Using remote sensing to measure channel widths with application to estimating peak-flow frequencies

AWRA

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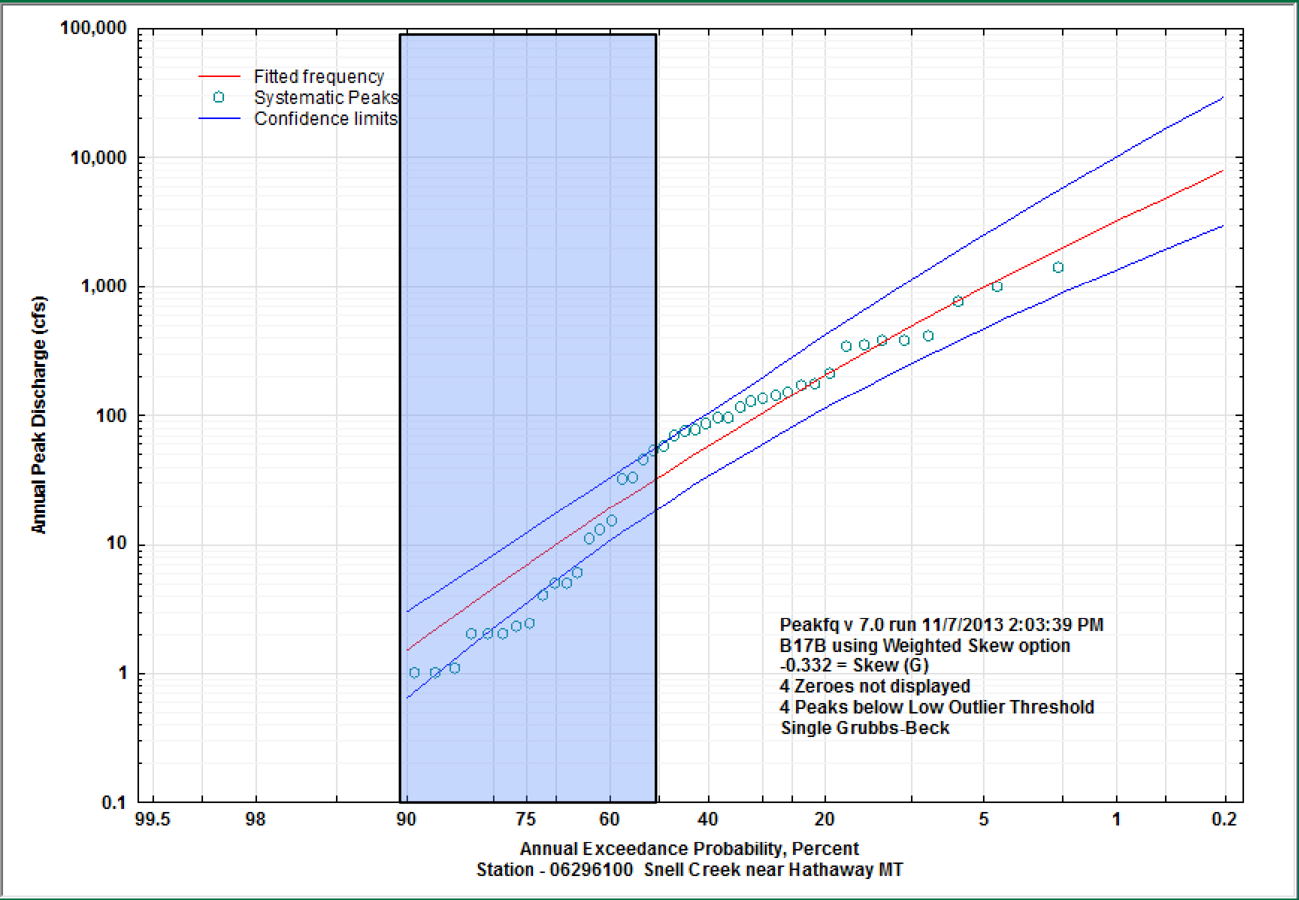
In cooperation with Montana Dept. of Transportation

Outline

- Background
- Methods
- Preliminary results
- Conclusions/Limitations

Peak-Flow Frequency Analysis

- **Annual Exceedance Probabilities (*AEP*)**
  - **a.k.a Flood frequency, X-year flood, peak-flow frequency, recurrence intervals**
- ***Q* is the streamflow discharge value associated with a given AEP.**



Commonly reported Q_{AEPs}

50% to 0.2%

(2-year to 500-year recurrence interval)

What about at stream locations that don't have gaging stations?

Methods for estimating Q_{AEPs} at ungaged locations

- **Regression analysis**
  - **Ordinary, weighted, generalized least squares**
- **Region of Influence**
- **Hydrologic models**
- **Machine learning**

Explanatory variables needed!!!!

