CHaMP Columbia Habitat Monitoring Program

Applying Twenty-First Century Technology to Solve Fish Management Questions at Multiple Scales

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Collaborators: Chris Beasley, Boyd Bouwes, Nick Bouwes, Andrew Hill, Chris Jordan, Mike Ward, Joe Wheaton, Carol Volk, Sarah Walker

Funders and More Collaborators

Bonneville
POWER ADMINISTRATION

ISEMP

NORTH ARROW RESEARCH

OREGON Fish & Wildlife

sitka technology group

CALIFORNIA DEPARTMENT OF FISH & WILDLIFE

NEZ PERCE FISHERIES

Rhithron Associates, Inc.

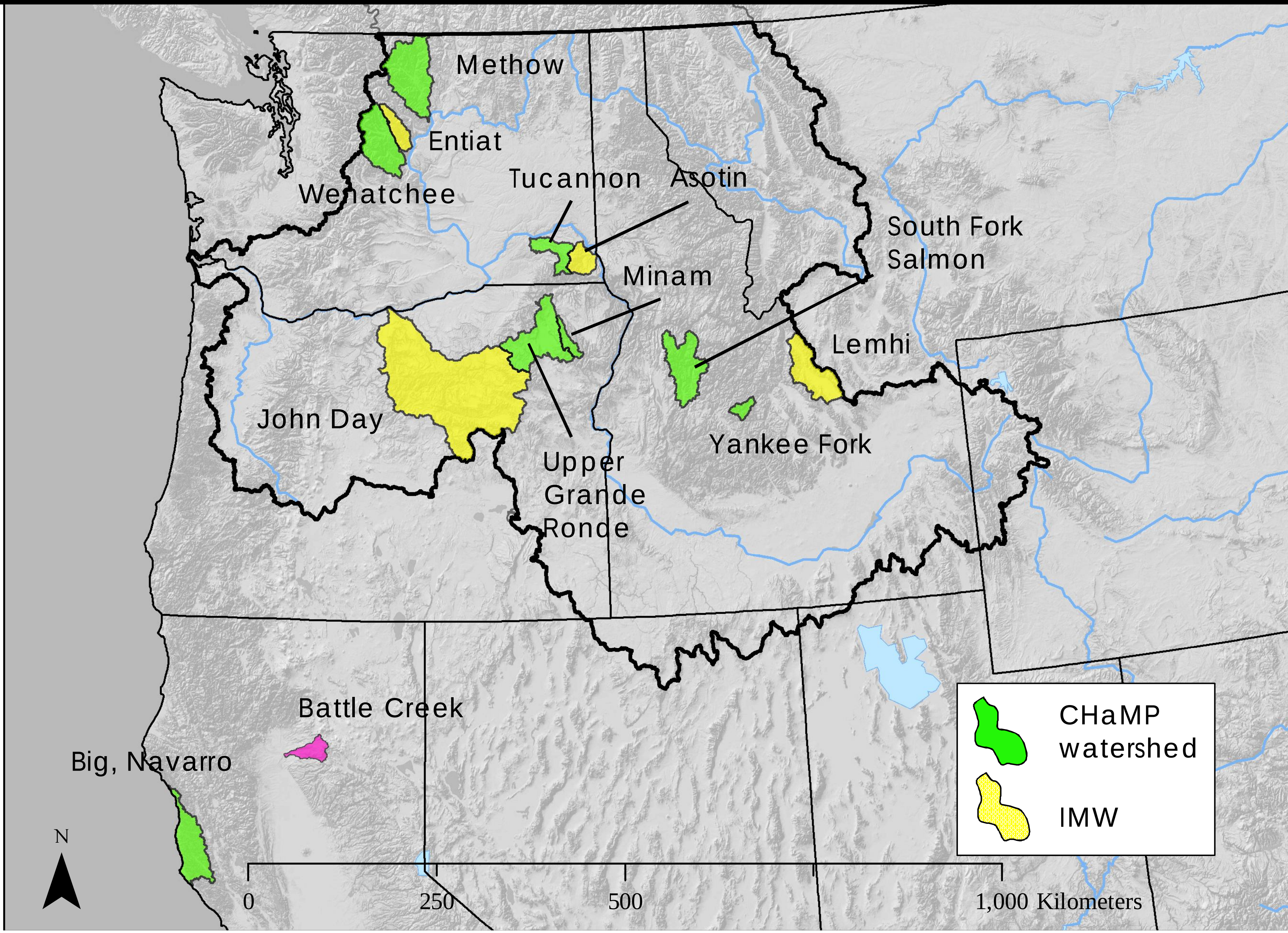
CampbellGlobal
FOREST & NATURAL RESOURCE INVESTMENTS

CHaMP Overview

- **Status and trends** monitoring program
- **Purpose:** answer management questions concerning the ESA-listed salmon populations of the 2008 Biological Opinion (NMFS 2008).

- **Specific management questions:**
  - Limiting factors
  - Relationship between habitat actions and fish
  - Effectiveness of actions on fish populations

Geographic Area



Sampling Design

Sample allocation – **Rotating panel**

- 25 sites per watershed per year
- Total of 45 sites

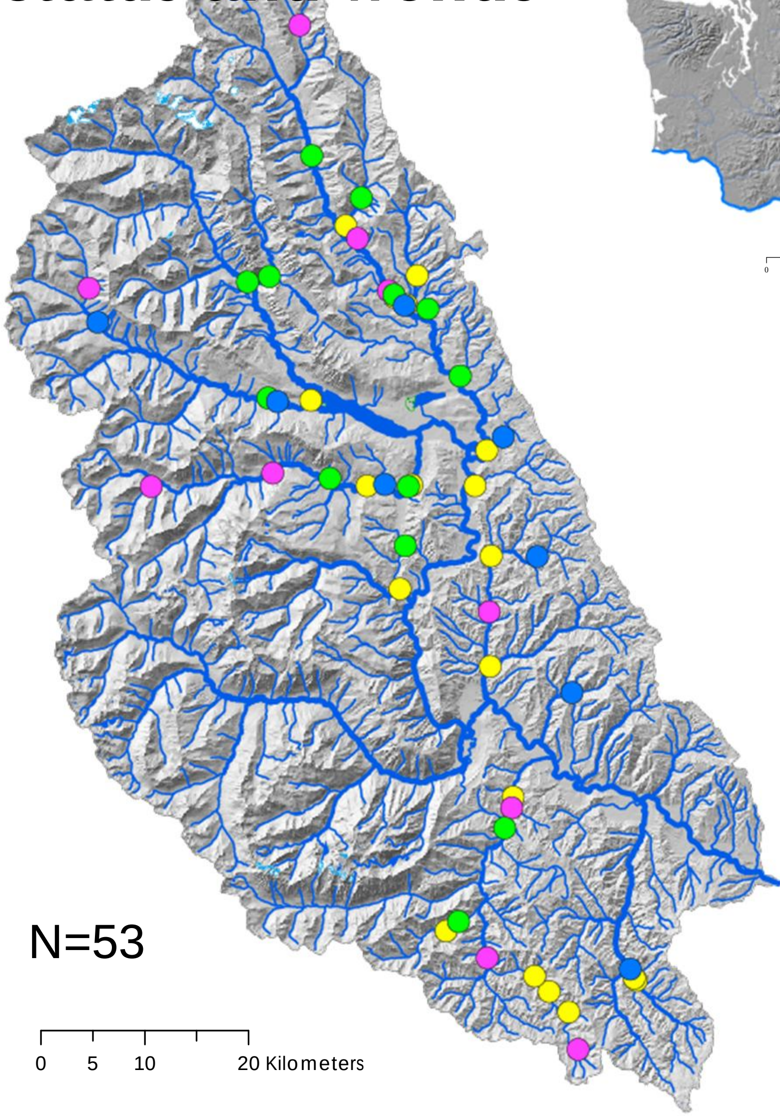
GRTS (Generalized Random Tessellation Stratified)

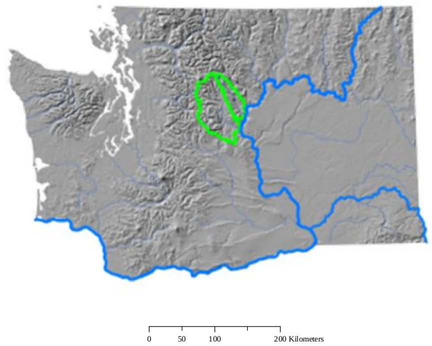
- Stratified
- Spatially Balanced
- Flexible
- Weighted

Panel	**Year 1** 2011	**Year 2** 2012	**Year 3** 2013	**Year 4** 2014	**Year 5** 2015	**Year 6** 2016	**Year 7** 2017	**Year 8** 2018	**Year 9** 2019
Annual Panel									
Rotating Panel 1									
Rotating Panel 2									
Rotating Panel 3									

