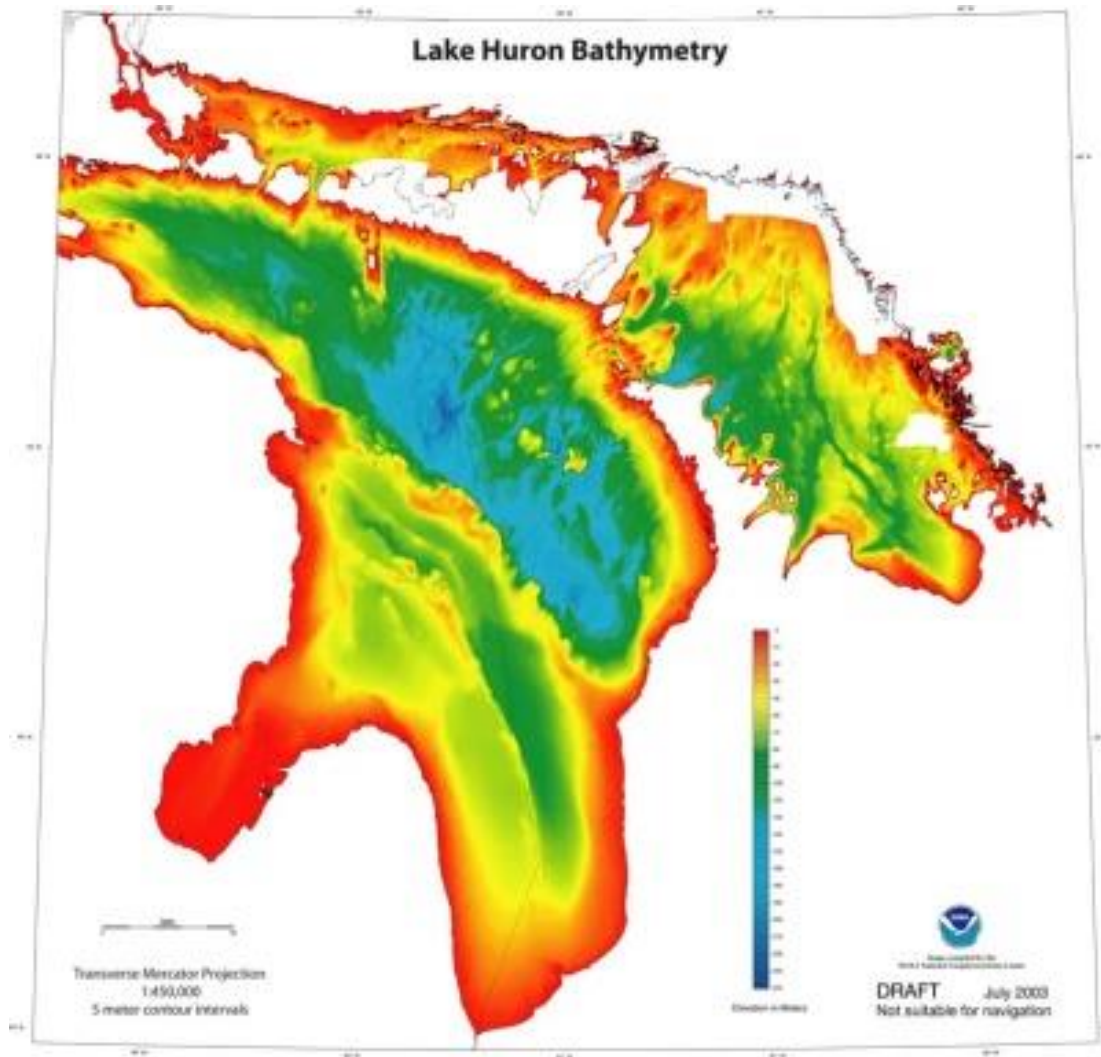


# Trends in Macroinvertebrates in the Lake Huron System

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# North Channel

*Years (sites):*

|             |             |
|-------------|-------------|
| <b>1973</b> | <b>(13)</b> |
| 2002        | (13)        |
| 2007        | (13)        |
| 2012        | (13)        |

# Main Basin

*Year (sites):*

|             |             |
|-------------|-------------|
| <b>1972</b> | <b>(25)</b> |
| 2000        | (65)        |
| 2003        | (85)        |
| 2007        | (77)        |
| 2012        | (80)        |

# Saginaw Bay

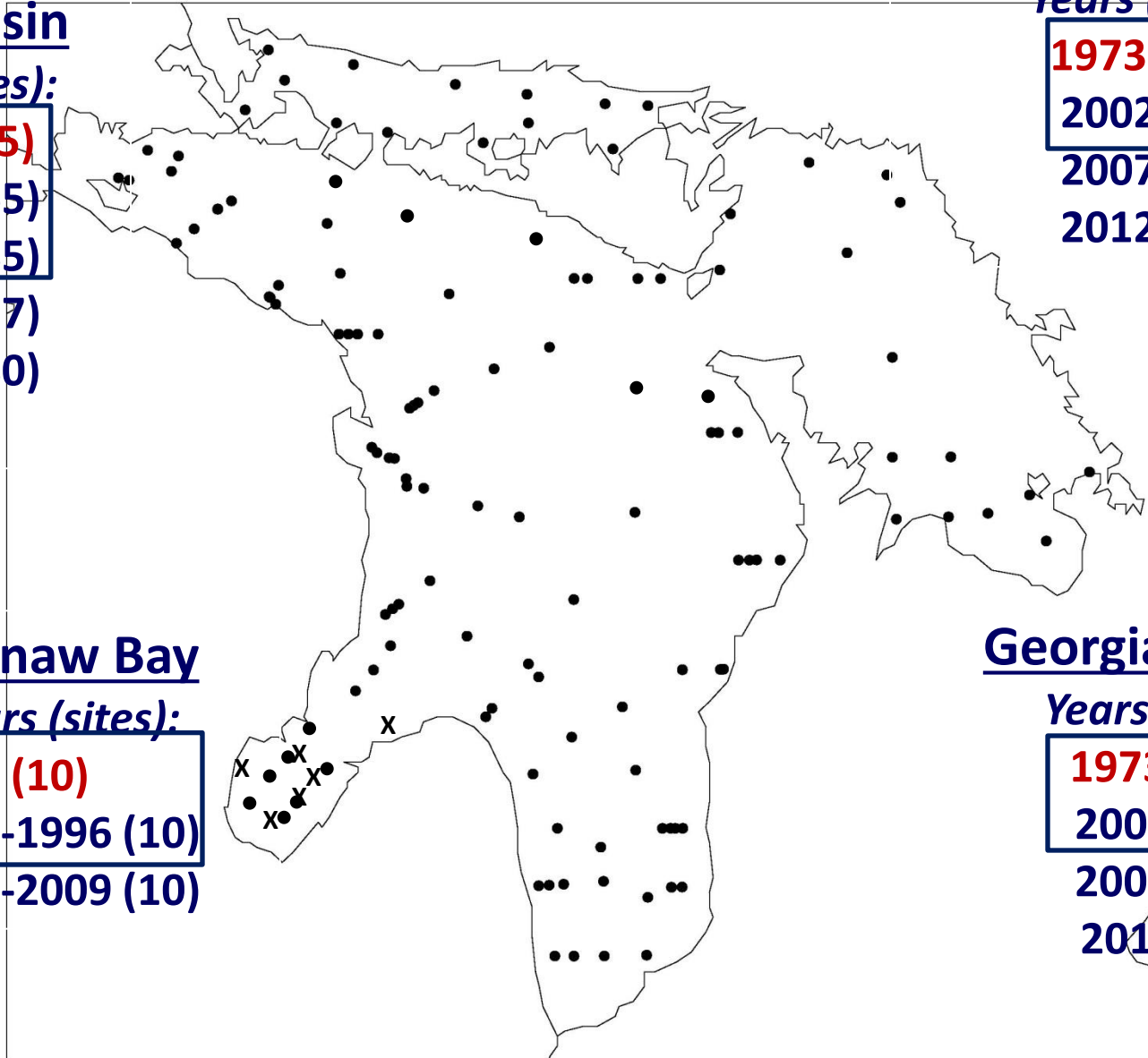
*Years (sites):*

|             |             |
|-------------|-------------|
| <b>1971</b> | <b>(10)</b> |
| 1987-1996   | (10)        |
| 2006-2009   | (10)        |