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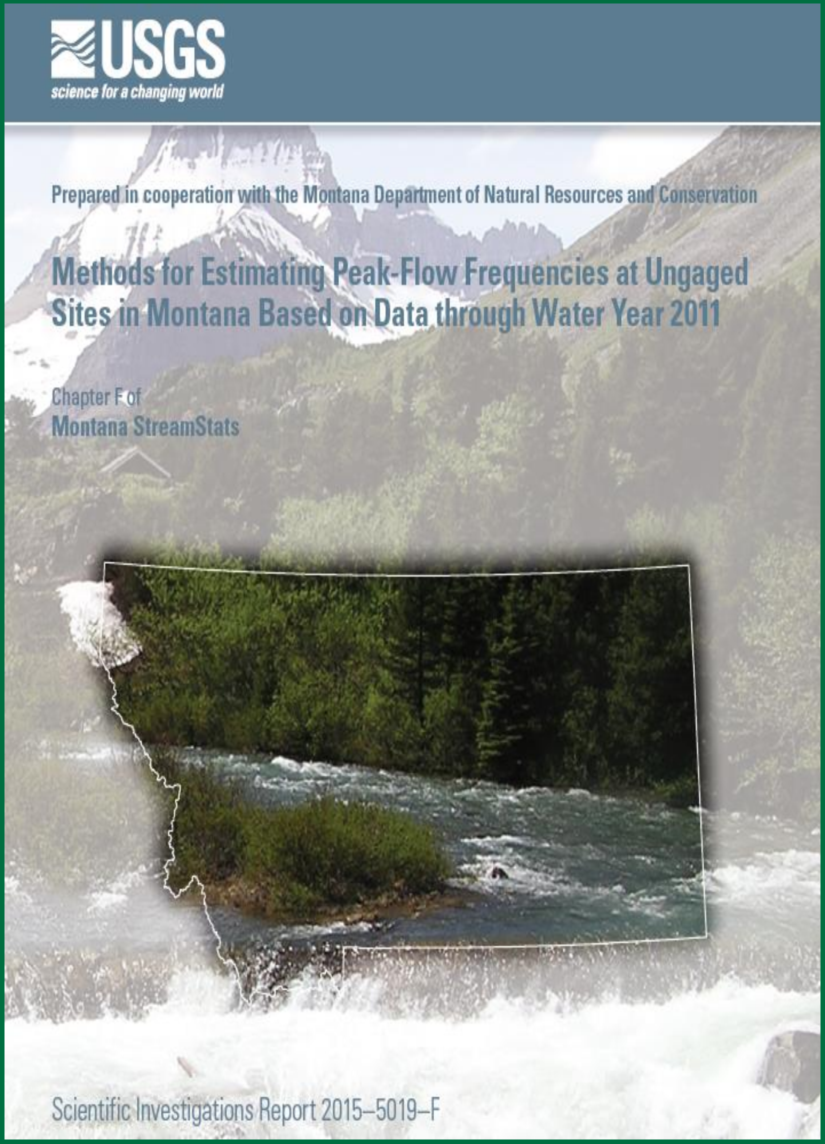
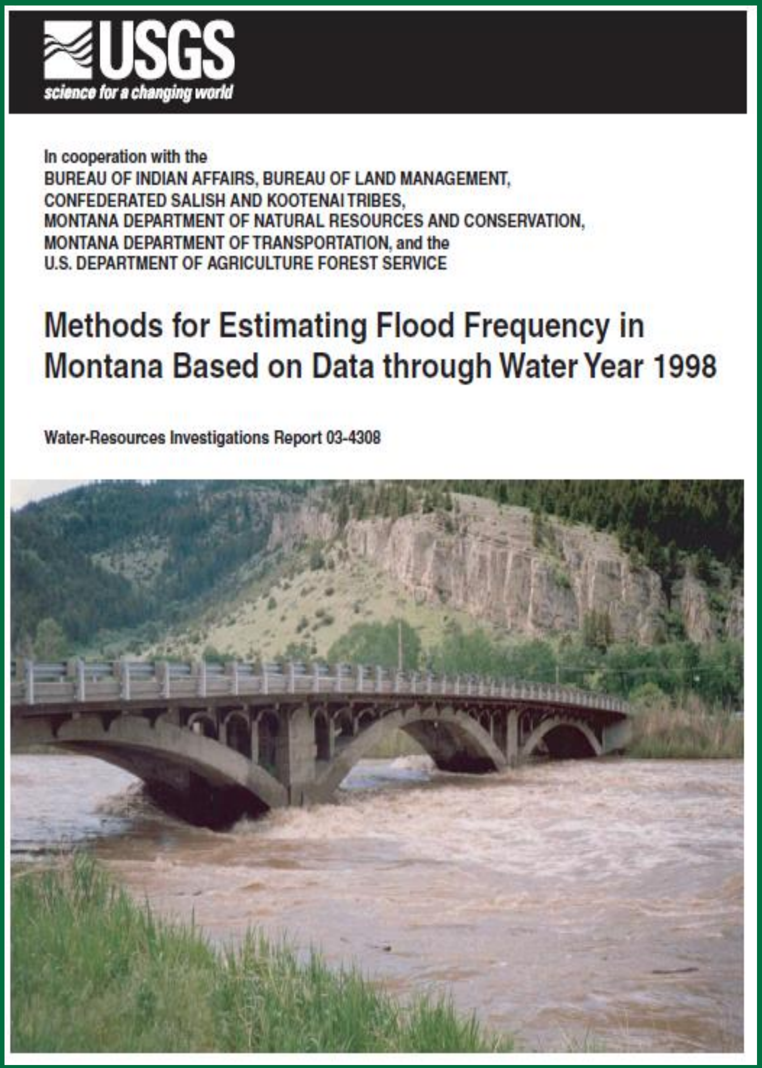
Current Regression Equations



- **Sando, Sando, McCarthy, and Dutton, 2016**
- **Regional Regression Equations based on Basin Characteristics**
- **Channel Width-data NOT included**

Previous Regression Equations



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In cooperation with the
BUREAU OF INDIAN AFFAIRS, BUREAU OF LAND MANAGEMENT,
CONFEDERATED SALISH AND KOOTENAI TRIBES,
MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION,
MONTANA DEPARTMENT OF TRANSPORTATION, and the
U.S. DEPARTMENT OF AGRICULTURE FOREST SERVICE

