

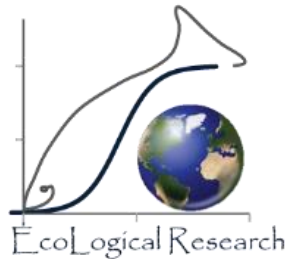
How do you account for fish habitat with a total station?

2015 CHaMP Camp

Cove, Oregon – June 1st, 2015

Presenter:

Joe Wheaton (USU)



OUTLINE

HOW DO YOU ACCOUNT FOR FISH HABITAT WITH A TOTAL STATION?

I. Background

II. Painting a Picture of Habitat – Topographically

III. Quantifying Habitat – From Topography

I. Hydraulics

II. Geomorphology

III. Fish Habitat

IV. Some Other Useful Byproducts of Topography

V. Take Homes

WHAT YOU'LL BE DOING THE NEXT 10 DAYS....

- If you're a CHaMP Newbie
- If you're a CHaMP Returnee



Module: Intro to Surveying (Total Station)

CHaMP Columbia Habitat Monitoring Program

PURPOSE:
To show how topographic data is acquired with a total station so that you can paint a topographic picture of your site quantitatively.



Using a Total Station to Paint the Topographic Picture

- Control Points**
- Benchmark
 - Topobench
- Hard Breaklines**
- Boundary
 - Top of Bank
 - Top of Road
 - Left Breakline
 - Right Breakline
 - Channel Unit

Learning Outcomes:

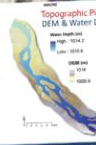
- Learn how to 'occupy a point' and level a tripod.
- Be able to set up a total station on a control point, position and orient the instrument within a coordinate system, and collect topographic data.

Resources:

CHaMP Protocol: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1303>
 CHaMP Surveying Manual: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1304>
 Total Station Setup Movie: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1305>
 Benchmark Dictionaries Key: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1306>

Connections to Other Modules:

A) Introduction to Topography (P&T) you will learn where to collect these points.
 B) Site Setup: you will learn how to set up a total station, how to paint the picture topographically.
 C) Topographic GIS: you will learn how to use topographic data collected here, to paint the picture topographically.
 D) Advanced Surveying with a Total Station: you will learn how to actually perform a complete survey.



Module: Intro to GIS

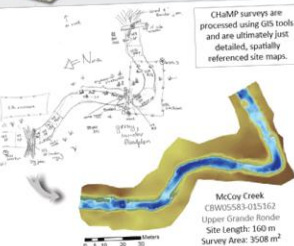
CHaMP Columbia Habitat Monitoring Program

Purpose:
To learn core GIS skills needed to process topographic survey points into a 3d topographic surface.

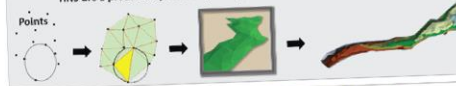


Learning Outcomes:

- Core GIS Skills:**
 - To navigate comfortably around in ArcGIS
 - To edit point, polygon, and line data (vectors)
 - To edit surface topography GIS data (TINs)
- Core CHaMP Survey Skills:**
 - Topographic surface are generated from field surveys
 - landscape features are represented in topographic surfaces



TINS are a product of processing survey point and line data into a 3d surface



Resources:

CHaMP GIS Processing: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1307>
 CHaMP GIS Processing: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1308>
 CHaMP GIS Processing: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1309>

Connections to Other Modules:

A) Introduction to Topography: you will learn where to collect points.
 B) Advanced GIS: you will learn how to create the points and lines from a total station survey into a surface using the CHaMP protocol.
 C) Advanced Surveying (Total Station): you will learn how to collect points and lines that will be processed using GIS.

Module: Intro to Topography

CHaMP Columbia Habitat Monitoring Program

Purpose:
To understand and explain the role of the rod person in the topographic survey.



Learning Outcomes:

- Familiarity with the prism rod and prism assembly
- Knowledge of survey point codes
- Knowledge of points and lines
- Familiarity with ways to survey efficiently and smartly
- An understanding of how to "read" and survey the fluvial landscape including knowing how to identify:
 - convergences
 - inflection points
 - channel features
 - footprint and bank



3D view of the DEM (derived over a hill) at the top of site. Some of the points and lines that were used in the survey are shown. The points are color-coded by elevation. The lines are color-coded by type. The points and lines are color-coded by type. The points and lines are color-coded by type.

3D view of the DEM (derived over a hill) at the bottom of site. Some of the points and lines that were used in the survey are shown. The points are color-coded by elevation. The lines are color-coded by type. The points and lines are color-coded by type.

3D view of the DEM (derived over a hill) at the bottom of site. Some of the points and lines that were used in the survey are shown. The points are color-coded by elevation. The lines are color-coded by type. The points and lines are color-coded by type.

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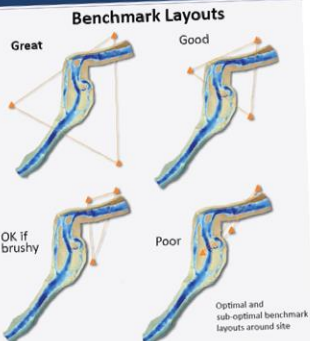
Module: Site Setup

CHaMP Columbia Habitat Monitoring Program

Purpose:
To learn proper methods for establishing new sites, reoccupying previously established sites, and laying out sites for a CHaMP survey.

Learning Outcomes:

- Use a GPS unit to find site locations
- Layout, install, and document permanent benchmarks and monuments that are the backbone of surveys.
- To find and use previously-installed benchmarks and monuments for resurveying old sites.
- To estimate bankfull and use in determining site length and setting transects.



Resources:

Site Layout: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1310>
 Method: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1311>
 Method: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1312>
 Method: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1313>
 Method: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1314>
 Method: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1315>
 Method: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1316>
 Method: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1317>
 Method: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1318>
 Method: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1319>
 Method: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1320>

Connections to Other Modules:

A) Surveying: you will learn how to use a GPS unit to find site locations.
 B) Site Setup: you will learn how to layout, install, and document permanent benchmarks and monuments that are the backbone of surveys.
 C) Topographic GIS: you will learn how to use topographic data collected here, to paint the picture topographically.
 D) Advanced Surveying with a Total Station: you will learn how to actually perform a complete survey.

Module: Channel Units

CHaMP Columbia Habitat Monitoring Program

Purpose:
To present channel unit delineation and classification methods.

Learning Outcomes:

- Learn how to delineate channel unit boundaries based on four elements:
 - Water Surface Composition
 - Bed Material Composition
 - Bedform (Concavity)
 - Flow Characteristics
- Use the dichotomous keys to classify Tier I and II channel units.
- Learn where/how to flag channel units for incorporation into the topographic survey.



Resources:

Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1321>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1322>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1323>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1324>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1325>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1326>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1327>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1328>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1329>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1330>

Connections to Other Modules:

A) Introduction to Topography: you will learn where to collect channel unit boundaries based on four elements.
 B) Advanced GIS: you will learn how to create the points and lines from a total station survey into a surface using the CHaMP protocol.
 C) Advanced Surveying (Total Station): you will learn how to collect points and lines that will be processed using GIS.

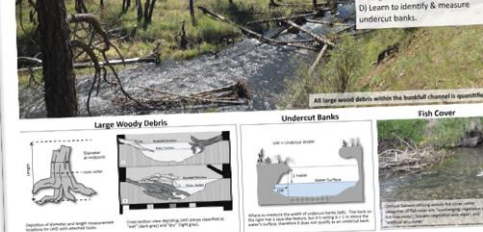
Module: Channel Unit Attributes

CHaMP Columbia Habitat Monitoring Program

Purpose:
To learn how to identify bankfull elevation, and quantify large woody debris (LWD), undercut banks, fish cover, and substrate composition.

Learning Outcomes:

- Learn to identify bankfull elevation, and quantify large woody debris (LWD), undercut banks, fish cover, and substrate composition.
- Learn to identify bankfull elevation, and quantify large woody debris (LWD), undercut banks, fish cover, and substrate composition.
- Learn to identify bankfull elevation, and quantify large woody debris (LWD), undercut banks, fish cover, and substrate composition.
- Learn to identify bankfull elevation, and quantify large woody debris (LWD), undercut banks, fish cover, and substrate composition.



Resources:

Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1331>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1332>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1333>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1334>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1335>
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 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1337>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1338>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1339>
 Channel Unit Classification: <https://www.champmonitoring.org/Program/TotalStation/Document/13/1340>

Connections to Other Modules:

A) Introduction to Topography: you will learn where to collect channel unit boundaries based on four elements.
 B) Advanced GIS: you will learn how to create the points and lines from a total station survey into a surface using the CHaMP protocol.
 C) Advanced Surveying (Total Station): you will learn how to collect points and lines that will be processed using GIS.



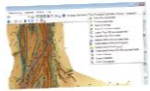
Module: Advanced GIS

CHaMP Columbia Habitat Monitoring Program

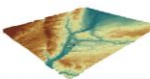
Purpose:
To successfully process a CHaMP survey through the CHaMP Toolbar and generate a 3D topographic surface.

Learning Outcomes:

1. Generate surfaces from total station point and line data.
2. Review accuracy of landscape representation in the surface.
3. Publish all files for upload to www.champmonitoring.org



The CHaMP User Promoting Toolbar in ArcMap. This can be used to upload the survey point data.



Digital Elevation Models (DEM) are used in CHaMP to create grid representations of topography and are used to derive many useful metrics and other simulation models. CHaMP DEMs are derived at 0.5m resolution from 3Dx.



Understanding the DEM helps the valley slope from the topography and highlights the local relief and morphology metrics to the stream. Once streamlines, water flow direction, stream can be simply represented using the derived CHaMP DEM with the older tool, that allows you to view and lower water levels like filling or draining a bathtub.

CHaMP Surveys transform real landscape features



Resources:
CHaMP GIS Processing Tutorial (GIS, Vector, TIN editing)
<http://www.champmonitoring.org/Program/Resource/Document/642/251>
CHaMP Toolbar Website
www.champmonitoring.org

Connections to Other Modules:
A) In the Surveying Module, you'll learn how to survey points.
B) In the Riparian Topography Module, you'll learn how to survey a stream bank.
C) In the Advanced Topography Module, you'll learn how to survey a stream bank and generate the total station data that will be imported into the CHaMP Toolbar.

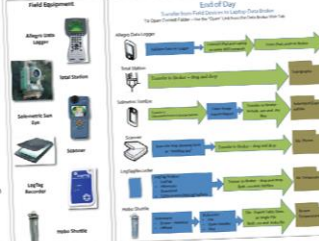
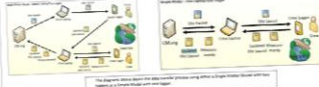
Module: Data / Gear Management

CHaMP Columbia Habitat Monitoring Program

Purpose:
The CHaMP information system includes a web-based interface (www.champmonitoring.org), Data Broker, and Logger. The goals of the information system include efficiently supporting field data collection and ensuring consistent high quality data.

Learning Outcomes:

- A) Review Hitches on www.champmonitoring.org
- B) Use Broker to acquire scanning materials for a hitch and a visit.
- C) Use Logger to download the visit packet from the Broker.
- D) Use Logger to validate and accept auxiliary data.
- E) Use Logger to upload the visit packet to the Broker.
- F) Use Laptop to download session packet to the Broker.
- G) Use Schematic software to post-process Skyline images.
- H) Use Broker to retrieve auxiliary files, photos, topographic files, solar input files, and scanned forms.
- I) Use Broker to accept visit files for upload to www.champmonitoring.org.
- J) Review Data Check-in status on www.champmonitoring.org.
- K) Review measurements on www.champmonitoring.org.



Resources:
Field Planning
Data Broker - Overview
Data Logger - Overview
Laptop Data Broker - Overview
Post Processing - Schematic Surfer
Landscape Data Broker - Upload Data
Landscape Data Broker - Upload Data
CHaMP Quality Assurance Guidelines

Module: Discharge and Drift

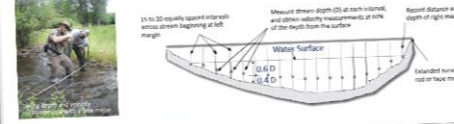
CHaMP Columbia Habitat Monitoring Program

Purpose:
To learn how to measure stream discharge and how to sample drift and how to calculate discharge.

Learning Outcomes:
A) Collect a quantitative sample that describes the abundance and composition of macroinvertebrates actively drifting in the water column and at water surface of a site.
B) Collect depth and velocity measurements at increments along a cross-section in order to calculate discharge at a site.



Cross-section of a streambed showing location of discharge measurements

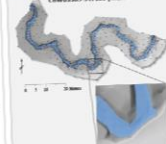


Resources:
CHaMP Tutorial
<http://www.champmonitoring.org/Program/Resource/Document/642/251>
Field Number Measurement Guide & Field Resource
<http://www.champmonitoring.org/Program/Resource/Document/642/251>
Field Number Measurement Guide & Field Resource
<http://www.champmonitoring.org/Program/Resource/Document/642/251>
CHaMP Macroinvertebrate Collection Form
<http://www.champmonitoring.org/Program/Resource/Document/642/251>
Macroinvertebrates - Bank Sample for Lab
<http://www.champmonitoring.org/Program/Resource/Document/642/251>

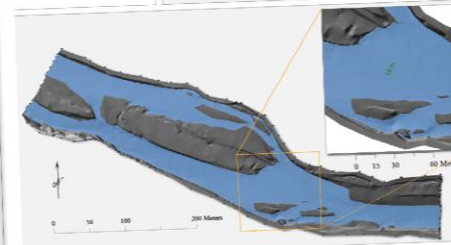
Module: Advanced Topography

CHaMP Columbia Habitat Monitoring Program

Purpose:
Provide hands-on training in topographic surveying by splitting into small groups and surveying a short section of stream. Emphasize (1) the importance of point spacing and distribution at sites of different sizes, (2) efficiency in survey workflow and good communication between riparian and gunner, and (3) how to best use the point and line codes



Learning Outcomes:
- Hands-on experience with surveying and using the total station and the prism rod
- Applied knowledge of survey point codes including when to use hard vs soft break lines
- Applied knowledge of "reading" the stream landscape
- Knowledge of several types of work flow strategies



Surveying work flow strategies:
Small streams can survey both banks and the channel in one visit.
Larger streams can survey one bank in the upstream direction, then survey the other bank during the downstream visit.
Double bank systems require 2-way radio communication.
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Double bank systems require 2-way radio communication.

Connections to Other Modules:
A) Surveying Total Station
B) Channel Structure Channel
C) Topo Survey Module

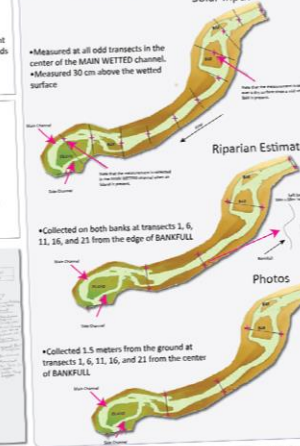
Resources:
Section 5.5 in the training version of the 2014 CHaMP Protocol
<http://www.champmonitoring.org/Program/Resource/Document/642/251>
CHaMP How To Guide: Surveying - Riparian
<http://www.champmonitoring.org/Program/Resource/Document/642/251>

Module: Solar Input, Riparian, Photos, Water Quality, Site Map

CHaMP Columbia Habitat Monitoring Program

Purpose:
This module covers how to measure transect and site level attributes. The primary objective is to install consistent and repeatable data collection methods while linking relationships between stream habitat and fish.

Learning Outcomes:
A) To understand how to use the SunEye to measure solar input.
B) To estimate riparian cover using standard measurement techniques.
C) To learn where and how to take photos at new and repair sites.
D) To learn how to use the conductivity meter and salinity kit.
E) To draw a detailed map that is useful for revisiting sites.



Connections to Other Modules:
A) During the Riparian Module, you will learn how to collect stream bank data.
B) During the Water Quality Module, you will learn about identifying water quality changes.

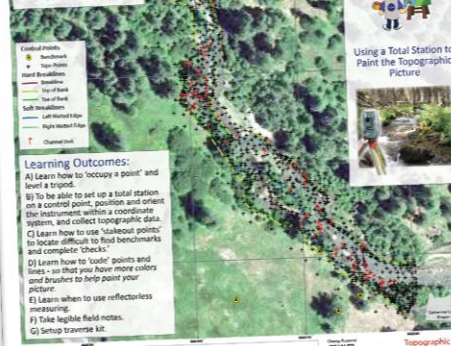
Resources:
Ability 19
SunEye Manual
Carter's Manual
<http://www.champmonitoring.org/Program/Resource/Document/642/251>

Module: Advanced Surveying (Total Station)

CHaMP Columbia Habitat Monitoring Program

Purpose:
To learn how to complete a topographic survey of a site with a total station.

Learning Outcomes:
A) Learn how to "occupy a point" and level a tripod.
B) To be able to set up a total station on a control point, position and orient the instrument within a coordinate system, and collect topographic data.
C) Learn how to use "stakeout points" to locate difficult to find benchmarks and complete "checks".
D) Learn how to "load" points and lines - so that your laser more colors and transfer to help your picture.
E) Learn when to use reflectorless measuring.
F) Take legible field notes.
G) Setup traverse kit.



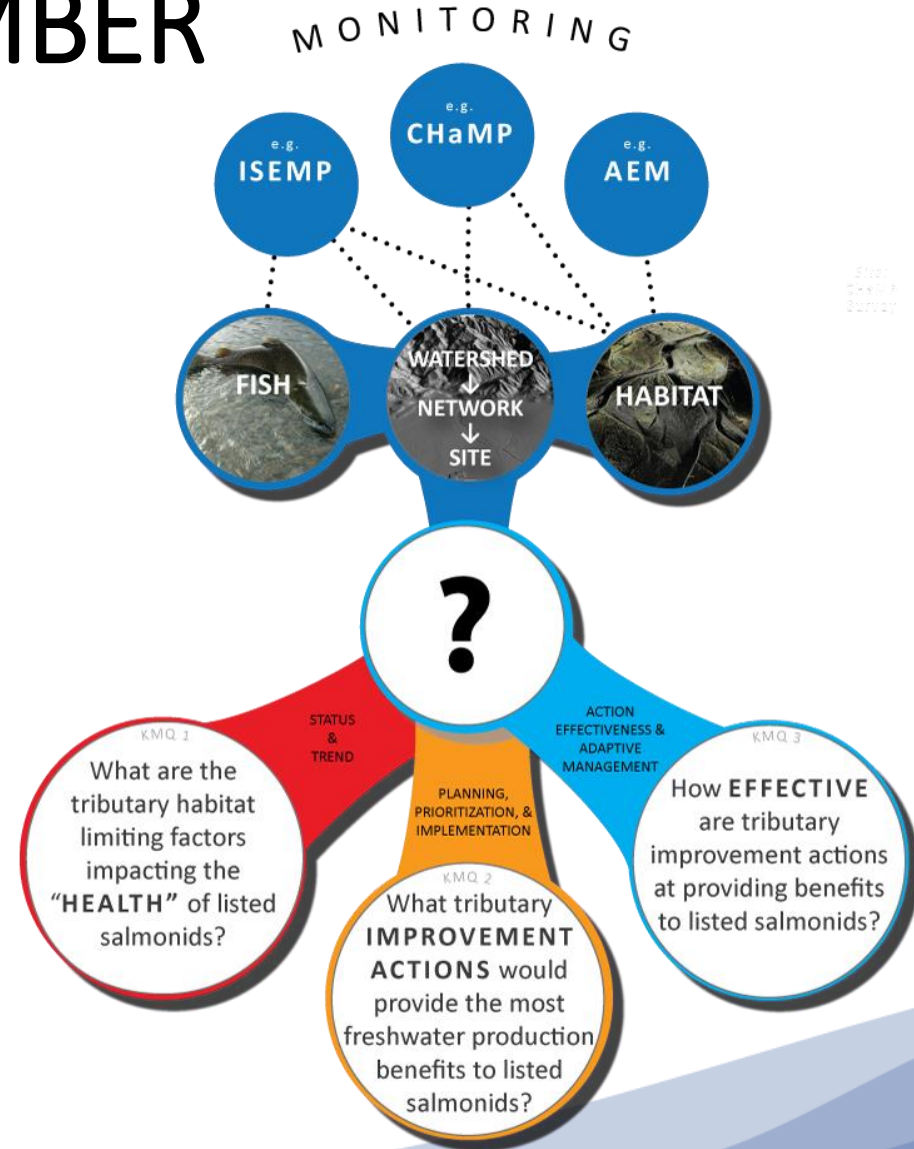
Resources:
CHaMP Tutorial
<http://www.champmonitoring.org/Program/Resource/Document/642/251>
Total Station Setup Module
<http://www.champmonitoring.org/Program/Resource/Document/642/251>
Benchmark Distribution Key
<http://www.champmonitoring.org/Program/Resource/Document/642/251>

Connections to Other Modules:
A) In the Surveying Module, you will learn about benchmarks, versus control points.
B) In the Riparian Module, you will learn how to use topographic data to create a stream bank map.
C) In the Advanced Topography Module, you will learn how to use topographic data to create a stream bank map.

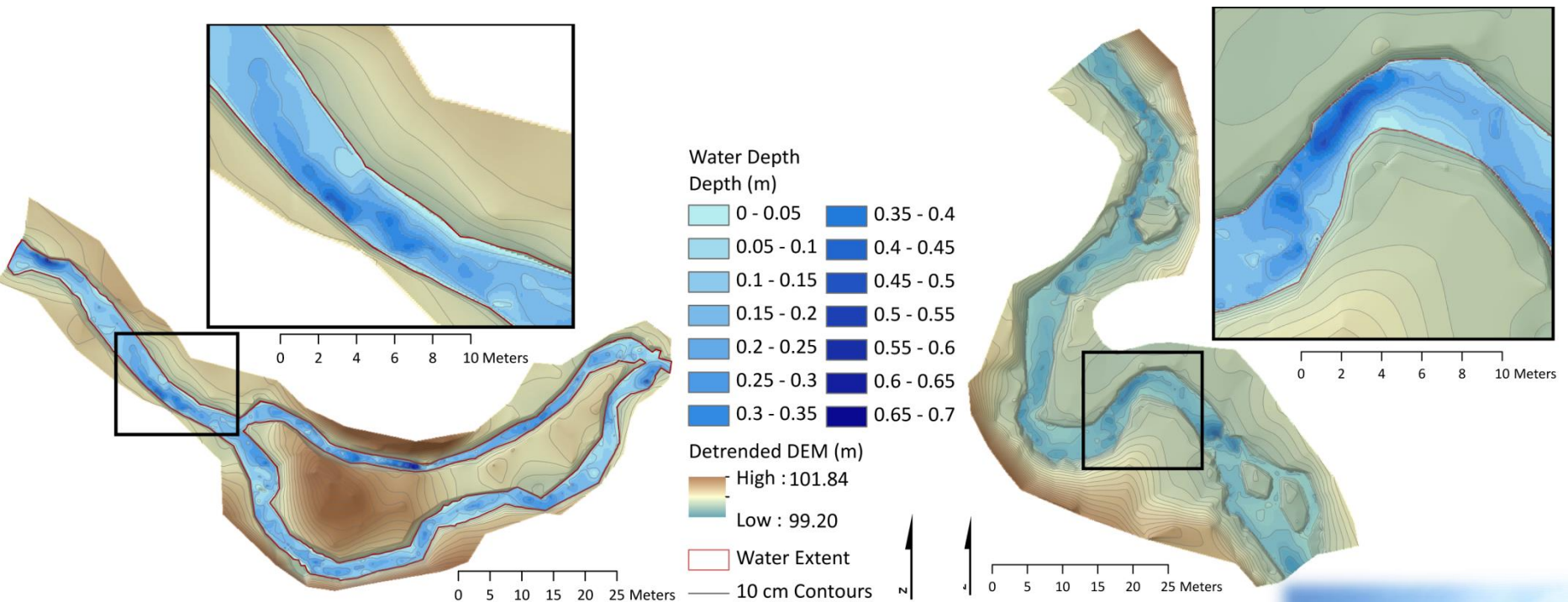


WHAT YOU'LL BE DOING AS A CHaMP CREW MEMBER

- Honing your skills as a topographic artist!
- Helping collect data that is actively being used to address KMQs related to salmon
- Contributing to building a rich archive of data that will be harvested for many years to come



MAKING PRETTY MAPS IS A BIG PART...



