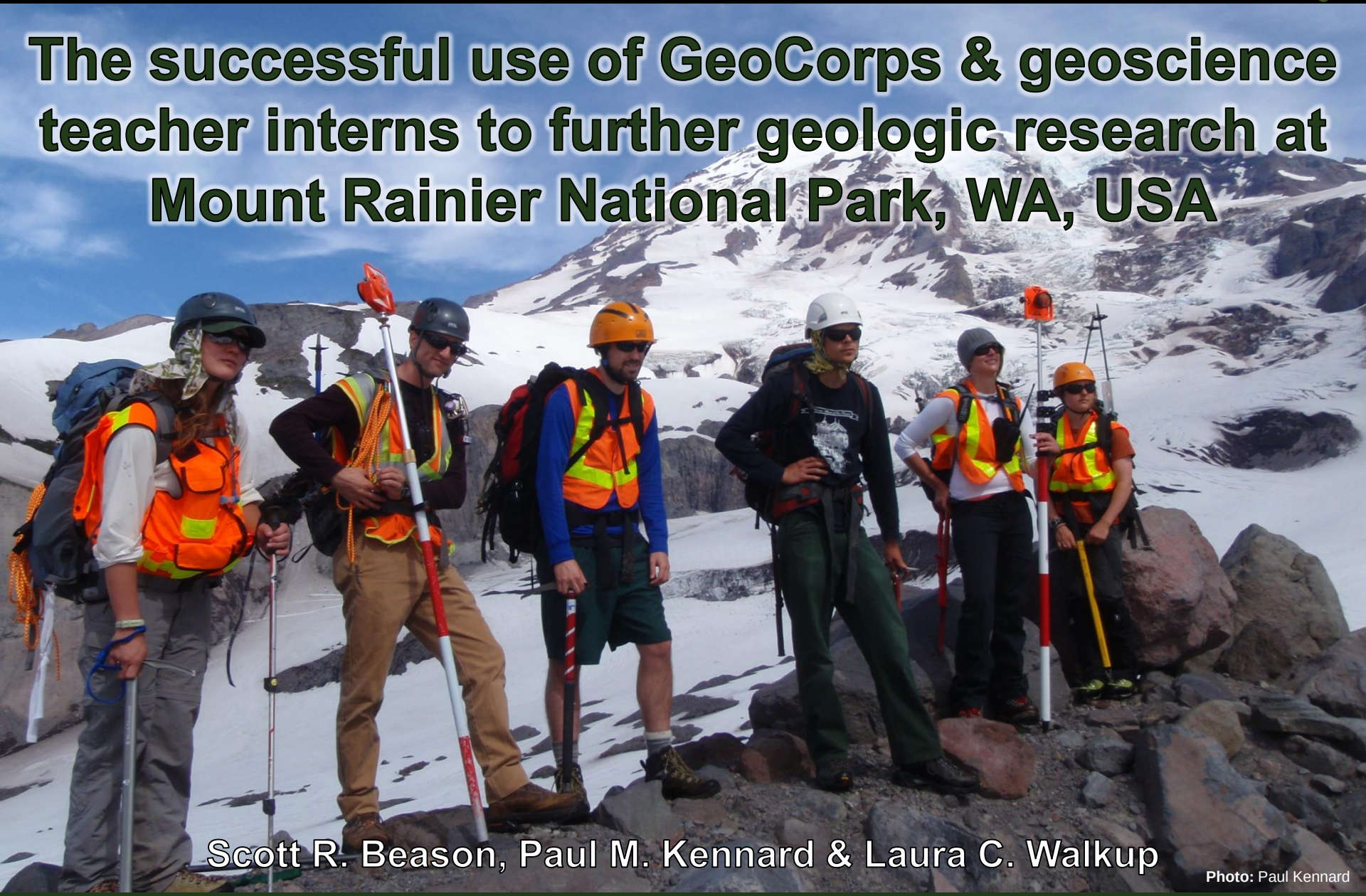
The successful use of GeoCorps & geoscience teacher interns to further geologic research at Mount Rainier National Park, WA, USA



Scott R. Beason, Paul M. Kennard & Laura C. Walkup

Photo: Paul Kennard

Program Background

NAGT

GeoCorps/Geoscients-in-the-Parks

- Offers short-term (12-week) paid geoscience positions at National Parks, Forests and BLM lands
- Stipend varies, but generally ~ $3,000
- Housing paid by host park
- Also offer Guest Scientist positions
- Classified as volunteers by parks
- Extremely competitive program

Mosaics in Science

- Program designed to increase diversity among those who seek STEM careers within the National Park Service
- Stipend varies, but generally $4,000
- Housing paid by host park
- Career workshop in DC included
- Classified as volunteers by parks
- Extremely competitive program

Geoscience Teachers-in-Parks

- Program developed by the National Association of Geoscience Teachers (NAGT)
- Offers geoscience teachers 8-week paid internships in parks (Stipend ~ $3,000)
- Initially started at Mammoth Caves, offered at Mount Rainier since 2011
- Classified as volunteers by parks
- Housing paid by host park

Mount Rainier National Park

Photo: Erol Kavountzis

Divisions & Responsibilities

Natural & Cultural Resources

- Work with park and outside researchers assisting with studies on landscape response to climate change
- Assist with research on alpine lakes and other aquatic habitat
- Document floods, debris flows, rock falls, and other geologic events as they occur

Interpretation

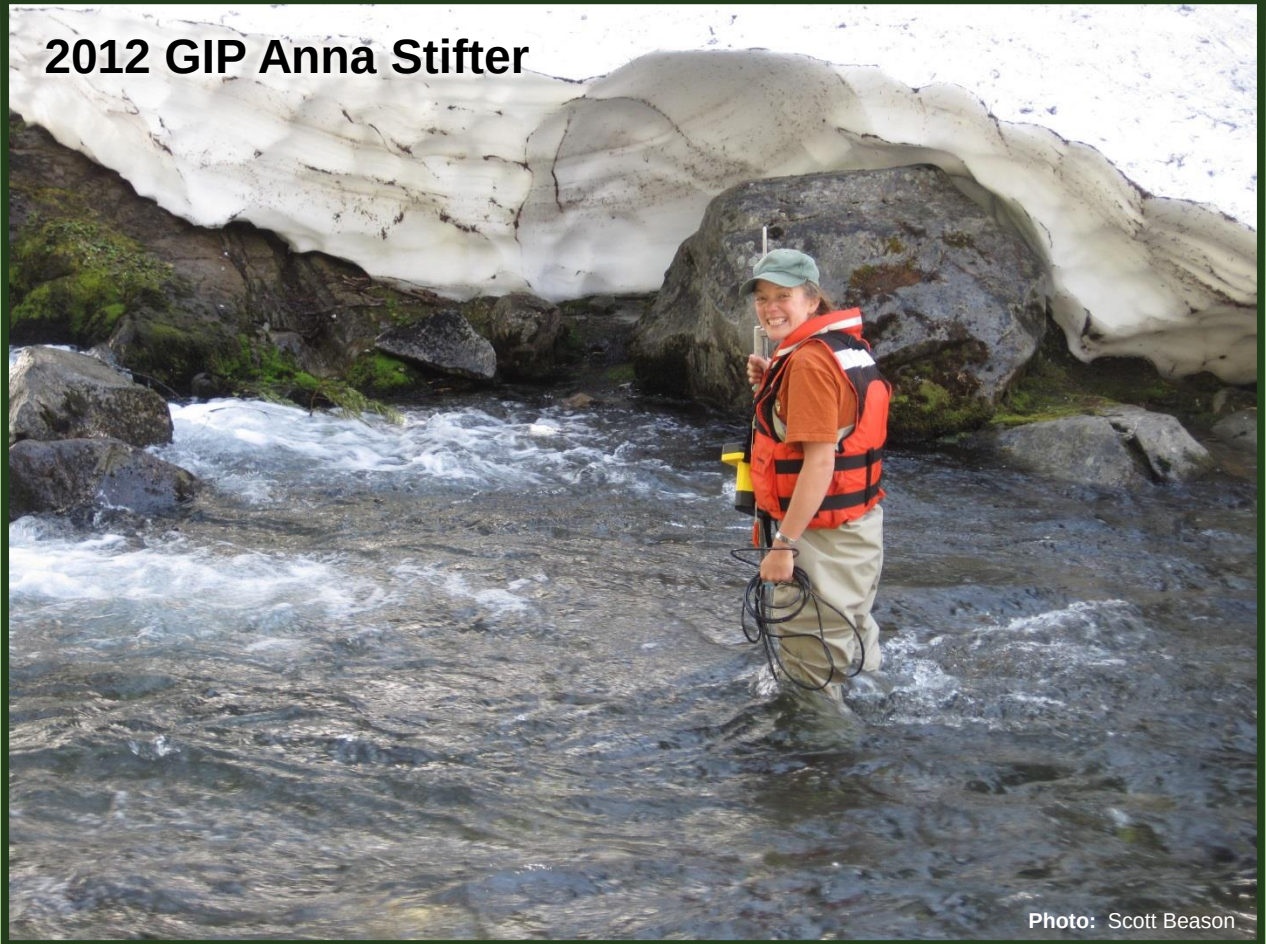
Divisions & Responsibilities

Natural & Cultural Resources

- Work with park and outside researchers assisting with studies on landscape response to climate change
- Assist with research on alpine lakes and other aquatic habitat
- Document floods, debris flows, rock falls, and other geologic events as they occur

Interpretation

- Staff front-line visitor centers at Longmire, Paradise, Sunrise, and Ohanapecosh
- Offer ranger-led interpretive hikes and programs
- Offer illustrated evening programs
- Offer Junior Ranger programs



GeoCorps and Geoscience Teacher Internships

RESULTS AT MORA

GIP/GTIP/TRT Numbers at MORA

Year	NCR GIP	NCR GTIP	INTERP GIP	INTERP TRT	TOTAL
1998	-	-	1	-	1
1999	-	-	1	-	1
2000	-	-	3	-	3
2001	-	-	1	-	1
2002	-	-	3	-	3
2003	-	-	2	-	2
2004	-	-	3	-	3
2005	1	-	2	-	3
2006	1	-	1	--	2
2007	-	-	2	-	2
2008	2	-	2	-	4
2009	1	-	2	3	6
2010	2	-	3	7	12
2011	2	-	5	2	9
2012	2	3	4	1	10
2013	2	2	4	1	9
2014	4	2	4	4	14
TOTAL	**16**	**7**	**43**	**18**	**85**

Key:

