

Long-term Synthetic Streamflow Generation

Empirical Frequency Pairing vs Chronologically Pairing

GLGY 699
November 4, 2021

1. Background
2. Case Study
3. Broader Trends
4. Summary

Background

- ▶ Long-term daily flow records are used for both engineering and environmental assessment
- ▶ Common approaches
 - ▶ Chronologically pairing (CP)
 - ▶ Empirical Frequency Pairing (EFP)
 - ▶ Scale by Drainage Area
 - ▶ Typically, only appropriate when location of interest is on the same water course and difference in watershed is less than an order of magnitude.

Background

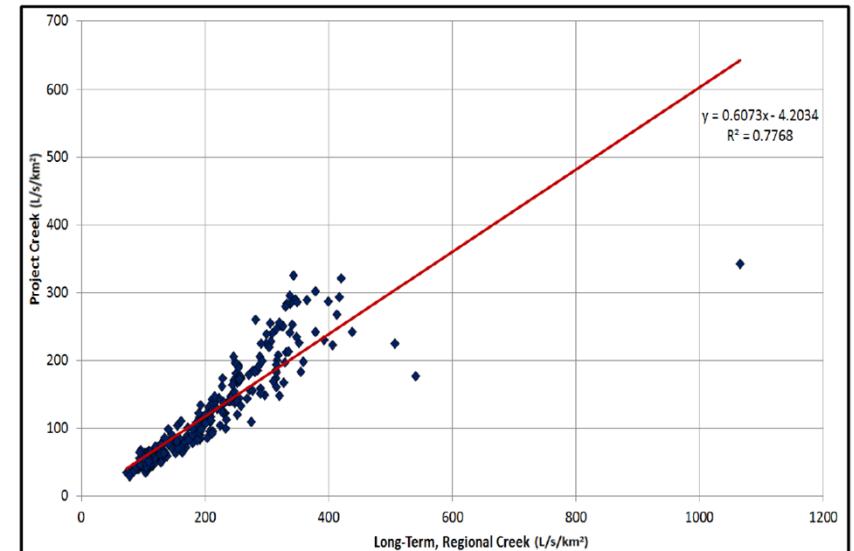
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► Chronologically Pairing (CP)

- Concurrent pairing of daily streamflow records
- Linear correlation to generate transfer functions

► Primary Assumptions

- Transfer functions are constant through time
- Past represents the future

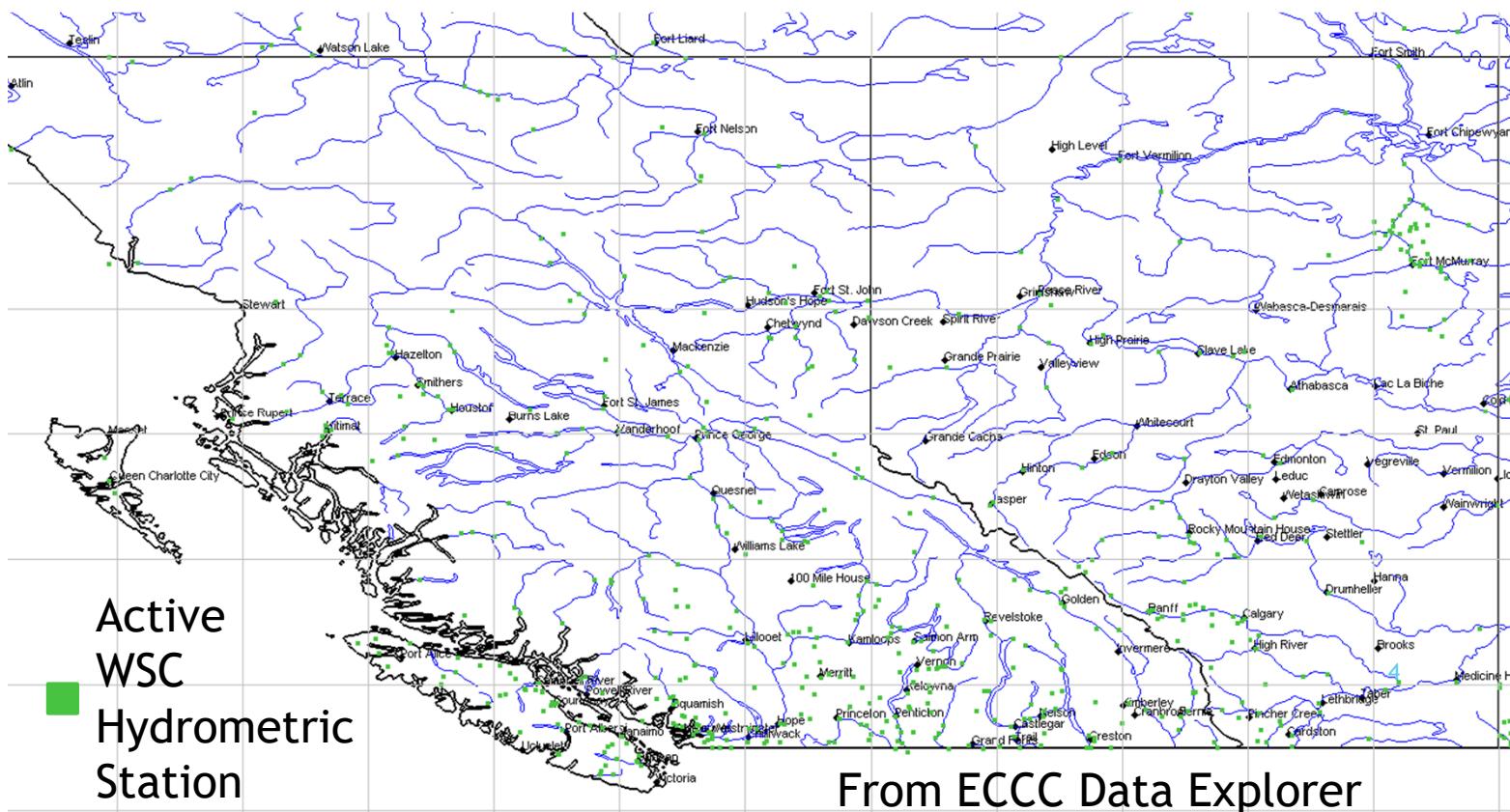


From Butt 2013

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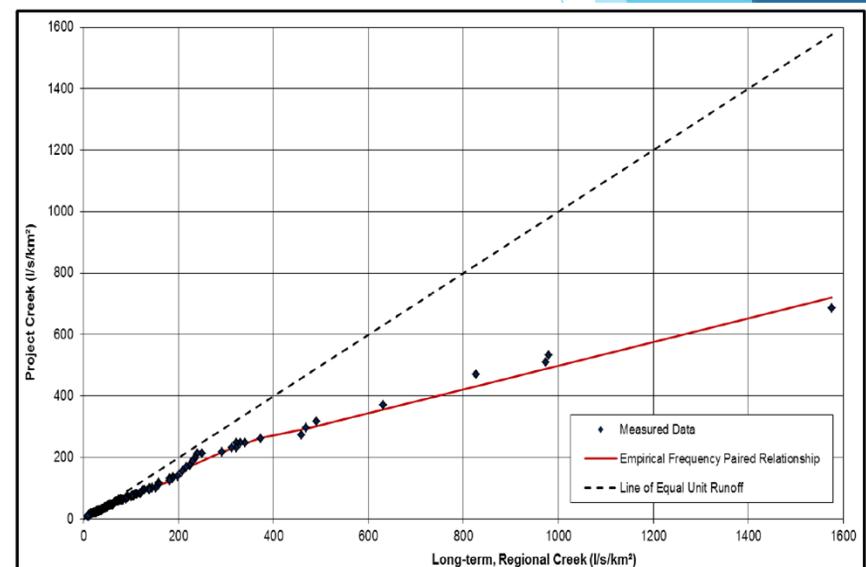
- ▶ Challenges matching hydrologic characteristics
 - ▶ Sparse regional hydrologic monitoring networks that skew towards high catchment areas
 - ▶ Relatively poor correlation of daily flows



