pyganadon spp*. or *Lampsilis spp*. between lakes (Figures 24-25). *Pyganadon spp*. do grow significantly faster ($p \leq 0.05$) than do *Lampsilis spp*. in all lakes. *Elliptio spp*. only occur in Grand Sable Lake.

We used the estimates of age, and the basic length frequency data, to determine year class distribution, recruitment patterns, and the percent of the population that had not yet reached sexual maturity. Age of sexual maturity is easily determined in the *Lampsilis spp*., as the directional planes of shell growth can be seen to alter once reproduction begins. This occurs at about years 5 to 7. Age of sexual maturity is less easily determined in *Pyganadon spp.*, but is also believed to occur between 4-5 years of age.

Year class distributions show recruitment has occurred almost yearly for both *Pyganadon spp.* (all species combined) and *Lampsilis spp.* (all species combined) in Big Beaver, Kingston, and Little Beaver lakes (Figures 20-21, and example in Figures 26-27). Only minimal recruitment has occurred in Grand Sable Lake for any of the unionid species. Both the length frequency and estimated age class distributions for *Pyganadon spp*. and *Lampsilis spp.* form a bell-shaped curve in Big Beaver and Little Beaver lakes, but this curve is skewed to the right (Figure 26-27). If age of sexual maturity is at year 5, as we have assumed, then a majority of the year classes for *Pyganadon spp.* are older--66% > age 5 in Little Beaver and 74% > age 5 in Big Beaver Lake. The situation is different in Grand Sable, as over 66% of the *Pyganadon spp*. were younger than 5 years of age (very few animals found).

Figure 26. Comparison of age class and length frequency for *Pyganadon spp*. in Big Beaver Lake. Moving average used to group age classes (5 year average).

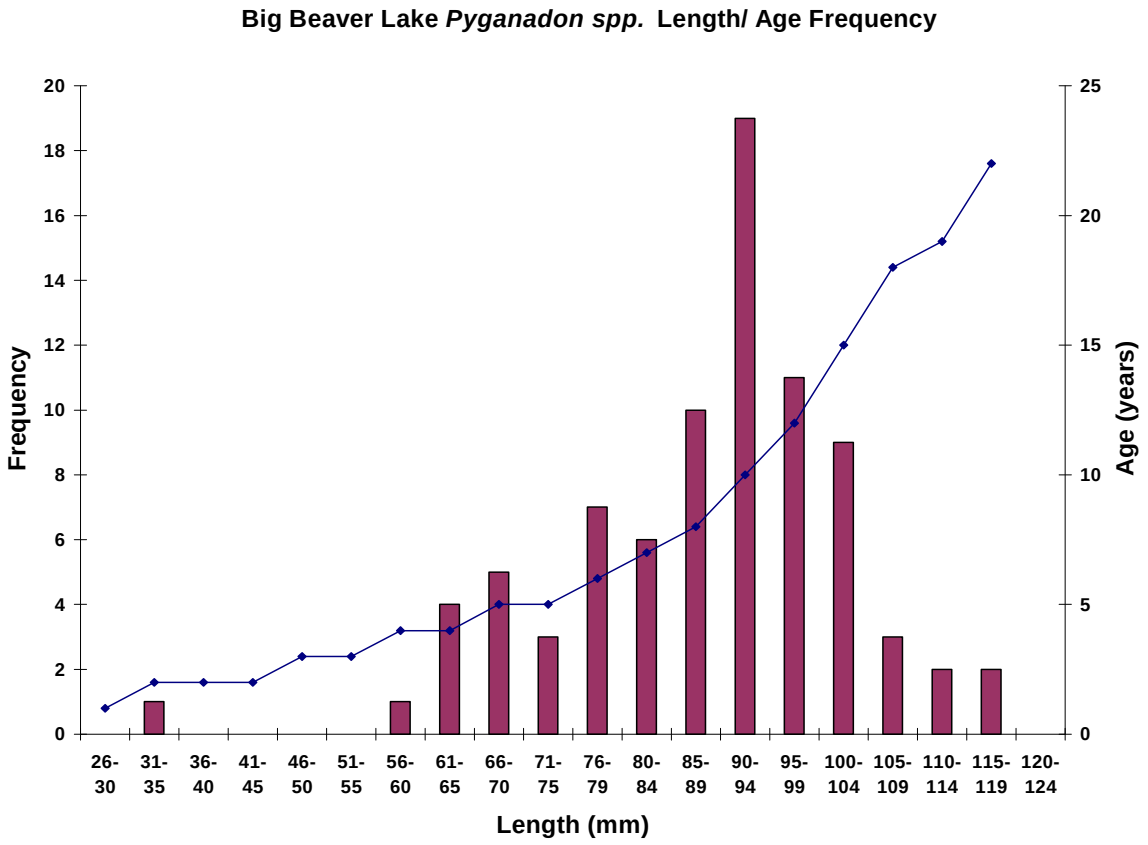
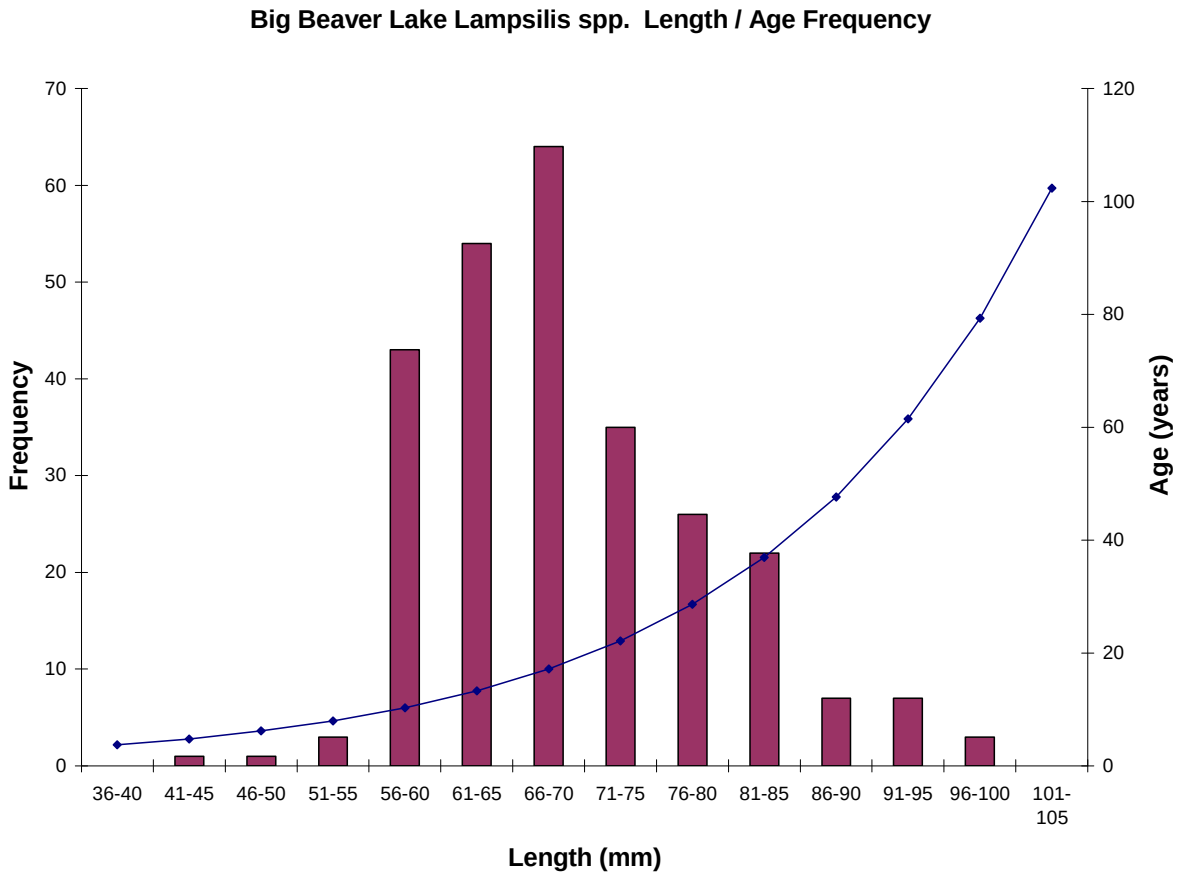


Figure 27. Comparison of age class and length frequency for *Lampsilis spp*. in Big Beaver Lake.

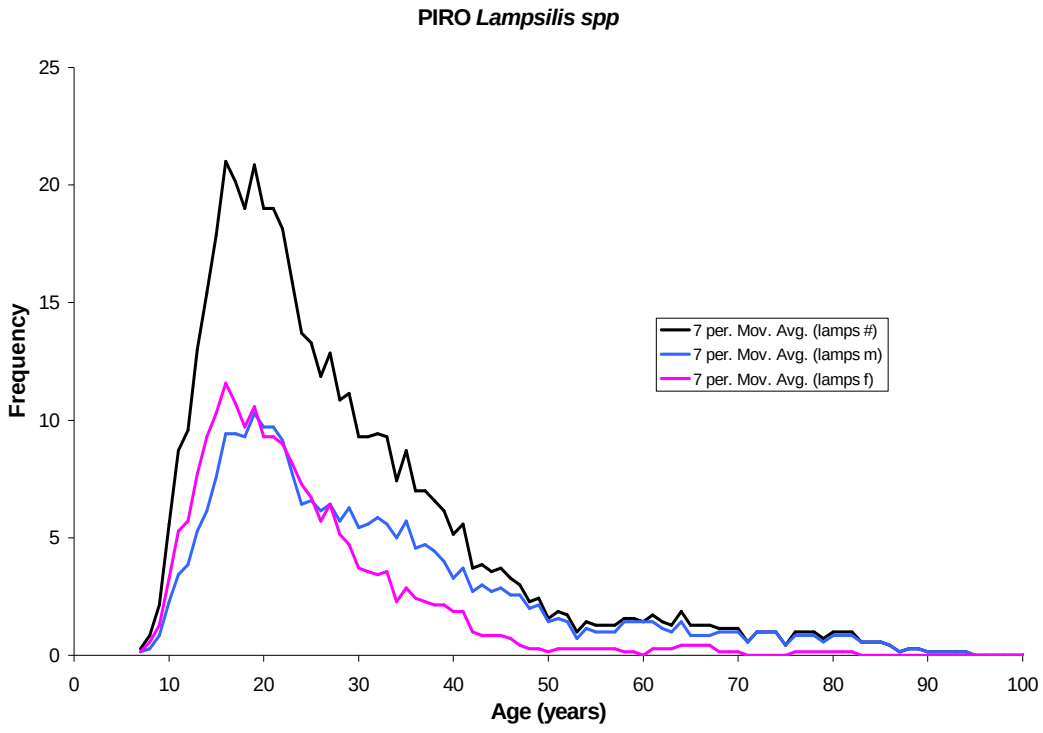


Length and age class distribution in *Lampsilis spp*. was further skewed towards older animals. No <5 year old *Lampsilis* were collected in any lake, but a number of 7-9 year old animals were. If we set the barrier at year 10, then 89 % of the animals were >10 years of age in Big Beaver, 85% in Little Beaver, 51% in Grand Sable (only found 5 *Lampsilis spp*. total of any age) and 99% in Kingston. Considering the consistent pattern of recruitment seen in this lake, the lack of young animals likely represents difficulty in sampling rather than lack of recruitment. Young unionids are often buried deeply in the sediment.

The *Elliptio spp*. in Grand Sable show no signs of recent recruitment in over 25 years. The smallest *Elliptio dilatata* found in the sampling grid was 48 mm long and estimated to be 26 years old. There is an unverified identification by Mr. Brian Carter of a 19 mm *Elliptio spp*. found, and left *in-situ* in the southern end of the lake. If this identification is accurate, then this animal would be approximately 10 years old. *Potamilus alatus* was not considered or dealt with further since only one animal was found.

A pattern seen in all the lakes, except Grand Sable, is an apparent shorter life span for female *Lampsilis spp*. (Figure 28). The numbers of females decline precipitously after they reach about age 25. This pattern has not been reported in the literature, but is also seen in Isle Royale *Lampsilis spp.*

Figure 28. Age distribution of male and female Lampsilis spp in Big Beaver, Kingston, and Little Beaver lakes, 1999.



Chemical Contaminants

Only trace amounts of p,pDDE and a few PCB congeners were found in tissues of the clams tested, from any lake (Appendix 5). Though detectable, the levels found are well below any concentrations of concern. Location or species differences were not detected, but sample size was low. Metal contaminants were also not at high enough levels to cause concern; concentrations are listed in appendix 5.

DISCUSSION

With one exception, the unionid populations inhabiting the waters of Pictured Rocks National Lakeshore are healthy, stable communities, composed of multiple year classes, exhibiting successful recruitment. The exception is the population in Grand Sable Lake. This community contains several species found nowhere else in the park and is on the verge of extirpation.

Unionid species composition found in PIRO is limited, but typically reflects lake populations in other parts of the Midwest. While these species are currently considered common, their range is being rapidly reduced throughout the Great Lakes drainage due to the range expansion of zebra mussels. Unionid populations within the Great Lakes proper suffered devastating losses from zebra mussels and food web changes, and have been almost completely destroyed in Lake Erie and Lake St. Clair. Severe population reductions are now occurring in lakes Michigan and Ontario. Zebra mussels are now found in 160 lakes in Michigan and in most of the lake-connected river systems. Unionid extirpation usually occurs within 5 years after zebra mussel invasion. The “common” unionid species in PIRO may within 10-15 years become key remnant fauna.

Unionid distribution in PIRO is somewhat atypical in that lakes, not streams, provide the only habitat available. Our hypothesis is that the streams in the park cannot support unionids because of the severe winter temperatures. These streams all flow over bedrock, with only shallow sand or gravel substrates, thus providing no area for the unionids to burrow into during the winter to avoid low water temperatures, freezing, and ice scour. Similarly, small shallow lakes such as Trappers Lake support only a few unionids because the lake freezes almost completely during exceptionally cold winters.

Our hypothesis that these populations are stable and "healthy" are based on a number of factors, such as the wide range in ages/lengths (from 2-145 years), the multiple numbers of year classes, and the presence of gravid females. The low numbers of young unionids found, those <5 years of age, is a common problem in unionid population studies. Young unionids are frequently buried deep within the sediments and are difficult to collect. However, the large number of year classes indicates that, unless radical changes occur in habitats or with the fish fauna, recruitment should continue.

Overall, Big Beaver, Chapel, and Little Beaver lakes support the largest number of unionids in the park. Big Beaver Lake contains the largest number of unionids lake-wide, but does not have the highest number of clams per square meter. This discrepancy is due to the amount of lake bottom available for colonization. In all of the lakes, the unionids consistently colonized the area above the thermocline. Thus, in Big Beaver, where the thermocline forms deep, unionids colonized a larger percentage of the lake. In contrast, in Grand Sable, the steep depth gradients and shallow thermocline compress available habitat close to shore.

There are two items of interest with these populations where we do not have enough information to formulate a reasonable hypothesis. The first relates to densities. The maximum density of clams found in PIRO was $3.37/m^2$ (Table 5). This is much lower than the maximum density of clams seen in Isle Royale lakes (maximum density $33/m^2$). We are not sure why unionid densities in PIRO are not higher, and why all available habitats are not completely colonized. We certainly can speculate, regarding differences in lake morphology, historical watershed manipulations, differences in fish stocking rates, etc. The lack of historical data on unionid densities makes it impossible to formulate a reasonable hypothesis.

The second problematic item relates to the lower life span of female *Lampsilis spp*. (Figure 28). This shorter life span of females has not been reported or observed in any other population. This does not mean that this isn't a natural phenomenon. Just that it has not been reported elsewhere. We are in the process of determining if this occurs at ISRO.

Organic contaminant concentrations in unionid tissues are low in all the lakes. At this time, contaminants are not a problem.

Grand Sable Lake

The unionid fauna in Grand Sable Lake is on the verge of extirpation. We were only able to find 19 live clams during 3 days of quantitative sampling. We also found 15 relatively recently dead animals (based on shell erosion), probably died within one-two years). The other lakes sampled had a much lower ratio of live to dead animals for all species: Big Beaver Lake 343 live/19 dead; Kingston Lake 99 live/7 dead; Little Beaver Lake 277 live/28 dead.

