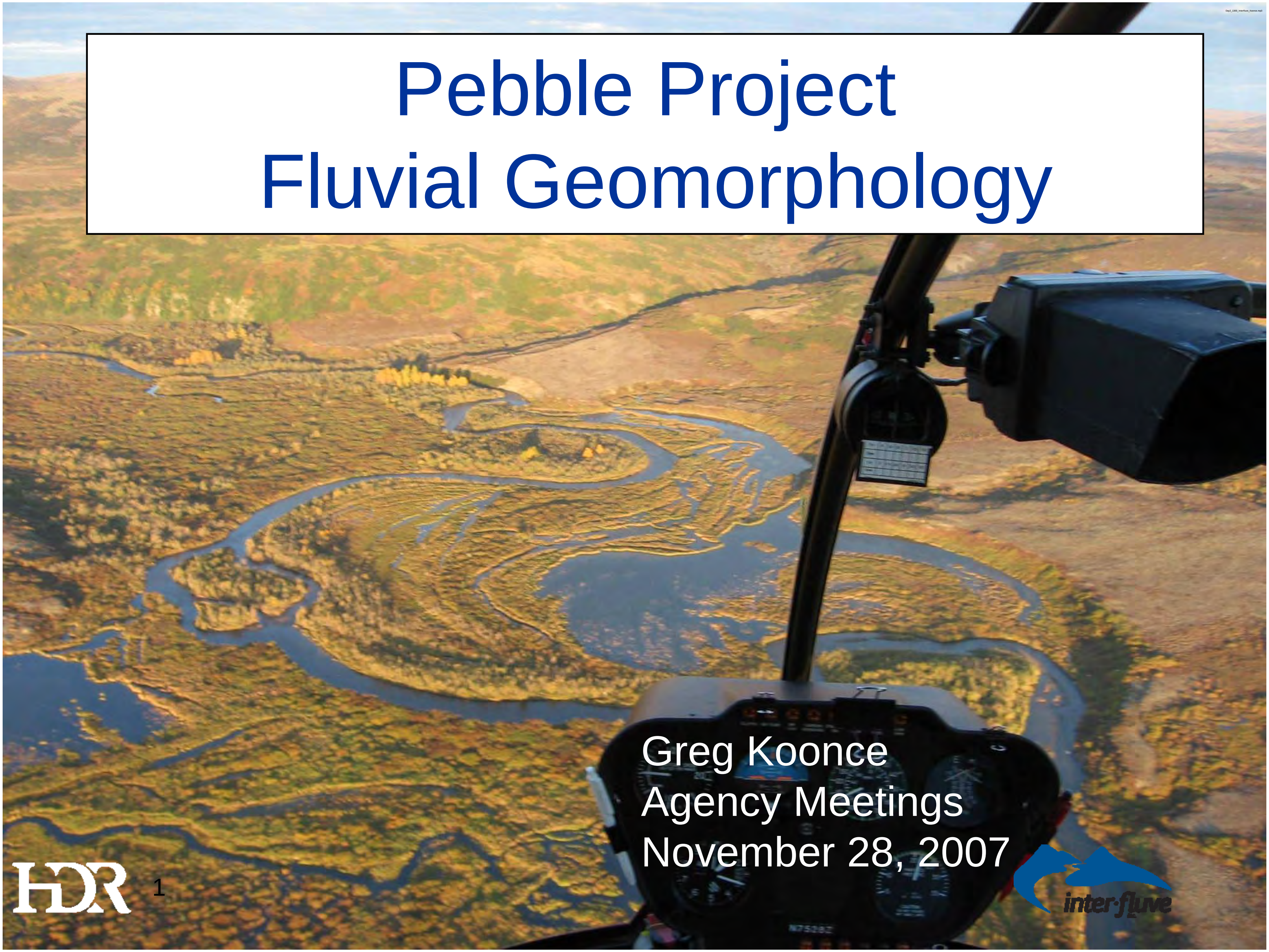
Pebble Project
Fluvial Geomorphology



Greg Koonce
Agency Meetings
November 28, 2007

Fluvial Geomorphology Team

Mike Brunfelt

Dan Miller

Rebecca Manners

Gardner Johnston

Mark Sogge

Greg Koonce

Ingrid Corson (HDR)