NCR
Natural and Cultural Resources Division

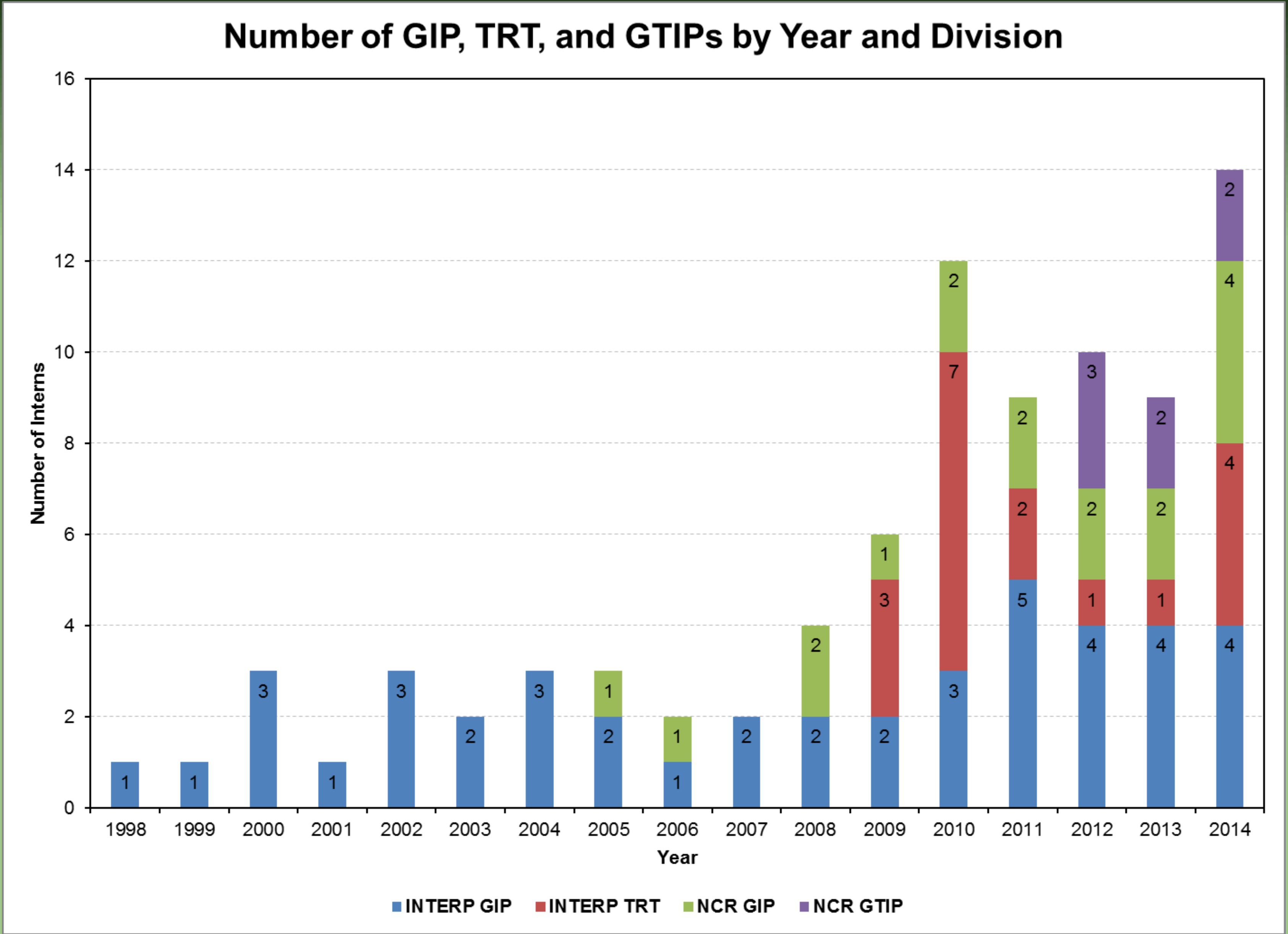
INTERP
Interpretation Division

GIP
Geologist-in-Park

GTIP
Geoscience-Teacher-In-Park

TRT
Teacher-Ranger-Teacher

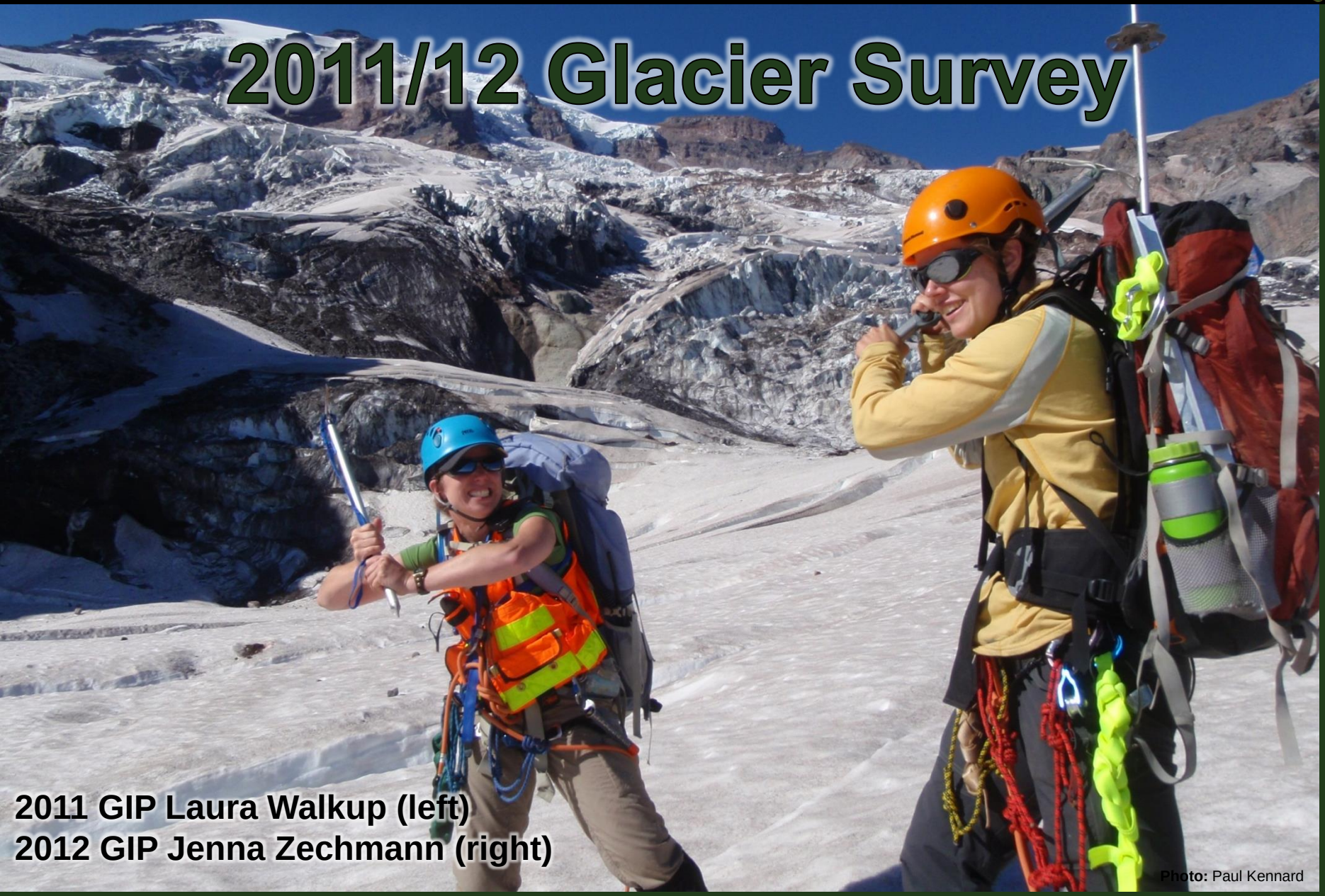
Data as of October 2014


Number of GIP, TRT, and GTIPs by Year and Division
Number of Interns
Year
0
2
4
6
8
10
12
14
16
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
INTERP GIP
INTERP TRT
NCR GIP
NCR GTIP

Recent successful geology projects at Mount Rainier

SUCCESSFUL STORIES

2011/12 Glacier Survey



2011 GIP Laura Walkup (left)
2012 GIP Jenna Zechmann (right)

Photo: Paul Kennard

Photos from the field

2012 GIP Anna Stifter

Photo: Laura Walkup

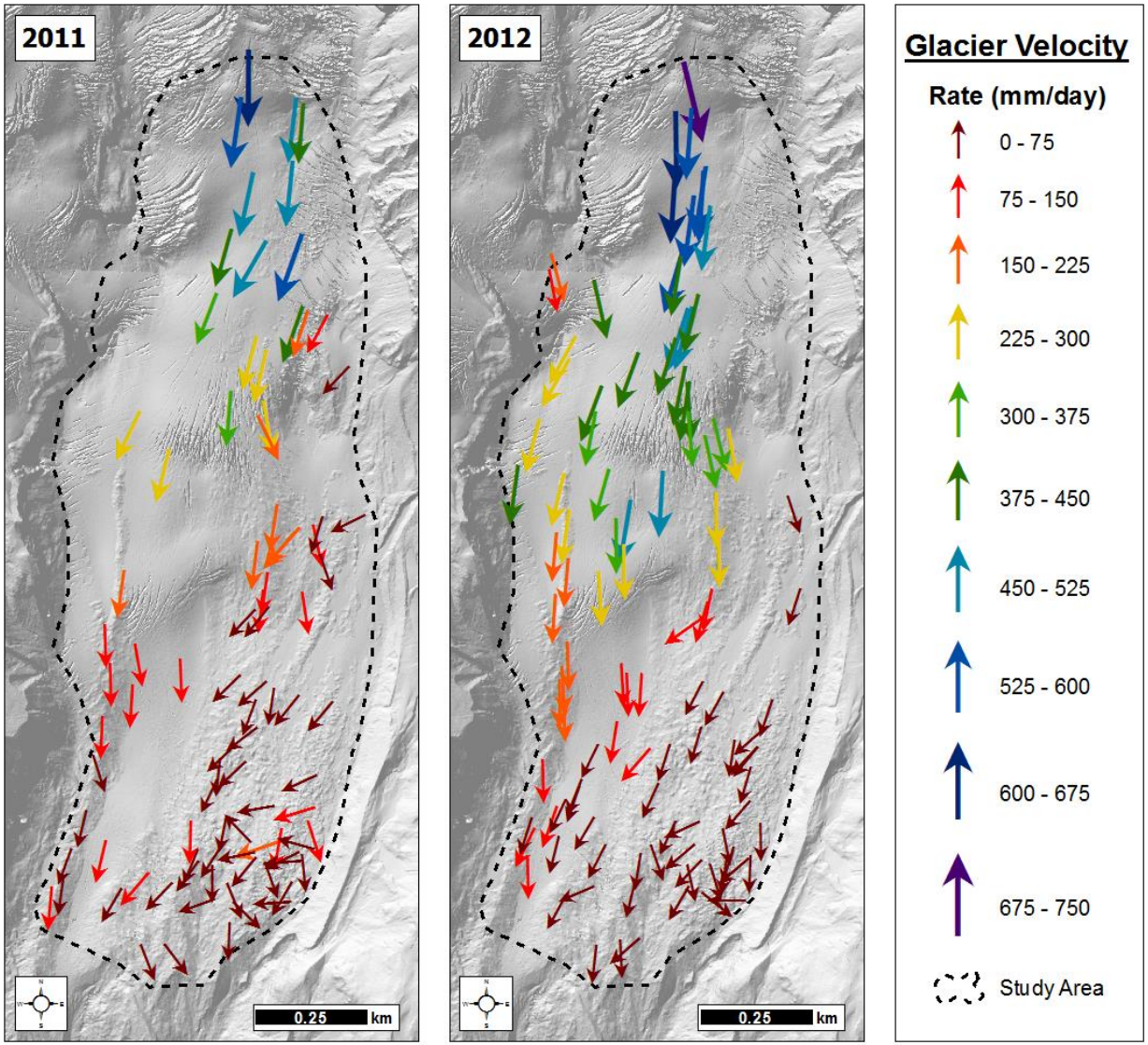
2011 GIP Laura Walkup (right)
2012 VIP Jeff Fortner (left)