The first problem in interpreting the status of this fauna is the lack of previous data on population structure and densities. Anecdotal information provided by Mr. Brian Carter indicates that at least *Elliptio spp.* used to be more numerous in the lake about 30-40 years ago. However, as seen in Tables 3 and 4, ALL unionid species are uncommon, not just *Elliptio spp*. Although numbers are low, length frequency distribution was not compressed. We collected two size classes of *Elliptio complanata*, four of *E. dilatata*, four of *Lampsilis spp*, and six of *Pyganadon grandis*. This is an excellent size distribution considering the low number of live animals seen. Assuming that each size class represents a different age class, reproduction is occurring in this lake, at a very low rate. However, while recent recruitment has occurred in *Lampsilis spp* and *Pyganadon grandis*, the youngest *Elliptio spp*. collected was 25 years old. Recruitment within *Elliptio spp.* is so minimal as to be practically non-existent.

A number of factors could be reducing Unionid numbers. One hypothesis is that this lake never supported a dense, lake-wide unionid community such as occurs in Big Beaver Lake. This limitation in Grand Sable could relate to the cold, oligotrophic nature of this lake slowing growth and reproductive frequency in combination with habitat limitations and human interference. Preferred habitat is substantial in overall area, but very compressed against the shoreline. As in the other lakes, the unionids in Grand Sable are located above the thermocline, which in this lake concentrates the animals in the 5-10’ littoral zone. This depth gradient comprises 23 hectares, more than in any lake, but

this represents only 8% of the available area. As seen in Figure 7, this depth gradient forms a thin ribbon-like edge to the lake. This preferred water depth is most common along the eastern shoreline, where the old swimming beach and boat ramp are located, and where the new road expansion and shoreline armoring occurred.

Another factor that cannot be discounted is the stocking of lake trout into the lake, and the subsequent crash of the yellow perch population. There are two possible effects from this introduction. The first is that the precipitous decline of yellow perch, which are a preferred host fish for unionid glochidia, prevented successful unionid recruitment. This would be a major problem for *Elliptio spp*, which use yellow perch as a fish host. While some yellow perch do still survive in this lake, there are such limited littoral areas and shoreline cover that the likelihood off successful glochidial attachment and release while the fish remains in the shallows is limited. Furthermore, while trout have been known to serve as host fish for some unionid species, these fish remain in deeper waters, where any released unionid larvae would not survive. Prior to trout introduction, the high density of yellow perch populations must have increased the likelihood of unionid larvae successfully completing development on a fish that remained in shallow waters.

We had initially assumed that the crash of the yellow perch fishery may have altered the food web of the lake by permitting zooplankton populations to rise to such levels that phytoplankton, an important unionid lipid source, were no longer available. However, additional shell sectioning has not been able to detect a difference in growth rates between animals in Grand Sable and those in other lakes (Figures 24 and 25). While food web changes undoubtedly occurred, food is not a factor in the low numbers of unionids in Grand Sable.

Human interference cannot be discounted as a problem causing historical reduction of this fauna. Mr. Brian Carter has indicated that many years ago, at least the *Elliptio spp*. were harvested by local kids since one of his friends found a large pearl in one of the mussels. We suspect that after this pearl became common knowledge many more unionids in the area were harvested and destroyed. Such harvesting may have amplified problems facing a population that had a naturally slow recruitment rate.

The value of the Grand Sable population is that *Elliptio spp*. are found nowhere else in the park. There may be several ways to stabilize this population, depending on

what is causing the limited population densities. For example, if low unionid densities are due to a fish host problem then one option would be to increase the stocking of an acceptable fish host such as yellow perch. But more is involved in clam recruitment that just the presence of a fish host. First, the fish must come into contact with a gravid unionid. Second, the fish infected with unionid larvae, or glochidia, must remain close to shore if the mature glochidia is to be released in suitable habitat above the thermocline. Clustering a few unionids in the littoral zone (5-10ft) and adding fish attractors such as brush piles may improve the chance that gravid adult unionids would come in contact with the fish host, and that maturing unionid larvae would be deposited in suitable habitat. If human interference has been a factor in suppressing unionid numbers in this lake, in combination of course, with other factors such as low growth and recruitment rates, then protecting these animals may require the establishment of a few sanctuaries, increased public education, keeping the swimming beach closed, etc.

Future Threats To PIRO Unionid Populations and Recommendations

There are a number of threats that may affect the future of the unionid populations in PIRO.

I. **Exotic species**. The main threat facing these unionids is the possibility that exotics species such as zebra mussels or round gobies will inadvertently be introduced into the lakes. Zebra mussels comprise the greatest threat, since once established in the lakes, their biofouling and food competition would result in rapid extirpation of the entire native clam fauna. The impact of round gobies would be subtler, through the displacement of the clam's native fish hosts. The presence of *Bythotrephes* in Big Beaver Lake indicates that vector pathways are present and open.

   These vector pathways involve human transport from an infected lake, likely Lake Superior into the inland lakes. Natural migration from Lake Superior inland, would be unlikely since outlet streams leading from the inland lakes into Lake Superior tend to end in high falls that could not be easily circumvented. Human vector activities include transport of boats infested with zebra mussels into inland lakes, use of live bait, particularly that captured by the fisherman in Lake Superior, that might contain

zebra mussels, round gobies, or rusty crayfish, and of course, intentional introductions by fisherman who have been told that zebra mussels increase fish populations.

Recommendations:

1. We recommend that use of live fish bait (except worms or grubs of various types) be banned from inland waters.
2. We recommend that NPS rangers examine boats and trailers at campgrounds during their regular rounds to check for presence of attached zebra mussels or aquatic vegetation that might harbor zebra mussels.
3. We recommend yearly surveys for zebra mussels around public access sites in all inland lakes, whether native clams are present in those lakes or not. Early infestations can be eliminated quickly by crushing the zebra mussels. Not all introductions become established populations!
4. We recommend an increase in public awareness/education efforts to prevent the spread of zebra mussels and round gobies. There is considerable educational material already prepared by Minnesota and Michigan Sea Grant programs and of course, the new NPS Exotic Species coordinator, Linda Drees is familiar with this type of material and can provide further assistance.
5. We recommend that any SCUBA divers or snorkelers using inland lakes be questioned regarding previous contact with infested waters, and encouraged to wash all gear in hot water and dry everything between dives in Lake Superior and inland lakes.
6. We recommend that any research crews be strongly encouraged to follow decontamination procedures when moving between lakes. There are a number of decontamination protocols in existence, one of which we have, or contact Linda Drees for more information.

II. **Fish Community Integrity.** Unionid recruitment and population densities appear to be better in lakes with high numbers of yellow perch and sunfish. Activities that

might lower yellow perch numbers, such as stocking lake trout, over harvesting of yellow perch, etc, should be minimized.

The Grand Sable Lake unionid population would likely increase if large numbers of yellow perch and sunfish, as well as other small non-game fish species could be reestablished in that lake, and if fish attractors such as brush shelters or rock piles were constructed in the littoral zone to keep perch in prime unionid habitat.

III. **0-10 ft Depth Contour**. This depth zone supports the largest number of unionids in any of the lakes, and in some lakes is the only zone colonized. This colonization preference relates to a number of factors, such as ice cover and thermocline. However, disruption and construction of structures, roads, etc., into this depth contour may eliminate much needed habitat.

IV. **Future Sampling.** Routine unionid surveys in Big Beaver, Kingston, and Little Beaver lakes should be conducted every ten years or so, to detect any changes in the basic unionid fauna. This is especially critical if other studies show a dramatic increase in otter populations. Predation on unionids by otters was noted in Big Beaver Lake, but is at this time, minimal.

Grand Sable Lake populations need more frequent surveys to monitor recruitment.

As mentioned previously, it is critical that surveys for exotic species be conducted yearly and containment and eradication programs established.

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APPENDIX 1.

Detailed Study Plan Including Quality Assurance/Quality Control Project Plan (QAPP) For:

A SURVEY OF UNIONID MUSSELS IN THE AQUATIC SYSTEMS OF TWO NATIONAL PARK SERVICE UNITS: ISLE ROYALE NATIONAL PARK AND PICTURED ROCKS NATIONAL LAKESHORE

July 7, 1999

Prepared by: Approval Signature: Date:

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Project/Task Organization:

Key personnel and organizations that are involved in the project include:

Principal Investigator and Project Leader
Susan Jerrine Nichols, USGS, BRD

The principal investigator will be assisted by other BRD staff including, but not limited to: Michael Stewart, USGS, BRD, Indiana Dunes National Lakeshore (general project assistance); Mike Schloesser, USGS, BRD, Ann Arbor (general and malacological assistance); and Mike Hoff, USGS, BRD, Ann Arbor (statistical assistance)

Park Service Representatives involved in the project include:

Lead Contact/Project Coordinator for Isle Royale National Park
Jack Oelfke

Lead Contact/Project Coordinator for Pictured Rocks National Lakeshore
Brian Kenner

Technical Contact for the National Park Service Water Resources Division
Roy Irwin, NPS, WASO, Fort Collins, CO.

Data users will include the Park Service Staff, USGS staff, others doing bivalve studies in the region, and the general public.

Problem Definition and Questions to be answered:

The first six questions are qualitative and semi-quantitative questions. Questions 7-10 are quantitative questions related to establishing baseline condition status for later comparison with subsequent changes and possible determination of long-term trends:

12. What unionid and other easily identified species of bivalves are present in representative lakes and streams on ISRO and PIRO?

13. At all sites sampled, what is the abundance classification of each species (rare, common, or very abundant)?

14. At these same sites, which species fall into quickly ascertainable age classifications (i.e., juvenile, adult) based on size? Which species are actively recruiting?

15. What is the overall status of the population- stable, marginal, or at-risk?

16. With certain caveats, at these same sites, which of the unionid and other bivalve species fall into classifications such as native, non-native, pollution/disturbance tolerant or intolerant, rare, ecological sentinel species, or undesirable species?

17. What are the key environmental variables at each habitat sampled and are specific unionid communities associated with certain variables? Variables to be considered will be such things as which fish are and other aquatic organisms are present in the same area, type of substrate, dissolved oxygen, total calcium, pH, secchi depth, water depth, and water velocity,

18. What is the quantity of each species present based on randomized quadrats or transects?

19. What is the annual incremental increase in shell length, or growth rate, for each species (based on dead shell- may not be possible for all species or for any endangered species)?

20. What proportion of the population sampled is composed of individual unionids <5years of age?

21. What is the amount and type of chemical contaminant present per gm of soft body tissue for each species sampled.

Management. regulatory or additional study decisions or potential actions that might hinge on the results of the study include deciding:

4) if unionid and other bivalve populations in various Park lakes are in good shape, appear to be under stress, or are at risk based on current status.
5) what type of long term monitoring of unionids and other bivalves is needed (if any) to keep an eye on trends. In the final report, the Parks would like the principle investigator to make specific recommendations on the frequency of monitoring needed (in any), where/what to monitor, and specific monitoring protocols, etc. The recommendations should be very specific so that any Park Service natural resource manager in the future could understand what needed to be done to adequately document trends
6) whether or not to try to eradicate or otherwise manage non-native bivalve species, hosts, or other biota that might be threatening native bivalve species.
7) what other management actions (if any) should be taken to see that unionids and other bivalves in ISRO and PIRO are protected according to NPS mandates.

Background Information and Previous Data:

The only background mollusk work available from ISRO was a report on the mollusks, mainly gastropods, found on the island (Walker, 1909). There is no existing unionid work available from the streams and lakes of PIRO. Probable mussel species that may be found at Isle Royale National Park and Pictured Rocks National Lakeshore are listed (Table 1, Dave Heath, WI DNR. A request to the Ohio State and Michigan State Mollusc Collections is ongoing to determine if unionids from these sites are present in their databases.

Previously collected data bases on environmental parameters (chlorophyll *a*, pH, secchi depth etc.) and fish communities for waters sampled will be examined and compiled for comparison with the unionid data collected by our survey.

Some initial "range-finding" and exploratory sampling will be done at PIRO to try the proposed methods and determine data variability (which can drive the number of samples needed). At this time, an effort will be made do fine tune optimum field methods and other study details. The QAPP may be modified based on the results of these exploratory efforts or the discovery of additional previous information or newly identified expert opinion.

Data Quality Objectives (DQOs):

General Introduction and Discussion of DQOs for Qualitative Questions (1-6):

The questions being asked are general ones. The information being collected is not being collected to respond to litigated issues or other issues expected to be especially contentious or otherwise be subject to any unusual scrutiny. The data is not being collected in response to Superfund (CERCLA) or Natural Resource Damage Assessment laws or other rigid processes that require particular protocols to be followed. So the guiding principal for DQOs in this project is simply scientific and general common sense (for example, does it pass the common sense and being able to say it with a straight face tests?) credibility. The questions being asked (see listing above) were divided into questions requiring qualitative versus quantitative answers to provide scientific credibility. For this modestly funded project, the QA/QC measures detailed in this plan should be adequate to insure that data collected will be of sufficient quality to answer the identified question(s) in a defensible manner. Precision, Accuracy, Representativeness, Completeness and Comparability (PARCC) terms are defined for qualitative and semi-quantitative questions as follows:

Precision: The variability of each set of repeat measurements will be quantified to give a simple indication of the precision (or lack thereof) of each method used. Precision is a measure of scatter among independent repeated observations of the same property. Using standardized protocols, optimal standard methods developed by an advisory team of experts, and trained teams, as specified herein, will all help minimize precision errors. In cases where many trial replicates are made, precision will be expressed as a standard deviation or relative standard deviation for normally distributed data or as some other measure of variability when the data is not normally distributed. In the case of the qualitative questions 1-6, reasonable quantitative DQOs are difficult to predict before the study is done. Also, the modest funding makes a high number of replicate trials impractical. Therefore, the professional judgement precision QC step taken for questions 1-6 will be that the principal investigator will present the results to at least one other malacologist and have that other person independently classify the results. The precision of the classifications made will be expressed as relative percent difference (RPD). The RPD is the larger value minus the smaller times 100 divided by the larger minus the smaller divided by two. The data quality objective is that the classifications will represent the best professional opinon of the principal investigator after getting an independent opinion of another malacologist and explaining the relative percent difference of opinions. The initial DQO for precision in the qualitative and semi-quantitative measurements is a relative percent difference (RPD) of 25% or less. In addition to this "professional judgement DQO", the following additional DQOs will be met to help insure adequate precision:

Precision will be estimated from repeated measurements. The investigators will ensure that 5% of the samples are resampled during the study by another team. In the case where use of a different team is impossible, such as dive samples in remote areas, the same team will repeat the sample immediately after the first sample is collected. Some of the samples will require cleaning and picking of young mussels from the sediment

collected. Each sample collected in this manner will be checked for completeness. Repeat samples will be handled the same as the original sample. The 5% of samples collected to check repeatability by the same team (or reproducibility among different teams) will meet a precision DQO of a relative standard deviation of 10% or less for repeatability (within team variation) and a precision DQO of 20% or less for reproducibility (between team variation).

Accuracy is a measure of confidence in a measurement. *Precision* and bias contribute random and systematic error in a measurement that together can negatively impact accuracy. Measurement accuracy can be determined by comparing a sample that has a known value, such as a standard reference material to the measurement result for that sample. Accuracy = average value minus the true value. For qualitative parameters such as secchi depth and macroinvertebrate abundance, however, no standard reference or performance evaluation exists. In these cases, the trainer's results will be considered the reference value and to which the trainees' results are compared. The DQO for accuracy in the qualitative and semi-quantitative measurements is a relative percent difference (RPD) of 25% or less.

Representativeness: The representativeness assessment is being done to insure that the data will be "representative" of the actual condition measured. Representativeness is defined as the degree to which the data represents a population parameter. This is affected by problems in any, or all, of the other attributes of data quality. Representativeness is also affected by the selection of sites to be sampled, the location of sites in a reach, and the time period when samples are collected. The random-stratified sample design is intended to maximize representativeness. The final study design will be reviewed by statisticians and study design experts to assure that the results are as representative as possible. The DQO for representativeness is to insure that the data is as representative as practicable by carefully following the randomization and other study design details (documented herein) that insure probability samples will be collected. If this is done, the data quality objectives for representativeness for the qualitative questions will be considered to have been 100% met.