# Georgian Bay

*Years (sites):*

|             |             |
|-------------|-------------|
| <b>1973</b> | <b>(15)</b> |
| 2002        | (15)        |
| 2007        | (15)        |
| 2012        | (15)        |

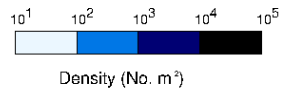
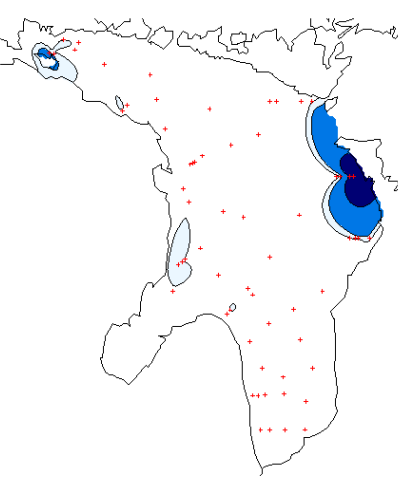


## *Dreissena polymorpha* (no./m<sup>2</sup> )

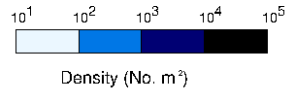
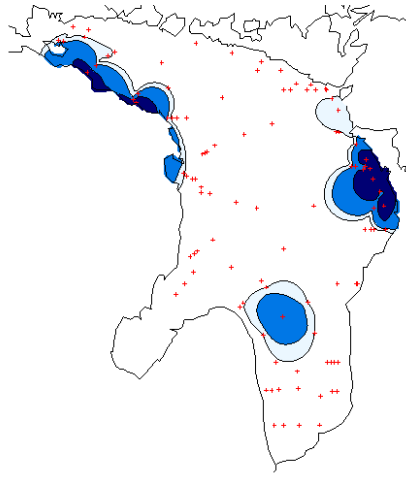
|                      | Year             |                |                |              |
|----------------------|------------------|----------------|----------------|--------------|
|                      | 18-30 m          | 31-50 m        | 51-90 m        | > 90 m       |
| <b>Main Basin</b>    |                  |                |                |              |
| 2000                 | <b>386 ± 342</b> | <b>6 ± 2</b>   | <b>0 ± 0</b>   | <b>0 ± 0</b> |
| 2003                 | <b>297 ± 209</b> | <b>7 ± 4</b>   | <b>20 ± 19</b> | <b>0 ± 0</b> |
| 2007                 | <b>0 ± 0</b>     | <b>20 ± 19</b> | <b>0 ± 0</b>   | <b>0 ± 0</b> |
| 2012                 | <b>1 ± 1</b>     | <b>0 ± 0</b>   | <b>0 ± 0</b>   | <b>0 ± 0</b> |
| <b>Georgian Bay</b>  |                  |                |                |              |
| 2002                 | <b>19 ± 10</b>   | <b>24 ± 23</b> | <b>2 ± 2</b>   | -----        |
| 2007                 | <b>29 ± 29</b>   | <b>4 ± 4</b>   | <b>2 ± 2</b>   | -----        |
| 2012                 | <b>0 ± 0</b>     | <b>18 ± 18</b> | <b>0 ± 0</b>   | -----        |
| <b>North Channel</b> |                  |                |                |              |
| 2002                 | <b>1 ± 1</b>     | <b>0 ± 0</b>   | <b>0 ± 0</b>   | -----        |
| 2007                 | <b>0 ± 0</b>     | <b>0 ± 0</b>   | <b>0 ± 0</b>   | -----        |
| 2012                 | <b>0 ± 0</b>     | <b>0 ± 0</b>   | <b>0 ± 0</b>   | -----        |

# Zebra Mussel

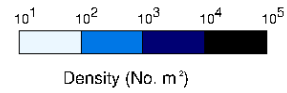
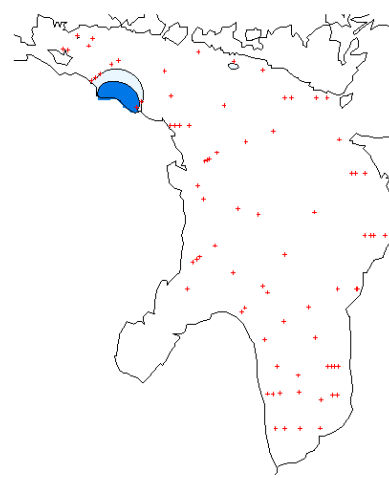
2000



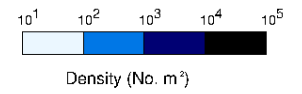
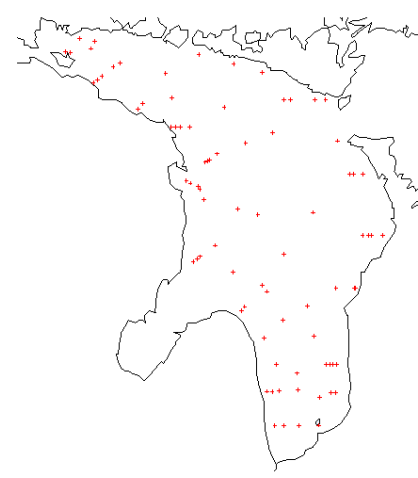
2003



2007



2012

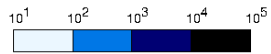
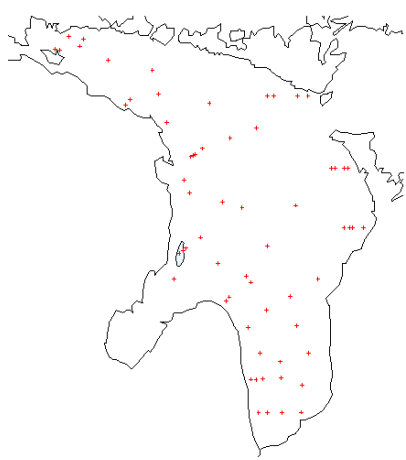


## *Dreissena r. bugensis* (no./m<sup>2</sup>)

|                      | Depth Interval     |                      |                    |                  |
|----------------------|--------------------|----------------------|--------------------|------------------|
|                      | 18-30 m            | 31-50 m              | 51-90 m            | > 90 m           |
| <b>Main Basin</b>    |                    |                      |                    |                  |
| <b>2000</b>          | <b>3 ± 2</b>       | <b>2 ± 1</b>         | <b>0 ± 0</b>       | <b>0 ± 0</b>     |
| <b>2003</b>          | <b>297 ± 180</b>   | <b>1,469 ± 757</b>   | <b>70 ± 44</b>     | <b>1 ± 1</b>     |
| <b>2007</b>          | <b>1,199 ± 432</b> | <b>2,392 ± 854</b>   | <b>305 ± 178</b>   | <b>135 ± 135</b> |
| <b>2012</b>          | <b>1,319 ± 762</b> | <b>1,357 ± 377</b>   | <b>1,125 ± 456</b> | <b>761 ± 615</b> |
| <b>Georgian Bay</b>  |                    |                      |                    |                  |
| <b>2002</b>          | <b>0 ± 0</b>       | <b>36 ± 24</b>       | <b>0 ± 0</b>       | -----            |
| <b>2007</b>          | <b>371 ± 371</b>   | <b>1,068 ± 1,065</b> | <b>1 ± 1</b>       | -----            |
| <b>2012</b>          | <b>5 ± 2</b>       | <b>568 ± 218</b>     | <b>19 ± 13</b>     | -----            |
| <b>North Channel</b> |                    |                      |                    |                  |
| <b>2002</b>          | <b>0 ± 0</b>       | <b>0 ± 0</b>         | <b>0 ± 0</b>       | -----            |
| <b>2007</b>          | <b>0 ± 0</b>       | <b>0 ± 0</b>         | <b>0 ± 0</b>       | -----            |
| <b>2012</b>          | <b>0 ± 0</b>       | <b>0 ± 0</b>         | <b>0 ± 0</b>       | -----            |

