Comparison of transect spacing and GPS/Sonar equipment for fluvial lake mapping

Author: Mason Johnson  Advisor: Christine Koeller

ABSTRACT
Bathymetric lake mappers are inconsistently employing survey techniques and GPS/Sonar equipment. Comparing transect spacing and GPS/Sonar equipment for fluvial lake mapping is needed. A bathymetric survey was conducted on the Stevens Point Flowage in 2013 from Bukelt Park north to the Highway 10 overpass. The surveyed area extends from Bukelt Park north to the Highway 10 overpass. The surveyed area is 2611 acres with a channel length of seven miles.

OBJECTIVES
1) Determine if significant differences exist between survey-grade (Trimble R6) and mapping-grade equipment (Lowrance HDS).
2) Determine adequate transect spacing using survey-grade equipment for estimating lake volume. [μ Tu = μ Tu] 

METHODS
Data Acquisition for 2013 Maps
- GPS/Sonar survey in summer-fall 2013 using survey-grade equipment (Trimble R6 GPS, Omnis Sonar RM depth sounder) (Figure 2).
- Real-time corrections were applied to Trimble equipment via WISCORS reference station (<1 cm horizontally, <3cm vertically).
- Grid transects were spaced 300 feet apart perpendicular to channel flow (Figure 3).
- Near shore depths were also acquired.
- XYZ positions were recorded every second.
- Lowrance survey data was collected using a similar method devoid of WISCORS differential corrections.

RESULTS
Table 1: Percent difference of lake volumes produced by Trimble vs Lowrance equipment.

<table>
<thead>
<tr>
<th>Transect Spacing (feet)</th>
<th>Volume (Acre-feet)</th>
<th>Trimble</th>
<th>Lowrance</th>
<th>Average</th>
<th>Difference</th>
<th>Percent Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>10254.22</td>
<td>9297.64</td>
<td></td>
<td>9775.93</td>
<td>956.58</td>
<td>9.79</td>
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<td>9894.37</td>
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<td>Average</td>
<td>10074.30</td>
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Paired t-Test (α=0.05) t Critical P-value
Lowrance vs. Trimble

Significant difference exists (P<0.05) between Trimble and Lowrance survey equipment.

Table 2: Calculated percent difference of Trimble lake volumes with different transect spacing.

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Paired t-Test (α=0.05) t Critical P-value
Lowrance vs. Trimble

Significant difference exists (P<0.05) between Trimble 300 and 600 foot transect spacing.

DISCUSSION
High cost, survey-grade equipment (Trimble), produces accurate GPS locations to the sub-centimeter level. Low-cost survey equipment (Lowrance) failed to produce an accurate representation of the Stevens Point Flowage when compared to Trimble. Error associated with Lowrance survey equipment resides in the inability to receive instantaneous coordinate corrections (Figure 9). Modeling lakes require a higher level of accuracy to represent them, depending on the objective.

Transects spaced 300 feet apart result in more accurate lake volume estimations. Increasing transect spacing will likely reduce accurate lake volume estimations. This poses a problem when developing best management practices. Lake managers controlling aquatic invasive species often use water level drawdown techniques to eliminate these species. Drawing down lakes to an extreme level can result in native plant's being unable to establish. Knowing lake volume reduces this risk.

Bibliography:

Figure 1: Stevens Point Flowage, Portage County, WI

Figure 2: Trimble/Lowrance survey equipment attached to transform of ship's bow while surveying.

Figure 3: Grid line transects spaced 300 feet apart and parallel to shore outline, Stevens Point Flowage spring 2013.

Figure 4: Transects spaced 300 feet manually removed.

Figure 5: Positional and depth error of Lowrance survey data.

Figure 6: Lowrance 1m raster.

Figure 7: Trimble 1m raster.

Figure 8: Depth variations of Lowrance model compared to Trimble.

Figure 9: Random points generated within each 10-acre grid.

Figure 10: Random points generated within each 10-acre grid.

Graph 1: Depth distribution of XYZ locations on Stevens Point Flowage, 2013.

Graph 2: Trimble/Lowrance survey equipment attached to transform of ship’s bow while surveying.

Graph 3: Grid line transects spaced 300 feet apart and parallel to shore outline, Stevens Point Flowage spring 2013.

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