

Viewshed Analysis of Scenic Trails in North Cascades National Park:

Where to See the Park's Characteristic Landforms

Cale Garrett and Lauren Wasby

North Cascades National Park (NOCA)



<http://www.nps.gov/noca/planyourvisit/maps.htm>

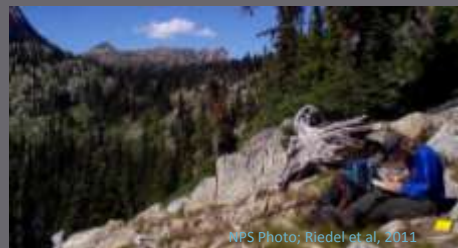
North Cascades National Park (NOCA)

- Designated in 1968
- 684,237 acres
- 93% wilderness
- Extreme vertical relief: 8000ft
- 312 glaciers
- Landscape shaped by glaciers, ice ages
- 400+ miles of trails

Riedel et al, 2011 and <http://www.nps.gov/noca/historyculture/stories.htm>; photo by author

Landform Mapping project

- Late 1980's to present
- Original purposes: archaeological sites, management plan R&D, ecological monitoring, soils mapping, site analysis
- Combination of photogrammetry methods



NPS Photo; Riedel et al, 2011

Landform Mapping project

- Color stereo-pair 1998 air photos at 1:12,000
- USFS LTA line work
- Bedrock geology maps
- Ground truthing at low elevations (under veg)
 - USGS 7.5 minute maps
 - UTM Mylar -> scanner
 - Landform polygons
 - Checked against NAIP imagery, 10m DEM, LiDAR

Riedel et al, 2011

Landforms of NOCA

Landform Type	Number Observed	Area km ²	% of NOCA
Valley Wall	176	1746.561	62.091
Cirque	769	383.923	13.649
Debris Apron	1382	239.074	8.499
Debris Cone	1326	95.333	3.389
Mass Movement - Debris Avalanche	290	49.633	1.764
Floodplain	73	46.411	1.650
*Floodplain Under Ross Lake	1	27.351	0.972
River Canyon	448	36.570	1.300
Mass Movement - Fall/Topple	1138	31.224	1.110
Ridge	330	29.779	1.059
Terrace	566	23.517	0.836
Arete	338	19.407	0.690
Bedrock Bench	397	18.516	0.658
Valley Bottom	114	15.767	0.561
Alluvial Fan	38	11.327	0.403
Neoglacial Moraine	594	10.139	0.361
Horn	163	8.934	0.318
Pleistocene Moraine	82	6.225	0.221
Other Mountain	126	3.207	0.114
Fan Terrace	89	2.793	0.099
Mass Movement - Debris Torrent	169	2.652	0.094
Pass	175	2.349	0.084
Undifferentiated	47	1.665	0.059
Mass Movement - Slump/Creep	67	0.289	0.010
Debris Cone Terrace	2	0.140	0.005
Shoreline	2	0.137	0.005
Delta	3	0.019	0.000
Mass Movement - Sackung	1	0.012	0.000
Mass Movement - SAIL	4	0.011	0.000
Esker	1	0.006	0.000
Totals	1525	2812.889	100.0

Riedel et al, 2011

Application: Viewshed Analysis

- What trails offer the best views of defining landforms?
- Narrowing our focus:
 - Most accessible, popular trails
 - Glacial landforms

Application: Viewshed Analysis

Landform Type	Number Observed	Area km ²	% of NOCA
Valley Wall	176	1746.561	62.091
Cirque	769	383.923	13.649
Debris Apron	1382	239.074	8.499
Debris Cone	1326	95.333	3.389
Mass Movement - Debris Avalanche	290	49.633	1.764
Floodplain	73	46.411	1.650
*Floodplain Under Ross Lake	1	27.351	0.972
River Canyon	448	36.570	1.300
Mass Movement - Fall/Topple	1138	31.224	1.110
Ridge	330	29.779	1.059
Terrace	566	23.517	0.836
Arete	338	19.407	0.690
Bedrock Bench	397	18.516	0.658
Valley Bottom	114	15.767	0.561
Alluvial Fan	38	11.327	0.403
Neoglacial Moraine	594	10.139	0.361
Horn	163	8.934	0.318
Pleistocene Moraine	82	6.225	0.221
Other Mountain	126	3.207	0.114
Fan Terrace	89	2.793	0.099
Mass Movement - Debris Torrent	169	2.652	0.094
Pass	175	2.349	0.084
Undifferentiated	47	1.665	0.059
Mass Movement - Slump/Creep	67	0.289	0.010
Debris Cone Terrace	2	0.140	0.005
Shoreline	2	0.137	0.005
Delta	3	0.019	0.000
Mass Movement - Sackung	1	0.012	0.000
Mass Movement - SAIL	4	0.011	0.000
Esker	1	0.006	0.000
Totals	1525	2812.889	100.0