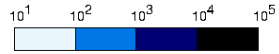
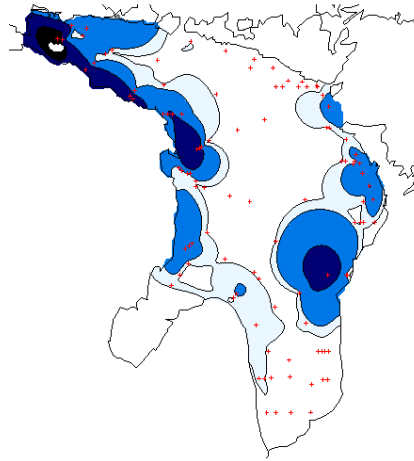
# Quagga Mussel

2000



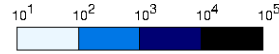
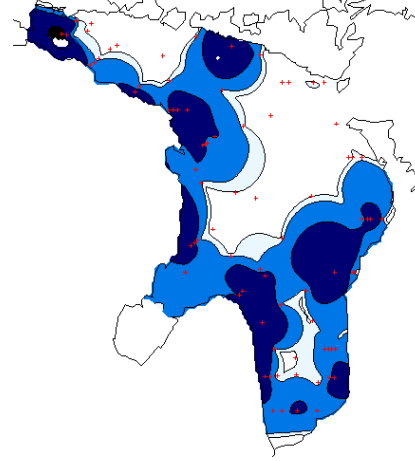
Density (No. m<sup>-2</sup>)

2003



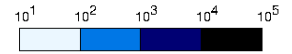
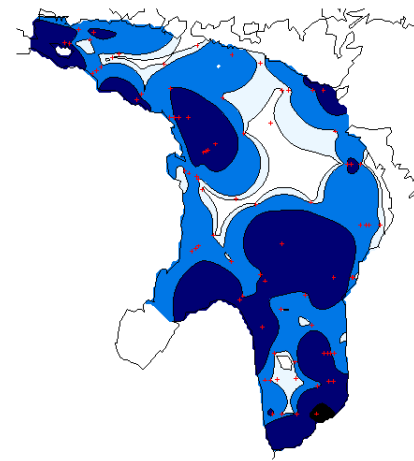
Density (No. m<sup>-2</sup>)

2007



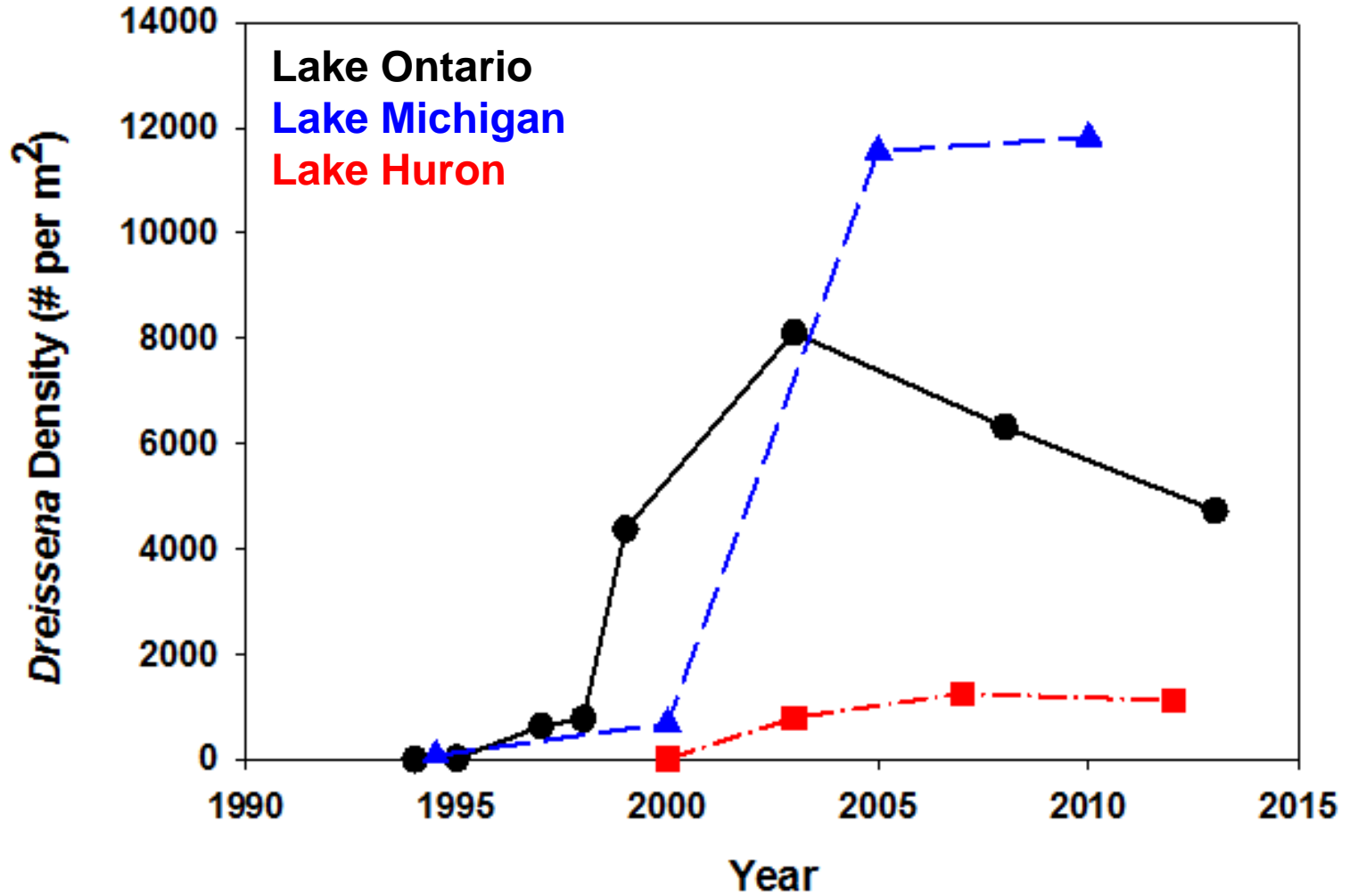
Density (No. m<sup>-2</sup>)