Completeness: In a simple sense, completeness is a measure of the number of samples taken compared to the number originally judged to be needed to use the information. Valid data must be acquired from a minimum number of sites in order to make population estimates with a specified level of confidence. To calculate percent completeness (%C), we will divide the number off measurements that have been judged valid by the total number of measurements originally agreed upon as being needed and then multiply by 100. The DQO for completeness in the qualitative and semi-quantitative information is a percent completeness of 80%.

Comparability: Comparability is the extent to which data from one study can be directly compared to either past data from the current project or (better yet, and often absolutely necessary to examine trends or regional significance) to data from another study. It is difficult to interpret the meaning of data if the methods used are so unique that there is no comparison data available. Therefore, our "comparability" QC will insure that lab and field methods are similar enough to those used by other investigators to insure that data

will be "comparable" to high-quality data from other studies. The use of QA data, uniform training of field crews, and incorporation of team duplicate sample sites into the study, will all help insure comparability. Before study methods are finalized, an effort will be made to standardize our methods with those used in other studies in the state (the Michigan Mussel Committee), so that new data is comparable. The DQO for comparability in the qualitative questions is to insure that the data is as comparable as practicable by carefully following study design details documented herein. If this is done, and the data is therefore at least 95% compatible (RPD of 5% or less) with at least one other important data set in the region, the DQO for qualitative questions will be considered to have been 100% met.

Taxonomic accuracy is critical to all the questions being considered in this project. Standard operating procedures used to help insure taxonomic accuracy include the specification of the taxon level (species), the specification of appropriate taxonomic reference material, and voucher specimen collections. The DQOs for precision and accuracy in taxonomic identification are:
1) a relative percent difference of 5% or less between the identifications of the principal investigator and a museum taxonomic expert at the University of Michigan or other institution of equal or better reputation in the identification of bivalves, and 2) a relative percent differences of 10% or less between the identifications of the principal investigator and any others who help identify the bivalves in this project.

DQOs for Quantitative Questions (7-10):

DQOs for question 7 (What is the quantity of each species present based on randomized quadrats or transects.

> Data collection for this question will involve destructive sampling, so precision and accuracy DQOs are difficult to develop. However, for this modestly funded project, the QA/QC measures for training, representativeness, comparability, and other PARCC parameters detailed elsewhere in this plan should be adequate to insure that data collected will be of sufficient quality to answer the identified question(s) in a defensible manner. During the initial stages of field sampling, the principle investigator will see if any practical quantitative DQOs for this type of data can be developed.

DQO for Question 8 (What is the annual incremental increase in shell length, or growth rate, for each species?):

> The SOPs call for each shell section to be aged independently by two different people. The expert trainer will be considered to produce the correct value. The comparison results of the all the others doing this procedure (after training is complete) shall have a precision DQO of a relative standard deviation of 10% or less.

Each trainee shall also have an accuracy DQO of a relative percent difference (RPD) of 10% or less compared to the results of the expert.

DQOs for Question 9 (What proportion of the population sampled is composed of individual unionids <5years of age.

The SOPs call for each shell section to be aged independently by two different people. The expert trainer will be considered to produce the correct value. The comparison results of the all the others doing this procedure (after training is complete) shall have a precision DQO of a relative standard deviation of 10% or less. Each trainee's results shall also have an accuracy DQO of a relative percent difference of 10% or less compared to the results of the expert.

DQOs for Question 10 (What is the amount and type of chemical contaminant present per gm of soft body tissue for each species sampled?):

Analysis techniques and QA/QC protocols to be used are described in Schmidt (1997), Schmidt and Hesselberg (1992), and Wilford et al. (1973). See Table 2 for detection limits.

QC samples used to help measure precision will include field and laboratory splits and duplicates. When more than two replicate measurements of the same sample are made, they are will be referred to as field (measuring both analytical and field precision) or lab (measuring precision of the lab analysis only) splits. As simple descriptive measures of variability, the relative standard deviation will be used to express the precision of repeated measurements of the same thing. When only two replicates are used, they will be referred to as duplicates and precision will be measured as the relative percent difference (RPD). The precision DQO for duplicate chemical analyses is 25% (or less) RPD. The precision DQO for spits chemical analyses is a 25% (or less) relative standard deviation. If the data seems to be from a non-normal distribution, quartiles will be used rather than 25% relative standard deviations.

Accuracy is a measure of confidence in a measurement. Measurement accuracy will be determined by comparing a sample that has a known value, such as a standard reference material to the measurement result for that sample. In the chemical analyses, QC samples will be used to help measure accuracy. The QC samples will include spikes (samples where the concentration of the chemical are known exactly. Percent recovery of the spiked material will be used to calculate analytical accuracy. The DQO for accuracy will be percent recovery of the laboratory control sample of 75-125%.

Representativeness: The representativeness assessment should insure that the data will be "representative" of the actual condition measured. Samples will be randomly selected to insure probability sampling. Precautions will instituted to make sure that samples neither add nor lose the contaminants being measured in

transit from the point of collection to lab analysis, so that the concentration measured is actually representative of the concentration which was present in the field. QC chemical samples used to help measure representativeness will include field blanks, equipment blanks, and rinsate blanks. The DQO for representativeness of chemical samples is a relative percent difference of 5% or less for each comparison of the sample blanks versus the controls.

To make sure the data is representative by avoiding false negatives, the following additional representativeness DQO will be used: 95% of all chemical analyses shall meet the following detection limits:

> Hexachlorobenzene, α- and γ-BHC, aldrin, dieldrin, endrin, α- and β-heptachlor epoxide, cis- and trans- nonachlors, p,p'-(DDE, DDD, and DDT), mirex (including 8-monohydro mirex), α- and γ-chlordanes, oxychlordane, toxaphenes (Cl 6 to Cl 10), and all other organochlorines not specified otherwise. Detection limits should be as low as state of the art permits and in no case higher than comparison benchmarks or higher than 0.01 ppm wet weight PQLs in tissues.
>
> Mercury: PQL detection limits 0.01 ppm (or lower) dry weight in tissues.
>
> Pentachlorobenzene, octachlorostryene, dacthal, and pentachlorophenyl methyl ether: Detection limits should be as low as state of the art permits and in no case higher than comparison benchmarks or higher than a PQL of 0.01 ppm wet weight in tissues.
>
> PCBs : Detection limits should be below the comparison benchmarks, by a factor of 10 whenever possible. Tissue detection limits in the ppb range are now possible (ATSDR. 1999. Toxicological Profile for Polychlorinated Biphyenyls). In no case should the PQL detection limits be above 0.05 ppm.

Completeness is defined as the percentage of measurements made that are judged to be valid according to specific validation criteria and entered into the data management system. Every effort will be made to avoid sample or data loss through accidents or inadvertence**.** The DQO for completeness in the chemical quantitative data is a percent completeness of 90%.

Comparability is addressed by utilizing standard EPA protocols from SW-846 guidance or the USGS Denver Water lab. When better methods are used, for example clean lab mercury methods with lower detection limits, only those methods which have already been used widely and gained scientific acceptance will be utilized. The (meta data) method details will be provided in the final report, along with a rationale explaining why the alternative methods are superior to standard SW-846 or Denver USGS water lab methods. The DQO for

comparability for chemical data is that 95% must meet the criteria specified in this paragraph.

The initial DQOs specified above may be modified by the principal investigator with the approval of Park Service contacts if the results of the initial investigations at Pictured Rocks National Lakeshore indicate that modifications are necessary.

Implementation plan details. A summarization of project tasks and standard operating procedures (SOPs):

Approach and Methods

Although species richness in qualitative timed searches and in quantitative quadrat searches are correlated, more mussel species can be found in timed searches than in quadrat searches (Vaughn et al. 1997). Timed searches tend to overestimate obvious species and underestimate the less easily seen species. Quadrats will underestimate rare species and the total number of species, unless a very large number of samples are collected. A previous study required. 368 quadrats at a site to achieve a 95% confidence level (Vaughn et al., 1997). Therefore, we intend to use a combination of these methods as suggested by Vaughn et al. (1997). Finding the unionid beds in each river or lake and then concentrating quadrat sampling in these locations is a method that combines both qualitative and quantitative methodology.

SOPs for Site selection and Overall Study Design:

For qualitative sampling, the location of sampling sites chosen to survey within each habitat and park will be based on (1) A minimum of three sample sites (lentic, lotic and littoral zones) within each habitat type in each park, selected from literature and reconnaissance searches, and (2) a minimum of three sites within each habitat type will be surveyed by qualitative techniques. Qualitative sampling is faster and cheaper than quantitative and thus more sites will be covered.

For quantitative sampling, a minimum of three sites within each habitat type will be selected for quantitative sampling. This will be based on resource management recommendations and on both random and non-random lake stratification parameters.

Initially, sites will be chosen non-randomly to maximize our ability to locate unionid populations. The selection criteria to be used are as follows: first, waters known to contain unionids based on shell found in the area by either park personnel or other research teams. If a number of such sites are present, those waters connected to one of the Great Lakes or suspected of being infested with zebra mussels will be sampled first (sites at maximum risk). The second selective criteria will be to sample waters with previously collected information on habitat, fish communities, and water quality information.

However, since one of the goals of this unionid survey is to provide a data base that can be used to test developing national unionid-specific IBI and ICI strategies, we will overlay these non-random site selection criteria with a random site stratification and selection system. The selection system entails grouping lakes and streams into functional classes based on habitat characteristics obtained from previously collected data provided by the parks. These characteristics include habitat such as water depth, clarity, chlorophyll a, pH, temperature regimes, hydrology patterns, fish populations, etc. We will overlay the waters we have sampled with these groupings and ensure that

representatives of each group have been sampled. We will then use principal component analyses to compare populations/ habitat, or use a non-parametric statistics if unionid populations are minimal. This type of information should provide baseline information for predicting unionid communities in park waters that we were not able to sample, but for which habitat data is available.

The divers will be placed on a line across the stream or lake and will float as much of the water body as possible searching for unionids. Once unionid beds are located, a square meter grid will be set-up across the entire bed, if possible, or at least 100 square meters of the bed (chosen randomly if bed is larger than this). The divers searching for unionids within the grid will sample the entire grid on timed surveys (15 min/diver for a maximum of 30 min/100 sq. meter grid). Species type, shell length, sex (if shell dimorphic) gravidity, and any other characteristics will be noted for every animal found.

A further 10% of the grids will be excavated. A grid will be selected, then a ¼ m quadrat frame placed randomly in it, and the entire substrate down to a depth of 15 cm removed, sieved and replaced if possible in the quadrat. All unionids will be identified and any juveniles that cannot be identified will be photographed and returned to the substrate. Once the unionid beds in each water body have been sampled, an equal number of 100 square meter grids will be placed randomly in areas where no unionid beds are found, and sampled as described above.

If no concentrated unionid populations are found in the water body, then 10-10x10 m^2 will be randomly placed in the water body, across various depths, and 100% of each 10x10 m^2 grids will be examined as described above, and a further 10% excavated.

Once waterbodies are clustered into groups, we will randomly choose examples from each group, and compare and contrast unionid populations from each group. This system will be field tested at Pictured Rocks, where access to sampling sites is easier. This dual sampling regime will provide a model for estimating potential unionid communities in waters that cannot be sampled directly.

Initial sampling techniques focus on finding the unionid beds in each river or lake and then concentrating quadrat random sampling within these strata.

<u>SOPs for sampling in large water bodies:</u>

Random ‘statistical’ sampling techniques will be used in water bodies too large for a total and complete float by the SCUBA divers. We will use transect lines to cut across potential longitudinal aggregations of unionids. This method involves sending the diver on randomly selected compass headings from one side of the water body to the other, or from the center of the water body to one shoreline. Five transects per 90° on the compass rose will be chosen randomly. Quadrat locations along this transect line will be chosen randomly, but one within every ten meters. Each quadrat will be fully excavated to at least a depth of 15 cm and all substrate material sieved. All unionids will be handled as described above.

These two sampling methods will be compared and contrasted for sampling bias at one lake and one stream in PIRO, which is more easily accessible and if possible at ISRO. This should enable us to predict the probability of finding unionid populations using statistical sampling at both parks.

Sampling methods will be modified according to the habitat that is surveyed and will include both stratified random sampling techniques and statistical sampling techniques using SCUBA divers or snorkelers (when water depth is <1.5 m). The dive team manager retains the final authority to alter sites sampled when safety concerns arise.

SOPs for Training:

Training: Field crews will be trained in the methods to be used for collecting mussels by unionid experts from the GLSC. Field crews will consist of at least on person highly experienced at sampling unionid populations (GLSC crew) along with additional less experienced personnel.

SOPs for Taxonomic Accuracy

Prior to any fieldwork, the principal investigators will examine museum collections to become familiar with mussel fauna found in the region (see Table 1). The PI (Nichols) has a collection permit (# 99-1055) from the Michigan Department of Natural Resources for collecting unionids including endangered species. Appropriate personnel from the permitting branch will be notified regarding new sampling locations. Historic information on mussel communities within the parks and surrounding areas will be obtained through a search and review of the literature, examination of museum collections, and contact with regional malacologists.

Taxonomic accuracy will be evaluated by conducting independent identifications of voucher specimens by an experienced taxonomist. Species identification will be based on live shell and collected dead shell. In the field, the divers will collect any dead shell found and record where it was collected. This shell will be sent to the University of Michigan Mollusc Collection for verification of identification and be used to prepare a field guide for each site. We will take pictures and video of each type of live shell found in the field. Shell vouchers for each type of live shell found will be collected. Using voucher shells, the randomly collected dead shell from each site, plus pictures of live individuals and array shots at each clam bed, we can correct all field ID problems later. Taxonomic keys will be distributed to each team along with a photograph of each mussel that is expected in the area. Training will be provided by the GLSC team on how to set transects or grids, clear quadrats, do excavations, determine gravidity and measure environmental parameters. SOPs include the following:

Photographic records: All crews will carry a 35-mm camera, a digital camera, and if possible, an underwater video camera. A picture of habitat and specimens collected will be taken at the site. More than one mussel can be photographed per slide.

Specimen record: A representative of each mussel species will be collected from each site (excluding endangered species). These will be preserved and returned to the laboratory. Voucher specimens will be deposited with ISRO and PIRO managers, plus at the University of Michigan Mollusc Collection.

Collection confirmations by experts: The voucher collection will be sent to mussel experts at the University of Michigan Mollusc Collection, and/or any other expert preferred by Park managers for taxonomic confirmations.

All mussels collected (except for a voucher collection and animals needed for contaminant analysis) will be identified, photographed, and returned to the wild. Voucher specimens of each species will be retained and mussels of questionable identification will be kept for positive identification. All freshly dead shells collected will be stored in a bag containing a field label including stream or lake name, location, date, and collector. Voucher specimens will be narcotized and fixed by using menthol crystals until immobilized, then placed into 70% ethanol. A labeled reference collection will be made for each park for deposit with the park collection manager or the state museum. Pictures will be provided of any rare or endangered mussels for which no shell was collected.

SOPs for Quantitative Questions:

Question: What is the annual incremental increase in shell length, or growth rate, for each species (based on dead shell- may not be possible for all species or for any endangered species)?
Standard Operating Procedures to be used: The shell will be sectioned on a perpendicular line from the umbo to the ventral margin of the shell. The cut sections will be sanded using fine grade, coated in glycerin, and examined under a 10X power dissecting scope. Internal annular rings will be determined using techniques described in Tevesz and Carter (1980). Each shell section will be aged independently by two different people. Length and age frequencies will be plotted using a modified Walford plot (regression). Comparisons between internal and external annuli (examination for non-annular external rings) will be done according to the techniques described in Downing et al. (1992).

Question: What proportion of the population sampled is composed of individual unionids <5years of age?
SOP: The relationship between length and age will be determined through shell sections. Differences in age and length between sites will be determined as described above.

