Distribution and Biomass of Macrophytes Growing Near Streams
U.S.D.A. Project Macrophyte Study Sites

Experimental → Controls

Beds dominated by milfoil near stream outlets
Key Questions About Macrophytes:

• What are the annual changes in biomass and standing crop in macrophyte beds near project streams?

• Is there a correspondence between nutrient loading, macrophyte biomass and standing crop?

• Are there differences in growth between beds associated with project experimental watersheds and control watersheds?
• 2-4 quadrat samples collected by divers at 1, 2, 3, 4 m
• Swimmers track the perimeter of the milfoil while boat with Trimble GPS operator follows
• Plants are separated by species and weighed
## Macrophyte Data for 2004 Growing Season

<table>
<thead>
<tr>
<th>Location</th>
<th>Transect #</th>
<th>Depth</th>
<th>Surface Area (m²)</th>
<th>Crop (Kg DW)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 m</td>
<td>2 m</td>
<td>3 m</td>
</tr>
<tr>
<td>* Near stream</td>
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</tr>
<tr>
<td>1</td>
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<td>243 ± 147</td>
<td>105 ± 38</td>
</tr>
<tr>
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<td>--</td>
<td>310</td>
<td>--</td>
</tr>
<tr>
<td>3</td>
<td>2*</td>
<td>--</td>
<td>280 ± 67</td>
<td>189 ± 70</td>
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<tr>
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<td>355 ± 35</td>
<td>120 ± 15</td>
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<td>76 ± 18</td>
<td>238 ± 122</td>
<td>221 ± 91</td>
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<tr>
<td>McPherson's Point</td>
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<td>64 ± 8</td>
<td>245 ± 47</td>
<td>107 ± 15</td>
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<tr>
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<td>2*</td>
<td>86 ± 26</td>
<td>208 ± 24</td>
<td>183 ± 51</td>
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<tr>
<td>Long Point Cove</td>
<td>1*</td>
<td>51 ± 22</td>
<td>143 ± 33</td>
<td>174 ± 62</td>
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<tr>
<td></td>
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<td>44 ± 27</td>
<td>124 ± 21</td>
<td>143 ± 32</td>
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<tr>
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<td>63 ± 16</td>
<td>122 ± 19</td>
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<td>Sand Point Gully</td>
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<td>12 ± 13</td>
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<td>93 ± 52</td>
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<td>36 ± 20</td>
<td>163 ± 42</td>
<td>143 ± 63</td>
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<td></td>
<td>1</td>
<td>270 ± 91</td>
<td>4 ± 5</td>
<td>168 ± 35</td>
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<td>Graywood Gully</td>
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<td>508 ± 158</td>
<td>258 ± 151</td>
<td>112 ± 48</td>
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<tr>
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<td>3</td>
<td>37 ± 16</td>
<td>191 ± 29</td>
<td>123 ± 80</td>
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</table>
Changes in the distribution of Eurasian Watermilfoil within individual beds such as Graywood gully.

Stations are 100-150 m apart along shore.

NM = no milfoil
**Regression Statistical Comparison**

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<tr>
<th>COMPARISON</th>
<th>R²</th>
<th>p value</th>
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<tbody>
<tr>
<td>TP Loading vs. Quad Biomass</td>
<td>0.08</td>
<td>0.59 (NS)</td>
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<tr>
<td>N Loading vs. Quad Biomass</td>
<td>0.015</td>
<td>0.59 (NS)</td>
</tr>
<tr>
<td>N Loading vs. Standing Crop</td>
<td>0.23</td>
<td>0.33 (NS)</td>
</tr>
<tr>
<td>Stream Discharge vs Bed Surf. Area</td>
<td>0.58</td>
<td>0.07 (NS)</td>
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</table>

**2004 Total P Load vs. Standing Crop**

Regression Equation:

\[ y = 74.984x + 152 \]