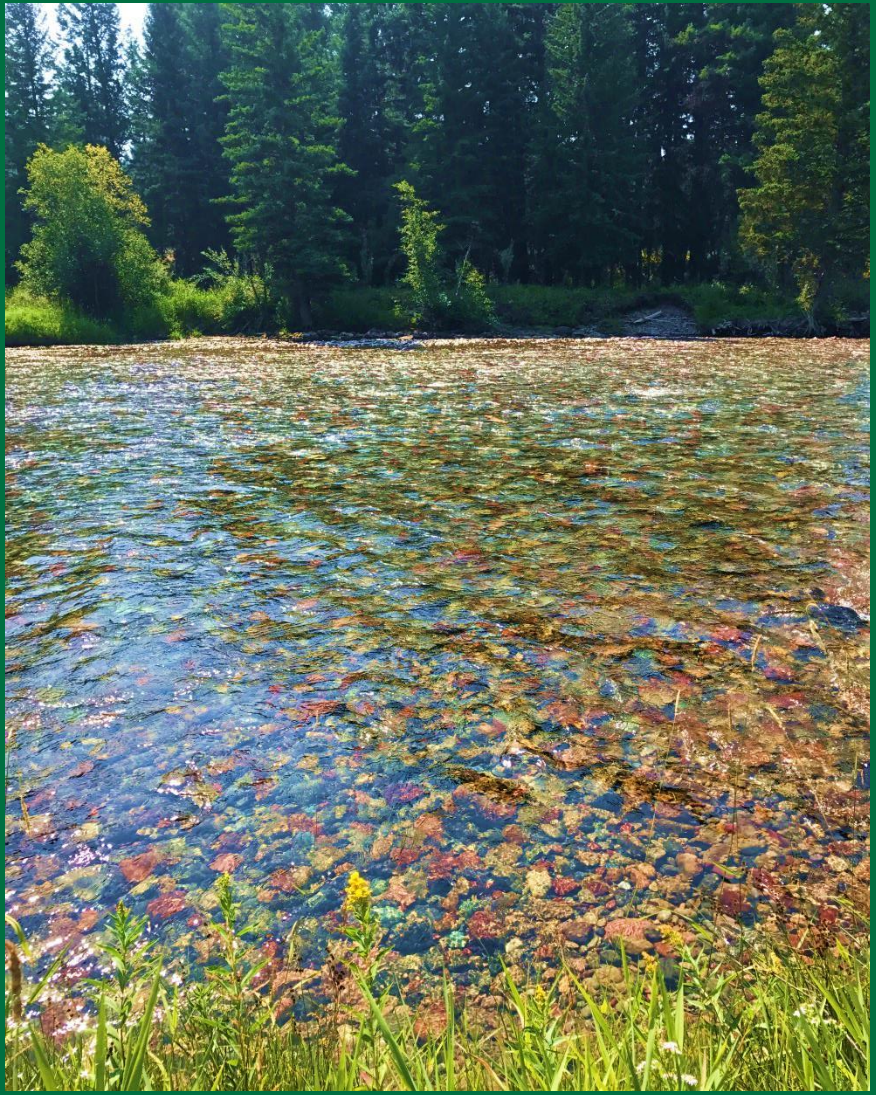
Methods for Estimating Flood Frequency in Montana Based on Data through Water Year 1998

Water-Resources Investigations Report 03-4308

- Parrett and Johnson, 2004
- Included Regression Equations based on Channel Width
- Also weighting option for basin characteristics and channel width

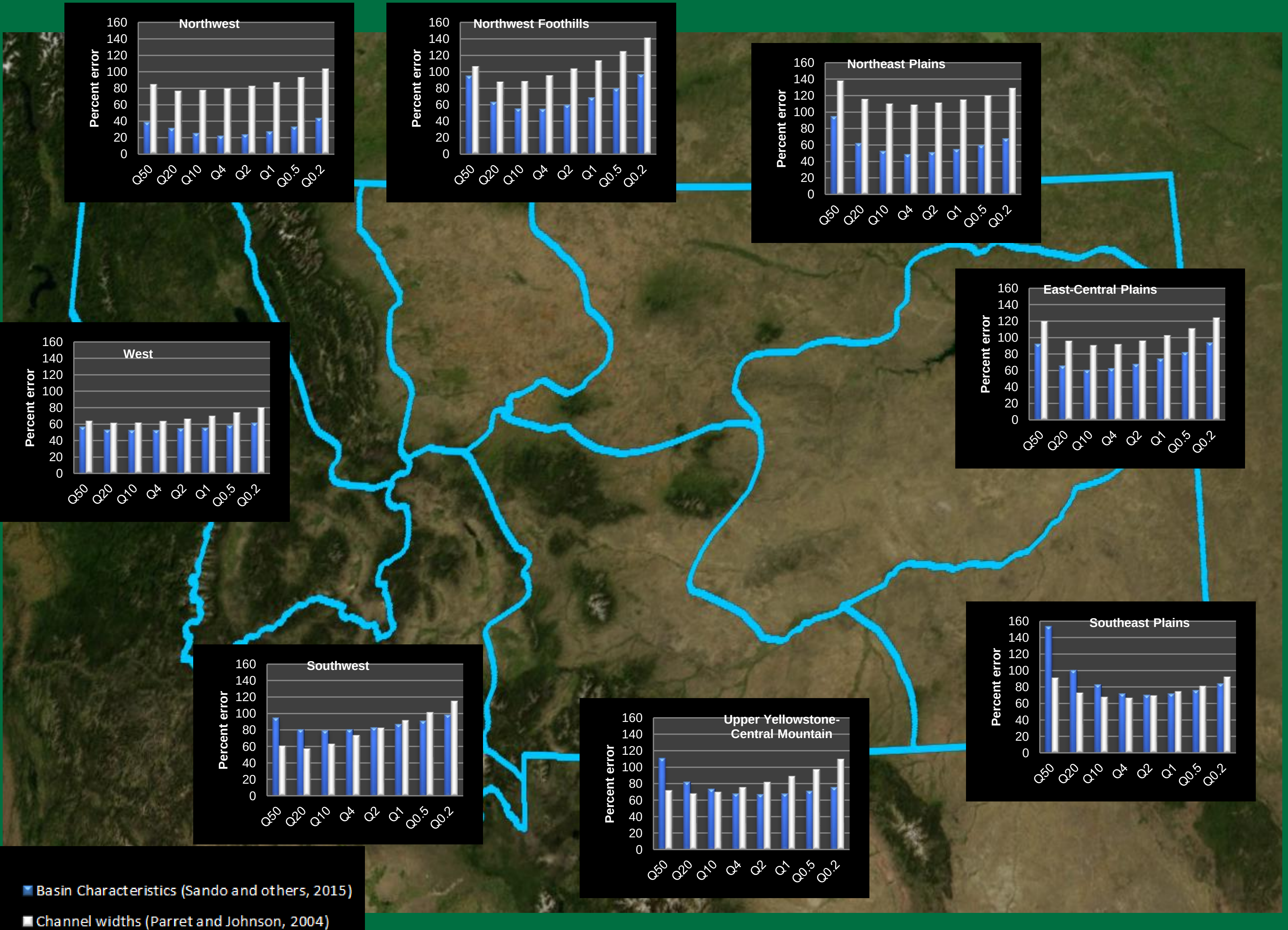
Developing Regional Regression Equations using Channel-Width Data

- Historical (1970s-1990s) on-site channel-width measurements
- New (2017) on-site channel-width measurements
- Channel-width measurements from aerial photographs



Why?