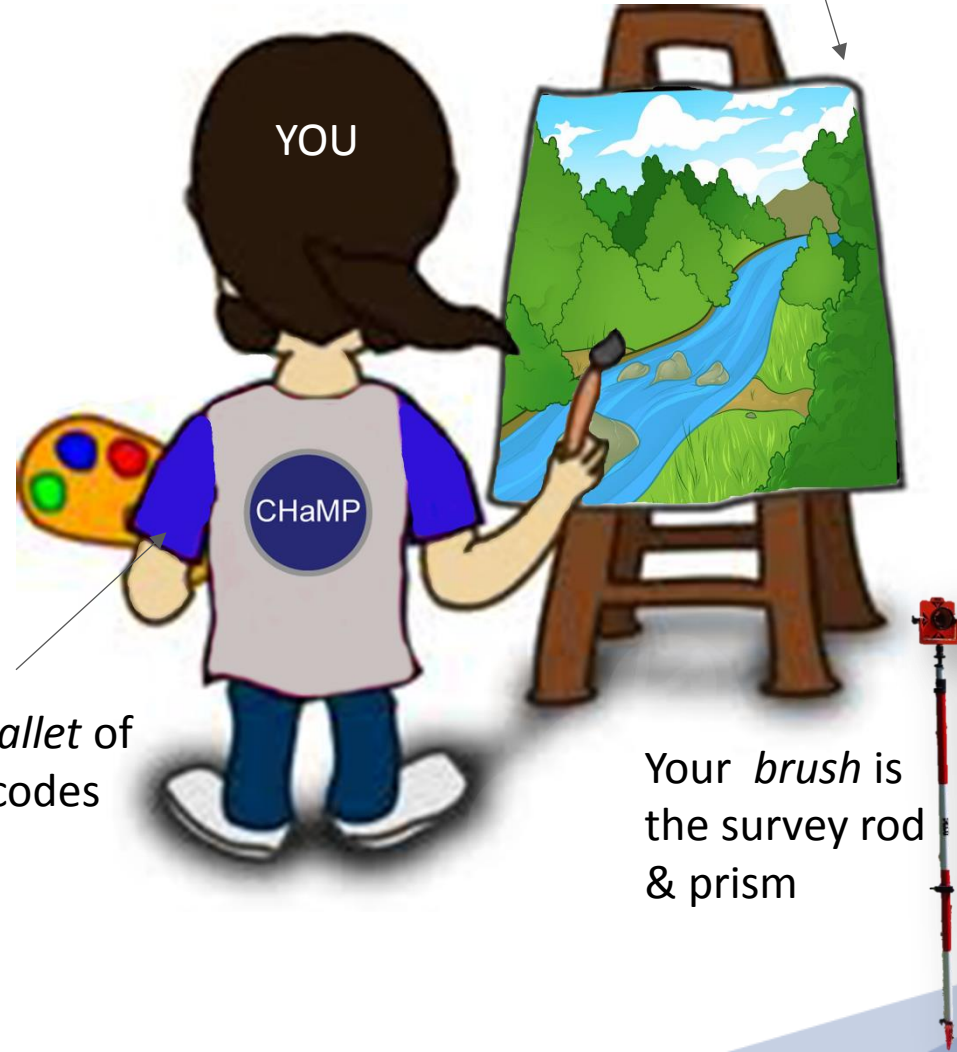
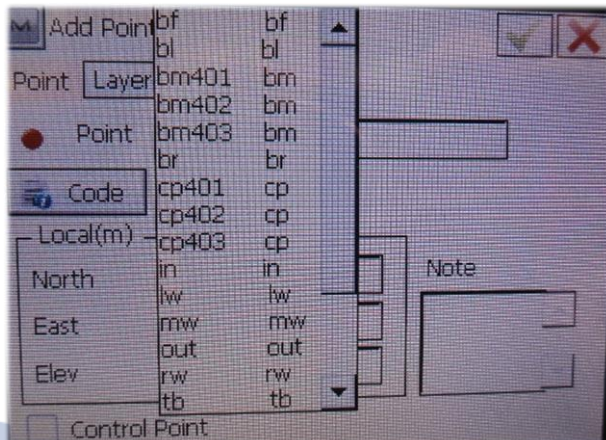
- You are both artists and technicians... you need to paint us a quantitative picture



Your *canvas* is
the site extent

YOU ARE NOT JUST SURVEYORS YOU ARE ARTISTS...

- We define for you:
 - The subject matter
 - The medium
 - The pallet



BUT, YOU ARE NOT ABSTRACT ARTISTS!

- Think of it as a pen & ink dot drawing....
- OR a detailed oil painting (when you connect the dots in GIS)
- NOT a watercolor
- NOT an abstraction



MODULES YOU'LL LEARN HOW TO DO THE PEN WORK (DOTS)

- Intro to Topography (Rod)

- Advanced Topography (Rod)



Module: Intro to Topography CHaMP Columbia Habitat Monitoring Program

Methow River (CBW05583-266521)

Purpose: Introduce and explain the role of the rod person in the topographic survey.

Learning Outcomes:

- Familiarity with the prism rod and prism assembly
- Knowledge of survey point codes
- Knowledge of points and lines
- Familiarity with ways to survey efficiently and smartly
- An understanding of how to "read" and survey the fluvial landscape including knowing how to identify:
 - concavities
 - convexities
 - inflection points
 - channel features
 - floodplain and bank

Lines surveyed in the topographic survey to illustrate linear features in the landscape. Lines are over the white top of the sticks to replicate a visualization in the TRS.

Top of Site

Bottom of Site

2-3' view of the TRS (shown over a hillside) at the bottom of the stream. In an arroyo, concavities, convexities and inflection points, important features in the longitudinal profile of the stream, are visible. Notice that bankfull (BF) was surveyed on each bank.

Water	10	Left side of point
Bank	11 <td>Right side of point</td>	Right side of point
Feature	12 <td>Channel head</td>	Channel head
	13	Bank break line
	14	Point
	15	Bank toe
	16	Bank top
	17	Bank toe
	18	Bank top
	19	Channel
	20	Channel
	21	Channel
	22	Channel
	23	Channel
	24	Channel
	25	Channel
	26	Channel
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	60	Channel

Important Definitions:

Inflection point: change in slope, or transition from a convexity to a concavity.

Concavity: topographical high point. An inflex to a convexity in the longitudinal profile of a stream.

Convexity: topographical low point. The deepest part of a pool is an example of a convexity.

Resources:

Section 5.8 in the training version of the 2014 CHaMP Protocol
<https://www.columbiahabitatsurveying.org/Program/Resource/inflectionpoint/144>

CHaMP How To Guide: "Surveying - Rodman Methods and Guidelines"
<https://www.columbiahabitatsurveying.org/Program/Resource/inflectionpoint/1335>

Connections to Other Modules:

- (A) Dear Maintenance Module
- (B) Generalized Spatial Indices
- (C) Channel Units/State Channels module
- (D) Site Survey Module

Module: Advanced Topography CHaMP Columbia Habitat Monitoring Program

Purpose: Provide hands-on training in topographic surveying by splitting into small groups and surveying a short section of stream. Emphasis: (1) the importance of point spacing and distribution at sites of different sizes, (2) efficiency in survey workflow and good communication between rodman and gunner, and (3) how to best use the point and line codes.

Learning Outcomes:

- Hands-on experience with surveying and using the total station and the prism rod
- Applied knowledge of survey point codes including when to use hard vs soft break lines
- Applied knowledge of "reading" the riverine landscape
- Knowledge of several types of work flow strategies

Surveying work flow strategies:

- Small streams: can survey both bank and the channel in one pass. Utilize vertical communication.
- Large streams: survey along one bank in the address direction, then survey the second channel making downstream, then survey the other bank in reverse direction. Utilize hand signals and 2-way radio communication.
- Double rod survey:
 - 1) Split into two teams getting the shot on one side. Rodman on green area. Prism gunner (to cover with hand) to keep both ends of the work length as both as possible.

Connections to Other Modules:

- (A) Learning (rod station)
- (B) Channel Units/State Channels module
- (C) The Survey Module

Resources:

Section 5.8 in the training version of the 2014 CHaMP Protocol
<https://www.columbiahabitatsurveying.org/Program/Resource/inflectionpoint/144>

CHaMP How To Guide: "Surveying - Rodman Methods and Guidelines"
<https://www.columbiahabitatsurveying.org/Program/Resource/inflectionpoint/1335>



PURPOSE OF TALK



- Address:

How do you account for fish habitat with a total station?



OUTLINE

HOW DO YOU ACCOUNT FOR FISH HABITAT WITH A TOTAL STATION?

I. Background

II. Painting a Picture of Habitat – Topographically

III. Quantifying Habitat – From Topography

I. Hydraulics

II. Geomorphology

III. Fish Habitat

IV. Some Other Useful Byproducts of Topography

V. Take Homes

HOW DO WE CHARACTERIZE HABITAT?

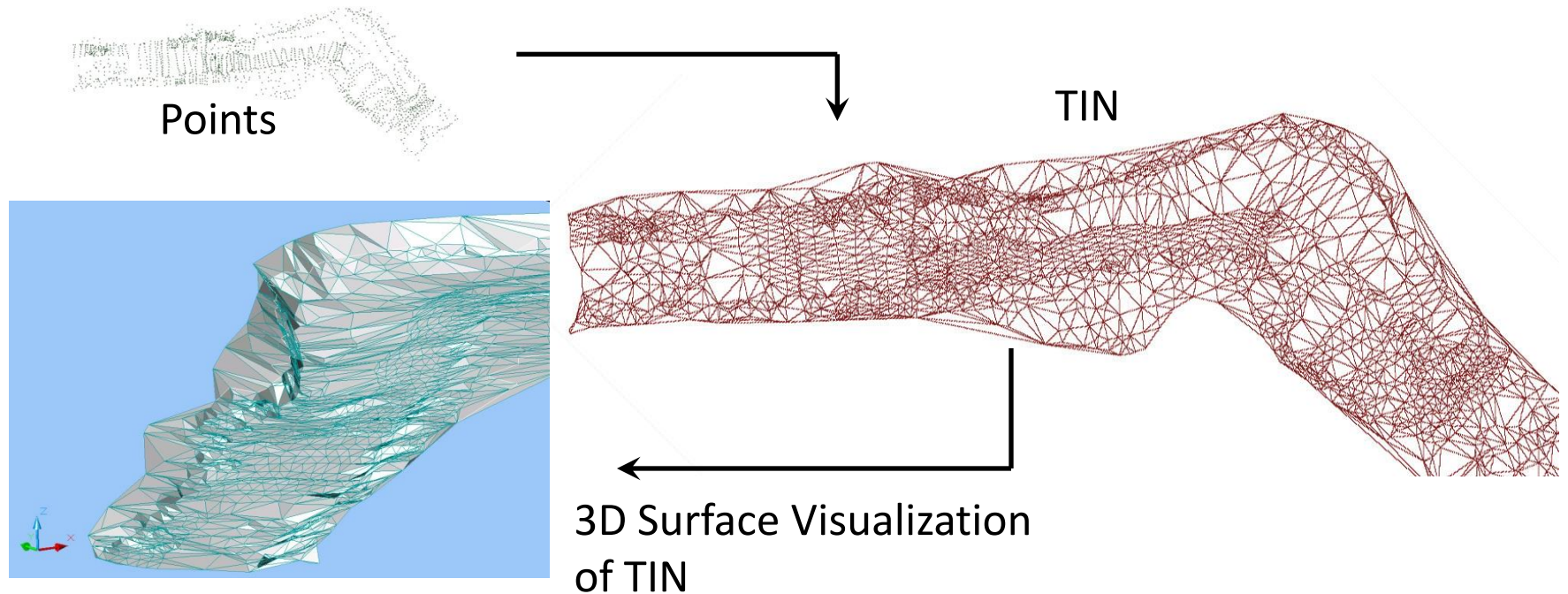
- Can be done with stick & tape



- But when we do it with topography, we can support a richer range of more mechanistic analyses

BUILDING A TIN FROM XYZ Points

Triangular Irregular Network (TIN): the simplest and most common interpolation technique for building surfaces with irregularly spaced elevation data (McCullagh, 1981)

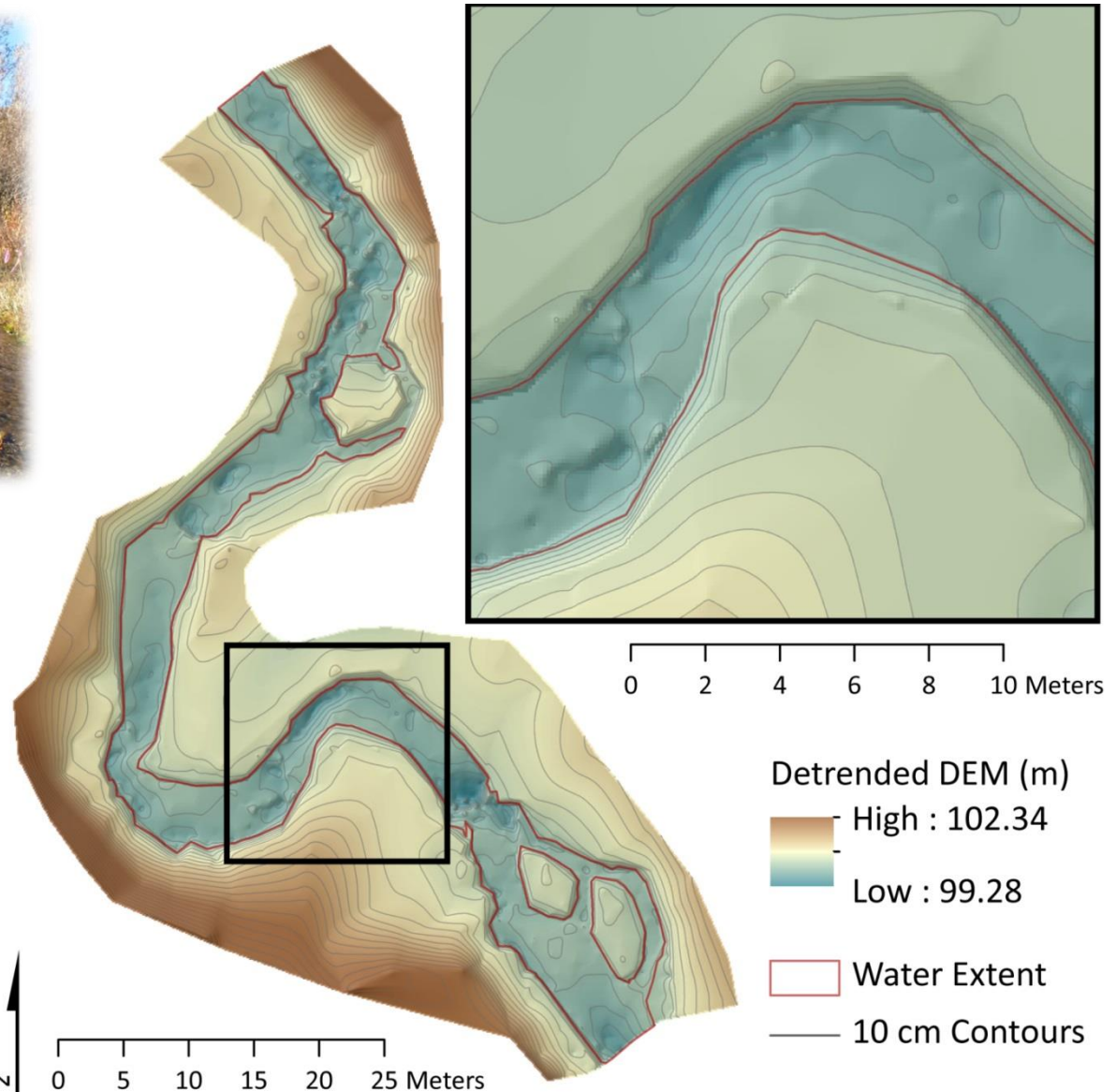
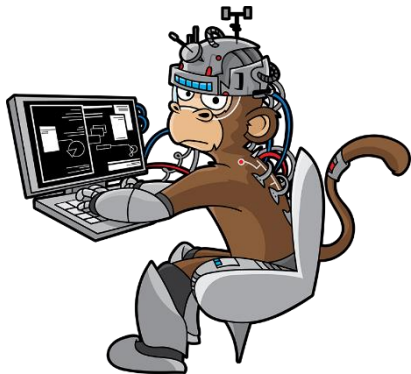


McCullagh MJ. 1981. Creation of smooth contours over irregularly distributed data using local surface patches. *Geophysical Analysis*. 13: 51-63.

YOU TAKE OWNERSHIP OF THE DATA

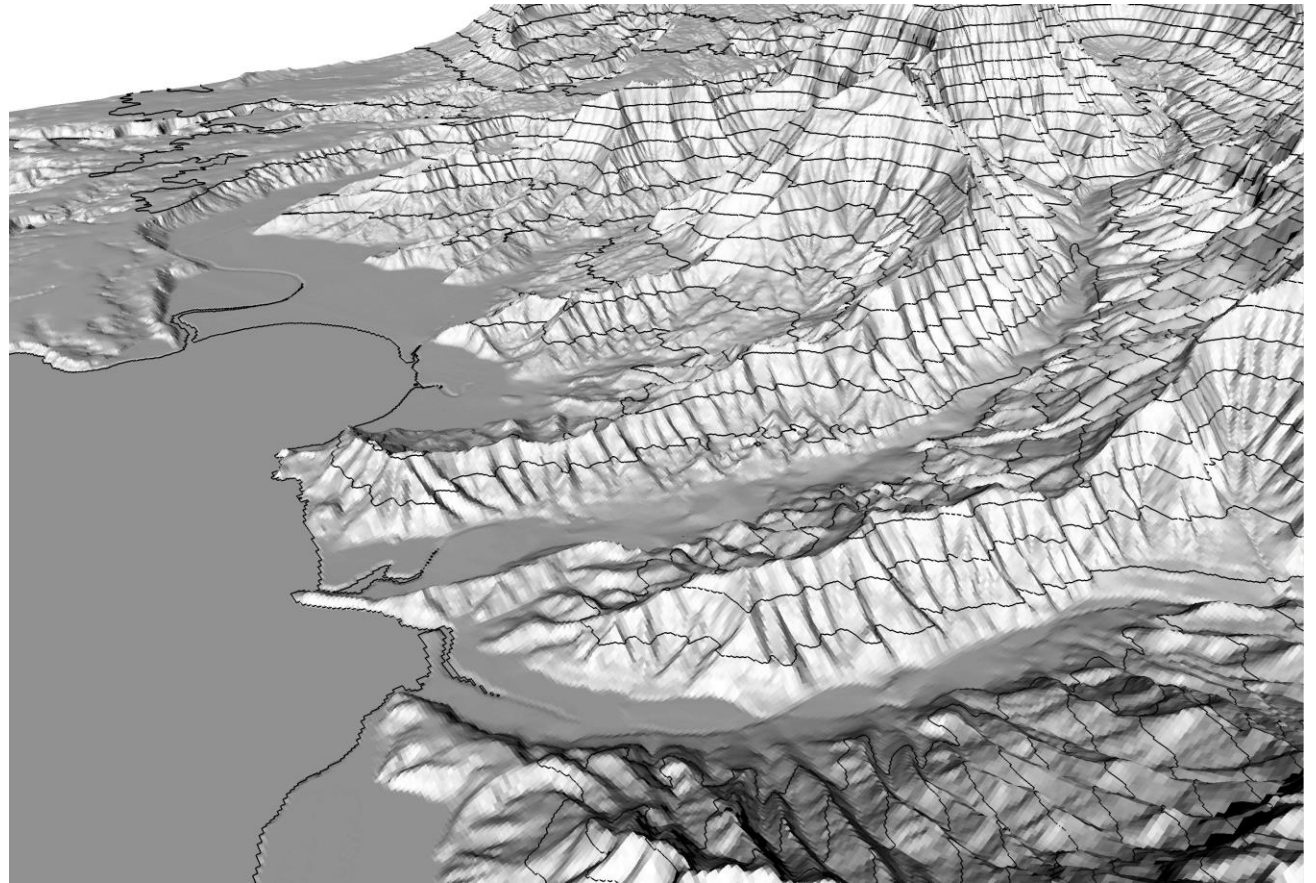


Crews post process the data!



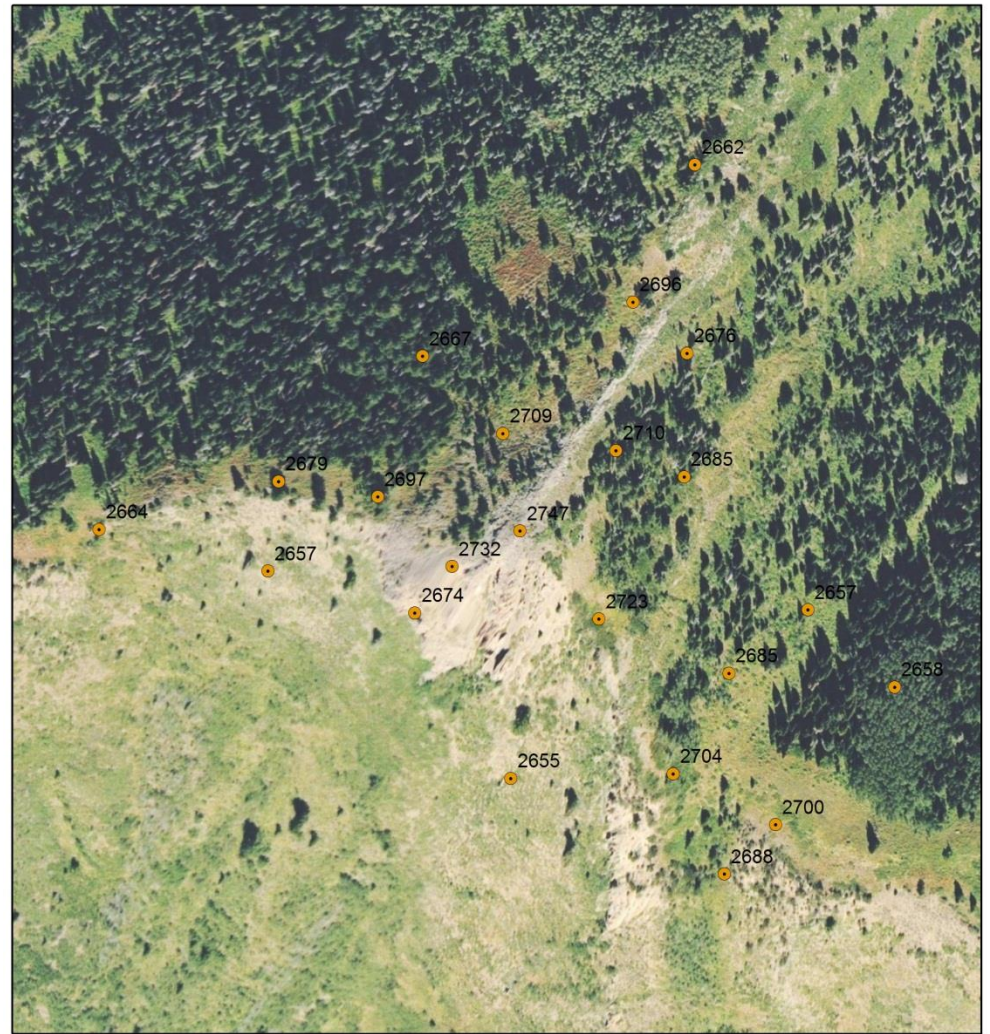
CONTOURS

- Lines of equal elevation... helps when draped over a 3D hillshade...