Photo: Paul Kennard

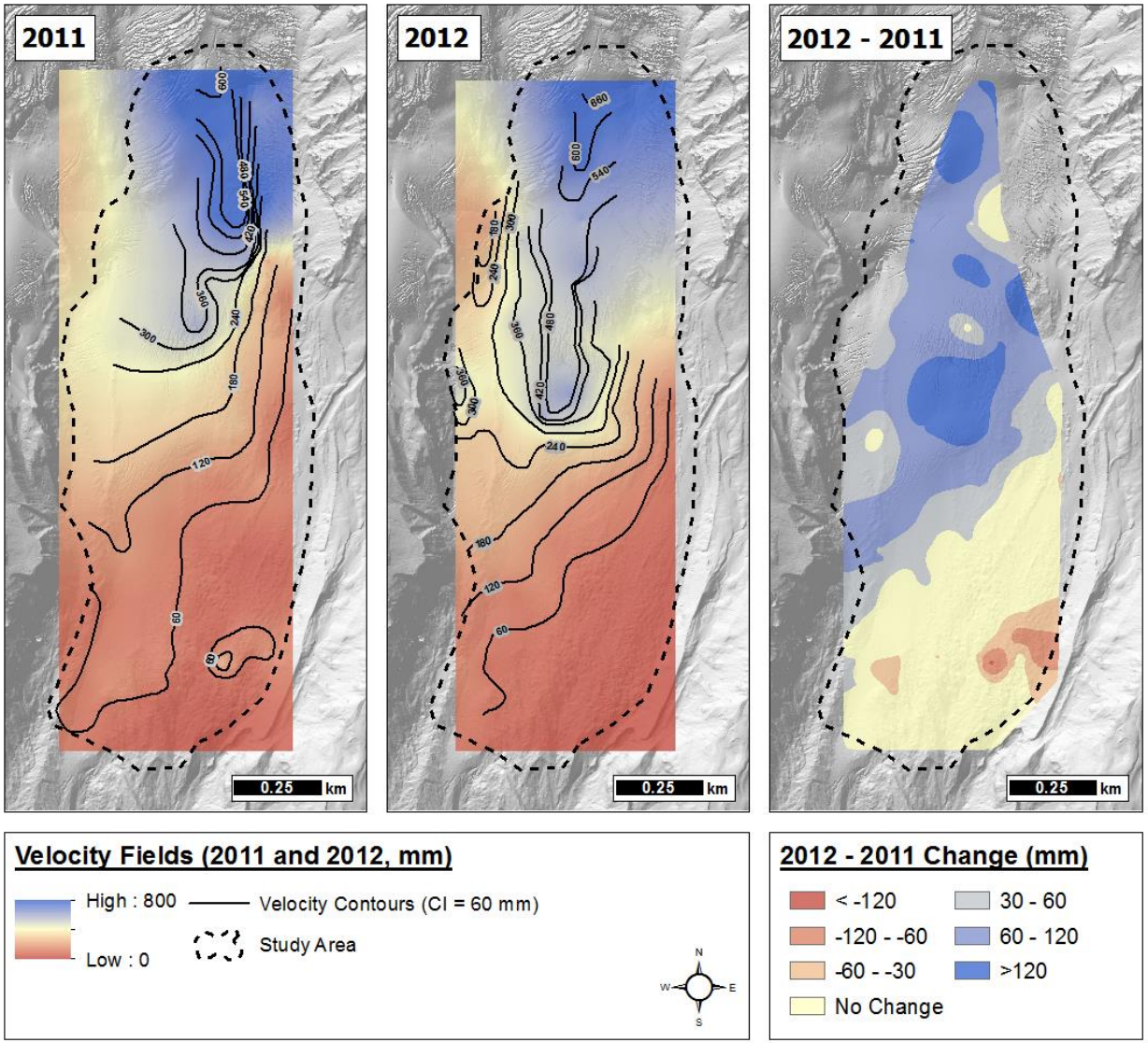
2012 GIP Eric McPherren

Photo: Laura Walkup

Results

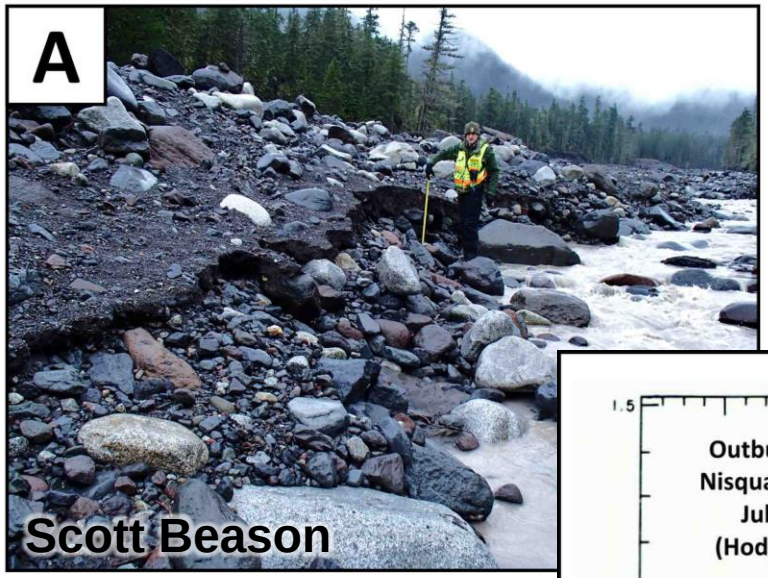

2011
2012
0.25 km
0.25 km
Glacier Velocity
Rate (mm/day)
0 - 75
75 - 150
150 - 225
225 - 300
300 - 375
375 - 450
450 - 525
525 - 600
600 - 675
675 - 750
Study Area

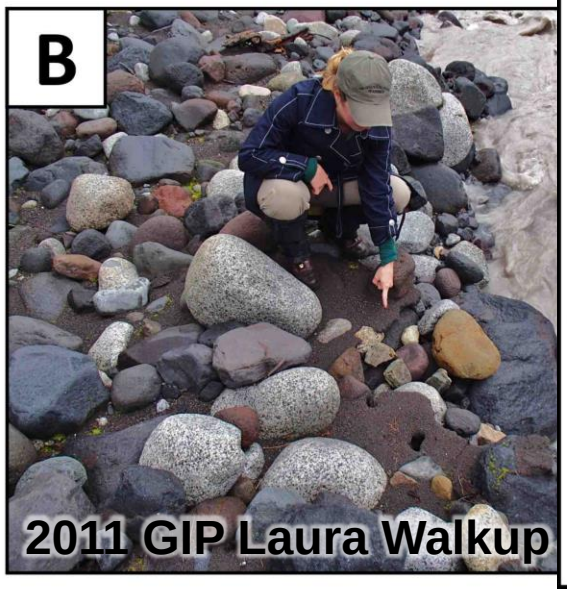
Results

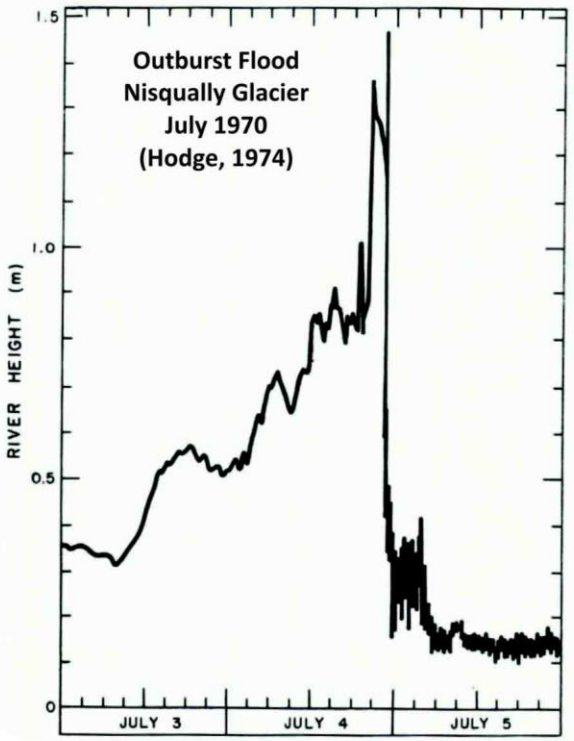

2011
2012
2012 - 2011
0.25 km
0.25 km
0.25 km
Velocity Fields (2011 and 2012, mm)
High : 800
Low : 0
Velocity Contours (CI = 60 mm)
Study Area
N
W
E
S
2012 - 2011 Change (mm)
< -120
-120 - -60
-60 - -30
No Change
30 - 60
60 - 120
>120

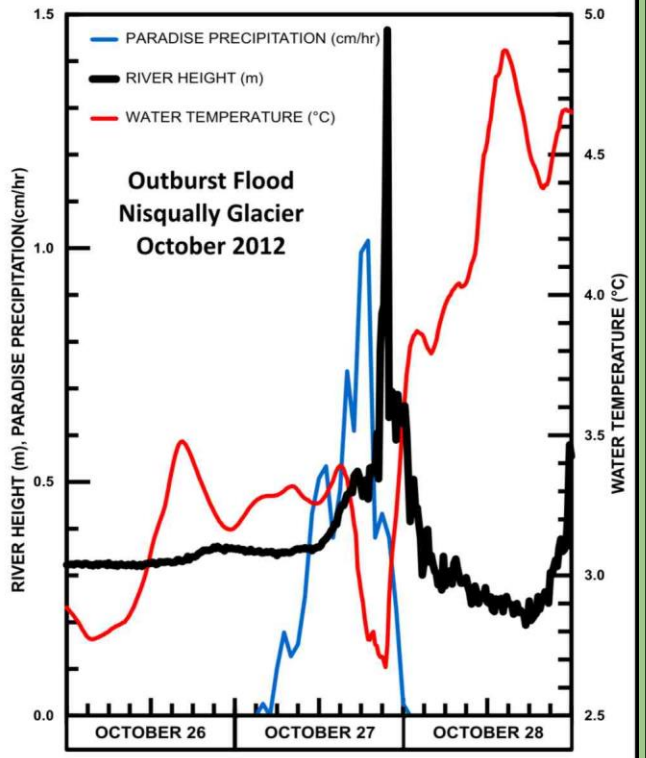
Outburst Flood

October 27, 2012
Approx. 1 m rise in stream stage









Products

Poster at 2013 GSA Meeting:

THE GEOLOGICAL SOCIETY OF AMERICA®

SURFICIAL ICE VELOCITIES OF THE LOWER NISQUALLY GLACIER AND THEIR RELATIONSHIP TO OUTBURST FLOOD HAZARDS AT MOUNT RAINIER NATIONAL PARK, WASHINGTON, UNITED STATES

WALKUP, Laura C.[1], **BEASON, Scott R.**[1], KENNARD, Paul M.[1], OHLSCHLAGER, Justin G.[2], and STIFTER, Anna C.[1]
(1) Mount Rainier National Park, 55210 238th Ave E, Ashford, WA 98304, lauracwalkup@gmail.com, (2) Geology, Portland State University, 17 Cramer Hall, 1721 SW Broadway, Portland, OR 97201

I. ABSTRACT

Mount Rainier, Washington, is the tallest of a number of glacier-clad volcanic peaks within the Cascade Range. Standing at 4,392 m (14,410 ft) and having 25 major glaciers, it contains more glacial ice than any other single peak in the contiguous United States. Glaciers are the headwaters of a number of rivers emanating from Mount Rainier, many of which flow to the Puget Sound, approximately 60 km (37 mi) away. Glaciers on Mount Rainier have unleashed damaging outburst floods (lahars) in the past, often without warning. Previous observations have indicated an empirical link between changing glacier velocities and glacial outburst flood hazards. Specifically, these observations of the glaciers' seaward flow suggest when outburst floods occurred. Additionally, the current Nisqually glacier extent is similar to glacial extent in the 1850s when an outburst flood impacted Longmire, one of the visitor destinations and work areas in the park.