- Previous studies – can be more reliable
- Basin characteristics can be complex
- Basin characteristics might predict what could happen (*a priori)*
- Channel width formed by prevailing streamflow. Show what has happened (*a posteriori)*


Northwest
Northwest Foothills
Northeast Plains
East-Central Plains
West
Southwest
Upper Yellowstone-Central Mountain
Southeast Plains
Percent error
Q50
Q20
Q10
Q4
Q2
Q1
Q0.5
Q0.2
Basin Characteristics (Sando and others, 2015)
Channel widths (Parret and Johnson, 2004)

Methods

Fieldwork component

Remote sensing component

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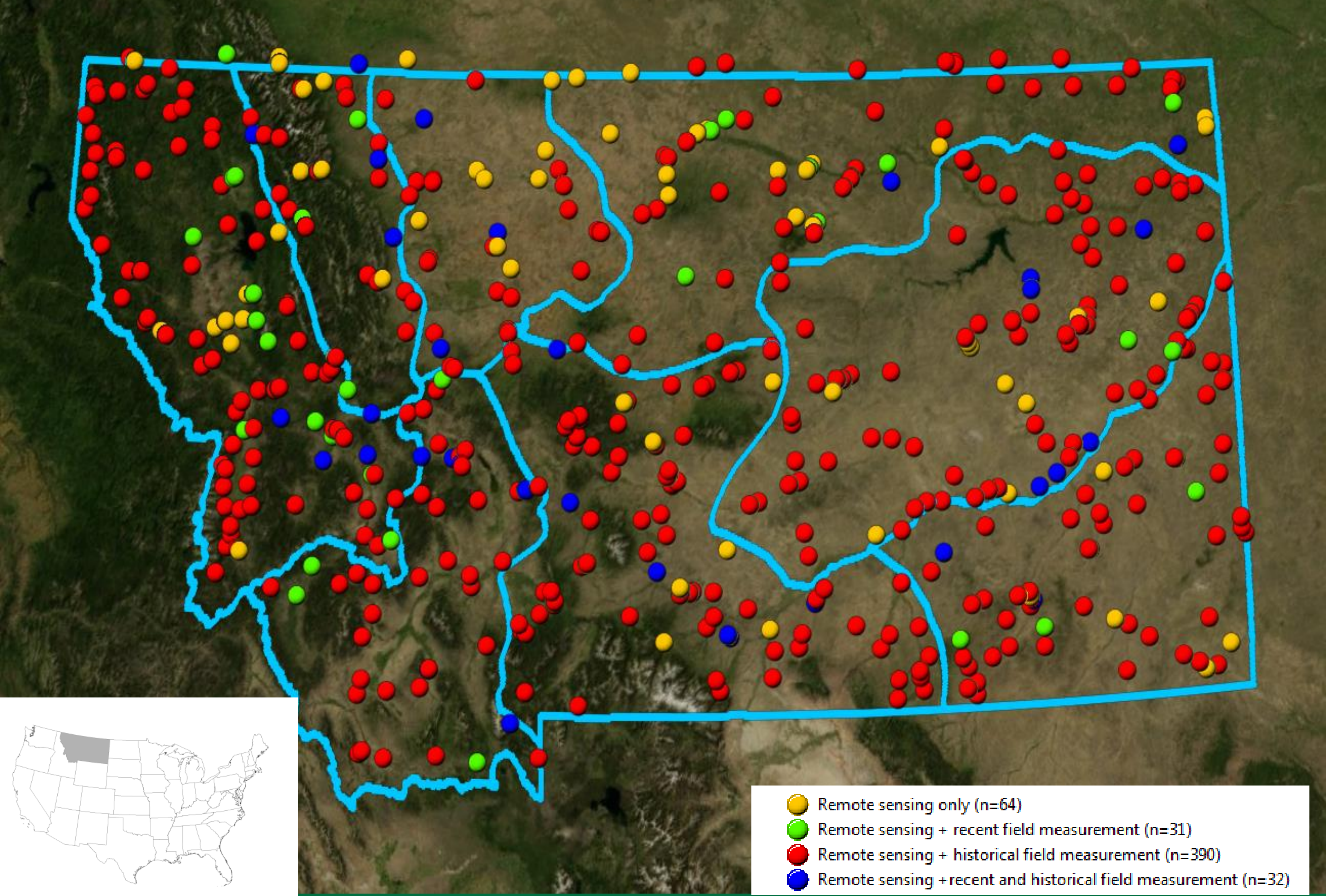
Site locations



Fieldwork

70 locations

At each location:

- 3 Active channel widths
- 3 Bankfull channel widths
- Channel bed/bank material
- Vegetation

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Channel Widths

Might be easier to see for ephemeral streams

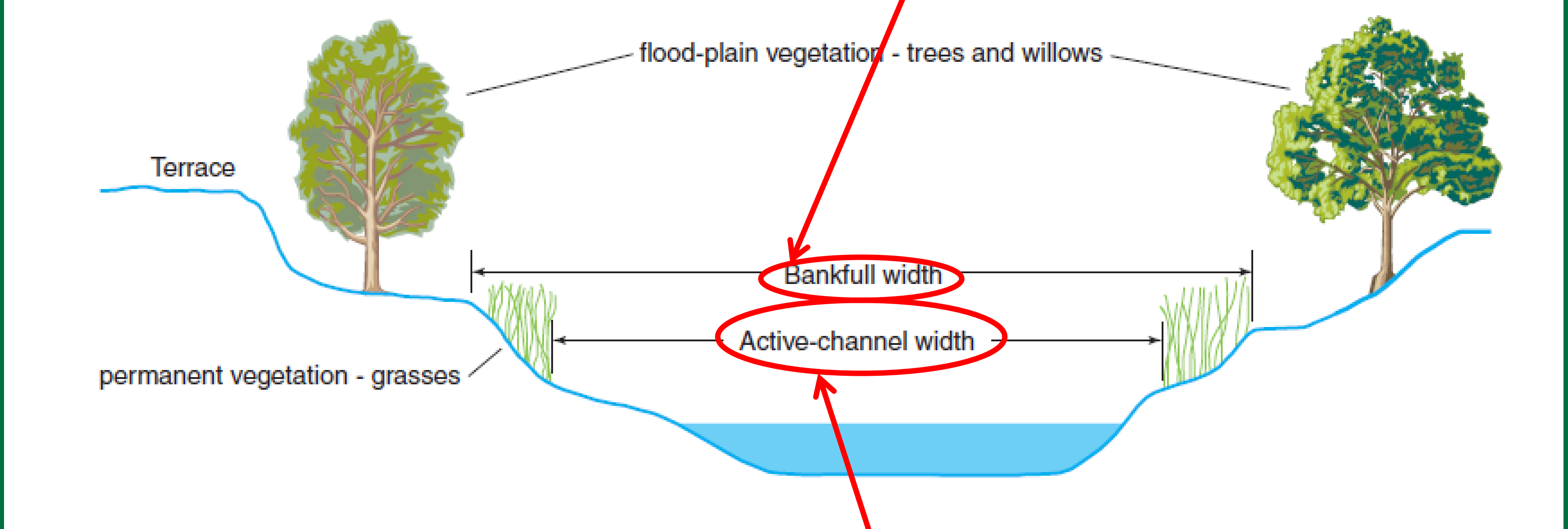

Figure 7. Typical stream cross section showing active-channel and bankfull widths.