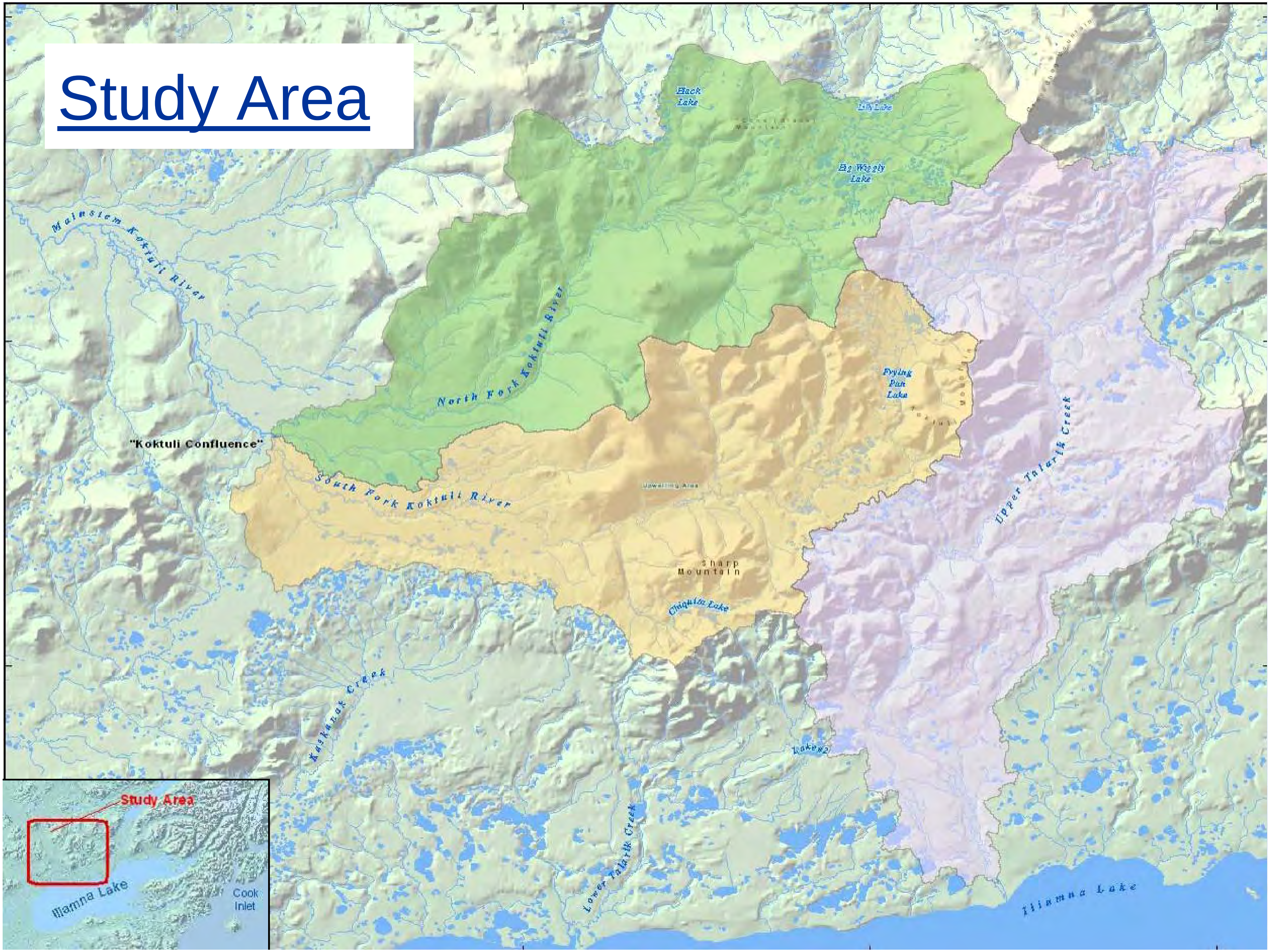
Discussion Topics

- Objectives
- Study Area
- Study Methods
- Results

Objectives

- Support the Instream Flow fisheries study in scope and findings.
- Determine how channel geometry (width and cross-sectional area) correlates with discharge.
- Characterize these relationships through empirical relationships.
- Develop relationships for each of the three drainages in the study area, as well as for the study area as a whole.
- Document those factors present in the study area which influence channel shape.

Study Area



Hack Lake
Lily Lake
Big Wiggly Lake
Mainstem Koktuli River
North Fork Koktuli River
"Koktuli Confluence"
South Fork Koktuli River
Frying Pan Lake
Upper Talarik Creek
Sharp Mountain
Chiquita Lake
Kaskanak Creek
Lower Talarik Creek
Iliamna Lake
Study Area
Iliamna Lake
Cook Inlet

Study Methods – Background

- Channel shape is a product of the relationship between water discharge and it's ability to deform the materials comprising it's boundaries

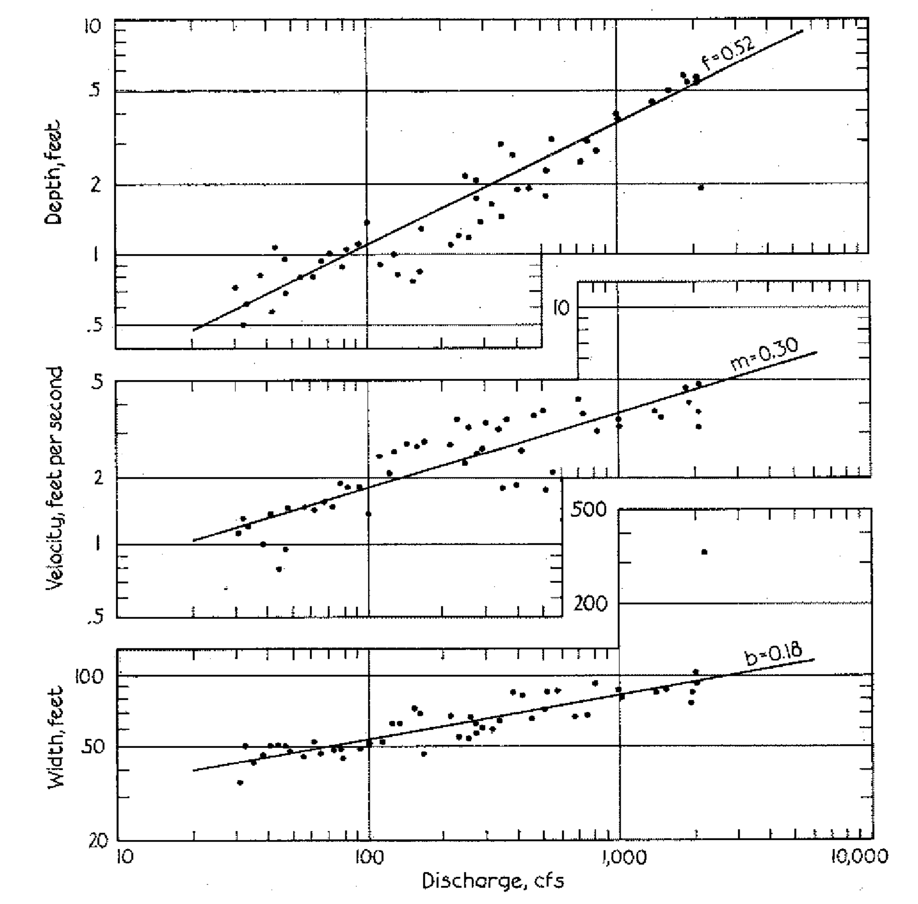
- Channels typically adjust their boundaries during those flows which fill or overtop their banks

- The flow which is predominately responsible for channel shape is referred to in this study as the *channel-forming* flow

- Changes in flow magnitude and frequency affect the channel-forming flow and therefore influence the shape of the channel.

Study Methods - Background, cont.

- Study design based on pre-existing work in the field of Fluvial Geomorphology on relationships between channel geometry and discharge

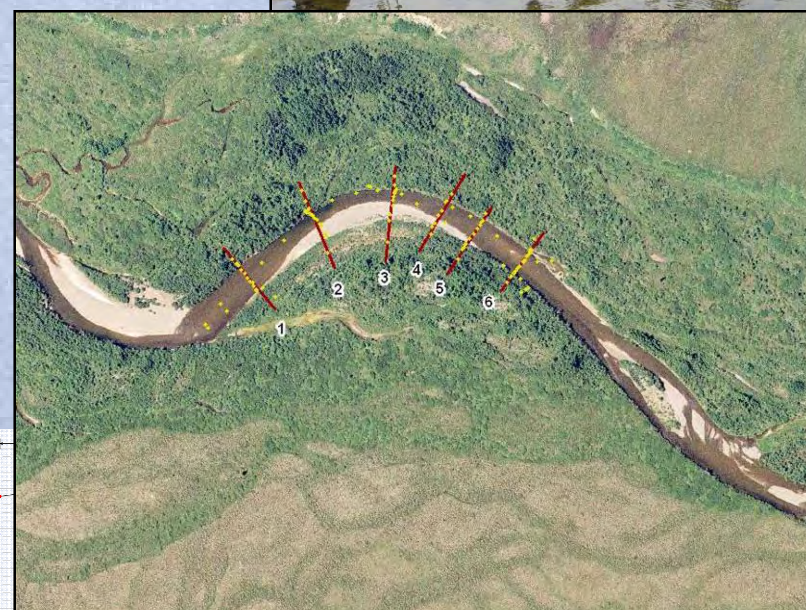


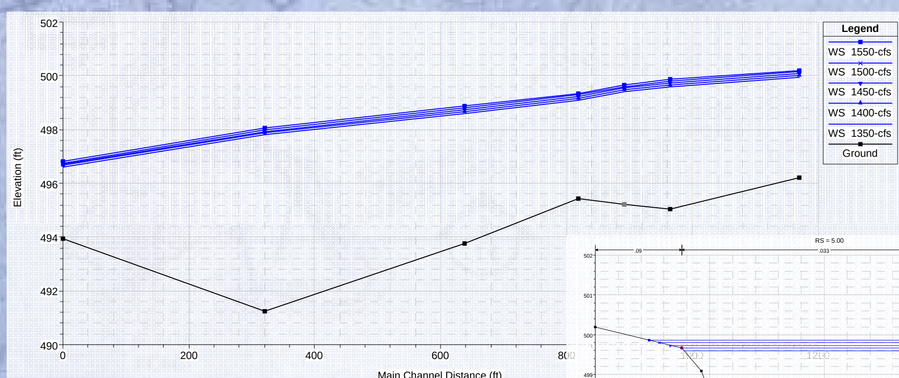
From:

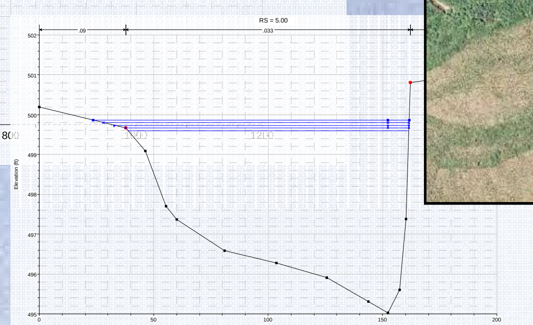
Fluvial Processes in Geomorphology. Leopold, Wolman and Miller,1964

Study Methods

- Field Data Collection Efforts
- Hydraulic Modeling
- Radio-Tag Study
- Site by Site Analysis
- Regression Equations





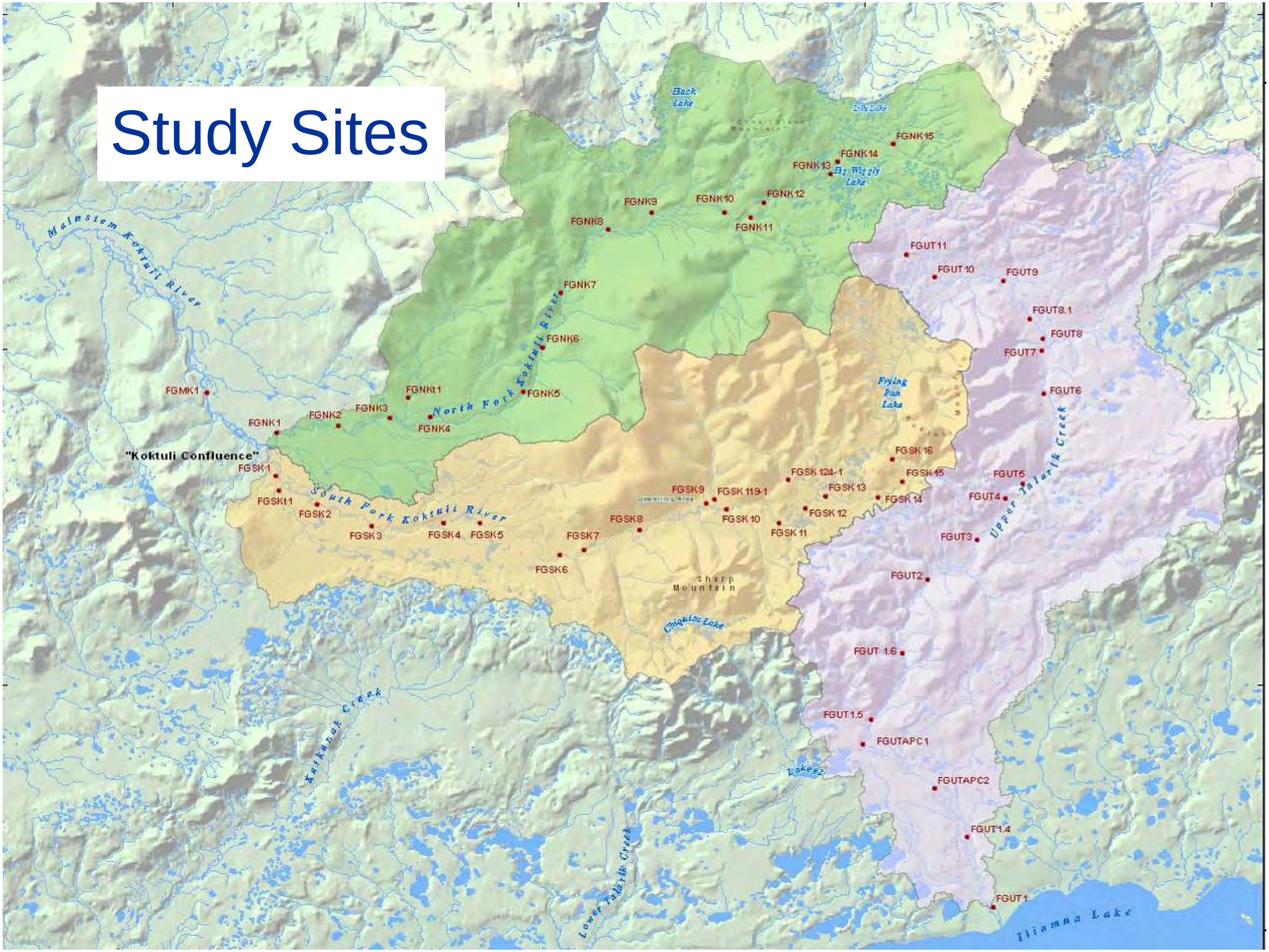


Methods: Field Data Collection

53 sites selected

- Single-thread riffle channel segments
- Readily deformable boundaries (i.e. no bedrock)
- Incremental changes in channel geometry dimensions with increase in drainage area

Study Sites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FGNK6
FGNK7
FGNK8
FGNK9
FGNK10
FGNK11
FGNK12
FGNK13
FGNK14
FGNK15
FGNKt1
FGSK1
FGSKt1
FGSK2
FGSK3
FGSK4
FGSK5
FGSK6
FGSK7
FGSK8
FGSK9
FGSK 119-1
FGSK 10
FGSK 11
FGSK 12
FGSK 13
FGSK 124-1
FGSK 14
FGSK 15
FGSK 16
FGUT1
FGUT1.4
FGUTAPC2
FGUTAPC1
FGUT1.5
FGUT 1.6
FGUT2
FGUT3
FGUT4
FGUT5
FGUT6
FGUT7
FGUT8
FGUT8.1
FGUT9
FGUT10
FGUT11