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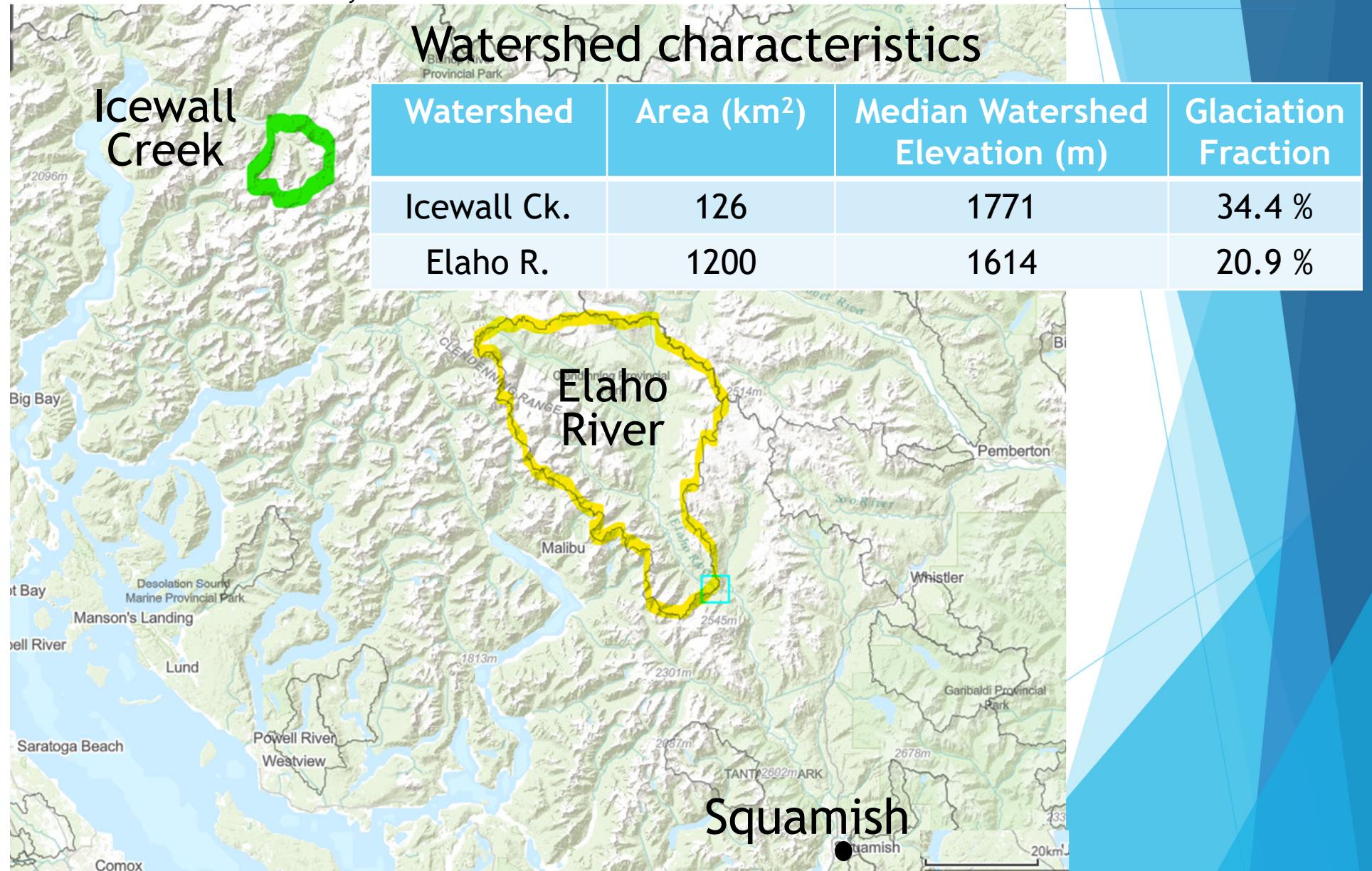
- ▶ Empirical Frequency Pairing (EFP)
 - ▶ Pair ranked concurrent daily records
 - ▶ Develop multi-step linear relationships
- ▶ Primary Assumptions
 - ▶ Frequency of the sample is representative of the population
 - ▶ Past represents the future



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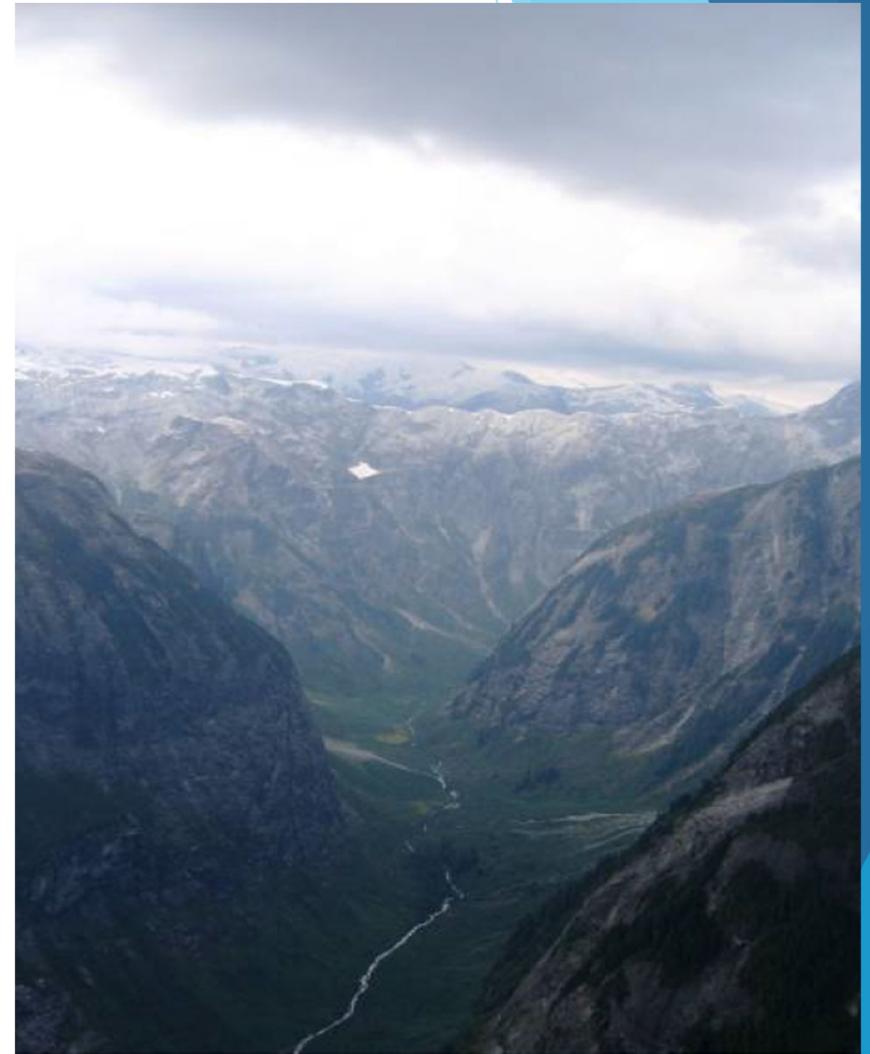
Case Study