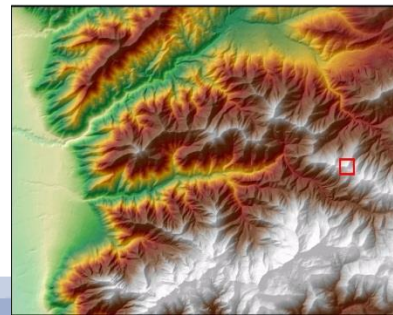


AN EXERCISE

- Elevations are real
 - Derived from 10 m DEM
- Integer Elevations
 - Rounded up elevations
- Context:
 - This is a peak where three ridges come together
 - Up between Big Cottonwood and Little Cottonwood Canyons in Wasatch Mountains



0 25 50 75 100 125 150 175 200 Meters

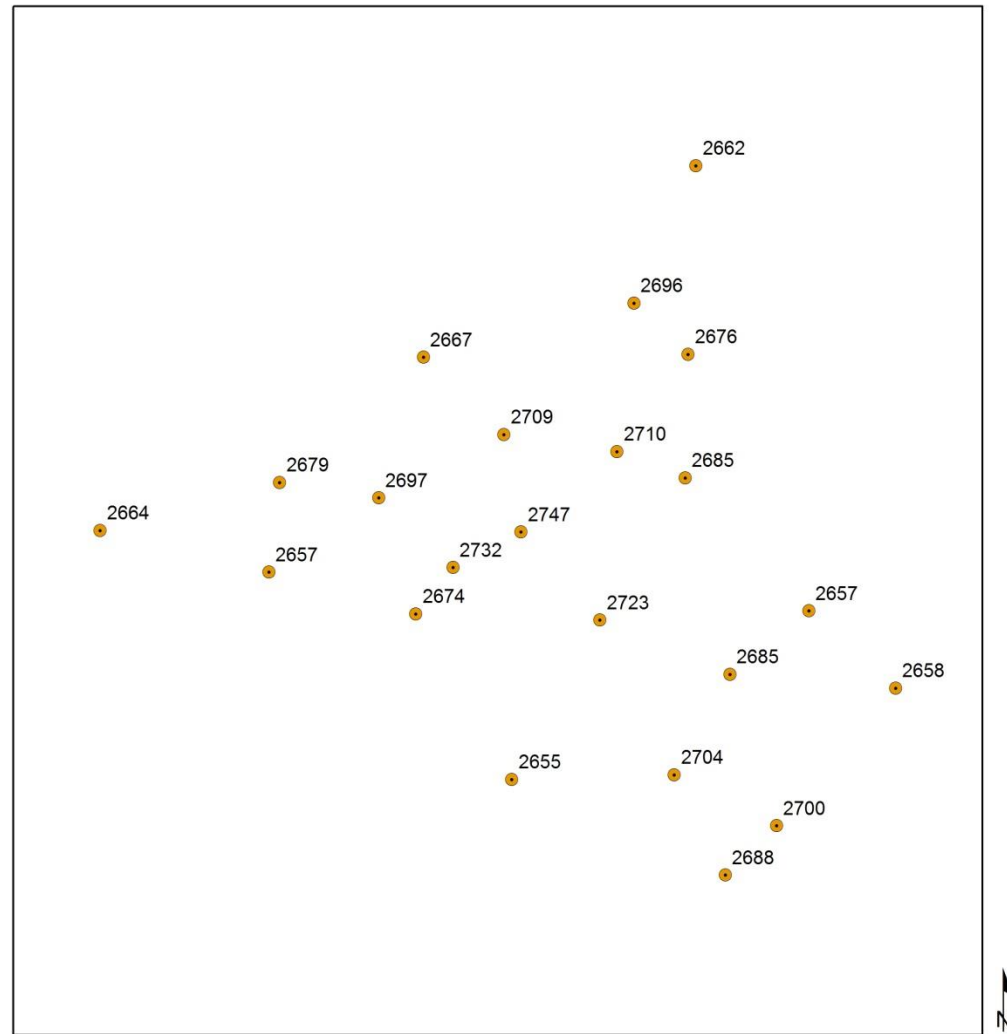


INSTRUCTIONS:

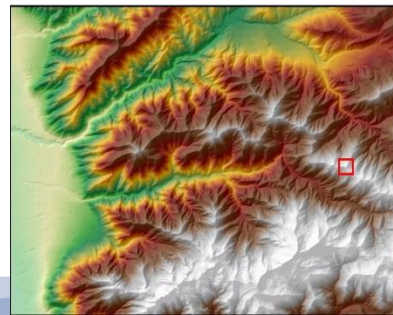
1. Connect all the dots to create a TIN
2. For each TIN edge, determine how many contours would intersect it at a 10 m contour interval (lightly label the contours)
3. Connect the contours up to draw a contour map

OVERVIEW

- We want to make a Contour Map from These Points
- Make a TIN first
- Divide up the tin lines by where our contour interval intersects them
- Connect the dots (those lines are contours)
- Label your Contours



0 25 50 75 100 125 150 175 200 Meters

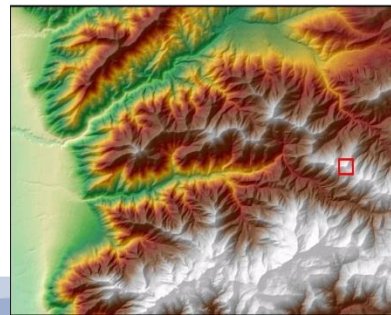
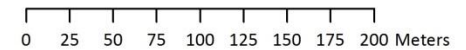
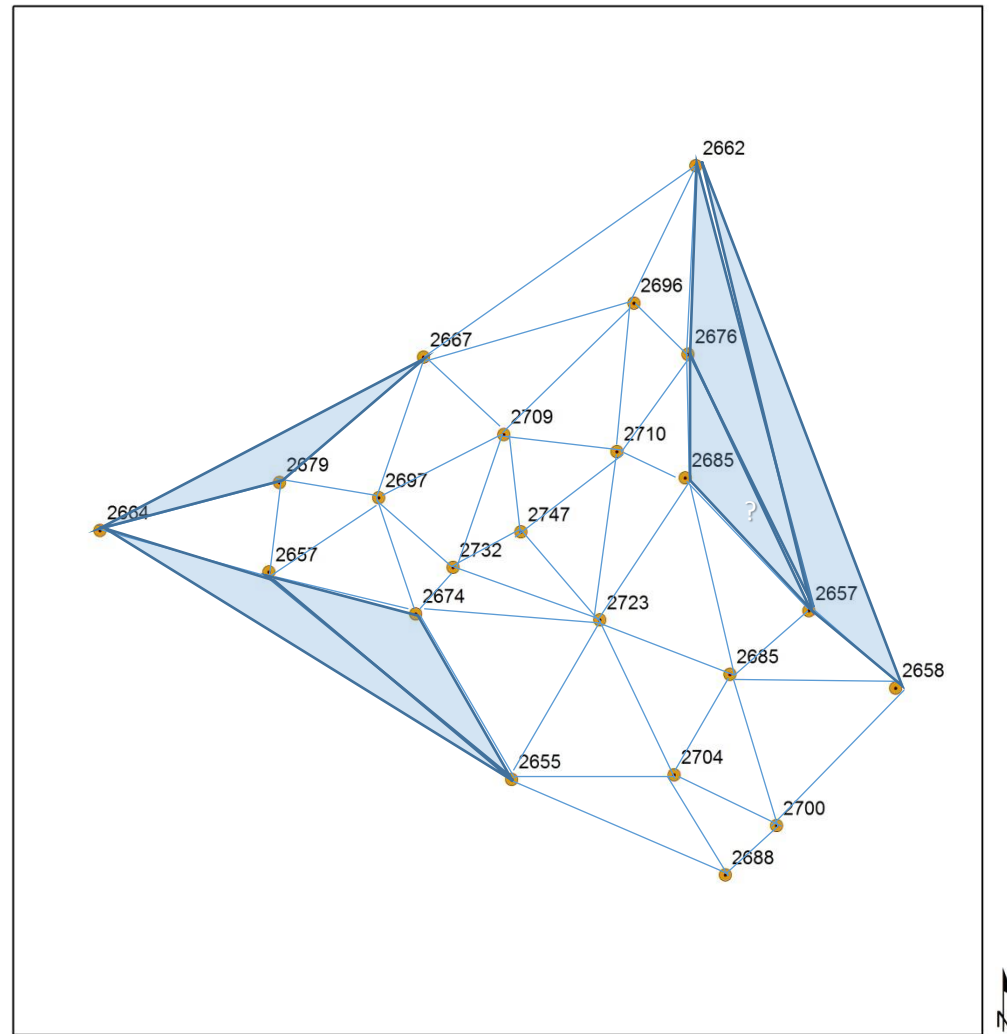


INSTRUCTIONS:

1. Connect all the dots to create a TIN
2. For each TIN edge, determine how many contours would intersect it at a 10 m contour interval (lightly label the contours)
3. Connect the contours up to draw a contour map

CONNECTING DOTS

- Start anywhere...
- Find three closest points
- Try and make your triangles as equilateral as possible...
- Careful with over interpolation

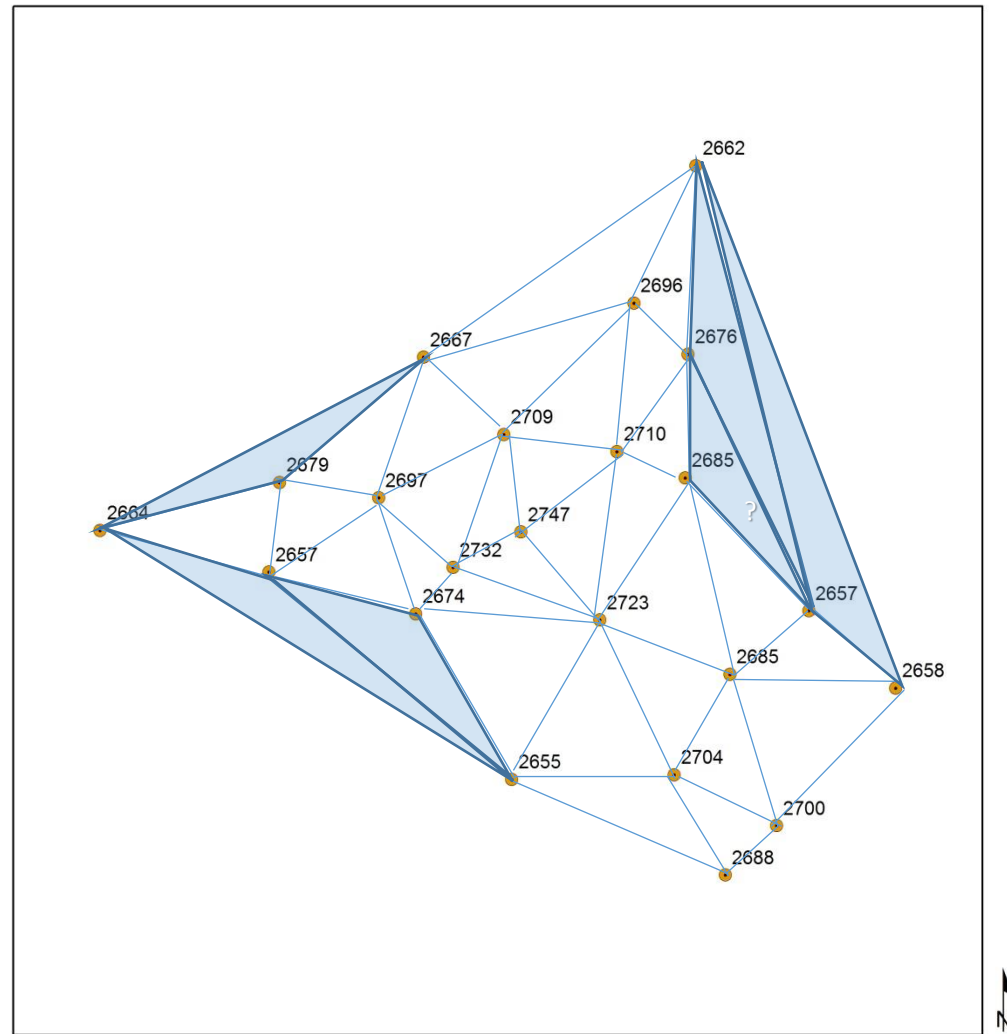


INSTRUCTIONS:

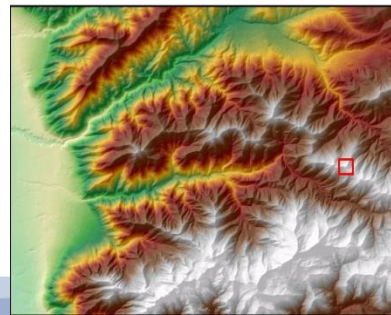
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CONNECTING DOTS

- Start anywhere...
- Find three closest points
- Try and make your triangles as equilateral as possible...
- **Careful with over interpolation**



0 25 50 75 100 125 150 175 200 Meters

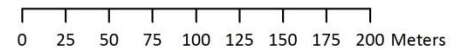
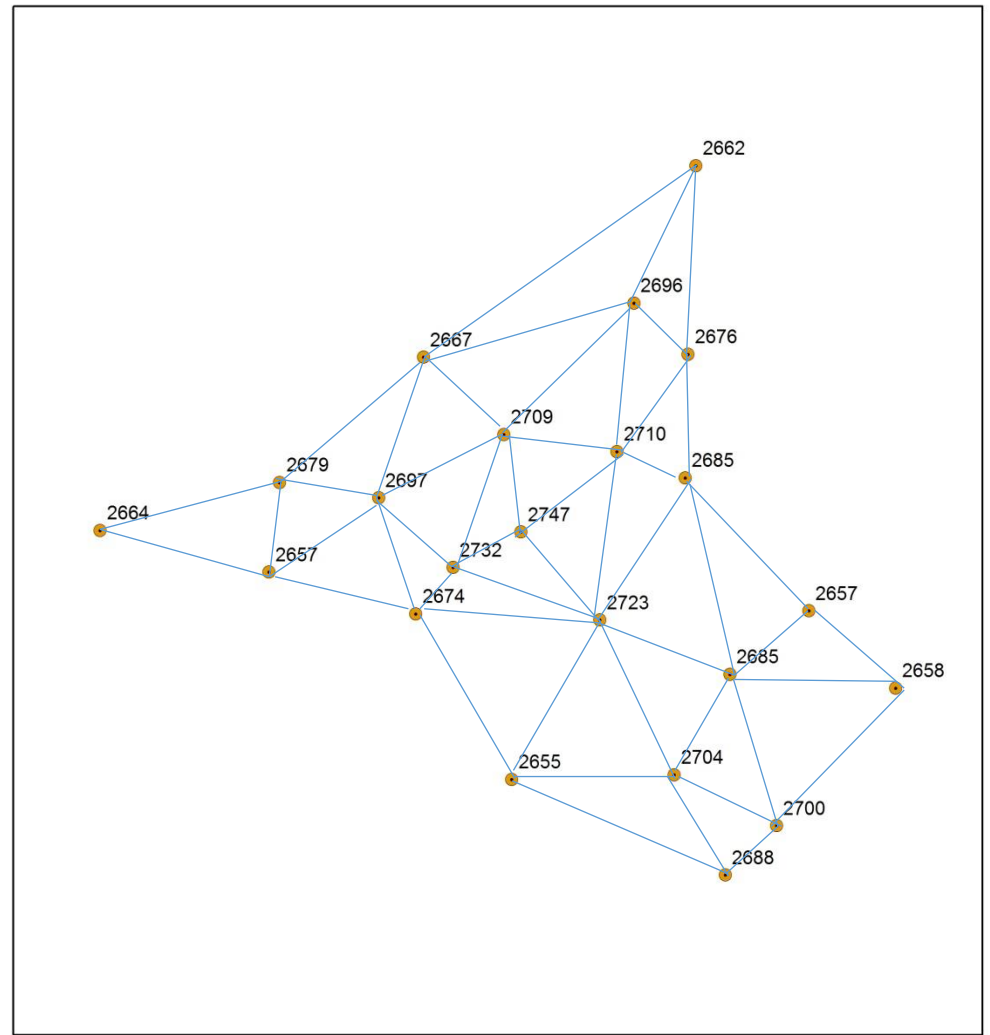


INSTRUCTIONS:

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3. Connect the contours up to draw a contour map

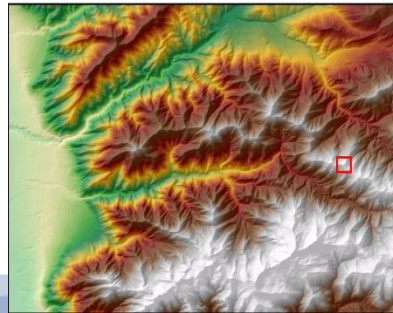
A TIN to CONTOURS

- What is max elevation?
 - 2747 m
- What is minimum elevation?
 - 2657 m
- What is elevation range?
 - $2747 - 2657 = 90$ m
- What is a good contour interval?
 - How about 10 m?



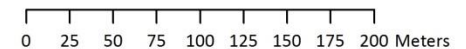
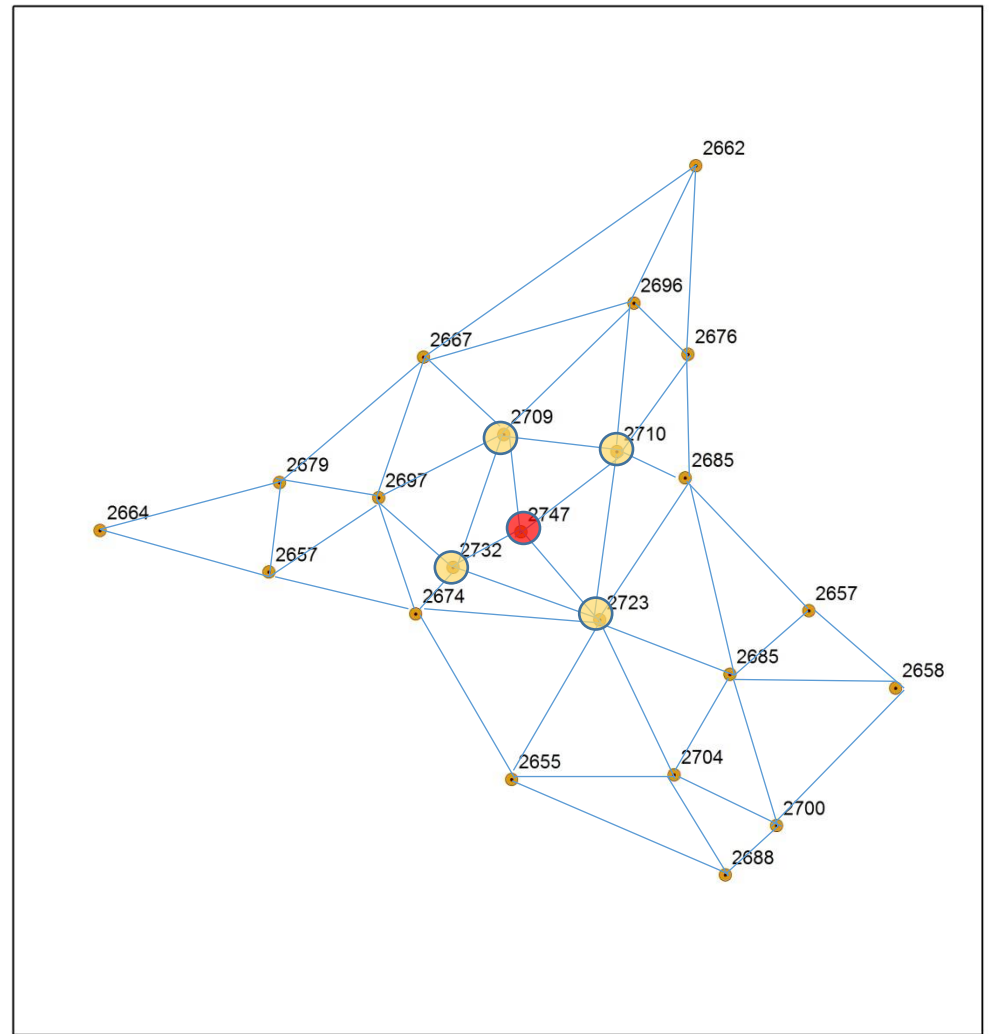
INSTRUCTIONS:

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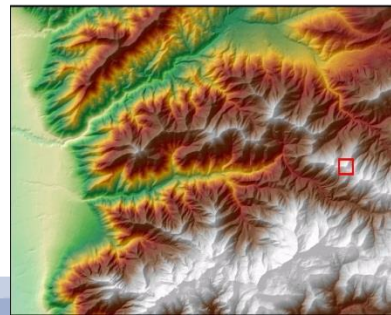
A TIN to CONTOURS

- Using a 10 meter contour interval... start with 2740 contour
- Find **point(s)** higher than 2740
 - Find connecting **lower points**
 - Put equidistant 1 m contour ticks between lines from 2747 to nearest lower neighbors.
 - Count down 7 to 2740, and make bold
 - Connect dots (linearly or artistically)



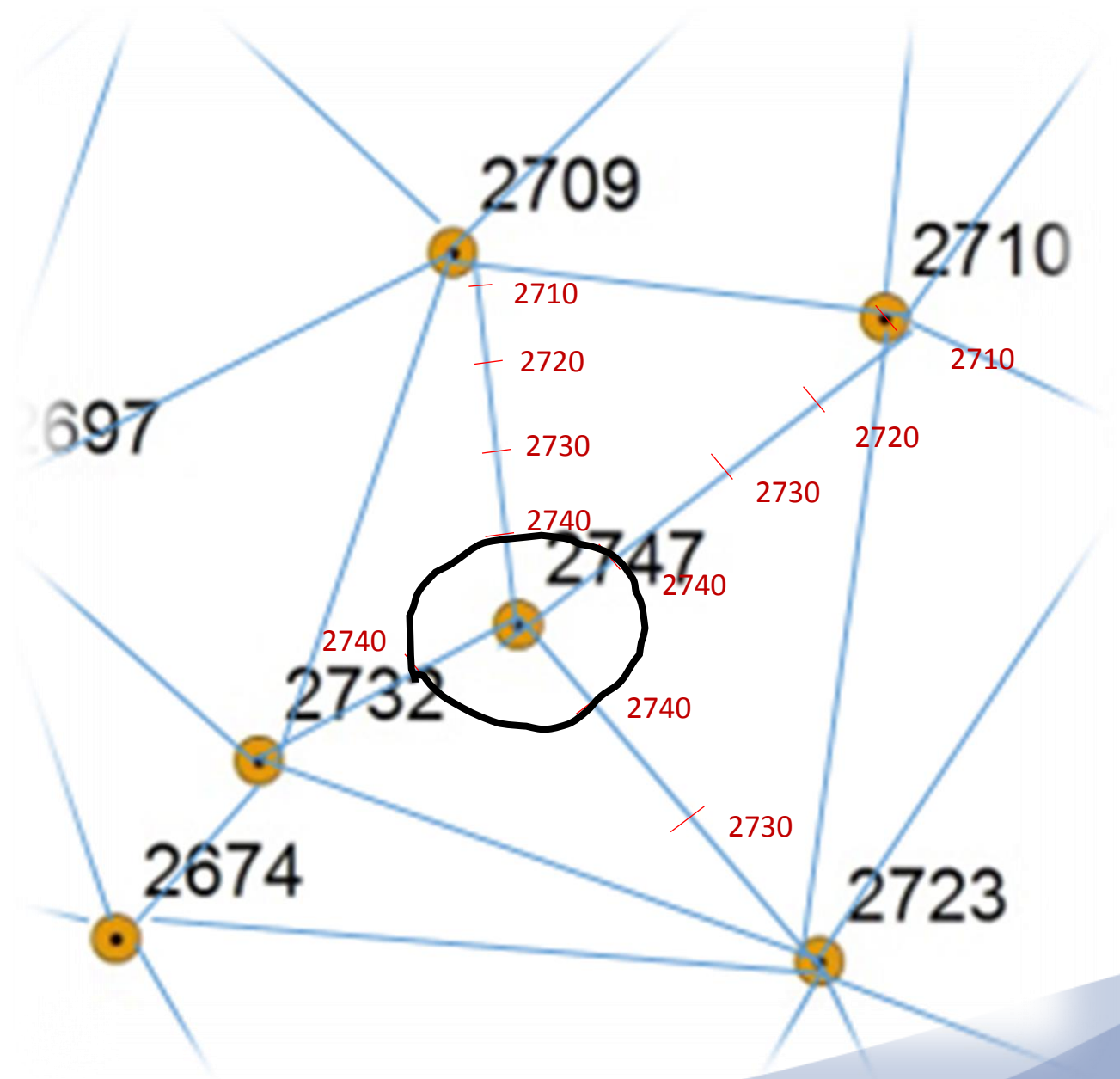
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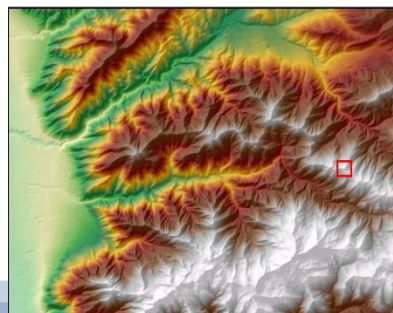
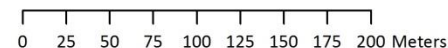
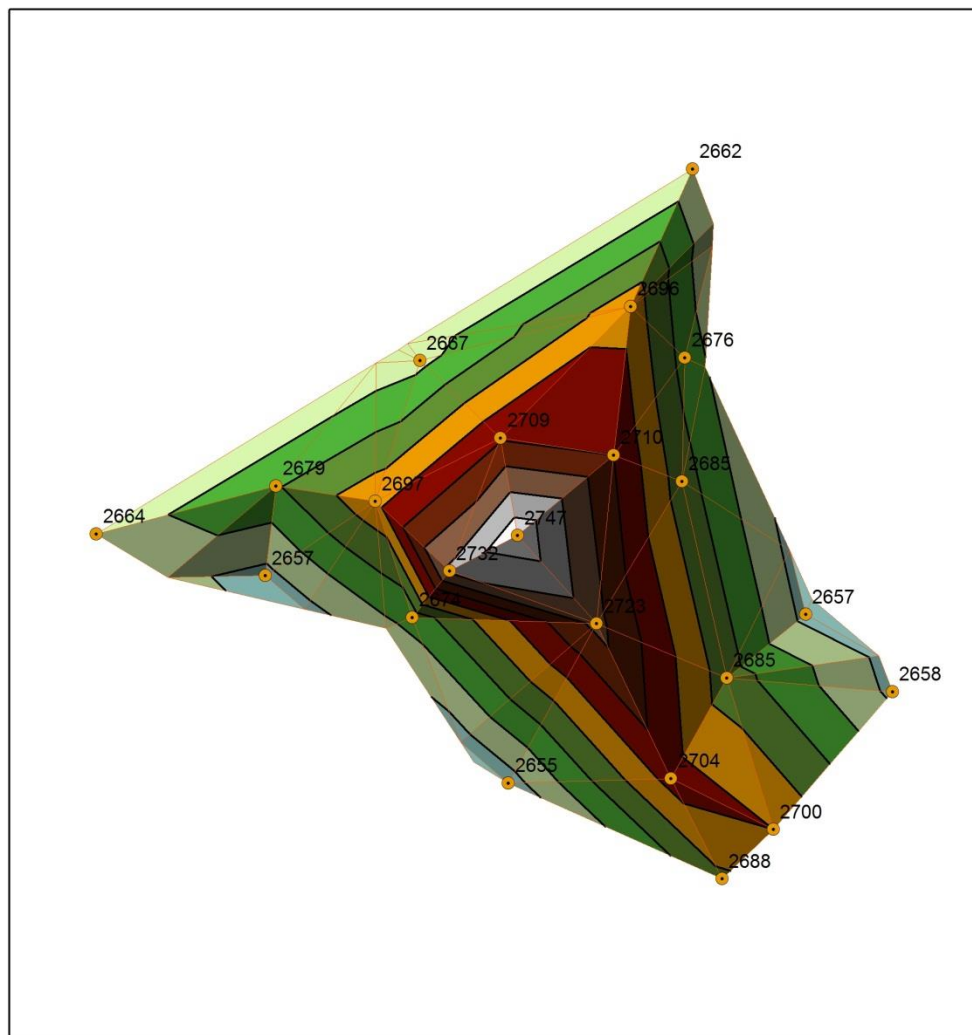
CONTOURS

1. Put ticks where 10 m contours would be
2. Between 2747 and 2732 how many 10 m contours?



YOUR CONTOURS?

