The impact of extreme summer flooding on river geomorphology, a meso and microscale approach, across a 200 year chronosequence in Glacier Bay, Alaska.

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Background:

Extreme rainfall events are increasing in frequency, magnitude and duration as a result of human driven climate change, causing major floods. For instance, 2012 saw the wettest summer in 100 years across much of the UK with associated significant flooding. Similar floods have been recorded across the temperate biome and are known to impact both river geomorphology and ecology. However, how these geomorphological changes respond to floods over a number of years is far less clear. Further to this, the role channel geomorphology plays in providing instream habitat complexity following flooding remains unquantified.

In South East Alaska the summer of 2014 broke a number of records associated with high precipitation and subsequently was one of the wettest summers on record. This resulted in persistent and repeated flood events across the region.

The Project:

The project aims to identify how geomorphic change, associated with the 2014 floods, varies across a four catchment chronosequence in Glacier Bay National Park. This project represents an important piece of my overall PhD research which aims to quantify the ongoing response of stream ecosystems to extreme summer flooding in Glacier Bay. The project's findings will provide important new information to river managers and policy makers across the globe with particular significance to those within the temperate biome including the UK and large parts of the USA. It is hoped that the results will guide future research and actions attempting to mitigate against species and community level impacts of flooding on freshwater ecosystems.

The committee's support facilitated a summer field season in August 2016 to Glacier Bay, Alaska (Figure 1). This expedition was a multidisciplinary collaboration between my host institution (University of Leeds) and the University of Birmingham. Over four weeks our team experienced excellent field conditions with low stream flows and good weather. Consequently we were successful in collecting a large amount of geomorphological and biotic data. However due to the time consuming nature of certain data collection methods a number of data sets targeted were not collected in the detail originally planned.

Samples collected:

- 10 full river channel cross sections were taken to map long term change in the channel structure
- 400 sediment b-axis measurements were collected to inform micro habitat availability
- >6km of instream habitat was mapped to sub metre accuracy to understand large scale habitat change
- 56 samples of macroinvertebrates and meiofauna were collected using surber samplers – predicted to contain over 10,000 individuals
- 780 juvenile salmonids (salmon, trout and char) were caught, weighed and measured
- >200 gut flushes of salmonids were made to be used for constructing provisional food webs
- 25 algal samples taken by standardised rock scrubs