Sampling Design: Upper Columbia

Status and Trends

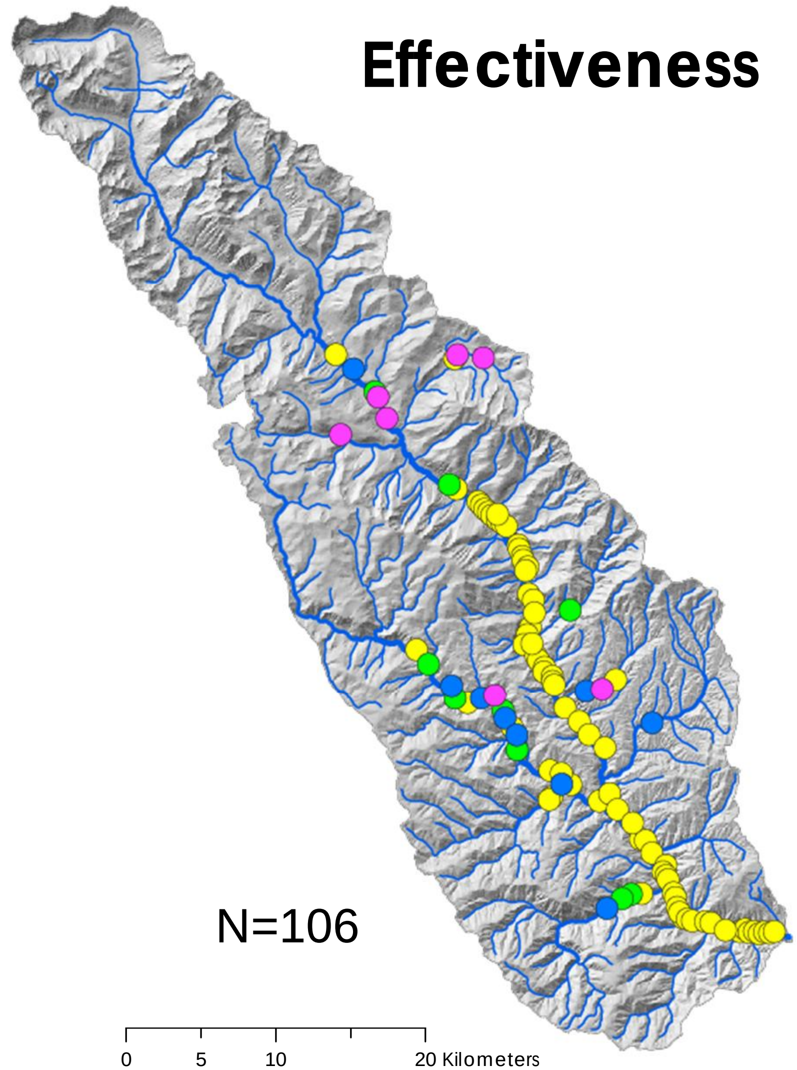




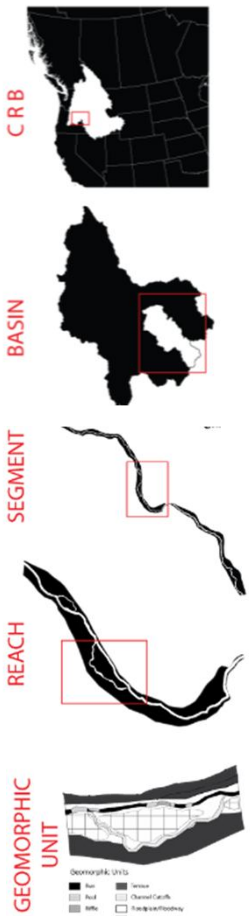
Legend

- Annual
- RP 1
- RP 2
- RP 3

Status and Trends + Effectiveness



Multiscalar Samplng Design



Spatial scale

Regional Setting

Controls on river character and behavior

Watershed

Valley Segment

River Reach

Geomorphic and Hydraulic Units

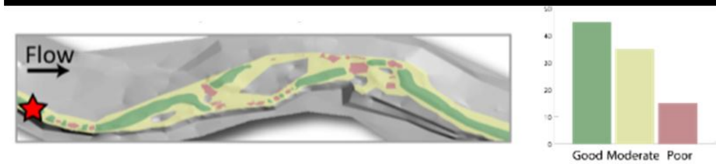
Floodplain features and in-channel units

TOP DOWN CONTROLS

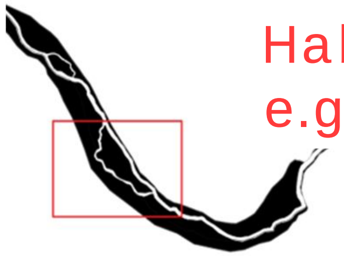
Geomorphic Reach Type

BOTTOM UP CONTROLS

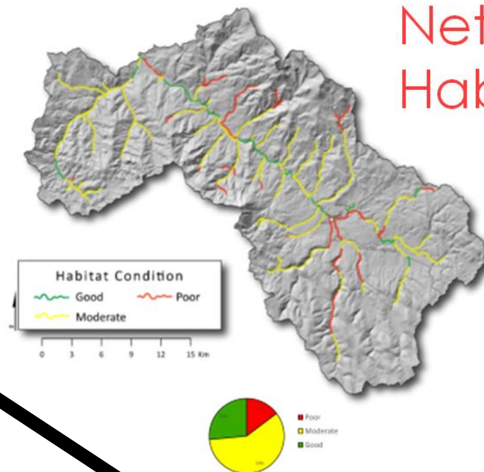
Different Scales For Different Needs



Microhabitat (HSI)