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Case Study

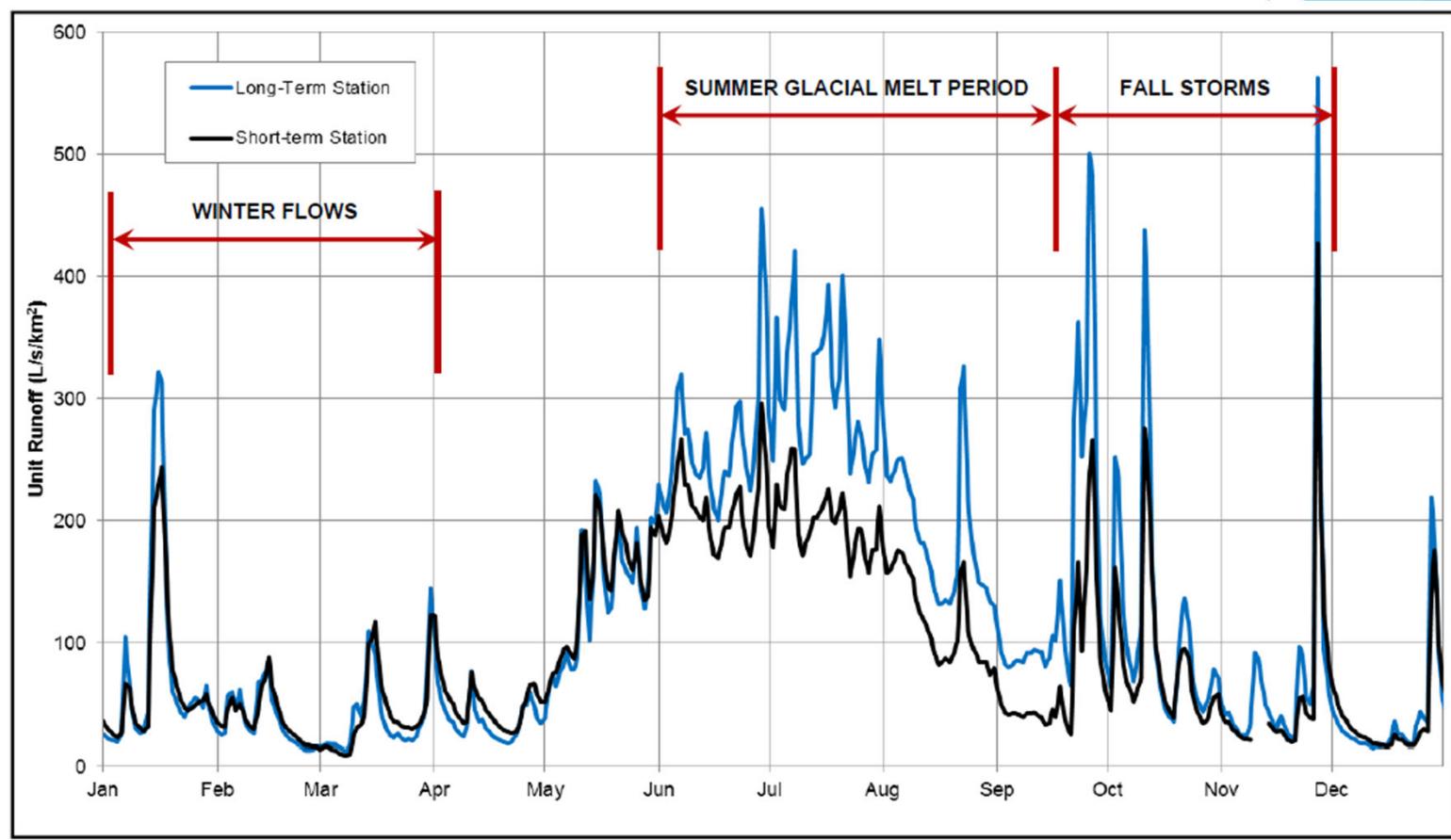
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Case Study

- ▶ Divide the annual hydrograph by process
 - ▶ Conducted on a Monthly or Seasonal Basis

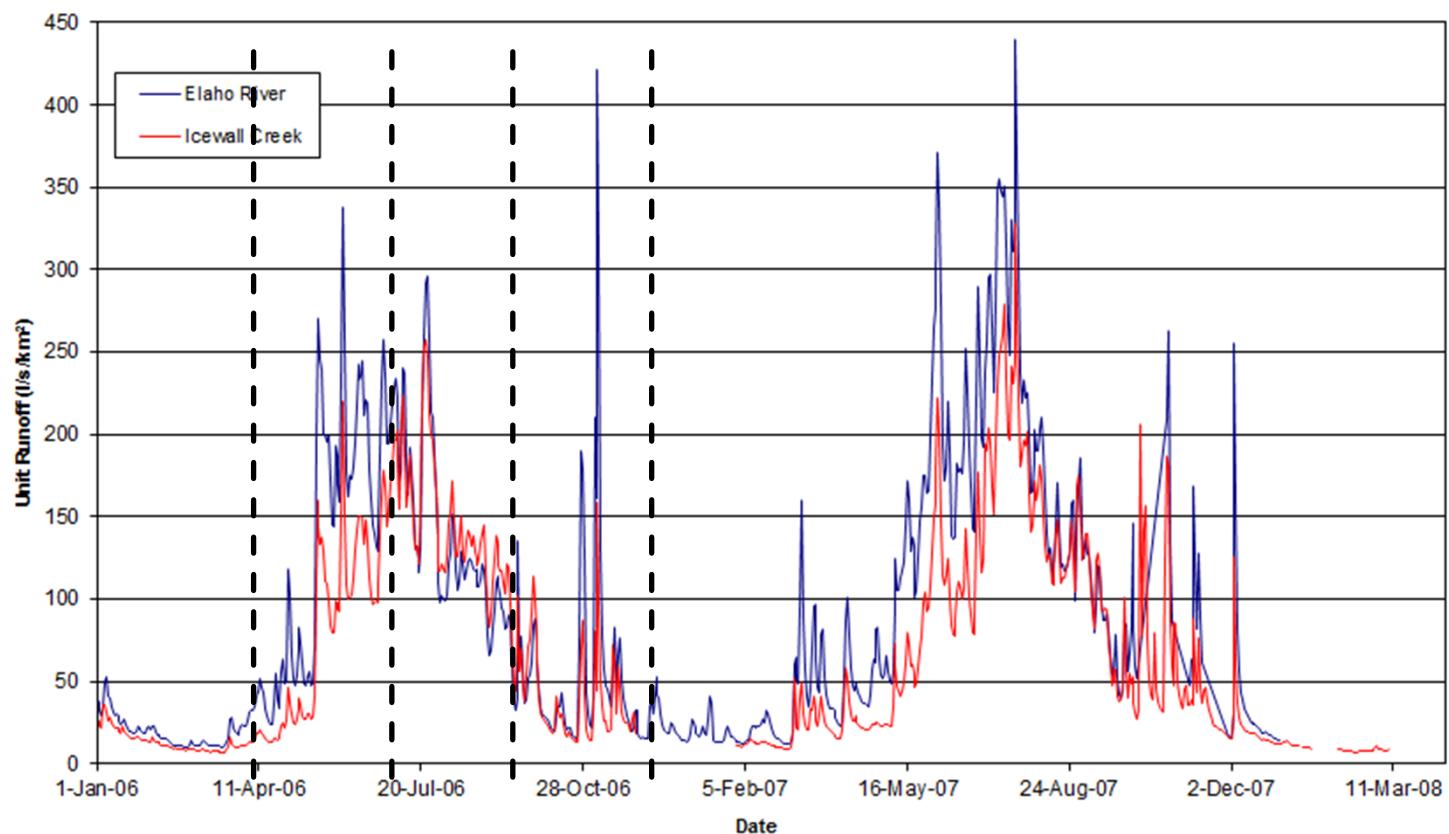


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Case Study

- ▶ Hydrographs show a high degree of correlation between watersheds.