Question: What is the amount and type of chemical contaminant present per gm of soft body tissue for each species sampled?
SOP: Live individuals of two species of unionids, preferably P. grandis and L. radiata (if present), will be collected from two sites per park and placed on ice as quickly as possible and sent to the Great Lakes Science Center. There, soft

tissues from each individual will be frozen at –40°F and processed individually. The following contaminant array will be surveyed: pesticides including hexachlorobenzene, pentachlorobenzene, octachlorostryene, α- and γ-BHC, aldrin, dieldrin, endrin, α- and β-heptachlor epoxide, cis- and trans- nonachlors, p,p'-(DDE, DDD, and DDT), mirex (including 8-monohydro mirex), α- and γ-chlordanes, oxychlordane, toxaphenes (Cl 6 to Cl 10), dacthal, and pentachlorophenyl methyl ether; PCBs (80 congeners, including most of the planar dangerous ones) and mercury. Analysis techniques and QA/QC protocols are described in Schmidt (1997), Schmidt and Hesselberg (1992), and Wilford et al. (1973). Field and lab methods shall follow recommendations of EPA (SW-846) or published USGS protocol and shall be detailed as meta data in the revised QAPP submitted with the first annual report.

Question: With certain caveats, at these same sites, which of the unionid and other bivalve species fall into classifications such as native, non-native, pollution/disturbance tolerant or intolerant, rare, ecological sentinel species, or undesirable species?
SOP: The following caveats will be factored into to these designations: There are no non-native unionids presently found in the continental United States. There are no undesirable unionid species. While three species (Lampsilis radiata/siliquoidea, Leptodea fragilis, and Pyganadon grandis) are commonly found in all types of habitats, the term "undesirable" is probably inapprorpriate as it implies something that must be eradicated rather than just a very adaptable species. Although not unionids, zebra mussels, asian clams, and various fingernail clams will be documented and reported. Taxonomic identification of fingernail clams is difficult, but an attempt will be made to identify them to the lowest level practicable.

SOPs for Documentation of habitat. With each qualitative and quantitative sample, we will also collect habitat data. These will include composition of substrate, water depth, and presence or absence of zebra mussels. These include scoring for stream and lake habitat variables (see field forms in the appendix).

Schedule of activities

June 1999	Methods/Site selection discussion
July 1999.....	Reconnaissance/Sampling (PIRO)
August-early September 1999.....	Reconnaissance/Sampling at ISRO
Fall……	Data entry
EOY	Report
June	Reconnaissance/Sampling at PIRO
August-early September 2000.....	Reconnaissance/Sampling at ISRO
Fall	Data entry
EOY	Report
June	Final report

Sampling dates will be scheduled after discussion with park managers and modified as needed. We have anticipated a total 28 days field sampling/park for the two-year period. If sampling is completed sooner in one park, the remaining days will be spent at the other.

Statistics to be used:

General Approach**:**

We will use both general statistics (median, range, etc.) as well as multivariate statistical methods to analyze the abundance data (number of mussels/taxon/transect), comparisons between populations within a water body and water bodies and potential relationships to habitats.
In addition to the basic statististics described above, we will use multivariate statistical methods to analyze abundance data (number of mussels/taxon/transect/grid). Hierarchical cluster analysis (Afifi and Clark 1990) will be used to reveal groups and patterns in abundance data across habitats. Principal component analysis will be used to reduce the dimensionality of the data by obtaining linear transformations of the mussel taxa variables and to summarize the major sources of variation in the abundance data (Jackson 1991). Raw data will be provided along with statistically manipulated data.

Statistics Related to Specific Questions:

Question: What is the quantity of each species present based on randomized quadrats or transects?
Statistics to be used: Simple descriptive statistics will be provided for each quadrat/transect sampled and for each 100 sq. m plot sampled. We will provide the raw data on the actual number and species of unionids collected in each type of quadrat, the median and range for each specie, plus the calculated #/m^2. The type of statistics used to test differences between quadrats will be determined once we determine if the distribution patterns of these animals across the 100 sq m plot/transect are normal or skewed. If the distribution is normal, tests such as ANOVAs and standard deviations will be used to further characterize the population in this plot/transect. Non-normal distribution patterns will be initially analyzed using more descriptive statistics such as the average deviation from the mean (AVEDEV), median, quartile, quantiles, etc. If necessary the data will be transformed either using a log or arcsign transformation. Non-parametric statistics will be used only as a last resort. Different 100 sq m plots or transects within the same water body will be initially compared using the techniques described above, with the statistical tests dependent on the distribution of the data. We will use multivariate statistical methods to analyze the abundance data (number of mussels/taxon/transect/plot).

Question: What is the annual incremental increase in shell length, or growth rate, for each species (based on dead shell- may not be possible for all species or for any endangered species)?
Statistics to be used: A probability chart indicating the accuracy of estimating age through the use of external annuli (usable on live animals) will be prepared. Differences in growth rates for a single species within a 100 sq. m plot or transect as well as between different plots or transects will be determined using ANOVA or Tukey's t-test depending on the sample size.

Question: What proportion of the population sampled is composed of individual unionids <5years of age?
Statistics to be used: Length frequency histogram will be prepared for every species, every water body, and every 100 sq. m plot or transect.

Question: What is the amount and type of chemical contaminant present per gm of soft body tissue for each species sampled?
Statistics to be used: Simple nonparametric descriptive statistics (median, interquartile ranges, etc.) will be used to summarize the results.

Documentation and Records; Summarization of data handling QA/QC SOPs.

High quality, defensible data is required for all National Park Service projects, Data will be entered into an Excel spreadsheet and checked by the principal investigator. These data, at the completion of the project, will be transferred to the park for eventual entry into EPA's STORET database. Meta-data will be provided for all sampling protocols and data analyses. The following steps will be done to insure that data meets the quality necessary for the purposes of the project: All grid plots, unionid beds, etc., will be entered as meta-data into EPA Storet system. Locations of grids and unionid beds will be further delineated by GPS locations and maps provided to park managers.

Data handling QA/QC steps include making sure that: (1) transcription or data transfer efforts are minimized, (2) information is not lost, (3) chain-of-custody is followed where appropriate, and (4) appropriate decision makers get the results in a form they can understand. All water-related data, including physical, chemical, substrate type, and biological data, will be reported to the parks for eventual placement into EPA's newly expanded STORET database by national park service personnel.

Data will be entered into standardized forms with all blanks filled out, At each site, the site leader will check all forms for completeness. A photocopy of the sheet will be made prior to mailing. Data will be entered into Excel format and checked by the principal investigator. At the end of the project, the Excel database will be presented to the park.

The basics of guidance for data entry, data verification, data validation, data documentation, data archiving, data backup, and version control, will all follow the NPS I&M guidance (www.nature.nps.gov/im/dmproto/joe4OOOl.htm) as closely as possible within the practicalities of funding levels available. For example:

Data verification will include the verification of the accuracy of all entries by their comparison with the original source to identify and correct errors. This will include checking the accuracy of the computerized records against the original source.

Data validation will include reviewing field and computerized data for range and logic efforts (the pH can't be 25). Unlike data entry and data verification, data validation requires in-depth knowledge about the data. Corrections or deletions of logical or range efforts in a data set will be done with notations in the original paper field records about how and why the data were changed. Modifications of the field data should be clear and concise but preserve the original data entries or notes (i.e., no erasing!).

Site identification by GPS. Site information will be recorded on a GPS unit or marked on a topographic map for later identification. These units, plus instruction on their use, will be made available to the field crews. Otherwise, the field crews will mark their sampling locations on topographic maps provided to them.

Data will be collected using the following data sheets (located at end of document):

Sheets 1&2. Stratified Random Field Sheet

Sheets 3&4. Statistical Sampling Sheet

Study Plan and QAPP Revisions

Provisions for the unexpected or alterations that need to be made in the final QAPP need to be anticipated. Unexpected situations often come up during the course of investigations and any major changes will need to be authorized by the Park representatives and WRD technical lead before being implemented. If changes are necessary, the QAPP will be revised accordingly as the study progresses.

The final QAPP will be attached (as an appendix) to the final report submitted to the Park Service. The QAPP plan thereby becomes an important part of post-project "meta-data" (data about data). The meta-data in the QAPP plan provides the detailed information reviewers need to understand exactly how the data was generated. Thus, the details of what was done must be available to those desiring to repeat the investigation exactly as it was done before. Access to these details is also critical to reviewers trying to understand data comparability, data representativeness, and other perspective on "what the data means." In peer-reviewed articles where attaching the entire QAPP is not allowed, an alternative way to include meta-data details of exactly what is done both in the field and the lab will be found.

Deliverables and other Reporting Requirements:

A. **Interim Report -** An interim progress report (EOY) win be due as an end-of-year report to the parks.

B. Final Report - Due EOY 2000 will be a draft final report to the parks. The final report is due June 2001 and will consist of the following parts:

1). Title page - listing the investigators and affiliations.

2). Abstract (suitable for an abstract journal).

3). Executive summary, management implications, and information needs.

4). Introduction

5). Methods (Brief)

6). Results

7). Discussion

8). Summary

9). Appendix I - species lists and abundance estimates per area sampled. Detailed maps of all areas sampled and where each species is to be found will be provided.

10). Appendix 2: Final Detailed Study Plan and QAPP including all SOPS, Detailed
Methods and metadata.

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Table 1. Unionid mussels that may be found in Isle Royale National Park and Pictured Rocks National Lakeshore (list compiled by David J. Heath, Wisconsin DNR).

Phylum Mollusca
Class Bivalvia
Order Unionoida
Family Unionidae

Subfamily Anodontinae

Anodonta cataracta cataracta (Eastern floater)
Anondonta cataracta marginata
Anodontoides ferussacianus (Cylindrical papershell)
Lasmigona complanata (White heelsplitter)
Lasmigona costata (fluted-shell)
Lasmigona compressa (Creek heelsplitter)
Pyganadon grandis f. grandis (Giant Floater)
Strophitus undulatus (Squawfoot)

Subfamily Ambleminae

Elliptio complanata (Eastern elliptio)

Subfamily Lampsilinae

Lampsilis cardium (=ventricosa) (Plain pocketbook)
Lampsilis siliquoidea (= radiata luteola) (Fatmucket)
Ligumia recta (Black sandshell)
Obovaria olivarioa (Hickorynut)

Table 2. PCB Congeners/trans nonachlor to be Determined by GC/NCI/SIM. Detection Limits for PCB Congeners and Trans Nonachlor for EPA Contract IAG DW14947842-01 (Remaining Pesticides to be Completed Before Analyses Begin)

Compound	Inst. Det. Lim. using 1 g sample (**ng/g** or parts/billion/gram dry tissue)
1. PCB Congener #31+#28	9
2. PCB Congener #33	4
3. PCB Congener #22	4
4. PCB Congener #52	12
5. PCB Congener #49	18
6. PCB Congener #47+#48	6
7. PCB Congener #44	25
8. PCB Congener #42	4
9. PCB Congener #41+#71	18
10. PCB Congener #64	4
11. PCB Congener #40	7
12. PCB Congener #63	0.4
13. PCB Congener #74	2
14 PCB Congener#70 + #76	1
15. PCB Congener #66	2
16. PCB Congener #95	6
17. PCB Congener #91	7
18. PCB Congener #56+#60	1
19. PCB Congener #84+#92+#89	1
20. PCB Congener #101	0.2
21. PCB Congener #99	0.4
22. Trans-nonachlor	0.08
23. PCB Congener #119	0.1
24. PCB Congener #83	0.6
25. PCB Congener #97	0.9
26. PCB Congener #81+#87	0.6
27. PCB Congener #85	0.3
28. PCB Congener #77	0.2
29. PCB Congener #110	0.5
30. PCB Congener #82	1
31. PCB Congener #151	0.02
32. PCB Congener #144+#135	0.03
33. PCB Congener #107	0.3
34. PCB Congener #123	0.1
35. PCB Congener #149	0.04
36. PCB Congener #118	0.3
37. PCB Congener #134	0.02
38. PCB Congener #114	0.4

39. PCB Congener #131	0.01
40. PCB Congener #146	0.01
41. PCB Congener #132+#153	0.02
42. PCB Congener #105	0.02
43. PCB Congener #141	0.1
44. PCB Congener #137+#176	0.08
45. PCB Congener #138+#163	0.04
46. PCB Congener #158	0.03
47. PCB Congener #129	0.01
48 . PCB Congener #126	0.03
49. PCB Congener #178	0.1
50. PCB Congener #175	0.1
51. PCB Congener #187+#182	0.08
52. PCB Congener #183	0.06
53. PCB Congener #128	0.02
54. PCB Congener #167	0.03
55. PCB Congener #185	0.04
56. PCB Congener #174	0.09
57. PCB Congener #177	0.1
58. PCB Congener #202	0.2
59. PCB Congener #171	0.1
60. PCB Congener #156	0.04
61. PCB Congener #173	0.06
62. PCB Congener #157	0.03
63. PCB Congener #200	0.2
64. PCB Congener #172	0.04
65. PCB Congener #197	0.04
66. PCB Congener #180	0.07
67. PCB Congener #193	0.08
68. PCB Congener #191	0.1
69. PCB Congener #199	0.2
70. PCB Congener #170+#190	0.09
71. PCB Congener #198	0.1
72. PCB Congener #201	0.3
73. PCB Congener #203+#196	0.4
74. PCB Congener #189	0.1
75. PCB Congener #195	0.1
76. PCB Congener #208	0.07
77. PCB Congener #207	0.1
78. PCB Congener #194	0.1
79. PCB Congener #205	0.2
80. PCB Congener #206	0.2
81. PCB Congener #209	0.07

82. Pentachlorobenzene	0.15
83. Hexachlorobenzene	0.6

84. Octachlorostyrene	0.5
85. p,p'-DDT	40.0
86. p,p'-DDE	10.0
87. p,p'-DDD	70.0
88. β-Heptachlor epoxide	2.0
89. Oxychlordane	1.0
90. Pentachlorophenyl methyl ether	0.5
91. Deildrin	0.5
92. Endrin	0.5
93. Aldrin	3.5
94. Lindane	1.0
95. Alpha BHC	4.0
96. Alpha Chlordane	0.2
97. γ-Chlordane	0.2
98. trans-Nonachlor	0.2
99. cis-Nonachlor	0.1
100. Tot. taxaphene	120.0
101. Dacthal	1.0
102. Photomirex	25.0
103. Mirex	2.0
104. Mercury	20.0

Internal QA/QC samples will include a blank, spike, duplicate, and reference unionid tissue samples (check) analyzed with each set of monitoring unionid samples. Additionally when each subject sample or QA sample is analyzed, internal standards of PCB congeners #136 and 204 will be added just prior to the analysis step to monitor sample injection and adjust instrument calibration for every sample analyzed. Also, each sample will be spiked with surrogates. The Great Lakes Science Center's current procedure requires that each sample is spiked (at least 50 times the measured background concentration) with PCB congeners #65 and 166 and octachloronaphthalene for the pesticides just prior to extracting contaminants from tissues. The relative response from these congeners is then compared to that obtained during the calibration step of the GC/MS and a recovery is then calculated. Results from the collected unionids are not usually corrected for recovery based on spiked samples. The purpose of the surrogate spike is to check each sample for different errors that may occur during sample preparation. Results from the surrogates are especially useful in determining extent of the problem and corrective action when spike or check results are outside the acceptance criteria.

Mercury content in unionid tissues is determined by using LECO High Frequency Induction Furnace. Reference samples are SPEC reference Plasma Standards. Blanks, replicates, and reference samples will be run with each set of unionid tissue samples.

A complete in-depth QA/QC and sampling handling protocol will be provided with the final report.

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SCIENTIFIC AND PROFESSIONAL ORGANIZATIONS
Michigan Unionid Committee, National Shellfish Association, National Unionid Conservation Society

PERTINENT GRANTS AND CONTRACTS
U.S. EPA: Reestablishing the Unionid Population in Metzger Marsh, Sept 1998- Sept 1999; $100,000.
U.S. National Biological Survey: 1) Development of refugia to protect Unionidae from zebra mussels and, 2) food web dynamics and nutritional requirements of Unionidae Aug. 1998- $100,000

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APPENDIX 2.

Physical characteristics of lakes and sampling points quantitatively surveyed in PIRO, 1999-2000.

Exact location of individual sampling sites can be found in Figures 1-4.