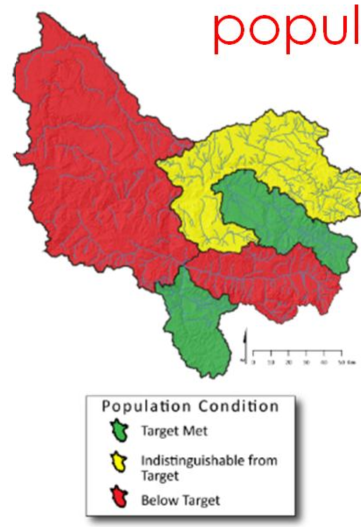


Habitat metric
e.g., pool frequency



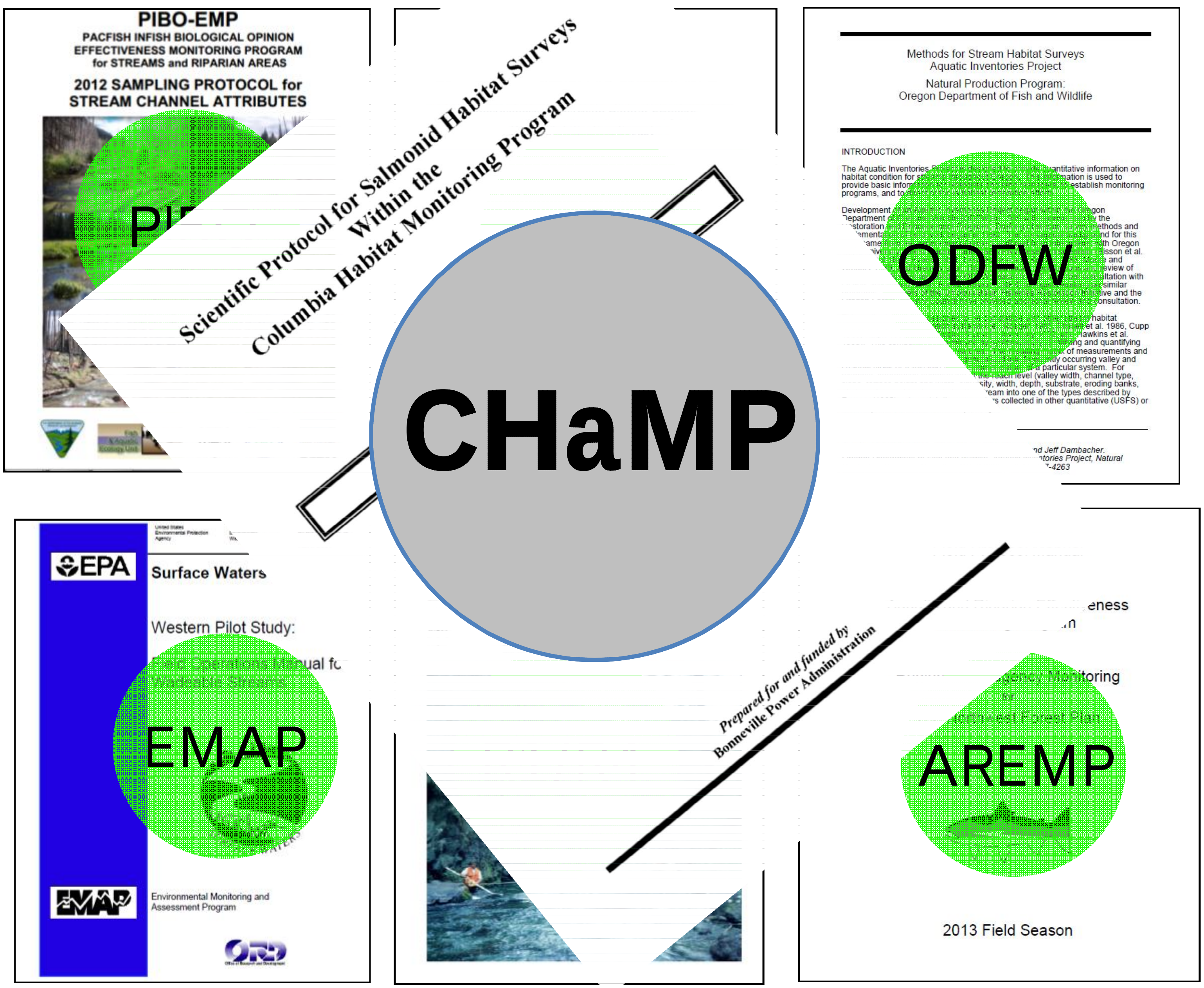
Network-Scale
Habitat Condition

Watershed /
population

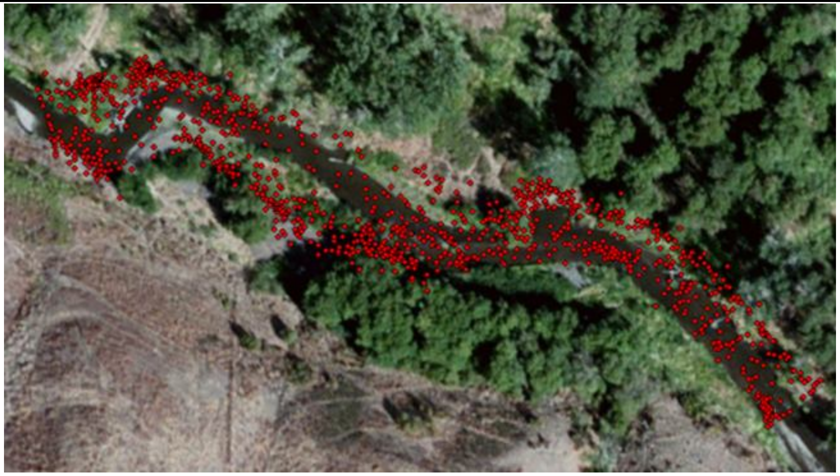


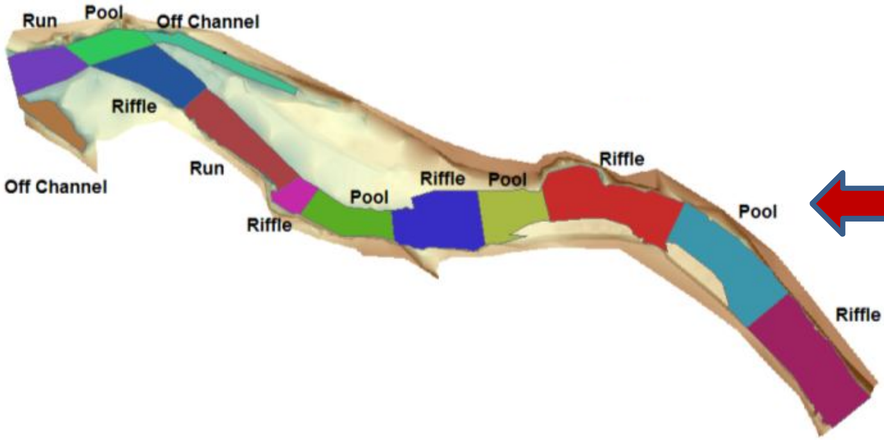
BASIN

Protocol Development

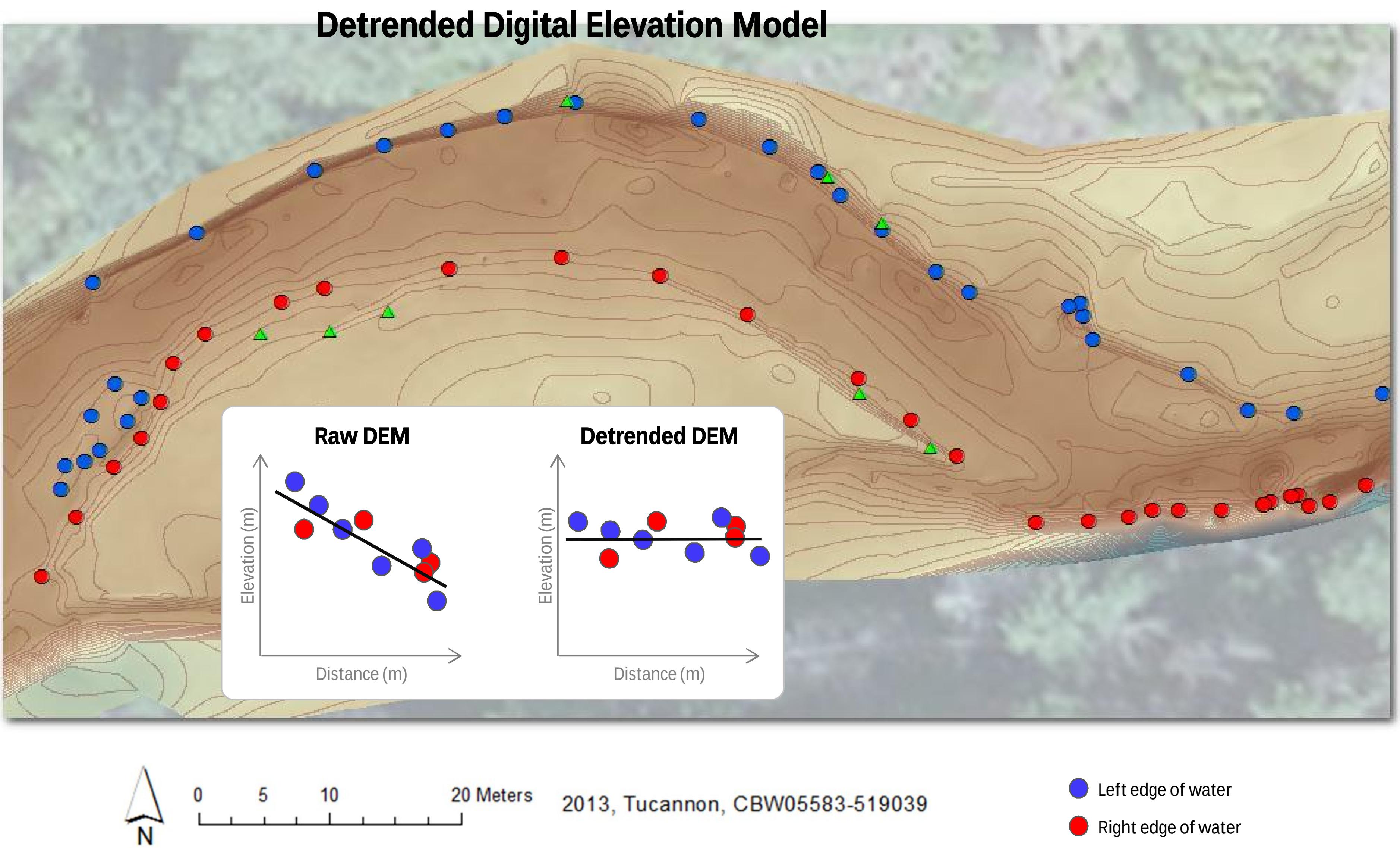


Topographic Survey

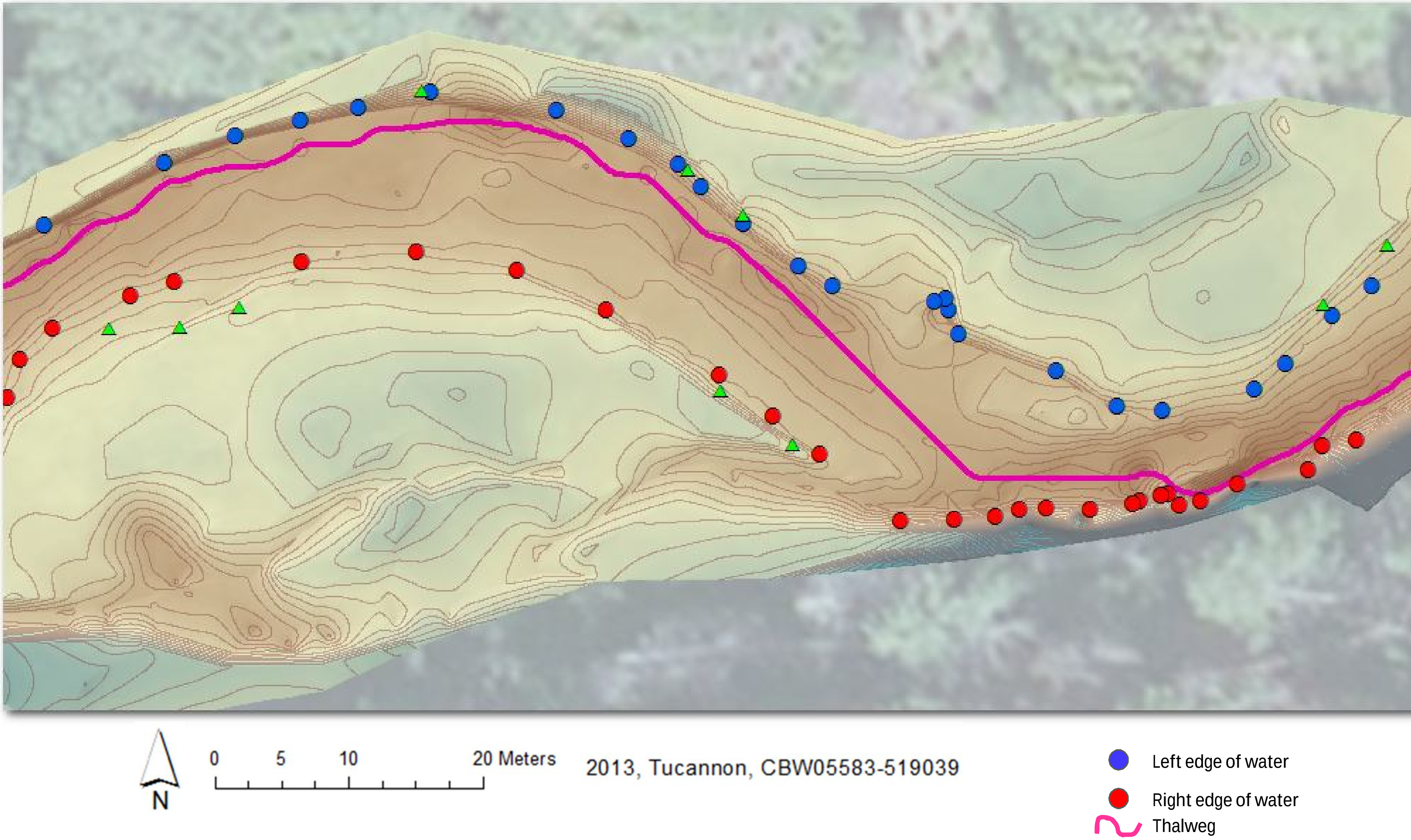




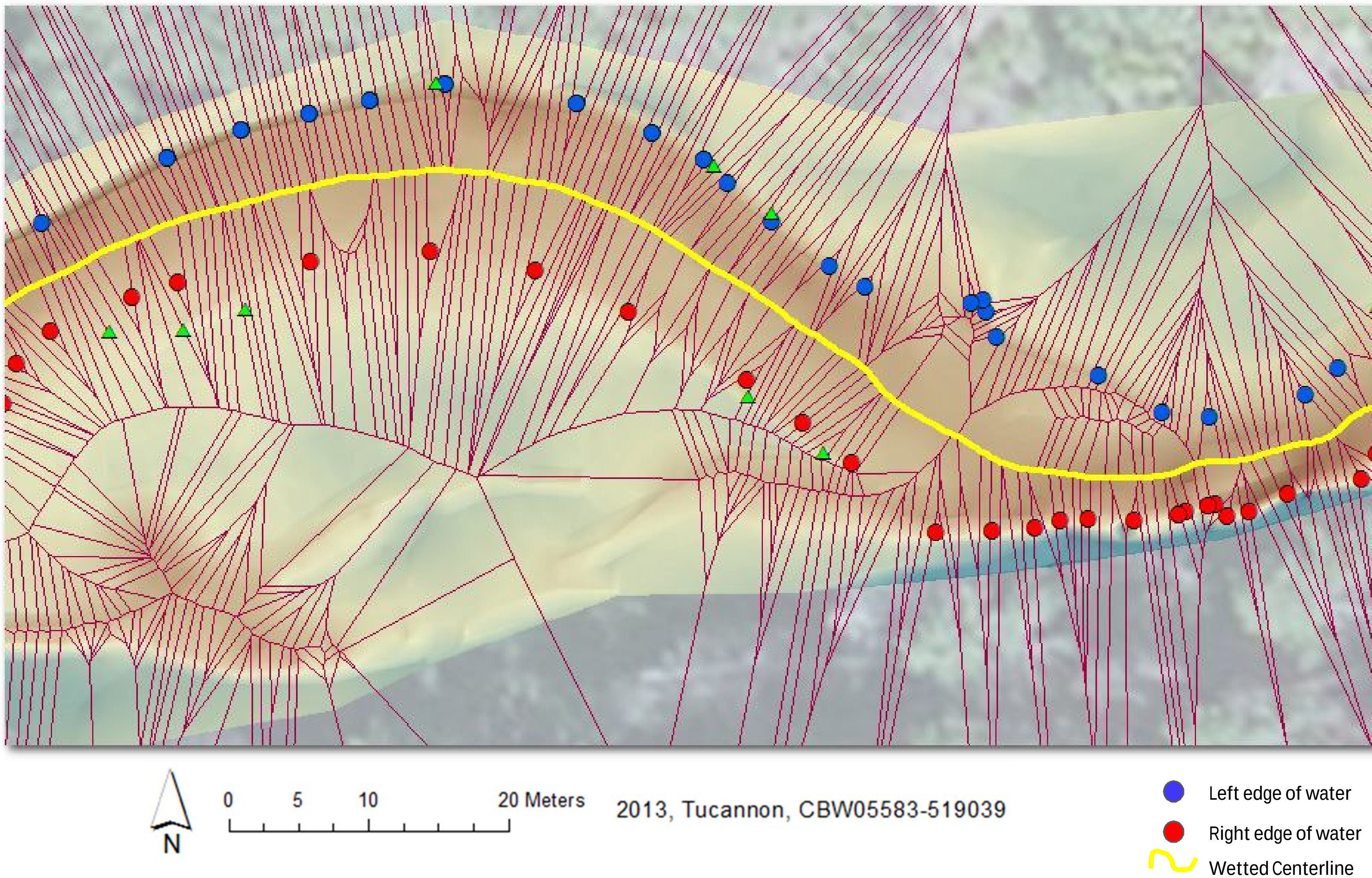
River Bathymetry Toolkit (RBT)