Methods: Field Data Collection

Hydraulic Cross-Section Survey

Riffle Sections

Hydraulic Boundary Conditions

Vegetation Lines

Tops of Banks

Water Surface Profile

Bed Sediments

Pebble Counts

Bulk Samples

Bank Conditions

Bank Excavation

Vegetation Composition

GPS Points

Photograph Documentation

Methods: Hydraulic Analysis

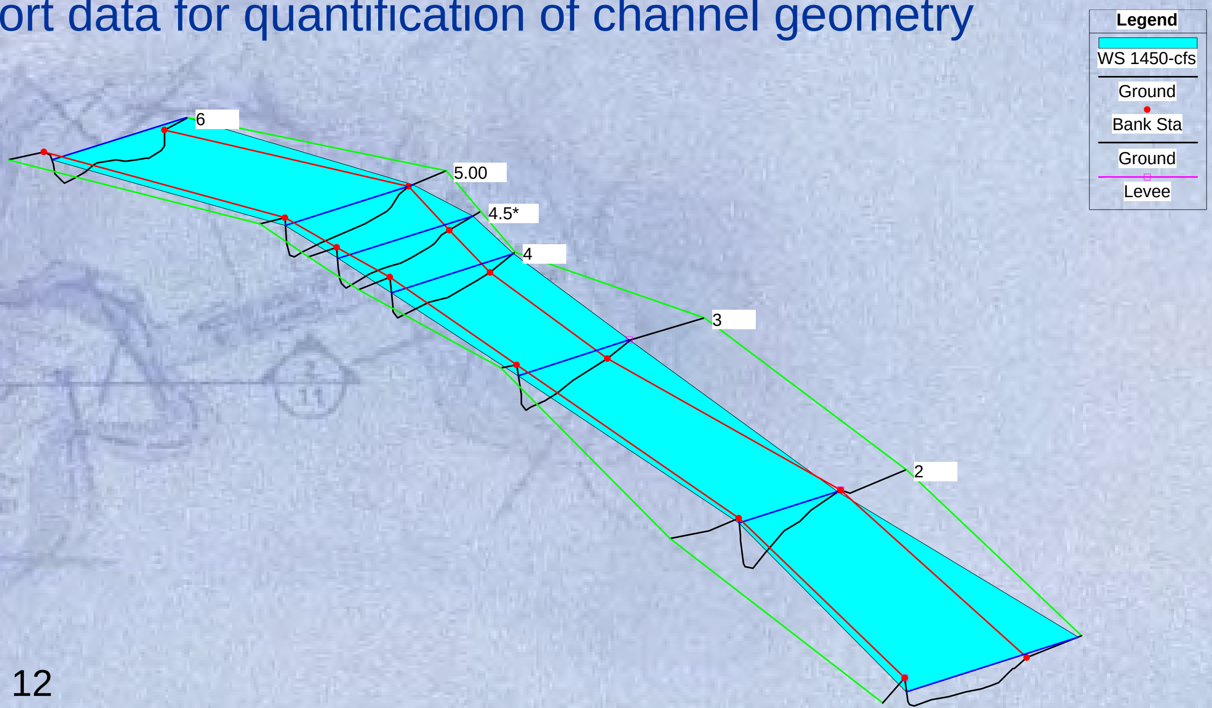
Build HEC-RAS 1-D Hydraulic Models

Calibrate with data from HDR Hydrology, USGS gages and IFS Flow Habitat Sites

Evaluate inundation patters

Export data for incipient motion analysis

Export data for quantification of channel geometry



Methods: Radio-Tag Rock Study

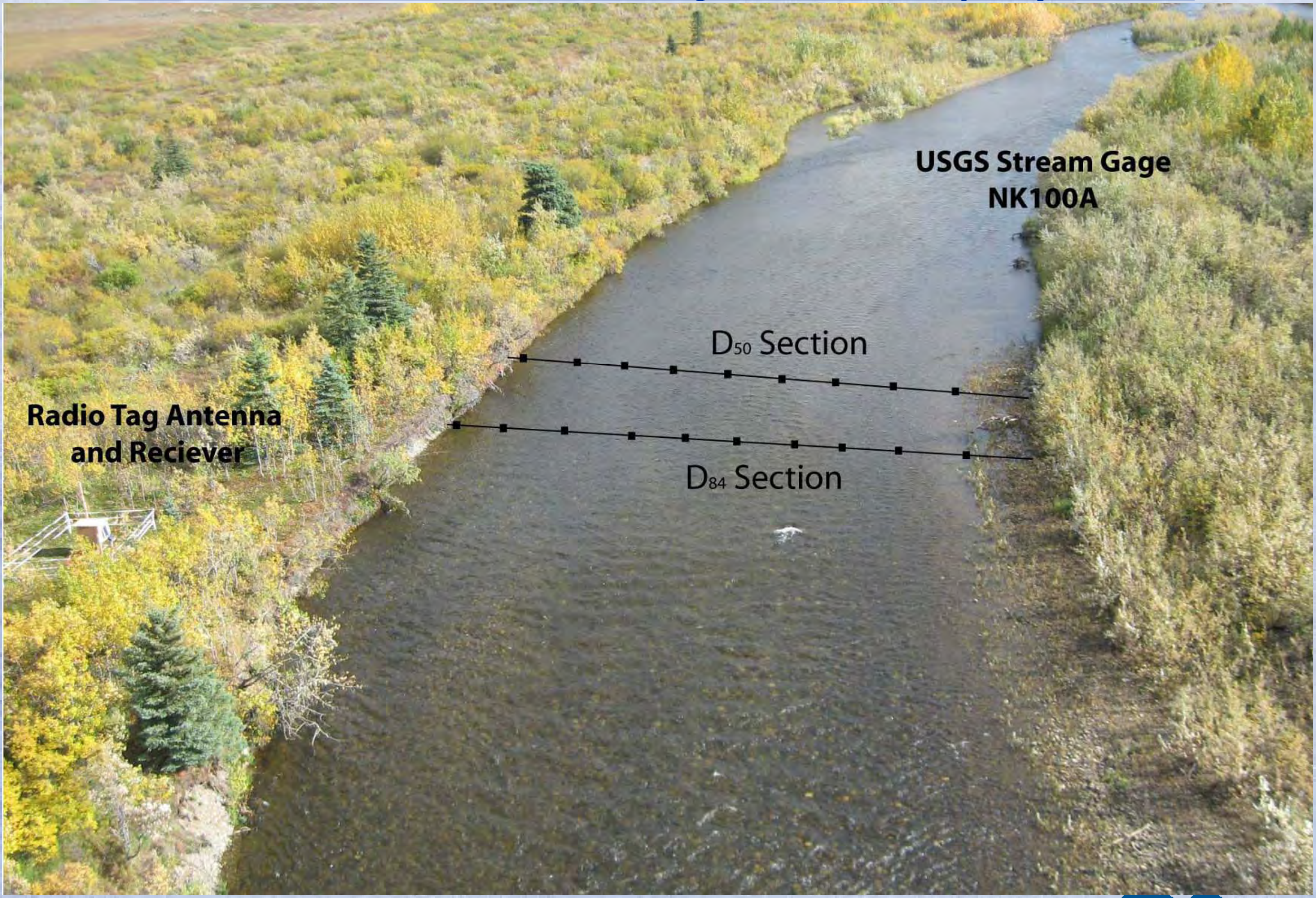
- Bed mobility, channel-forming discharge and channel geometry are linked together in alluvial channels.
- Having a measure of bed mobility increases certainty of relationship.
- Measuring bed mobility benefits analysis at other sites.
- Radio rocks movement was tracked near the USGS gage station on the North Fork Koktuli.