Grand Sable Lake: The initial assessment of this lake was that it was deep, cold, with few fish or clams, and what clams were present were up close to shore. A few fish were seen, especially by grids 2 & 3, but not in the numbers seen in other lakes. Large snails (6-7 mm in length) were common. Non-decomposed woody material and leaves were common, both on the surface and in the sediments. The thermocline was detected at about 12-13 ft (3.6-4 m). Depths are presented in feet, since all the bathymetric data provided by NPS for all the lakes were in feet. Metric conversions are in parenthesis. No water flow was detected at any site. Underwater visibility was excellent, 15-20 ft. Water temperature was 23.3°C for the first trip and 21.9°C for the second. pH was 7.0.

			GPS	
Record:	LAKE:	LAKE ID:	LATITUDE:	LONGITUDE:
28	Grand Sable	1	46° 39’ 9.745”	86° 1’ 44.553”. This station is by the park area, the old swimming beach. Depth gradient sharp, 0-15’(0-4.5 m). sandy substrate, with some vegetation in deeper area. One 100 m^2 grid plus three 0.25 m^2. excavated grids (no clams).
29	Grand Sable	2	46° 39’ 3.775”	86° 1’ 43.988”. This station is on the point, sandy substrate, with no vegetation. 0-10’ (0-3m). One 100 m^2. grid plus three 0.25 m^2. excavated grids. No unionids.
31	Grand Sable	4	46° 38’ 56.517”	86° 1’ 46.674”. Station in cove, sandy substrate with 50% submersed vegetation. Depth 8-10’ (2.5-3.1 m).

100 m^2. grid plus three 0.25 m^2. excavated grid. Unionids present in 100 m^2 grid, but not in any of the 0.25 m^2 grids.

32 Grand Sable 5 46° 38' 49.267" 86° 1' 52.733". Sandy substrate, 1% vegetation (looks like *Eleocharis*, but not verified). Steep depth gradient of 9-20 ft. (), but the clams were all within 5-7 ft. One 100 m^2 grid.

33 Grand Sable 6 46° 38' 43.299" 86° 1' 54.627". Sandy substrate. No vegetation. One 100 m^2 grid at 5-7 ft.

34 Grand Sable 7 46° 38' 33.351" 86° 1' 55.849". Sandy substrate with some large rocks scattered in grid. No vegetation. One 100 m^2 grid at 5-7 ft.

35 Grand Sable 8 46° 38' 26.401" 86° 1' 53.463". Depositional zone. Soft sil/loon shit substrate. 75% submergent vegetation cover (*Potamogeton*). One 100 m^2 grid at 3-5 ft. No clams.

36 Grand Sable 9 46° 38' 26.012" 86° 1' 55.222". Deeper edge of depositional zone (#8). Silty area with no vegetation. One 100 m^2 grid 10-11 ft. Clams present.

1 Grand Sable 21 46° 38' 31.742" 86° 2' 42.200". West side of lake. Rough weather, almost swamped the canoe. This station has a sand shelf right by shore, like a sand depositional zone, with a steep gradient within 30 ft of shore. Lots of tree snags along shoreline, but no submergent vegetation. One 100 m^2 grid at 3-9ft. Also did three 0.25 m^2 excavated grids, but found nothing.

2 Grand Sable 22 46° 38' 30.396" 86° 2' 43.982" . This station is part of a shallow water line walk or transect that I (SJN) did to keep occupied while the divers were sampling deeper waters. I started at site 21 and waded to

here (0-5 ft depth). All sand substrate, with tree snags close to shore. No clams at all.

3 Grand Sable 23 46° 38’ 49.502” 86° 2’ 23.263”. This station is on point by cove where we launched the canoes.. Sandy subtsrate, 25% *Potamogeton*, and lots of woody material. One 100 m^2 grid at 3-5 ft depth. Also did three 0.25 m^2 excavated grids but found nothing.

Kingston Lake:

Our initial impression of this lake was one of high productivity. The lake was shallow, full of fish, with the clams (*Lampsilis*) found right along the shoreline, in less than 15 cm of water. Submersed vegetation was abundant and schools of small- mouth bass followed the divers everywhere. Neither water flow nor underwater springs were detected. Underwater visibility was 5-7 ft. Divers saw lots of *P. grandis* in the deeper parts of the lake (5-6 ft), but we collected very few in the grids. A lot of the clams were in the 5-6 ft. depth zone.

GPS

Record:	LAKE:	LAKE ID:	LATITUDE:	LONGITUDE:
18	Kingston	1	46° 35’ 2.189”	86° 13’ 12.292”.

This station number represents two depth zones, with grids taken at each. One 100 m^2 grid, 1a=0-1.5 ft. Sandy area with seven Lampsilis luteola almost on shore, only barely covered with water (recent water level change?). This is about the only site in the lake where clams were seen this shallow. One 100 m^2 grid, 1b=1.5-5ft. Sandy/silt area without vegetation cover. Four of the female *Lampsilis luteola* were gravid and working mantle lures. Three 0.25 m^2 excavated grids sampled, but none contained any clams at all. This sampling was done in July, 1999. A team was present back on this lake during November, 20th, 1999. The shallow clams were not to be seen.

19	Kingston	2	46° 34’ 59.425”	86° 13’ 3.489”

Two depth zones were sampled at this station as well. One 100 m^2 grid , 2a=0-1.5 ft. Sandy area, no vegetation. One gravid female *Lampsilis* seen that was working mantle lure. One 100 m^2 grid, 2b=5-10ft. Sandy area with about 10% macrophyte cover (Potamogeton spp). Three gravid *Lampsilis* seen.

20 Kingston 3 46° 34’ 55.307” 86° 13’ 4.872”. Two depth zones. One 100 m^2 grid , 3a=0-1.5 ft. Sandy-silty substrate, no vegetation. In this case, the second grid has its own GPS number.

21 Kingston 3(b) 46° 39’ 2.225” 86° 1’ 45.348”. One 100 m^2 grid , 3b=5-10ft. Sandy-silty substrate, with some gravel and submersed logs. Submergent vegetation covered about 20% of area.

30 Kingston 4 46° 35’ 7.254” 86° 13’ 37.448”. Down from camp on peninsula. Two depth zones. One 100 m^2 grid , 4a=1-1.5 ft. Sand, silt, mud substrate. No clams present. No vegetation. One 100 m^2 grid, 4b=5-10ft. Clams present.

Big Beaver Lake: Visibility in this lake much better than in Little Beaver, usually around 2 m. Thermocline not detected, and clams distributed deeper here than in any other lake. Unionids often gravitating toward the 5-7 ft. depth zone. Lots of young-of-year fish seen in the shallows, various minnows and yellow perch. The only lake in PIRO where large sponges were sited (see Figure 2).

		GPS		
Record:	LAKE:	LAKE ID:	LATITUDE:	LONGITUDE:
4	Big Beaver	1	46° 33’ 41.369”	86° 21’ 29.691”. In bay to right of outlet to Little Beaver. Unionids found right up by shore, in less than 2 cm water. One 100 m^2 grid at 0-6 ft (0-2 m). 80% vegetation cover, mostly *Potamogeton*. Sandy substrate, with no gravel or rock. Looks like a sand depositional zone. Lots of small fish in the vegetation, minnows and yellow perch. Three-0.25 m^2 excavated grids collected, but no clams.

5 Big Beaver 2 46° 33’ 36.801” 86° 21’ 24.329”. East from site 1, in embayment. Clams in <1.5 ft. Saw lots of tiny, long dead Sphaerid shells; this appears to be a depositional area. Signs of predation on some unionids, as a few chewed shell present. One 100 m^2 grid <1.5 ft. Sand, no vegetation.

37 Big Beaver 3 46° 33’ 35.274” 86° 21’ 21.064”. In bay just past site 2. Four- 100 m^2 grids taken at this site, in different depth zones. All had sand substrate. One 100 m^2 grid, 3a, 0-1.5 ft- no vegetation. One 100 m^2 grid, 3b, 1.5-5 ft. deep. 3c, 10-15 ft. Sand substrate, 40% vegetation (*Potamogeton*, *Vallisneria*). 3d, 15-20 ft. Mucky substrate, no silt, no vegetation.

6 Big Beaver 4 46° 33’ 36.068” 86° 21’ 15.241”. Four 100 m^2 grids taken at this site at different depth profile. Not a depositional zone. Substrate for all grids is a gradation of sand/cobble patches from shore to below 20ft. Clams occur down to 20-21 ft. Divers have not detected thermocline yet. Lots of dead snail shells along shoreline. First 100 m^2 grid, 4a, 0-1.5 ft. 100% cobble, rock substrate right along shore. Walking was difficult. Clams found in just a few centimeters of water nestled in bedrock, though only one live one showed up in grid. No clams in grid, but were noted at this depth wedged between rocks outside the grid. As a side note, when the divers returned to this site in November 1999, before ice-cover, these shallow clams, wedged in between the rocks, could not be found. It is off this point that the large sponges were found. It is the only place so far, that such sponges have been seen in PIRO.

7 Big Beaver 10 46° 34’ 21.494” 86° 20’ 46.247”. Northeast of outlet stream to Lake Superior. Three 100 m^2 grids and three 0.25 m^2 grids at this site. I (SJN) also walked down the stream for a couple of hundred yards while the divers were working the main grids. Saw no clams, nor signs of clams. I checked under deadfalls, rocks and dug through the sand in about 20 places. One 100 m^2 grid 10a, 0-1.5 ft deep. All sand. Second 100 m^2 grid was 5010 ft. deep. All sand, no vegetation. Third grid was at 10-15ft. deep. All sand, no vegetation. Three 0.25 m^2 grids at same depths. No clams in small grids.

8 Big Beaver 11 46° 34’ 19.894” 86° 20’ 49.758”. This is the coordinate for the mouth of the outlet stream to Lake Superior. See note above. There was one clam, a *L. radiata* female, just at the stream opening.

9 Big Beaver 13 46° 34’ 29.468” 86° 20’ 20.419”. Sharp depth gradient. Three 100 m^2 grids and three 0.25 m^2 grids at comparable depths. The first 100 m^2 grid was at 0-5 ft. Sandy substrate at shallows with silty mud at deeper area. The second 100 m^2 grid was at 5-20 ft., mud substrate. The third grid was at 20-26 ft, with real soft sediments. The clams were located mostly between 10-20 feet. Mud stops at about 20’, and the real soft sediments dominate. The fourth 100 m^2 grid was at 20-26ft. Mucky sediments. A few clams.

10 Big Beaver 14 46° 34’ 30.424” 86° 20’ 18.670”.

11 Big Beaver 141 46° 34’ 34.705” 86° 20’ 11.348”

12 Big Beaver 142 46° 34’ 36.864” 86° 20’ 7.195”. These three GPS points represent a line transect taken by SJN while the divers were in the water working on the three 100 m^2 grids and three 0.25 m^2 grids at site 13 as described above. The line started at 14 and ended at 142 for a distance of ****m^2. The water depth was 0-3ft. with every clam seen within 10ft of the line recorded. Sand deposition area. SJN even surveyed the wetland area adjacent to point 141. Did six 0.25 excavated grids. There were two live L. radiata (length=65mm Male; 64mm male) at 14. Absolutely no clams in excavated grids.

13 Big Beaver 15 46° 34’ 24.374” 86° 20’ 37.151”.

14 Big Beaver 150 46° 34’ 23.017” 86° 20’ 36.526”. Backtracking back towards Little Beaver entrance. Selected this site because the shoreline was steeper-looked like deeper area. Substrate at shallower depth was sand, gradually being replaced by silt/mud at 10ft. Four 100 m^2 grids taken. The first grid 0-1.5 ft had no clams and was all sand. The second at 5-10ft. was a mixture of sand and mud, no vegetation. Lots of clams. The third was at 10-15 ft, and the fourth at

20-25 ft. Mud/silt substrates. Few clams at 20-25 ft. The two GPS coordinates, 15 and 150, represent the end points of another transect done by SJN while divers were in the water. Depth ranged from 0-1.5 m^2. One live L. radiata at point 15 in three ft water. All sandy substrate.

15 Big Beaver 16 46° 33' 58.606" 86° 21' 13.705"

16 Big Beaver 160 46° 33' 58.038" 86° 21' 12.310". Three 100 m^2 grids and three 0.25 m^2 grids collected here. The 16 and 160 represent another short transect done by SJN while divers were in the water. The distance from 16 to 160 was ****. Four live *L. radiata* were seen at start point 16, (Male=64,64,70; Female=65). None within 10ft of transect either side otherwise. Depth ranges from 0-3 ft (1m^2). Subtrate was sand/gravel mix. As for the 100 sq. ft. grids, the first was at 5-10 ft, the ssecond at 12-16 ft, and the third at 20-25 ft. The three 0.25 m^2 grids were at the same depths and had no clams.

17 Big Beaver 17 46° 33' 46.022" 86° 21' 28.445". This is statistical sampling point. Six 100 m transects by divers at compass headings 10°, 50°, 71°, 160°, 210°, and 270°. Sand and gravel substrates.

38 Big Beaver 69 46° 33' 34.108" 86° 20' 21.537". On southeast side of lake, near stream outlet. Sand gravel substrate, no vegetation. Three 100 m^2 grids.

Little Beaver Lake: This lake had the worst visibility of any lake sampled, usually less than one meter. Substrate below about 12 ft (4m) was soft muck (colloquially called loon shit). The thermocline on July 30th, 1999, was detected at 9-10ft. No clams were seen (felt) below 10ft, with most between 5-7 ft. Numerous small fish were seen (minnows, yellow perch, etc.)

22 Little Beaver 1 46° 33' 28.381" 86° 21' 44.250". This site is right by boat ramp. Sharp depth profile so grid depth ranged from 0-10ft, even though it was anchored on one edge in knee-deep water. Substrate very soft silt with lots of organic and woody debris. 100% cover with bulrush, lotus, and other macrophytes. One 100 m^2 grid- clams present. Three 0.25m^2 excavated grids were taken, but no clams of any size found.

23 Little Beaver 2 46° 33' 30.213" 86° 21' 37.040". Across from boat ramp. One 100 m^2 grid, at 0-8ft. Substrate 70% sand, 30% cobble. About 50% of 100 m^2 grid contained horsetail grass. Three 0.25 excavated grids were taken, but no clams of any size were found.

24 Little Beaver 3 46° 33' 27.662" 86° 21' 38.918". Water depth profile sharp, with 100 m^2 grid ranging in depth from 0-10 ft. No vegetation. Substrate all rock, bedrock, and cobble. Unionids were propped up on rocks, in crevices, and in some cases under rocks. No 0.25 m^2 excavated grids were attempted here since we did not bring along any dynamite.

25 Little Beaver 4 46° 33' 36.617" 86° 21' 40.848". One 100 m^2 grid, at 0-8ft. Substrate was gravel, cobble, 10% sand. Vegetation (*Isoetes*) present, covering 20% of grid.

26 Little Beaver 5 46° 33' 44.296" 86° 21' 43.751". Near patch of emergent vegetation. One 100 m^2 grid , depth 5-10ft. Soft silty/sandy substrate (95% of grid). 10% emergent bulrush cover. 5% large organic debris. Clams feel very heavy (sediment uptake?). Lots of little fish seen (minnows, yellow perch).

27 Little Beaver 6 46° 33' 42.509" 86° 21' 52.551". By point of land with rock cliffs and huge fir tree. One 100 m^2 grid. Large rocks in grid (10%), gravel (40%), cobble (20%) and some sand. No vegetation. Water depth 5-10 ft, but the clams were at 5-6 ft, period. 35% of clams were found under the rocks.

APPENDIX 3. Raw Data Files

Kingston Lake--PIRO

L. luteola

		0-1.5ft				1.5-5ft				5-10ft		
	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex
Grid 1	63	f			63	f	68	f				
	67	f			60	f	69	f				
	59	f			70	f	68	f				
	70	f			58	f	72	m				
	71	m			61	f						
	68	m			70	f						
	72	m			78	f						
					87	f						
					81	f						
					76	f						
					81	f						
					51	f						
					80	f						
					68	m						
					71	m						
					80	m						
					76	m						
					60	m						
					86	m						
					83	m						
					69	m						
					83	m						
					71	m						
					74	m						
					86	m						
					69	m						
					69	m						
					76	m						
					90	m						
					72	m						

Kingston Lake cont.