Might be easier to see for perennial streams

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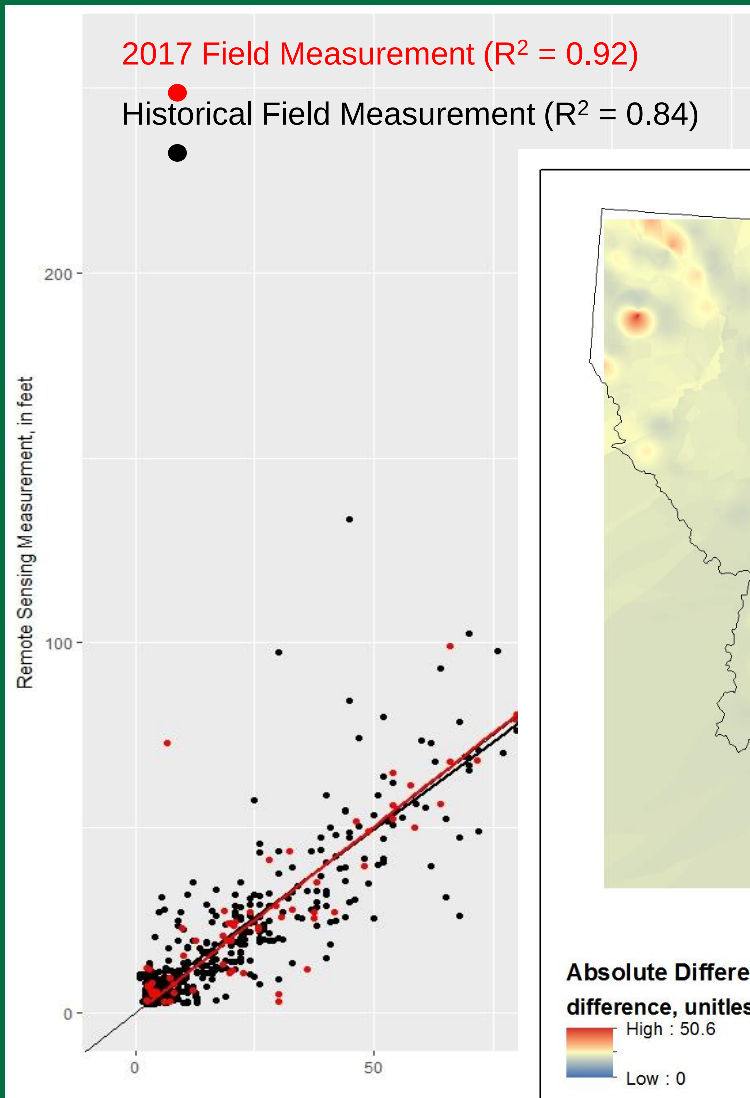
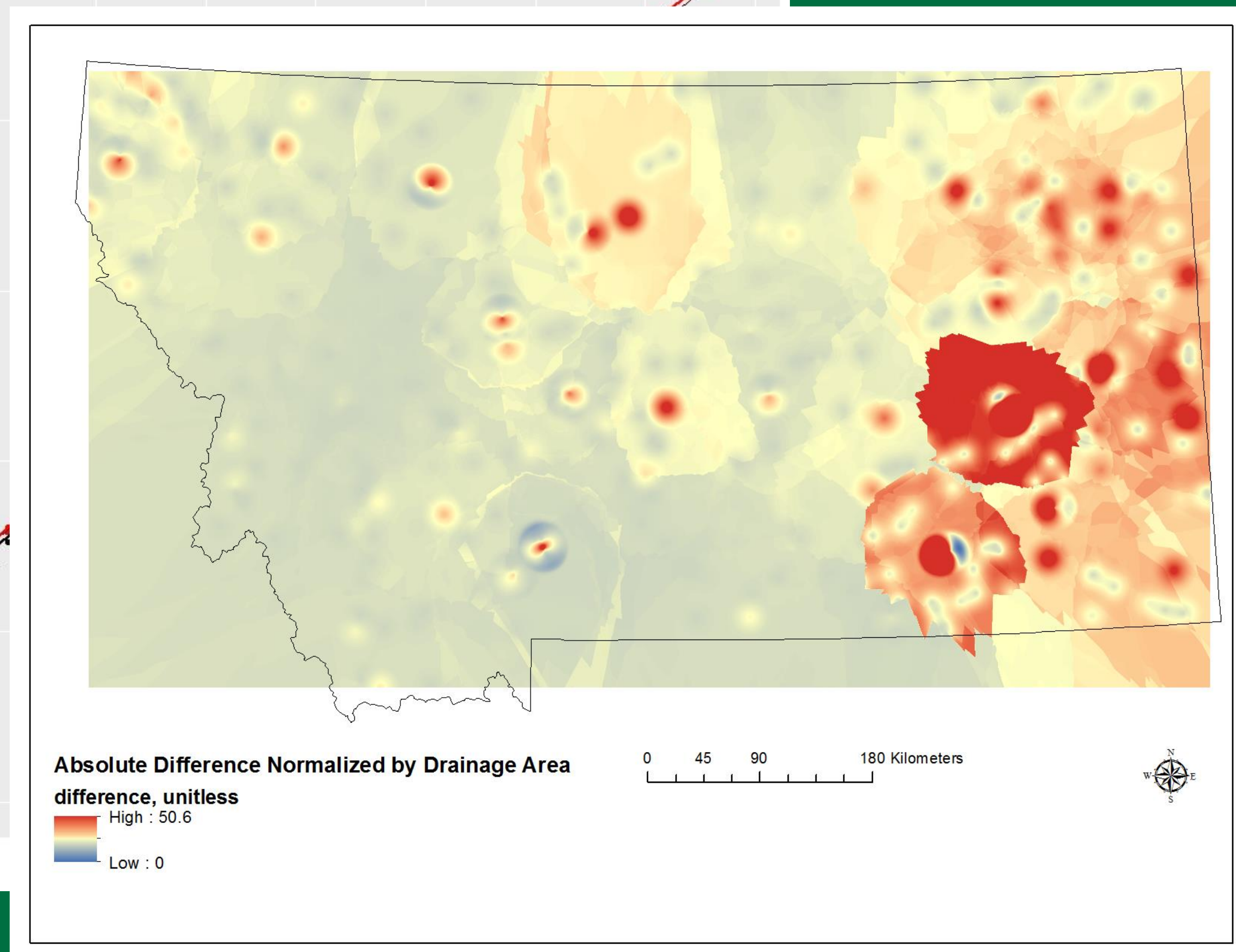
Bankfull Channel Width

