

THE NEW DNR LANDSLIDE HAZARDS PROGRAM



Kara Jacobacci, G.I.T.
Landslide Hazards Program
Washington Geological Survey
Washington Department of Natural Resources

LEGISLATIVE FUNDING

- 2015 session DNR requested \$6.6M and 14 positions
- Received \$4.6M and 7 positions
 - Five in landslide hazards program
 - Two in a state lidar survey
 - ~\$2M to collect lidar



LANDSLIDE HAZARDS PROGRAM

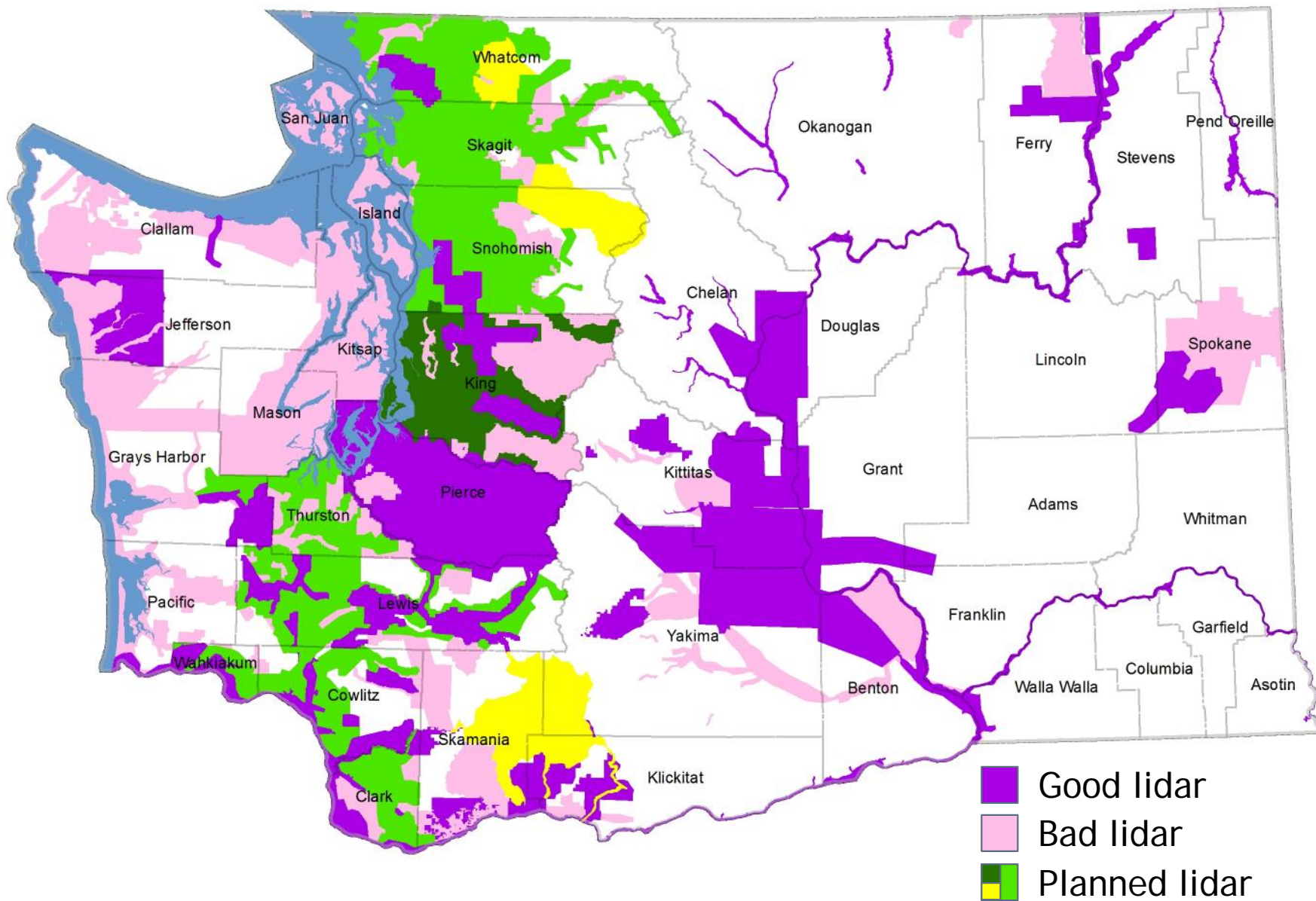


- Started hiring January 2016 with 5 full time geologists
- Help communities reduce losses from landslides by accurately mapping landslides from lidar
 - Produce inventory and susceptibility maps
 - Assist communities to understand and take action to reduce loss and increase public safety
 - Outreach, public meetings, publications, information sheets, etc.
- Use a combination of cutting-edge, computer-based mapping and traditional fieldwork to identify landslides

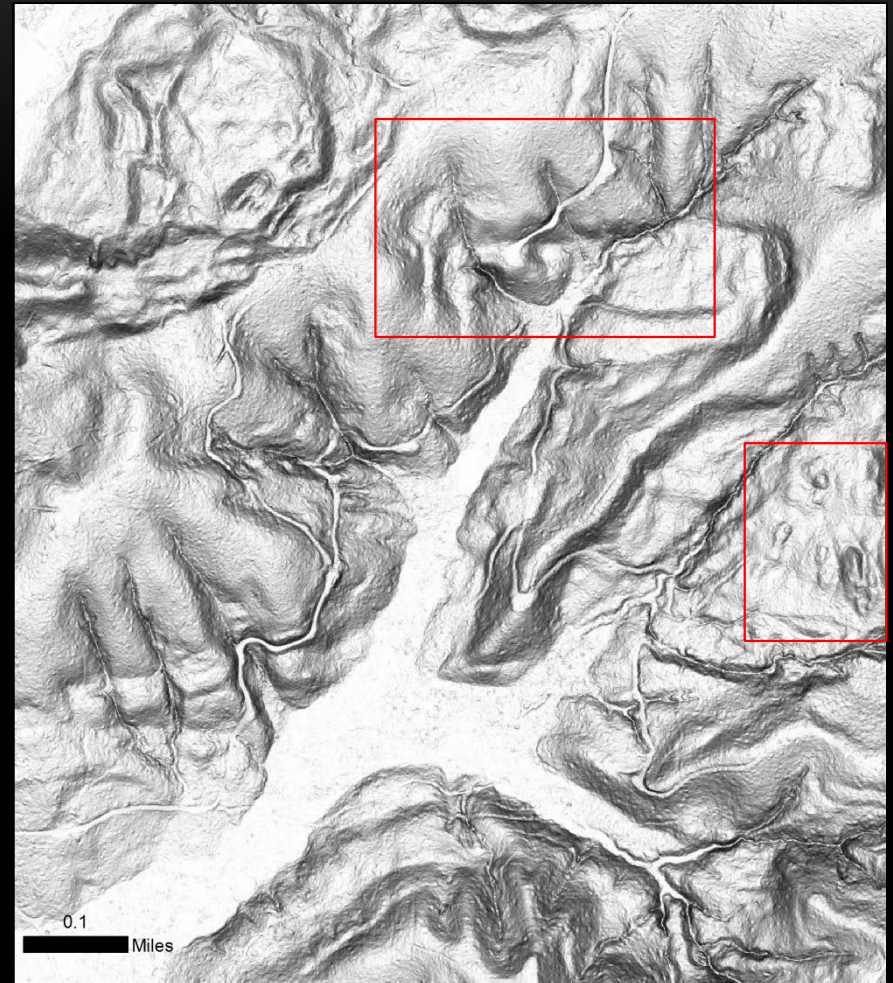


Investigating a landslide deposit at Mission Ridge Ski Resort.

LIDAR PROGRAM



WHAT IS "GOOD" LIDAR?