Grid 2	71	m							74	f	75	f
	68	m							69	f	92	f
	68	f							78	f		
	75	f							74	f		
	61	f							59	f		
									79	m		
									70	m		
									80	m		
									76	m		
									79	m		
									76	m		
									84	m		
									86	m		
									80	m		
									81	m		
									65	m		
									71	m		
									81	m		
									72	m		
									64	m		
									70	m		
Grid 3	61	m							80	m		
	72	m							75	m		
	65	f							79	m		
									75	f		
									86	f		
									80	f		

Kingston Lake cont.

Grid 4									82	f	62	m
									72	f		
									76	f		
									89	f		
									80	f		
									80	f		
									86	f		
									89	f		
									72	f		
									85	f		
									75	f		
									80	f		
									79	f		
									59	f		
									77	f		
									85	f		
									78	m		
									91	m		
									90	m		
									96	m		
									97	m		

	Grid 2/5-10'	
P. cataracta	85	
P grandis	89	
	Grid 3/5-10'	
L. radiata	84	f
	77	m
	90	m
	94	m

Little Beaver Lake

Little Beaver-PIRO																								
The depths of all grids were 0-10ft																								
	Grid 1		Dead		Grid 2		Dead		Grid 3		Dead		Grid 4		Dead		Grid 5		Dead		Grid 6		Dead	
Species	L(mm)	Sex	L (mm)	Sex	L(mm)	Sex	L (mm)	Sex	L(mm)	Sex	L (mm)	Sex	L(mm)	Sex	L (mm)	Sex	L(mm)	Sex	L (mm)	Sex	L(mm)	Sex	L (mm)	Sex
L. luteola	68	f			78	m	93	m	85	f			57	f	92	m	65	f			66	f		
L. luteola	72	f			67	m	86	m	52	f			68	f	91	m	89	m			60	f		
L. luteola	65	f			65	m	95	m	62	f			69	f	102	m					89	f		
L. luteola	67	f							54	f			64	f	90	m					54	f		
L. luteola	66	f							63	f			58	f	78	f					70	f		
L. luteola	71	f							54	f			72	f	83	f					76	f		
L. luteola	87	m							94	f			73	f	77	f					80	m		
L. luteola	76	m							77	f			80	f	81	f					77	m		
L. luteola									70	m			86	f							74	m		
L. luteola									72	m			85	f							62	m		
L. luteola									72	m			66	f							54	m		
L. luteola													64	f							88	m		
L. luteola													62	f							59	m		
L. luteola													82	f							67	m		
L. luteola													64	f							80	m		
L. luteola													66	f							62	m		
L. luteola													61	f							60	m		
L. luteola													66	f							75	m		
L. luteola													62	f							60	m		
L. luteola													66	m							88	m		
L. luteola													78	m							62	m		
L. luteola													65	m							59	m		
L. luteola													85	m										
L. luteola													65	m										

L. luteola													75	m									
L. luteola													80	m									
L. luteola													76	m									
L. luteola													77	m									
L. luteola													80	m									
L. luteola													85	m									
L. luteola													76	m									
L. luteola													75	m									
L. luteola													74	m									
L. luteola													54	m									
L. luteola													81	m									
L. luteola													70	m									
L. luteola													83	m									
L. luteola													80	m									
L. luteola													74	m									
L. luteola													79	m									
L. luteola													67	m									
L. luteola													77	m									
L. luteola													86	m									
L. luteola													82	m									
L. luteola													87	m									
L. luteola																							
L. radiata	77	f	78	m	87	m			74	m			90	m	83	m	87	m	92	m			
L. radiata			75	m	83	m			100	m			77	m	102	m							
L. radiata					86	m			89	m			81	m	85	m							
L. radiata					72	f							90	m	72	f							
L. radiata													75	m	77	f							
L. radiata													85	m	85	f							
L. radiata													86	m	67	f							
L. radiata													89	m	93	f							
L. radiata													72	f									
L. radiata													64	f									
L. radiata													78	f									
L.													77	f									

radiata																							
L. radiata													75	f									
L. radiata													68	f									
L. radiata													67	f									
L. radiata													68	f									
P. grandis	101				92		86		94		92		56		102		111				81		
P. grandis	68				79				75				101		106		92				77		
P. grandis	101				61				89				85		99		113				48		
P. grandis					84				107				100		62		86				97		
P. grandis					88				78				118				131				92		
P. grandis					71				98				92								112		
P. grandis					99				99				107								54		
P. grandis					90				97				92								94		
P. grandis					109								107								84		
P. grandis					92								111								64		
P. grandis					95								79								28		
P. grandis					60								97								60		
P. grandis					75								92								92		
P. grandis					102								93								90		
P. grandis					87																52		
P. grandis					80																96		
P. grandis																					63		
P. grandis																					83		
P. grandis																					72		
P. grandis																					80		
P. grandis																					98		
P. grandis																					86		
P. grandis																					72		
P. grandis																					87		
P. grandis																					85		
P. grandis																					90		
P. grandis																					75		
P. grandis																					70		

P. grandis																					85			
P. grandis																					87			
P. grandis																					60			
P. grandis																					84			
P. grandis																					97			
P. cataracta intergrade	93				96				97		101		115		81		101				76			
	88				90				101				106		81						77			
	86				80				95				105								58			
					65				103				85								82			
					82								102											
					92								115											
					82								92											
					80								94											
					84								92											
					92								109											
													106											
													99											
													97											
													90											
													102											
P. cataracta	93				96		76		101				99		98		93		101		77			
	95				86				91				98		102						71			
	95				69				90				99		92						77			
					77				93				110		84						67			
					97				107				93		91						70			
					71				93				106								86			
					97				102				110								77			
					69								118								81			
					84								98								90			
					94								104								93			
					92																92			
																					81			
																					83			

Grand Sable Lake--PIRO

P. grandis

	1.5-5ft				5-10ft				10-15ft				15-20ft			
	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex
Grid 1																
Grid 2																
Grid 3					36											
Grid 4					64											
					80											
Grid 5																
Grid 6							92									
Grid 7					64		63									
Grid 8																
Grid 9					49		78									
							89									
							91									
Grid 10																
Grid 11	52															
	77															

E. dilatata

	1.5-5ft				5-10ft				10-15ft				15-20ft			
	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex
Grid 1																
Grid 2																
Grid 3					64											
					48											
Grid 4	56															
Grid 5																
Grid 6					54											
Grid 7																
Grid 8																
Grid 9					58											
Grid 10					75											
Grid 11																

GRAND SABLE

P. cataracta

	1.5-5ft				5-10ft				10-15ft				15-20ft			
	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex
Grid 1																
Grid 2																
Grid 3							102									
							85									
Grid 4			98													
Grid 5																
Grid 6							90									
Grid 7							86									
Grid 8																
Grid 9					86		101									
Grid 10																
Grid 11																

L. complanata

	0-5ft				5-10ft				10-15ft				15-20ft			
	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex
Grid 1																
Grid 2																
Grid 3																
Grid 4																
Grid 5																
Grid 6																
Grid 7							55									
Grid 8																
Grid 9																
Grid 10																
Grid 11																

GRAND SABLE

L. radiata

	0-5ft				5-10ft				10-15ft				15-20ft			
	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex
Grid 1																
Grid 2																
Grid 3																
Grid 4																
Grid 5					53	f										
Grid 6					70	m	70	m								
Grid 7					49	m	65	f								
							68	f								
Grid 8																
Grid 9																
Grid 10					65	m										
Grid 11																

L. luteola

	0-5ft				5-10ft				10-15ft				15-20ft			
	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex
Grid 1																
Grid 2																
Grid 3																
Grid 4																
Grid 5																
Grid 6																
Grid 7																
Grid 8																
Grid 9																
Grid 10					67	m										
Grid 11																

Big Beaver--PIRO
1999-2000

P. grandis

	0-1.5ft	1.5-5ft	5-10ft	10-15ft	15-20ft	20-25ft
Grid 1			96			
			97			
			68			
			87			
Grid 3		91				
		106				
		94				
Grid 4			91	60	89	
			35	65	100	
			90	90	80	
				95	101	
				97		
				78		
Grid 5				116		
				96		
Grid 6		68				98
Grid 7			64	65		
			76	90		
			101	67		
			96	82		
			88			
			71			
			74			
			80			
			84			

Big Beaver cont.

P. cataracta

	0-1.5ft	1.5-5ft	5-10ft	10-15ft	15-20ft	20-25ft
Grid 1			77			
Grid 2	85					
Grid 3				90		
				95		
Grid 4	77		110	104	94	
			118	90	91	
			95	105	95	
				70	96	
				100	103	
					92	
Grid 5			115			
Grid 6		95			110	
		95			68	
					83	
					81	
					97	
					105	
					104	
					87	
					102	
					92	
					93	
Grid 7				92		

Big Beaver Lake

L. luteola

	0-1.5ft				**1.5-5ft**				**5-10ft**				**10-15ft**				**15-20ft**
	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)	Sex	Dead	Sex	L (mm)
Grid 1									82	m	77	m					
									67	f							
									62	f							
									74	m							
									70	m							
									70	m							
									64	f							
									70	f							
									81	m							
									68	m							
									64	f							
									68	m							
Grid 2	84	m															
	81	m															
	72	f															
Grid 3					65	f							62	m			
					64	f											
					66	f											
					63	f											
					80	m											
					66	m											
					78	m											
					64	m											
					70	m											
					68	m											
					77	m											
					77	m											
					85	m											
					80	m											
					81	m											
					76	m											
					75	m											
					72	m											
					74	m											

Big Beaver cont.

Grid 4									69	f			66	m			67
									64	f			69	m			64
									70	f			67	m			72
									71	f			65	m			69
									70	f			60	m			64
									81	f			65	m			62
									72	f			62	m			55
									73	f			62	m			49
									70	f			65	m			51
									60	f			64	f			72
									77	f			64	f			64
									71	f			70	f			64
									70	f			67	f			
									60	f			64	f			
									71	f			57	f			
									56	f			60	f			
													62	f			
													60	f			
Grid 5									69	m			58	f			
									72	m			56	f			
									75	m			60	f			
									72	m			56	m			
									59	f			65	m			
									64	f			61	m			
									65	f			60	m			
									69	f			72	m			
													56	m			
													56	m			
													45	?			
													53	m			
													62	m			

Big Beaver cont.

Grid 6					65	m			62	m							
					71	m			71	m							
					75	m			79	m							
					67	m			73	m							
					78	m			82	m							
					75	m			65	m							
					78	m			80	m							
					67	f			58	m							
					77	f			57	m							
					62	f			65	f							
									58	f							
									58	f							
									66	f							
									58	f							
									62	f							
									65	f							
									61	f							
									66	f							
Grid 7									64	m			65	m			
									67	m			57	m			
									58	m			58	m			
									59	m			67	m			
									66	m			56	m			
									74	m			59	m			
									64	m			68	m			
									62	m			60	m			
									58	m			67	m			
									61	m			50	?			
									64	m			63	m			
									60	m			58	m			
									68	m			57	m			
									66	m			65	f			
									60	m			62	f			
									62	f			59	f			
									60	f			57	f			
									58	f			57	f			
									65	f			57	f			
									60	f							
									65	f							
									63	f							
									64	f							
									60	f							
									62	f							

Chapel Lake

TRANSECT	DEPTH	HABITAT	GRID	SPECIES	LENGTH	SEX	AGE
1		PUT IN OFF OF CHAPEL FALLS TRAIL					
	0-5	50% VEG, Pot. Spp., sand wit detritus	1	LR	81	F	18
			2	LR	98	M	
			3	LR	79	M	
			3	LR	61	M	
			4	LR	84	M	
			4	LR	76	M	
			4	LR	73	F	
			4	LR	92	M	
			5	LR	94	M	
			5	LR	72	F	11
			5	LR	98	M	
			5	LR	70	F	
			5	LL	83	M	
			5	LR	78	F	
			5	LR	116	M	
			5	PL	66		10
	5-10'		1	LR	78	F	
			2	PL	89		10
			3	0			
			4	0			
			5	0			
	10-15'	SHARP DROPOFF, WOODY DEBRIS AND SOFT MUCK	1	LL	81	M	12
			2	LL	67	F	8
			3	0			
			4	0			
			5	0			
	15-20'	SHARP DROPOFF, WOODY DEBRIS	1	0			
			2	0			
			3	0			
			4	0			
			5	0			
	20-25'	SHEER ROCK	1	0			
			2	0			
			3	0			
			4	0			
			5	0			

Chapel Lake cont

2	SOUTH OF CREEK MOUTH SAND WITH 1CM DETRITUS, 50% VEG POT. SPP., VALISNERIA, ISOETES, SCIRPUS, EQUISETUM, GROUNDWATER INPUT, VERY			
0-5	COLD	1 LR		62 M
		2	0	
		3	0	
		4	0	
		5	0	
5-10'	SAND WITH MUCK	1	0	
		2	0	
		3	0	
		4	0	
		5	0	
10-15'	SAND WITH MUCK	1	0	
		2	0	
		3	0	
		4	0	
		5	0	
15-20'	SAND WITH MUCK	1	0	
		2	0	
		3	0	
		4	0	
		5	0	
20-25'	SAND WITH MUCK			
		1	0	
		2	0	
		3	0	
		4	0	
		5	0	

Chapel Lake cont

3	SMALL POINT ACROSS FROM FALLS			
0-5	SAND WITH 1CM DETRITUS, 5% VEG POT. SPP., ISOETES, COONTAIL	1 LR		87 M
		1 LR		89 F
		1 LR		119 M
		1 LR		45
		1 LR		78 F
		1 LR		68 M
		2 LR		65 F
		2 LR		92 F
		2 LR		73 M
		3 PC		99
		3 PC		15
		3 LR		90 F
		3 LR		81 F
		3 LR		86 F
		3 LR		82 M
		3 LR		84 M
		3 LR		86 M
		3 LR		87 M
		4	0	
		5	0	
5-10'	SAND WITH MUCK	1 LR		84 F
		2	0	
		3	0	
		4	0	
		5	0	
10-15'	SILT OVER CLAY	1 LL		45
		2	0	
		3	0	
		4	0	
		5	0	
15-20'	SILT OVER WOODY DEBRIS	1	0	
		2	0	
		3	0	
		4	0	
		5	0	
20-25'	SILT OVER WOODY DEBRIS	1	0	
		2	0	
		3	0	
		4	0	
		5	0	

Chapel Lake cont

4	AT BEND ACROSS AND TO THE NORTH OF S. 34 CREEK SAND WITH WOODY DEBRIS 20% VEG POTAMOGETON AND VALISNERIA				
0-5	SAND WITH WOODY DEBRIS 20% VEG POTAMOGETON AND VALISNERIA	1 LR		91 M	
		1 LR		92 F	
		1 PC		81	
		2 LR		86 F	
		3 LR		90 M	
		3 LR		98 M	
		3 LR		96 F	
		3 LR		86 F	
		3 LR		67 F	
		3 LR		76 F	
		4 LR		92 F	14
		4 LR		79 F	17
		5	0		
5-10'	SAND WITH WOOD DEBRIS	1 LR		96 M	
		2	0		
		3	0		
		4	0		
		5	0		
5	CHAPEL CREEK OUTLET				
0-5	6" OF SOFT FLOC OVER SANDY SOIL	1 LR		93 M	
		2 LR		105 M	
		3	0		
		4	0		
		5	0		
6	1/2 WAY BETWEEN FALLS AND OUTLET				
0-5	6" OF SOFT FLOC OVER SANDY SOIL	1 LR		85 F	15
		2	0		
		3	0		
		4	0		
		5	0		

Chapel Lake cont

7	SMALL POINT ON EAST SIDE, NEAR FALLS 100 YDS AWAY				
0-5	6" OF SOFT FLOC OVER SANDY SOIL	1 PC		115	
		1 LR		97 M	
		2 LR		115 F	
		3 PC		55	
		3 PC		95	
		3 LR		85 M	15
		4	0		
		5 PC		85	
		5 LR		91	
		5 LR		85	
5-10'	6" OF SOFT FLOC OVER SANDY SOIL				
		1	0		
		2	0		
		3	0		
		4	0		
		5	0		
10-15'	6" OF SOFT FLOC OVER SANDY SOIL				
		1	0		
		2	0		
		3	0		
		4	0		
		5	0		

Chapel Lake cont.