2012

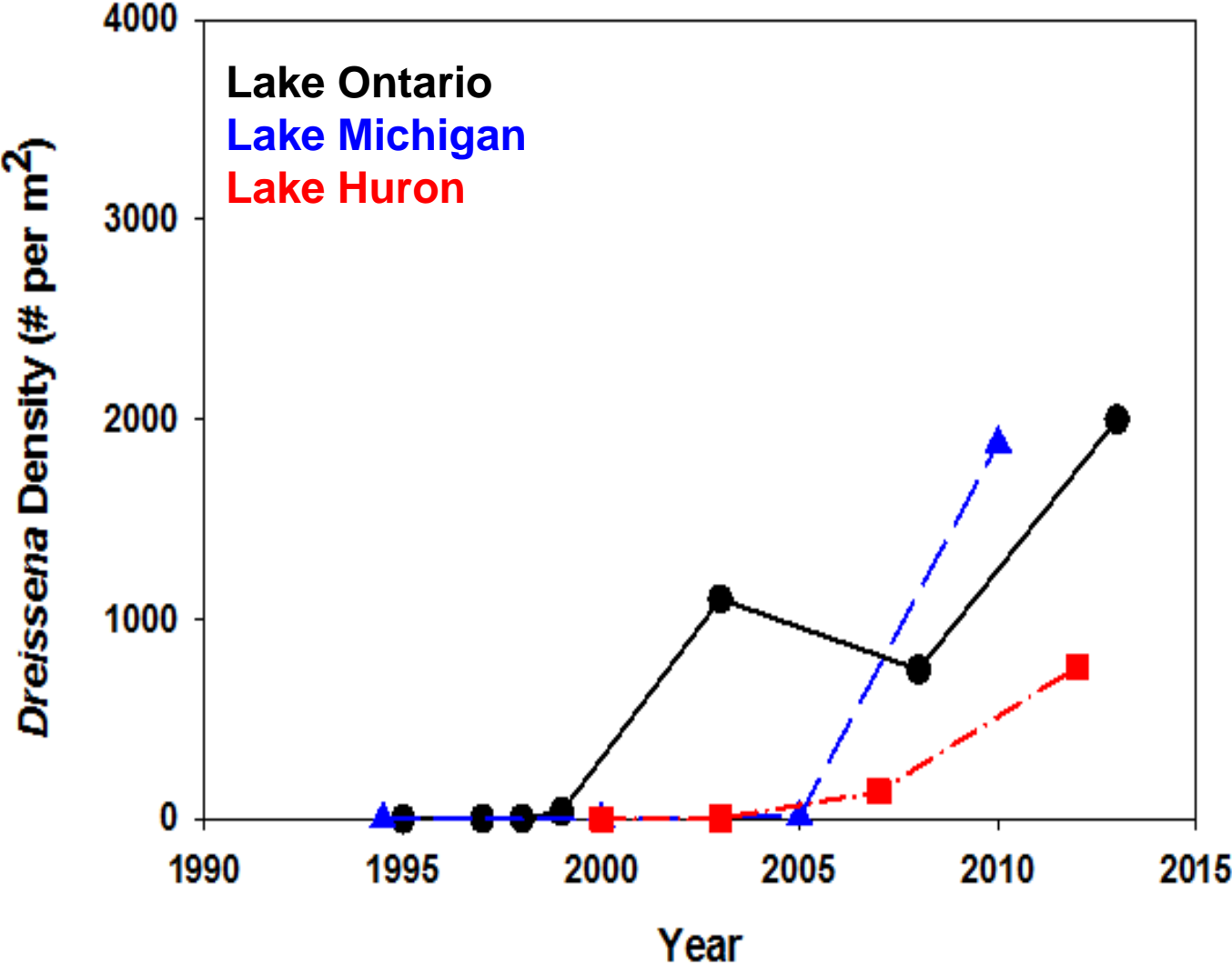


Density (No. m<sup>-2</sup>)

## Mean Dreissenid Density, 30-90 m



# Mean Dreissenid Density, > 90 m





Mean ( $\pm$  SE) biomass (AFDW, g tissue/m<sup>2</sup>) by depth interval in  
Lakes Huron, Ontario, and Michigan

| Depth<br>Interval | Lake (Year)                |                           |                            |
|-------------------|----------------------------|---------------------------|----------------------------|
|                   | Lake Huron<br>(2012)       | Lake Ontario<br>(2013)    | Lake Michigan<br>(2010)    |
| 18-30             | <b>4.8</b> $\pm$ 2.5 (14)  | <b>24.1</b> $\pm$ 9.8 (9) | <b>11.1</b> $\pm$ 2.0 (48) |
| 31-50             | <b>12.4</b> $\pm$ 4.5 (30) | <b>24.4</b> $\pm$ 6.5 (6) | <b>23.8</b> $\pm$ 2.0 (37) |
| 51-90             | <b>5.5</b> $\pm$ 2.1 (31)  | <b>22.7</b> $\pm$ 1.7 (8) | <b>25.4</b> $\pm$ 2.3 (41) |
| >90               | <b>4.3</b> $\pm$ 4.0 (8)   | <b>6.7</b> $\pm$ 2.0 (23) | <b>1.6</b> $\pm$ 1.8 (18)  |

**Relationship between shell length (SL; mm) and ash-free dry weight (AFDW tissue; mg) as derived from the allometric equation:**

$$\ln \text{AFDW} = a + b \ln \text{SL}$$

|                             | <b>a</b>      | <b>b</b>     | <b>n</b>   | <b>R<sup>2</sup></b> | <b>15 mm</b> |
|-----------------------------|---------------|--------------|------------|----------------------|--------------|
| <b>Lake Huron (2012)</b>    |               |              |            |                      |              |
| 18-30                       |               |              |            |                      |              |
| 31-50                       | <b>-5.060</b> | <b>2.589</b> | <b>140</b> | <b>0.89</b>          | <b>7.0</b>   |
| 51-90                       | <b>-5.915</b> | <b>2.899</b> | <b>87</b>  | <b>0.91</b>          | <b>6.9</b>   |
| >90                         |               |              |            |                      |              |
| <b>Lake Ontario (2013)</b>  |               |              |            |                      |              |
| 18-30                       | <b>-5.258</b> | <b>2.581</b> | <b>53</b>  | <b>0.57</b>          | <b>5.7</b>   |
| 31-50                       |               |              |            |                      |              |
| 51-90                       | <b>-6.624</b> | <b>2.997</b> | <b>47</b>  | <b>0.84</b>          | <b>4.4</b>   |
| >90                         | <b>-5.813</b> | <b>2.805</b> | <b>42</b>  | <b>0.84</b>          | <b>6.0</b>   |
| <b>Lake Michigan (2010)</b> |               |              |            |                      |              |
| 18-30                       | <b>-5.857</b> | <b>2.814</b> | <b>122</b> | <b>0.63</b>          | <b>5.8</b>   |
| 31-50                       | <b>-5.528</b> | <b>2.617</b> | <b>172</b> | <b>0.85</b>          | <b>4.8</b>   |
| 51-90                       | <b>-5.601</b> | <b>2.683</b> | <b>269</b> | <b>0.87</b>          | <b>5.3</b>   |
| >90                         | <b>-5.993</b> | <b>2.854</b> | <b>24</b>  | <b>0.98</b>          | <b>5.7</b>   |
| <b>Saginaw Bay (2008)</b>   | <b>-5.836</b> | <b>2.775</b> | <b>27</b>  | <b>0.90</b>          | <b>5.4</b>   |
| <b>Saginaw Bay (2010)</b>   | <b>-3.035</b> | <b>1.766</b> | <b>25</b>  | <b>0.77</b>          | <b>5.7</b>   |