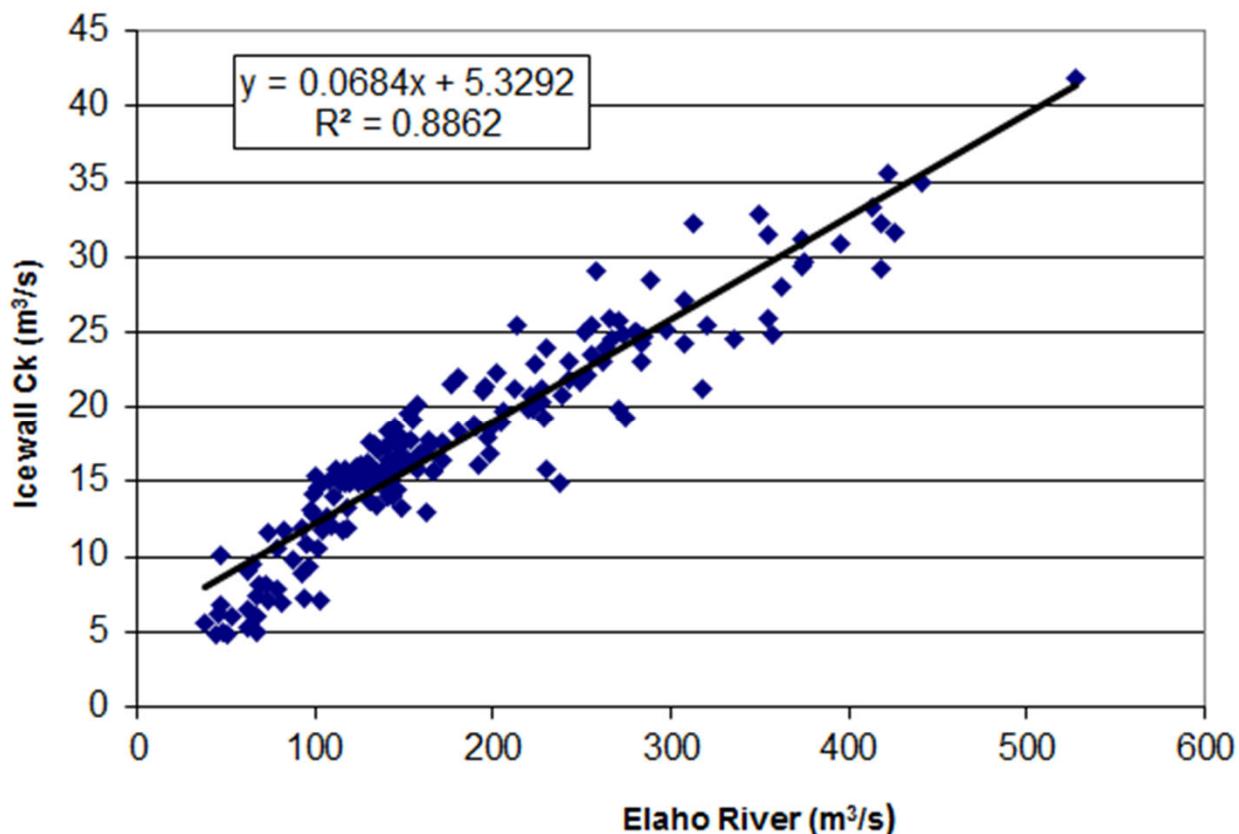


From Perkins et al 2012

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Case Study

- ▶ Glacial melt regression (July to September)
 - ▶ Regression of concurrent daily streamflow (CP)