This study explores whether the surficial velocity field of the Nisqually glacier is changing and if ice velocity changes can be used to indicate glacial outburst flood potential. We hypothesize that the lower Nisqually glacier were surveyed weekly during the summer/fall of 2011 and 2012. The surficial velocity field of that lower 3 km² (1.6 km²). Differential ice was calculated from repeated measurements between 2011 and 2012, observed velocities in the upper portions of the study area as a distinct while the lower portion of the glacier showed an increased the same. Shortly after the ice/glacier study was buried in October 2012, we observed substantial downslope (~1 m (3 ft)) rise in river stage at Longmire during a rainstorm on the upper mountain. Field evidence corroborated the stage record and indicates a small outburst flood (approximately 15 m³) (526 ft³) was released from the glacier during this maneuver.

Our work contributes to the understanding of glacial outburst floods and provides a model and flow of evidence that through ice velocities precede outburst floods. Further study of glacial velocity fields could provide a predictive methodology for glacial outburst floods in similar terrains. These results are critical for employee, visitor, and infrastructure protection in dynamic proglacial environments experiencing the effects of climate change, such as those at Mount Rainier.

II. LOCATION

Map showing the study area within the Nisqually glacier on the southern side of Mount Rainier. The Nisqually Glacier is the largest south-facing glacier on Mount Rainier and it is the source for the Nisqually river, which parallels much of the main access road into the Park. Glacial velocity surveying occurred from the terminus, at approximately 1,980 m (6,496 ft), up to about the 2,100 m (6,890 ft) level (above the seasonal equilibrium line). Reverse survey ends approximately 1 km (0.6 mi).

III. BACKGROUND

The Nisqually Glacier has one of the longest histories of scientific examination of any glacier in the United States, having been studied since the 1850s. Most historic studies on the Nisqually look at mass balance, glacial extent, or surface elevation, while few have examined glacial velocity. Past research indicates that the lower Nisqually glacier has oscillated and glacial velocities throughout the measurement history. These reliable historical velocity data spread across decades to thereby below:

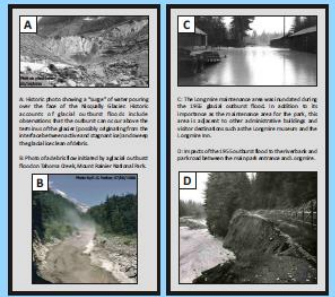
Survey Interval	Location on Glacier	Velocities on Nisqually (m/day)	Velocities on Nisqually (ft/day) (Lower Flow)	Data Source
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Empiric evidence suggests that jökulhlaups at Mount Rainier tend to occur when large amounts of stagnant ice is present in that lower reaches. Additionally, Hodge (1974) found that the current velocity of the Nisqually glacier increased significantly in the vicinity of the Ausilliarian Ice (1.6), while slowing occurred toward the terminus (relative to the previous summer) just prior to the 1974 outburst flood.

It is suggested that observed variations in ice velocity were correlated with the amount of liquid water temporarily stored within the glacier. This indicates that the presence of more englacial water tends to faster ice velocities and a higher potential for outburst floods, while the absence of large quantities of englacial water leads to slower glacial flow and fewer outburst floods. If this is consistently the case, annual glacial velocity measurement could be a powerful tool in the prediction of potentially devastating glacial outburst floods.

At least four major damaging glacial outburst floods have been released from the Nisqually glacier, along with many smaller outburst events. The floods of 1926 and 1968 damaged the bridge below the glacial terminus, and the floods in 1955 and 1963 destroyed it (Hodge, 1970). In Mount Rainier National Park, downstream tourist areas like Longmire are susceptible to flooding associated with glacial outburst floods, as evidenced in the 1968 event when the community was inundated with floodwater. In addition, much of the main access road into the park parallels the Nisqually River.

IV. HISTORIC OUTBURST FLOODS



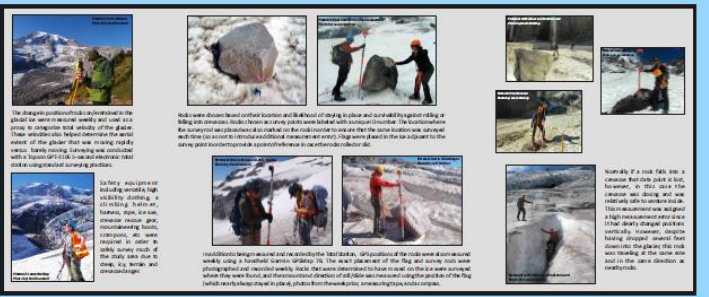
A: Historic photo showing a "surge" of water pouring over the face of the Nisqually Glacier. Historic accounts of glacial outburst floods include observations that the outburst can occur above the terminus of the glacier (possibly originating from the interface between subglacial stagnant ice/and sweep the glacial bed/ice of debris.

B: Photo of substantial flow initiated by a glacial outburst flood on Tahoma Creek, Mount Rainier National Park.

C: The Longmire maintenance area was inundated during the 1968 glacial outburst flood. In addition to its importance as the maintenance area for the park, this area is adjacent to other administrative buildings and visitor destinations such as the Longmire museum and the Longmire Inn.

D: Impacts of the 1968 Southeast flood to the riverbank and parkroad between the main park entrance and Longmire.

V. METHODS



The changing positions of rocks can be monitored in the glacial ice were measured weekly and used as a proxy to categorize total velocity of the glacier. These velocities also helped determine the aerial extent of the glacier that was moving rapidly versus barely moving. Surveying was conducted with a Topcon GPT-3102N 2-second electronic total station using standard surveying practices.

Safety equipment including sensible, high visibility clothing, a US military helmet, ear, knee, and elbow protection, ice axe, crevasse rescue gear, mountaineering boots, crampons, etc. were required in order to safely survey much of the study area due to steep, icy, terrain and crevasse danger.

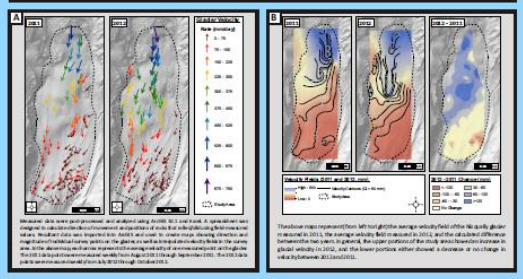
Rocks were chosen based on their location and likelihood of staying in place and survivability against rolling or falling into crevasses. Rocks chosen as survey points were labeled with a unique Sharpie number. The location where the survey rod was placed was also marked on the rock in order to ensure that the same location was surveyed each time (so as not to introduce additional measurement error). Flags were placed in the ice adjacent to the survey point in order to provide a spatial reference in case the rock collector did.

Eventually if a rock falls into a crevasse that data point is lost, however, in this case the crevasse was closing and was relatively safe to venture into/in. This re-measurement was assigned a high measurement error since it had clearly changed positions vertically. However, despite having dropped several feet down into the glacier, the rock was traveling at the same rate and in the same direction as nearby rocks.

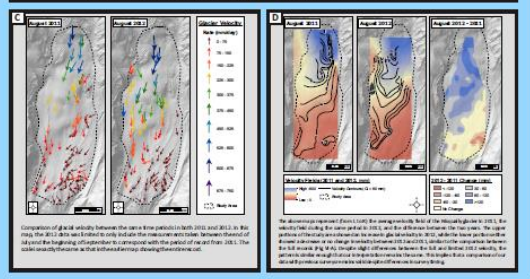
In addition to being re-measured and recorded by the total station, GPS positions of the rocks were also re-measured weekly using a handheld Garmin GPSMap 76. The exact placement of the flag and survey rocks were photographed and recorded weekly. Rocks that were determined to have moved on the ice were surveyed where they were found, and the associated direction of drift/lake was measured using the position of the flag (which nearly always stayed in place), photos from the weekly/misc. snow/sighting trips, and a compass.

VI. NISQUALLY GLACIAL VELOCITY RESULTS

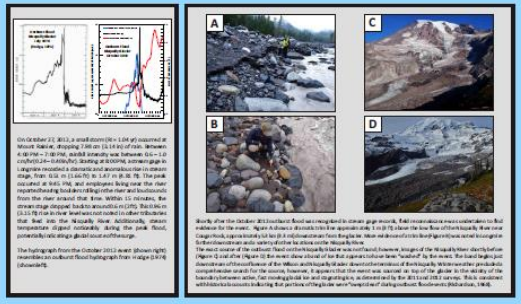
2011 and 2012 Velocity Fields (Full Record)



August 2011 and August 2012 Velocity Fields (Same time intervals)



VII. FALL 2012 GLACIAL OUTBURST FLOOD



On October 22, 2012, a small storm (90 = 1.04 yr) occurred at Mount Rainier, dropping 7.66 cm (3.14 in) of rain. Between 4:00 PM – 7:00 PM, rainfall intensity was between 0.5 – 1.0 cm/hr (0.24 – 0.40 in/hr), starting at 5:00 PM, a stream gage in Longmire recorded a dramatic and anomalous rise in stream stage, from 0.61 m (1.66 ft) to 1.67 m (5.48 ft). The peak occurred at 9:45 PM, and employees living near the river reported hearing boulders rolling in the river and loud sounds from the river around that time. Within 15 minutes, the stream stage dropped back to around 0.61 m (2 ft). Rainfall (0.5 – 0.75 in/hr) was in the river level was not noted in other tributaries that feed into the Nisqually River. Additionally, stream temperature dipped noticeably during the peak flood, potentially indicating glacial-lacustrine origin.

The hydrograph from the October 2012 event (shown right) resembles an outburst flood hydrograph from Hodge (1974) (shown left).