Violet Prairie Quadrangle. Left: Pre-2016 lidar. Right: New 2016 lidar

LIDAR AT THE WASHINGTON GEOLOGICAL SURVEY

- RCW 43.92.025 - WGS granted funding to collect, maintain, and distribute lidar data in support of geologic hazards
 - Collect high quality data that will support multiple applications
 - Maintain and offer lidar collection contract services
 - Partner with state, local, tribal and Federal agencies as well as private groups to maximize resources
 - Develop a public portal for lidar data and derivative products distribution
 - Move forward with state-wide collection
- Abby Gleason - Lidar Manager -
Abigail.Gleason@dnr.wa.gov
 - www.dnr.wa.gov/lidar



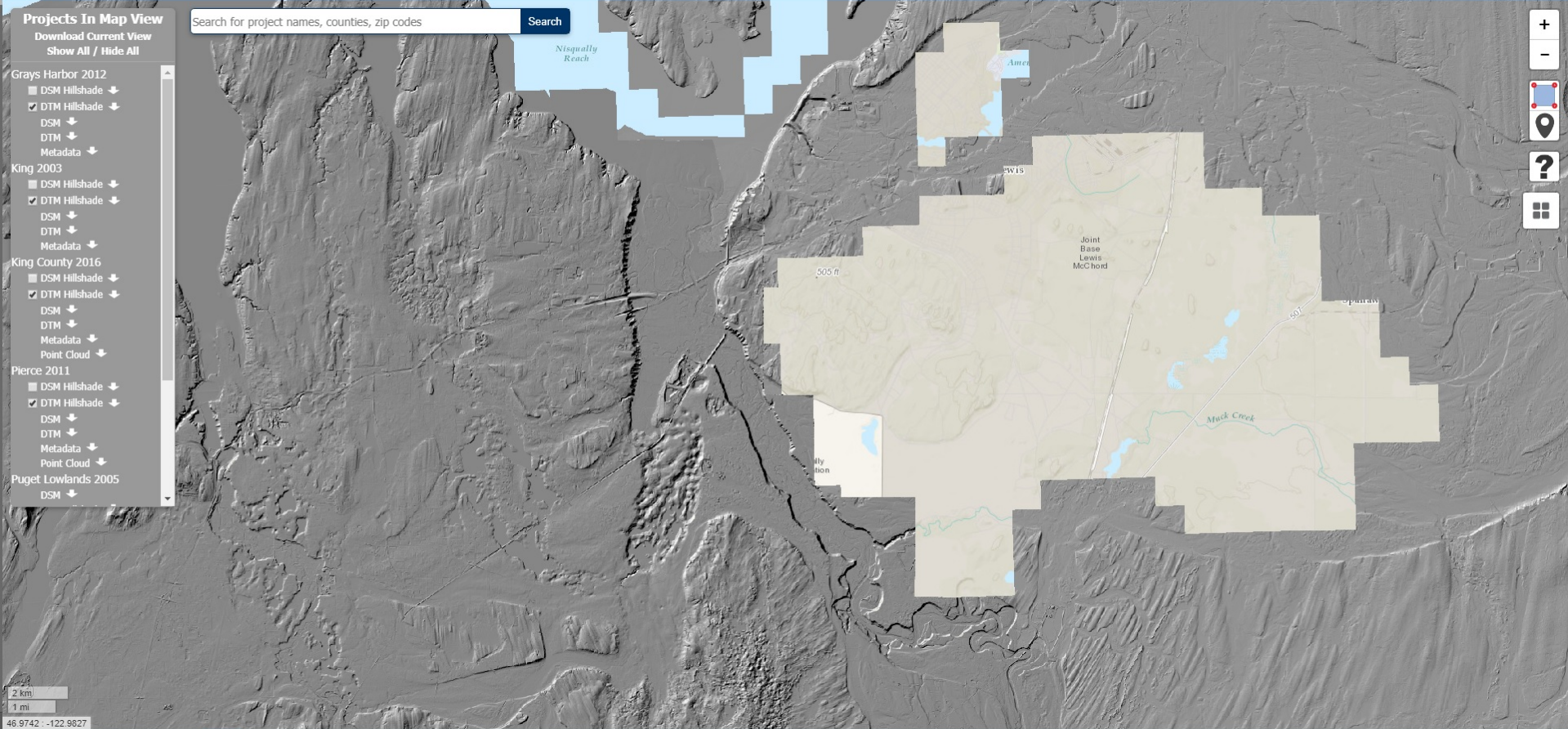
LIDAR PORTAL

Projects In Map View
Download Current View
Show All / Hide All

Search for project names, counties, zip codes

- Grays Harbor 2012
 - DSM Hillshade
 - DTM Hillshade
 - DSM
 - DTM
 - Metadata
- King 2003
 - DSM Hillshade
 - DTM Hillshade
 - DSM
 - DTM
 - Metadata
- King County 2016
 - DSM Hillshade
 - DTM Hillshade
 - DSM
 - DTM
 - Metadata
 - Point Cloud
- Pierce 2011
 - DSM Hillshade
 - DTM Hillshade
 - DSM
 - DTM
 - Metadata
 - Point Cloud
- Puget Lowlands 2005
 - DSM

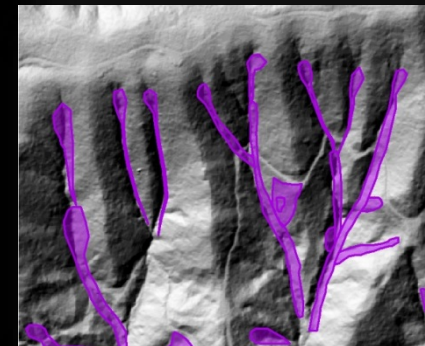
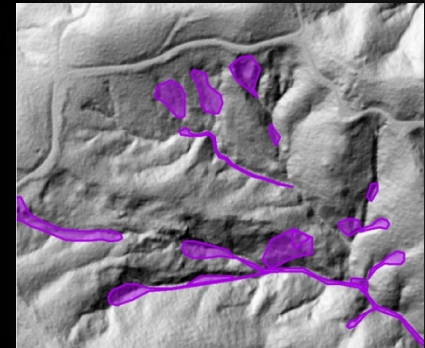
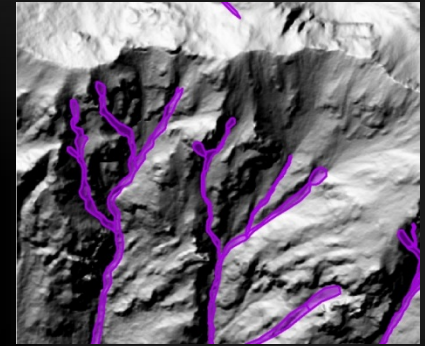
2 km
1 mi
46 9742 - -122 9827



LANDSLIDE INVENTORY

WHAT'S WRONG WITH THE EXISTING LANDSLIDE INVENTORY?

- >200 sources
 - DNR, USFS, forest management companies, NPS, USGS, colleges, etc.
 - Different mapping techniques, protocols, validation process, mapping purposes, mapper skills, etc.
 - Numerous false positives
- >50,000 landslides
 - 313 documented field validation



HOW CAN WE IMPROVE THE EXISTING LANDSLIDE DATABASE?