Riedel et al, 2011

Application: Viewshed Analysis

Landform Type	Number Observed	Area km ²	% of NOCA
Cirque	769	383.923	13.649
Mass Movement - Debris Avalanche	290	49.633	1.764
Mass Movement - Fall/Topple	1138	31.224	1.110
Ridge	330	29.779	1.059
Arete	338	19.407	0.690
Bedrock Bench	397	18.516	0.658
Neoglacial Moraine	594	10.139	0.361
Horn	163	8.934	0.318
Pleistocene Moraine	82	6.225	0.221
Mass Movement - Debris Torrent	169	2.652	0.094
Pass	175	2.349	0.084
Mass Movement - Slump/Creep	67	0.289	0.010
Mass Movement - Sackung	1	0.012	0.000
Mass Movement - SAIL	4	0.011	0.000
Esker	1	0.006	0.000

Riedel et al, 2011

Application: Viewshed Analysis

- What trails offer the best views of defining glacial landforms?



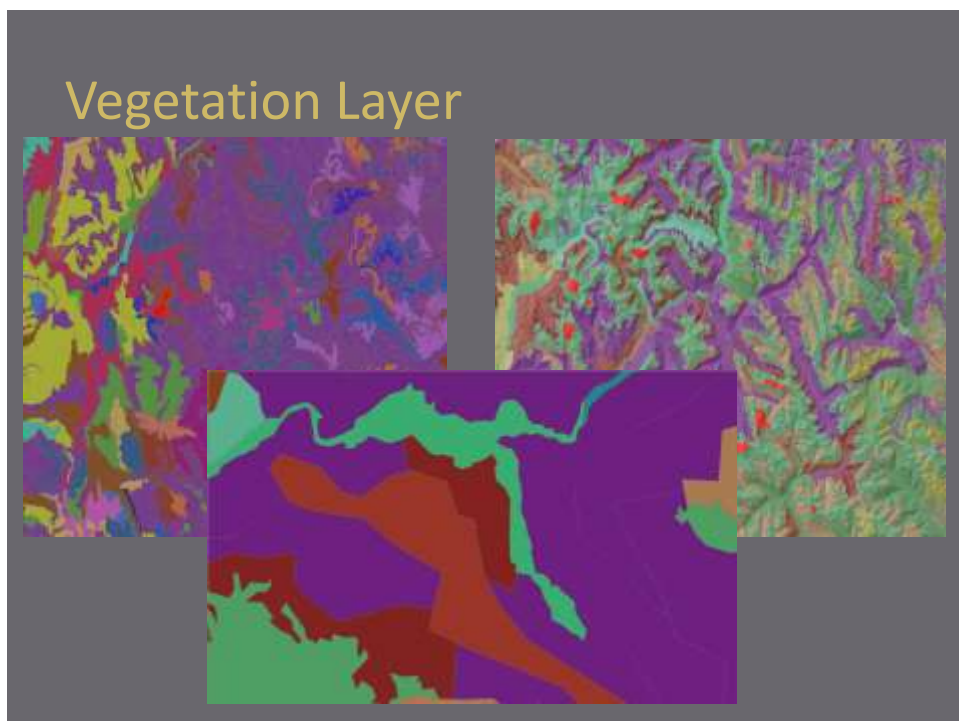
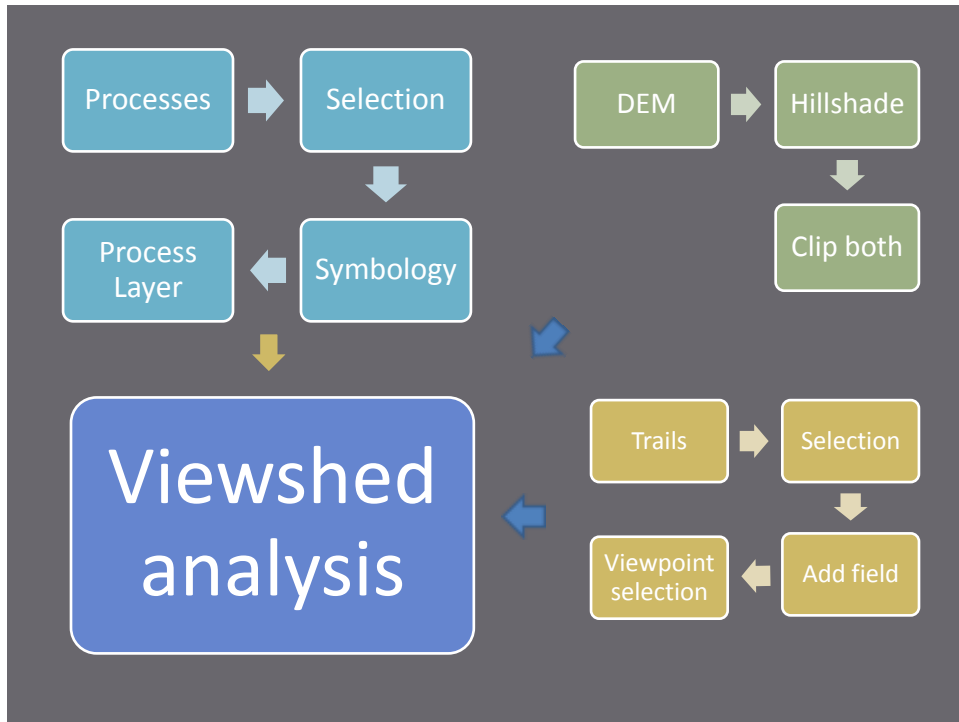
NPS Photo; Riedel et al, 2011