VIII. OUTCOMES

This study shows that measurable glacial velocity changes do occur between subsequent summers. Our data supports Hodge's observation of increased velocity in the vicinity of the ELA, concurrent with decreased velocity toward the terminus prior to the occurrence of an outburst flood. If this trend is consistent and measurable, monitoring of glacial velocity would have powerful tools in the prediction of outburst floods/hazards.

Key Findings:

- Seasonal patterns of velocity exist.
- Yearly velocity surveys could allow us to monitor glacier conditions and predict outburst flood cause.
- Real-time GPS tracking could potentially be a better glacier float and provide short-term outburst flood warning.
- Stream gauges can be used to determine the fluctuations in glacial discharge, and could allow us to detect smaller outburst floods that might be less noticeable at the downstream gauge further downstream.

Continued Questions:

- What velocities are "normal" for the lower Nisqually?
- What is the relationship between velocity and englacial water volume?
- What is the actual flood hazard posed by the Nisqually to both the Park and Park visitors?
- How well can the runoff and flood hazard be gauged?
- Why did the glacier accelerate/"surge" in the months leading up to the 1968 flood?
- Can the melt season cause outburst floods?
- Can the melt season cause the englacial flow and movement of such floods?
- How do velocities change with elevation?

Hodge, S.M., 1970, Variations in sliding, ice deformation and surface profile on Nisqually Glacier, Mount Rainier, Washington: Institute of Arctic and Alpine Research, Occasional Paper No. 1, 74 p.

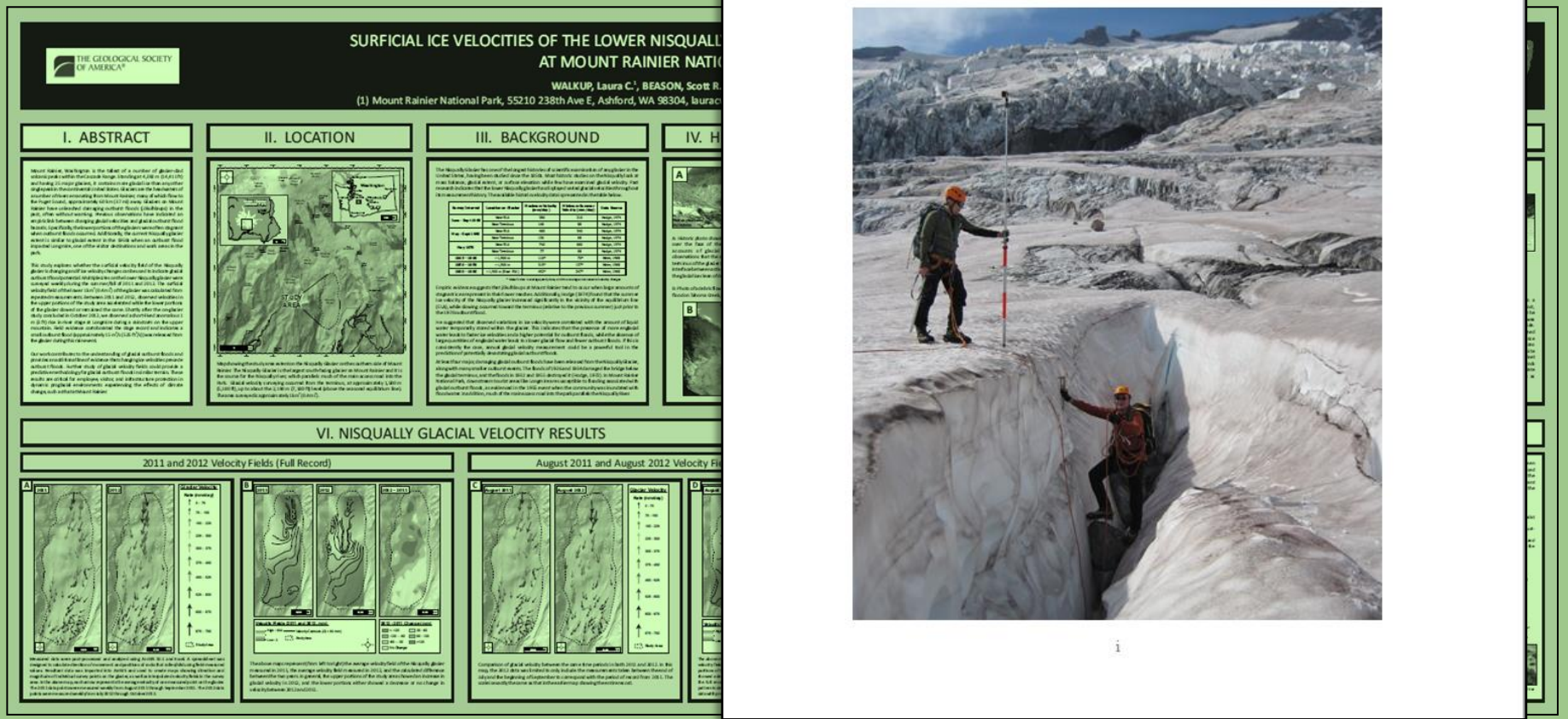
Hodge, S.M., 1974, Variations in the sliding of a temperate glacier: Journal of Glaciology, v. 13, no. 69, p. 349–369.

Hodge, S.M., 1976, Short-term ice-marginal motion and some of its consequences: Journal of Glaciology, v. 16, no. 74, p. 159–176.

Products

Forthcoming NRDS Paper:

Poster at 2013 GSA Meeting:



National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Surficial Velocities of the Nisqually Glacier, Mount Rainier National Park, 2011 and 2012

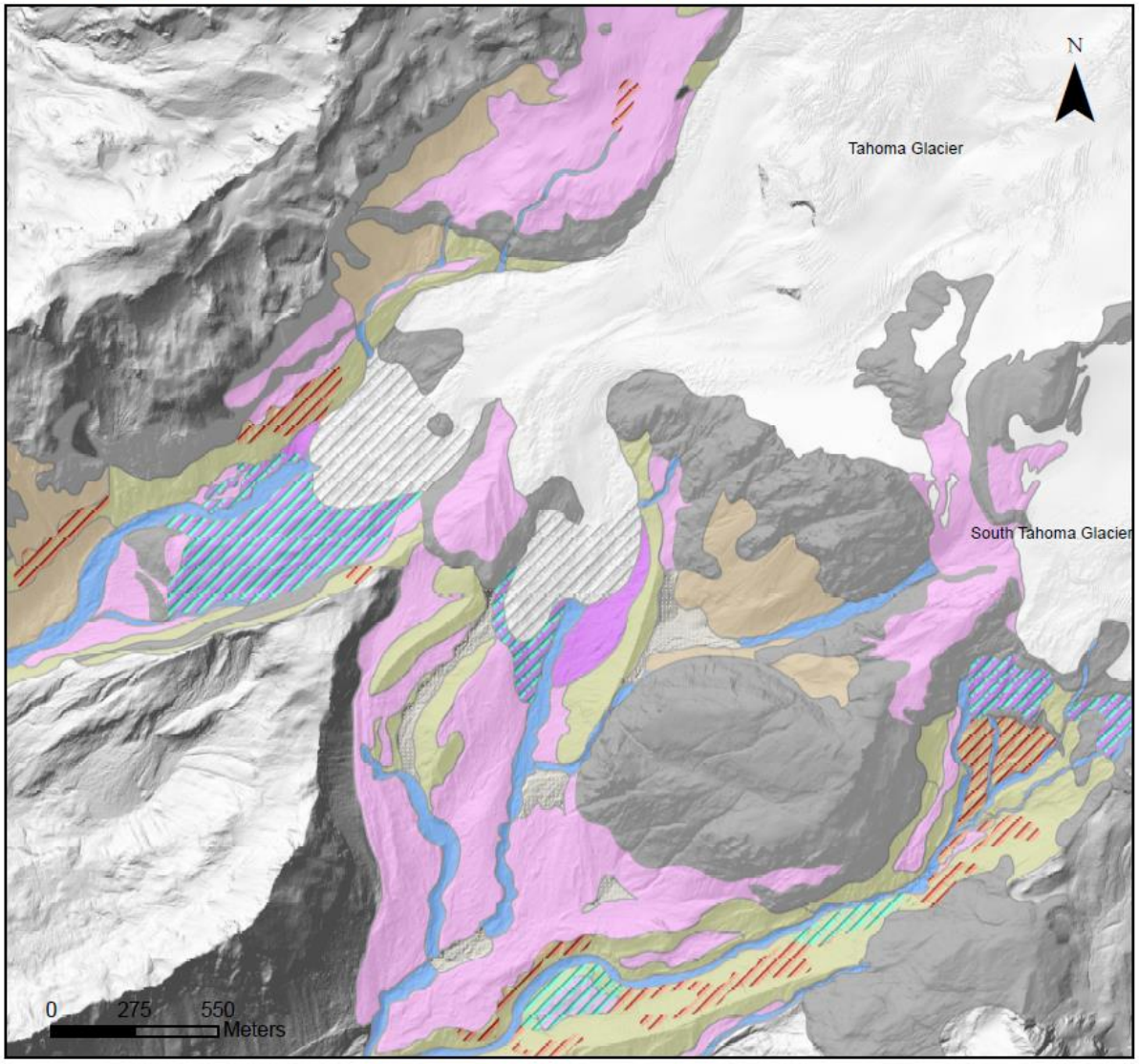
Natural Resource Data Series NPS/XXXX/NRDS—20XX/XXX

i

Glacier Mapping

2012 GIP Jenna Zechmann

Periglacial land cover at the termini of the Tahoma and South Tahoma glaciers



Feature type

- Bedrock
- Scree
- Outwash/Alluvium
- Channel
- Moraine
- Moraine, end
- Moraine, oversteep
- Moraine, ice cored
- Moraine, possibly ice cored
- Moraine, rock cored
- Rills

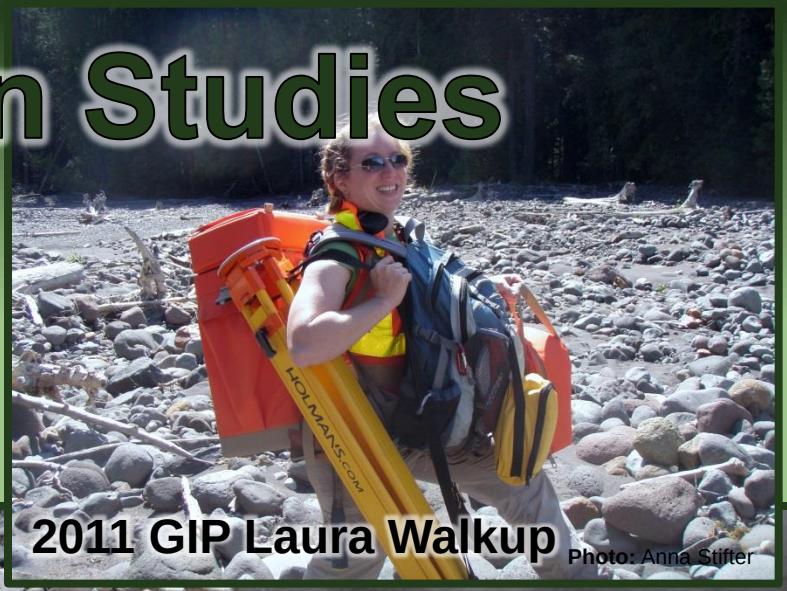
Glacial ice type

- Active
- Stagnant

Map created in 2012 by Jenna Zechmann based on data from 2007 and 2008 LiDAR flights, 2007 and 2011 NAIP imagery, and 2012 ground-based photographs, field observations, and GPS data.