- Collect more and better lidar
- Create a new landslide inventory
 - Lidar enables geologists to accurately and precisely delineate landslide landforms
 - Reduce false positives
- Emphasize mapping where people live, work, and drive
- Produce a standard landslide inventory protocol and database
 - Assist municipalizes, colleges, consultants, etc.
 - Provide technical assistance, trainings, and QA/QC
 - Post all data on the Washington Geology Information Portal
 - www.dnr.wa.gov/geologyportal

PROTOCOL FOR LANDSLIDE INVENTORY MAPPING FROM LIDAR DATA IN WASHINGTON STATE

by Stephen L. Slaughter, L.G., L.E.G, William J. Burns, R.G., R.E.G.,
Katherine A. Mickelson, L.G., Trevor Contreras, L.G., L.E.G.,
Kara Jacobacci, and Alyssa Biel

WASHINGTON
GEOLOGICAL SURVEY
Bulletin 81
April 2017

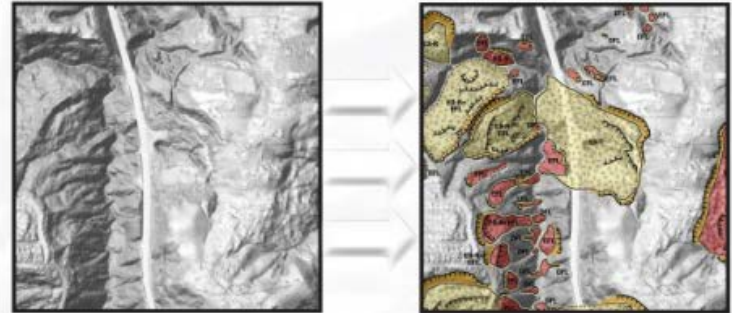
PEER REVIEWED



WASHINGTON STATE DEPARTMENT OF
NATURAL RESOURCES
DIVISION OF GEOLOGY AND EARTH RESOURCES

PROTOCOL FOR INVENTORY MAPPING OF LANDSLIDE DEPOSITS FROM LIGHT DETECTION AND RANGING (LIDAR) IMAGERY

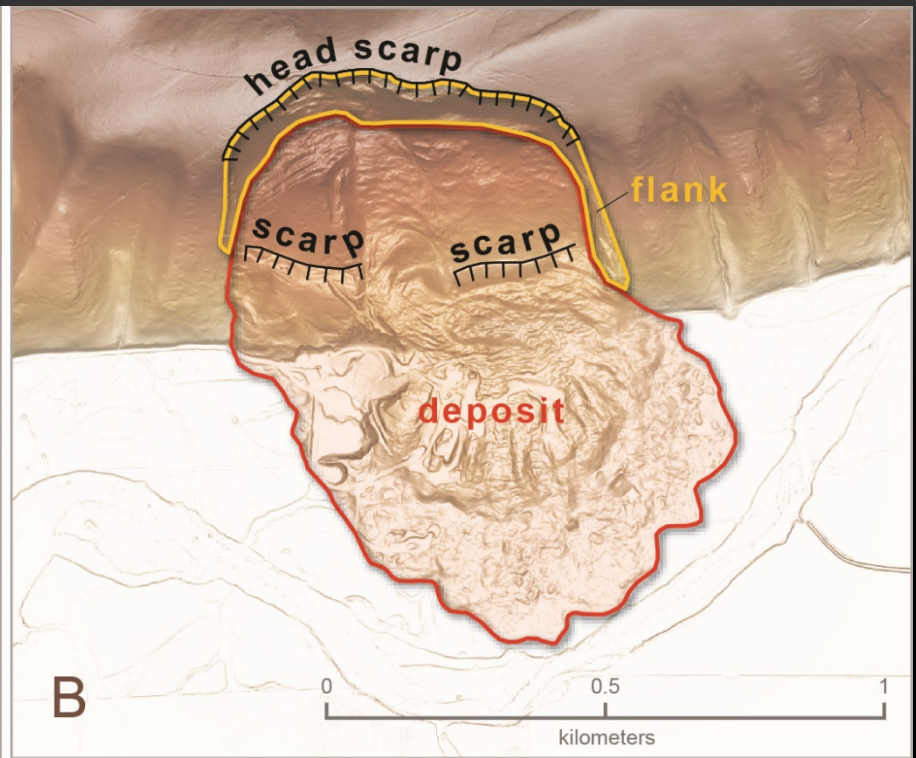
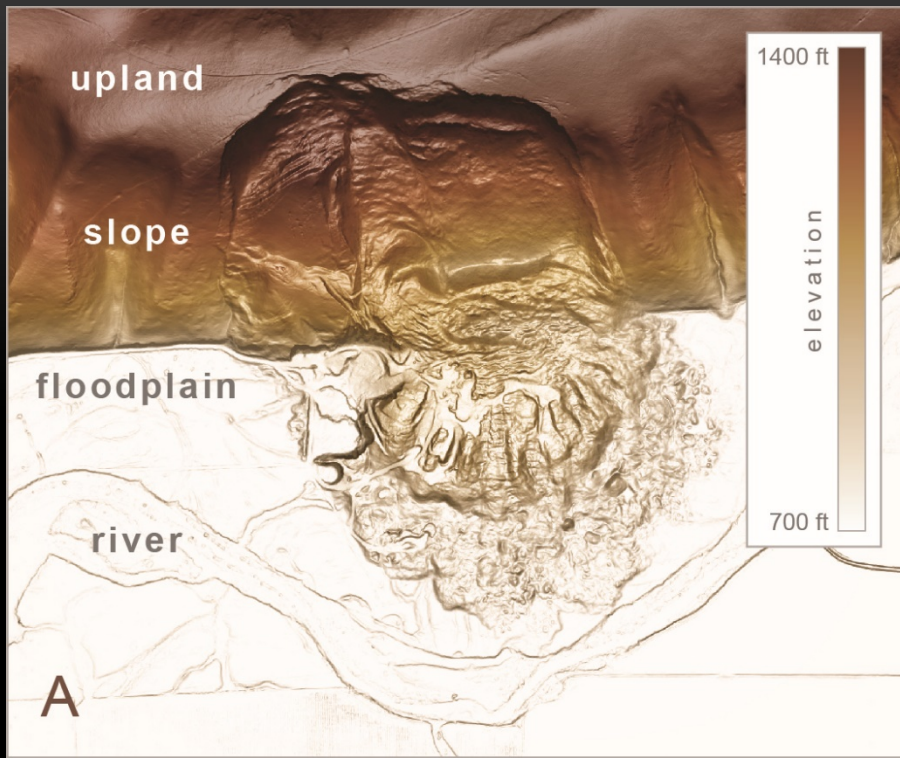
by William J. Burns and Ian P. Madin



SPECIAL PAPER 42

2009





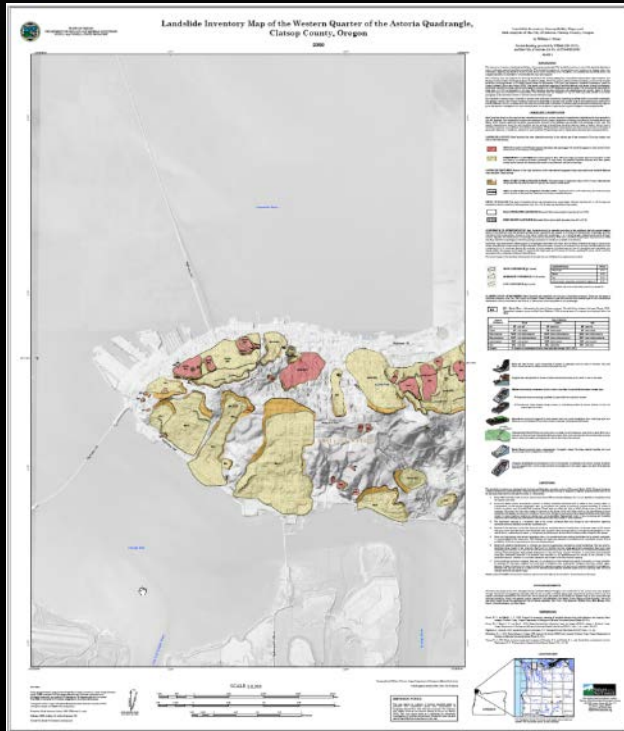
Some Landslide Attributes

Landslide ID	Movement Type	Confidence	Slope Angle	Headscarp Height	Movement Direction
410	Slide - Rotational	High (30-40)	25°	150 ft	292.5°
835	Flow	Moderate (11-29)	34°	134 ft	157.5°