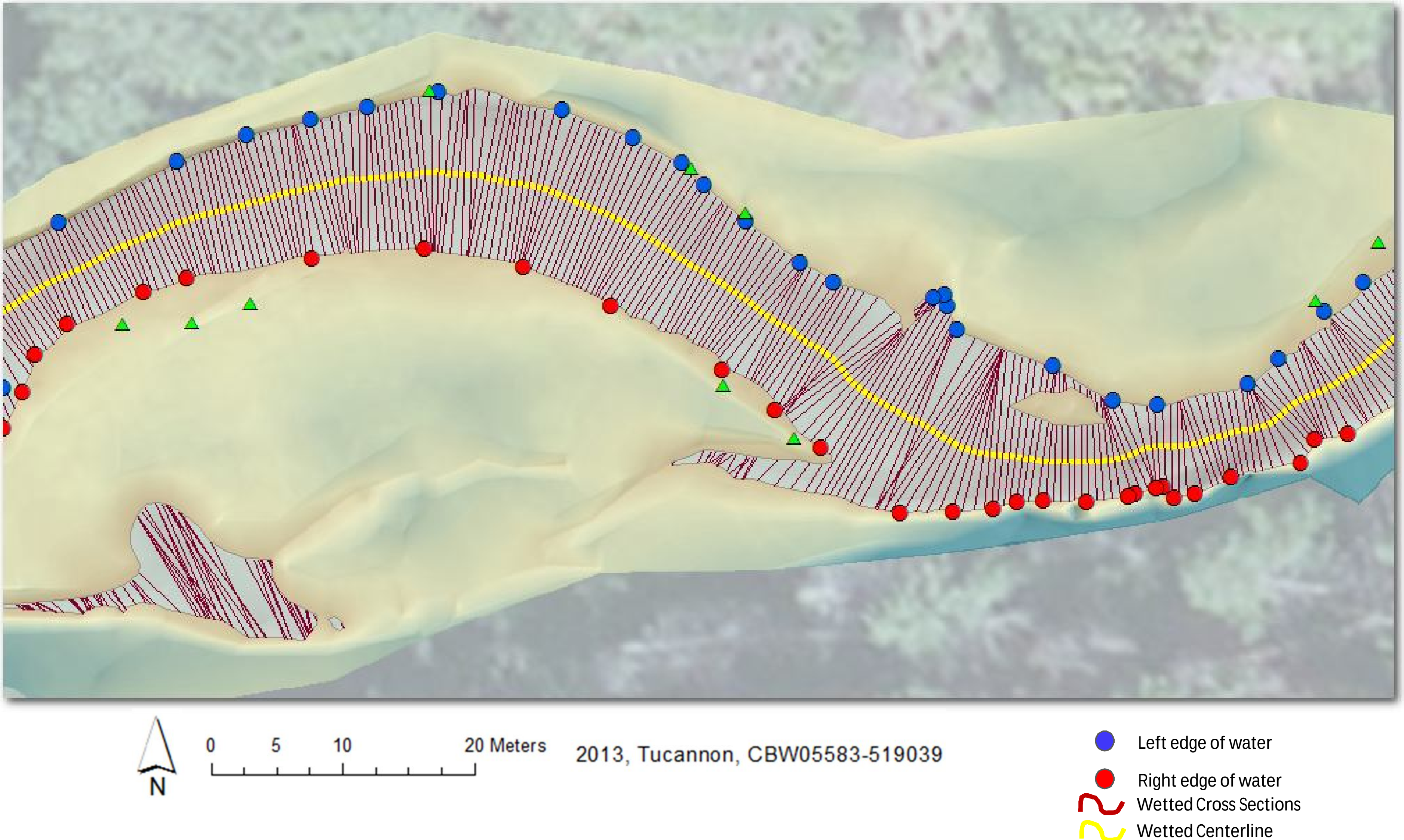
Thalweg


N
0
5
10
20 Meters
2013, Tucannon, CBW05583-519039
Left edge of water
Right edge of water
Thalweg