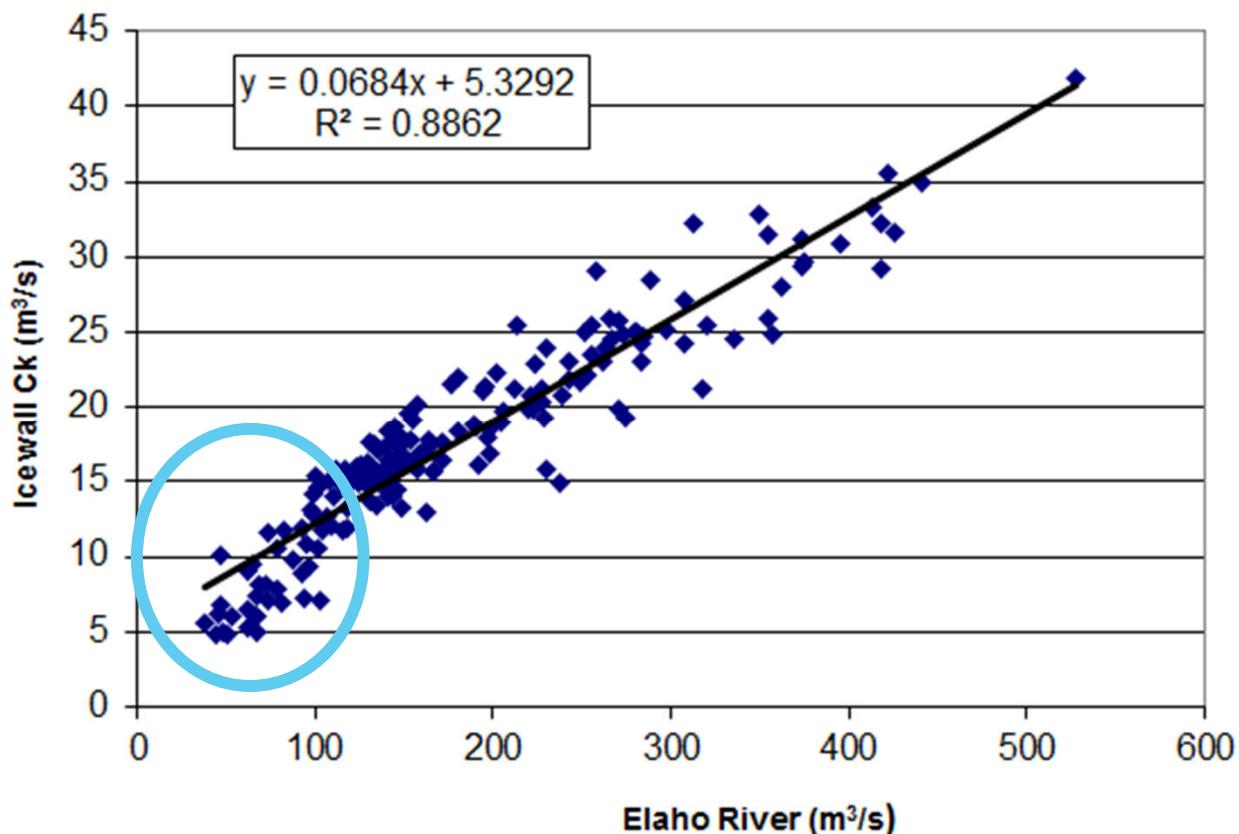


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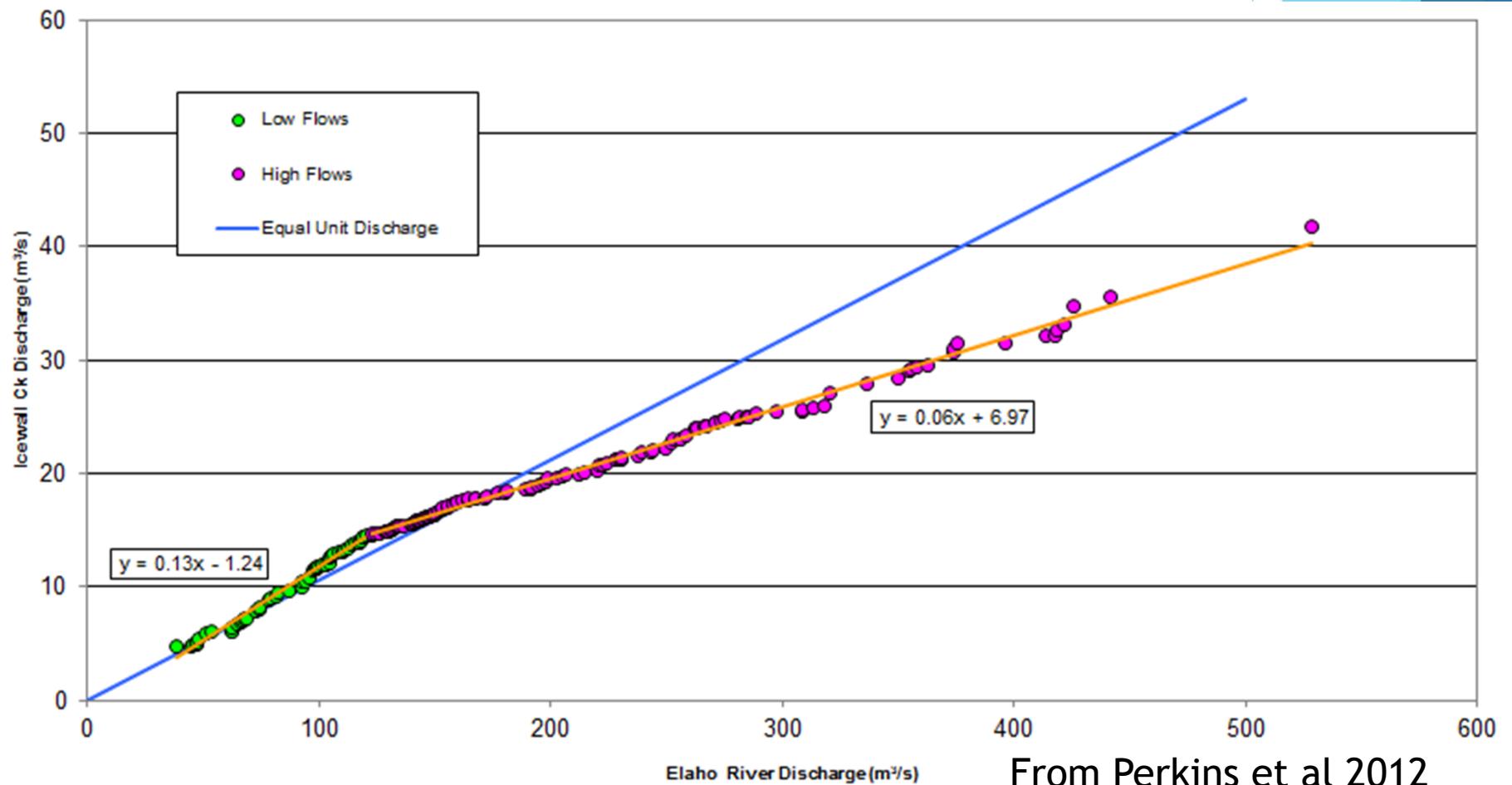


From Perkins et al 2012

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- ▶ Glacial melt regression (July to September)
 - ▶ Regression of ranked daily streamflow (EFP)