Methods: Radio-Tag Rock Implanting

Methods: Radio-Tag Rock Deployment

inter-fluve

Methods: Radio-Tag Rock Deployment



Methods: Radio-Tag Rock Tracking

Methods: Site by Site Analysis

Identify Channel-Forming Discharge for 52 Sites

- Incipient Motion Analysis (Results from Radio-Tag Study)
- Inundation Patterns
- Hydrology Data

Identify Channel Geometry at estimates of Channel Forming Discharge

- Channel Width
- Cross-Sectional Area
- Slope

Methods: Regressions

Regressions are power-law functions of the form:

$$(w, A) = aQ^b$$

w: channel width at the channel forming discharge (ft)

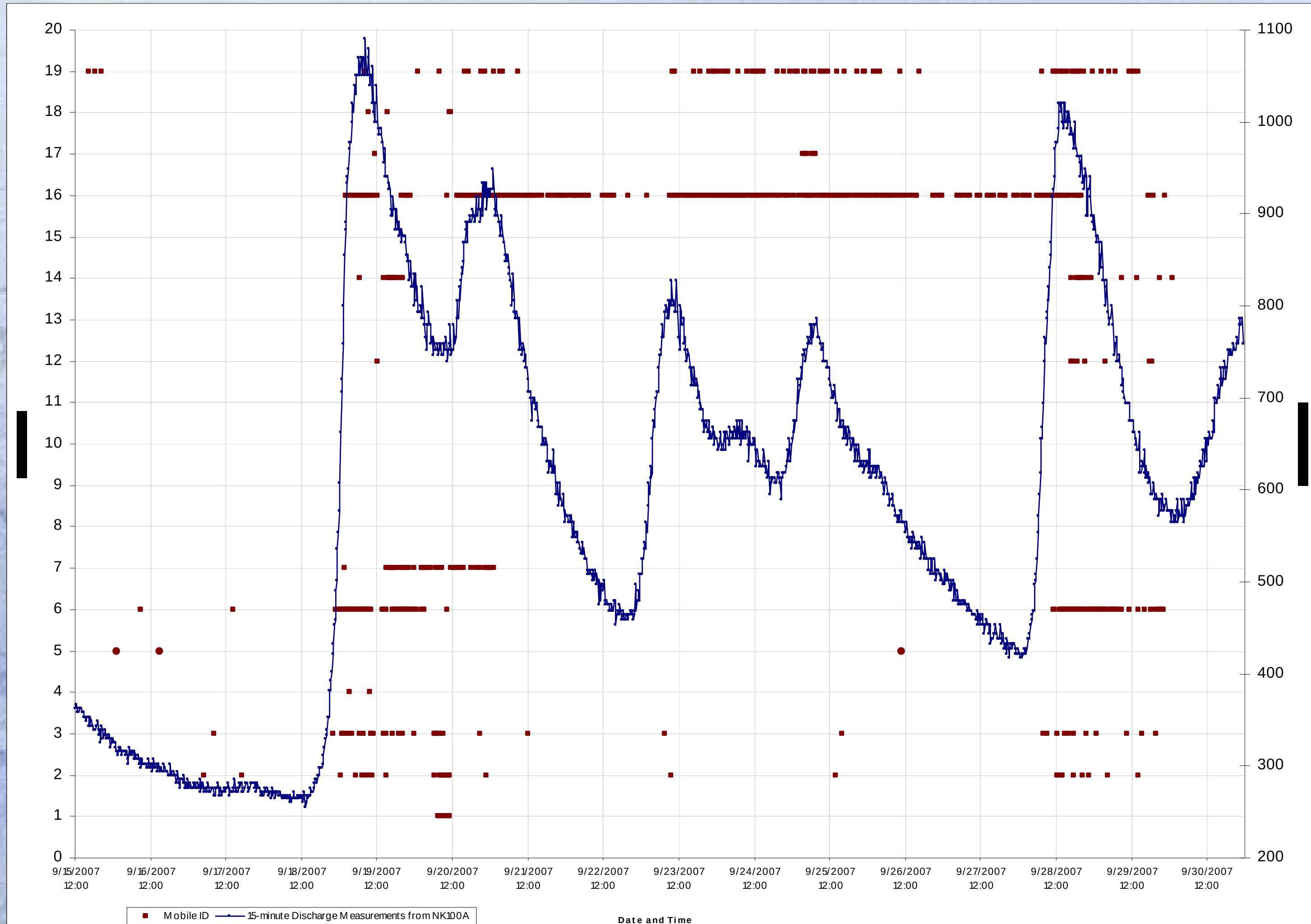
A: cross-sectional area at the channel forming discharge (ft)

Q: channel forming discharge (cfs)