Data

- DEM of North Cascades National Park area
- Corresponding hillshade
- Trails vector layer
- Landform maps identifying different landform types by watershed
- Vegetation layer (WDFW GAP Land Cover Dataset)
- Satellite imagery layer as an overlay

Methods

- Select trails
- Merge trails layer
- Identify optimal viewpoint along each trail (clip from vegetation layer, assess against DEM/Hillshade)
- Run viewshed analysis from those points
- Compare results: which trails provide the most diverse views?



Thunder Knob

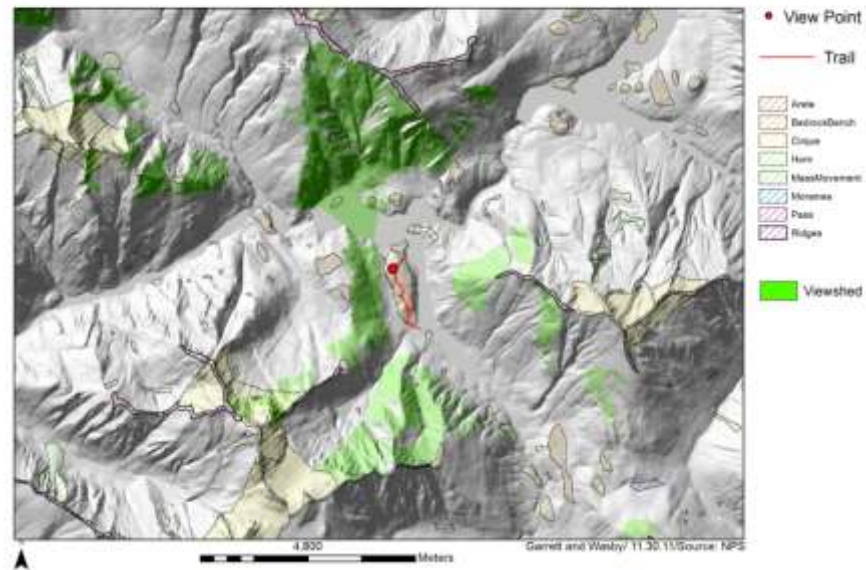


Thunder Knob



Thunder Knob Trail

Visible Processes: Arete, Bedrock Bench, Cirque, Horn, Mass Movement, Pass, Ridges