8	MOUTH OF SEC 34 CREEK			
0-5	6" OF SOFT FLOC OVER SANDY SOIL	1 LR		95 M
		1 LR		89 M
		1 PC		76
		4	0	
		5	0	
5-10'	6" OF SOFT FLOC OVER SANDY SOIL			
		1	0	
		2	0	
		3	0	
		4	0	
		5	0	
10-15'	6" OF SOFT FLOC OVER SANDY SOIL			
		1 PC		
		2	0	
		3	0	
		4	0	
		5	0	
15-20'	6" OF SOFT FLOC OVER SANDY SOIL			
		1	0	
		2	0	
		3	0	
		4	0	
		5	0	
20-25'	6" OF SOFT FLOC OVER SANDY SOIL			
		1	0	
		2	0	
		3	0	
		4	0	
		5	0	
25-30'	6" OF SOFT FLOC OVER SANDY SOIL			
		1	0	
		2	0	
		3	0	
		4	0	
		5	0	
30-35'	6" OF SOFT FLOC OVER SANDY SOIL			
		1	0	

	2	0
	3	0
	4	0
	5	0
35-40' 6" OF SOFT FLOC OVER SANDY SOIL		
	1	0
	2	0
	3	0
	4	0
	5	0

APPENDIX 4. Basic Statistics

Kingston Lake (#/sqM)

DEPTH	*L. radiata*	*L. luteola*	*P. grandis*	*P. cataracta*	Total
0-1.5'	0	0.0375	0	0	0.0375
1.5-5'	0	0.3	0	0	0.3
5-10'	0.013	0.16	0.003	0.003	0.179
MINIMUM	0	0.0375	0	0	0.0375
1ST QUARTILE	0	0.09875	0	0	0.10825
2ND QUARTILE	0	0.16	0	0	0.179
3RD QUARTILE	0.0065	0.23	0.0015	0.0015	0.2395
MAXIMUM	0.013	0.3	0.003	0.003	0.3
MEAN	0.004333	0.165833	0.001	0.001	0.172167
MEDIAN	0	0.16	0	0	0.179

	0-1.5'	1.5-5'	5-10'	TOTAL
L. radiata	0	0	0.013	0.013
L. luteola	0.0375	0.3	0.16	0.4975
P. grandis	0	0	0.003	0.003
P. cataracta	0	0	0.003	0.003
MINIMUM	0	0	0.003	0.003
1ST QUARTILE	0	0	0.003	0.003
2ND QUARTILE	0	0	0.008	0.008
3RD QUARTILE	0.009375	0.075	0.04975	0.134125
MAXIMUM	0.0375	0.3	0.16	0.4975
MEAN	0.009375	0.075	0.04475	0.129125
MEDIAN	0	0	0.008	0.008

BIG BEAVER (#/sqM)

DEPTH	*L.radiata*	*L luteola*	*P. grandis*	*P. intergrade*	*P. cataracta*	Total
0-1.5'	0.01	0.01	0	0	0.00666667	0.005333
1.5-5'	0.04	0.096667	0.01333333	0.006666667	0.005	0.032333
5-10'	0.093333	0.2	0.02666667	0.013333333	0.01	0.068667
10-15'	0.018333	0.102	0.024	0.004	0.016	0.032867
15-20'	0.0175	0.076	0.0125	0.012	0.03	0.0296
20-25'	0.01	0.01	0.005	0	0	0.005
MINIMUM	0.01	0.01	0	0	0	0.005
1ST QUARTILE	0.011875	0.0265	0.006875	0.001	0.00541667	0.0114
2ND QUARTILE	0.017917	0.086333	0.01291667	0.005333333	0.00833333	0.030967
3RD QUARTILE	0.034583	0.100667	0.02133333	0.010666667	0.0145	0.032733
MAXIMUM	0.093333	0.2	0.02666667	0.013333333	0.03	0.068667
MEAN	0.031528	0.082444	0.01358333	0.006	0.01127778	0.028967
MEDIAN	0.017917	0.086333	0.01291667	0.005333333	0.00833333	0.030967

	0-1.5'	1.5-5'	5-10'	10-15'	15-20'	20-25'	TOTAL
L radiata	0.01	0.04	0.093	0.018	0.018	0.01	0.0315
L. luteola	0.01	0.097	0.2	0.102	0.076	0.01	0.0825
P. grandis	0	0.013	0.027	0.024	0.013	0.005	0.013667
P.intergrade	0	0.007	0.013	0.004	0.012	0	0.006
P. cataracta	0.007	0.005	0.01	0.016	0.03	0	0.011333
MINIMUM	0	0.005	0.01	0.004	0.012	0	0.006
1ST QUARTILE	0	0.007	0.013	0.016	0.013	0	0.011333
2ND QUARTILE	0.007	0.013	0.027	0.018	0.018	0.005	0.013667
3RD QUARTILE	0.01	0.04	0.093	0.024	0.03	0.01	0.0315
MAXIMUM	0.01	0.097	0.2	0.102	0.076	0.01	0.0825
MEAN	0.0054	0.0324	0.0686	0.0328	0.0298	0.005	0.029
MEDIAN	0.007	0.013	0.027	0.018	0.018	0.005	0.013667

LITTLE BEAVER (#/sqM)

All grids 0-10'

	Transect						
	1	2	3	4	5	6	TOTAL
L. radiata	0.01	0.04	0.03	0.16	0.01	0	0.041667
L. luteola	0.08	0.02	0.11	0.45	0.02	0.22	0.15
P. grandis	0.03	0.16	0.08	0.14	0.05	0.33	0.131667
P. cataracta	0.03	0.11	0.07	0.1	0.01	0.13	0.075
P. intergrade	0.03	0.1	0.04	0.15	0.01	0.04	0.061667

L. radiata	MINIMUM	1ST QUARTILE	2ND QUARTILE	3RD QUARTILE	MAXIMUM	MEAN	MEDIAN
L. luteola	0	0.01	0.02	0.0375	0.16	0.041667	0.02
P. grandis	0.02	0.035	0.095	0.1925	0.45	0.15	0.095
P. cataracta	0.03	0.0575	0.11	0.155	0.33	0.131667	0.11
P. intergrade	0.01	0.04	0.085	0.1075	0.13	0.075	0.085

GRAND SABLE

DEPTH	*L. radiata*	*L. luteola*	*P. grandis*	*P. cataracta*	*E. dillatata*	Total
0-1.5'	0	0	0	0	0	0
1.5-5'	0	0	0.002	0	0.001	0.0006
5-10'	0.001	0.003	0.006	0.001	0.005	0.0032
10-15'	0	0.001	0	0	0	0.0002
MINIMUM	0	0	0	0	0	0
1ST QUARTILE	0	0	0	0	0	0.00015
2ND QUARTILE	0	0.0005	0.001	0	0.0005	0.0004
3RD QUARTILE	0.00025	0.0015	0.003	0.00025	0.002	0.00125
MAXIMUM	0.001	0.003	0.006	0.001	0.005	0.0032
MEAN	0.00025	0.001	0.002	0.00025	0.0015	0.001
MEDIAN	0	0.0005	0.001	0	0.0005	0.0004

	0-1.5'	1.5-5'	5-10'	10-15'	TOTAL
L. radiata	0	0	0.001	0	0.00025
L. luteola	0	0	0.003	0.001	0.001
P. grandis	0	0.002	0.006	0	0.002
P. cataracta	0	0	0.001	0	0.00025
E. dillatata	0	0.001	0.005	0	0.0015
MINIMUM	0	0	0.001	0	0.00025
1ST QUARTILE	0	0	0.001	0	0.00025
2ND QUARTILE	0	0	0.003	0	0.001
3RD QUARTILE	0	0.001	0.005	0	0.0015
MAXIMUM	0	0.002	0.006	0.001	0.002
MEAN	0	0.0006	0.0032	0.0002	0.001
MEDIAN	0	0	0.003	0	0.001

APPENDIX 5. Chemical Contaminant Data

Metallic Contaminant Data

		Grand Sable Lake	Big Beaver Lake	Little Beaver Lake	Kingston Lake
		Pyganadon grandis	*Pyganadon grandis*	*Pyganadon grandis*	*Lampsilis radiata*
Barium	(mg/kg)	629	181	259	79.1
Cadmium	(mg/kg)	0.8409	0.3972	1.4918	0.2975
Chromium	(mg/kg)	7.58	0.819	1.07	2.29
Copper	(mg/kg)	0.6016	2.057	3.702	1.606
Lead	(mg/kg)	0.6535	0.6649	12.62	1.302
Mercury	(mg/kg)	0.0143	0.0051	0.0196	0.0091
Nickel	(mg/kg)	0.6212	0.8116	0.2941	1.318
Zinc	(mg/kg)	171	127	78.1	50.4

Organic Contaminant Data

Year	Lake	Scientific Name	Composite ID	Contaminant	Conc	Units
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#209	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#202	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#118	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#66	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#77	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#105	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#74	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#197	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#180	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#52	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#194	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#42	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#101	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#95	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#99	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#110	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#149	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#131	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#128	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#156	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#174	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#22	0	ng/g
1999	Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#33	0	ng/g

1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#40	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#189	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#175	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#200	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#206	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#44	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#49	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#97	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#146	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#64	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#82	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#151	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#178	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#183	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#177	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#171	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#167	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#199	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#172	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#201	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#208	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#195	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#207	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#134	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#141	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#185	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#129	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#119	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#83	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#123	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#85	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#91	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#173	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#198	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#157	0.19 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#193	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#107	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#63	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#114	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#126	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#158	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#191	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#204	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#205	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#31+#28	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#41+#71	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#47+#48	0 ng/g

1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#56+#60	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#70+#76	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#81+#87	7.99 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#132+#153	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#137+#176	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#138+#163	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#144+#135	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#170+#190	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#187+#182	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#203+#196	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	PCB#84+#92+#89	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Heptachlor epoxide-B	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Hexachlorobenzene	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Mirex	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	OXYCHLORDANE	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Octachlorostyrene	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Aldrin	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Photo Mirex	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	p,p'-DDT	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	alpha-Chordane	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	cis-Nonochlor	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Lindane	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Dieldrin	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Pentachlorobenzene	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Endrin	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	p,p'-DDD	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	p,p'-DDE	2.25 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Heptachlor epoxide-A	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	alpha-Chlordane	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Toxaphene	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Toxaphene Cl10	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Toxaphene Cl6	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Toxaphene Cl7	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Toxaphene Cl8	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105001	Toxaphene Cl9	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#209	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#202	0.16 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#118	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#66	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#77	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#105	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#74	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#197	0.23 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#180	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#52	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#194	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#42	0 ng/g

1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#101	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#95	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#99	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#110	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#149	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#131	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#128	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#156	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#174	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#22	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#33	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#40	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#189	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#175	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#200	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#206	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#44	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#49	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#97	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#146	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#64	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#82	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#151	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#178	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#183	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#177	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#171	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#167	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#199	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#172	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#201	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#208	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#195	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#207	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#134	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#141	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#185	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#129	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#119	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#83	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#123	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#85	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#91	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#173	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#198	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#157	0.19 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#193	0 ng/g

1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#107	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#63	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#114	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#126	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#158	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#191	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#204	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#205	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#31+#28	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#41+#71	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#47+#48	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#56+#60	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#70+#76	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#81+#87	7.91 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#132+#153	0.25 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#137+#176	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#138+#163	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#144+#135	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#170+#190	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#187+#182	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#203+#196	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	PCB#84+#92+#89	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Heptachlor epoxide-B	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Hexachlorobenzene	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Mirex	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	OXYCHLORDANE	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Octachlorostyrene	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Aldrin	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	trans-Nonachlor	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Photo Mirex	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	p,p'-DDT	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	alpha-Chordane	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	cis-Nonochlor	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Lindane	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Dieldrin	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Pentachlorobenzene	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Endrin	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	p,p'-DDD	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	p,p'-DDE	2.12 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Heptachlor epoxide-A	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	alpha-Chlordane	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Toxaphene	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Toxaphene Cl10	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Toxaphene Cl6	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Toxaphene Cl7	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Toxaphene Cl8	0 ng/g
1999 Little Beaver Lake	*Pyganadon cataracta lacustris*	1999A105002	Toxaphene Cl9	0 ng/g

1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#209	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#202	0.16 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#118	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#66	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#77	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#105	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#74	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#197	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#180	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#52	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#194	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#42	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#101	0.41 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#95	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#99	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#110	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#149	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#131	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#128	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#156	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#174	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#22	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#33	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#40	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#189	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#175	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#200	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#206	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#44	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#49	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#97	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#146	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#64	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#82	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#151	0.27 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#178	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#183	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#177	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#171	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#167	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#199	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#172	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#201	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#208	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#195	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#207	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#134	0 ng/g

1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#141	0.91 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#185	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#129	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#119	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#83	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#123	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#85	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#91	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#173	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#198	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#157	0.16 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#193	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#107	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#63	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#114	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#126	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#158	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#191	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#204	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#205	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#31+#28	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#41+#71	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#47+#48	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#56+#60	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#70+#76	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#81+#87	9.86 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#132+#153	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#137+#176	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#138+#163	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#144+#135	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#170+#190	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#187+#182	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#203+#196	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	PCB#84+#92+#89	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Heptachlor epoxide-B	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Hexachlorobenzene	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Mirex	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	OXYCHLORDANE	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Octachlorostyrene	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Aldrin	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	trans-Nonachlor	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Photo Mirex	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	p,p'-DDT	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	alpha-Chordane	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	cis-Nonochlor	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Lindane	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Dieldrin	0 ng/g

1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Pentachlorobenzene	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Endrin	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	p,p'-DDD	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	p,p'-DDE	2.28 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Heptachlor epoxide-A	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	alpha-Chlordane	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Toxaphene	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Toxaphene Cl10	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Toxaphene Cl6	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Toxaphene Cl7	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Toxaphene Cl8	0 ng/g
1999 Little Beaver Lake	*Lampsilis radiata*	1999A105003	Toxaphene Cl9	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#209	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#202	0.23 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#118	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#66	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#77	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#105	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#74	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#197	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#180	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#52	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#194	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#42	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#101	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#95	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#99	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#110	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#149	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#131	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#128	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#156	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#174	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#22	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#33	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#40	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#189	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#175	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#200	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#206	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#44	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#49	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#97	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#146	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#64	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#82	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#151	0 ng/g

1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#178	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#183	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#177	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#171	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#167	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#199	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#172	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#201	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#208	0.05 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#195	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#207	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#134	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#141	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#185	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#129	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#119	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#83	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#123	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#85	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#91	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#173	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#198	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#157	0.16 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#193	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#107	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#63	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#114	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#126	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#158	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#191	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#204	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#205	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#31+#28	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#41+#71	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#47+#48	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#56+#60	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#70+#76	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#81+#87	9.42 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#132+#153	0.25 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#137+#176	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#138+#163	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#144+#135	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#170+#190	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#187+#182	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#203+#196	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	PCB#84+#92+#89	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Heptachlor epoxide-B	0 ng/g

1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Hexachlorobenzene	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Mirex	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	OXYCHLORDANE	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Octachlorostyrene	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Aldrin	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	trans-Nonachlor	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Photo Mirex	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	p,p'-DDT	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	alpha-Chordane	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	cis-Nonochlor	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Lindane	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Dieldrin	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Pentachlorobenzene	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Endrin	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	p,p'-DDD	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	p,p'-DDE	1.94 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Heptachlor epoxide-A	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	alpha-Chlordane	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Toxaphene	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Toxaphene Cl10	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Toxaphene Cl6	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Toxaphene Cl7	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Toxaphene Cl8	0 ng/g
1999 Little Beaver Lake	*Pyganadon grandis*	1999A105004	Toxaphene Cl9	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#209	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#202	0.14 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#118	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#66	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#77	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#105	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#74	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#197	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#180	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#52	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#194	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#42	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#101	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#95	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#99	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#110	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#149	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#131	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#128	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#156	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#174	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#22	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#33	0 ng/g