- Here's the ArcGIS derived TIN shown w/ same 10 m contour interval you should have used
- How close does yours look to this?



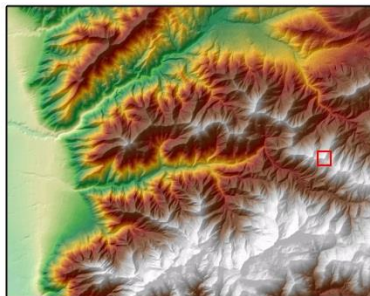
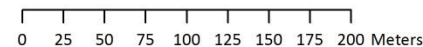
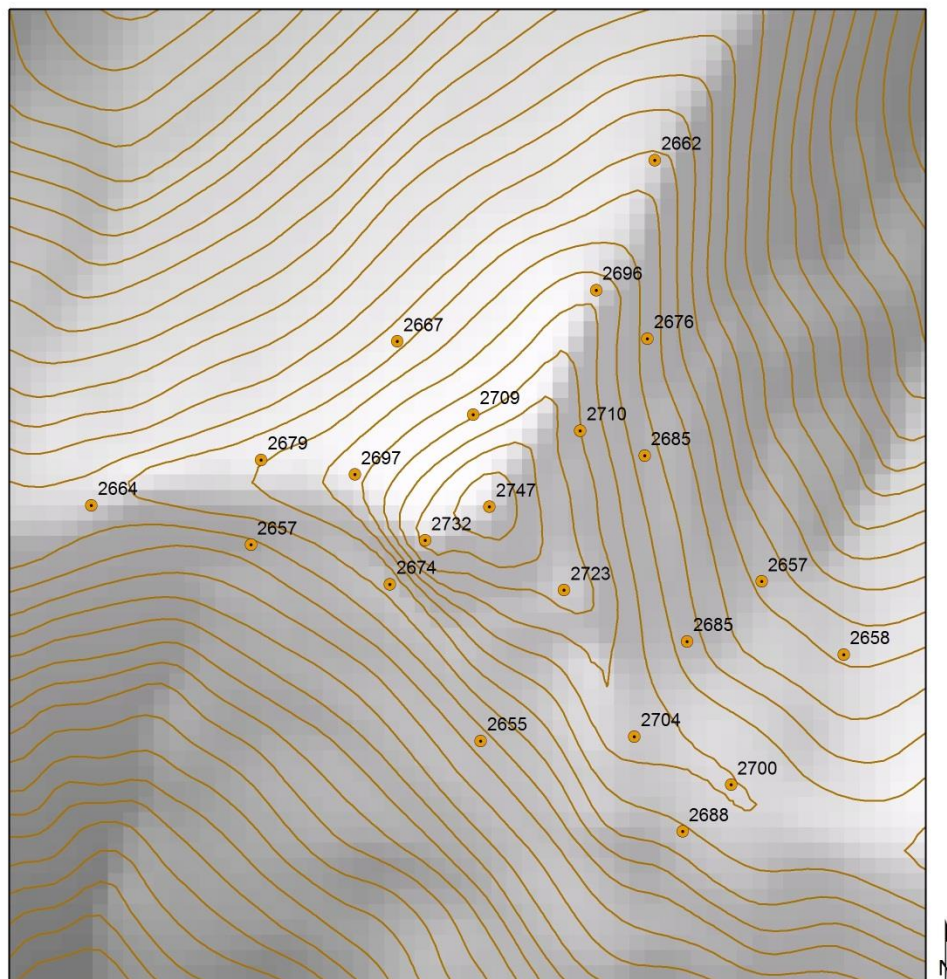
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3. Connect the contours up to draw a contour map

ACTUAL

- Here's what the actual 10 m contours look like for this location
- Hillshade shown in background
- Both derived from USGS NED 10 m DEM

TIN & CONTOUR EXERCISE



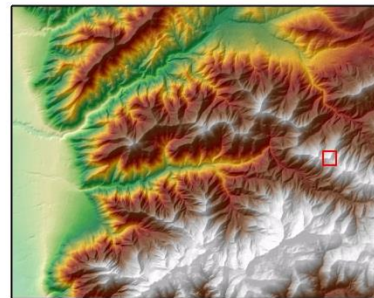
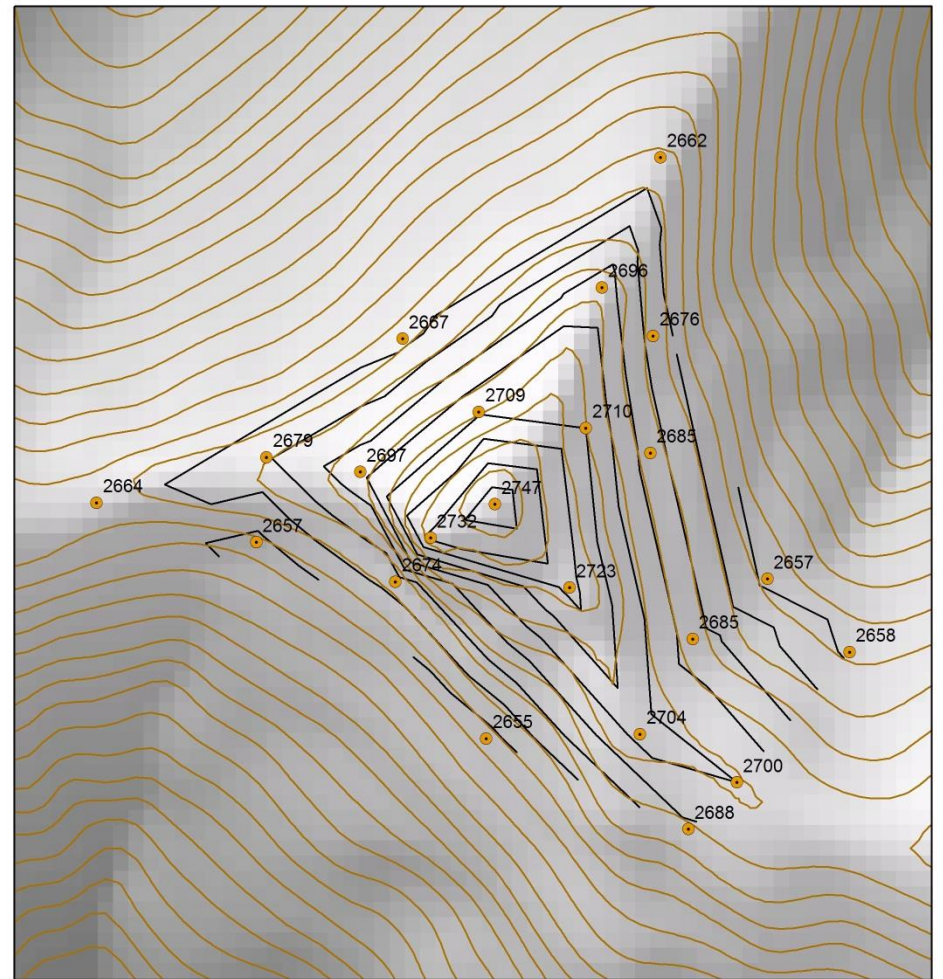
INSTRUCTIONS:

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3. Connect the contours up to draw a contour map

COMPARED

- Reasonably close...
- Why are they different?
- How many points did we use (i.e. sample)?
- How many points were used for brown contours?
- What is difference between contour interval, pixel resolution and point resolution?

TIN & CONTOUR EXERCISE



0 25 50 75 100 125 150 175 200 Meters

INSTRUCTIONS:

1. Connect all the dots to create a TIN
2. For each TIN edge, determine how many contours would intersect it at a 10 m contour interval (lightly label the contours)
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OUTLINE

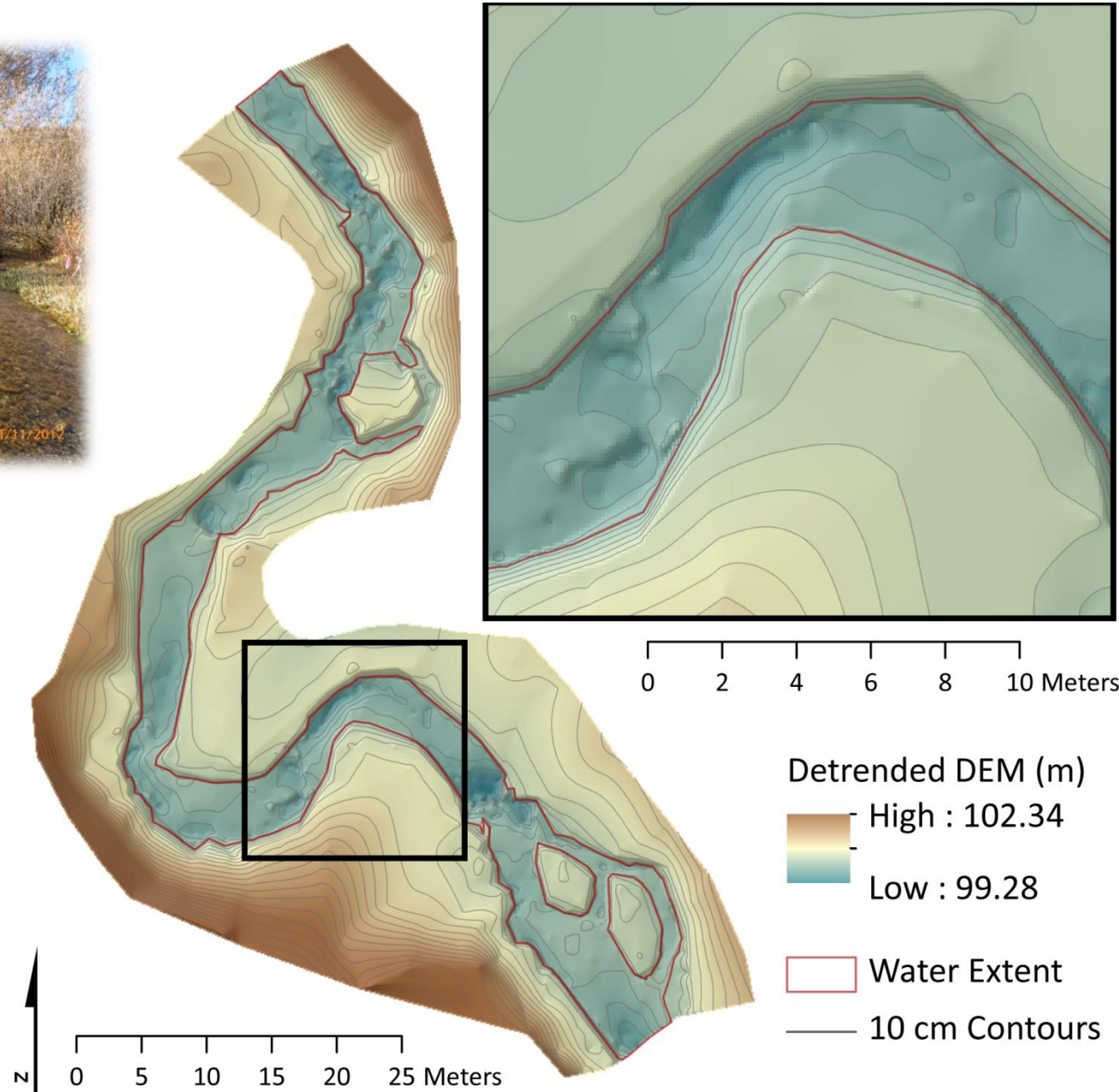
HOW DO YOU ACCOUNT FOR FISH HABITAT WITH A TOTAL STATION?

- I. Background
- II. Painting a Picture of Habitat – Topographically
- III. Quantifying Habitat – From Topography**
 - I. Hydraulics
 - II. Geomorphology
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- IV. Some Other Useful Byproducts of Topography
- V. Take Homes

WHAT DO YOU DO WITH TOPO SURVEY?



1. Build TIN
2. Convert to DEM
3. Detrend
4. Morphology Pops out
5. Flood....



MODULES YOU'LL LEARN HOW TO CONNECT THE DOTS

- Intro to GIS

- Advanced GIS

Module: Intro to Surveying (Total Station) CHaMP Columbia Habitat Monitoring Program

PURPOSE:
To show how topographic data is acquired with a total station so that you can paint a topographic picture of your site quantitatively.

Painting a Picture of the Riverine Landscape

Using a Total Station to Paint the Topographic Picture

Control Points:
• Benchmark
• Topographic
• Head Breaklines
• Breakline
• Top of Bank
• Low of Bank
• Sub Breaklines
• Left Wetland Edge
• Right Wetland Edge
• Channel Edge

Learning Outcomes:
A) Learn how to 'occupy a point' and level a tripod.
B) To be able to set up a total station on a control point, position and orient the instrument within a coordinate system, and collect topographic data.

Resources:
CHaMP Protocol: <https://www.champmonitoring.org/Program/Protocol/DocumentFile/1/103>
Intro to Surveying Manual: <https://www.champmonitoring.org/Program/Detail/DocumentFile/2/334>
Total Station Setup Movie: <https://www.champmonitoring.org/Program/Detail/DocumentFile/2/334>
Benchmark Dichotomous Key: <https://www.champmonitoring.org/Program/Detail/DocumentFile/1/103>

Connections to Other Modules:
A) Introduction to Topography (IHP) you will learn where to collect these points.
B) Site Setup, you will learn more about benchmarks, control points.
C) Top to Bottom, you will learn how to use topographic data collected here, to paint the picture topographically.
D) In Advanced Surveying with a Total Station, you will learn how to actually perform a complete survey.

Topographic Picture DEM & Water Depth

Module: Advanced Surveying (Total Station) CHaMP Columbia Habitat Monitoring Program

Purpose:
To learn how to complete a topographic survey of a site with a total station.

Painting a Picture of the Riverine Landscape

Using a Total Station to Paint the Topographic Picture

Control Points:
• Benchmark
• Topographic
• Head Breaklines
• Breakline
• Top of Bank
• Low of Bank
• Sub Breaklines
• Left Wetland Edge
• Right Wetland Edge
• Channel Edge

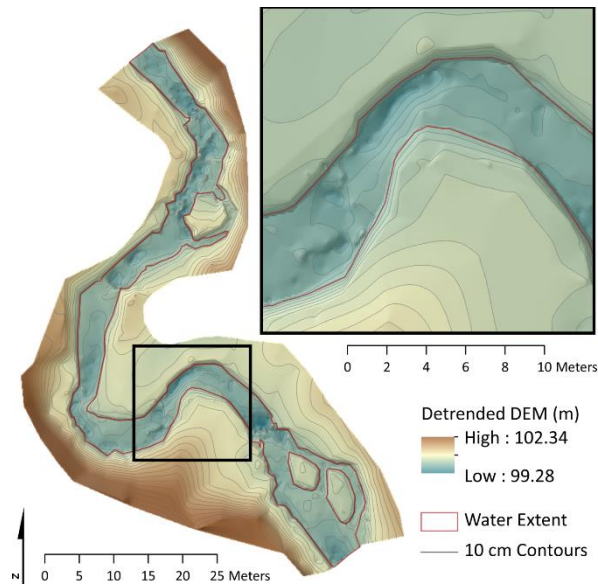
Learning Outcomes:
A) Learn how to 'occupy a point' and level a tripod.
B) To be able to set up a total station on a control point, position and orient the instrument within a coordinate system, and collect topographic data.
C) Learn how to use 'stakeout' points, to locate difficult to find benchmarks, and complete 'checks.'
D) Learn how to 'code' points and lines, so that you have more colors and brushes to help paint your picture.
E) Learn when to use reflectless measuring.
F) Take legible field notes.
G) Setup traverse kit.

Resources:
CHaMP Protocol: <https://www.champmonitoring.org/Program/Protocol/DocumentFile/1/103>
Intro to Surveying Manual: <https://www.champmonitoring.org/Program/Detail/DocumentFile/2/334>
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D) In Advanced Surveying with a Total Station, you will learn how to actually perform a complete survey.

Topographic Picture DEM & Water Depth

WHAT WE DO WITH TOPO SURVEY?



- For Physical Habitat, I will talk to you about:
 - Hydraulics, Geomorphology leads to fish habitat
- For why fish might care, Pete will talk to us about more specifically what fish need out of their habitat
- For upscaling these results to address Key Management Questions, Chris will talk to us about Survey Design & Extrapolation for Life Cycle Modelling

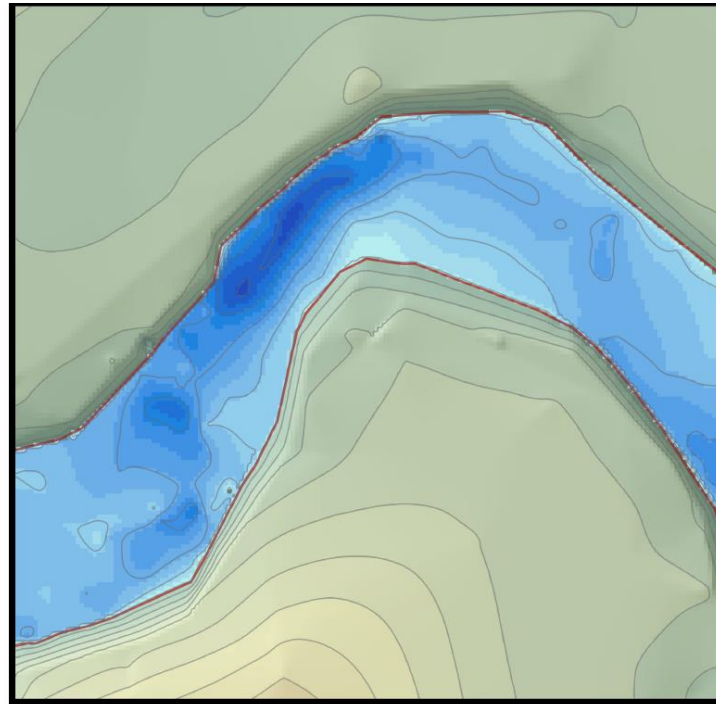
OUTLINE

HOW DO YOU ACCOUNT FOR FISH HABITAT WITH A TOTAL STATION?

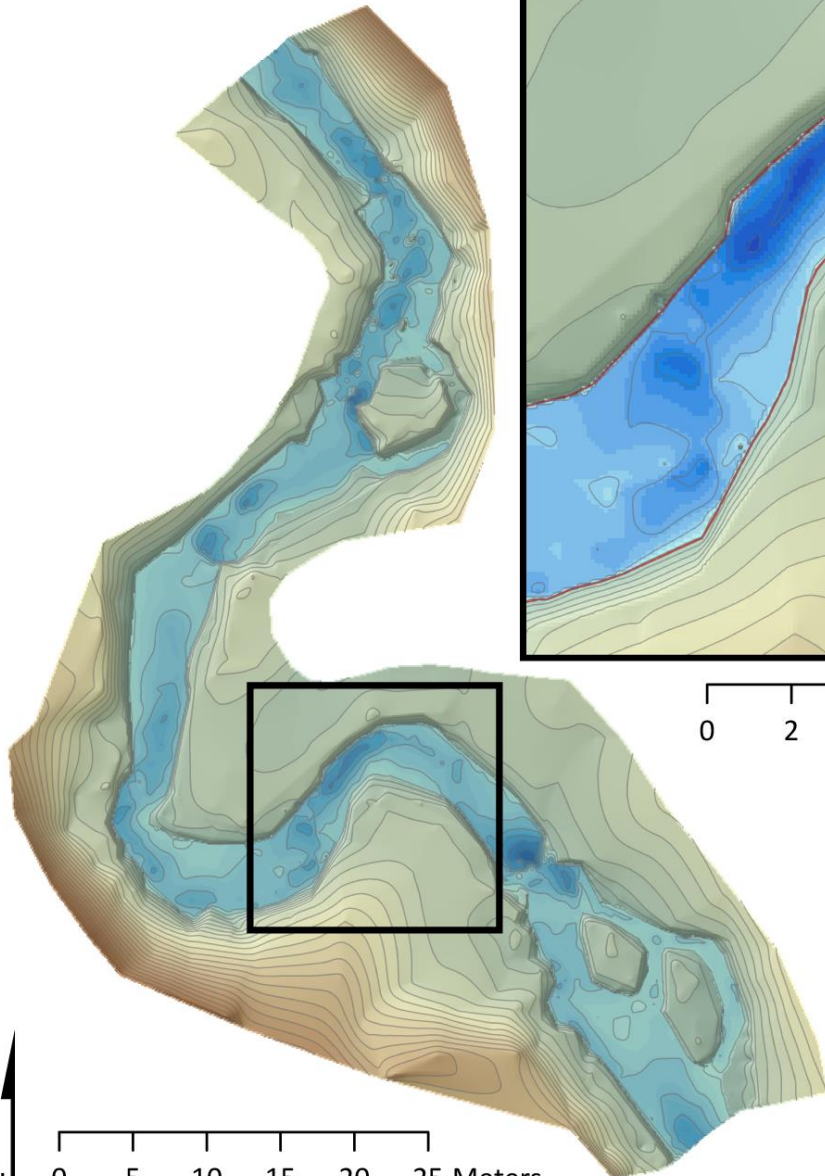
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½ A HYDRAULIC MODEL

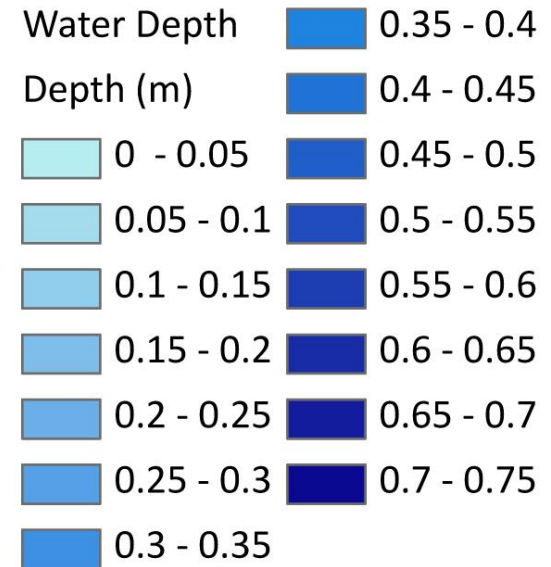
From field data...
survey of waters
edge...