LANDSLIDE SUSCEPTIBILITY

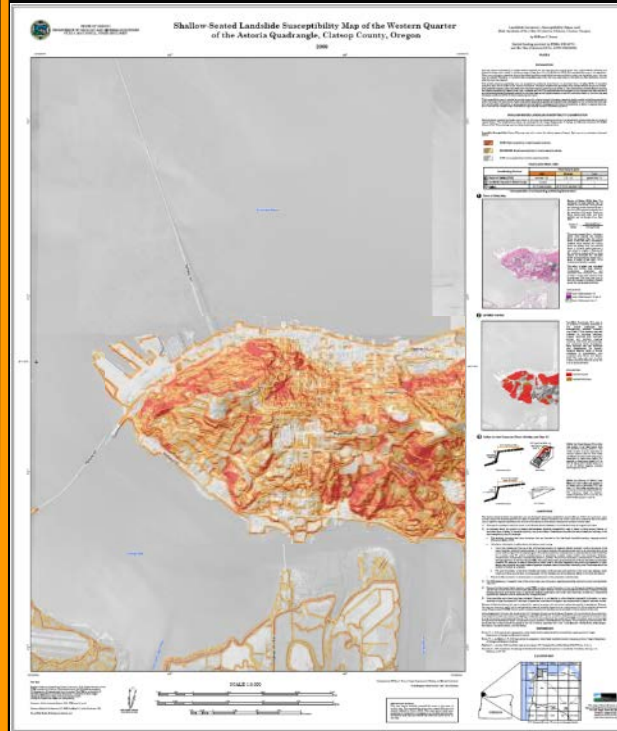
Facts from the past

Models that try to predict the future



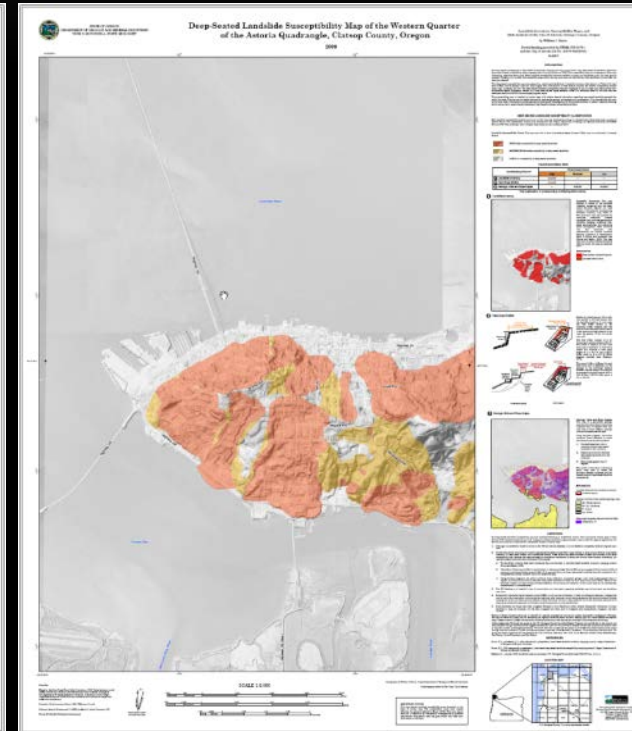
Inventory

Map of Existing
Landslide Deposits



Shallow-Landslide
Susceptibility

Maps of Places Likely to have Landslides in the Future



Deep-Landslide
Susceptibility

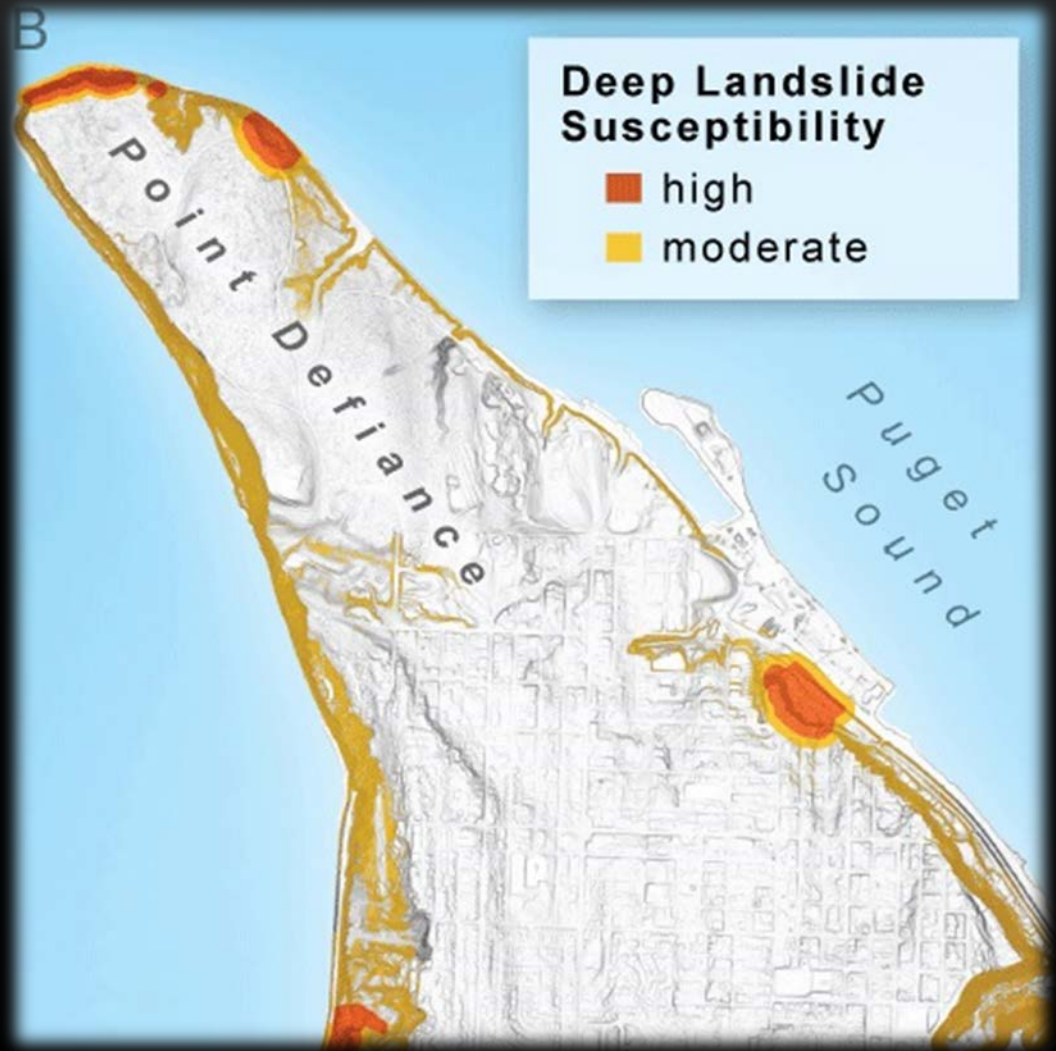
SHALLOW LANDSLIDE SUSCEPTIBILITY

- DOGAMI SP-45
- Geology
- Slope
- Factor of Safety Calculations

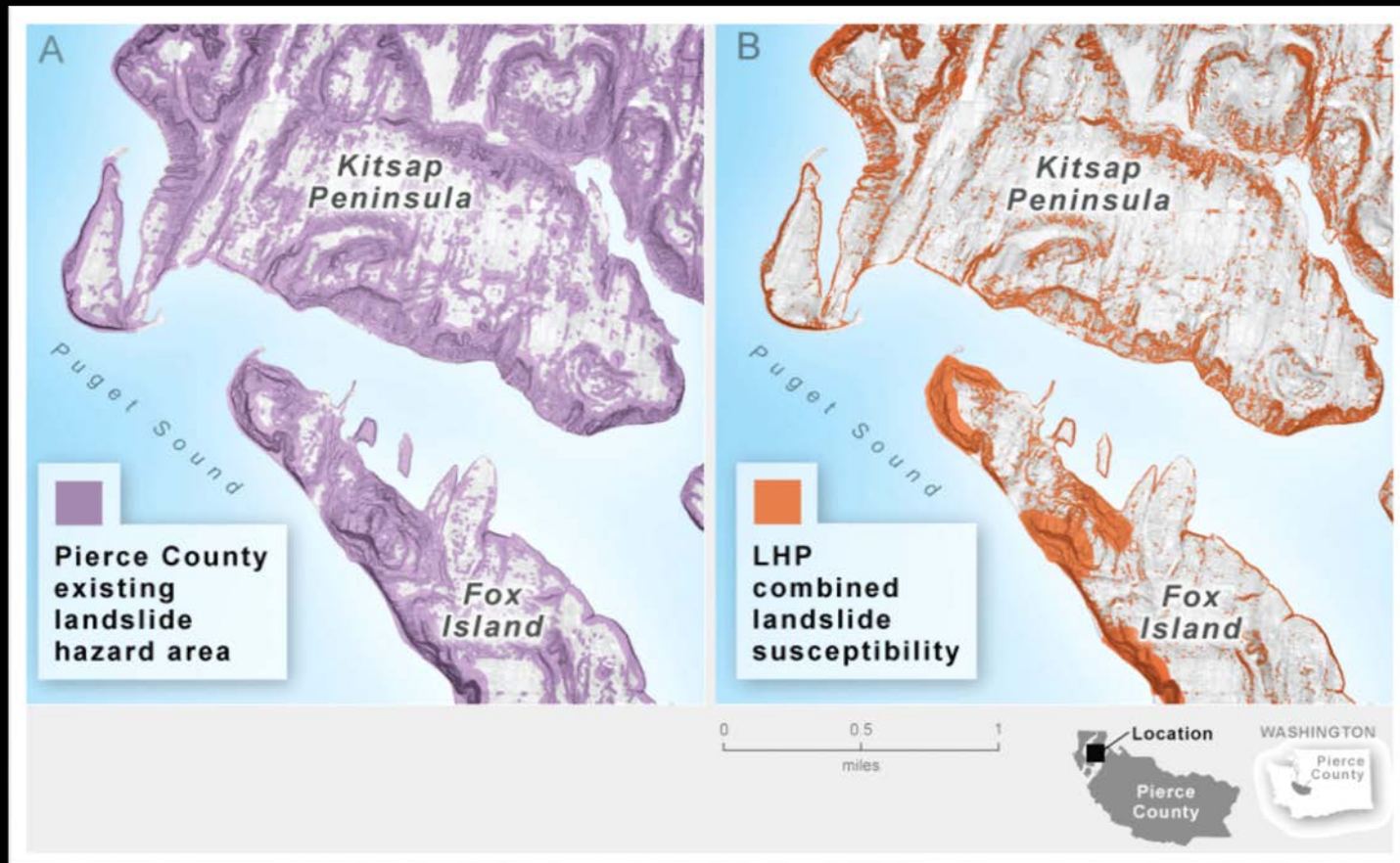


DEEP LANDSLIDE SUSCEPTIBILITY

- DOGAMI SP-48
- Susceptible Geologic Units
- Susceptible Geologic Contacts