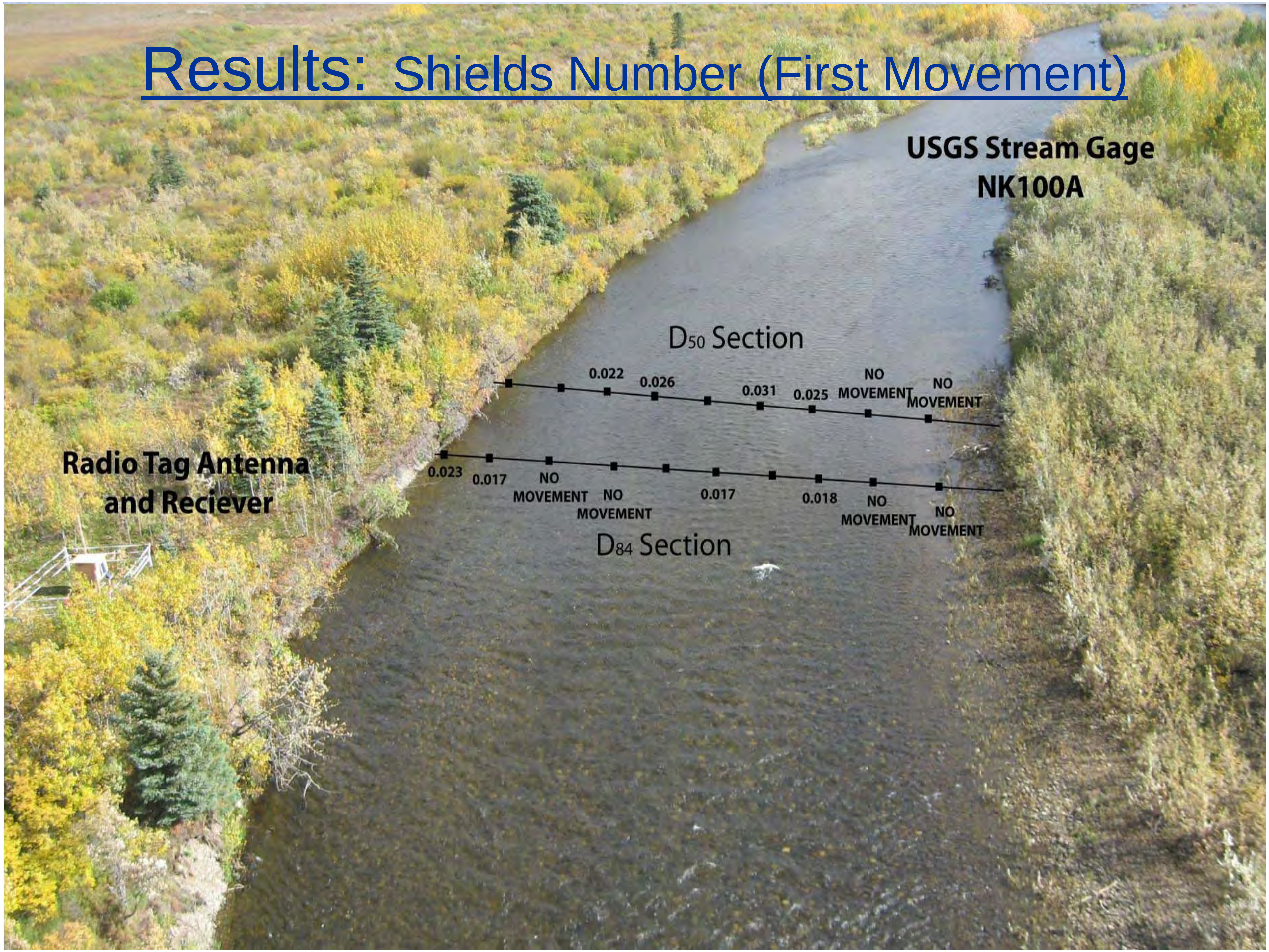
a: coefficient

b: exponent

Results: Radio-Tag Rock Movements



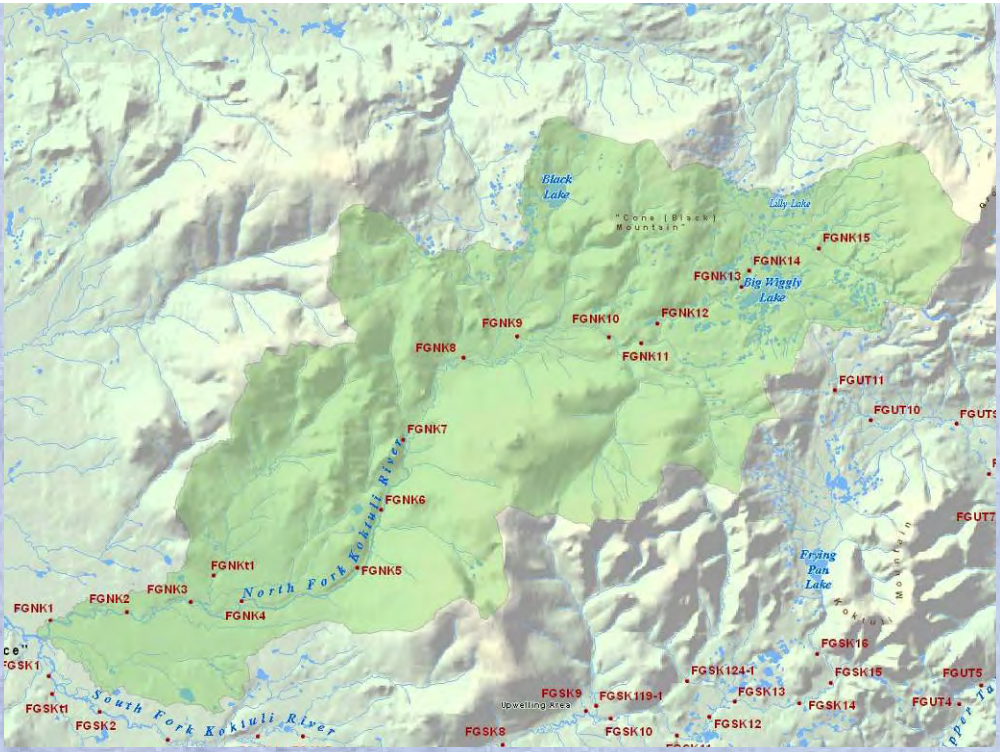
Results: Shields Number (First Movement)

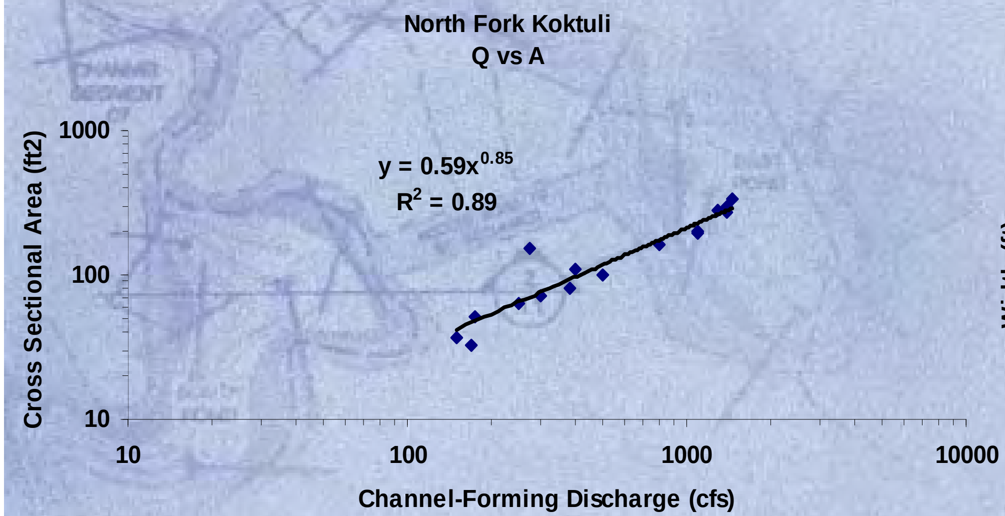


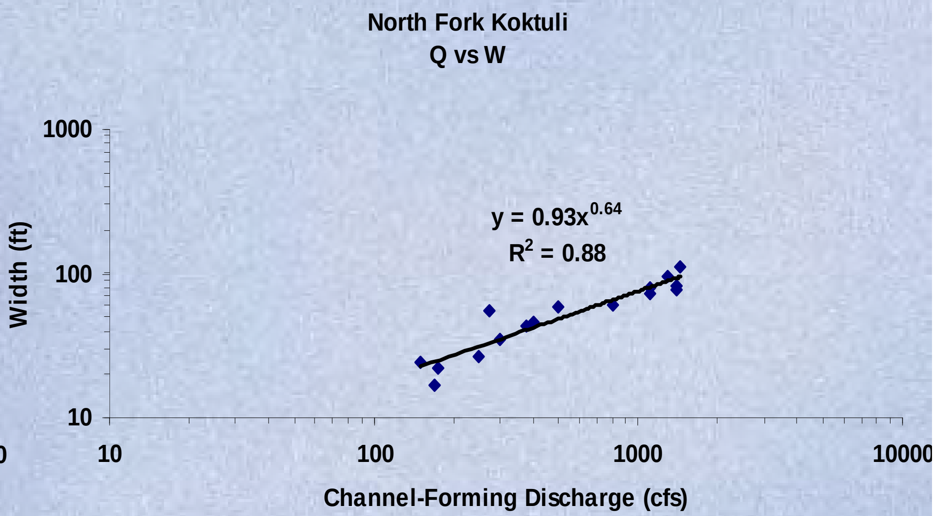
Results: Regressions

	Coefficient	Exponent	R^2
DRAINAGES			
NK			
Q to W	0.93	0.64	0.88
Q to A	0.59	0.85	0.89
SK			
Q to W	1.42	0.56	0.78
Q to A	1.21	0.75	0.90
UT			
Q to W	0.61	0.83	0.96
Q to A	1.57	0.54	0.91
COMBINED			
Q to W	1.22	0.59	0.87
Q to A	0.72	0.82	0.92
SLOPES			
Q to W			
Flat	0.62	0.70	0.77
Moderate	1.04	0.61	0.89
Steep	1.83	0.52	0.86
Q to A			
Flat	1.80	0.75	0.91
Moderate	0.55	0.87	0.96
Steep	0.63	0.82	0.98