Wetted Centerline

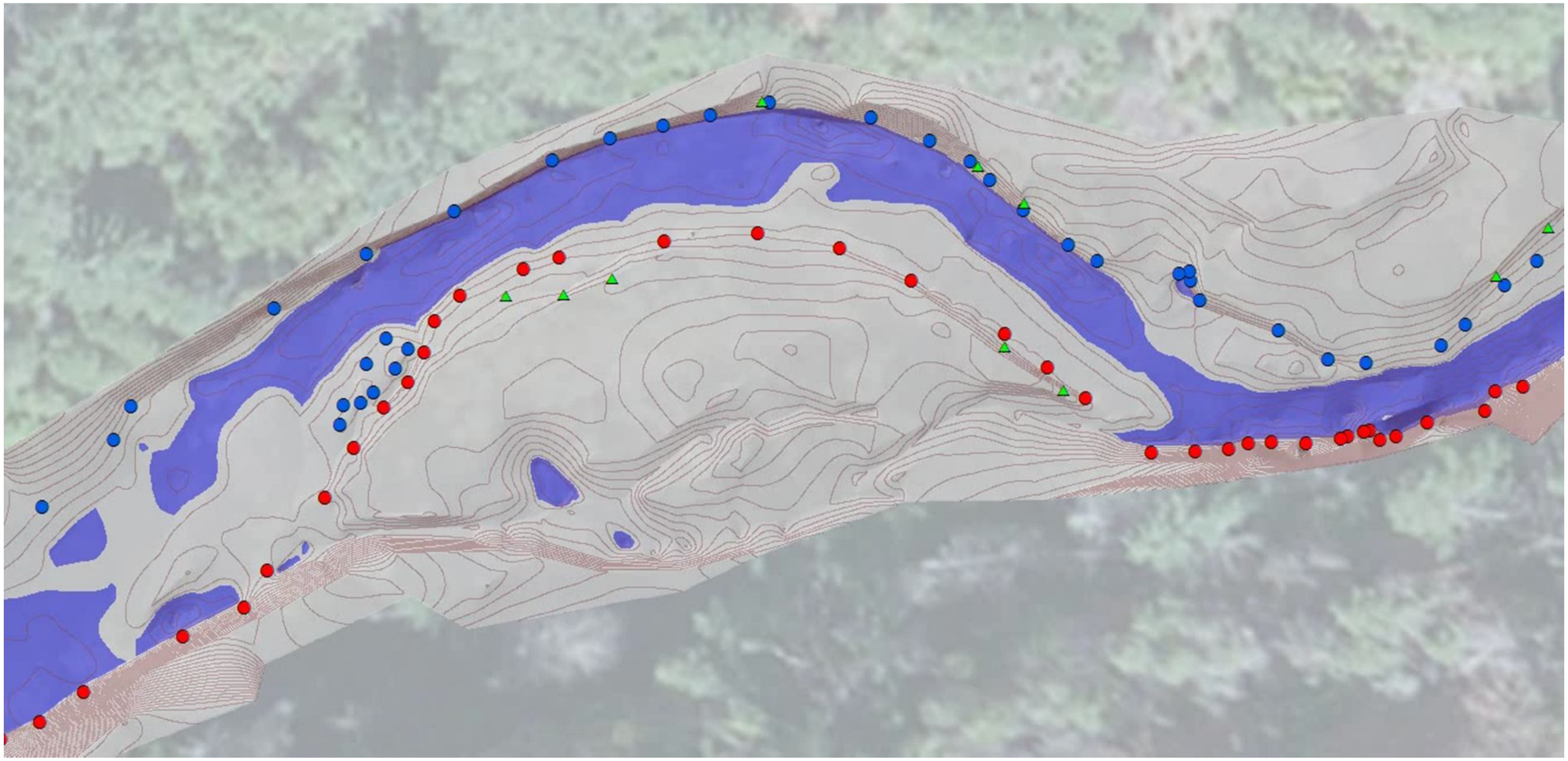


Cross Sections

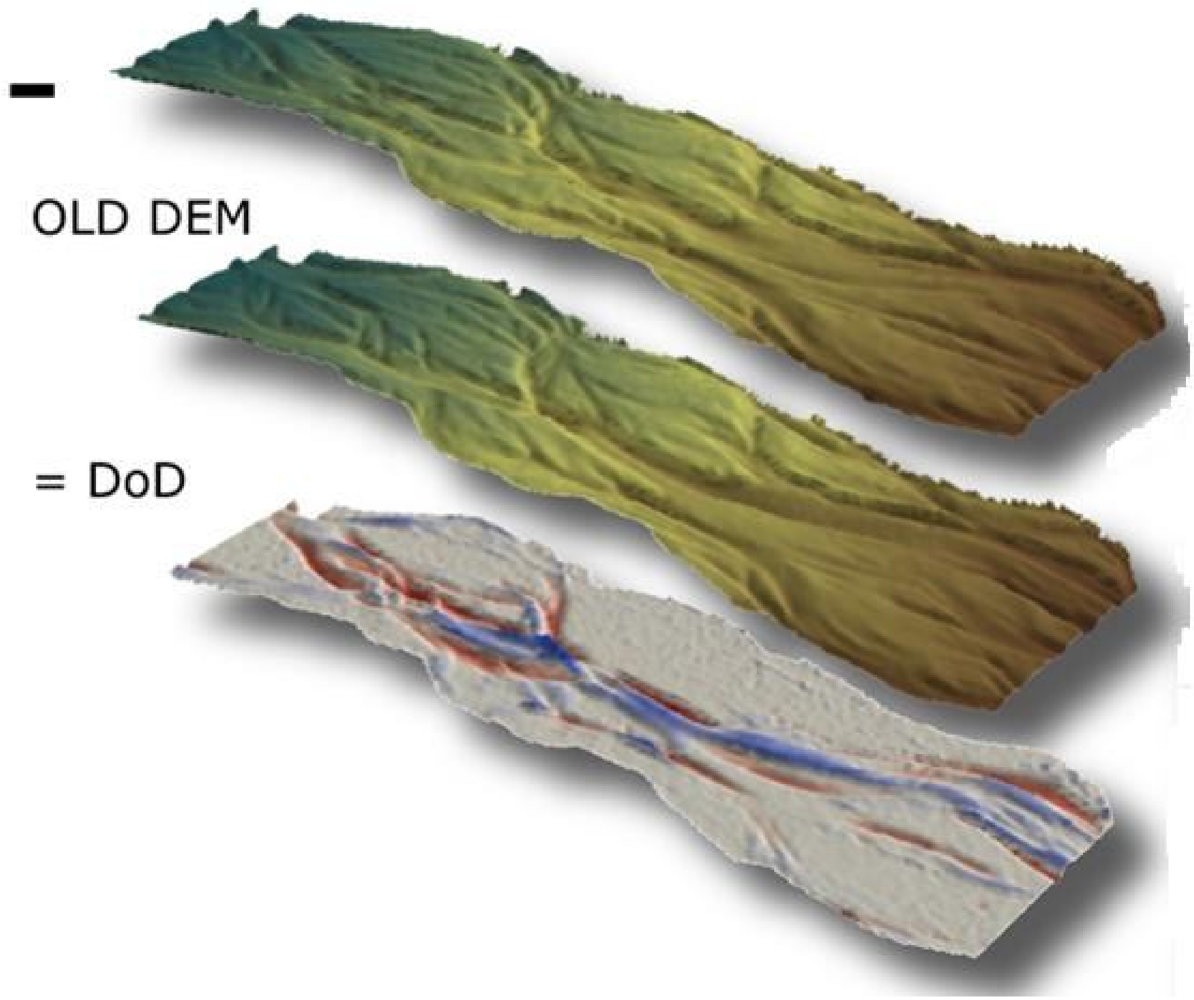


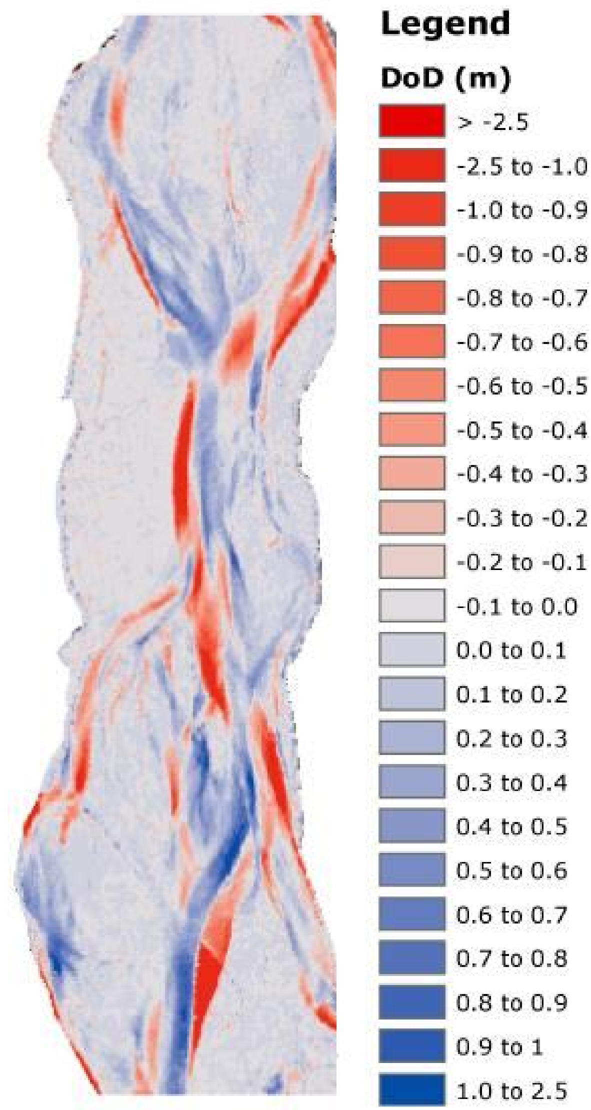
RBT Stage Slider

Crews find the best fit for the water extent and bankfull by interactively varying the water stage depth in the detrended DEM. Any stage can be modeled, not just the observed stage.



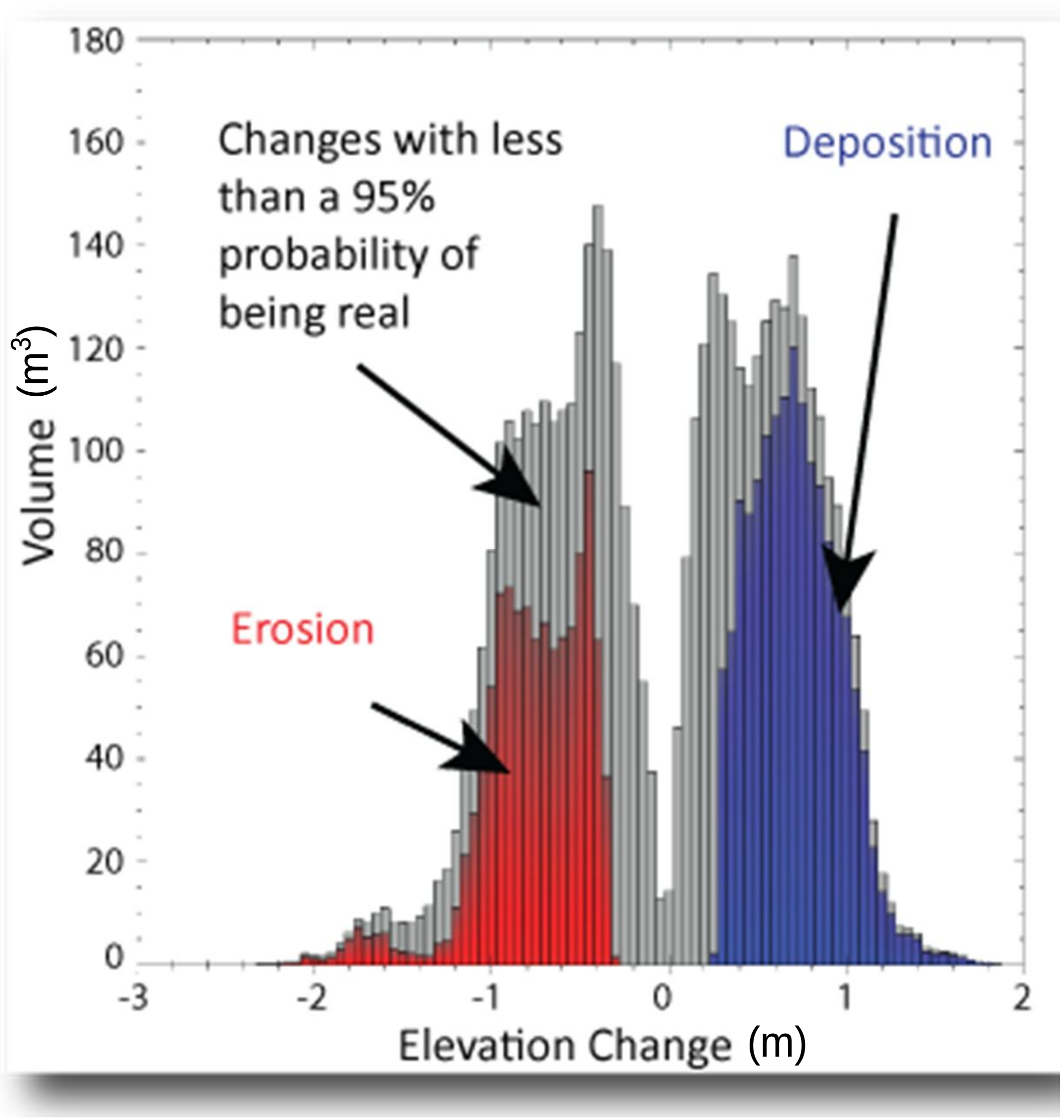
Geomorphic Change Detection



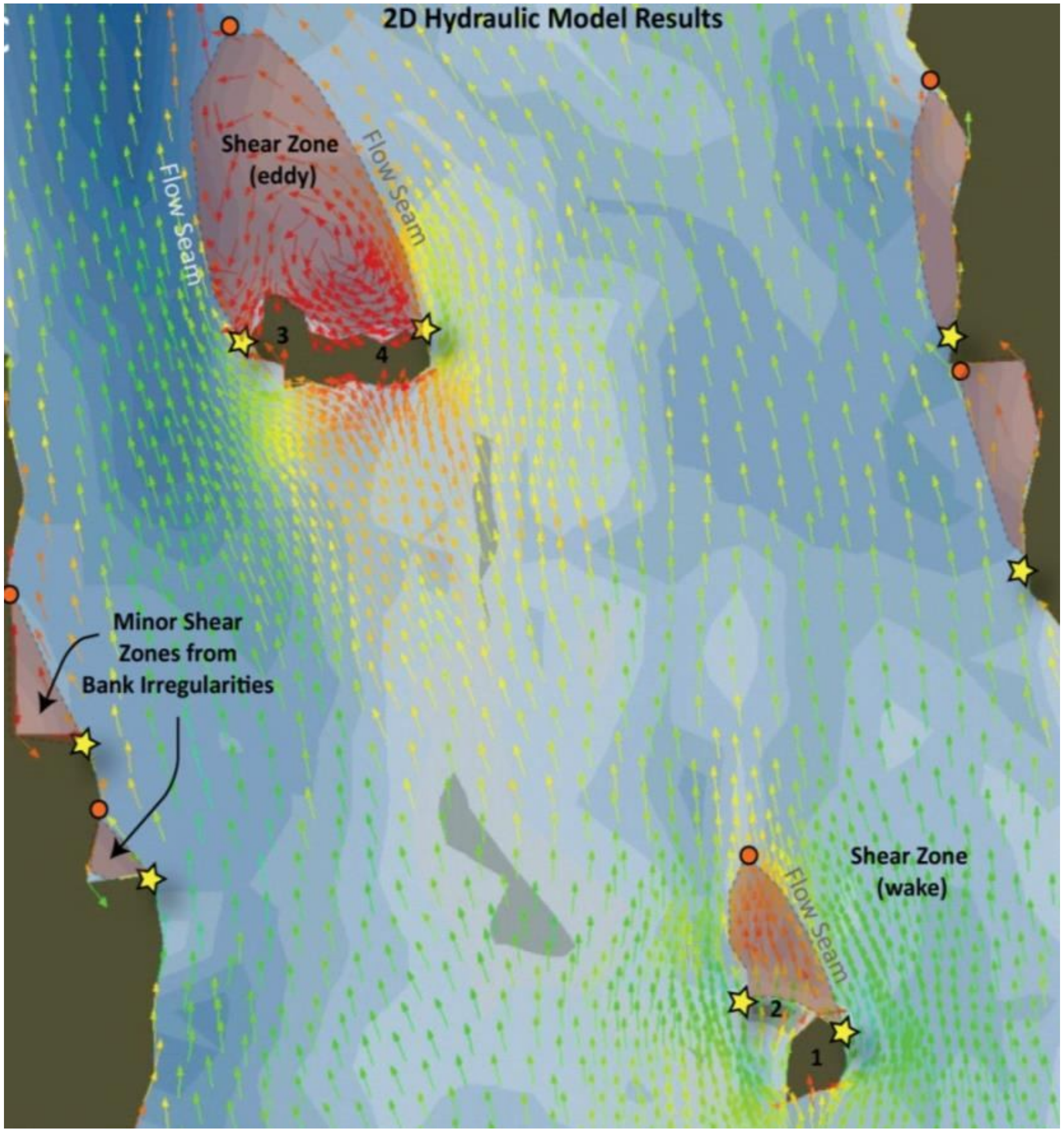


© Wheaton (2008)