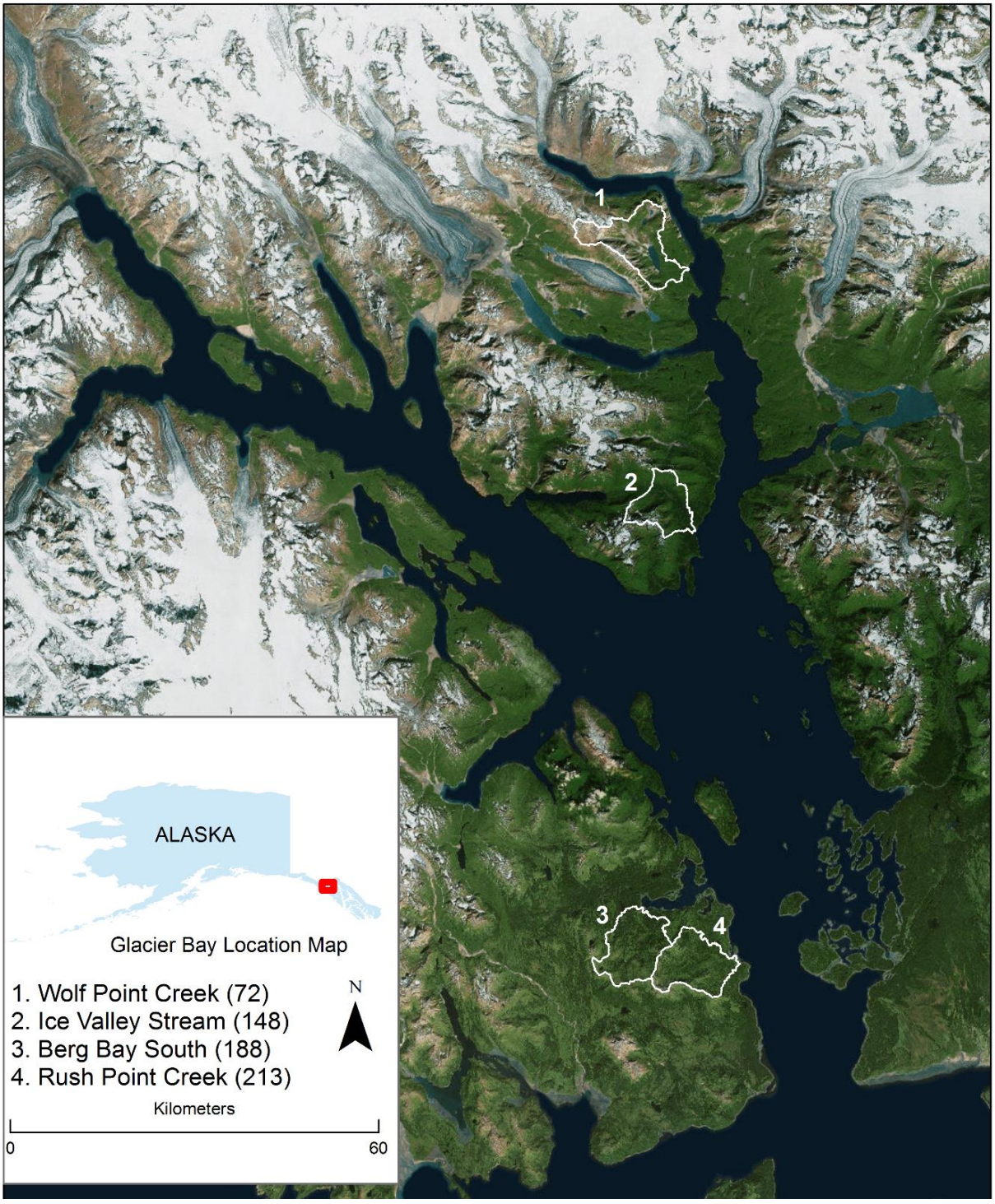

***Figure 1**. Map of Glacier Bay, Alaska. Catchments where a full complement of biotic and geomorphological data were collected (White). Catchment age in brackets. Developed from up to date satellite imagery and digital elevation models as part of the project.*

Initial data processing and next steps:

To date microhabitat availability data has been processed to produce cumulative length frequencies of sediment b axis size which initially suggests in macroinvertebrate microhabitat older sites have smaller sediment sizes when compared to younger sites (Figure 2). CGU GPS data has been post processed and maps for each site have been created (e.g. Figure 3). Further initial visual analyses of CGU diversity and relative abundances have been performed this suggests some changes when compared to previous analyses at the research rivers (Figure 4)[1].