- Slope
- Preferred Direction of Movement



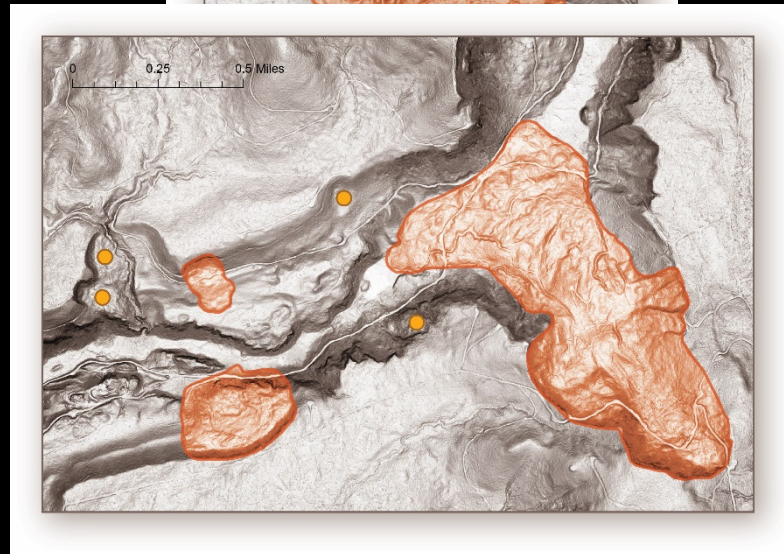
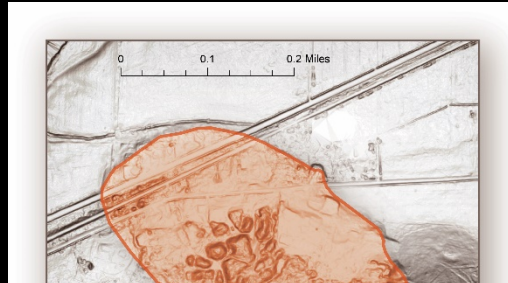
- The county-wide LHP landslide and susceptibility data results in a 51% reduction
- This reduction may significantly lower the number of false-positive geotechnical reports



SLIP MAPPING

[Streamlined Landslide Inventory Protocol]

- High confidence landslides: digitized as a polygon
- Lower certainty landslides: digitized with a point and attributed with low or moderate confidence



Pierce County
Landslide Inventory
Washington Geological Survey
Landslide Hazards Program