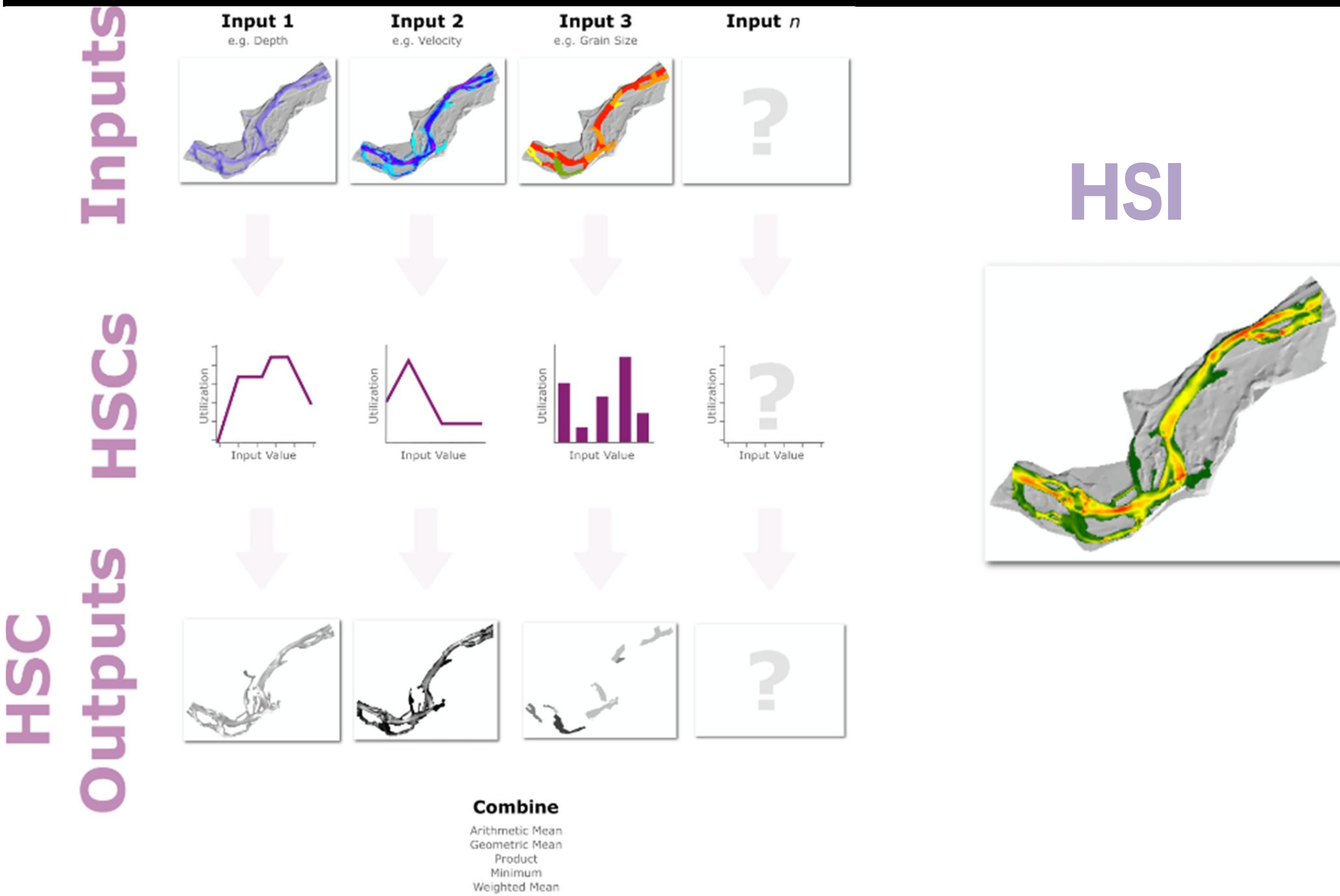
Geomorphic Change Results



Shear Zones

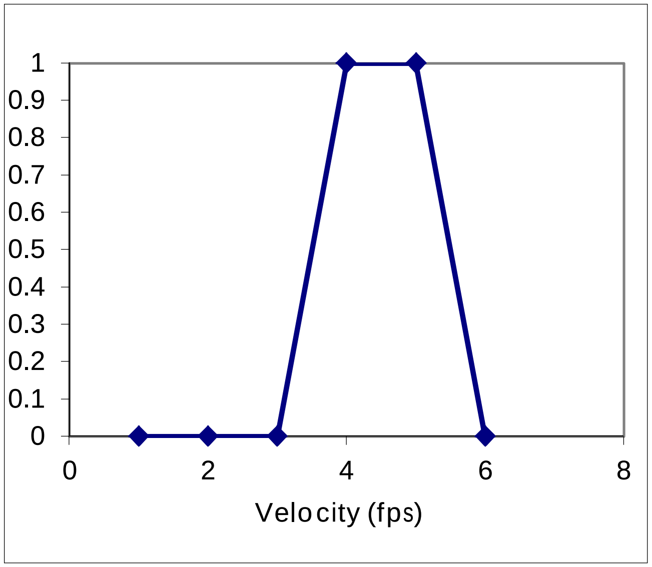

2D Hydraulic Model Results
Shear Zone
(eddy)
Flow Seam
Flow Seam
3
4
Minor Shear
Zones from
Bank Irregularities
Shear Zone
(wake)
Flow Seam
2
1