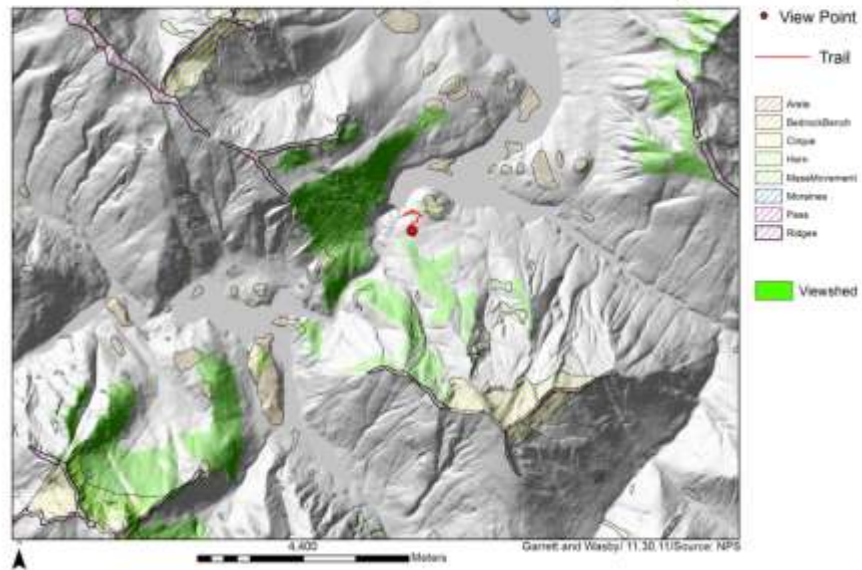


Ross Dam



Ross Dam Trail

Visible Processes: Bedrock Bench, Mass Movement, Ridges



Sourdough Mountain



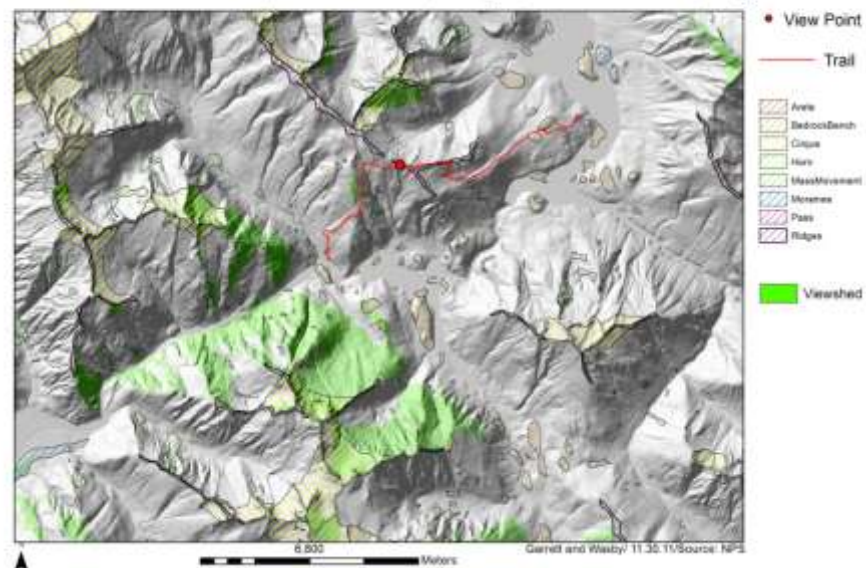
NPS photo

Sourdough Mountain



Sourdough Trail

Visible Processes: Arete, Bedrock Bench, Cirque, Mass Movement, Ridges



Maple Loop

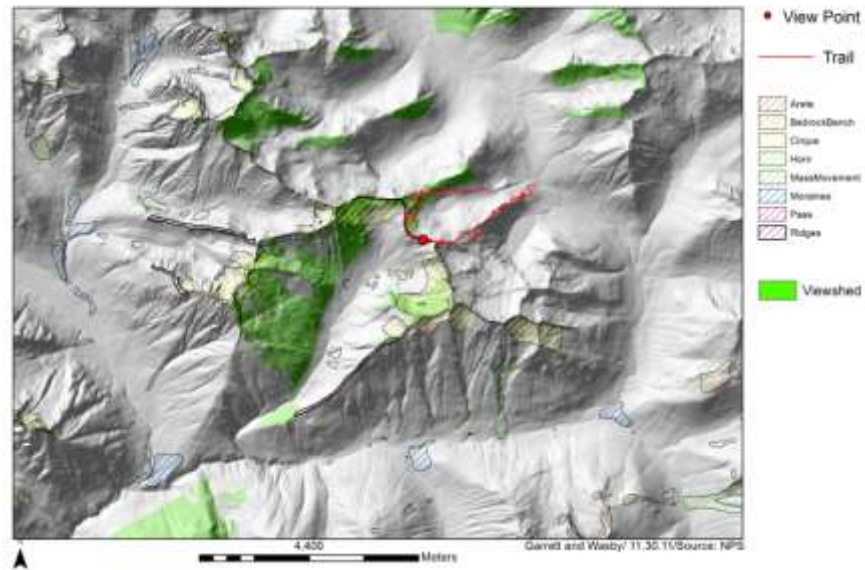


Maple Loop



Maple Pass Trail

Visible Processes: Arete, Cirque, Horn, Ridges



Thornton Lake

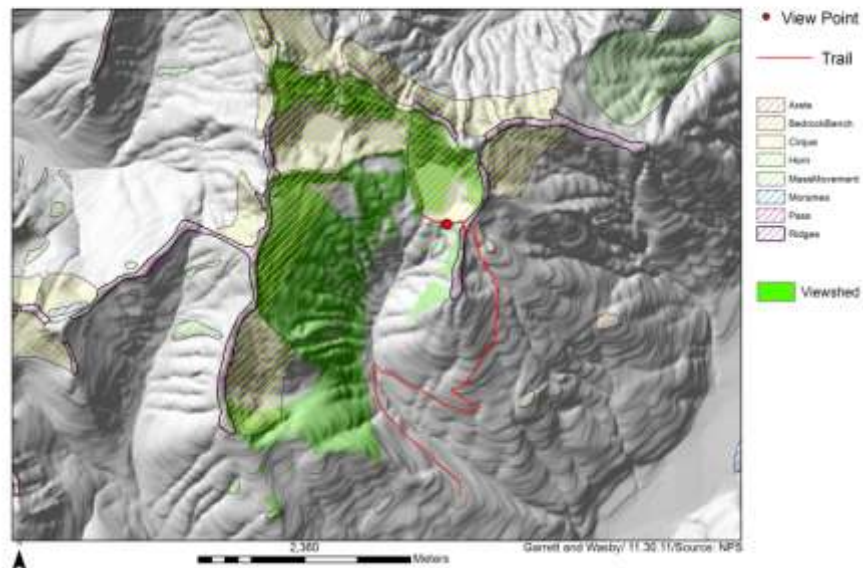


Thornton Lake



Thornton Trail

Visible Processes: Arete, Bedrock Bench, Cirque, Horn, Mass Movement, Ridges



Cascade Pass



photo by author

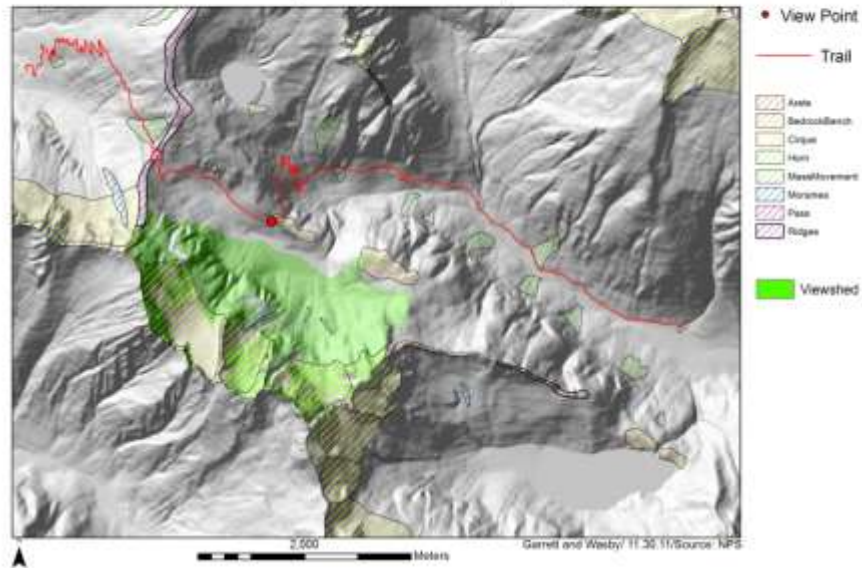
Cascade Pass



photo by author

Cascade Trail

Visible Processes: Arete, Bedrock Bench, Horn, Moraine



Easy Pass



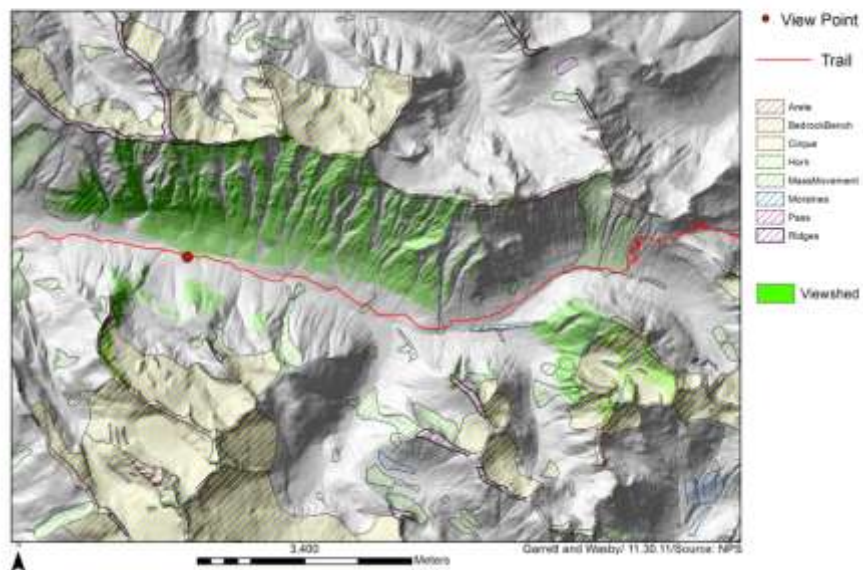
Easy Pass



NPS photo