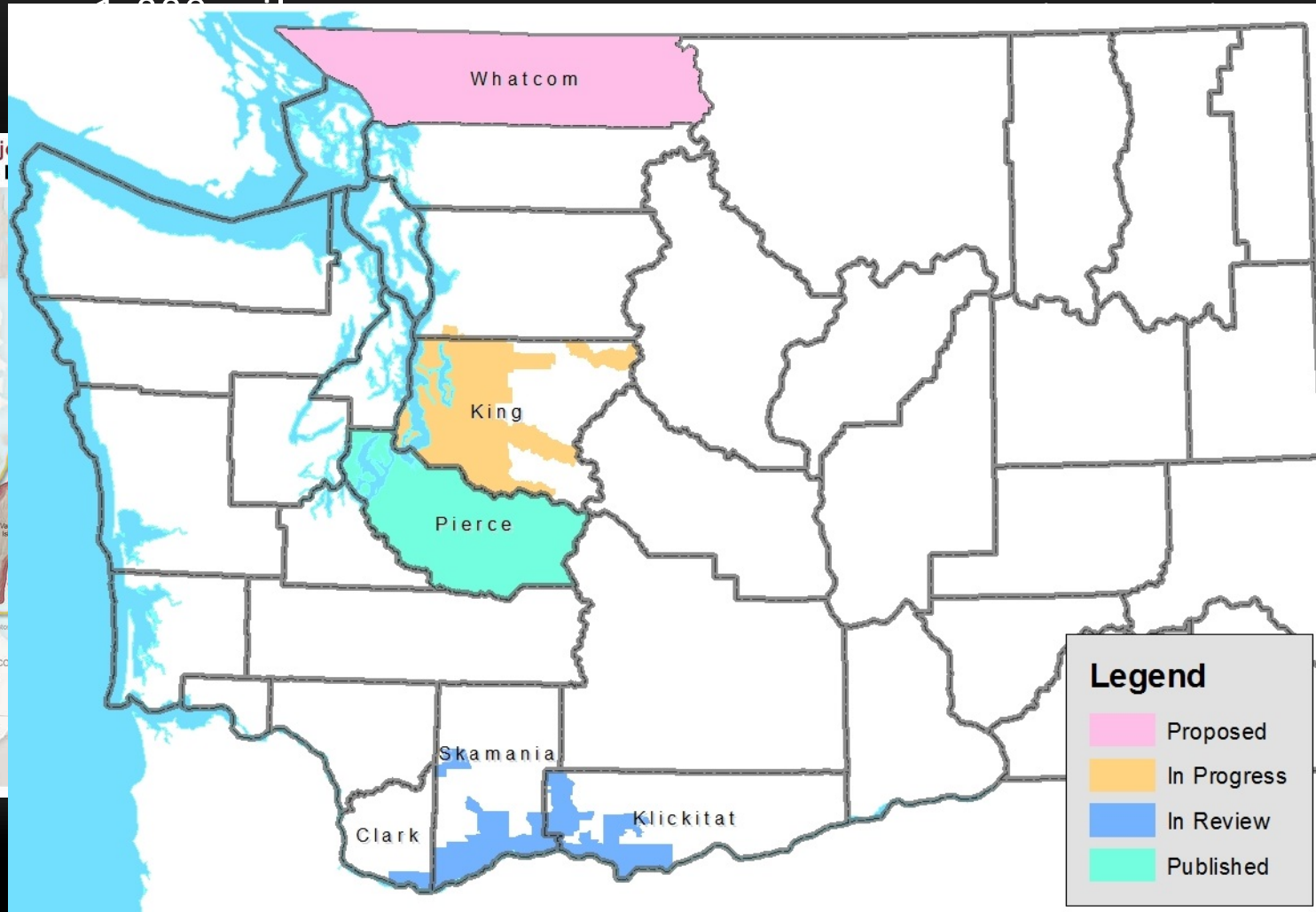
Washington Geological Survey 4/17/2017

- 1276 landslides mapped (628 detailed and 648 SLIP)
- https://fortress.wa.gov/dnr/geologydata/publications/ger_ri39_pierce_county_landslide_inventory.zip

NEXT PROJECTS

- King County -

- New lidar fall 2017:



Proposed Project for Landslide I



Whatcom,
Kagit

A Homeowner's Guide to Landslides

for Washington and Oregon



WASHINGTON DIVISION OF
GEOLOGY AND EARTH RESOURCES
OREGON DEPARTMENT OF
GEOLOGY AND MINERAL INDUSTRIES



LANDSLIDES ARE ONE OF THE MOST COMMON AND DEVASTATING NATURAL HAZARDS IN THE PACIFIC NORTHWEST. THE DAMAGE THEY CAUSE IS ALMOST NEVER COVERED BY INSURANCE.

HOMEOWNER'S GUIDE TO LANDSLIDES

- Landslide triggers
- Areas prone to landslides
- Signs of landslide activity
- How to reduce your risk

WHAT CAN YOU USE IN THE MEANTIME?

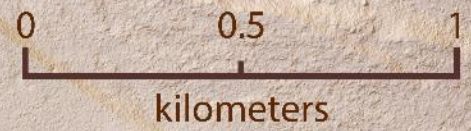
- <https://geologyportal.dnr.wa.gov/>
- Preexisting landslide compilation maps - we have variable scale mapping of assorted vintages that cover much of the state. This data is available at the portal link above.

GEOLOGY PORTAL DEMONSTRATION

QUESTIONS?



Cedar River, King County



ADDITIONAL RESOURCES

- [Recently Reported Landslides Map](#) - updated daily when events occur.
- <https://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/landslides> - landslides page on WGS website



Table of Contents

Search layers: Search by name and tags

Clear

- Landslide Compilations**
 - ▶ 1:24,000-scale Landslides from Geologic Mapping
 - ▼ 1:100,000-scale Landslides from Geologic Mapping
 - ▶ Miscellaneous Landslides
 - ▶ Watershed Analysis Landslides
 - ▶ Reconnaissance-level Landslide Mapping
 - ▶ Salish Sea Landforms
 - ▶ 1:24,000-scale and Watershed Analysis Study Extents

Identify

Miscellaneous Landslides

Deep-seated

Salish Sea Landforms

Deep-seated earthflow

1:24,000-scale and Watershed Analysis Study Extents

Vashon

Feature Information

Landslide Type: Deep-seated
DSLS Morphology: Dormant indistinct
Gradient (degrees): 10
Gradient Method: Gradient degrees determined from Lidar
Slope Morphology: Irregular
Geologic Unit Label: --
Landslide Certainty: Probable
Landslide Limit Date: --
Field Check: Not checked in the field
Infrastructure Damage: Undetermined
Land Use: Unknown
Location Confidence: Low-Moderate

Scale: 144,448

Lat: 47.4559 Long: -122.4499

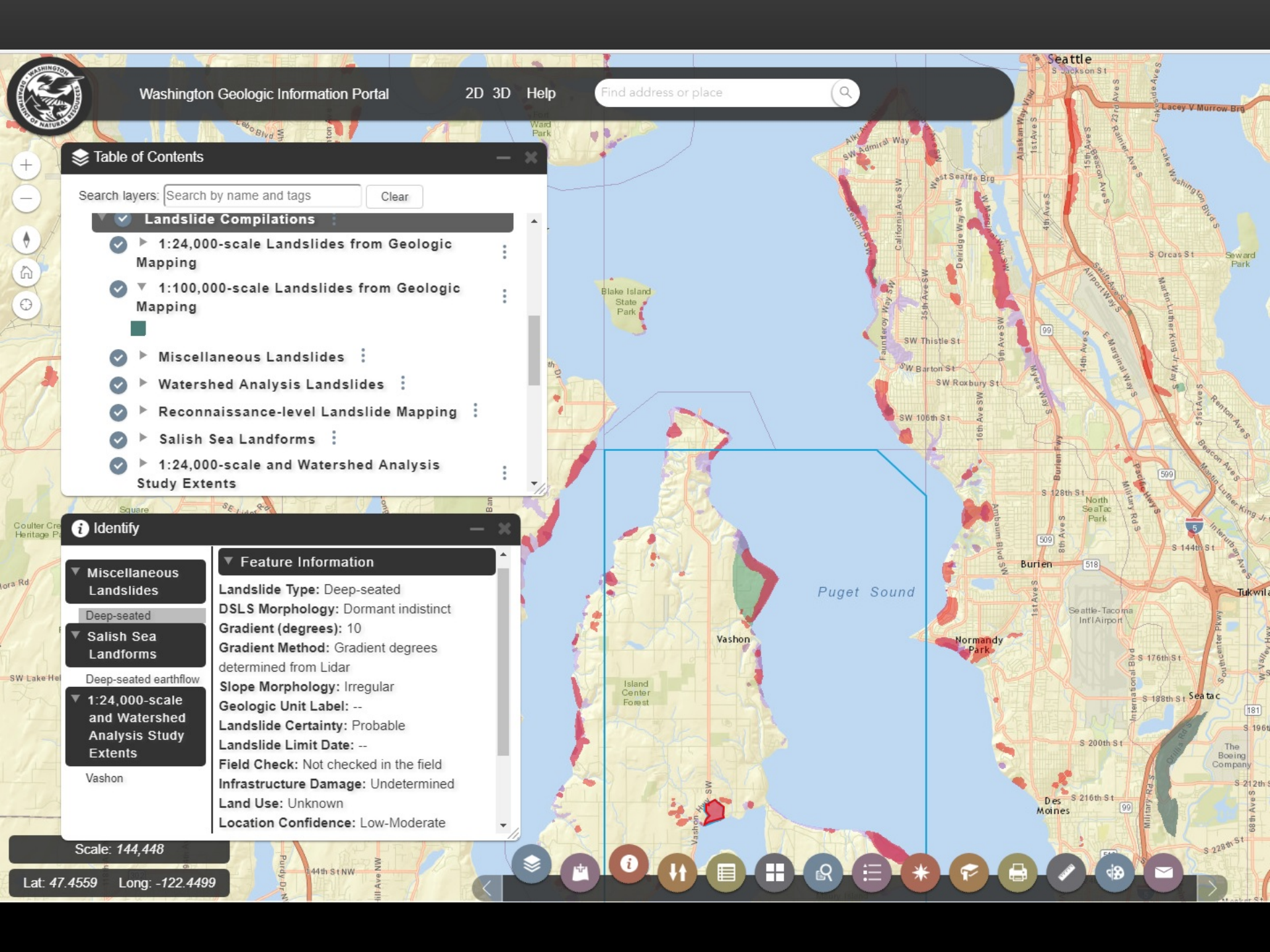




Table of Contents

Search layers: Search by name and tags

Clear

Earthquake Data

Landslide Data

- Landslide Inventory (beginning 2017)
 - Scars
 - Scars and Flanks
 - Landslide Deposits
 - Simplified Landslide Inventory Protocol
 - Study Areas
 - Deep Susceptibility
 - Shallow Susceptibility