Remote sensing

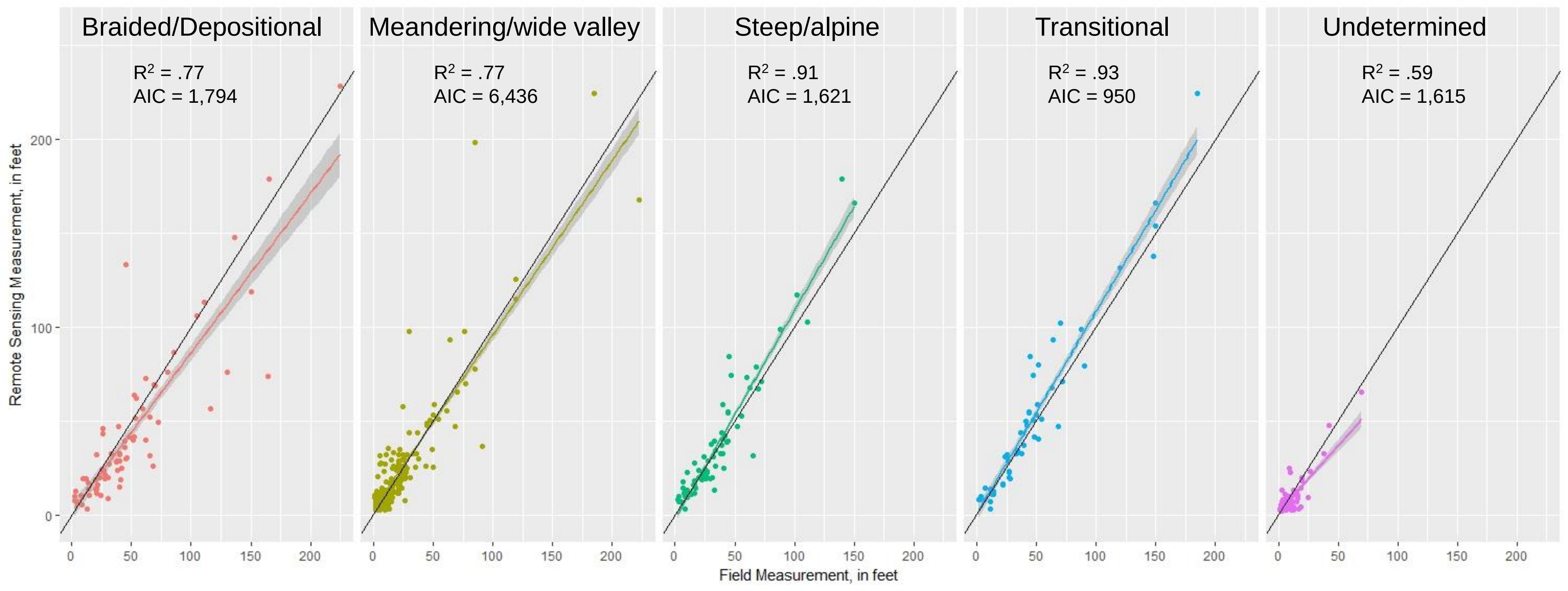
- 2 independent measurers
- 517stations
- Natural Color NAIP
- July/August 2015
- Parameters
  - Channel width
  - Channel type
  - Vegetation
  - Channel constraints
  - Measurer confidence

Preliminary Results





Channel types



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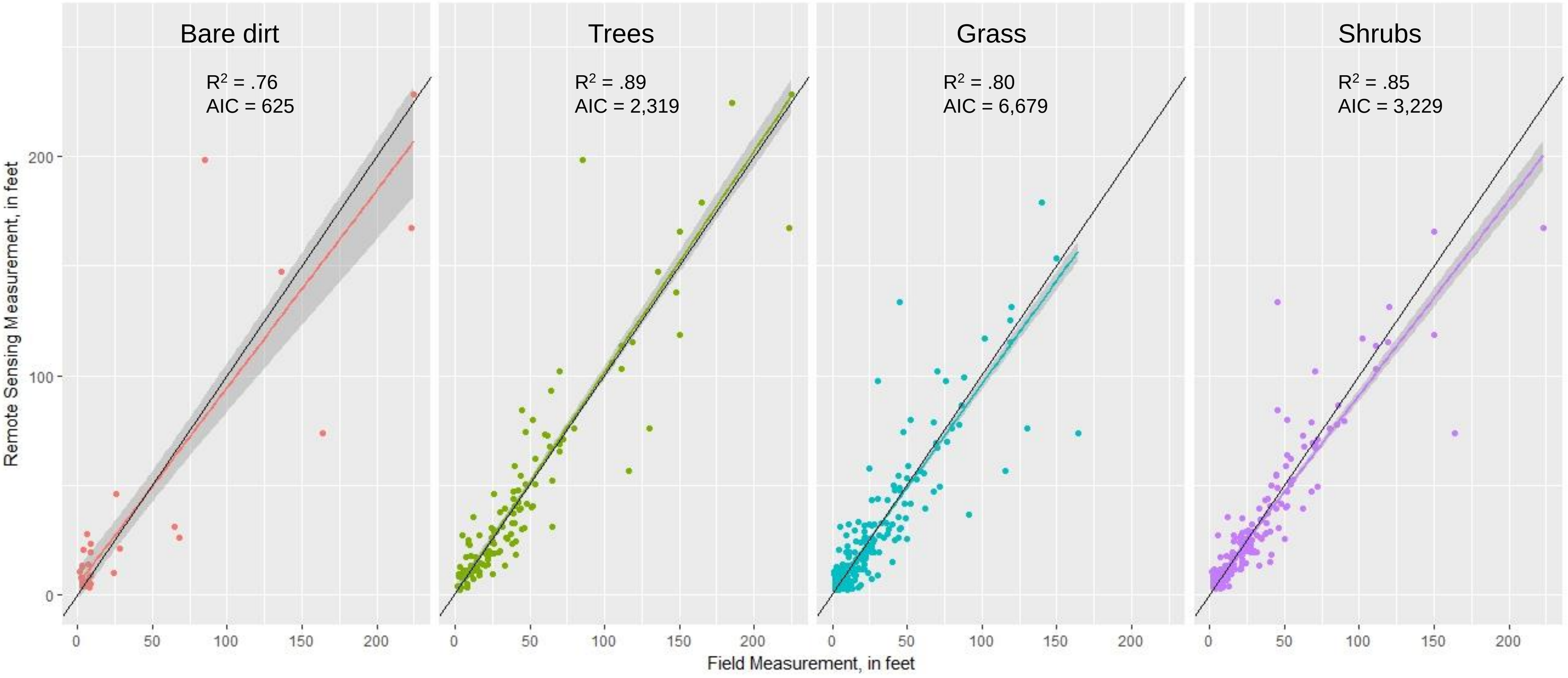
Vegetation Type