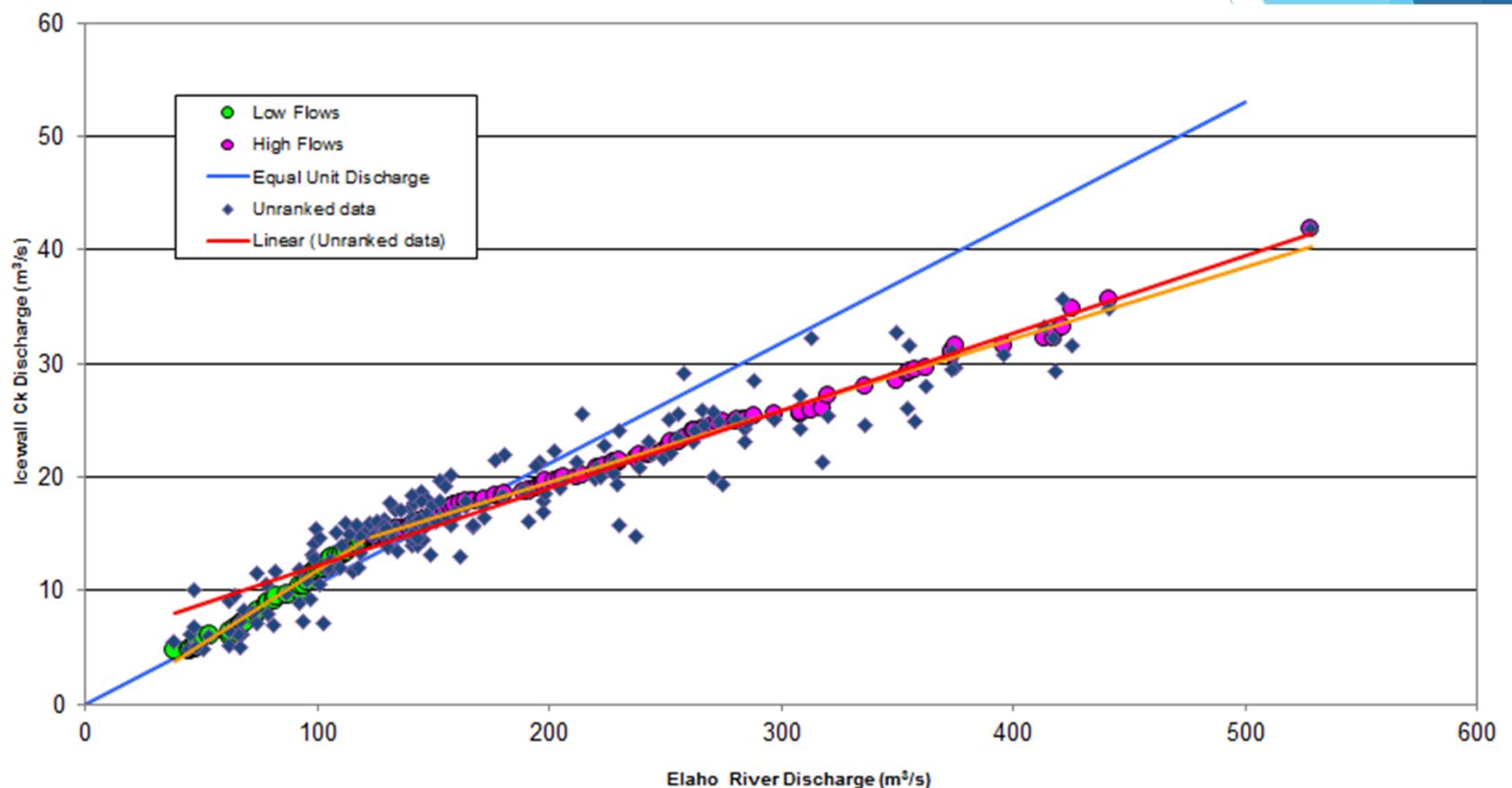


From Perkins et al 2012

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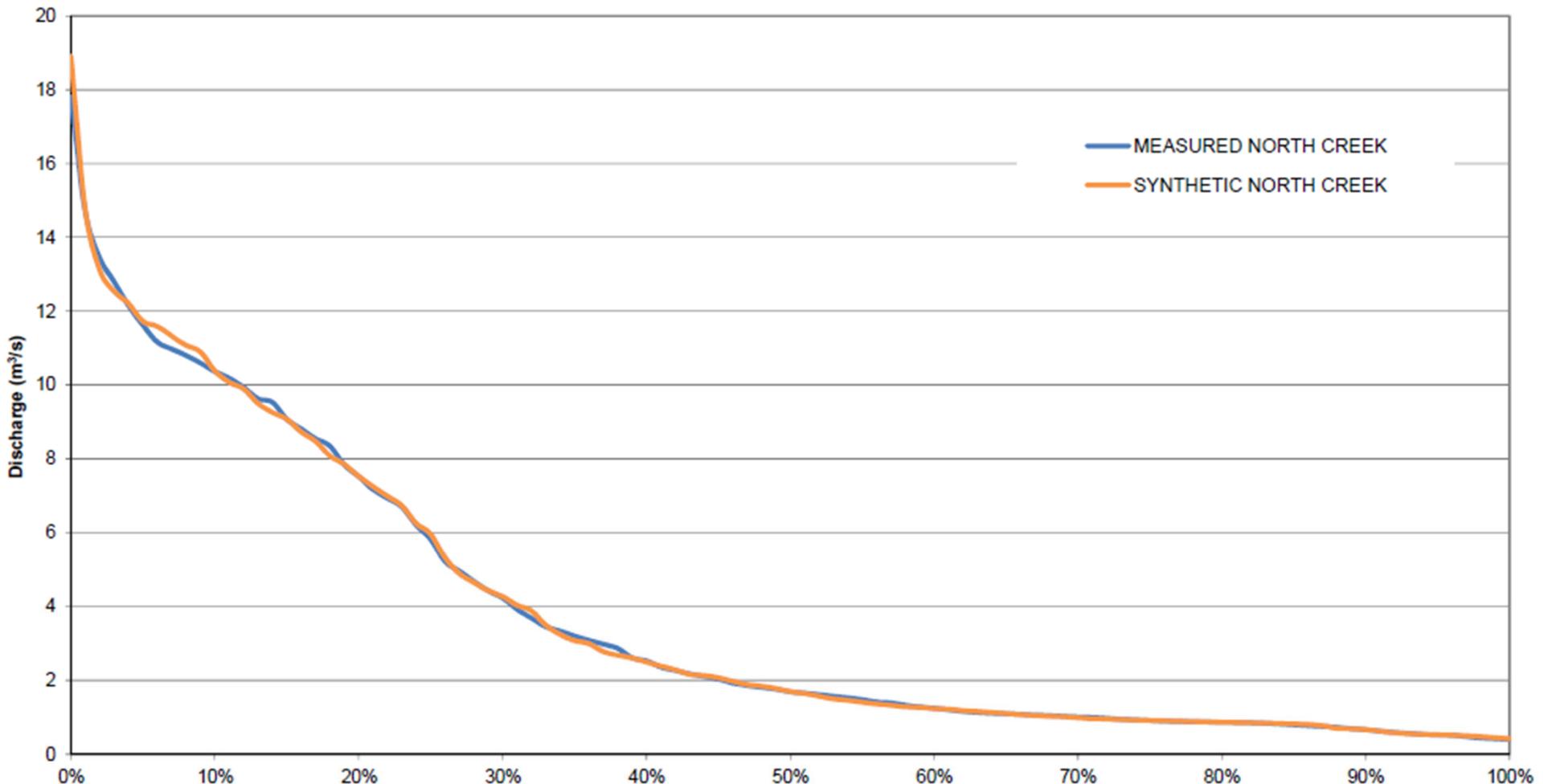
- ▶ Glacial melt regression (July to September)
 - ▶ Ranked and unranked data