Glacier extents created by Tom Sisson using 2007 and 2008 LiDAR data, and modified by Jenna Zechmann to reflect 2012 extents determined from GPS survey and field observations.

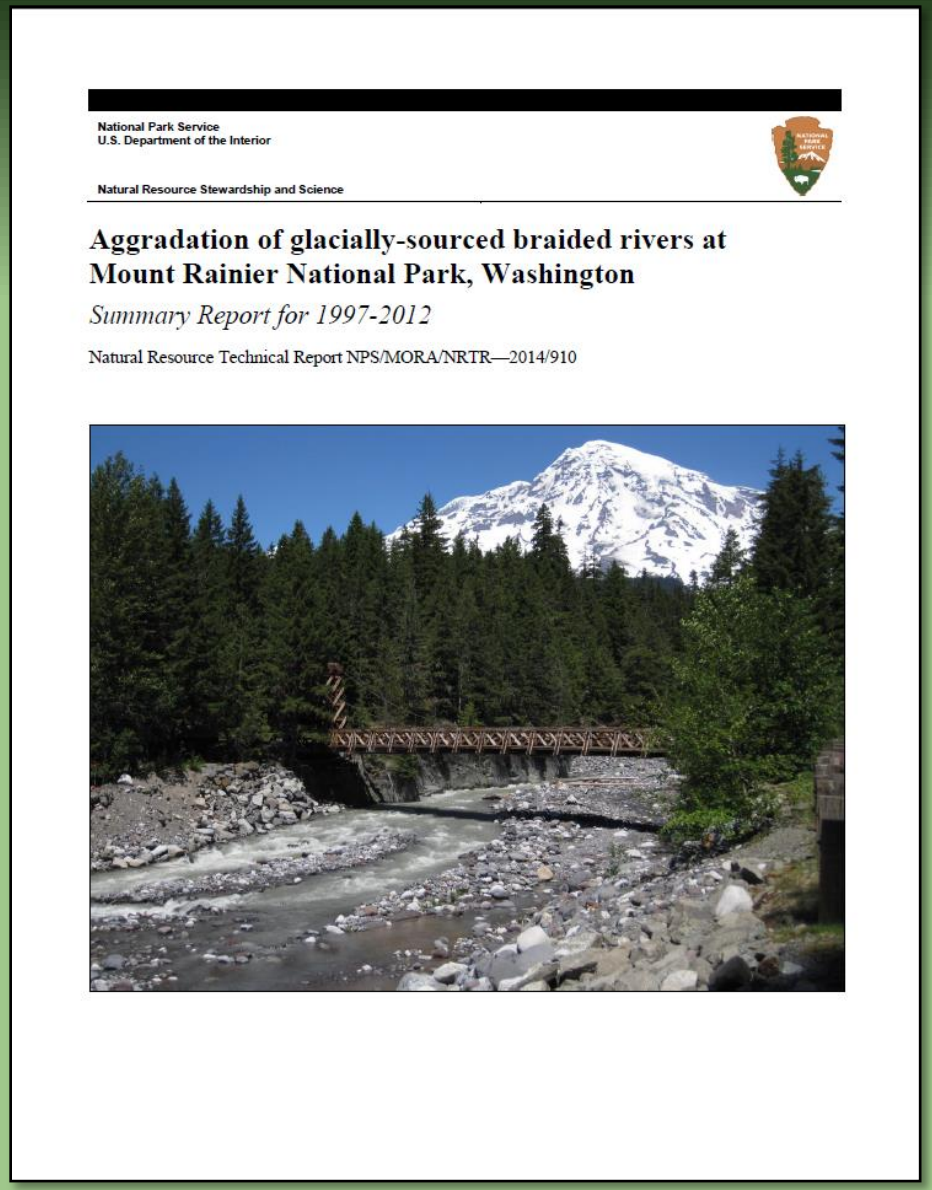
Aggradation Studies



Aggradation Study Products

Natural Resource Technical Report: (Will be published this week!)

Beason, S.R., Walkup, L.C., and P.M. Kennard: Aggradation of glacially-sourced braided rivers at Mount Rainier National Park, Washington: Summary report for 1997-2012: Natural Resource Technical Report NPS/MORA/NRTR—2014/910, 104p.


National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Aggradation of glacially-sourced braided rivers at Mount Rainier National Park, Washington

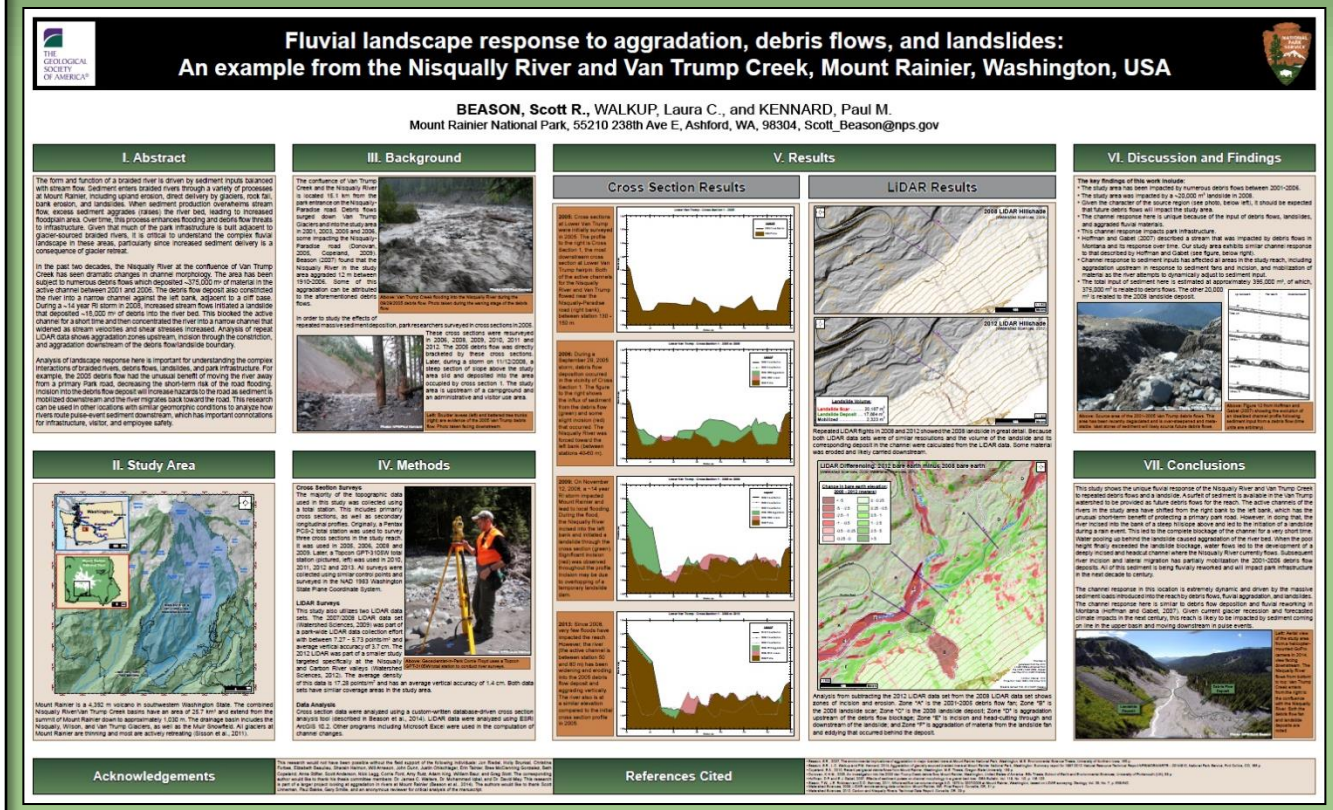
Summary Report for 1997-2012

Natural Resource Technical Report NPS/MORA/NRTR—2014/910

Fluvial landscape response to aggradation, debris flows, and landslides: An example from the Nisqually River and Van Trump Creek, Mount Rainier, Washington, USA

BEASON, Scott, et al.

On Right Now!



Fluvial landscape response to aggradation, debris flows, and landslides:
An example from the Nisqually River and Van Trump Creek, Mount Rainier, Washington, USA

BEASON, Scott R., WALKUP, Laura C., and KENNARD, Paul M.
Mount Rainier National Park, 55210 238th Ave E, Ashford, WA, 98304, Scott_Beason@nps.gov

I. Abstract

The form and function of a braided river is driven by sediment inputs balanced with stream flow. Sediment enters braided rivers through a variety of processes at Mount Rainier, including upland erosion, direct delivery by glaciers, rock fall, bank erosion, and landslides. When sediment production overwhelms stream flow, excess sediment aggrades (raises) the river bed, leading to increased floodplain area. Over time, this process enhances flooding and debris flow threats to infrastructure. Given that much of the park infrastructure is built adjacent to glacier-sourced braided rivers, it is critical to understand the complex fluvial landscape in these areas, particularly since increased sediment delivery is a consequence of glacier retreat.

In the past two decades, the Nisqually River at the confluence of Van Trump Creek has seen dramatic changes in channel morphology. The area has been subject to numerous debris flows which deposited ~375,000 m³ of material in the active channel between 2001 and 2006. The debris flow deposit also constricted the river into a narrow channel against the left bank, adjacent to a cliff base. During a ~14 year RI storm in 2006, increased stream flows initiated a landslide that deposited ~18,000 m³ of debris into the river bed. This blocked the active channel for a short time and then concentrated the river into a narrow channel that widened as stream velocities and shear stresses increased. Analysis of repeat LiDAR data shows aggradation zones upstream, incision through the constriction, and aggradation downstream of the debris flow/landslide boundary.

Analysis of landscape response here is important for understanding the complex interactions of braided rivers, debris flows, landslides, and park infrastructure. For example, the 2006 debris flow had the unusual benefit of moving the river away from a primary Park road, decreasing the short-term risk of the road flooding. Incision into the debris flow deposit will increase hazards to the road as sediment is mobilized downstream and the river migrates back toward the road. This research can be used in other locations with similar geomorphic conditions to analyze how rivers route pulse-event sediment downstream, which has important connotations for infrastructure, visitor, and employee safety.

III. Background

The confluence of Van Trump Creek and the Nisqually River is located 16.1 km from the park entrance on the Nisqually-Paradise road. Debris flows surged down Van Trump Glaciers and into the study area in 2001, 2003, 2003 and 2006, some impacting the Nisqually-Paradise road (Donovan, 2005; Copeland, 2009). Beason (2007) found that the Nisqually River in the study area aggraded 12 m between 1910-2006. Some of this aggradation can be attributed to the aforementioned debris flows.

