TOPCAT & ROUGHNESS ESTIMATION
Introduction

Importance of Surface Roughness

• Better characterize study sites
  – Distinguish geomorphic units

• Input to different models
  – Error models
    • Correlation to point accuracy
      – MBES, TLS, ALS, SfM
  – Habitat suitability models
  – Grain size distribution

• ‘2.5D’ Elevation
ToPCAT Algorithm

- Topographic Point Cloud Analysis Toolkit
- Efficient point cloud decimation algorithm
- Igor Rychkov\textsuperscript{1} & James Brasington\textsuperscript{2} (2012)
- Accepted by scientific community
  \( \rightarrow \) 4x to 7x impact factor
Decimation...

- **Topographic Point Cloud Analysis Toolkit (ToPCAT)**
- Look at statistical estimates of variance for elevation
  - Absolute Zmin & Zmax
  - Zmean
  - range
  - stdev - The absolute $\sigma$
  - n - Count of number of points in cell (i.e. point density)

- **Addresses memory & processing issues**

ToPCAT Outputs

Calculates:

- Max*
- Min*
- Mean*
- Standard deviation*
- Skew*
- Kurtosis*
- Number of points used to calculate statistics

* Respects original x, y
* Centroid statistic & detrended also calculated
Output – Decimated Point Cloud

- Grid centered product with valuable statistical info
- Quick conversion to raster format
Locally Detrending

- Algorithm requires minimum of 4 points
- Isolates values from the influence of slope
  - Looking only at the local variation of $z$ values
- Skew and kurtosis can be used as further lines of evidence
Grain Size Distribution Calculator

- Relationship between locally detrended standard deviation and grain size
- Wentworth pebble count bins*

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Table 3. Median Particle Size and Corresponding Grid Statistics for Selected Patches in the River Feshie:

<table>
<thead>
<tr>
<th>Sample</th>
<th>Median Particle Size $D_{50}$ (mm)</th>
<th>SD of Elevation ($\sigma_z$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Raw (mm)</td>
<td>Detrended (mm)</td>
</tr>
<tr>
<td>Patch 1</td>
<td>30.3</td>
<td>9.4</td>
</tr>
<tr>
<td>Patch 2</td>
<td>41.8</td>
<td>12.4</td>
</tr>
<tr>
<td>Patch 3</td>
<td>43.9</td>
<td>20.4</td>
</tr>
<tr>
<td>Patch 4</td>
<td>49.8</td>
<td>17.4</td>
</tr>
<tr>
<td>Patch 5</td>
<td>59.5</td>
<td>15.3</td>
</tr>
<tr>
<td>Patch 6</td>
<td>74.6</td>
<td>53.1</td>
</tr>
<tr>
<td>Patch 7</td>
<td>82.4</td>
<td>50.1</td>
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<tr>
<td>Patch 8</td>
<td>91.9</td>
<td>37</td>
</tr>
<tr>
<td>Patch 9</td>
<td>92.8</td>
<td>33.3</td>
</tr>
<tr>
<td>Patch 10</td>
<td>92.8</td>
<td>24.1</td>
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<tr>
<td>Patch 11</td>
<td>99.9</td>
<td>88.6</td>
</tr>
<tr>
<td>Patch 12</td>
<td>117.4</td>
<td>36.1</td>
</tr>
</tbody>
</table>

*Statistical relations are also presented in Figure 12.

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*easily modifiable
Initial Results

- > 60 River miles of data from North of Hells Canyon Complex 2008 to 2013 successfully processed
- Use in FIS error models
- Good results via field verification