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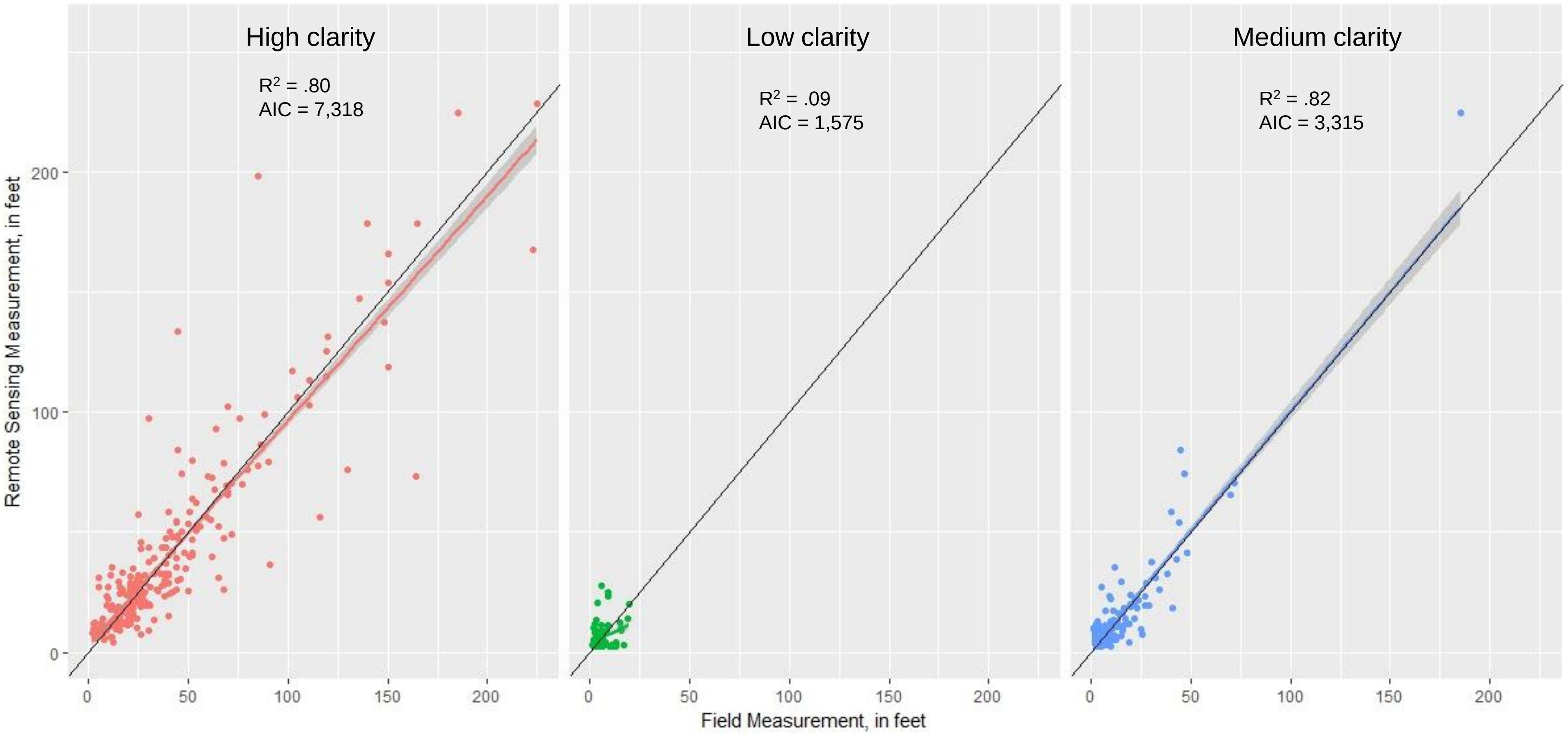
Permanent Vegetation Clarity