Identify

Landslide Deposits

410

Scars and Flanks

410

Scars

410

410

Feature Information

Landslide ID: 410
 Material: Earth or debris
 Movement Description: Slide-Rotational
 Confidence: High (30-40)
 Relative Age of Landslide: Pre-historic (>150 years)
 Year of Movement: --
 Field Verified Flag: Yes
 Slope Angle (degrees): 25
 Head Scarp Height (feet): 150
 Failure Depth (feet): 136
 Movement Direction (degrees): 292.5
 Volume (cubic feet): 42040024

Scale: 144,448

Lat: 47.3002 Long: -122.7960





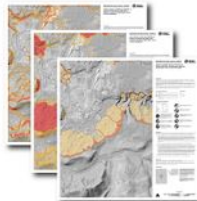
Table of Contents

Search layers: Search by name and tags Clear

- 1:24,000-scale Geologic Mapping
- 1:100,000-scale Geologic Mapping
- 1:250,000-scale Geologic Mapping
- 1:500,000-scale Geologic Mapping
- Earthquake Data
- Landslide Data
 - Landslide Inventory (beginning 2017)
 - Scarps
 - Scarps and Flanks
 - Landslide Deposits
 - Simplified Landslide Inventory Protocol
 - Study Areas
 - Deep Susceptibility
 - Moderate
 - High
 - Shallow Susceptibility
 - Landslide Compilations
 - 1:24,000-scale Landslides from Geologic Mapping

Standard Print

Landslide Print



Landslide inventory maps show detailed landslide inventory mapping based on lidar, and include both deep and shallow landslide susceptibility. These three 36 in. x 36 in. maps print at a scale of 1:8,000. Zoom and center to your area of interest before printing.

Warning: Only landslide inventory layers will be printed. PDFs may take several minutes to generate.

[Generate PDF](#) [Download pdf](#)

Identify

Shallow Susceptibility

--

Study Areas

1

Landslide Deposits

366

Deep Susceptibility

--

Feature Information

Landslide ID: 366
 Material: Earth or debris
 Movement Description: Slide-Rotational / Flow
 Confidence: Low (0-10)
 Relative Age of Landslide: Pre-historic (>150 years)
 Year of Movement: -- null
 Field Verified Flag: No
 Slope Angle (degrees): 20
 Head Scarp Height (feet): 60
 Failure Depth (feet): 56
 Movement Direction (degrees): 67.5
 Volume (cubic feet): 127943129
 Average Internal Scarp Distance: -- null
 Landslide Name: -- null
 Comments: -- null

Scale: 18,056

Lat: 46.9363 Long: -122.2387





Table of Contents

Search layers: Search by name and tags

Clear

Geologic Mapping

1:24,000-scale Geologic Mapping

1:100,000-scale Geologic Mapping

Geologic Units 100k

Contacts 100k

Folds 100k

Faults 100k

Linear Geologic Features 100k

Geologic Unit Points 100k

Attitude Measurements 100k

Identify

Geologic Units 100k

Qgo

Feature Information

Geologic Unit Label: Qgo

Geologic Age: Pleistocene

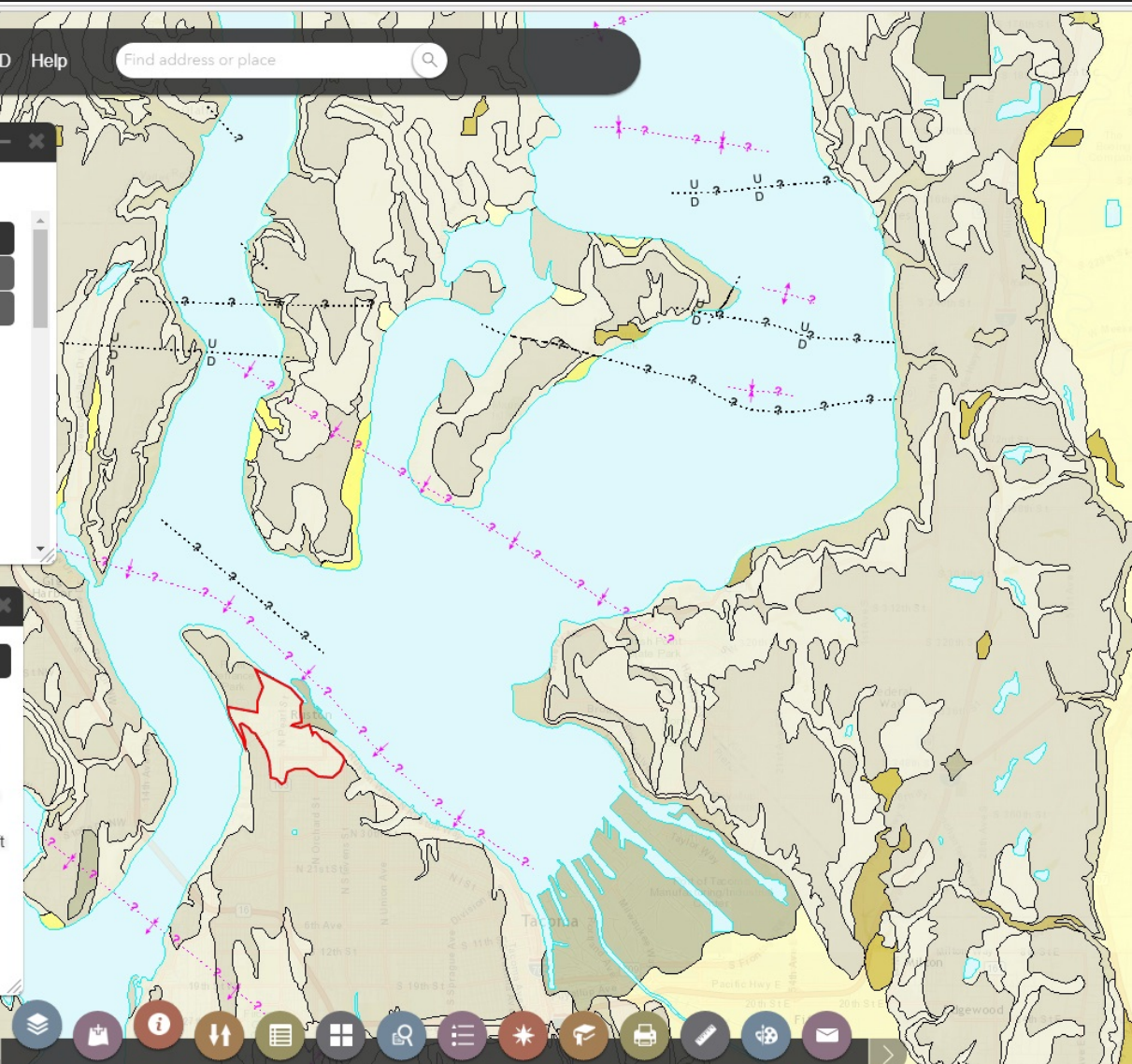
Lithology: continental glacial outwash, Fraser-age