R² = 0.62

p = 0.04
## Average Surface Standing Biomass Area Crop

<table>
<thead>
<tr>
<th>Location</th>
<th>Year</th>
<th>Average Biomass grams m⁻²</th>
<th>Surface Area m²</th>
<th>Standing Crop Kg Dry Weight</th>
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<td>184 ± 43</td>
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<td>2001</td>
<td>467 ± 183</td>
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<td>2002</td>
<td>71 ± 40</td>
<td>3,688</td>
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<td>2003</td>
<td>138 ± 92</td>
<td>11,819</td>
<td>1631</td>
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<td>2004</td>
<td>227 ± 77</td>
<td>11,909</td>
<td>2,703</td>
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<td>Cottonwood Gully</td>
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<td>193 ± 85</td>
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<td>373 ± 168</td>
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<td>McPherson's Point</td>
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<td>262 ± 134</td>
<td>23,192</td>
<td>6,192</td>
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<td>2001</td>
<td>459 ± 202</td>
<td>25,783</td>
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<td>2002</td>
<td>151 ± 74</td>
<td>12,004</td>
<td>1,813</td>
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<td>304 ± 176</td>
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<td>2004</td>
<td>186 ± 57</td>
<td>30,099</td>
<td>5,598</td>
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<td>2001</td>
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<td>2003</td>
<td>140 ± 75</td>
<td>1,440</td>
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<td>93 ± 42</td>
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<td>Sand Point Gully</td>
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<td>212 ± 29</td>
<td>9,535</td>
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<td>2001</td>
<td>484 ± 300</td>
<td>9,781</td>
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<td>131 ± 34</td>
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<td>238</td>
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<tr>
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<td>2001</td>
<td>412 ± 162</td>
<td>36,148</td>
<td>14,897</td>
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<td>2002</td>
<td>193 ± 123</td>
<td>6,703</td>
<td>1,294</td>
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<td>2003</td>
<td>131 ± 79</td>
<td>14,186</td>
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<td>2004</td>
<td>190 ± 54</td>
<td>26,864</td>
<td>5,104</td>
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</table>

### 2001 Biomass
- **High**: Sutton, North, Sand, Graywood
- **Low**: Cottonwood, Long Pt. Cove

### 2002 Biomass
- **High**: Cottonwood, Sand
  - **Int**: North, Long Pt. Cove, Graywood
- **Low**: Sutton

### 2003 Biomass
- **High**: North, Sand
  - **Int**: Long Pt. Cove
- **Low**: Sutton, Cottonwood, Graywood

### 2004 Biomass
- One statistical grouping
Annual Trends in Milfoil Bed Surface Area

Experimenta

Contro

Bed Surface Area (% of multi-year average)

Long Point
Sand Point Gully
Cottonwood Gully
Long Point Cove
Graywood Gully
Sutton Point
McPhersons Point

2000
2001
2002
2003
2004

ND ND ND ND ND ND ND

Experimenta
Contro
Annual Trends in Milfoil Bed Standing Crop

<table>
<thead>
<tr>
<th>Location</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
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<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
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<tr>
<td>Cottonwood Gully</td>
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<td>170</td>
<td>180</td>
<td>190</td>
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<td>150</td>
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<tr>
<td>McPhersons Point</td>
<td>100</td>
<td>110</td>
<td>120</td>
<td>130</td>
<td>140</td>
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</tbody>
</table>

Bed Standing Crop (% of multi-year average)

Experimental vs. Control
Relationship of Macrophyte Standing Crop to Average Daily Loading for USDA watersheds

2001
$R^2 = 0.77$
p = 0.05
n = 6

2002
$R^2 = 0.93$
p = 0.045
n = 5

2003
$R^2 = 0.95$
p < 0.01
n = 5

2004
$R^2 = 0.67$
p < 0.047
n = 6
<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Dependent Variable</th>
<th>Sample Size</th>
<th>Regression Coefficient</th>
<th>Significance (P value)</th>
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<tr>
<td>2004 Discharge</td>
<td>Max. Surface Area</td>
<td>5</td>
<td>0.97</td>
<td>0.007</td>
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<td>2004 Discharge</td>
<td>5 yr Avg. Surface Area</td>
<td>5</td>
<td>0.92</td>
<td>0.001</td>
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<tr>
<td>Bed Surface Area</td>
<td>Standing Crop</td>
<td>29</td>
<td>0.72</td>
<td>&lt;&lt;0.001</td>
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<tr>
<td>Avg. Quadrat Biomass</td>
<td>Standing Crop</td>
<td>26</td>
<td>0.39</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Location</td>
<td>Year</td>
<td>TP Load</td>
<td>Quad Wt g. m(^2)</td>
<td>Area m(^2)</td>
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<td>-----------------</td>
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<td>---------------------</td>
<td>--------------</td>
</tr>
<tr>
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<td>6</td>
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<tr>
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<td>2004</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
Conclusions

• Upstream management practices have not influenced the growth of milfoil beds.

• A statistically significant relationship between loading of Phosphorus and standing crops persists, but Nitrogen loading for the first time was not a good predictor of biomass.
Conclusions

• Discharge was a strong predictor of maximum bed surface area and average standing crop.

• Is the TP-Standing Crop relationship a statistical artifact?
  • Standing crops are also a significant function of biomass, a variable that is independent of habitat area.
  • Relative ranking of individual watersheds (loading, standing crop) change from year to year, yet the overall relationship of TP and standing crop persists.
  • Bed surface area is also variable and it may be under the influence of nutrient loading