**Mean ( $\pm$  SE) Density (no./m<sup>2</sup>) and AFDW Biomass (g/m<sup>2</sup>)  
of *Dreissena* in Saginaw Bay**

| Year        | Inner Bay (6 sites)               |                                 | Outer Bay (1 site)             |             |
|-------------|-----------------------------------|---------------------------------|--------------------------------|-------------|
|             | Density                           | Biomass                         | Density                        | Biomass     |
| 1991        | 9,305 $\pm$ 6,389                 | 12.3 $\pm$ 7.6                  | 3,408 $\pm$ 2,772              | 0.7         |
| 1992        | 31,334 $\pm$ 15,627               | 58.6 $\pm$ 28.1                 | 4,695 $\pm$ 2,542              | 19.5        |
| 1993        | 3,803 $\pm$ 1,592                 | 4.5 $\pm$ 2.1                   | 5,813 $\pm$ 2,384              | 15.3        |
| 1994        | 5,633 $\pm$ 1,945                 | 9.2 $\pm$ 2.4                   | 9,925 $\pm$ 1,590              | 32.6        |
| 1995        | 2,562 $\pm$ 1,126                 | 4.9 $\pm$ 1.6                   | 3,824 $\pm$ 525                | 27.1        |
| 1996        | 5,261 $\pm$ 3,224                 | 14.7 $\pm$ 6.4                  | 6,981 $\pm$ 1,670              | 57.5        |
| <b>Mean</b> | <b>4,314</b>                      | <b>8.3</b>                      | <b>6,636</b>                   | <b>33.1</b> |
| <b>2008</b> | <b>538 <math>\pm</math> 103</b>   | <b>2.0 <math>\pm</math> 0.4</b> | <b>596 <math>\pm</math> 54</b> | <b>3.9</b>  |
| <b>2009</b> | <b>421 <math>\pm</math> 90</b>    | <b>1.5 <math>\pm</math> 0.6</b> | <b>411 <math>\pm</math> 55</b> | <b>2.0</b>  |
| <b>2010</b> | <b>1,808 <math>\pm</math> 996</b> | <b>1.4 <math>\pm</math> 1.0</b> |                                |             |
| <b>Mean</b> | <b>922</b>                        | <b>1.6</b>                      | <b>504</b>                     | <b>3.0</b>  |

1991-1996 = 100% Zebra mussels

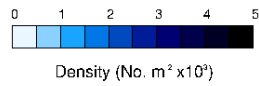
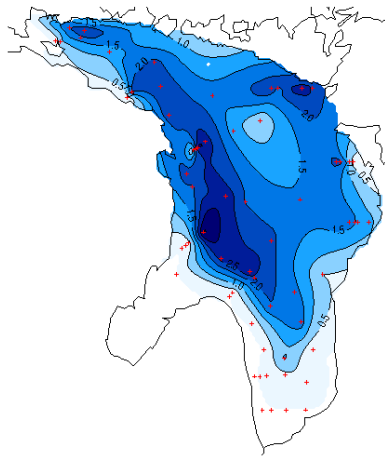
2008-2010 = 80% Quagga mussels; 20% Zebra mussels

## *Diporeia* (no./m<sup>2</sup> )

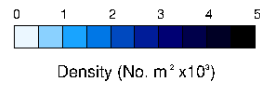
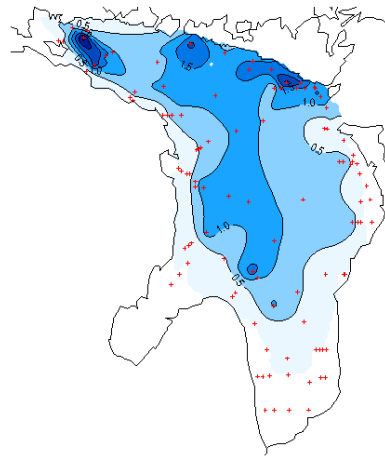
|                      | Depth Interval       |                    |                      |                    |
|----------------------|----------------------|--------------------|----------------------|--------------------|
|                      | 18-30 m              | 31-50 m            | 51-90 m              | > 90 m             |
| <b>Main Basin</b>    |                      |                    |                      |                    |
| 1972                 | <b>1,898 ± 1,008</b> | <b>5,892 ± 750</b> | <b>4,857 ± 551</b>   | -----              |
| 2000                 | <b>244 ± 237</b>     | <b>876 ± 287</b>   | <b>1,918 ± 177</b>   | <b>1,646 ± 254</b> |
| 2003                 | <b>97 ± 92</b>       | <b>248 ± 103</b>   | <b>900 ± 130</b>     | <b>984 ± 65</b>    |
| 2007                 | <b>1 ± 1</b>         | <b>16 ± 9</b>      | <b>176 ± 59</b>      | <b>427 ± 82</b>    |
| 2012                 | <b>0 ± 0</b>         | <b>0 ± 0</b>       | <b>70 ± 31</b>       | <b>256 ± 69</b>    |
| <b>Georgian Bay</b>  |                      |                    |                      |                    |
| 1973                 | <b>2,117 ± 661</b>   | <b>1,603 ± 663</b> | <b>1,507 ± 354</b>   | -----              |
| 2002                 | <b>1,687 ± 830</b>   | <b>1,457 ± 596</b> | <b>1,684 ± 306</b>   | -----              |
| 2007                 | <b>74 ± 74</b>       | <b>40 ± 38</b>     | <b>99 ± 56</b>       | -----              |
| 2012                 | <b>2 ± 2</b>         | <b>0 ± 0</b>       | <b>0 ± 0</b>         | -----              |
| <b>North Channel</b> |                      |                    |                      |                    |
| 1973                 | <b>1,369 ± 471</b>   | <b>1,520 ± 96</b>  | <b>3,441 ± 1,663</b> | -----              |
| 2002                 | <b>2,046 ± 705</b>   | <b>896 ± 401</b>   | <b>3,349 ± 43</b>    | -----              |
| 2007                 | <b>1,022 ± 423</b>   | <b>660 ± 432</b>   | <b>253 ± 253</b>     | -----              |
| 2012                 | <b>470 ± 179</b>     | <b>618 ± 325</b>   | <b>14 ± 13</b>       | -----              |

# *Diporeia*

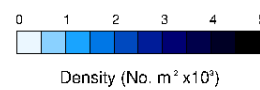
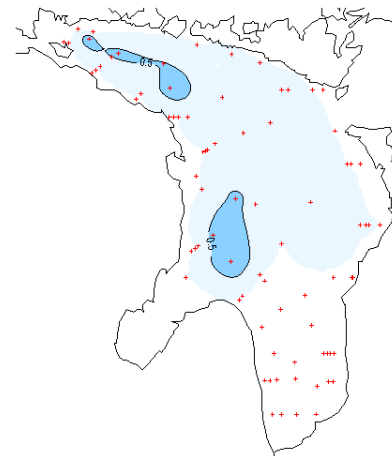
2000



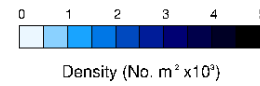
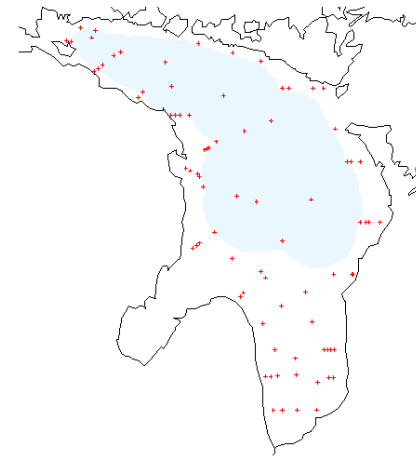
2003