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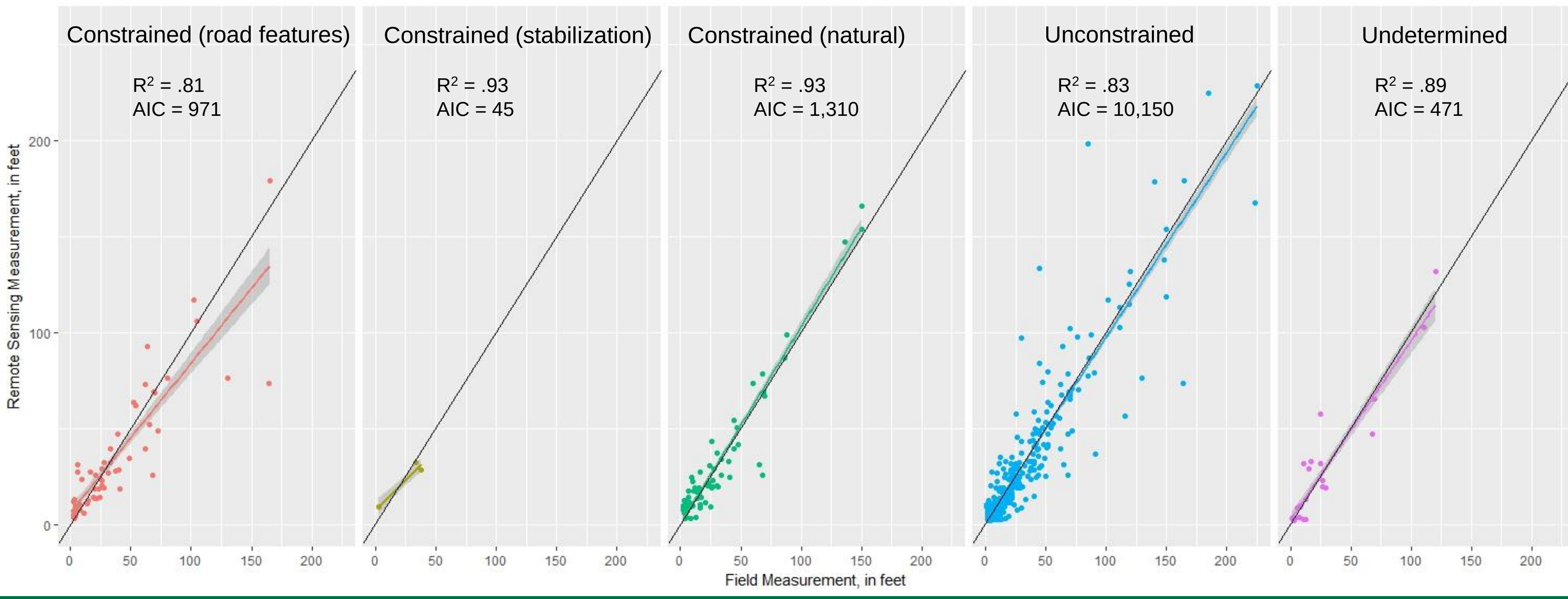
Channel constraint



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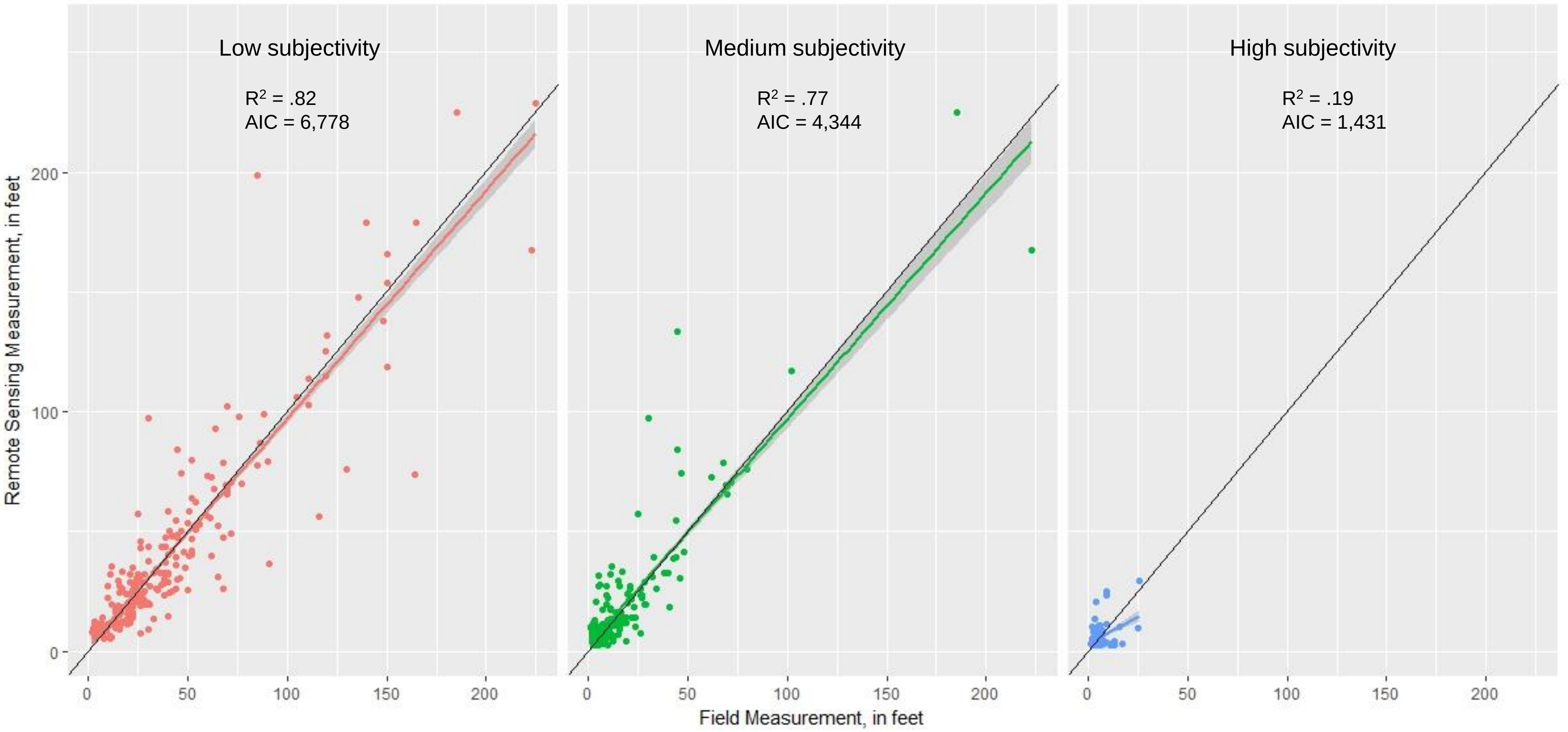
Subjectivity of site selection



Preliminary Conclusions

- Using aerial photography to measure channel widths might work best for:
  - Streams that don't change much with riparian zones comprised of permanent vegetation with clearly visible edges.
- Including Lidar derivatives (channel bathymetry, canopy height, channel type, channel migration) could improve estimates

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Limitations

- Results are preliminary
- Changes in channel geometry from natural and anthropogenic factors
- Gage locations often at non-ideal locations
- Basin sizes vs spatial resolution of imagery
- Large and/or recent flood events

Questions?

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