0 2 4 6 8 10 Meters



0 5 10 15 20 25 Meters



Detrended DEM (m)

High : 102.34

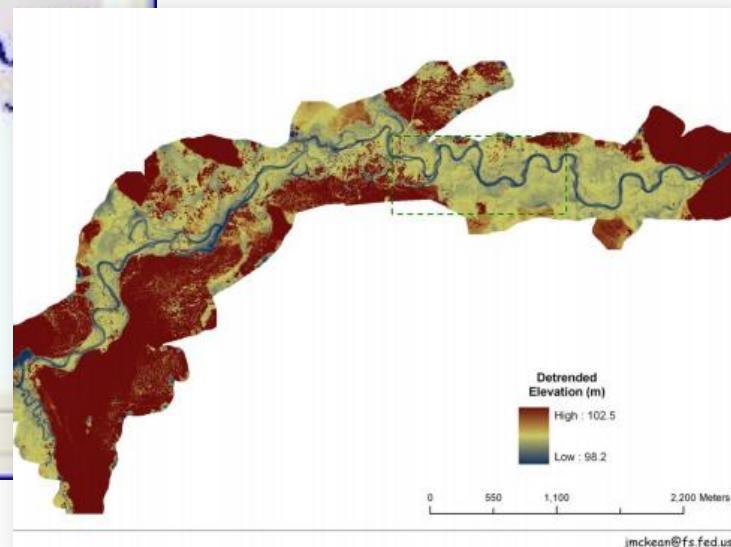
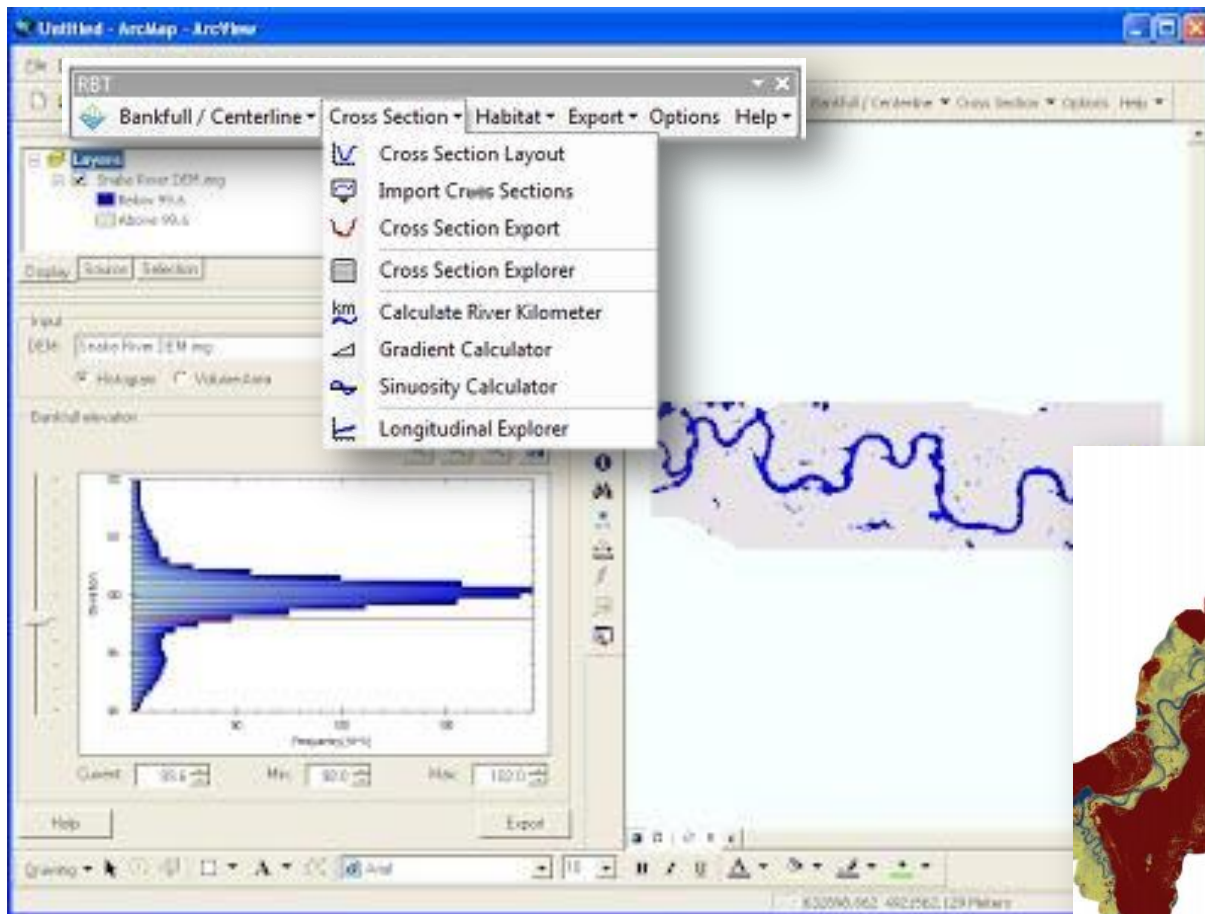
Low : 99.28

Water Extent

10 cm Contours

RIVER BATHYMETRY TOOLKIT

- Poor Man's Hydraulic Model...



RBT: <http://essa.com/tools/rbt/>



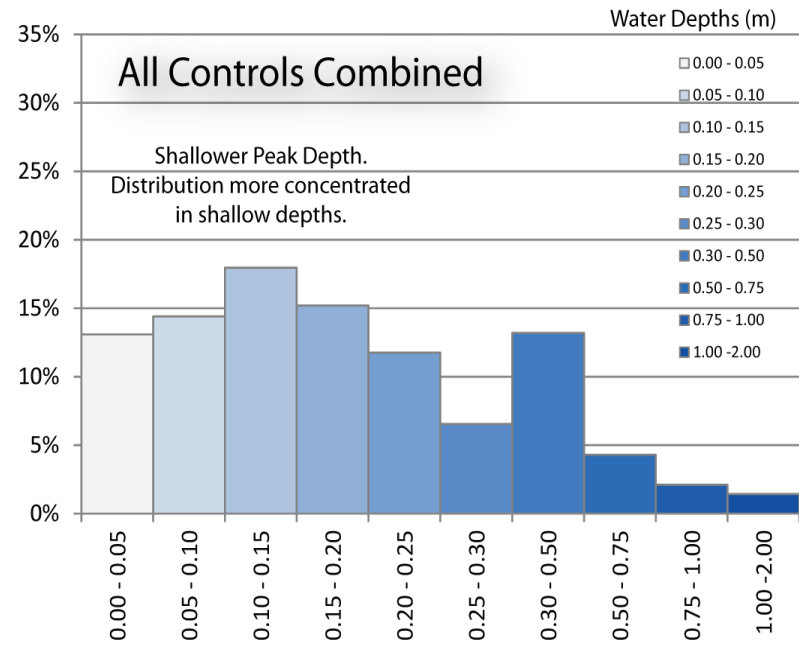
McKean et al. (2009)
DOI: doi:10.3390/rs1041065

DEPTH HETEROGENEITY

- Use depth distributions to look at one form of diversity of hydraulic habitat
- Comparison of restoration treatment (using beaver) & controls

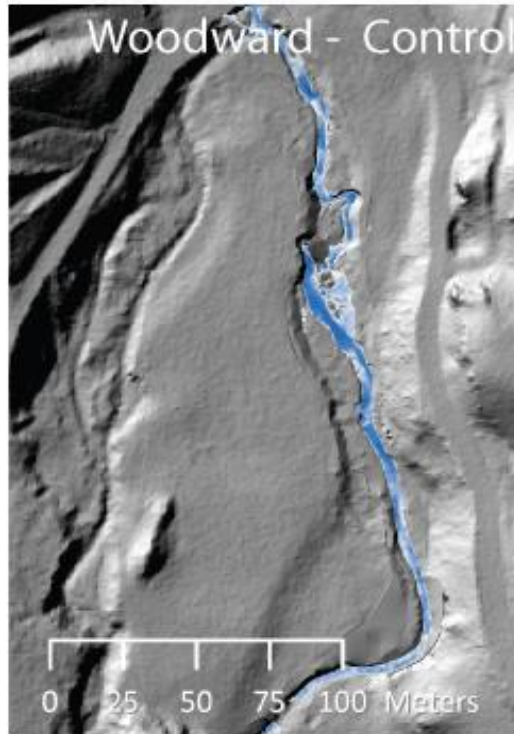
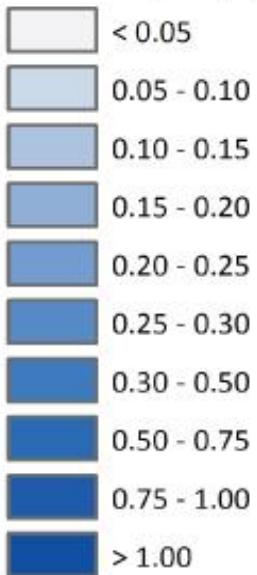


A



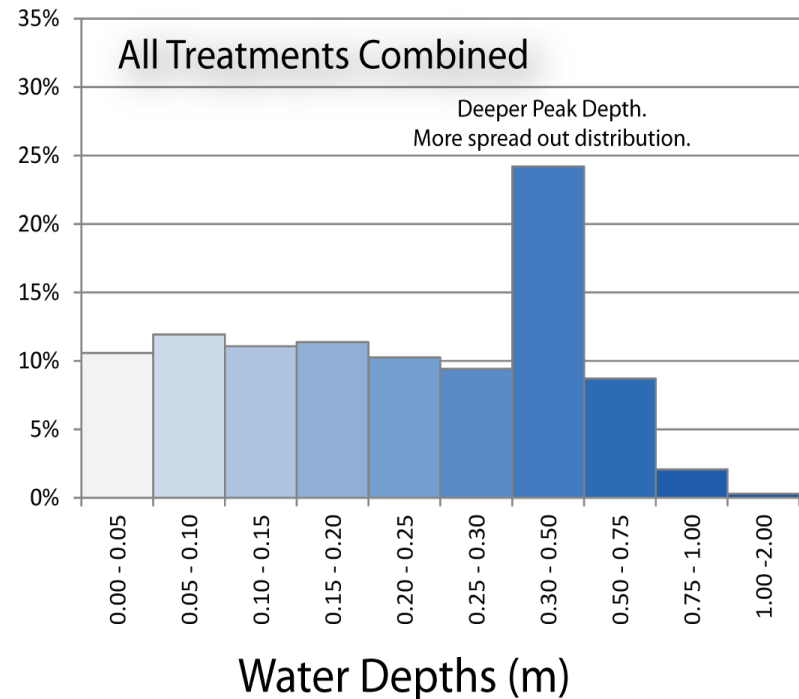
Legend

Water Depth (m)



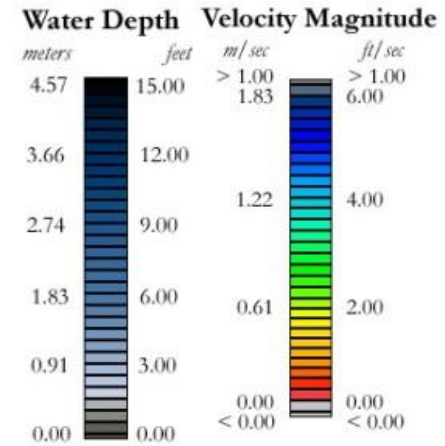
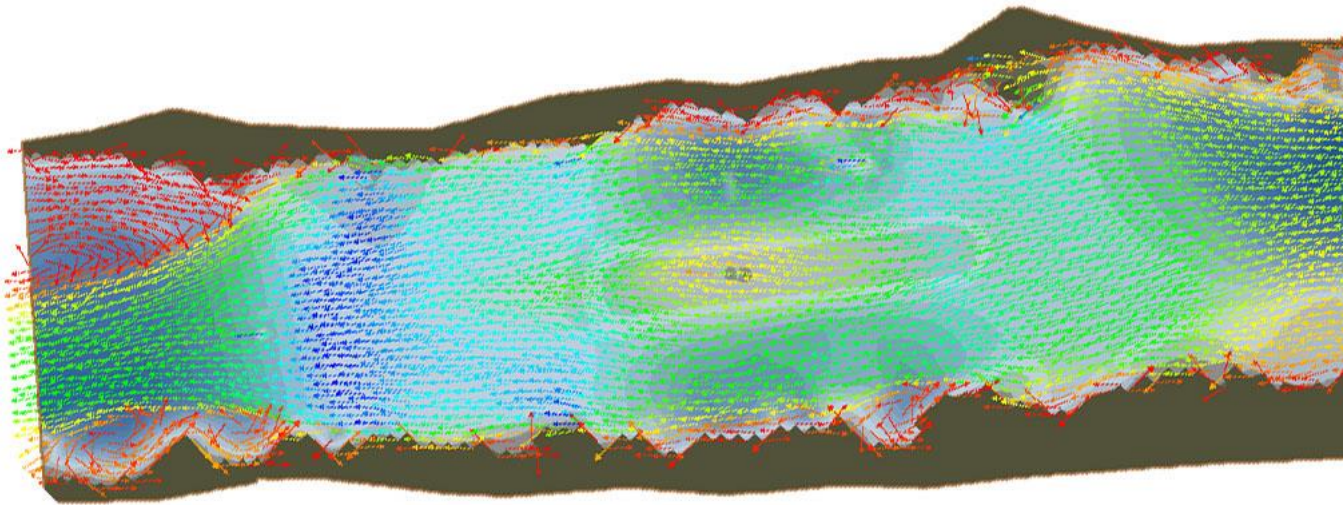
C

B



TOPO SUPPORTS: HYDRAULIC MODELS

- Can be 1D, 2D or 3D....



OUTLINE

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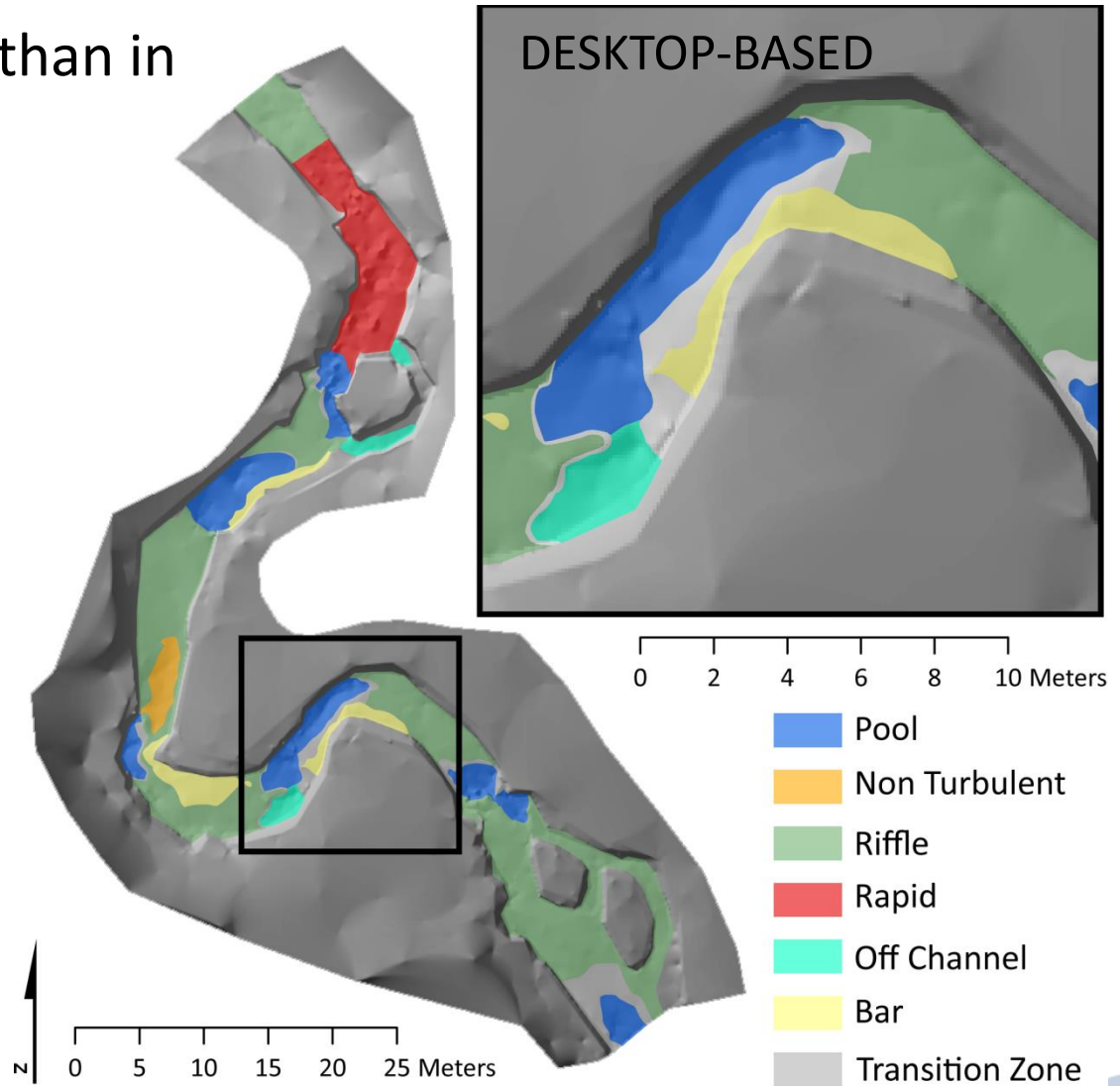
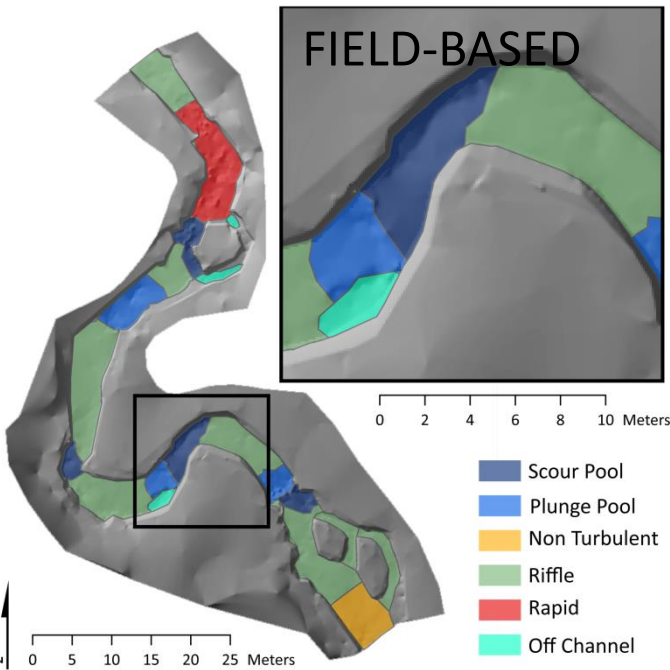
GEOMORPHOLOGY?

- The study of landforms (e.g. geomorphic units) and the processes that shape them?
 - The landform bit we can describe as a snapshot (status)
 - The processes play out over time (trend)
- What processes specifically?
 - Erosion and Deposition



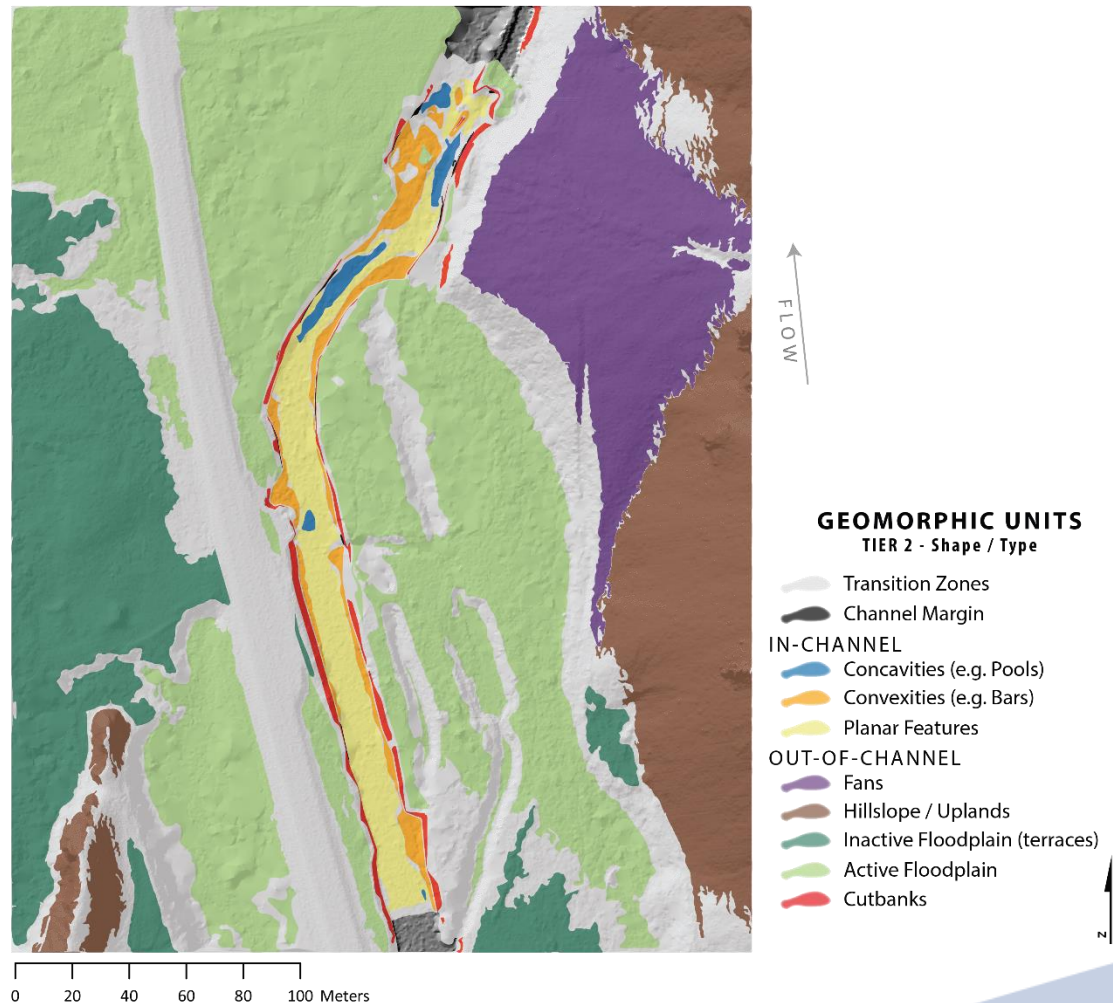
DERIVE HABITAT UNITS FROM TOPO & WD

- More refined boundaries than in field alone
- Transitions emerge as important...



GUT - BLENDING WITH REMOTE SENSING

- Using CHaMP topography to derive in-channel geomorphic units & LiDaR to Derive out-of-channel geomorphic units - GUT



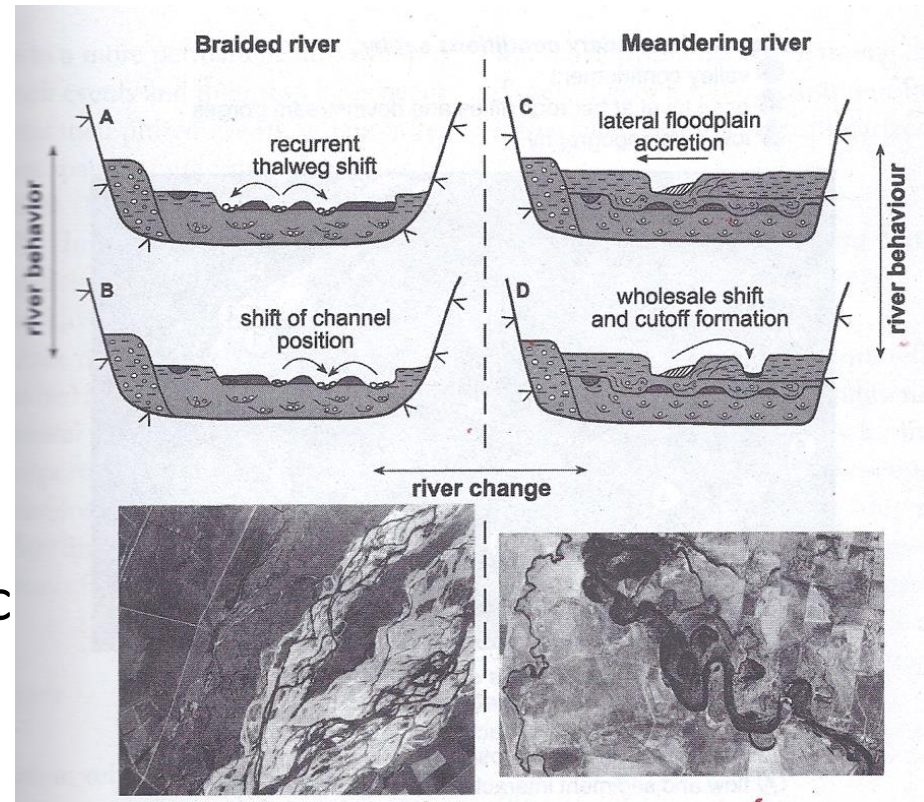
DYNAMIC STREAMS = HEALTHY ECOSYSTEMS

- We *believe* this...
- Lots of cool studies *showing* feedbacks and links...
- We *know* that heterogeneity is linked to dynamism
- How do we *monitor* and describe such dynamics?