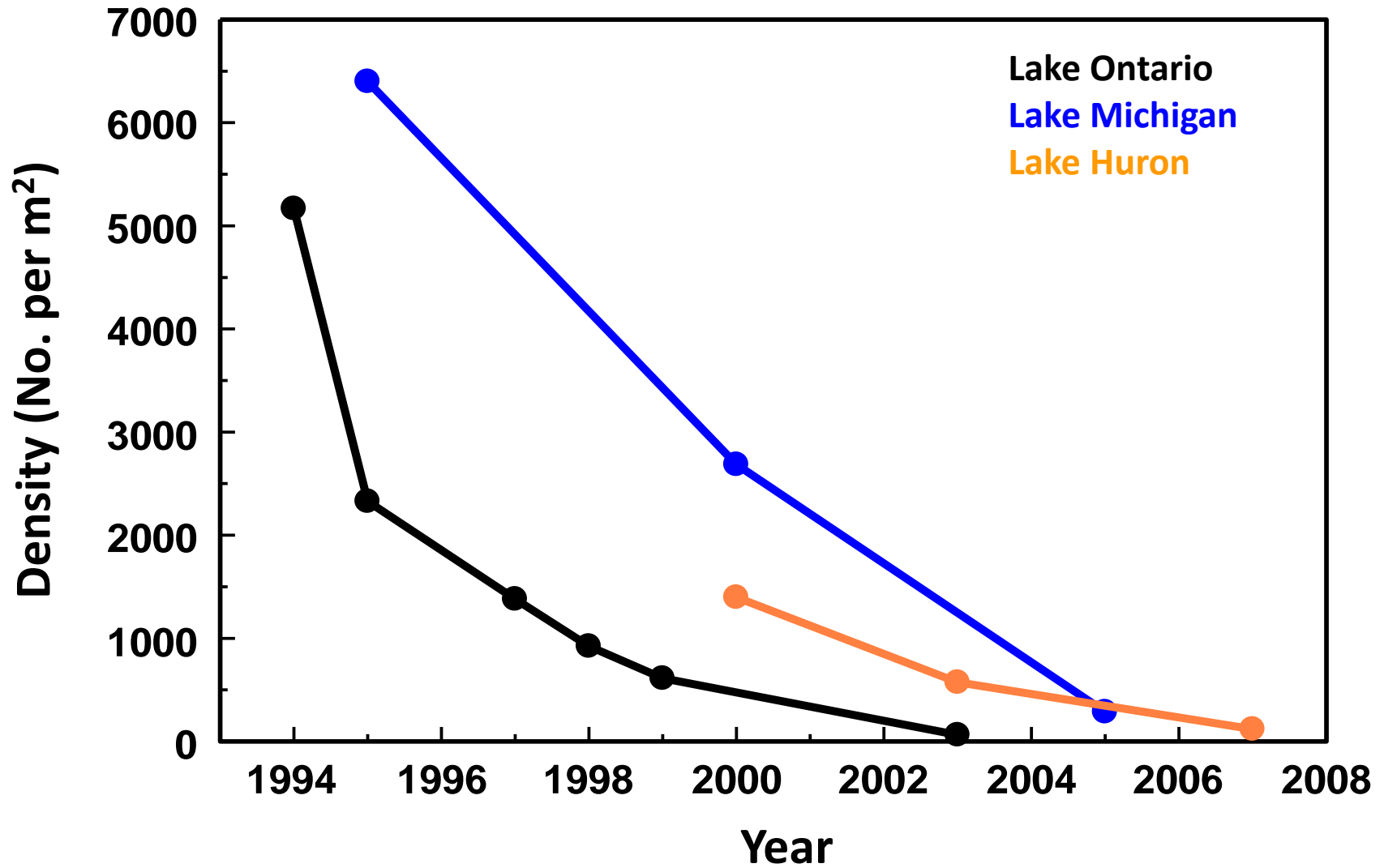
2007



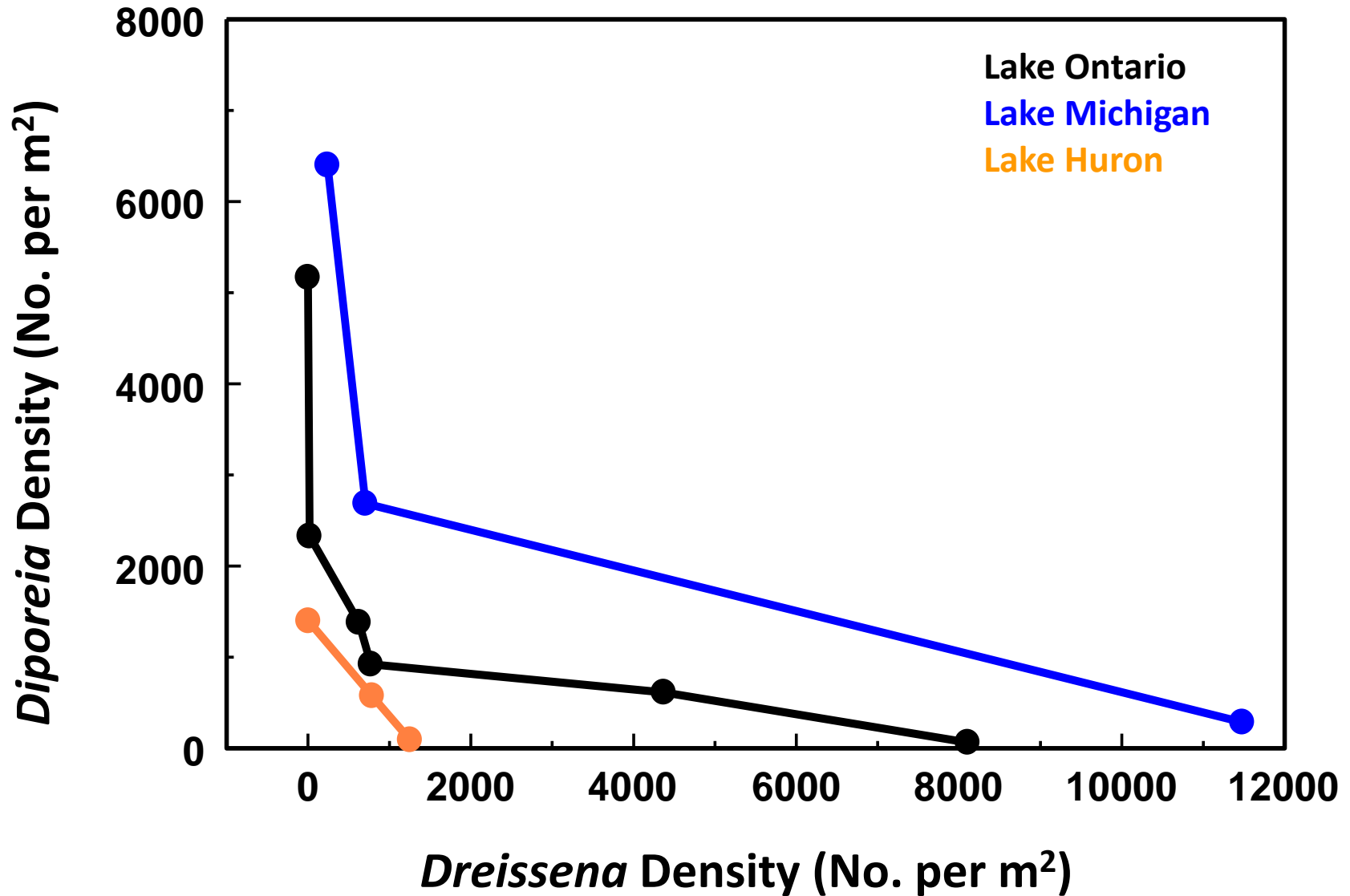
2012



## Mean *Diporeia* Density, 30-90 m



# Mean Densities at 30-90 m



## Dry Weight (mg) of a 5-mm *Diporeia* prior to *Dreissena* invasion

| Lake     | Year       | Depth (m) | Dry Wt., 5 mm | Reference                     |
|----------|------------|-----------|---------------|-------------------------------|
| Michigan | 1976       | 65-115    | <b>0.82</b>   | Lubner (1979)                 |
| Michigan | 1981       | 15        | <b>0.87</b>   | Winnell and White (1984)      |
| Michigan | 1981       | 42        | <b>0.88</b>   | Winnell and White (1984)      |
| Michigan | 1988,1989  | 45        | <b>0.72</b>   | Cavaletto et al. (1996)       |
| Michigan | 1988, 1989 | 100       | <b>0.55</b>   | Cavaletto et al. (1996)       |
| Ontario  | 1968       | 35        | <b>0.98</b>   | Johnson and Brinkhurst (1971) |
| Ontario  | 1988, 1989 | 35        | <b>1.17</b>   | Cavaletto et al. (1996)       |
| Ontario  | 1988, 1989 | 125       | <b>0.99</b>   | Cavaletto et al. (1996)       |
| Huron    | 1980       | 10-55     | <b>0.24</b>   | Johnson (1988)                |