Above: Van Trump Creek flooding into the Nisqually River during the 08/29/2003 debris flow. Photo taken during the waning stage of the debris flow.

In order to study the effects of repeated massive sediment deposition, park researchers surveyed in cross sections in 2006. These cross sections were resurveyed in 2006, 2008, 2009, 2010, 2011 and 2012. The 2006 debris flow was directly bracketed by these cross sections. Later, during a storm on 11/12/2008, a steep section of slope above the study area slid and deposited into the area occupied by cross section 1. The study area is upstream of a campground and an administrative and visitor use area.

Left: Boulder levees (left and flattened tree trunks right) are evidence of the 2006 van Trump debris flow. Photo taken facing downstream.

II. Study Area

Mount Rainier is a 4,392 m volcano in southwestern Washington State. The combined Nisqually River/Van Trump Creek basins have an area of 28.7 km² and extend from the summit of Mount Rainier down to approximately 1,030 m. The drainage basin includes the Nisqually, Wilson, and Van Trump Glaciers, as well as the Muir Snowfield. All glaciers at Mount Rainier are thinning and most are actively retreating (Sisson et al., 2011).

IV. Methods

Cross Section Surveys

The majority of the topographic data used in this study was collected using a total station. This includes primarily cross sections, as well as secondary longitudinal profiles. Originally, a Pentax PCS-2 total station was used to survey three cross sections in the study reach. It was used in 2006, 2006, 2008 and 2009. Later, a Topcon GPT-3100N total station (pictured, left) was used in 2010, 2011, 2012 and 2013. All surveys were collected using similar control points and surveyed in the NAD 1983 Washington State Plane Coordinate System.

Above: Geoscientist-in-Park Corrie Thuyl uses a Topcon GPT-3100N total station to conduct cross surveys.

LiDAR Surveys

This study also utilizes two LiDAR data sets. The 2007/2008 LiDAR data set (Watershed Sciences, 2009) was part of a park-wide LiDAR data collection effort with between 7.27 – 8.73 points/m² and average vertical accuracy of 3.7 cm. The 2012 LiDAR was part of a smaller study targeted specifically at the Nisqually and Carbon River valleys (Watershed Sciences, 2012). The average density of this data is 17.28 points/m² and has an average vertical accuracy of 1.4 cm. Both data sets have similar coverage areas in the study area.

Data Analysis

Cross section data were analyzed using a custom-written database-driven cross section analysis tool (described in Beason et al., 2014). LiDAR data were analyzed using ESRI ArcGIS 10.2. Other programs including Microsoft Excel were used in the computation of channel changes.

V. Results

Cross Section Results

2006: Cross sections at Lower Van Trump were first surveyed in 2006. The profile to the right is from Section 1, the most downstream cross section at Lower Van Trump henpin. Both of the active channels for the Nisqually River and Van Trump flowed near the Nisqually-Paradise road (right bank), between station 130 – 150 m.

2006: During a September 29, 2006 storm, debris flow deposition occurred in the vicinity of Cross Section 1. The figure to the right shows the influx of sediment from the debris flow (green) and some slight incision (red) that occurred. The Nisqually River was forced into the left bank (between stations 4540 m).

2008: On November 12, 2008 a ~14 year RI storm impacted Mount Rainier and lead to local flooding. During the flood, the Nisqually River flowed into the left bank and initiated a landslide through the cross section (green). Significant incision (red) was observed throughout the profile. Incision may be due to overtopping of the temporary landslide dam.

2012: Since 2006, very few floods have impacted the reach. However, the river (the active channel is between station 80 – 150 m) has been actively cutting laterally into the 2006 debris flow deposit and aggrading vertically. The river also is at a similar elevation compared to the initial cross section profile in 2006.

LiDAR Results

2008 LiDAR Hillshade

2012 LiDAR Hillshade

Repeated LiDAR flights in 2008 and 2012 showed the 2008 landslide in great detail. Because both LiDAR data sets were of similar resolutions and the volume of the landslide and its corresponding deposit in the channel were calculated from the LiDAR data. Some material was eroded and likely carried downstream.

LiDAR Differencing: 2012 bare earth minus 2008 bare earth

Analysis from subtracting the 2012 LiDAR data set from the 2008 LiDAR data set shows zones of incision and erosion. Zone "A" is the 2001-2006 debris flow fan; Zone "B" is the 2008 landslide scar; Zone "C" is the 2008 landslide deposit; Zone "D" is aggradation upstream of the debris flow blockage; Zone "E" is incision and head-cutting through and downstream of the landslide; and Zone "F" is aggradation of material from the landslide fan and eddying that occurred behind the deposit.

VI. Discussion and Findings

The key findings of this work include:

- The study area has been impacted by numerous debris flows between 2001-2006.
- The study area was impacted by a ~20,000 m³ landslide in 2008.
- Given the character of the source region (see photo, below left), it should be expected that future debris flows will impact the study area.
- The channel response here is unique because of the input of debris flows, landslides, and aggraded fluvial materials.
- This channel response impacts park infrastructure.
- Hoffman and Gabet (2007) described a stream that was impacted by debris flows in Montana and its response over time. Our study area exhibits similar channel response to that described by Hoffman and Gabet (see figure, below right):
- Channel response to sediment inputs has affected all areas in the study reach, including aggradation upstream in response to sediment fans and incision, and mobilization of material as the river attempts to dynamically adjust to sediment input.
- The total input of sediment here is estimated at approximately 398,000 m³, of which, 375,000 m³ is related to debris flows. The other 20,000 m³ is related to the 2008 landslide deposit.

Above: Some area of the 2001-2006 van Trump debris flows. This area has been recently degraded and is now exposed and mass. Note, dark stone of sediment and mass source from debris flow.

Above: Figure from Hoffman and Gabet (2007) showing the response of an incised channel profile following sediment input from a debris flow (the area we extract).

VII. Conclusions

This study shows the unique fluvial response of the Nisqually River and Van Trump Creek to repeated debris flows and a landslide. A surfeit of sediment is available in the Van Trump watershed to be provided as future debris flows for the reach. The active channels of the rivers in the study area have shifted from the right bank to the left bank, which has the unusual shortterm benefit of protecting a primary park road. However, in doing that, the river flowed into the bank of a steep hillslope above and led to the initiation of a landslide during a rain event. This led to the complete blockage of the channel for a very short time. Water pooling up behind the landslide caused aggradation of the river bed. When the pool height finally exceeded the landslide blockage, water flows led to the development of a deeply incised and headcut channel where the Nisqually River currently flows. Subsequent river incision and lateral migration has partially mobilization the 2001-2006 debris flow deposits. All of this sediment is being fluvially reworked and will impact park infrastructure in the next decade to century.

The channel response in this location is extremely dynamic and driven by the massive sediment loads introduced into the reach by debris flows, fluvial aggradation, and landslides. The channel response here is similar to debris flow deposition and fluvial reworking in Montana (Hoffman and Gabet, 2007). Given current glacier recession and forecasted climate impacts in the next century, this reach is likely to be impacted by sediment coming on line in the upper basin and moving downstream in pulse events.

Left: Aerial view of the study area. Note the active channel is between station 80 – 150 m. Also note the debris flow deposit (dark gray) and the Nisqually River flows from bottom to top (van Trump Creek enters from the right). Both rivers are actively reworking the debris flow deposit.

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Poster 124-11 (Booth #138)

Discharge Measurements

2013 GTIP Amy Rutz (left)
2013 GTIP Greg Stott (right)

2012 GTIP William Baur

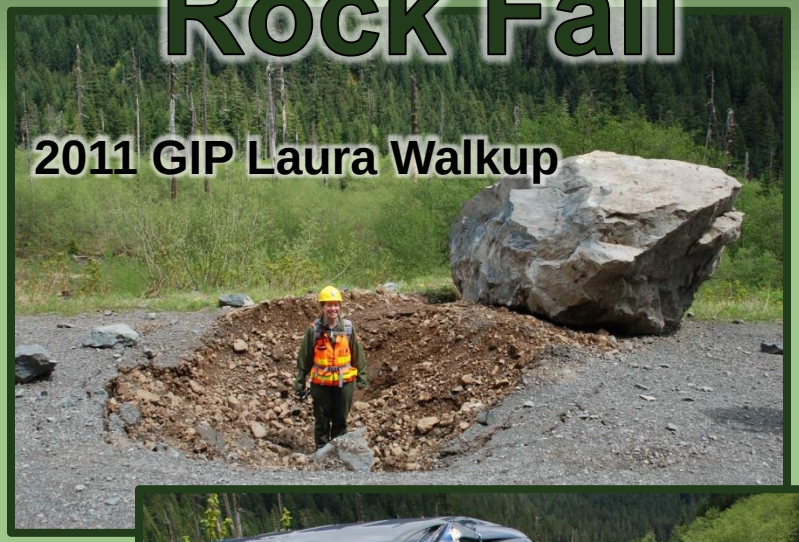
Photos: Scott Beason

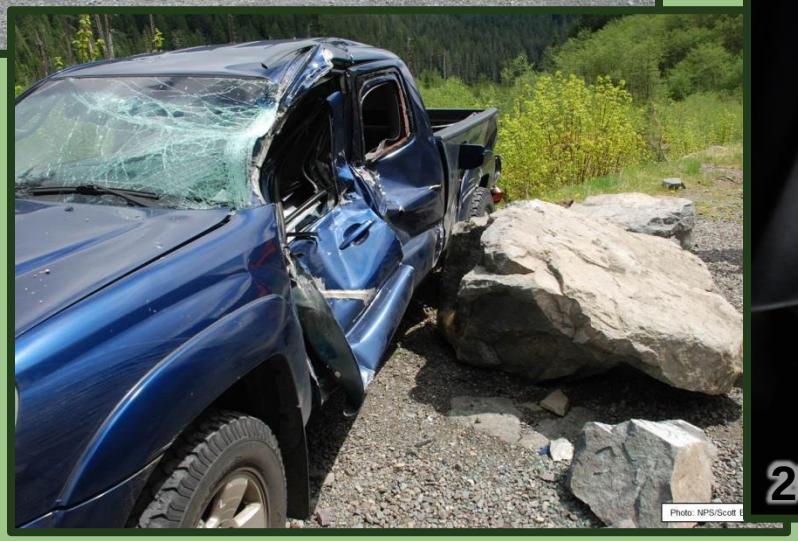
Discharge Measurement Products

Water Data Reports (all in review)