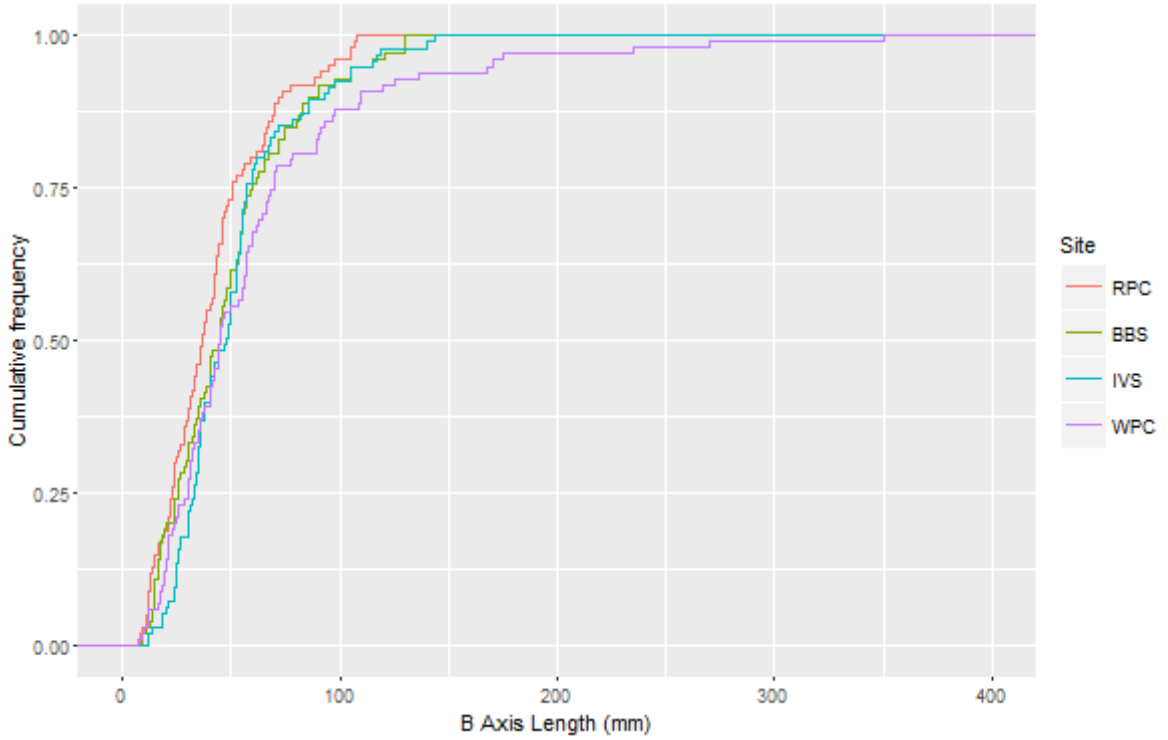

Figure 2. *Cumulative B axis length frequency plot. Demonstrating relationship between age of sites and sediment availability following flooding.*

The next priorities in data analyses are to begin comparisons with pre-flood data and to construct channel cross sections from data collected in the summer of 2016. Once this has been completed the project will be written up to form a chapter of my PhD and an academic paper focussing on geomorphological change of rivers following persistent long term flooding, it is proposed that this analyses will also incorporate historical data associated with a high magnitude short term flood which occurred in the region in 2005

Expenditure:

The full amount of funds provided by the British Society for Geomorphology were used to cover transport costs in South East Alaska.

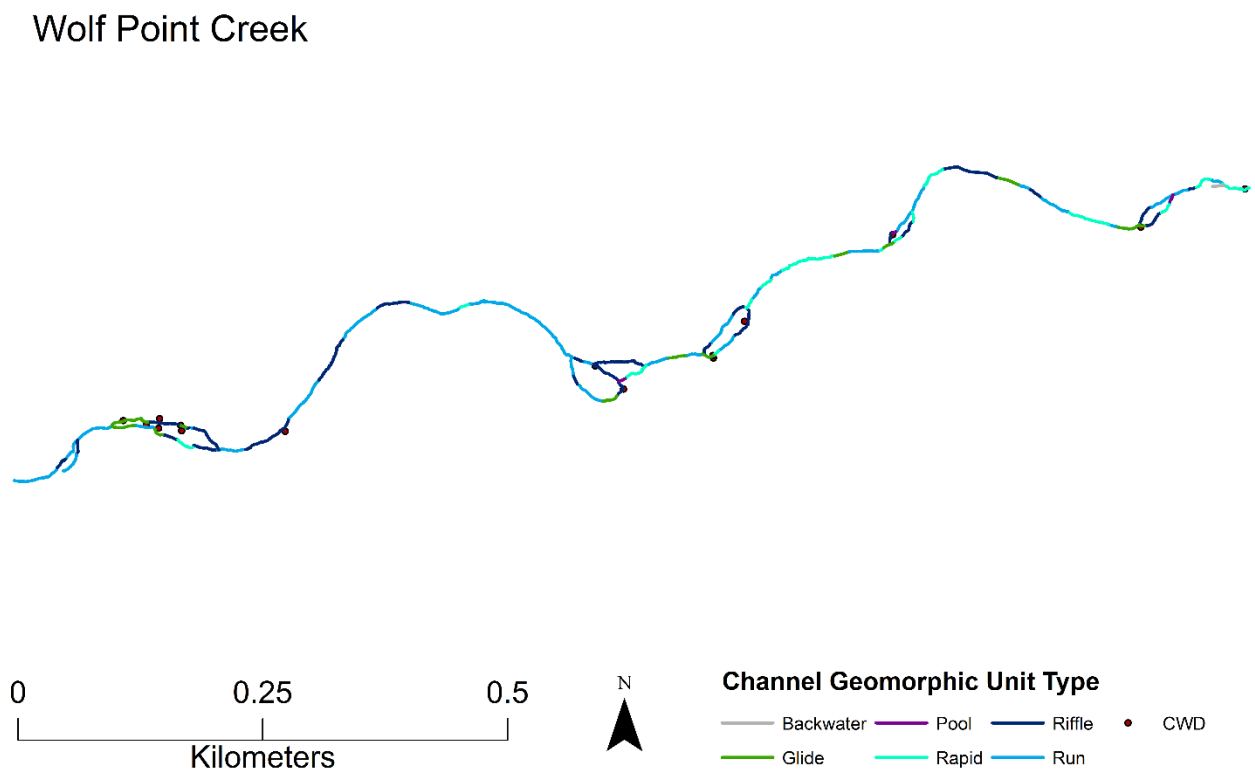

Figure 3. *Channel Geomorphic Unit (CGU) map of the youngest research river Wolf Point Creek.*

Engagement:

Whilst in Glacier Bay the project team was able to engage with a number of park staff. Three National Park Service employees were taken into the field with the research team and received training in a number of sampling procedures associated with freshwater geomorphological research. This included two young professionals at the start of their careers in fisheries biology. Equally all National Park Service employees who joined the research team in the field were offered talks and opportunities for discussion about the value of the work and its wider context and importance. Further to this the project produced an outreach leaflet available to all guests at National Park Service Headquarters detailing our work, its importance and where in the bay we would be working in case they were in the region during that time.