## Oligochaeta (no./m<sup>2</sup> )

|                      | Year                 |                    |                    |                  |
|----------------------|----------------------|--------------------|--------------------|------------------|
|                      | 18-30 m              | 31-50 m            | 51-90 m            | > 90 m           |
| <b>Main Basin</b>    |                      |                    |                    |                  |
| 1972                 | <b>2,664 ± 919</b>   | <b>2,831 ± 414</b> | <b>443 ± 74</b>    | -----            |
| 2000                 | <b>1,648 ± 410</b>   | <b>1,196 ± 314</b> | <b>792 ± 87</b>    | <b>661 ± 69</b>  |
| 2003                 | <b>1,783 ± 417</b>   | <b>1,460 ± 368</b> | <b>374 ± 41</b>    | <b>443 ± 74</b>  |
| 2007                 | <b>8,114 ± 2,748</b> | <b>2,980 ± 802</b> | <b>500 ± 62</b>    | <b>559 ± 138</b> |
| 2012                 | <b>8,137 ± 2,853</b> | <b>2,328 ± 404</b> | <b>710 ± 92</b>    | <b>489 ± 154</b> |
| <b>Georgian Bay</b>  |                      |                    |                    |                  |
| 1973                 | <b>781 ± 628</b>     | <b>522 ± 307</b>   | <b>270 ± 239</b>   | -----            |
| 2002                 | <b>707 ± 344</b>     | <b>767 ± 293</b>   | <b>413 ± 144</b>   | -----            |
| 2007                 | <b>1,810 ± 1,349</b> | <b>607 ± 248</b>   | <b>150 ± 60</b>    | -----            |
| 2012                 | <b>1,199 ± 632</b>   | <b>2,077 ± 720</b> | <b>397 ± 123</b>   | -----            |
| <b>North Channel</b> |                      |                    |                    |                  |
| 1973                 | <b>952 ± 592</b>     | <b>205 ± 51</b>    | <b>29 ± 10</b>     | -----            |
| 2002                 | <b>653 ± 269</b>     | <b>322 ± 163</b>   | <b>1,174 ± 232</b> | -----            |
| 2007                 | <b>477 ± 230</b>     | <b>257 ± 119</b>   | <b>306 ± 243</b>   | -----            |
| 2012                 | <b>1,039 ± 493</b>   | <b>370 ± 173</b>   | <b>173</b>         | -----            |

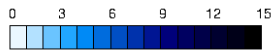
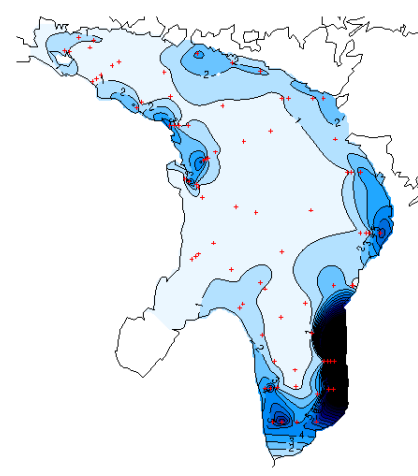
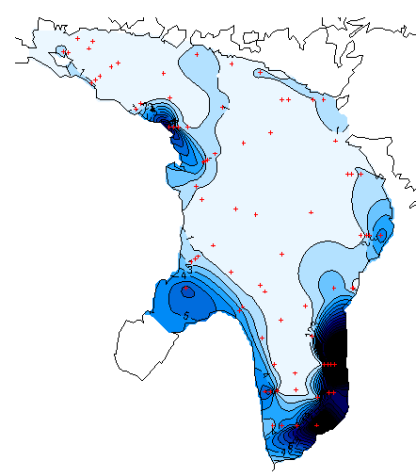
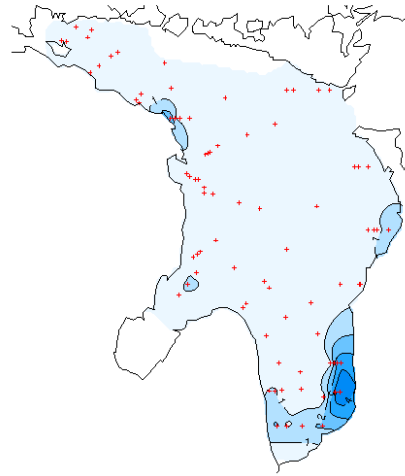
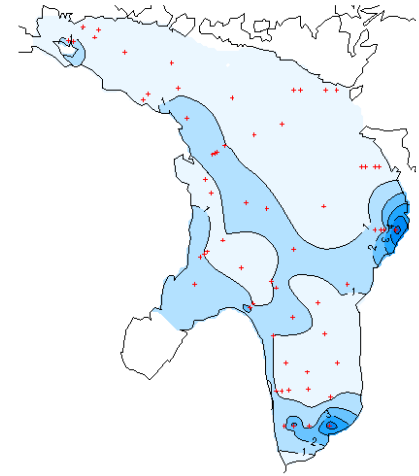
# Oligochaeta

2000

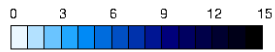
2003

2007

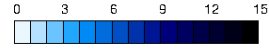
2012



Density (No.  $m^{-2} \times 10^3$ )



Density (No.  $m^{-2} \times 10^3$ )

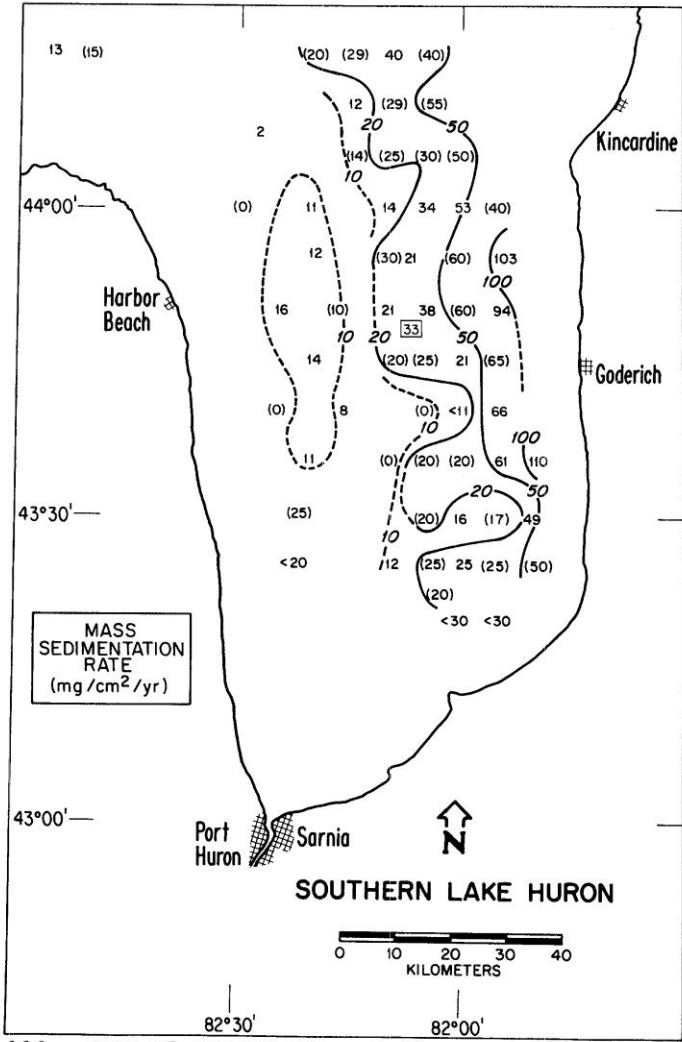


Density (No.  $m^{-2} \times 10^3$ )