WAYS A RIVER CAN ADJUST LOCALLY

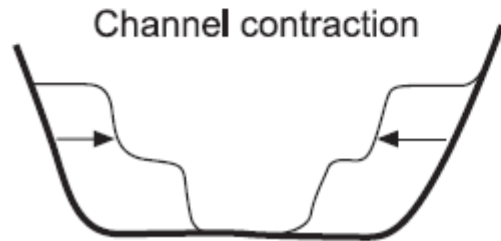
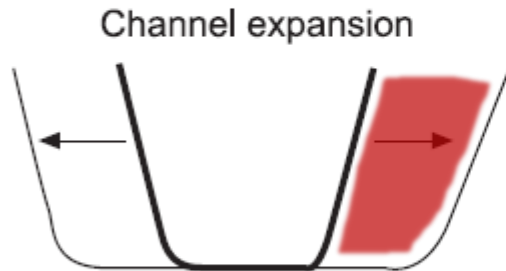
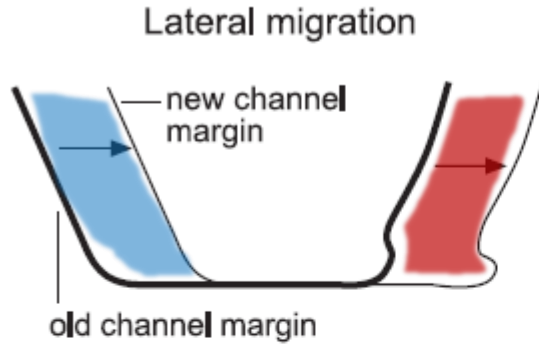
- Adjustments (Erosion/Deposition)
 - Channel morphology
 - Channel Size
 - Channel Shape
 - Bed Character
 - Planform
 - Arrangement of geomorphic units



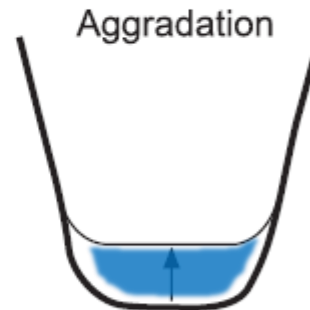
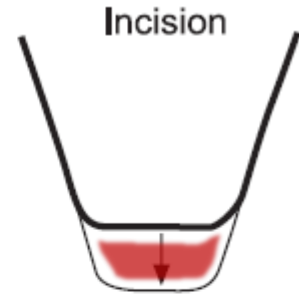
- An adjustment is not a *change* in river type!
- “River *behavior* equates to adjustments around a characteristic assemblage of geomorphic units”

ADJUSTMENTS TO CHANNEL SHAPE

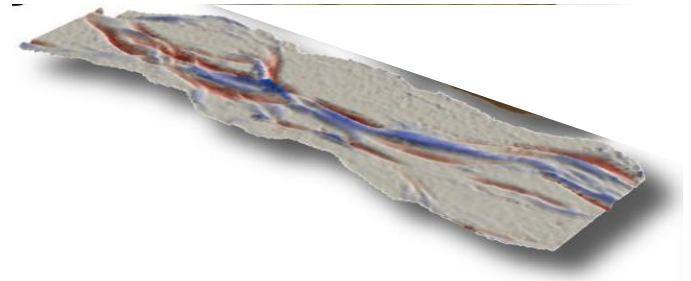
Lateral adjustment processes



Vertical adjustment processes



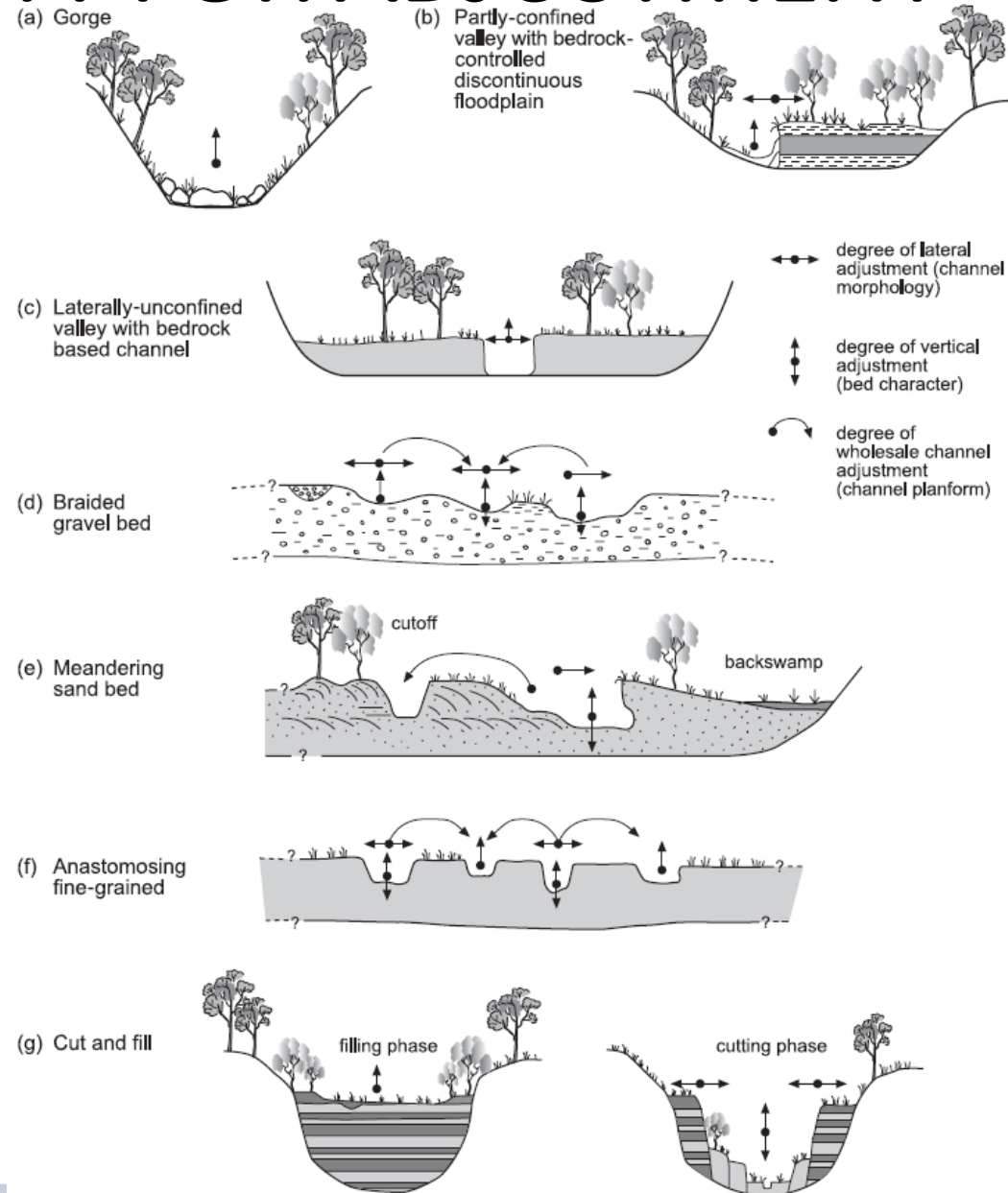
- Geomorphologists have lots of special names for things...
- Basically, all expressions or special cases of **erosion** or **deposition**



From Brierley & Fryirs (2005)

NATURAL CAPACITY FOR ADJUSTMENT

- Plausible limits on what adjustments are possible
- Geomorphic context matters
 - Confinement
 - Sediment Supply
 - Flow Regime
 - Vegetation
 - Land use
 - History

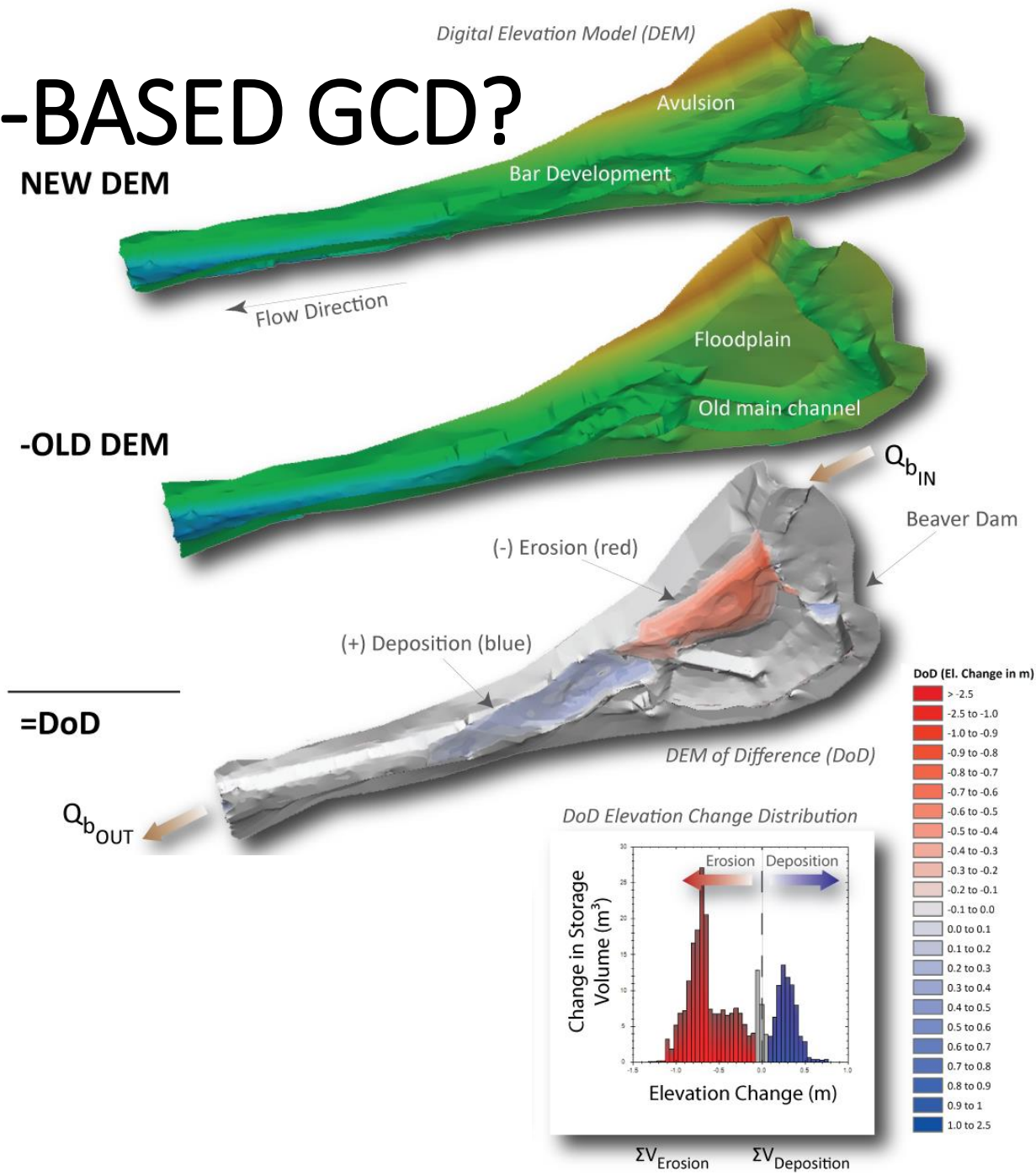


From Brierley & Fryirs (2005)

WHAT IS DEM-BASED GCD?

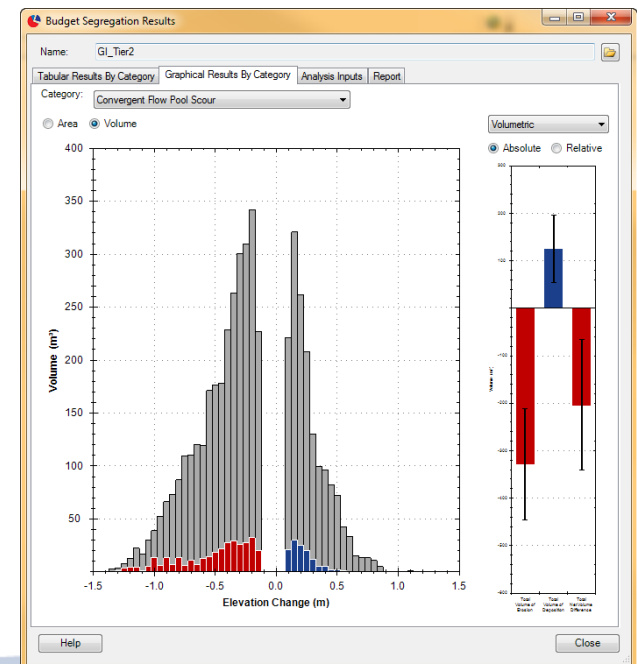
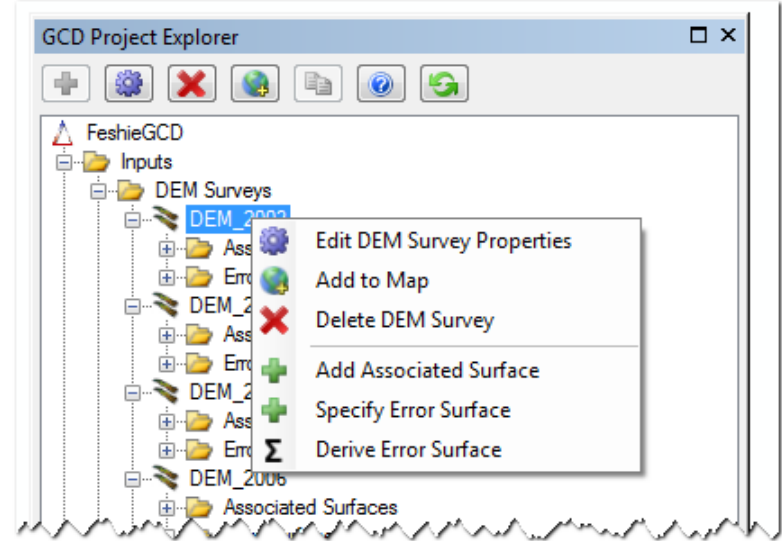
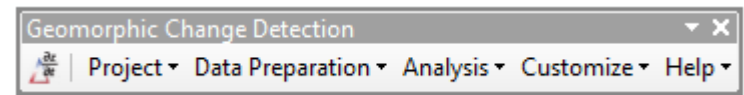
A little background...

- DEM -> digital elevation model
- GCD -> geomorphic change detection
- Of everything that CHaMP measures, GCD is one of most sensitive to the quality of the data and influences like crew variability



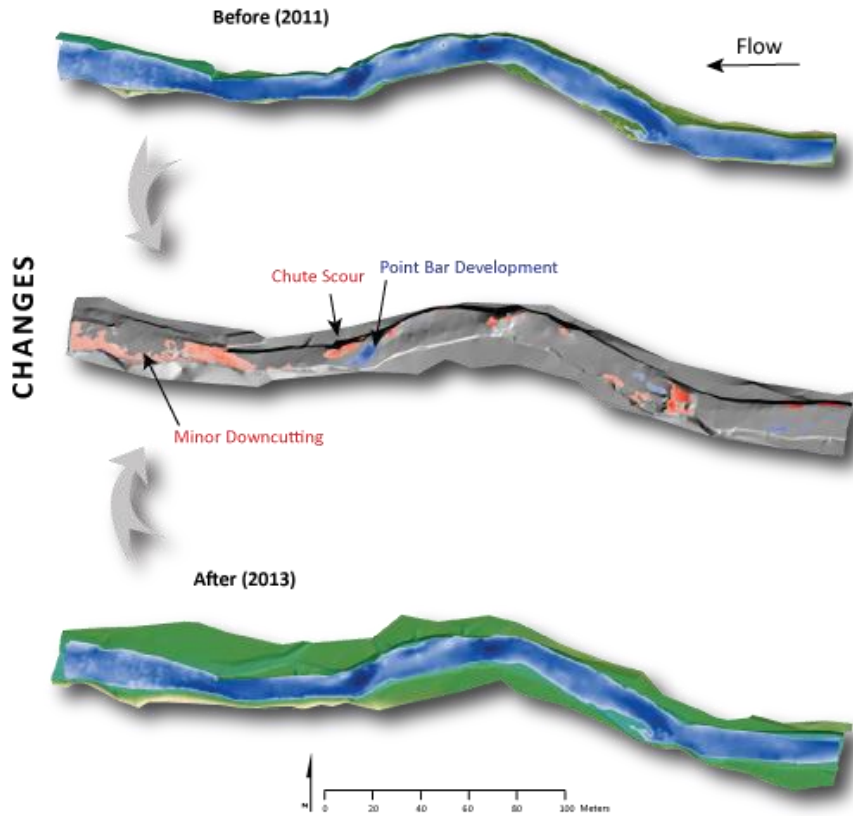
GCD RUNS AUTOMATICALLY ON CM.ORG

- GCD Projects Run Centrally
- Detailed DoD output map & reports
- Summary Results for:
 - Bankfull Union of Surveys
 - By Channel Units
- You can download *.gcd file to:
 - Visualize output
 - Perform additional analysis

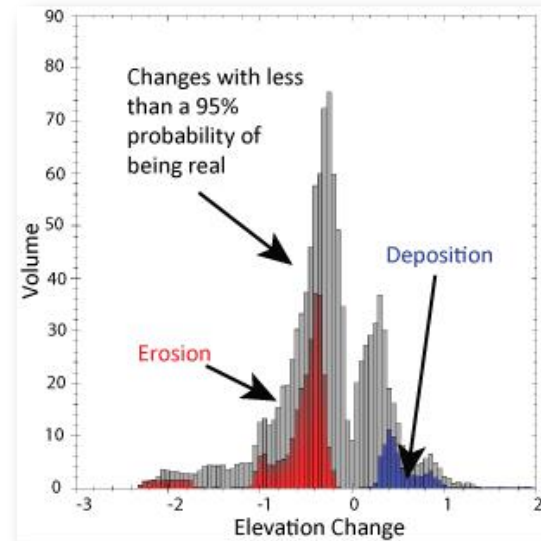


GCD TO DESCRIBE BEHAVIOR... IN A POOR CONDITION VARIANT

DYNAMIC RIVER BEHAVIOR
CHANGES CAPTURED WITH CHaMP

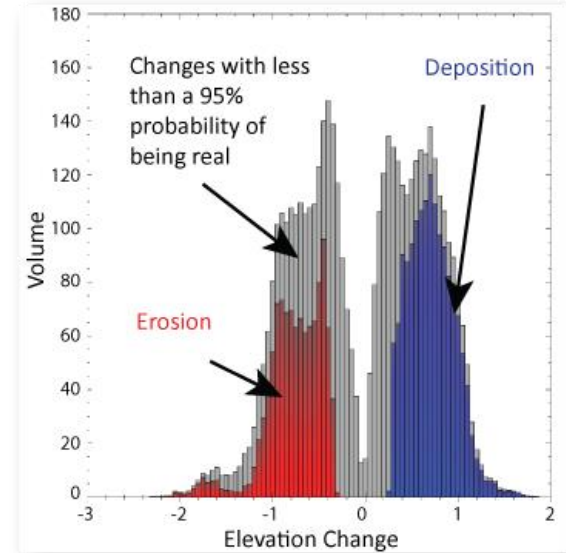
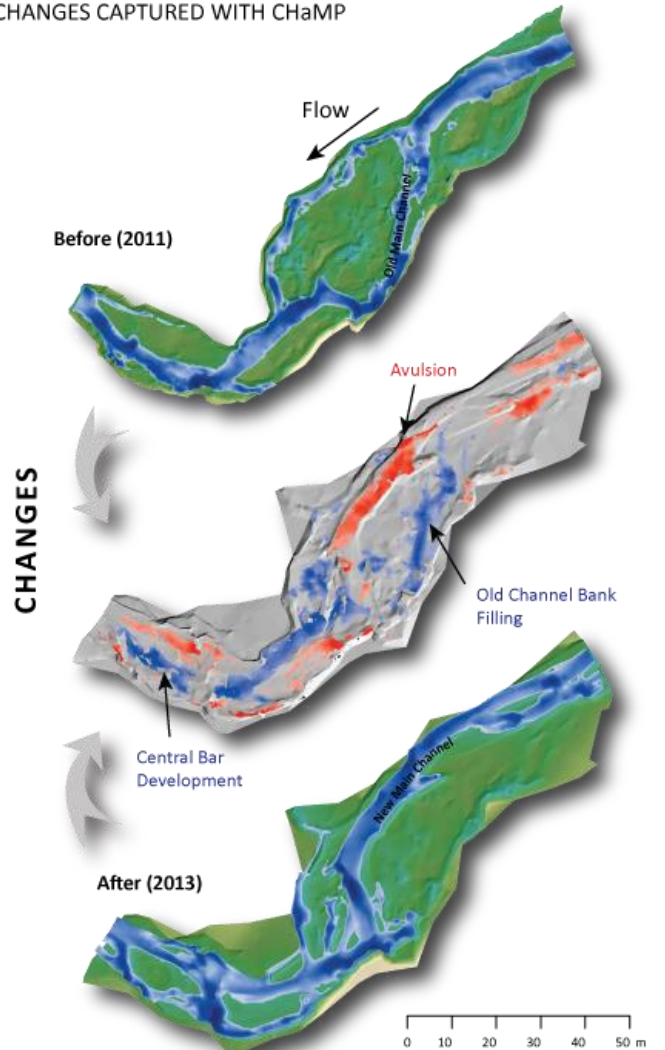


Champ Site: Tucannon River, WA ID: CBW05583-386091



GCD TO DESCRIBE BEHAVIOR... IN A GOOD CONDITION VARIANT

DYNAMIC RIVER BEHAVIOR
CHANGES CAPTURED WITH CHaMP



Champ Site: Tucannon River, WA ID: CBW05583-481459

IN A PERFECT WORLD...

- The signal (the change we're trying to detect) is much greater than our noise....

$$\frac{\partial z}{\partial t} \gg \delta(z)$$

- In many instances, the noise is of similar magnitude to our noise...

$$\frac{\partial z}{\partial t} \approx \delta(z)$$

- Better in places where vertical changes are large!

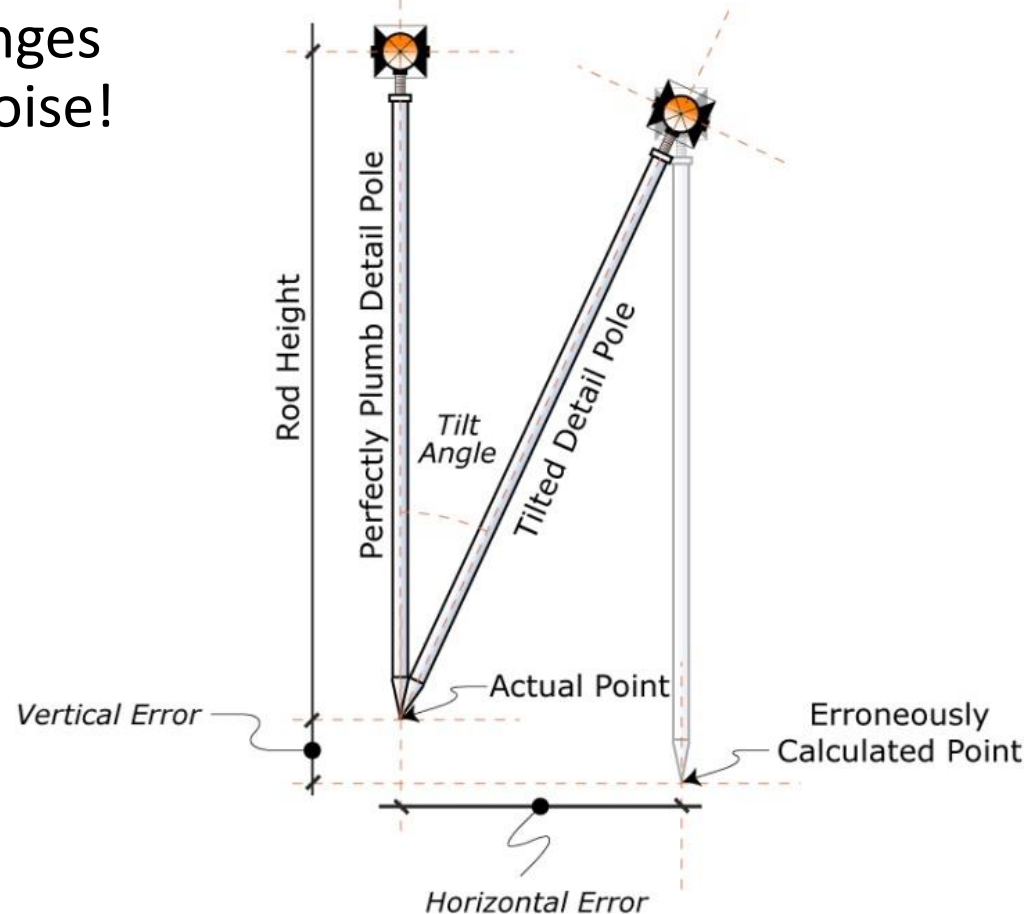
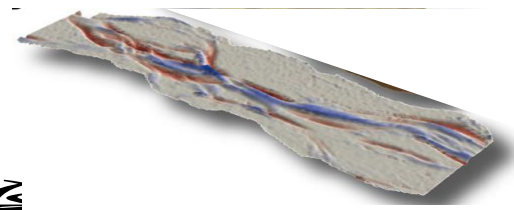


Surface Noise:

- LiDaR : +/- 10 to 25 cm (14 to 36 cm_{min} LoD)
- Total Station: +/- 2 to 10 cm (3 to 14 cm_{min} LoD)

SO PAY ATTENTION....

- How well you survey, determines our ability to detect real changes and distinguish these from noise!