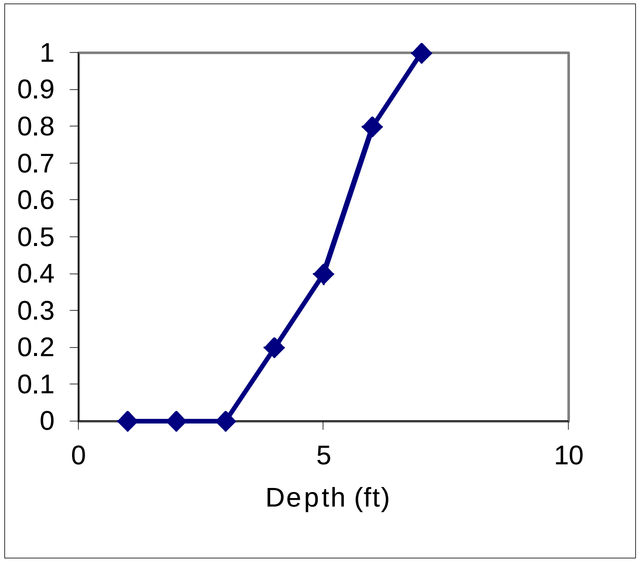
Habitat Suitability Model

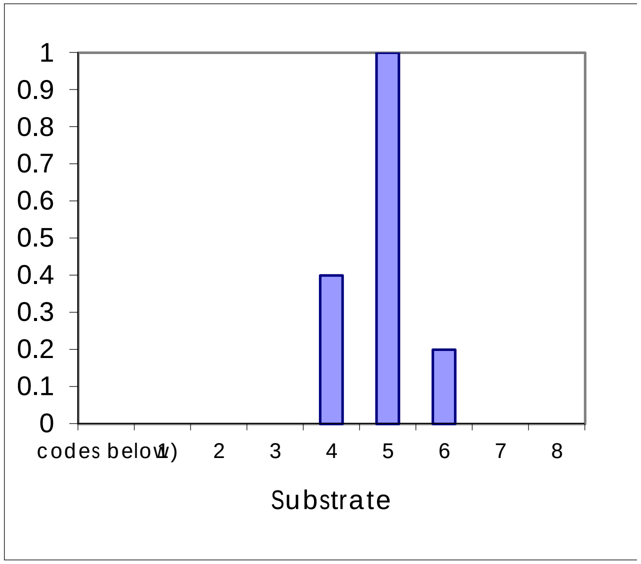


Habitat Suitability Curves

Chinook Spawners



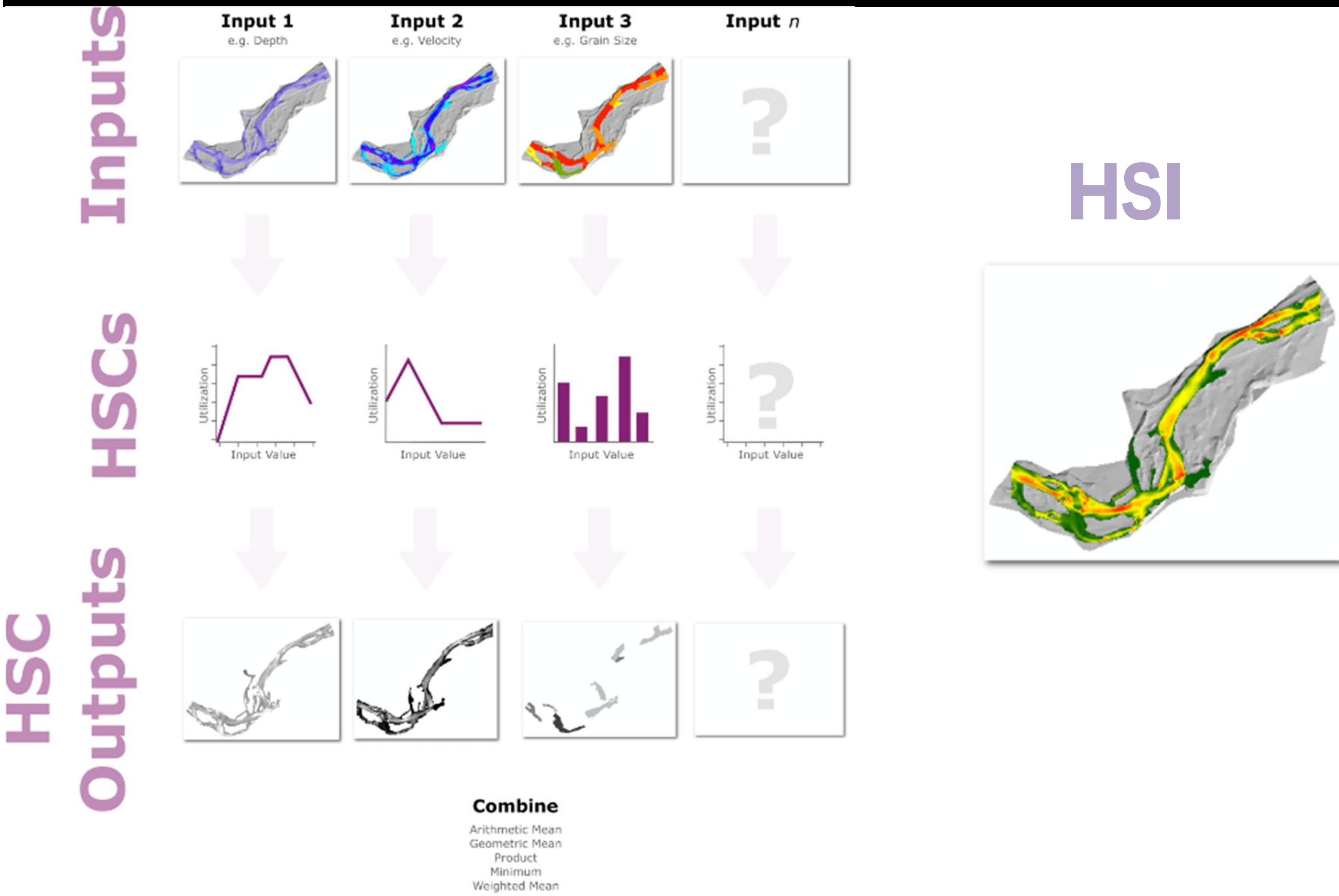




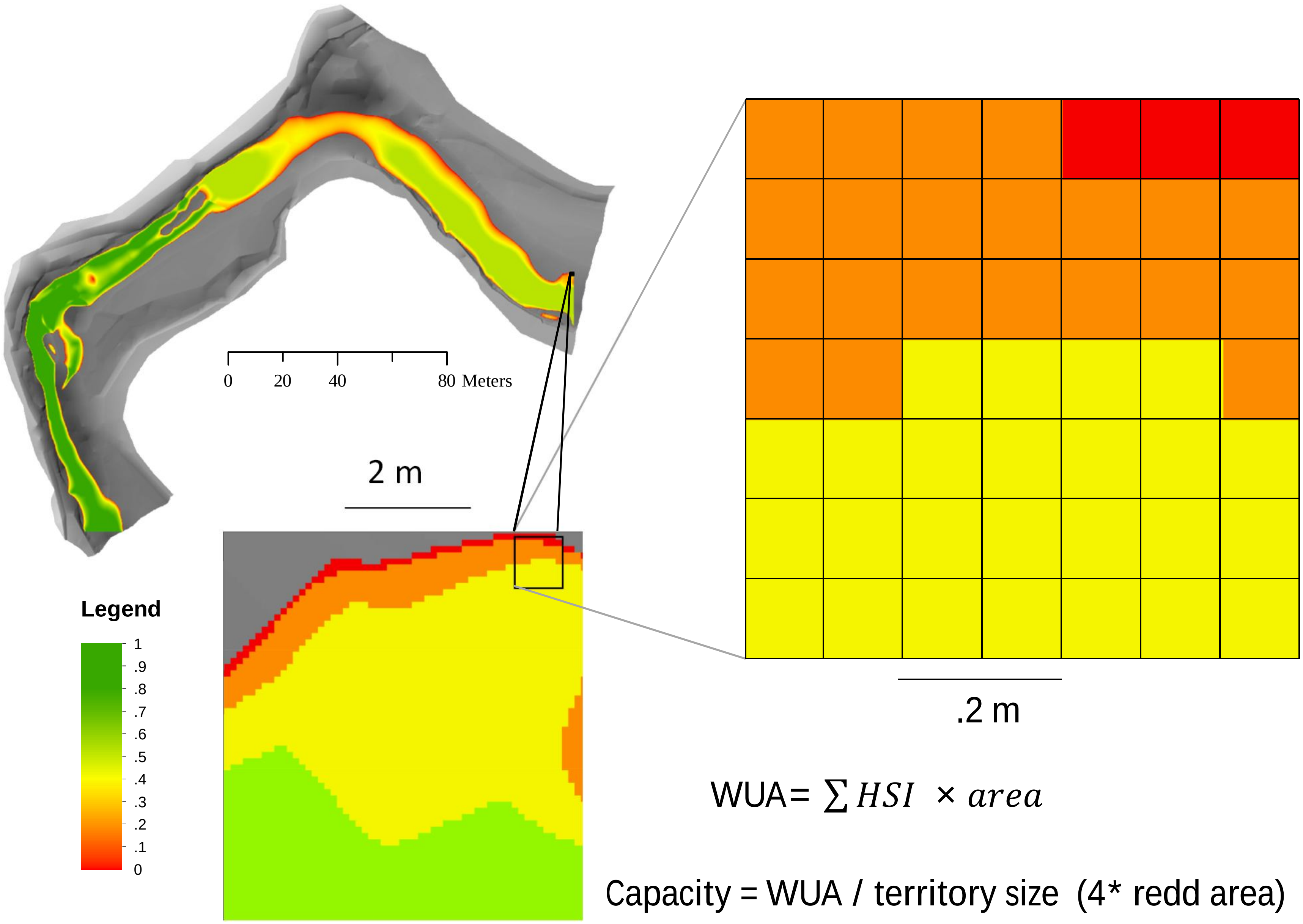
Source: http://pubs.usgs.gov/sir/2004/5173/data/habitat_curves/
EA Engineering, Science and Technology Inc., 1991 a, 1991b; Rubin et al., 1991; R2 Resource Consultants, 2004

Maret TR, Hortness JE, and Ott DS. 2006. Instream flow characterization of upper Salmon River Basin streams, central Idaho, 2005: US Geological survey Scientific Investigations Report 2006-5230, 110 p

Habitat Suitability Model



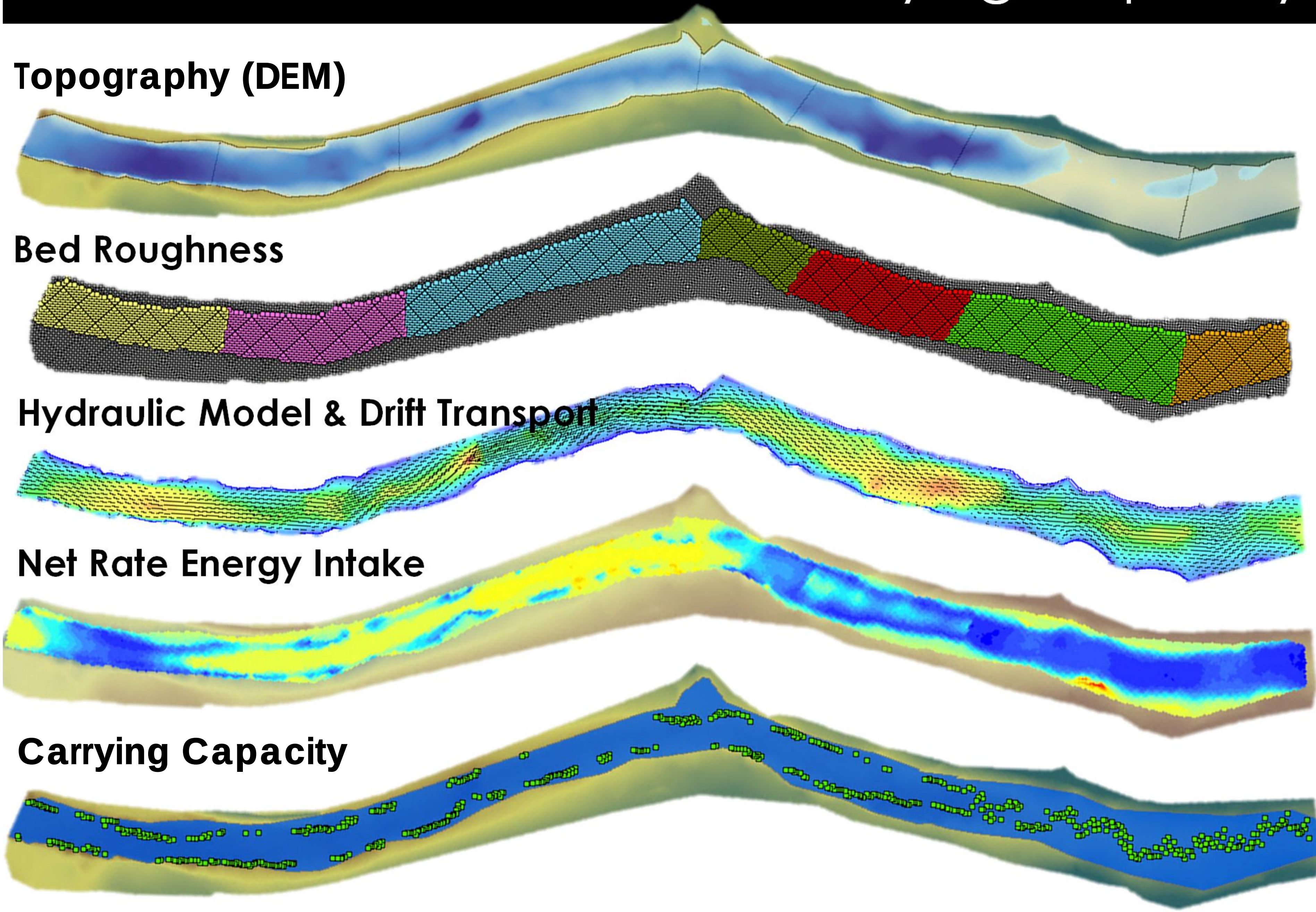
Spatially Explicit Habitat Suitability



$$\text{WUA} = \sum HSI \times area$$

Capacity = WUA / territory size (4* redd area)

Habitat Measurements → Carrying Capacity

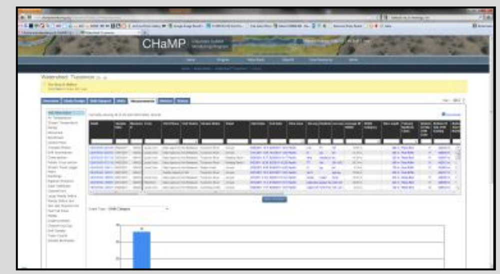


Data Management

Auxiliary Data Workflow

Data Logger

Data Broker



champmonitoring.org

Upload to website

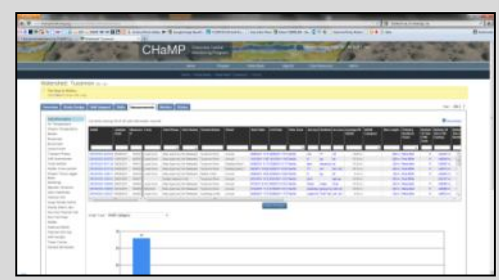
Topographic Data Workflow

Total Station

CHaMP Topo Toolbar

ArcGIS

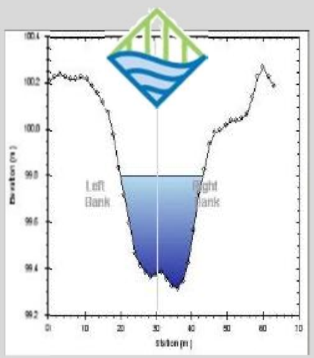
RBT



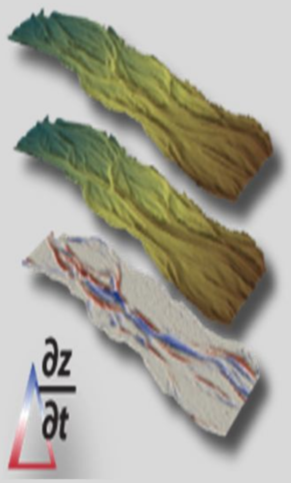
Website Upload

Automatically Generated Metrics

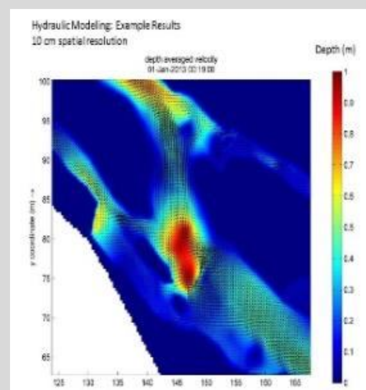
RBT-generated metrics



Geomorphic Change Detection Outputs

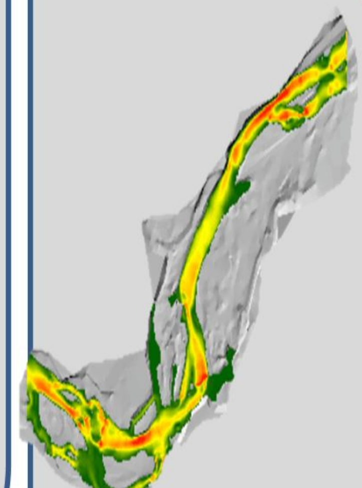


2D-Hydraulic Model Outputs

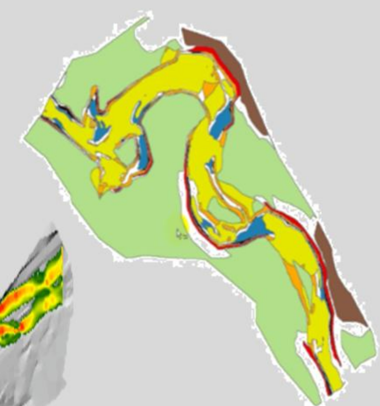


On champmonitoring.org

Habitat Suitability Models



Geomorphic Unit Tool (GUT)