From Perkins et al 2012

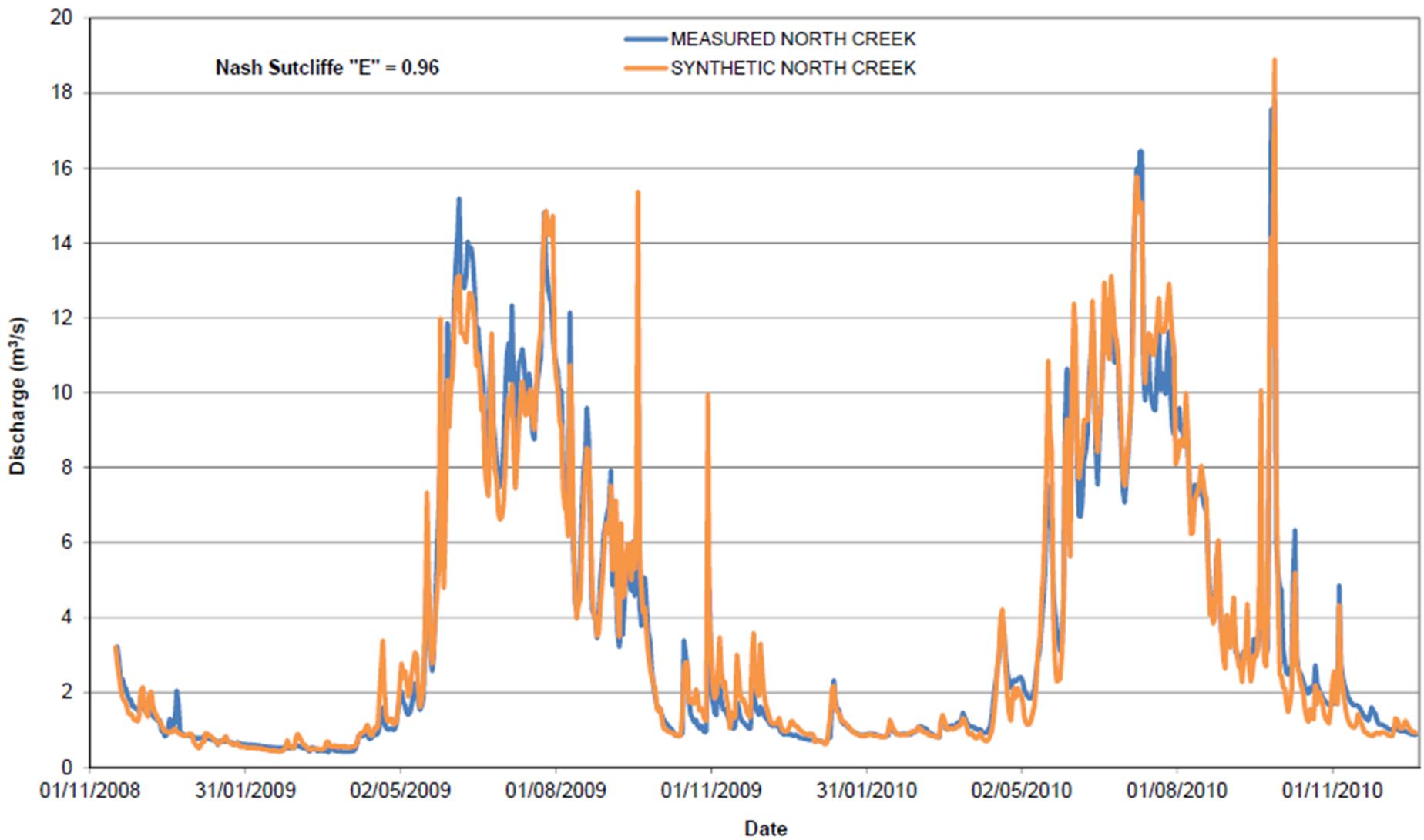
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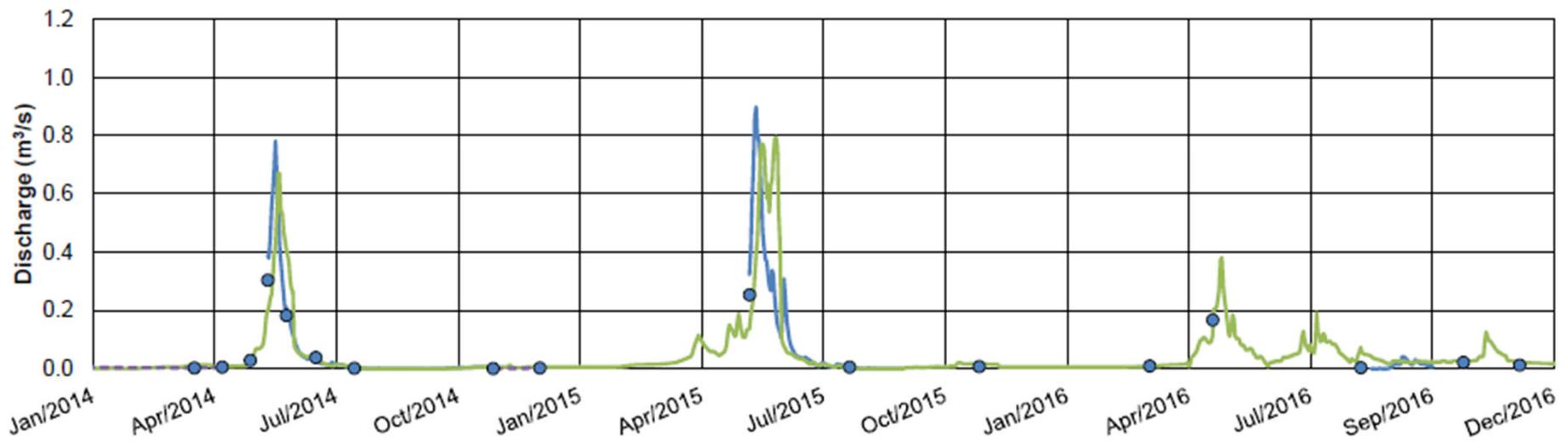
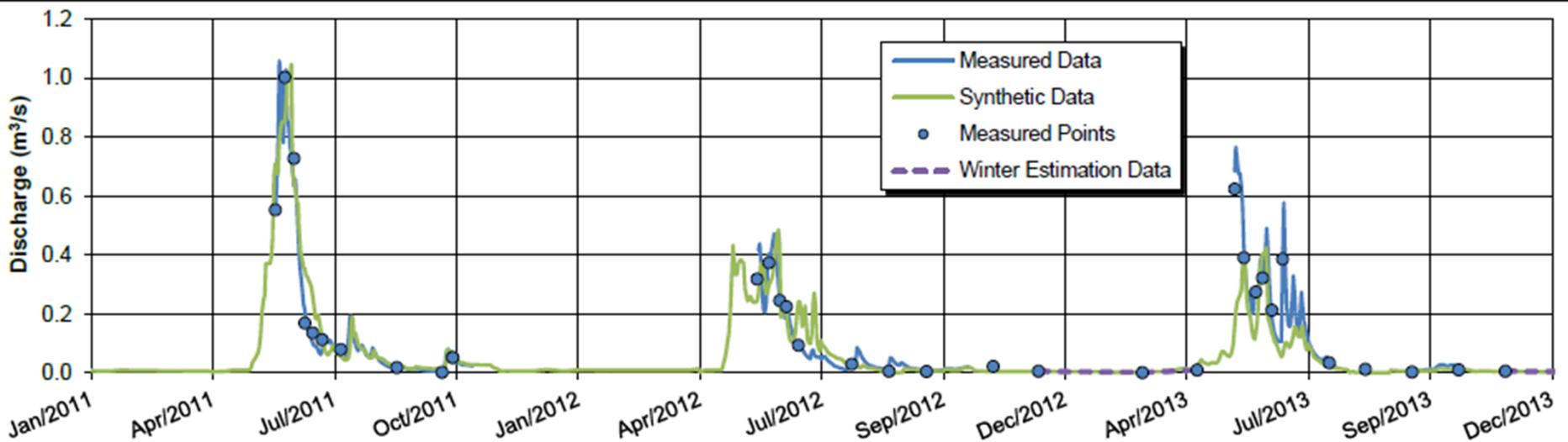
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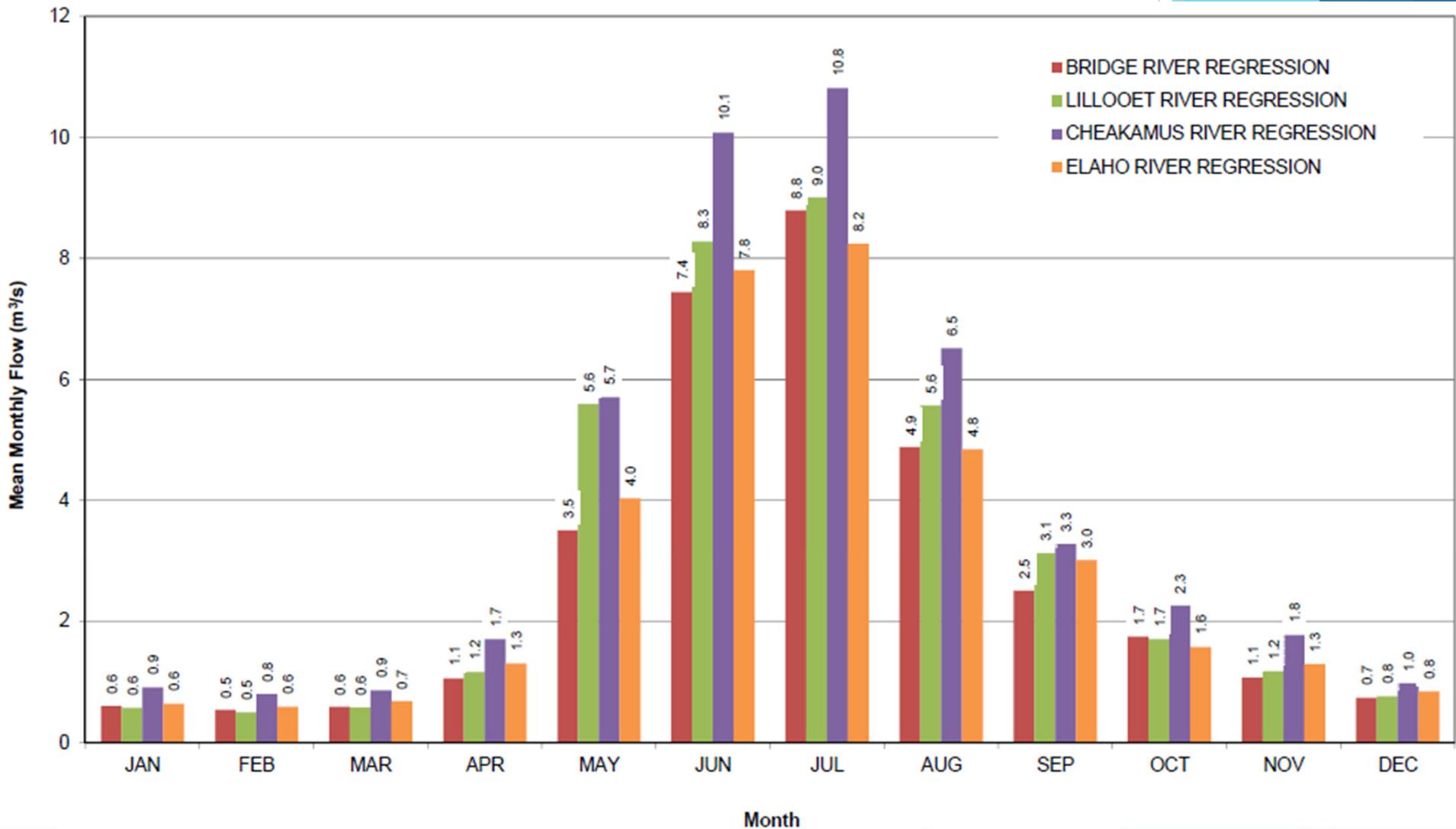
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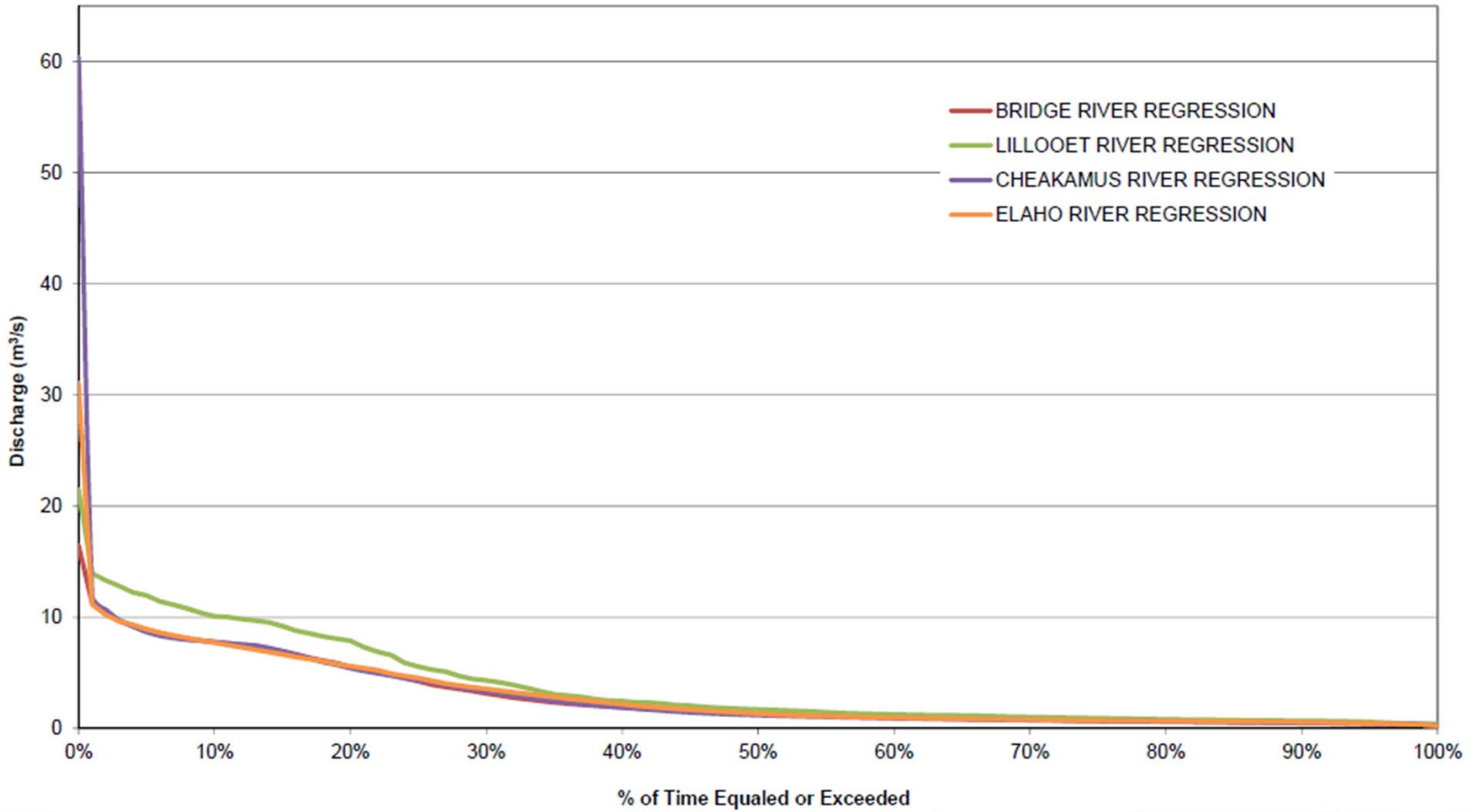
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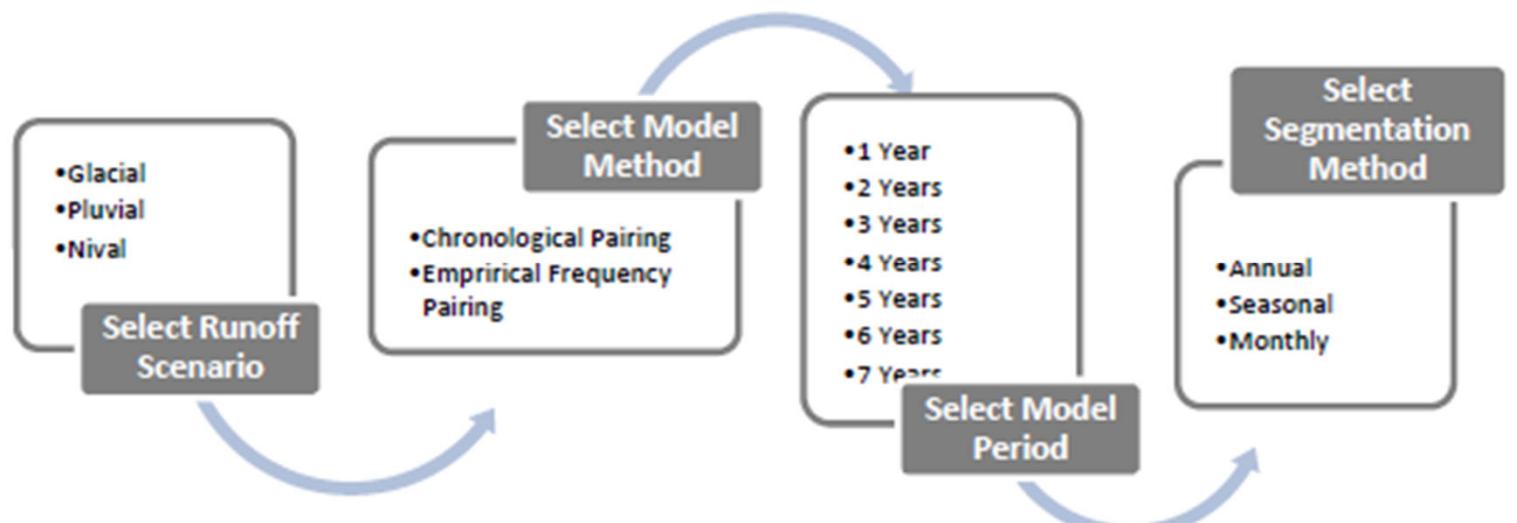
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Broader Trends