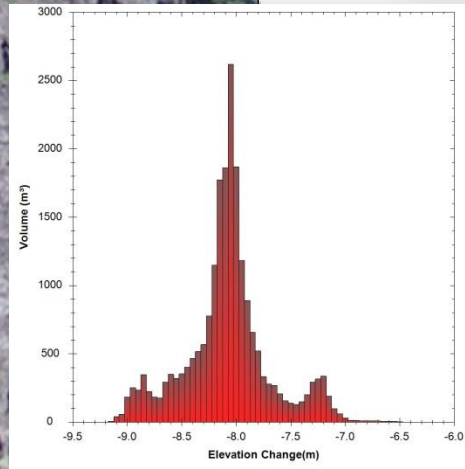
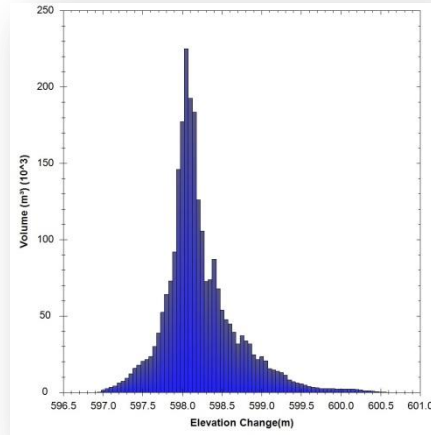
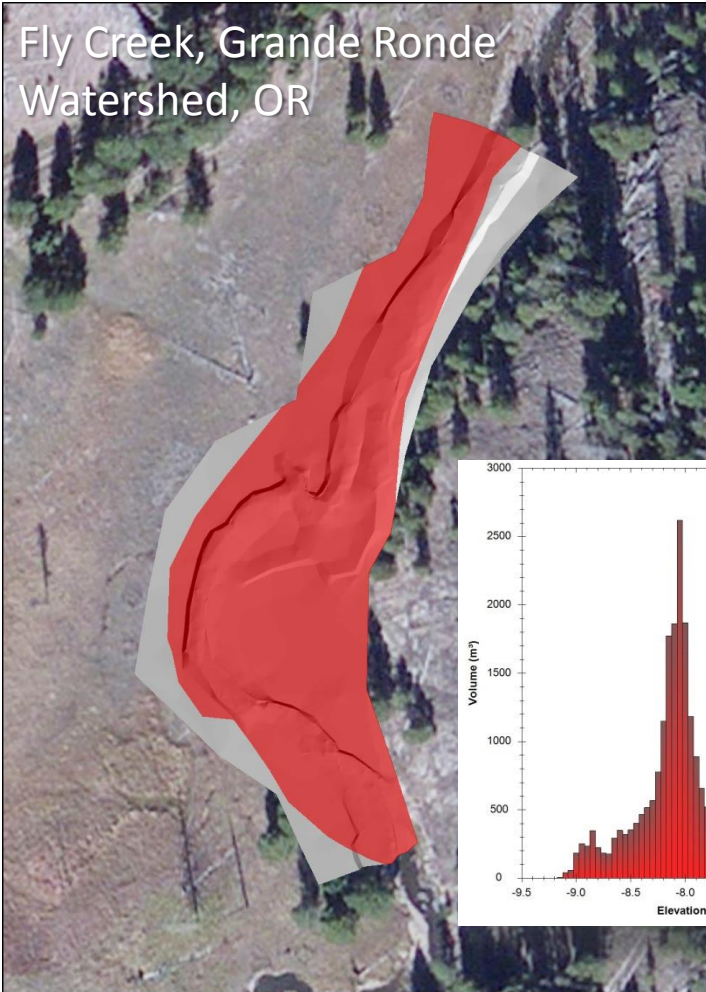
© Wheaton (2008)

- Will it *really* matter?
- If you're not sure, ask!

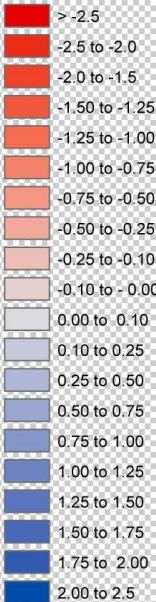


OBVIOUS DATUM PROBLEMS...

Fly Creek, Grande Ronde Watershed, OR



dodProbThresh



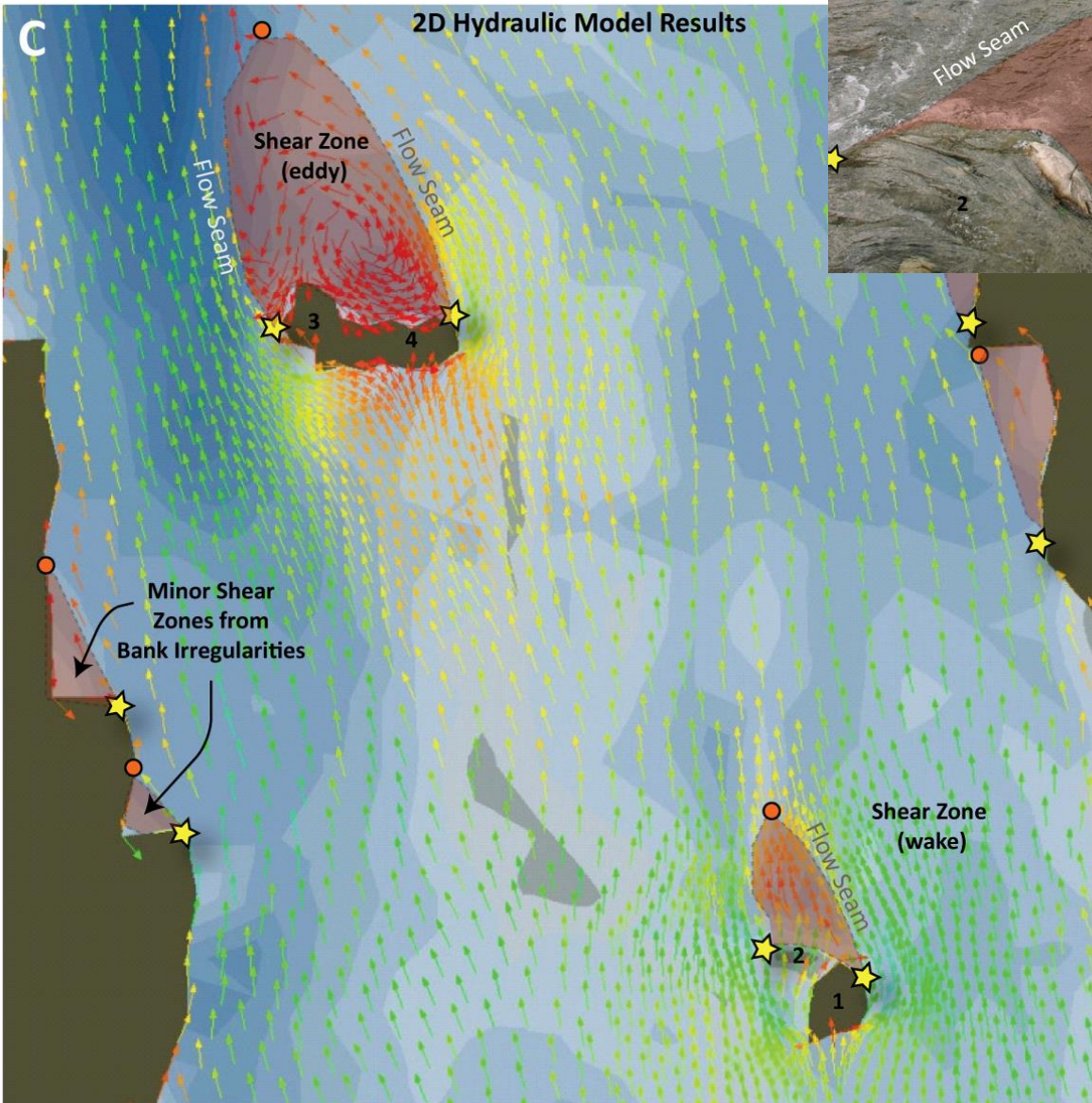
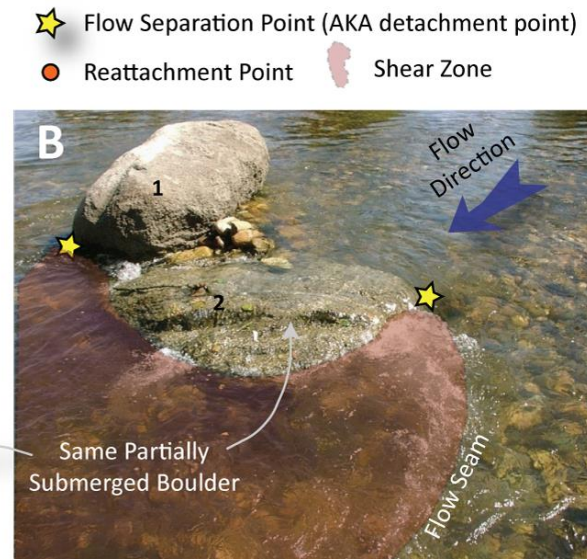
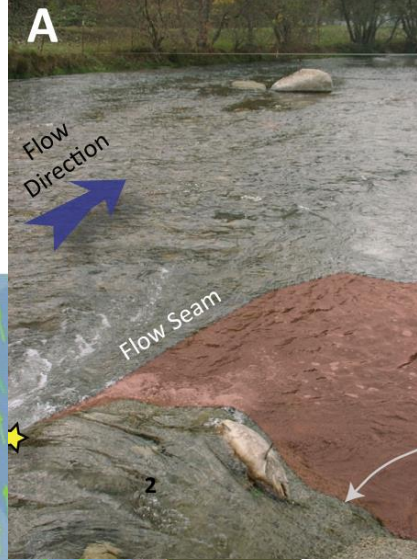
Camas Creek, John Day Watershed

OUTLINE

HOW DO YOU ACCOUNT FOR FISH HABITAT WITH A TOTAL STATION?

- I. Background
- II. Painting a Picture of Habitat – Topographically
- III. Quantifying Habitat – From Topography**
 - I. Hydraulics
 - II. Geomorphology
 - III. Fish Habitat**
- IV. Some Other Useful Byproducts of Topography
- V. Take Homes

ENERGY REFUGIA & SHEAR ZONES



★ Flow Separation Point (AKA detachment point)

● Reattachment Point

Shear Zone

THREE TYPES OF REFUGIA...

1. **Predation** Refugia – (Cover) Protection from Predation
2. **Energy** Refugia - Resting Areas (i.e. shear zones)
3. **Thermal** Refugia – Get away from the mean!

Predation Refugia from:

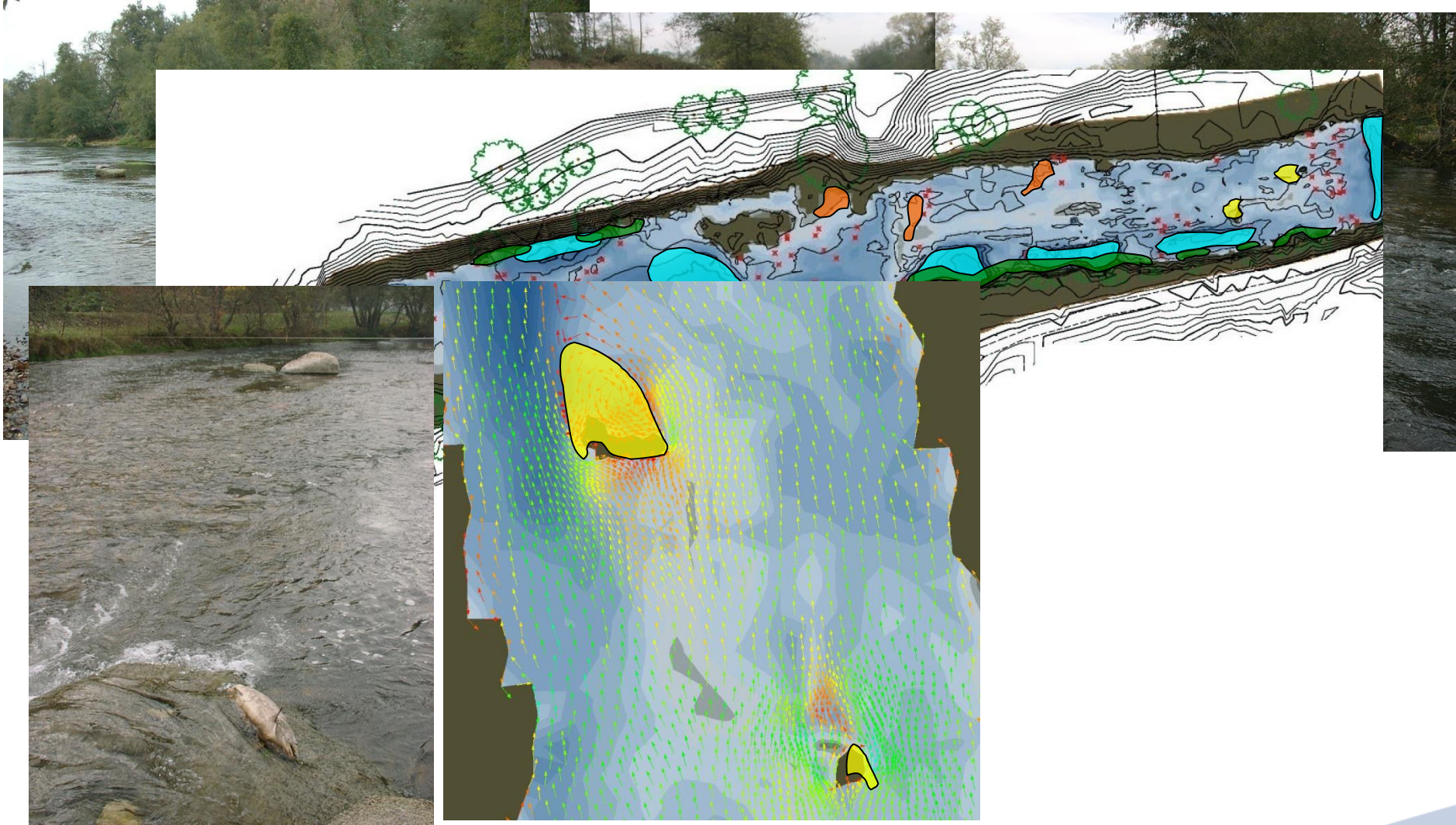
- Bank Vegetation
- LWD
- Boulders
- Deep Pools

Energy Refugia from Shear Zones induced by:

- Irregular Banks
- LWD
- Boulders
- Bed Forms



DEFINING HABITAT HETEROGENEITY - REFUGIA



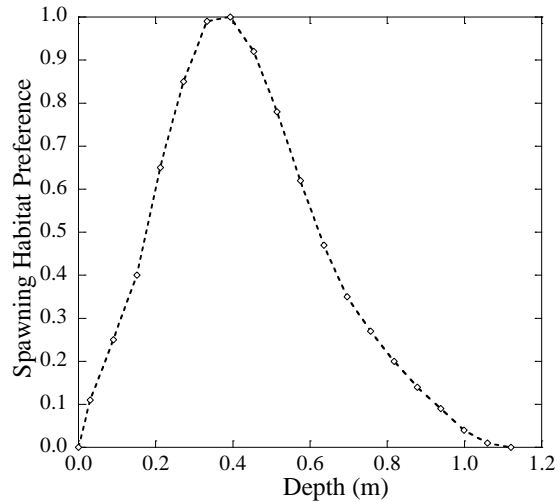
IS HETEROGENEITY IMPORTANT TO A SPAWNING FEMALE SALMON?

Habitat Heterogeneity is usually assumed to support species diversity (assumed to be good).

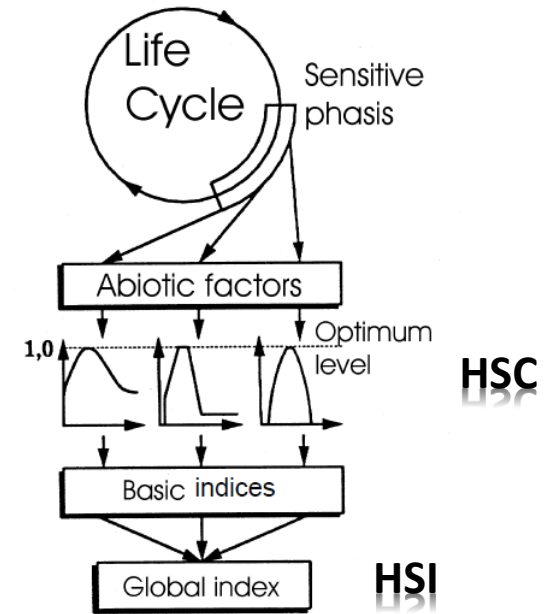
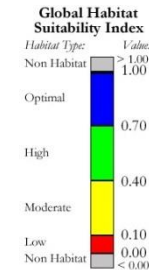
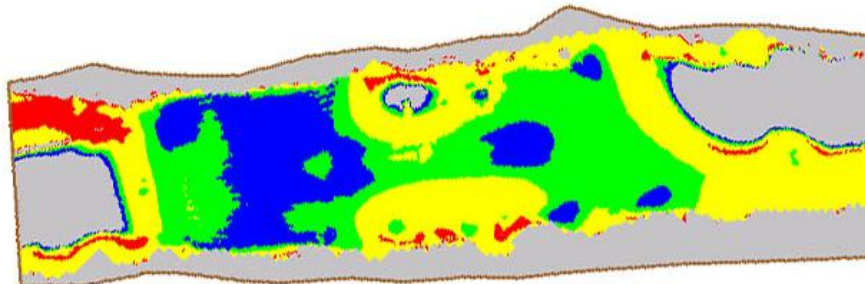
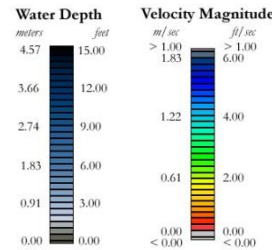
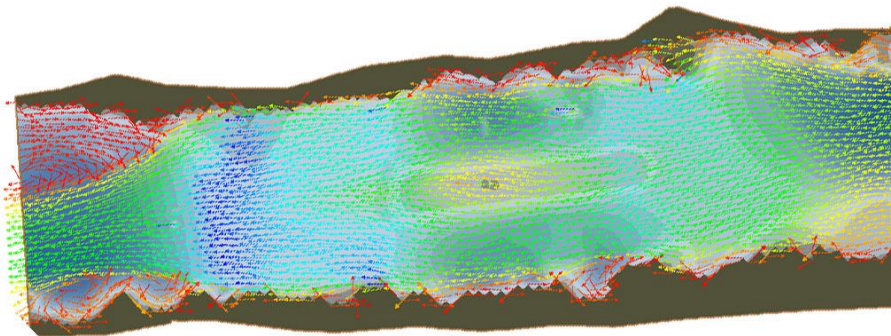


What are specific ecological benefits of habitat heterogeneity to spawning salmonids?

FISH HABITAT MODELS...



- Pete will talk to us about two different flavors of FHM (there are many more)
 - Net Rate of Energy Intake (NREI) – Summer Juvenile
 - Habitat Suitability Index (HSI) – Adult Spawners



Building a classical fish *preferendum* model

From LeClerc (2005)

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PRODUCTS

More strategic improvement actions could save millions through more realistic investment in actions more likely to work!



SUMMARY PRODUCTS

- Can be directly produced from CHaMP/ISEMP

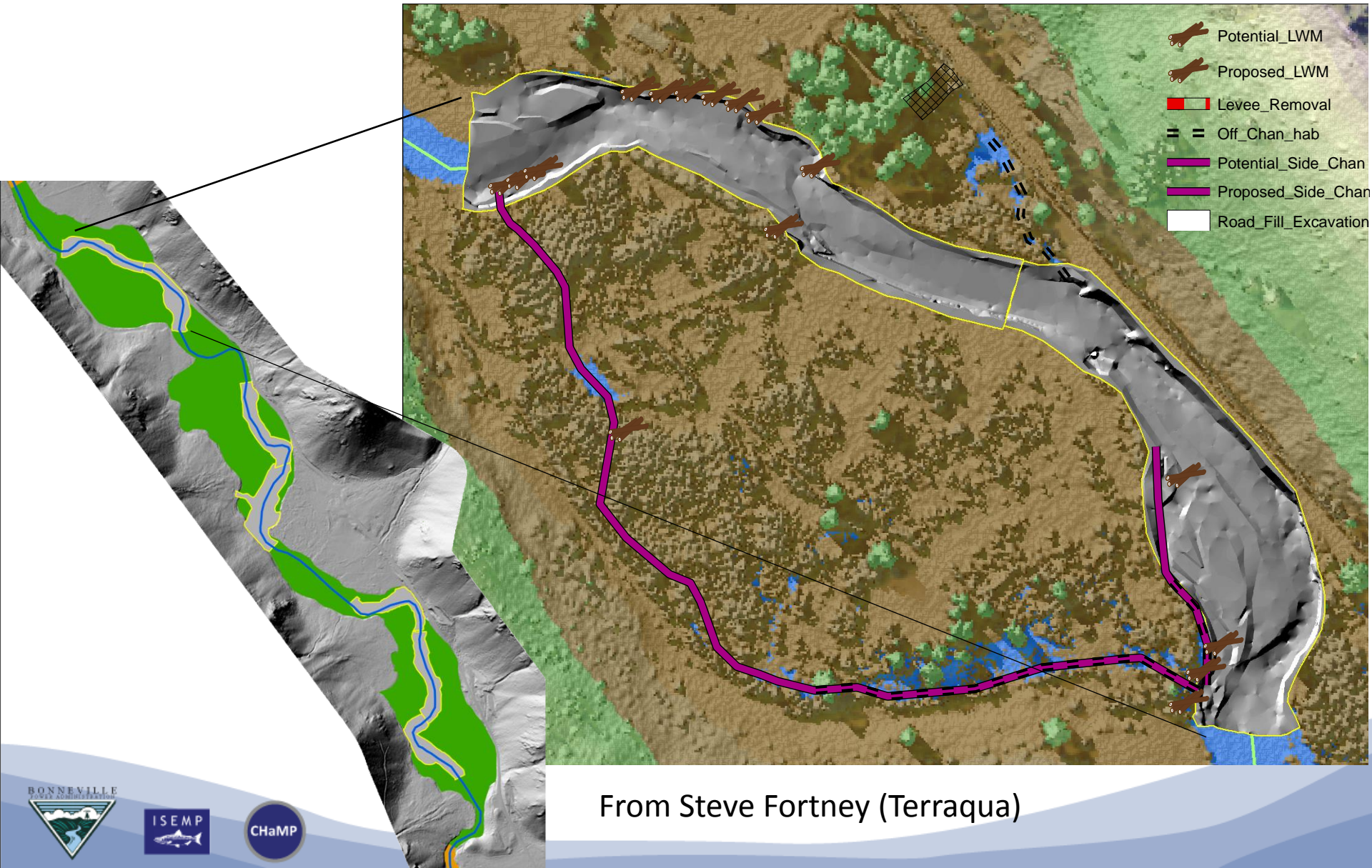
- Can be better *informed* by CHaMP/ISEMP/AEM
- Still requires expert and stakeholder input (e.g. Atlas)



- Can be better *informed* by CHaMP/ISEMP/AEM
- Still requires expert designers...