1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#40	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#189	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#175	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#200	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#206	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#44	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#49	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#97	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#146	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#64	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#82	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#151	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#178	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#183	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#177	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#171	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#167	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#199	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#172	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#201	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#208	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#195	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#207	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#134	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#141	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#185	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#129	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#119	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#83	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#123	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#85	0.84 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#91	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#173	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#198	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#157	0.18 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#193	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#107	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#63	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#114	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#126	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#158	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#191	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#204	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#205	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#31+#28	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#41+#71	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#47+#48	0 ng/g

1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#56+#60	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#70+#76	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#81+#87	8.8 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#132+#153	0.32 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#137+#176	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#138+#163	0.53 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#144+#135	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#170+#190	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#187+#182	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#203+#196	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	PCB#84+#92+#89	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Heptachlor epoxide-B	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Hexachlorobenzene	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Mirex	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	OXYCHLORDANE	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Octachlorostyrene	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Aldrin	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	trans-Nonachlor	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Photo Mirex	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	p,p'-DDT	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	alpha-Chordane	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	cis-Nonochlor	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Lindane	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Dieldrin	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Pentachlorobenzene	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Endrin	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	p,p'-DDD	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	p,p'-DDE	1.89 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Heptachlor epoxide-A	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	alpha-Chlordane	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Toxaphene	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Toxaphene Cl10	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Toxaphene Cl6	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Toxaphene Cl7	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Toxaphene Cl8	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105001	Toxaphene Cl9	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#209	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#202	0.15 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#118	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#66	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#77	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#105	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#74	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#197	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#180	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#52	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#194	0 ng/g

1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#42	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#101	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#95	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#99	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#110	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#149	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#131	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#128	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#156	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#174	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#22	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#33	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#40	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#189	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#175	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#200	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#206	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#44	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#49	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#97	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#146	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#64	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#82	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#151	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#178	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#183	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#177	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#171	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#167	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#199	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#172	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#201	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#208	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#195	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#207	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#134	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#141	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#185	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#129	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#119	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#83	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#123	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#85	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#91	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#173	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#198	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#157	0.17 ng/g

1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#193	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#107	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#63	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#114	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#126	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#158	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#191	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#204	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#205	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#31+#28	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#41+#71	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#47+#48	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#56+#60	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#70+#76	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#81+#87	9.16 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#132+#153	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#137+#176	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#138+#163	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#144+#135	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#170+#190	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#187+#182	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#203+#196	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	PCB#84+#92+#89	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Heptachlor epoxide-B	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Hexachlorobenzene	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Mirex	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	OXYCHLORDANE	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Octachlorostyrene	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Aldrin	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	trans-Nonachlor	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Photo Mirex	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	p,p'-DDT	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	alpha-Chordane	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	cis-Nonochlor	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Lindane	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Dieldrin	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Pentachlorobenzene	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Endrin	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	p,p'-DDD	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	p,p'-DDE	2.44 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Heptachlor epoxide-A	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	alpha-Chlordane	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Toxaphene	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Toxaphene Cl10	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Toxaphene Cl6	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Toxaphene Cl7	0 ng/g
1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Toxaphene Cl8	0 ng/g

1999 Big Beaver Lake	*Lampsilis luteola*	1999B105002	Toxaphene Cl9	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#209	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#202	0.18 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#118	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#66	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#77	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#105	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#74	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#197	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#180	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#52	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#194	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#42	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#101	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#95	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#99	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#110	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#149	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#131	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#128	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#156	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#174	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#22	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#33	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#40	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#189	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#175	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#200	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#206	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#44	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#49	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#97	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#146	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#64	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#82	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#151	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#178	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#183	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#177	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#171	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#167	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#199	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#172	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#201	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#208	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#195	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#207	0 ng/g

1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#134	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#141	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#185	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#129	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#119	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#83	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#123	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#85	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#91	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#173	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#198	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#157	0.17 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#193	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#107	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#63	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#114	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#126	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#158	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#191	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#204	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#205	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#31+#28	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#41+#71	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#47+#48	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#56+#60	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#70+#76	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#81+#87	8.53 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#132+#153	0.3 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#137+#176	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#138+#163	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#144+#135	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#170+#190	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#187+#182	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#203+#196	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	PCB#84+#92+#89	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Heptachlor epoxide-B	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Hexachlorobenzene	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Mirex	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	OXYCHLORDANE	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Octachlorostyrene	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Aldrin	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	trans-Nonachlor	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Photo Mirex	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	p,p'-DDT	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	alpha-Chordane	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	cis-Nonochlor	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Lindane	0 ng/g

1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Dieldrin	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Pentachlorobenzene	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Endrin	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	p,p'-DDD	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	p,p'-DDE	1.91 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Heptachlor epoxide-A	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	alpha-Chlordane	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Toxaphene	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Toxaphene Cl10	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Toxaphene Cl6	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Toxaphene Cl7	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Toxaphene Cl8	0 ng/g
1999 Big Beaver Lake	*Pyganadon cataracta lacustris*	1999B105003	Toxaphene Cl9	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#209	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#202	0.19 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#118	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#66	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#77	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#105	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#74	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#197	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#180	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#52	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#194	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#42	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#101	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#95	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#99	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#110	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#149	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#131	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#128	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#156	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#174	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#22	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#33	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#40	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#189	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#175	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#200	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#206	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#44	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#49	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#97	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#146	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#64	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#82	0 ng/g

1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#151	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#178	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#183	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#177	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#171	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#167	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#199	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#172	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#201	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#208	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#195	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#207	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#134	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#141	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#185	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#129	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#119	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#83	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#123	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#85	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#91	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#173	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#198	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#157	0.17 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#193	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#107	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#63	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#114	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#126	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#158	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#191	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#204	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#205	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#31+#28	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#41+#71	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#47+#48	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#56+#60	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#70+#76	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#81+#87	9.44 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#132+#153	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#137+#176	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#138+#163	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#144+#135	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#170+#190	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#187+#182	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#203+#196	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	PCB#84+#92+#89	0 ng/g

1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Heptachlor epoxide-B	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Hexachlorobenzene	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Mirex	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	OXYCHLORDANE	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Octachlorostyrene	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Aldrin	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	trans-Nonachlor	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Photo Mirex	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	p,p'-DDT	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	alpha-Chordane	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	cis-Nonochlor	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Lindane	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Dieldrin	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Pentachlorobenzene	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Endrin	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	p,p'-DDD	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	p,p'-DDE	2.03 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Heptachlor epoxide-A	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	alpha-Chlordane	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Toxaphene	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Toxaphene Cl10	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Toxaphene Cl6	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Toxaphene Cl7	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Toxaphene Cl8	0 ng/g
1999 Kingston Lake	*Pyganadon grandis*	1999C105001	Toxaphene Cl9	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#209	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#202	0.17 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#118	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#66	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#77	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#105	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#74	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#197	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#180	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#52	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#194	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#42	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#101	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#95	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#99	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#110	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#149	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#131	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#128	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#156	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#174	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#22	0 ng/g

1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#33	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#40	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#189	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#175	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#200	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#206	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#44	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#49	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#97	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#146	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#64	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#82	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#151	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#178	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#183	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#177	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#171	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#167	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#199	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#172	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#201	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#208	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#195	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#207	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#134	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#141	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#185	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#129	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#119	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#83	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#123	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#85	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#91	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#173	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#198	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#157	0.18 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#193	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#107	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#63	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#114	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#126	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#158	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#191	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#204	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#205	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#31+#28	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#41+#71	0 ng/g

1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#47+#48	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#56+#60	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#70+#76	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#81+#87	8.74 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#132+#153	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#137+#176	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#138+#163	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#144+#135	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#170+#190	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#187+#182	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#203+#196	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	PCB#84+#92+#89	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Heptachlor epoxide-B	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Hexachlorobenzene	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Mirex	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	OXYCHLORDANE	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Octachlorostyrene	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Aldrin	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	trans-Nonachlor	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Photo Mirex	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	p,p'-DDT	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	alpha-Chordane	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	cis-Nonochlor	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Lindane	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Dieldrin	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Pentachlorobenzene	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Endrin	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	p,p'-DDD	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	p,p'-DDE	1.74 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Heptachlor epoxide-A	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	alpha-Chlordane	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Toxaphene	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Toxaphene Cl10	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Toxaphene Cl6	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Toxaphene Cl7	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Toxaphene Cl8	0 ng/g
1999 Kingston Lake	*Lampsilis luteola*	1999C105002	Toxaphene Cl9	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#209	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#202	0.18 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#118	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#66	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#77	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#105	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#74	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#197	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#180	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#52	0 ng/g

1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#194	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#42	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#101	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#95	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#99	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#110	0.85 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#149	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#131	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#128	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#156	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#174	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#22	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#33	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#40	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#189	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#175	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#200	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#206	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#44	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#49	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#97	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#146	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#64	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#82	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#151	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#178	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#183	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#177	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#171	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#167	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#199	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#172	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#201	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#208	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#195	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#207	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#134	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#141	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#185	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#129	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#119	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#83	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#123	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#85	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#91	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#173	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#198	0 ng/g

1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#157	0.18 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#193	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#107	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#63	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#114	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#126	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#158	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#191	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#204	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#205	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#31+#28	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#41+#71	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#47+#48	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#56+#60	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#70+#76	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#81+#87	9.12 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#132+#153	0.23 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#137+#176	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#138+#163	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#144+#135	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#170+#190	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#187+#182	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#203+#196	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	PCB#84+#92+#89	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Heptachlor epoxide-B	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Hexachlorobenzene	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Mirex	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	OXYCHLORDANE	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Octachlorostyrene	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Aldrin	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	trans-Nonachlor	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Photo Mirex	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	p,p'-DDT	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	alpha-Chordane	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	cis-Nonochlor	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Lindane	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Dieldrin	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Pentachlorobenzene	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Endrin	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	p,p'-DDD	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	p,p'-DDE	2.26 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Heptachlor epoxide-A	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	alpha-Chlordane	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Toxaphene	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Toxaphene Cl10	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Toxaphene Cl6	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Toxaphene Cl7	0 ng/g

1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Toxaphene Cl8	0 ng/g
1999 Grand Sable Lake	*Eliptio dilatata*	1999D105001	Toxaphene Cl9	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#209	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#202	0.18 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#118	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#66	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#77	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#105	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#74	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#197	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#180	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#52	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#194	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#42	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#101	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#95	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#99	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#110	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#149	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#131	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#128	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#156	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#174	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#22	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#33	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#40	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#189	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#175	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#200	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#206	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#44	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#49	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#97	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#146	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#64	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#82	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#151	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#178	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#183	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#177	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#171	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#167	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#199	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#172	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#201	0.16 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#208	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#195	0 ng/g

1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#207	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#134	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#141	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#185	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#129	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#119	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#83	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#123	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#85	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#91	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#173	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#198	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#157	0.17 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#193	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#107	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#63	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#114	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#126	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#158	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#191	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#204	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#205	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#31+#28	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#41+#71	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#47+#48	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#56+#60	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#70+#76	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#81+#87	9.48 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#132+#153	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#137+#176	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#138+#163	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#144+#135	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#170+#190	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#187+#182	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#203+#196	0.17 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	PCB#84+#92+#89	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Heptachlor epoxide-B	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Hexachlorobenzene	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Mirex	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	OXYCHLORDANE	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Octachlorostyrene	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Aldrin	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	trans-Nonachlor	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Photo Mirex	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	p,p'-DDT	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	alpha-Chordane	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	cis-Nonochlor	0 ng/g

1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Lindane	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Dieldrin	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Pentachlorobenzene	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Endrin	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	p,p'-DDD	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	p,p'-DDE	2.38 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Heptachlor epoxide-A	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	alpha-Chlordane	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Toxaphene	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Toxaphene Cl10	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Toxaphene Cl6	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Toxaphene Cl7	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Toxaphene Cl8	0 ng/g
1999 Grand Sable Lake	*Lampsilis luteola*	1999D105002	Toxaphene Cl9	0 ng/g

APPENDIX 6. Background on the Unionid Genera and Species Found at PIRO

Elliptio complanata, the eastern elliptio, is a thick shelled, slow-growing mussel that reaches a maximum length of 13 cm. The shell is dark brown in color, with no distinguishing stripes or rays and the nacre is usually white or light pink (see Figure 3). The shells do not show sexual dimorphism. This species tolerates a wide variety of habitats and is widely distributed in the Great Lakes drainage basin, including Lake Superior, and along the Atlantic slope. This mussel uses a number of fish hosts (Table 3). Yellow perch would be the most probable fish host found in Grand Sable Lake.
Elliptio dilatata, the spike or lady finger, is about the same size as the eastern elliptio (maximum recorded length 13 cm) but is more widely distributed throughout the Mississippi drainage system (see Figure 3). It can easily be distinguished from other mussels by its elongated shape, ventral indentation (full adult) and purple nacre. Young mussels (< 6 cm) tend to be lighter brown in color, with a strong posterior wing, while older animals become very dark brown. No shell stripes or bars are visible, nor are there any external sexual differences. These mussels are usually found in rivers and are tolerant of any type of substrate except shifting sand. As with the eastern elliptio, this is a heavy shelled, slow growing, long-lived species. This species of mussel also relies on yellow perch as one of its fish hosts (Table 3).
The distributions of *Lampsilis luteola*, the fat mucket, and *L. radiata*, are difficult to describe since no taxonomic authority can agree on whether these are true species, subspecies, or variants of *L. siliquoidea.* In general, this group of *Lampsilis* is widely distributed throughout the Mississippi drainage system (see Figure 3). The maximum size of these animals is about 13.5 cm, and the shell varies from extremely dark reddish brown, with no stripes, to pale tan with green stripes. Females have a posterior inflation to the shell (sexually dimorphic) and use a mantle lure to attract fish hosts. This mussel prefers quieter waters and has no limitations with regards to substrate. These are heavy shelled, slow-growing, long-lived animals. *Lampsilis* use a wide variety of fish as hosts for their larvae, including percids, centrarchids, and cyprinids.

Potamilus alatus, or the pink heelsplitter, is a large unionid, up to 15 cm in length, dark brown in color, with pink nacre. (In taxonomic keys from about ten years ago, this

animal was called *Proptera alata*). Its presence in Grand Sable is unexpected. This mussel has not been reported from Lake Superior, although it is found in the Red and Winnipeg rivers in Canada. Our hypothesis is that these mussels were accidentally introduced into the lake. The only known fish host is the freshwater drum, which does not occur in Grand Sable, though glochidia-infected drum may have been accidentally stocked with some of the game fish.

Pyganadon grandis, or the giant floater, is the most adaptable widespread unionid in North America (see Figure 3). It is a fast growing, thin-shelled mussel, with no proven external sexual characteristics and can easily reach 26 cm in length. The shell is light-to-medium brown, usually without stripes, and inflated (roundish ventral edge). The nacre is white. This mussel is found in most habitats, except fast flowing areas, and at all temperature extremes. This mussel can use a wide variety of fish hosts.
Pyganadon cataracta cataracta, the lake floater, is more commonly found on the Atlantic slope. As with all *Pyganadon spp*, this is a fast growing, thin-shelled mussel, with no proven external sexual characteristics, but usually is less than 20 cm in length. The shell is elongated, medium-dark brown, usually without stripes and with white nacre. This mussel is also found in most habitats, except fast flowing areas. This mussel can use a wide variety of fish hosts.

Unionids have a parasitic larval stage and most use a fish host to complete their development. The following is a list of the known fish hosts utilized by the unionid species found at Pictured Rocks. Source used Watters (1994)

Unionid Species	Known Fish Host
Elliptio complanata	Banded killifish, green sunfish, largemouth bass, white crappie, yellow perch
Elliptio dilatata	Black crappie, flathead catfish, gizzard shad, sauger, white crappie, yellow perch
Lampsilis siliquoidea (both forms)	Black crappie, bluegill, common shiner, largemouth bass, pumpkinseed, rock bass, sauger, small mouth bass, walleye, white bass, white crappie, white sucker, and yellow perch.
Potamilus alatus	Freshwater drum
Pyganadon grandis	Black crappie, bluegill, bullhead, carp, common shiner, darters, freshwater drum, gar, killifish, largemouth bass, pumpkinseed, rock bass, sauger, small mouth bass, stickleback, walleye, white bass, white crappie, white sucker, and yellow perch. In some localities, may not always require fish host to complete life cycle.
Pyganadon cataracta	Unknown, but assumed to be similar to *P. grandis*