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► Butt 2013 -> Master's thesis to compare these methods across BC



► Results compared by

- Long-term flow duration curves (FDC)
- Low and high flows

Summary

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- ▶ Butt 2013 found that:
 - ▶ EFP was found to be more accurate and precise in synthesizing long-term streamflow than CP.
 - ▶ EFP was found to become more accurate with longer concurrent record, while CP provides little change over time.
- ▶ Important to establish that watersheds are hydrologically similar when using EFP
 - ▶ Correlation between the ranked datasets is not a test of hydrologic similarity
- ▶ EFP is a helpful tool to understand and interpret hydrological data
 - ▶ Improved fit between data records
 - ▶ Improved synthetic data over the range of flows (low flows through to high flows)
 - ▶ Physical assessment of trends - data quality and understanding of processes

References

- ▶ Perkins T., K. Terry, J. Cathcart, and C. Nistor. June 5 to 8 2012. Ranked regression analysis for the prediction of long-term streamflow conditions. Canadian Water Resources Association and the Canadian Geophysical Union. Banff.
- ▶ Butt C. 2013. Evaluation of the Performance of frequency and chronological pairing techniques in synthesising long-term streamflow. Masters of Applied Science. University of British Columbia.

A photograph of a rugged mountain landscape. A massive, dark rock cliff dominates the left side of the frame, its surface partially covered in patches of green moss and small trees. Below the cliff, a dense forest of coniferous trees extends towards the right. The sky is heavily overcast with thick, grey fog that hangs low, obscuring the upper slopes of the mountains and creating a somber, atmospheric scene.

Questions?