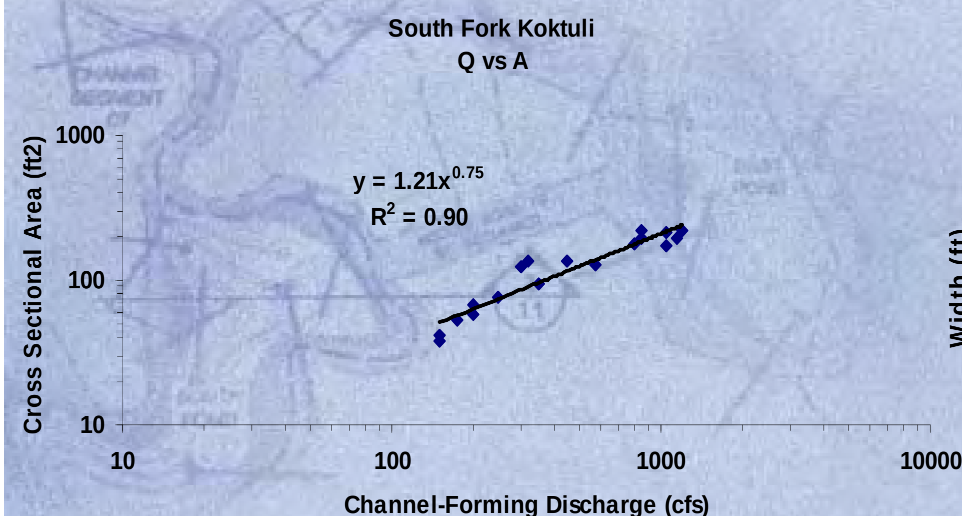
Results: North Fork Koktuli River Regressions

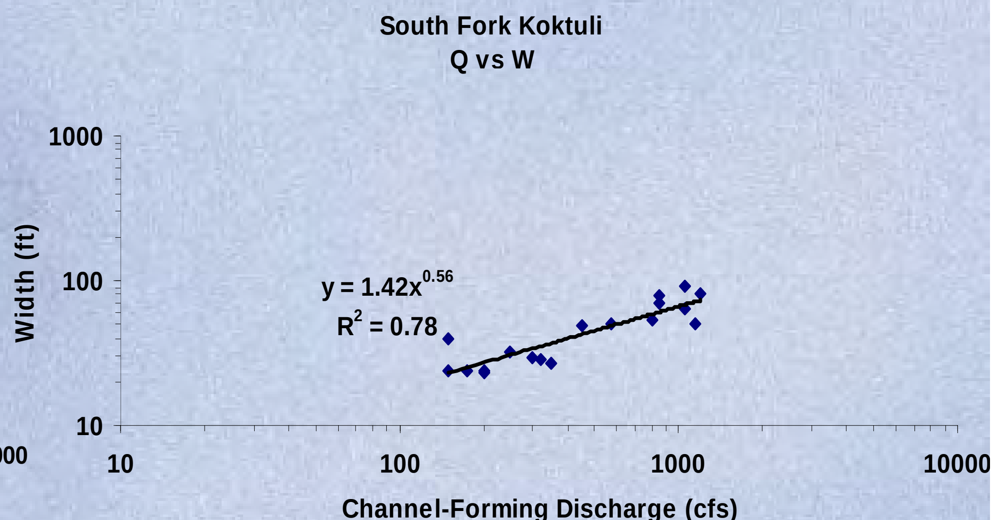




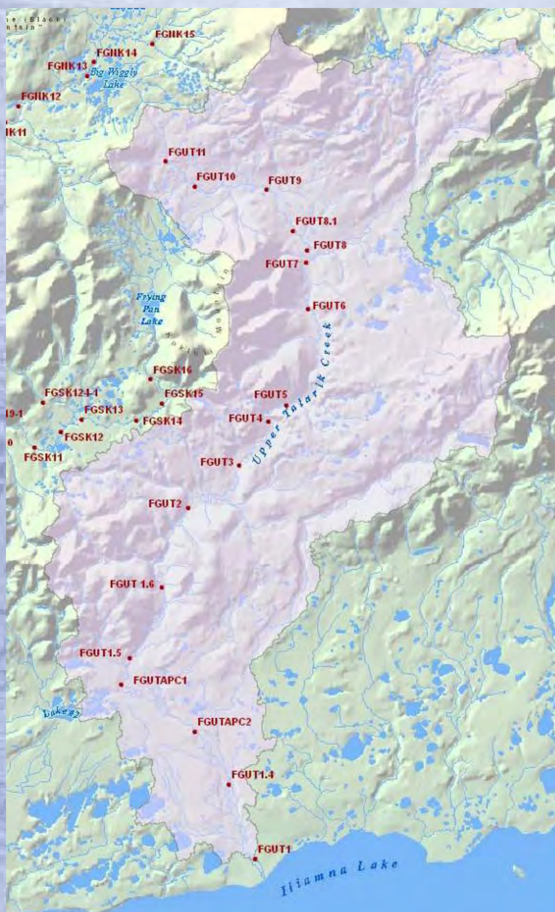


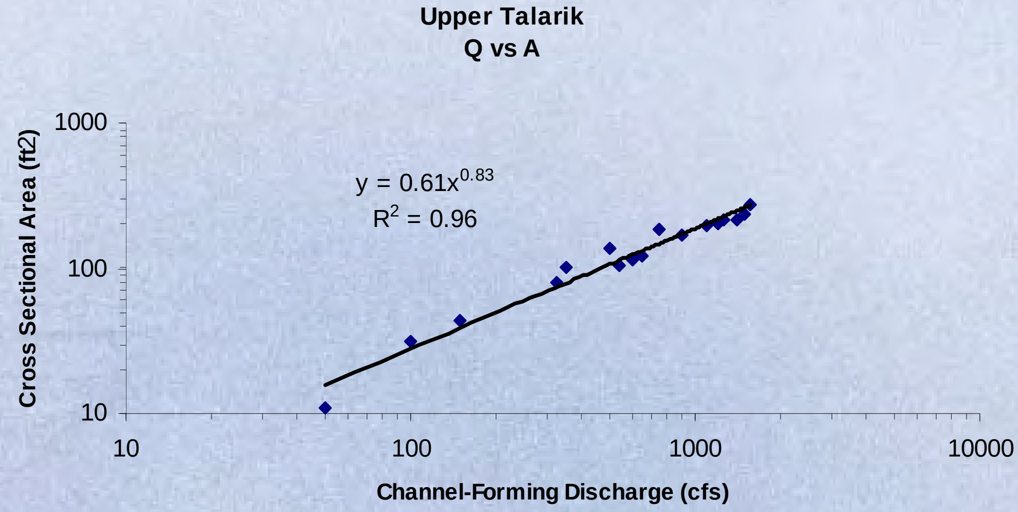
Results: South Fork Koktuli River Regressions

