Mapping headwater streams using LiDAR: Finding streams beyond the blue lines

Neil Olson
New Hampshire Geological Survey/Department of Environmental Services
Headwater streams underrepresented in the maps

- North Carolina: National Hydrography Dataset (NHD) underestimates by 64% Benstead and Leigh (2012)
- Massachusetts: NHD underestimates 21% of the field-verified steams Brooks and Colburn (2011)
- North Carolina: NHD underestimates by 56% Colson et al. (2008)
Difficulties with photo-interpretation

• New Hampshire is the most forested state in the contiguous US (88.9%) (Nowak and Greenfield 2012)
• You can’t map what you can’t see
National Map standard:
Horizontal accuracy of 40 ft for 90% of streams
Flowlines outside of waterbodies

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NHD Length M</td>
<td>172206</td>
</tr>
<tr>
<td>Erase Length M</td>
<td>74412</td>
</tr>
<tr>
<td>% out of Range</td>
<td>43.21</td>
</tr>
</tbody>
</table>
Morphological Filters

From Cho et al 2010 and Rodriguez 2007

Original DEM

Dilation (maximum)

Closing (min(max))

BotHat (closing-DEM)
Methods

- Find channelized areas
- Find valley areas
- Find areas where water would accumulate
- Find areas where these coincide and represent a large area
- Use these as seed points
- Accumulate the seed points and convert to lines
11x11 BotHat
Both 11x11 and 3x3
Grouped and Thresholded
Accumulated and converted to vector
# Seacoast Results

<table>
<thead>
<tr>
<th>Drainage Density (mi/mi^2)</th>
<th>NHD+</th>
<th>NHD</th>
<th>NHDlidar</th>
<th>1918</th>
<th>2 SD</th>
<th>1 SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>-32% increase</td>
<td>-32</td>
<td>--</td>
<td>13</td>
<td>53</td>
<td>164</td>
<td>256</td>
</tr>
<tr>
<td>sites</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>28</td>
<td>18</td>
</tr>
</tbody>
</table>

*An additional 34 sites not on an extracted flowline were visited.*
Field Site Scores

0 = No water
1 = Water in pools only
2 = Water present, no flow
3 = Interstitial flow
4 = Continuous flowing water

Avg. Score

1 SD only
2 SD
1 SD and 2 SD
Flow Acc

n=80
Field Sites

- % of Sites
- % of 4s
- % of 0s

1 SD only: % of Sites
2 SD: % of Sites
1 SD and 2 SD: % of Sites
Flow Acc: % of Sites
Permanance

• Ten streams in the seacoast region were fitted with simple state sensors following the design of Bhamjee and Lindsay 2011
• Streams were unmapped tributaries to 1\textsuperscript{st} order NHD streams
$y = 4 \times 10^{-7}x + 0.4907$

$R^2 = 0.0163$
Questions?

Funding provided by USGS grant G11AC20527
Thanks to Jeremy Nicoletti, Rick Chormann, Shan Zuidema, Jake Seterra and Matt Davis

References

- Bhamjee, R and Lindsay, JB, 2011 Ephemeral stream sensor design using state loggers. Hydrology and Earth Systems Science 15 pp1009-1021
- Nowak, D.J. and Greenfield, E.J. 2012 Tree and impervious cover in the United States, Landscape and Urban Planing 107 pp 21-30
- Rodriguez, F., Maire, E., Courjault-Rade, P., and Darrozes, J., 2002. The Black Top Hat Function applied to a DEM: A tool to estimate recent incision in a mountainous watershed (Estibere Watershed, Central Pyrenees), Geophysical Research Letters v29 no.6 1085