Mt. Wow Rock Fall

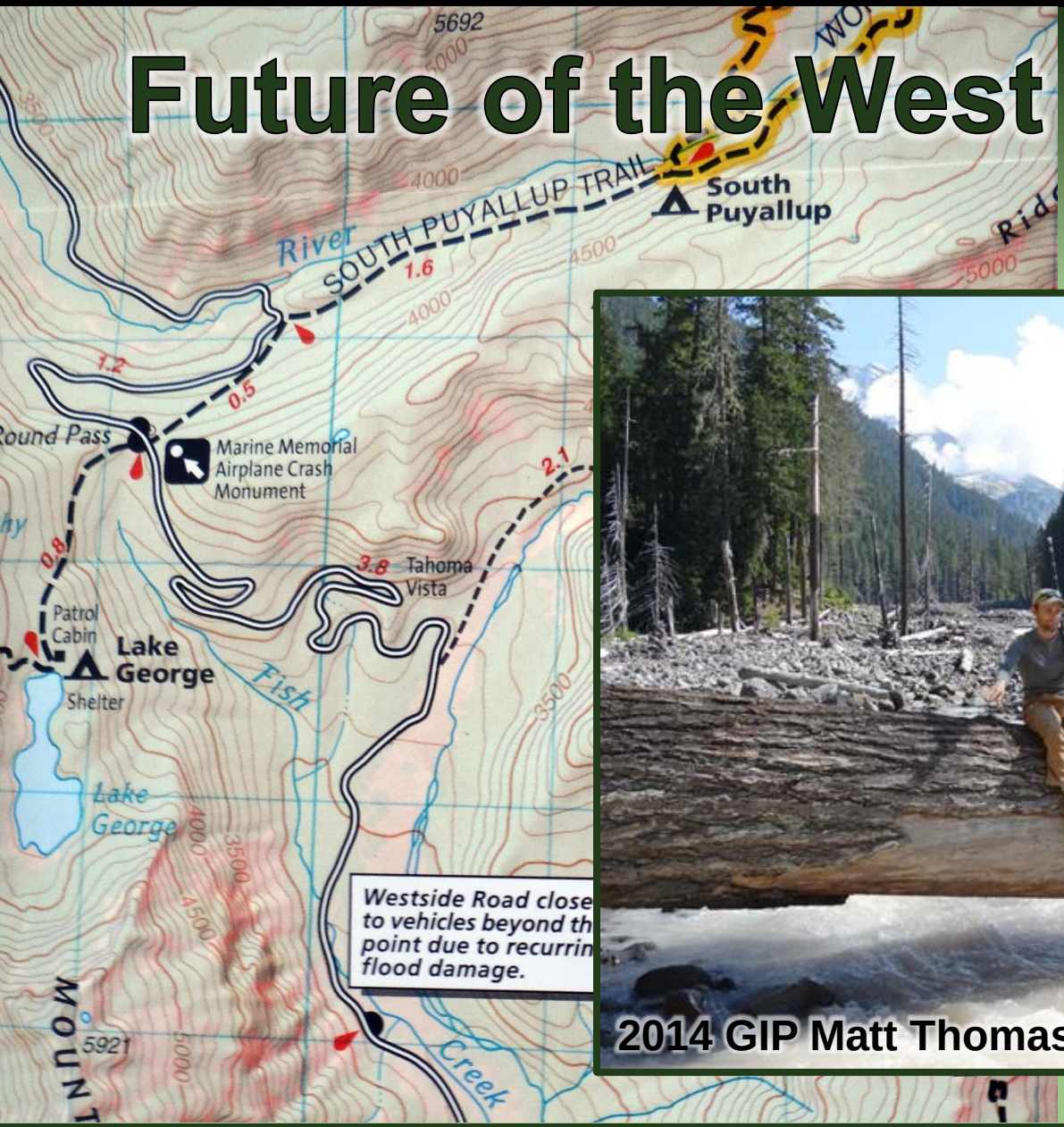
Mt. Wow Rock Fall





All Photos: Scott Beason

Future of the West Side Road



2014 GIP Matt Thomas

Photo: Theresa Schwartz

National Park Service
U.S. Department of the Interior

Pacific West Region – Mount Rainier National Park

Leveraging anecdotal, topographic, and hydrologic insights to identify challenges in managing the Westside Road, Mount Rainier National Park, Washington State

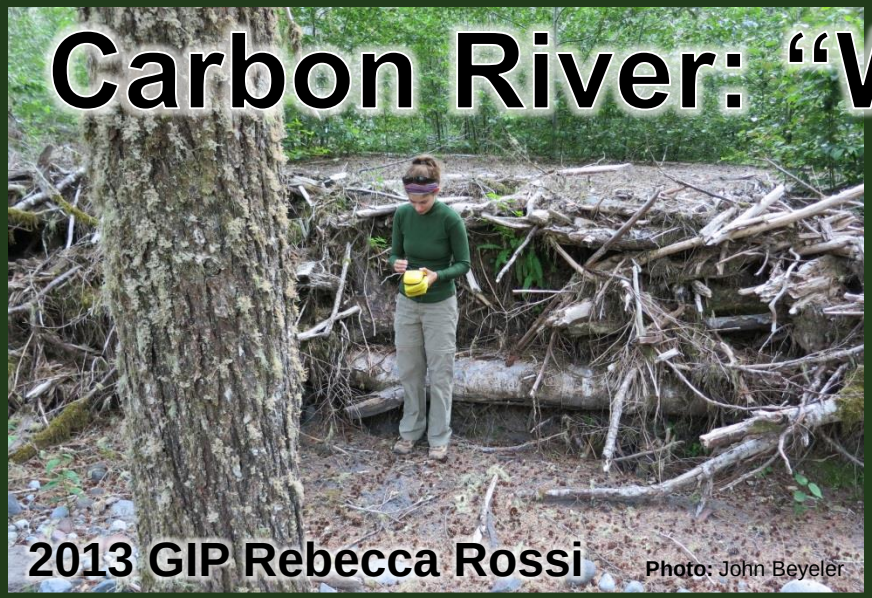
Intern
Matthew A. Thomas, GeoCorps / GIP - Geomorphology Technician (#2014049)

Supervisor
Paul Kennard, Regional Geomorphologist

Project Timeline
7.14.2014 to 10.3.2014

Presented to Mount Rainier Management Team

Carbon River: "War of the Woods"



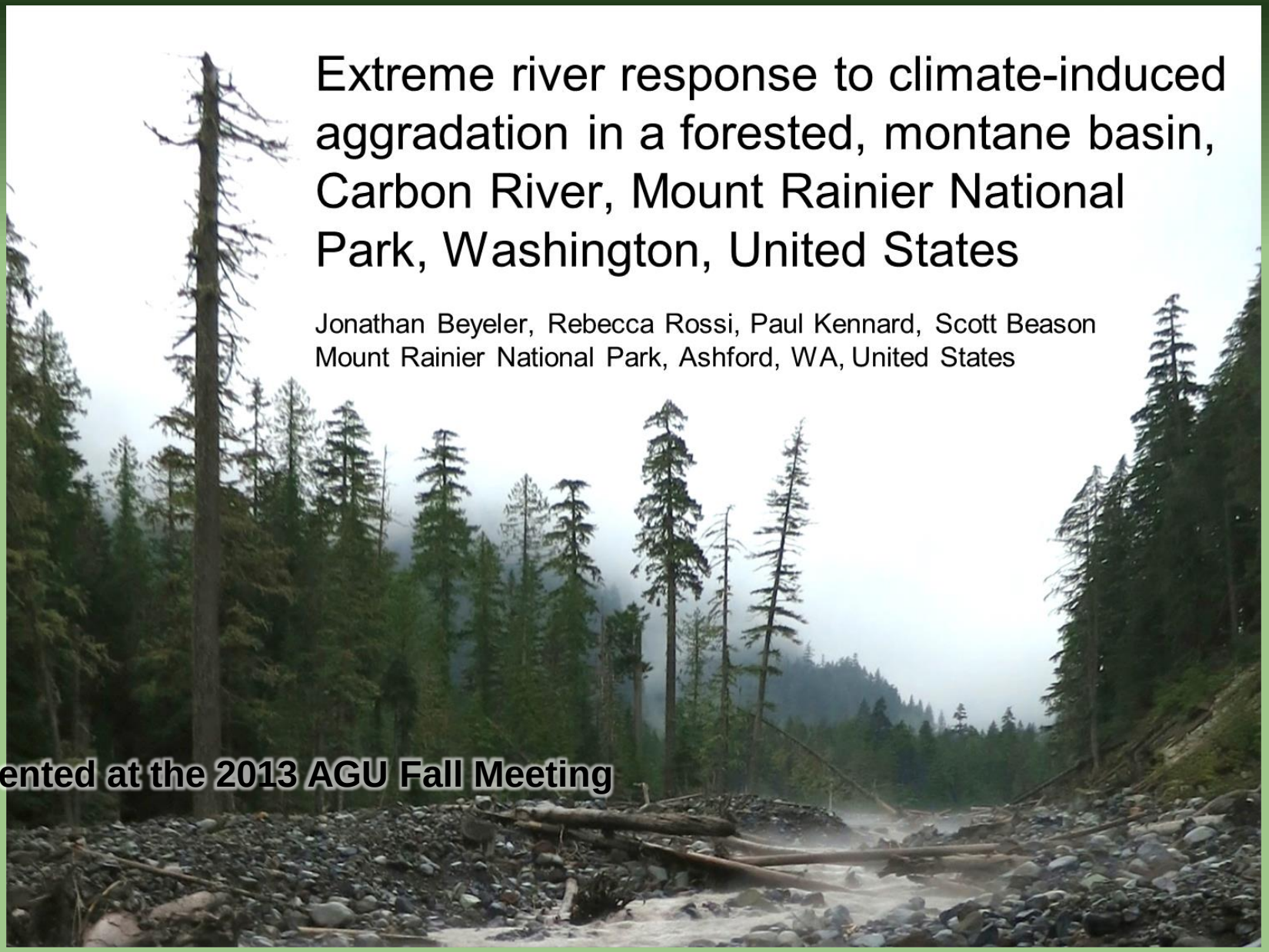
2013 GIP Rebecca Rossi

Photo: John Beyeler

Photo: John Beyeler

2013 GIP Rebecca Rossi (Left)
2013 GIP John Beyeler (Right)

Photo: Dean Koepfler, The News Tribune



Extreme river response to climate-induced aggradation in a forested, montane basin, Carbon River, Mount Rainier National Park, Washington, United States

Jonathan Beyeler, Rebecca Rossi, Paul Kennard, Scott Beason
Mount Rainier National Park, Ashford, WA, United States

Presented at the 2013 AGU Fall Meeting

Stick around for more!

Monitoring mountain lakes at Mount Rainier National Park and the North Coast and Cascades Network

GOODMAN, Arianna, et al.

I speak geology: A summer as an interpretive specialist at Mount Rainier National Park

GROSS, Benjamin M.

Photo: Scott Beason

Is the program worth it?

SUMMARY

Is the program worth it?

SUMMARY

Advantages

- Cost effective for all agencies
- Excellent experience for interns
- Easy to post a position
- The park gets highly motivated and eager-to-learn interns
- Able to select the best match for the job
- Interns contribute to scientific research

Disadvantages

- Very few disadvantages!
- Short time frame (8-12 weeks vs. 26 weeks for seasonal employees) – Mosaics and GTIPs can work longer (up to 1 year)
- Wide range of skills (undergrad through post-doc) – Not completely a bad thing!

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- **Many, many more!**

Thank You!

2012 GIP Jenna Zechmann (left) & Steve Wilson (right)

Photo: Jenna Zechmann