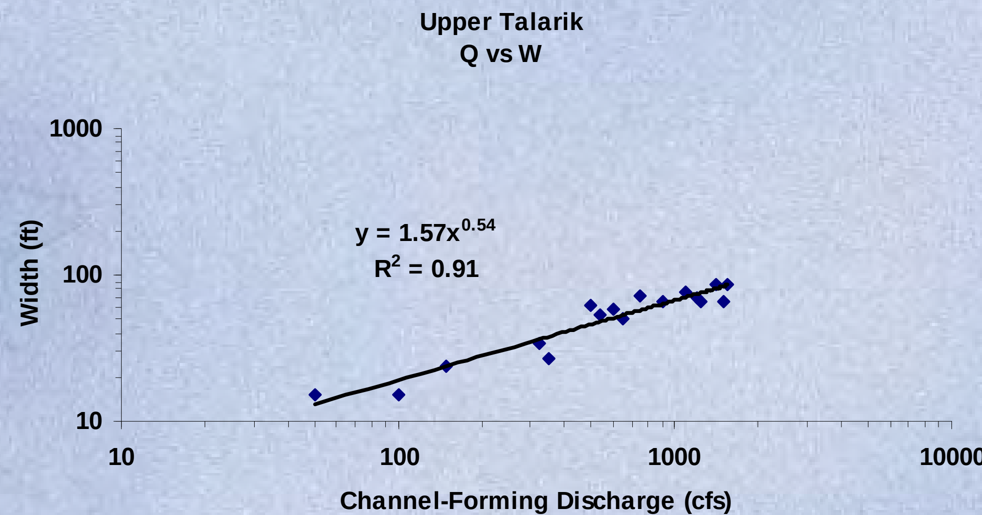




Results: Upper Talarik Creek Regressions



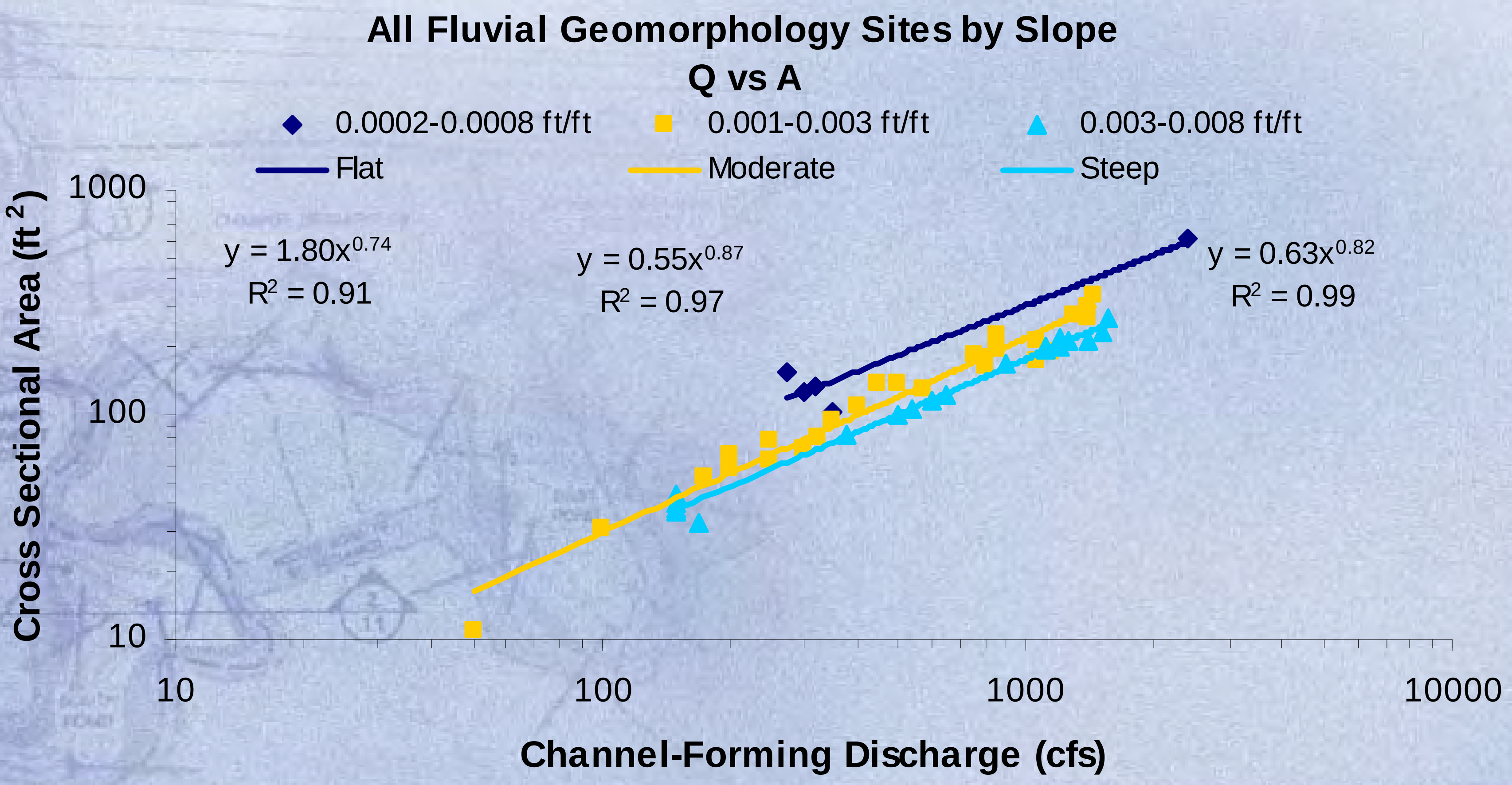




Results: Factors influencing channel shape

- Variability exists within sites
  - Some sites had a wide range in results between incipient motion analysis, channel geometry and inundation patterns
  - Ranges around each value of channel forming discharge, width and cross-sectional area
- Variability exists between sites
  - Floodplain vegetation
  - Lateral migration and floodplain processes
  - Lag deposits
  - Channel history (i.e. beaver activity)
  - Slope

Results: Regression based on slope



HDR

inter-fluve

Summary

- Regressions within basins
- Regressions based on slope
- North Fork Shields lower than average published values
- These regressions provide a tool to estimate changes in channel geometry with changes in discharge