Named Units: mostly Vashon Stade in western WA; unnamed in eastern WA

Symbology: Pleistocene continental glacial drift

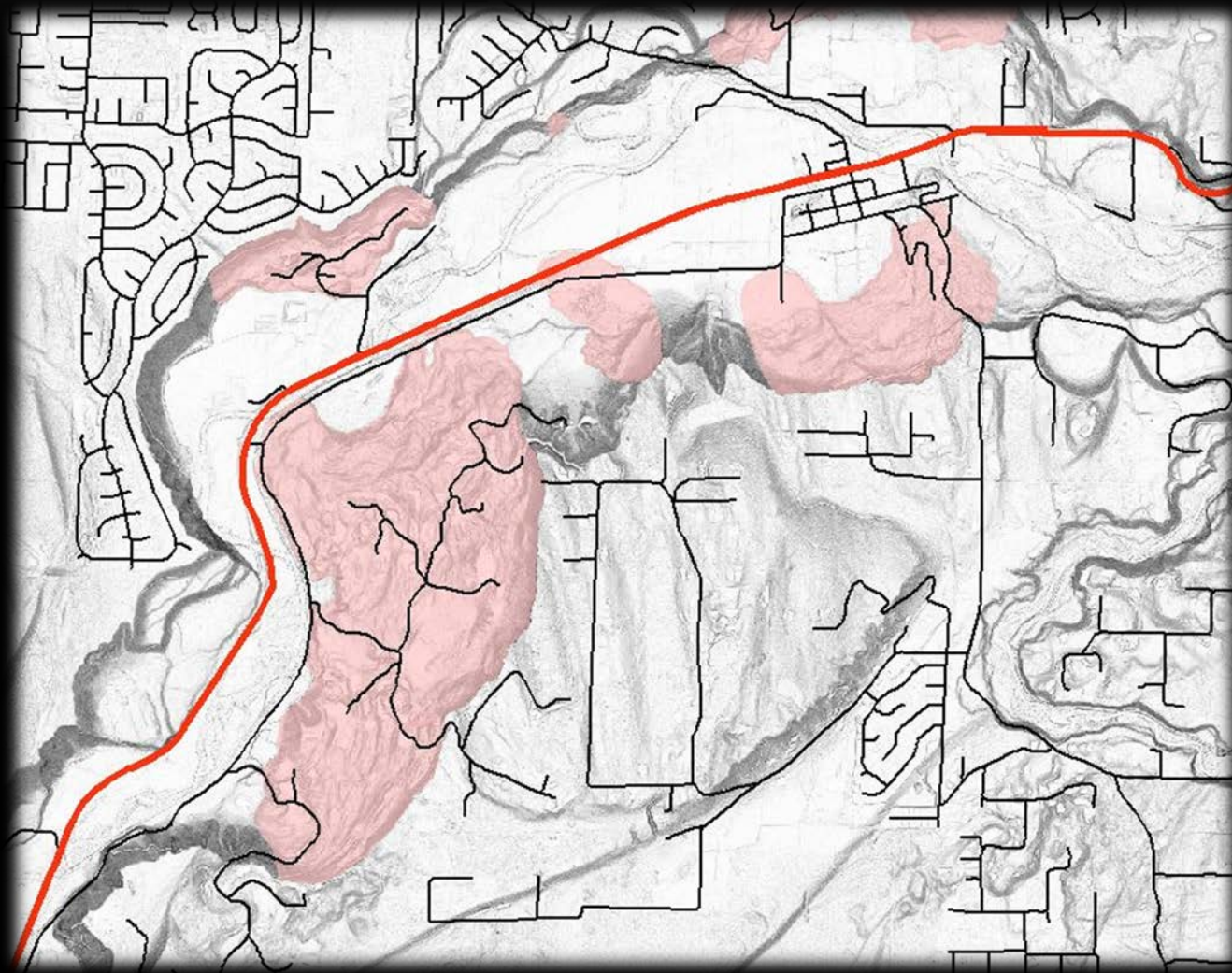
Scale: 144,448

Lat: 47.2785 Long: -122.5656



LANDSLIDE INVENTORY - EXPOSURE ANALYSIS

	Total (Miles)	Vulnerable (Miles)
Highway length	406	2.5
Arterial Road length	5085	29
Electric Towers	1056	0

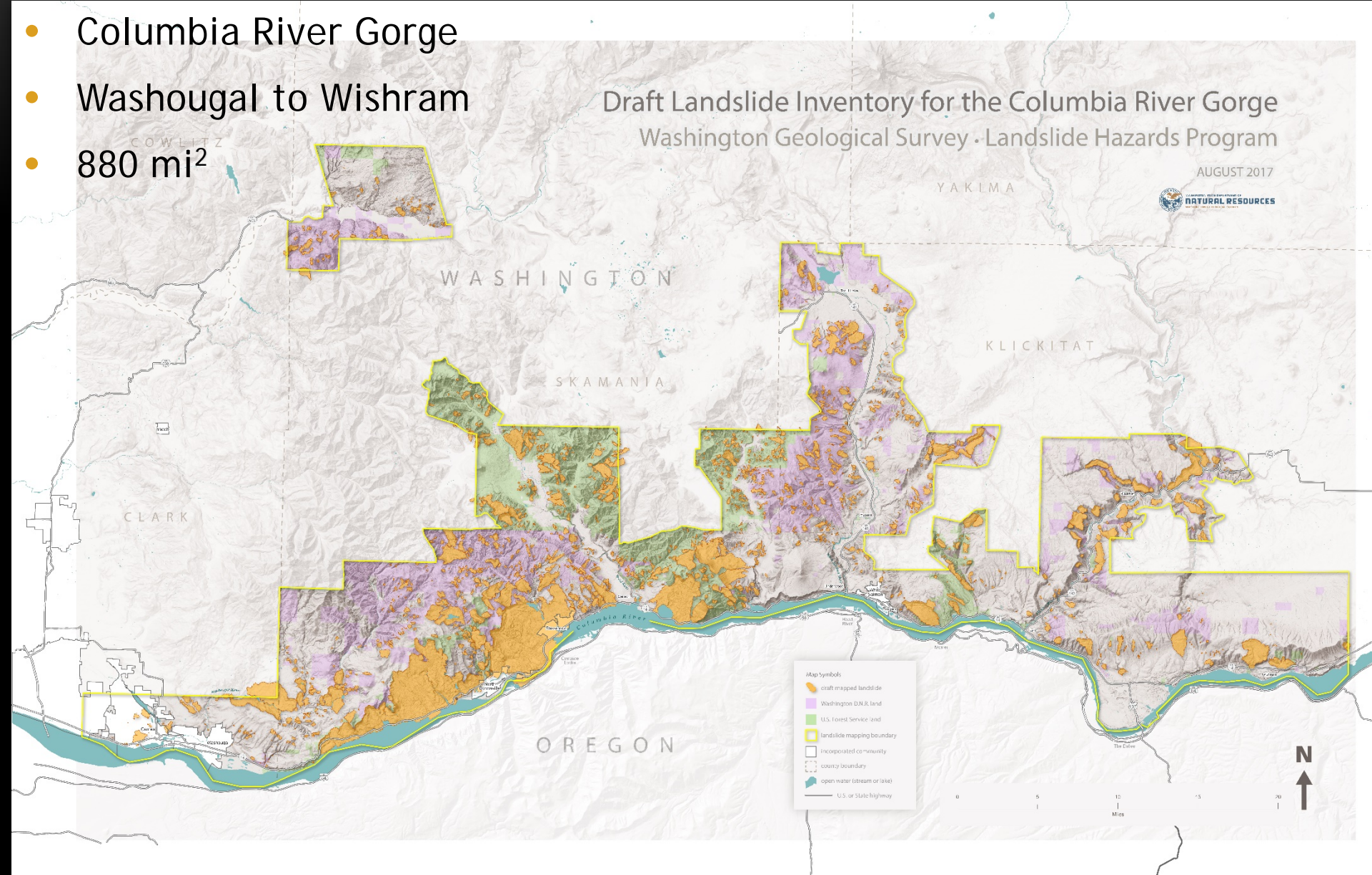


CURRENT PROJECT

- Columbia River Gorge
- Washougal to Wishram
- 880 mi²

Draft Landslide Inventory for the Columbia River Gorge
Washington Geological Survey · Landslide Hazards Program

AUGUST 2017



SR530 LANDSLIDE COMMISSION

- Recommendation 2:
Support a statewide landslide hazard and risk mapping program
- SB5088
- RCW 43.92.025
 - *Conduct and maintain an assessment of landslide hazards and apply lidar to identify landslide hazards and estimate potential hazard consequences...*



SR 530 LANDSLIDE COMMISSION FINAL REPORT

December 15, 2014