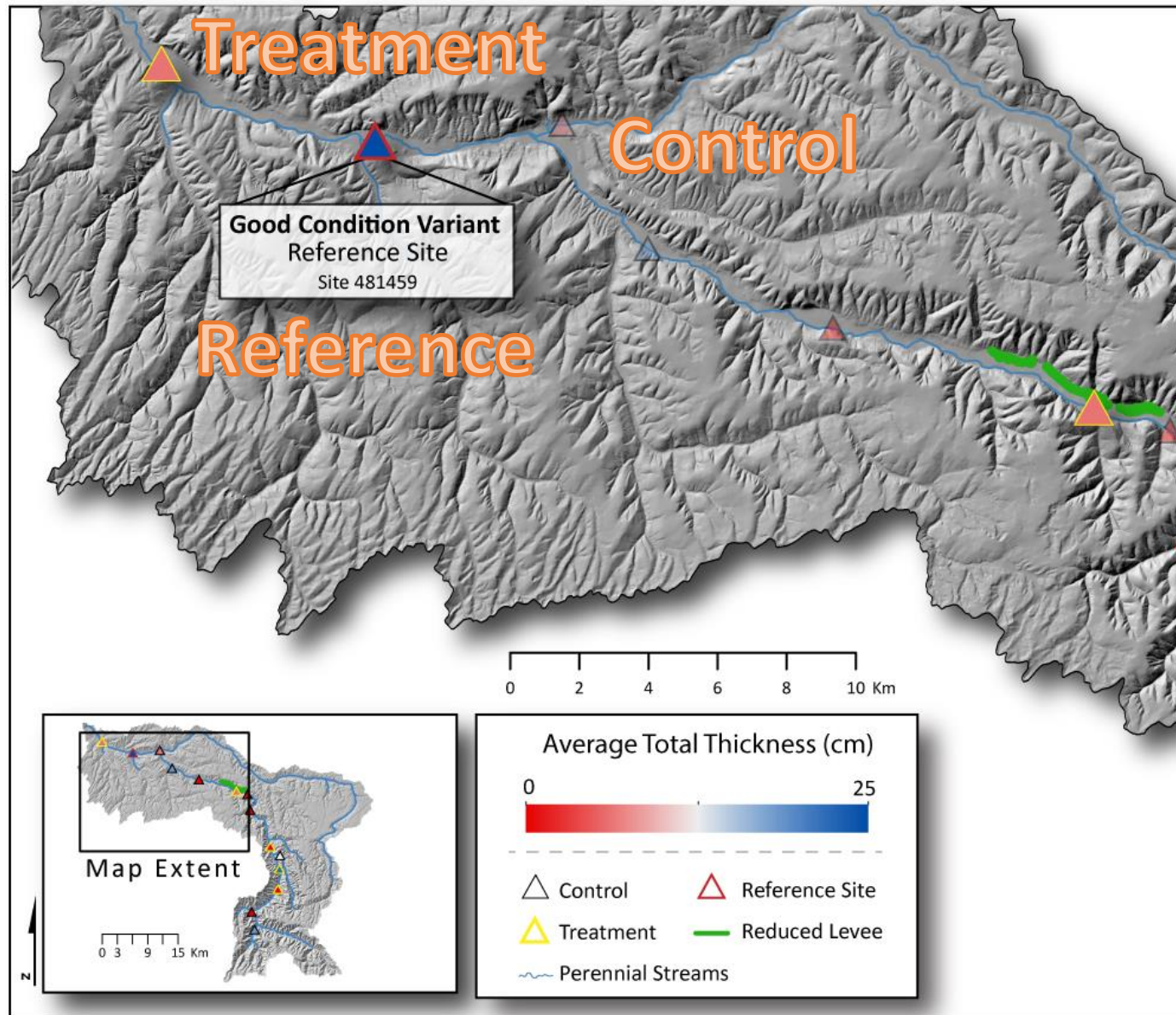
CHAMP DATA CAN BE USED AS BASEMAP & BASELINE FOR DESIGN



From Steve Fortney (Terraqua)

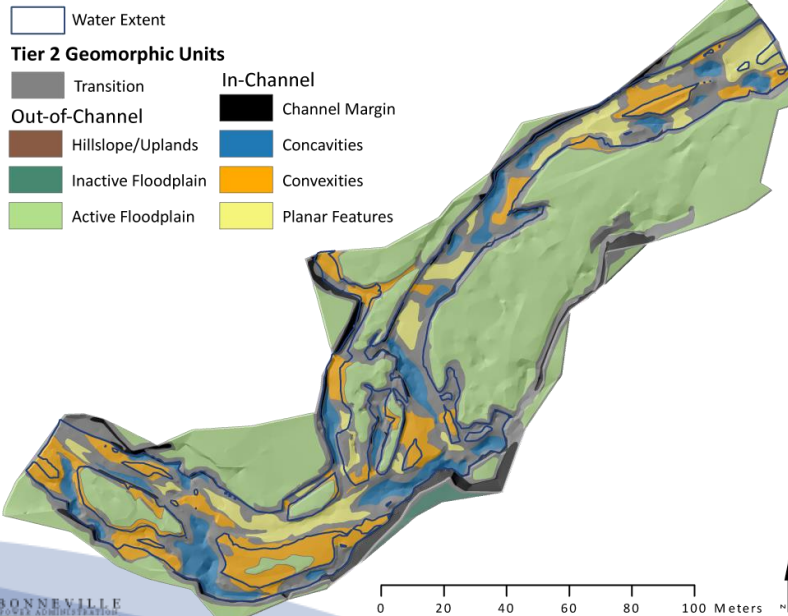


USING CHAMP SITES AS ANALOGS

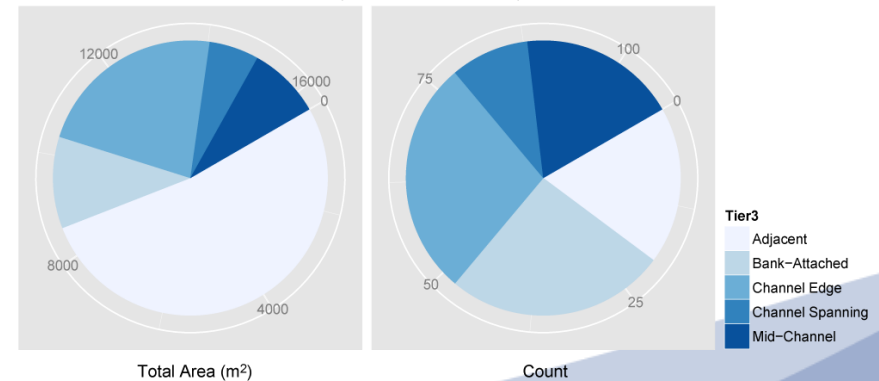


ANALOGS FOR DESIGN

- Multi-threaded channel with diverse range of habitat serving critical functions for salmonids at various life stages
- The regular turn-over of this habitat is maintained by dynamic behavior (regular erosion and deposition).



Tier 3 Geomorphic Units
Reference Site (CBW05583-481459)



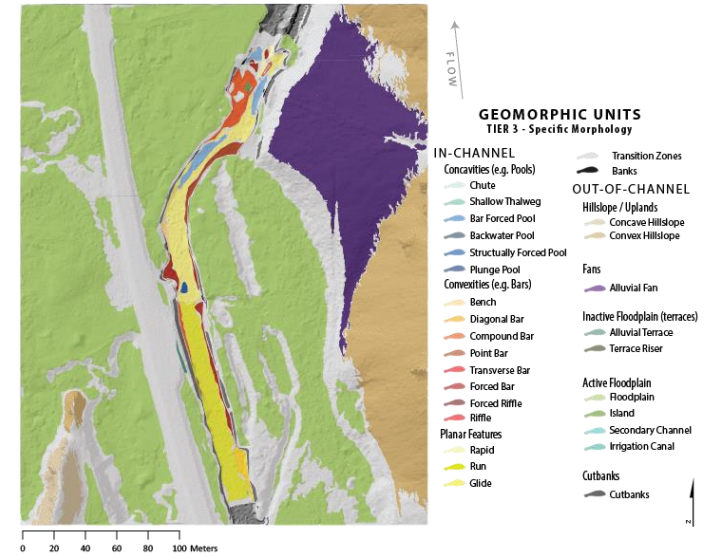
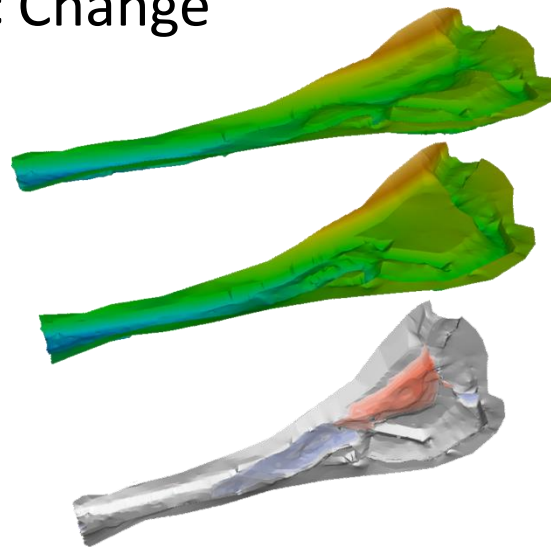
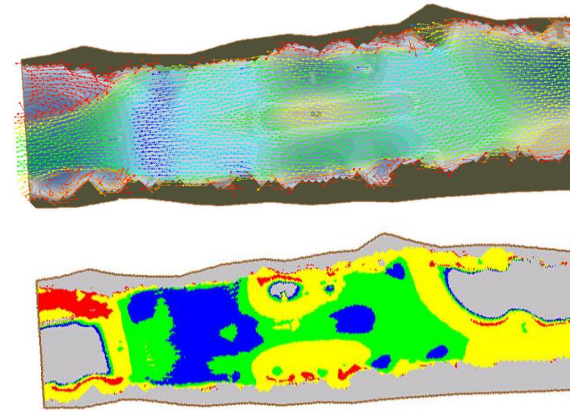
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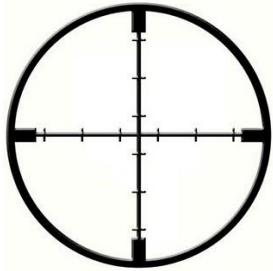
SO... PAINTING QUANTITATIVE PICTURES

- From Topographic Snapshot
 - Habitat Units
 - Habitat Heterogeneity
 - Hydraulic Models
 - Ecohydraulic Models
- Multiple Topos
 - Geomorphic Change Detection



2 PERSON CREW...

- Who's the artist?



Dumb end of a stick?



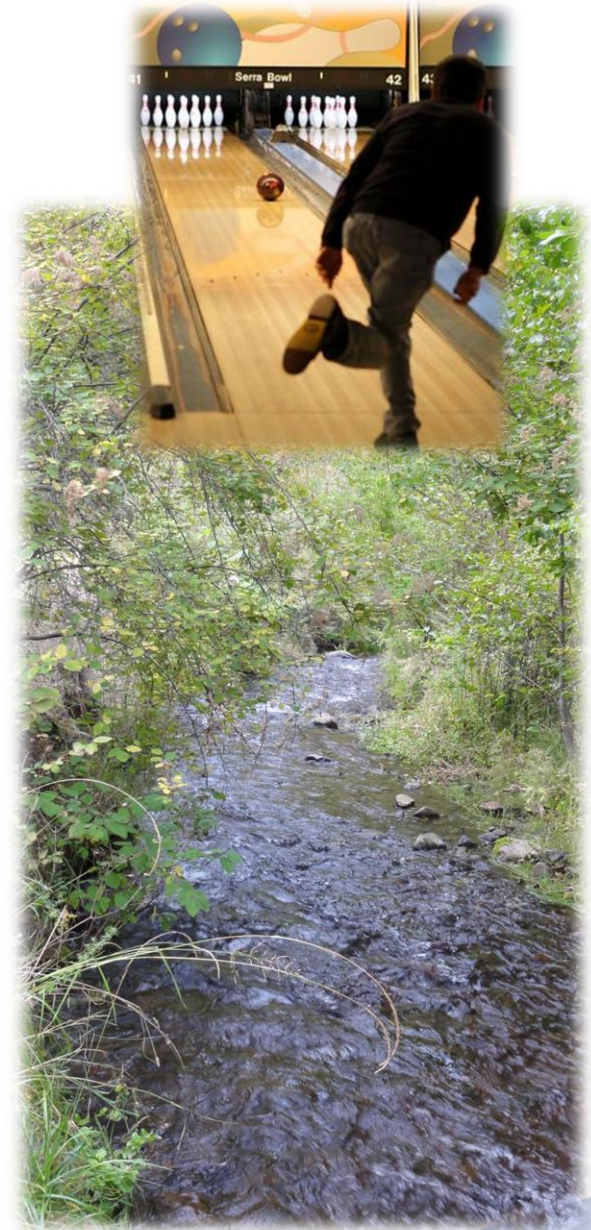
MAIN TAKE HOMES

- Topography helps us paint a quantitative picture of habitat
- Topography derivatives:
 - Habitat Units
 - Hydraulic Models
 - Habitat Suitability Models
- Repeat topography helps quantify processes that create, maintain & destroy habitat
- Useful not just in status & trend monitoring, but also restoration design and effectiveness monitoring



MANY PLACES IN CRB

- Riparian not all that bad... compared to some places
- Nothing like what it once was
- Habitat highly simplified
 - Armored
 - Few pools / Not much large wood
 - Few active bars

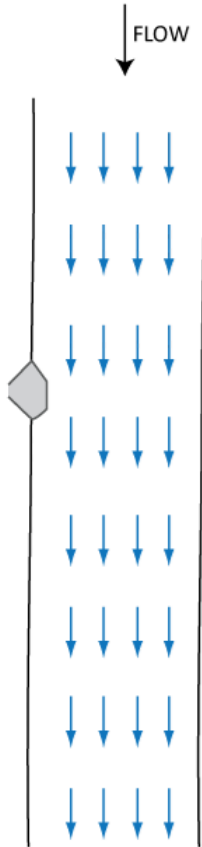


TYPICAL **HD LWD** STRUCTURES

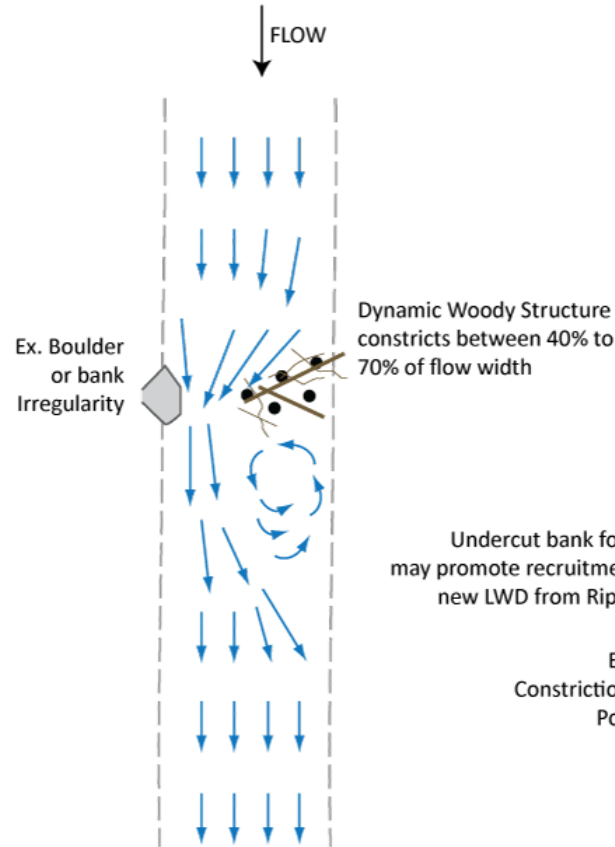


SIMPLE PALS HYPOTHESIZED RESPONSE

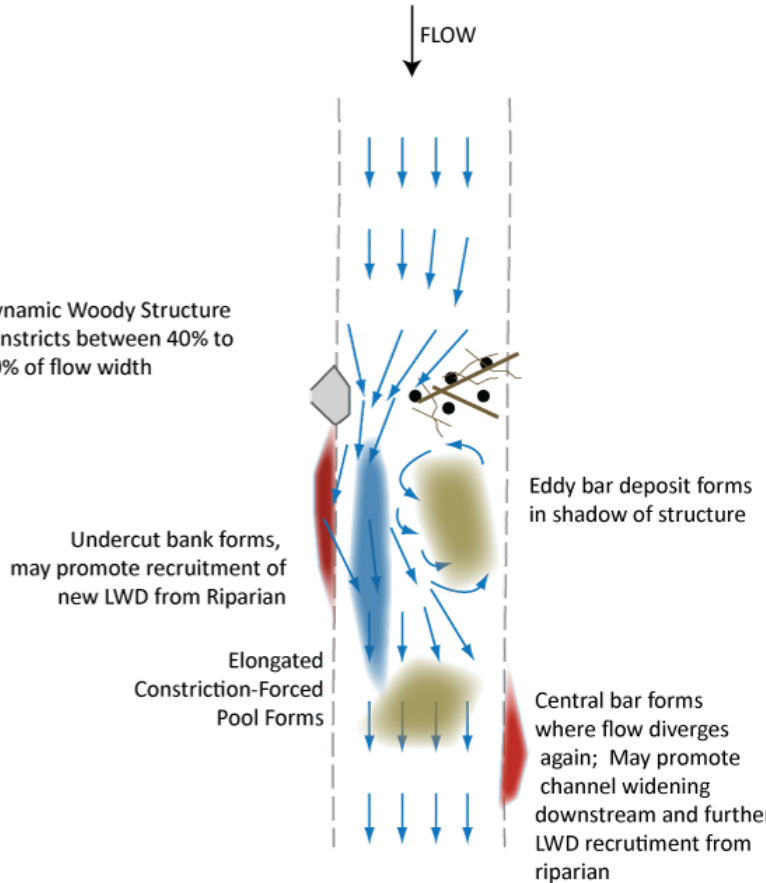
Initial Condition







Design Placement



Dynamic Response

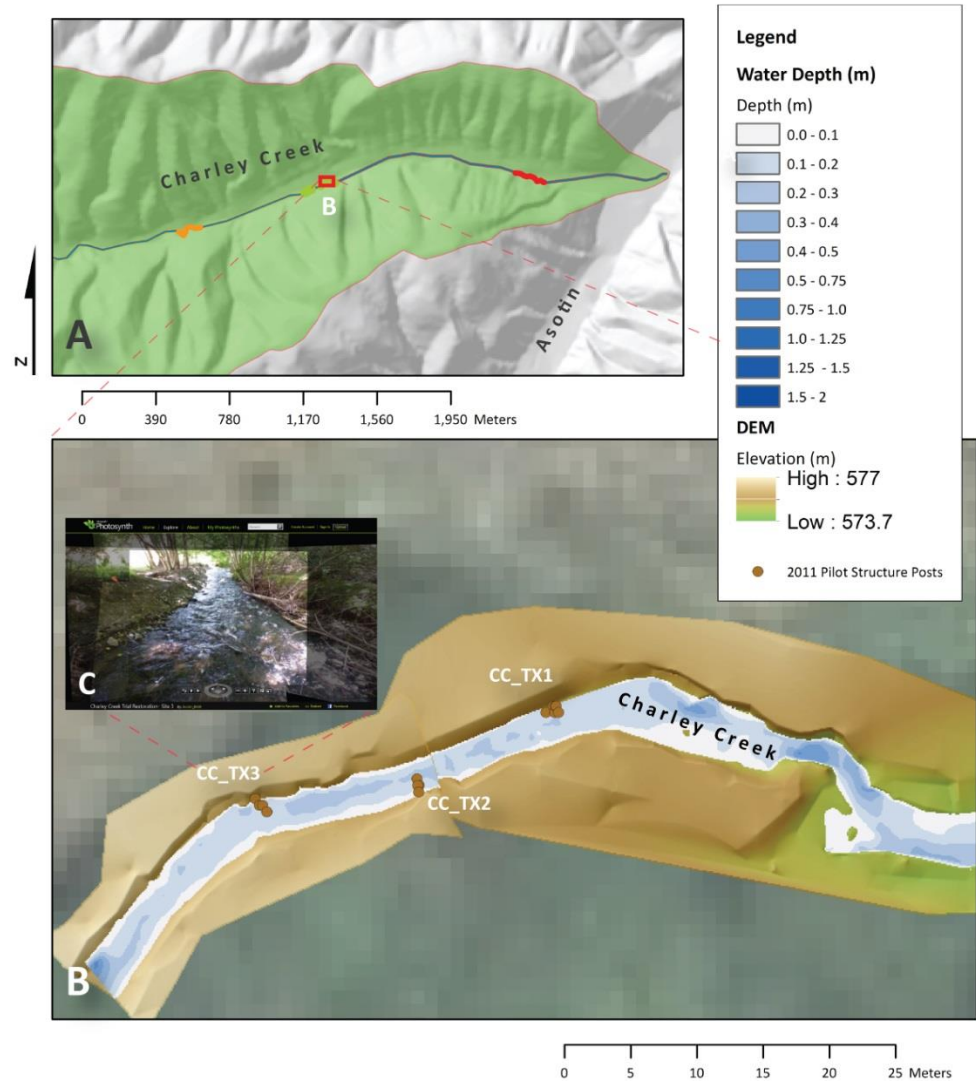


LEGEND

-  Velocity Vectors
-  Wooden Posts (driven into bed)
-  Woody debris of various sizes, shapes & complexity
-  12" to 18" diameter logs (variable length of 4' to 6' and can be handled by two people)

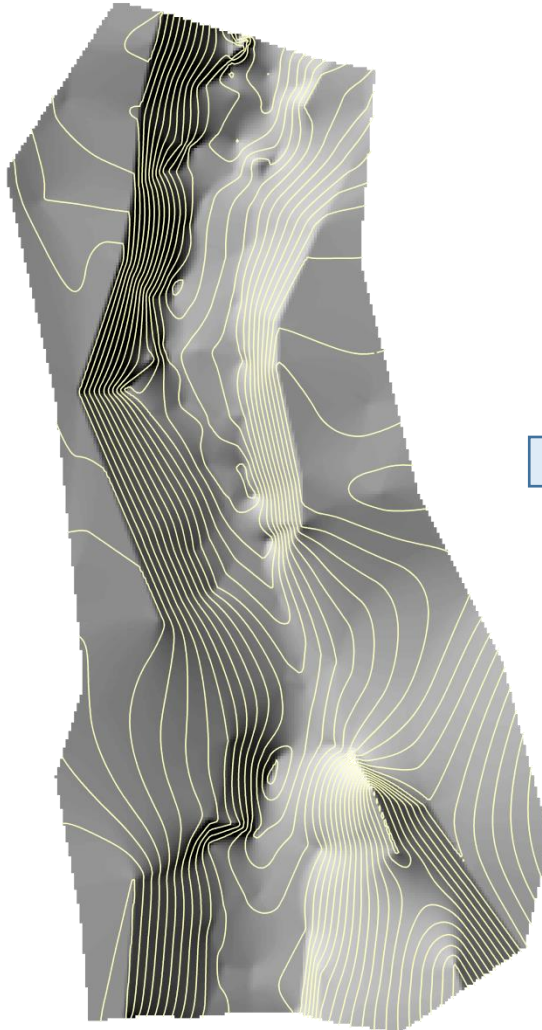
PILOT OR AEM TESTING VS. DESIGN STAGE

- Do we have to build it to test it?

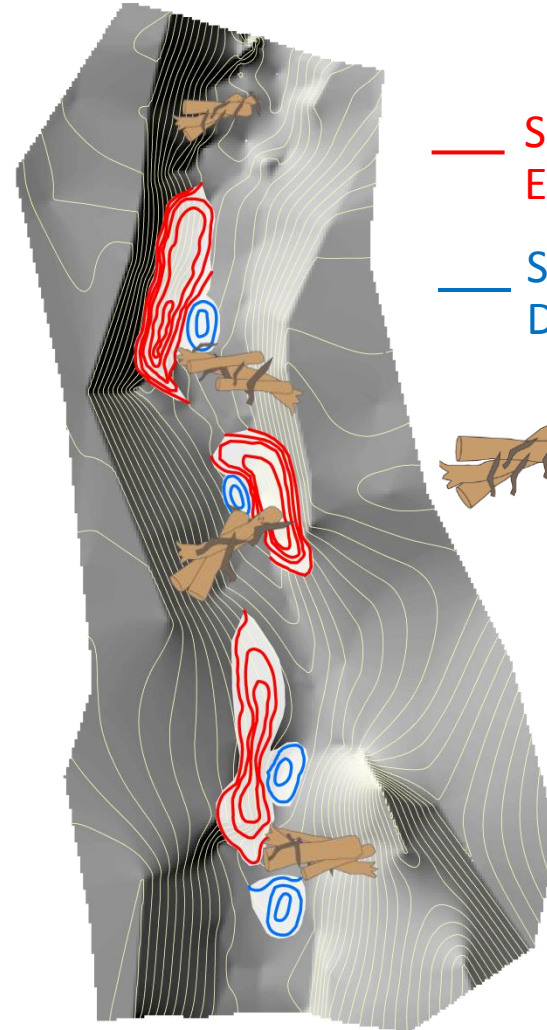


A DESIGN HYPOTHESIS TEST...

Existing Topography



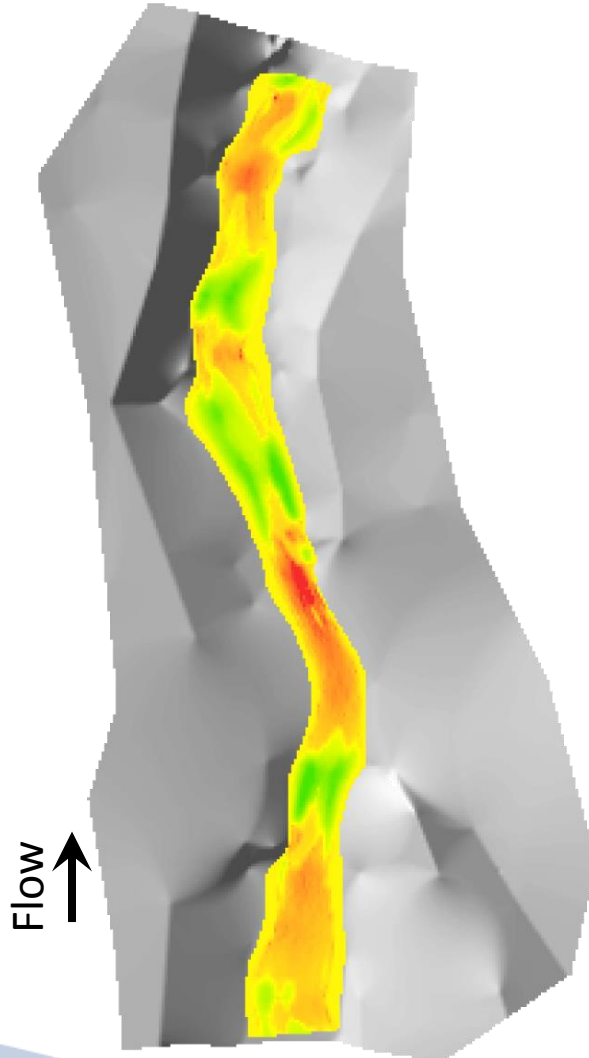
Simulated Change



- Simulated Erosion
- Simulated Deposition
- Wood Structures

DOES DESIGN PRODUCE INTENDED BENEFIT FOR FISH?

NREI Before LWD Structures



Potential NREI