Easy Pass Trail

Visible Processes: Arete, Cirque, Horn, Mass Movement, Moraine, Pass, Ridges



Conclusions

	ARETE	BEDROCK BENCH	CIRQUE	HORN	MASS MOVEMENT	MORaine	PASS	RIDGE
CASCADE	X	X		X		X		
EASY PASS	X		X	X	X	X	X	X
MAPLE PASS	X		X	X				X
ROSS DAM		X			X			X
SOURDOUGH	X	X	X		X			X
THORNTON	X	X	X	X	X			X
THUNDER	X	X	X	X	X		X	X

- Easy Pass and Thunder Knob offer access to the most variety of processes
- Ross Dam and Cascade offer the fewest
- Moraines and passes are some of the most difficult features to see from this selection of trails

Limitations

- No vegetation layer means views may be obstructed by vegetation
- Assumes distances are adequate to see various landforms
- Assume trails are open

Things left to do...

- Calculate the sum of multiple points in raster calculator (or run multipoints as one viewshed)
- Take time to run polylines in Viewshed tool
- Calculate area of each process within viewshed
- Add vegetation layer



Future research

- What specific viewpoints along each trail offer the most diverse views?
- Develop a reference sheet listing landforms visible for all 67 trails for use in visitor centers
- Create a panoramic 3D scene from each viewpoint, labeling landforms

Sources

Data layers courtesy of Steve Dorsch, NOCA geologist/geomorphologist

North Cascades National Park Complex, <http://www.nps.gov/noca/index.htm>

North Cascades National Park's Photostream,
<http://www.flickr.com/photos/northcascadesnationalpark/>

Riedel, J., Brady, S., Dorsch, S., Larrabee, M., Wegner, J., Bowerman, N. 2011. *Geomorphology of North Cascades National Park: Landform Mapping at North Cascades National Park Service Complex, Washington*. Natural Resource Technical Report NPS/NCCN/NRTR—2010/draft. National Park Service, Fort Collins, Colorado.