Conclusions:

To date the project has seen a number of successes including: an excellent field season where a vast amount of data was collected; engagement with NPS staff; exposure online through social media and websites; whilst a number of lay publications are currently being written. The project is on course to achieve its proposed aims.

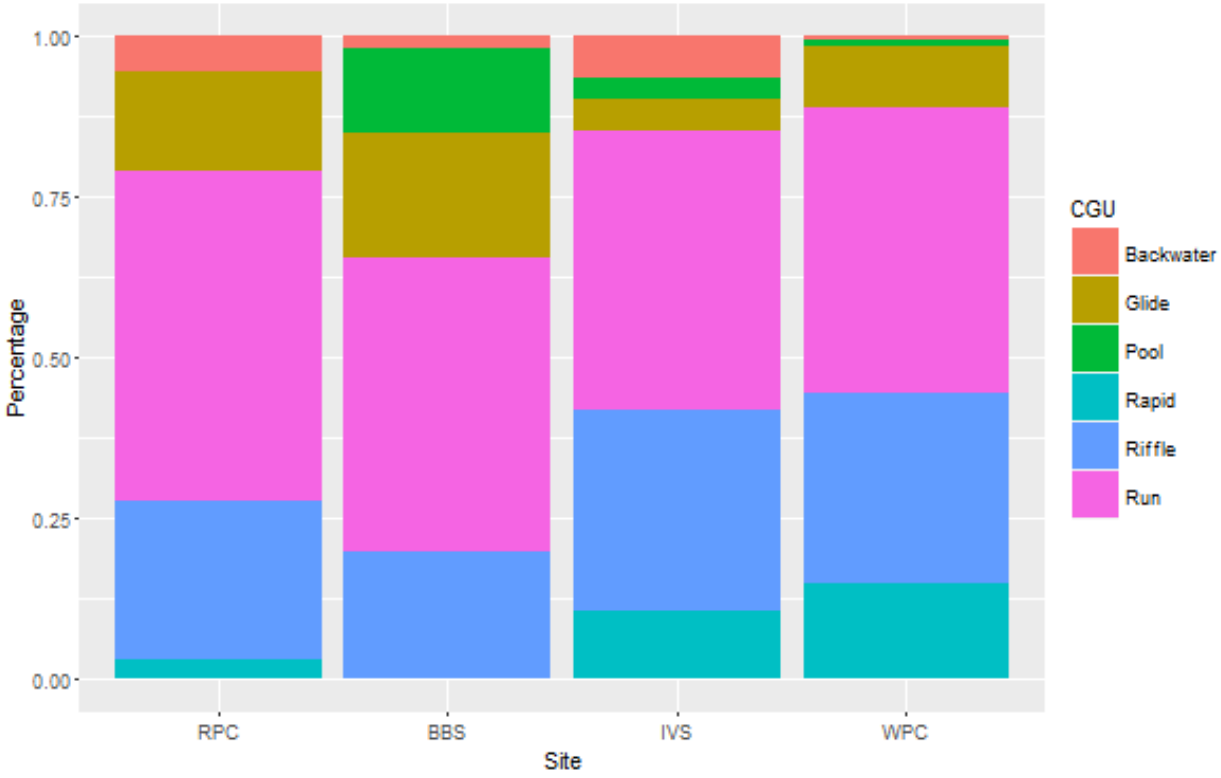

***Figure 4**. Stacked percentage bar plot of CGU's at each research river. All site's dominant CGU's are runs - whilst younger sites IVS and WPC have larger percentages of fast flow type CGU's than older sites BBS and RPC and older sites have larger contributions of slow flow CGU types than younger sites.*

References:

1 Klaar, M. J., Maddock, I. & Milner, A. M. The Development of Hydraulic and Geomorphic Complexity in Recently Formed Streams in Glacier Bay National Park, Alaska. *River Res Appl* **25**, 1331-1338 (2009).