THE EFFECTS OF SPECIFIC GRAVITY ON INVENTORY METHODS FOR HATCHERY RAINBOW TROUT

Eric Pankau, Beau Gunter and John Cassinelli
What is Specific Gravity?

• AKA Relative Density

\[ \text{SG} = \frac{\rho_{\text{substance}}}{\rho_{\text{H}_2\text{O}}} \]

• Simplified as the ratio of the mass of a substance to the mass of an equal volume of water

\[ \text{SG}_{\text{substance}} = \frac{\rho_{\text{substance}}}{\rho_{\text{H}_2\text{O}}} = \frac{M_{\text{substance}} / V_{\text{substance}}}{M_{\text{H}_2\text{O}} / V_{\text{H}_2\text{O}}} = \frac{M_{\text{substance}}}{M_{\text{H}_2\text{O}}} \]
How Does This Relate to Aquaculture?

- Displacement of H$_2$O used to calculate fish biomass
- Commonly used for inventory, transport & stocking
Many RBT production facilities assume SG value of 1.00

A constant SG value is commonly assumed across all size classes

Literature varies on the accuracy of SG values (Lewis et al. 1994, NC State 2012)

Targeting actual SG values could improve fish inventory accuracy & reduce potential error
Purpose of this Research

Attempt to answer 2 key questions

1. Do actual SG values vary significantly from the assumed SG of 1.00?

2. Do SG values vary significantly between size class?
Methods

• 3N RBT sampled @ 3”, 6” and 10” in length (typical IDFG stocking sizes)

• Sample groups = 50 fish samples w/ 5 replicates per group (250 fish total)

• 6 total sample groups:
  • 2 groups of Grace Fish Hatchery (GFH) 3”
  • 2 groups of GFH 6”
  • 1 group of Nampa Fish Hatchery (NFH) 10”
  • 1 group of Hagerman State Fish Hatchery (HSFH) 10”
• Total length and weight taken for each fish

• $\text{H}_2\text{O}$ displacement measurement then taken for each fish

• Single factor ANOVA used to test for statistical significance
Fish anesthetized one at a time

Total length taken to nearest mm
Fish lightly dried to remove excess H$_2$O

Total weight (g) to most accurate graduation possible
Collect $\text{H}_2\text{O}$ displaced by fish

Step 1:
Zero the displacement collection cylinder
Step 2: Add fish to displacement collection cylinder

\[ \Delta H_2O \text{ level} \]
Step 3: Draw H₂O into syringe until no more H₂O can be drawn (i.e. back to the zero point)
Weigh the H$_2$O displaced by fish

$$SG = \frac{\text{weight of fish}}{\text{weight H}_2\text{O displaced}}$$
Refining the accuracy of our displacement samples
## Grouping Trials by Size Class

### SG Comparisons by Trial w/in Size Classes (α = 0.05)

*statistically significant variations are highlighted (p < 0.05)*

<table>
<thead>
<tr>
<th>Treatment Comparison</th>
<th>Mean SG Values</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFH 3” (1) : GFH 3” (2)</td>
<td>0.997 : 1.005</td>
<td>0.088</td>
</tr>
<tr>
<td>GFH 6” (1) : GFH 6” (2)</td>
<td>1.017 : 1.020</td>
<td>0.0921</td>
</tr>
<tr>
<td>NFH 10” : HSFH 10”</td>
<td>1.004 : 1.003</td>
<td>0.691</td>
</tr>
</tbody>
</table>
Results

Specific Gravity

3''

6''

10''
### Statistical Significance

Comparison of Actual SG to Assumed SG of 1.00 (α = 0.05)

*statistically significant variations are highlighted (p < 0.05)*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean (±SE)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>3''</td>
<td>1.000 ± 0.002</td>
<td>0.835</td>
</tr>
<tr>
<td>6''</td>
<td>1.019 ± 0.001</td>
<td>1.1E-78</td>
</tr>
<tr>
<td>10''</td>
<td>1.003 ± 0.001</td>
<td>6.8E-06</td>
</tr>
</tbody>
</table>
### SG Comparisons by Size Class (α = 0.05)

*statistically significant variations are highlighted (p < 0.05)*

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<tbody>
<tr>
<td>3&quot; : 6&quot;</td>
<td>1.000 : 1.019</td>
<td>9.9E-13</td>
</tr>
<tr>
<td>3&quot; : 10&quot;</td>
<td>1.000 : 1.003</td>
<td>0.240</td>
</tr>
<tr>
<td>6&quot; : 10&quot;</td>
<td>1.019 : 1.003</td>
<td>9.1E-36</td>
</tr>
</tbody>
</table>
Specific Gravity & Length by Size Class

$R^2 = 0.0015$
Data Trends cont’d

Specific Gravity & Weight by Size Class

$R^2 = 3\times10^{-5}$
Specific Gravity & C-Factor by Size Class

$R^2 = 0.0043$
• We were concerned w/ hatchery specific data
• Other factors can influence SG:
  • Species, Swim bladder inflation, body fat content, etc. (Taylor 1922)

**Our bottom line:**

What is the potential influence of SG on RBT displacement measurements?

• Actual SG < assumed SG = underestimate
• Actual SG > assumed SG = overestimate
Potential RBT Production Influence

Assuming SG = 1.00

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<tr>
<td>3”</td>
<td>1.000</td>
<td>=</td>
</tr>
<tr>
<td>6”</td>
<td>1.019</td>
<td>1.9% ↑</td>
</tr>
<tr>
<td>10”</td>
<td>1.003</td>
<td>0.3% ↑</td>
</tr>
</tbody>
</table>
Additional work is needed from Fish Production professionals to investigate and determine the Mean SG for other species reared at our Idaho hatcheries (ex. Chinook Salmon, steelhead, kokanee).
Acknowledgements

Thank you to the Grace Hatchery, Nampa Hatchery, Hagerman State Hatchery, IDFG Southeast Region staff, Bryan Grant (IDFG Eastern Hatchery Complex Mgr.) and Dr. Ken Rodnick (Idaho State University) for all their help.