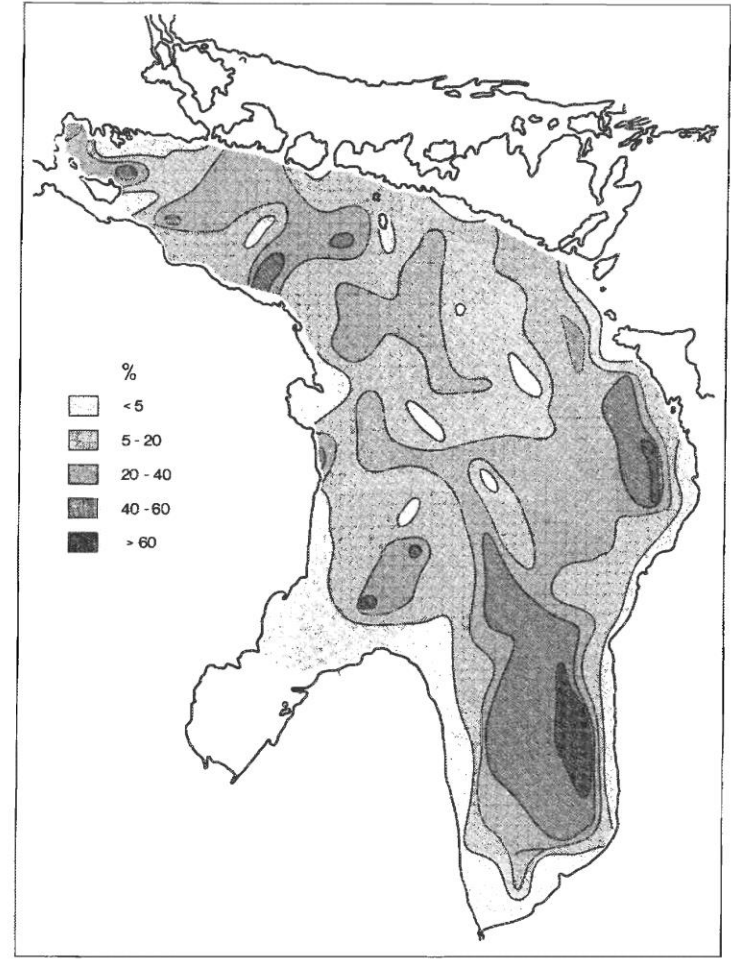


Density (No.  $m^{-2} \times 10^3$ )





Source: Robbins (1980)



Source: Thomas et al. (1973)

## Sphaeriidae (no./m<sup>2</sup> )

|                      | Depth Interval     |                    |                  |                 |
|----------------------|--------------------|--------------------|------------------|-----------------|
|                      | 18-30 m            | 31-50 m            | 51-90 m          | > 90 m          |
| <b>Main Basin</b>    |                    |                    |                  |                 |
| 1972                 | <b>609 ± 402</b>   | <b>1,275 ± 210</b> | <b>462 ± 104</b> | -----           |
| 2000                 | <b>457 ± 196</b>   | <b>237 ± 37</b>    | <b>323 ± 44</b>  | <b>104 ± 35</b> |
| 2003                 | <b>47 ± 21</b>     | <b>67 ± 13</b>     | <b>106 ± 17</b>  | <b>80 ± 42</b>  |
| 2007                 | <b>183 ± 64</b>    | <b>114 ± 24</b>    | <b>127 ± 19</b>  | <b>109 ± 50</b> |
| 2012                 | <b>62 ± 24</b>     | <b>129 ± 30</b>    | <b>100 ± 16</b>  | <b>92 ± 25</b>  |
| <b>Georgian Bay</b>  |                    |                    |                  |                 |
| 1973                 | <b>302 ± 189</b>   | <b>806 ± 383</b>   | <b>389 ± 203</b> | -----           |
| 2002                 | <b>1,814 ± 526</b> | <b>853 ± 214</b>   | <b>175 ± 58</b>  | -----           |
| 2007                 | <b>71 ± 25</b>     | <b>161 ± 94</b>    | <b>84 ± 14</b>   | -----           |
| 2012                 | <b>143 ± 143</b>   | <b>109 ± 63</b>    | <b>63 ± 16</b>   | -----           |
| <b>North Channel</b> |                    |                    |                  |                 |
| 1973                 | <b>983 ± 384</b>   | <b>780 ± 236</b>   | <b>898 ± 236</b> | -----           |
| 2002                 | <b>875 ± 280</b>   | <b>357 ± 163</b>   | <b>635 ± 200</b> | -----           |
| 2007                 | <b>232 ± 41</b>    | <b>338 ± 137</b>   | <b>78 ± 21</b>   | -----           |
| 2012                 | <b>853 ± 288</b>   | <b>308 ± 141</b>   | <b>124</b>       | -----           |

## Chironomidae (no./m<sup>2</sup> )

|                      | Depth Interval   |                  |                 |                |
|----------------------|------------------|------------------|-----------------|----------------|
|                      | 18-30 m          | 31-50 m          | 51-90 m         | > 90 m         |
| <b>Main Basin</b>    |                  |                  |                 |                |
| 1972                 | <b>419 ± 149</b> | <b>134 ± 28</b>  | <b>65 ± 14</b>  | -----          |
| 2000                 | <b>883 ± 451</b> | <b>379 ± 140</b> | <b>73 ± 11</b>  | <b>53 ± 12</b> |
| 2003                 | <b>238 ± 55</b>  | <b>62 ± 14</b>   | <b>27 ± 5</b>   | <b>17 ± 5</b>  |
| 2007                 | <b>754 ± 210</b> | <b>250 ± 50</b>  | <b>25 ± 6</b>   | <b>20 ± 15</b> |
| 2012                 | <b>277 ± 71</b>  | <b>457 ± 159</b> | <b>61 ± 18</b>  | <b>50 ± 15</b> |
| <b>Georgian Bay</b>  |                  |                  |                 |                |
| 1973                 | <b>57 ± 19</b>   | <b>200 ± 141</b> | <b>35 ± 10</b>  | -----          |
| 2002                 | <b>162 ± 34</b>  | <b>94 ± 26</b>   | <b>44 ± 11</b>  | -----          |
| 2007                 | <b>725 ± 353</b> | <b>164 ± 124</b> | <b>56 ± 13</b>  | -----          |
| 2012                 | <b>99 ± 85</b>   | <b>72 ± 62</b>   | <b>22 ± 10</b>  | -----          |
| <b>North Channel</b> |                  |                  |                 |                |
| 1973                 | <b>231 ± 57</b>  | <b>126 ± 53</b>  | <b>104 ± 85</b> | -----          |
| 2002                 | <b>99 ± 22</b>   | <b>198 ± 57</b>  | <b>54 ± 25</b>  | -----          |
| 2007                 | <b>676 ± 383</b> | <b>469 ± 242</b> | <b>28 ± 21</b>  | -----          |
| 2012                 | <b>276 ± 80</b>  | <b>194 ± 68</b>  | <b>841</b>      | -----          |

## Summary - Main Points

- ▶ **Dreissenid populations have stabilized at < 90 m but are still increasing at > 90 m**
- ▶ **At 31-90 m, dreissenid biomass in Lake Huron is about 1/3 that found at similar depths in Lakes Michigan and Ontario.**
- ▶ ***Diporeia* continues to decline in the main basin. Declines are apparent even in Georgian Bay and North Channel where there are few dreissenids.**
- ▶ **Oligochaetes have increased in the nearshore (< 30 m ), particularly in the southeastern portion of the lake.**

# Thanks for Your Attention!

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