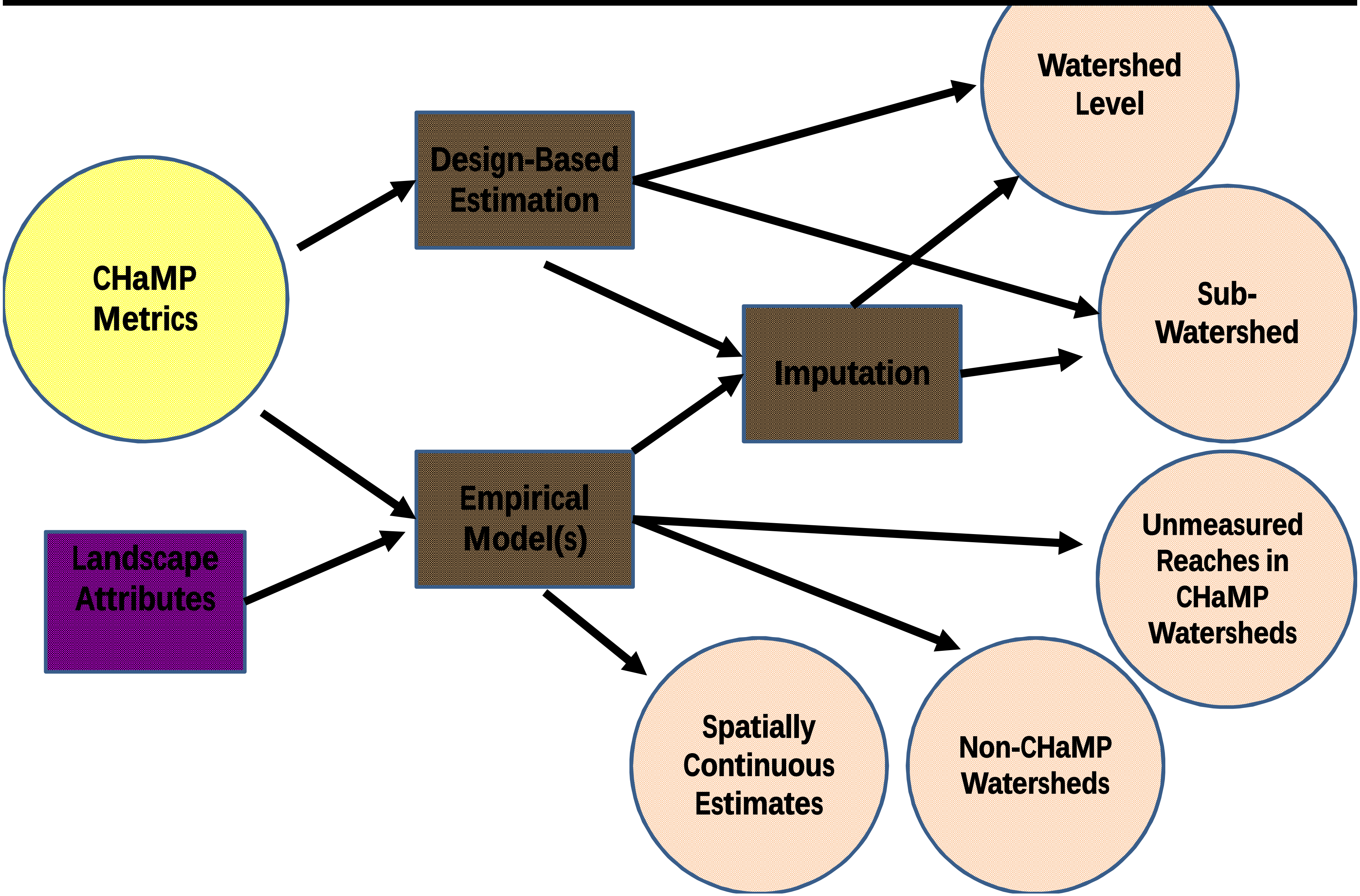
Desktop-only

Metric Assessment

- **variance decomposition** is conducted annually to assess metric capability

- Other CHaMP metric assessment tools:
  - 10% repeat surveys
  - Crew variability study to quantify bias
  - Comparison of metrics shared with those of other regional monitoring programs

Upscaling



Watershed Level
Design-Based Estimation
CHaMP Metrics
Sub-Watershed
Imputation
Empirical Model(s)
Landscape Attributes
Unmeasured Reaches in CHaMP Watersheds
Spatially Continuous Estimates
Non-CHaMP Watersheds

Geomorphic Reach Types

Confined

Bedrock Canyon

Confined Valley Boulder Bed

Confined Valley Coarse Plane Bed

Confined Valley Step Cascade

Confined Valley With Floodplain Pockets

Steep Alpine Headwaters

Steep Ephemeral Hillslope

Steep Perennial Headwaters

Partly Confined Valley

Bedrock Controlled Discontinuous Floodplain

Fan/Terrace Controlled Discontinuous Floodplain

Low Sinuosity Planform Controlled Anabranching

Low To Moderate Sinuosity Planform Controlled Discontinuous Floodplain

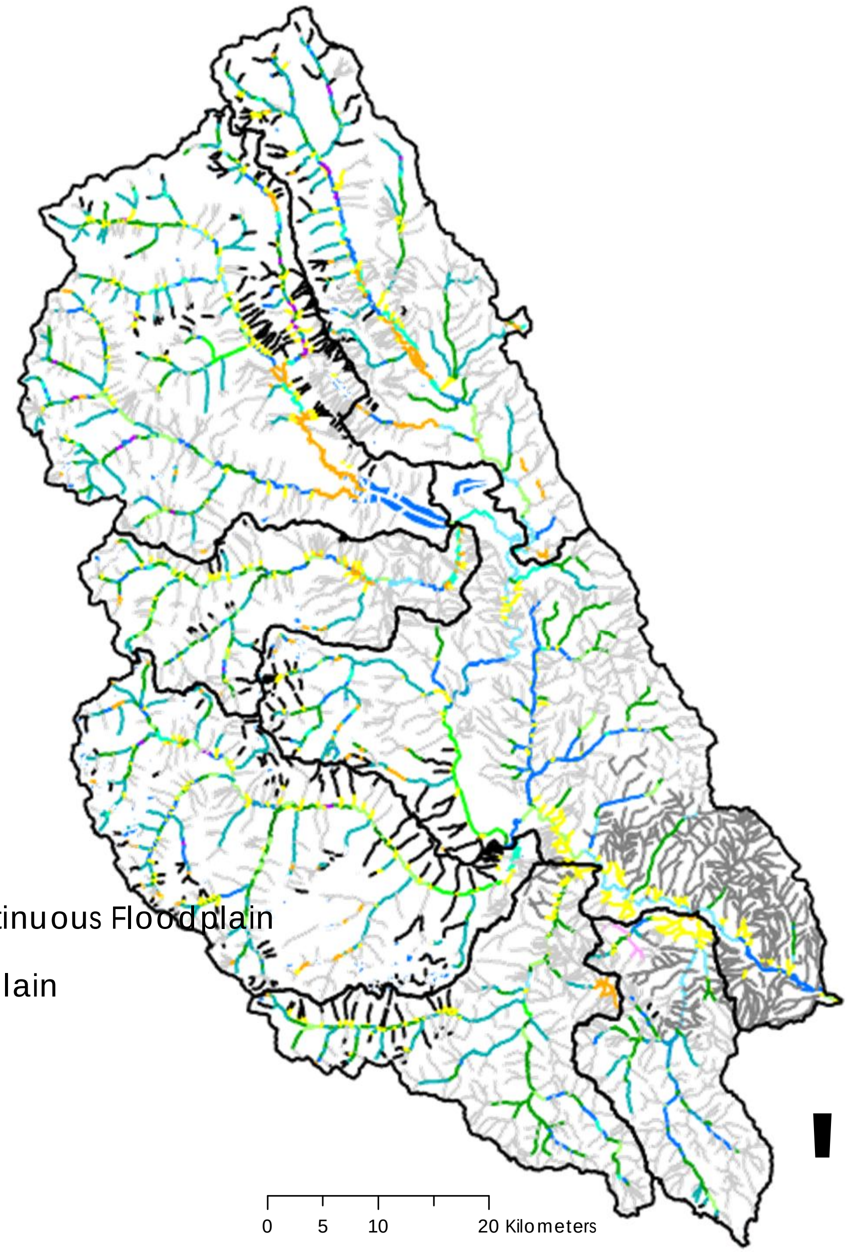
Meandering Planform Controlled Discontinuous Floodplain

Laterally Unconfined

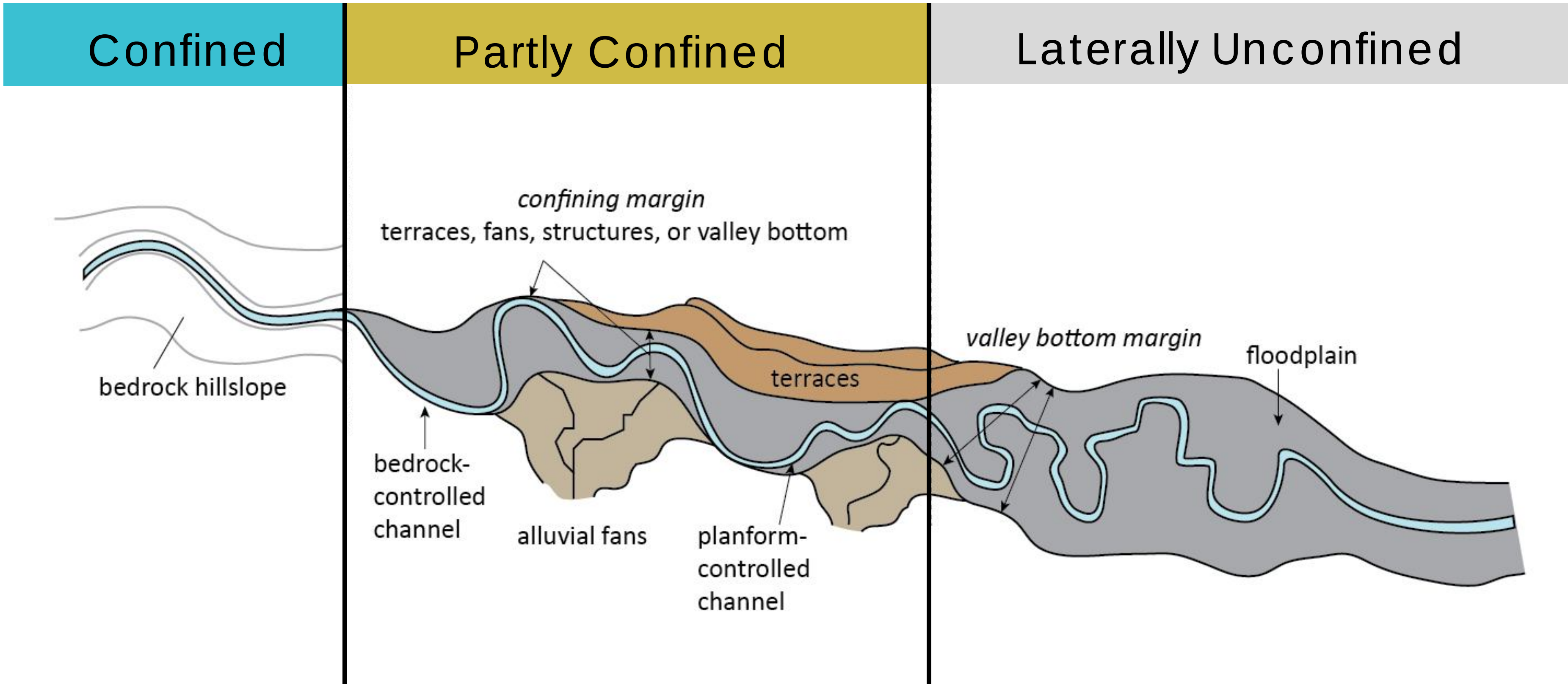
Alluvial Fan

Intact Valley Fill

Moderate To High Sinuosity Gravel/Sand Bed

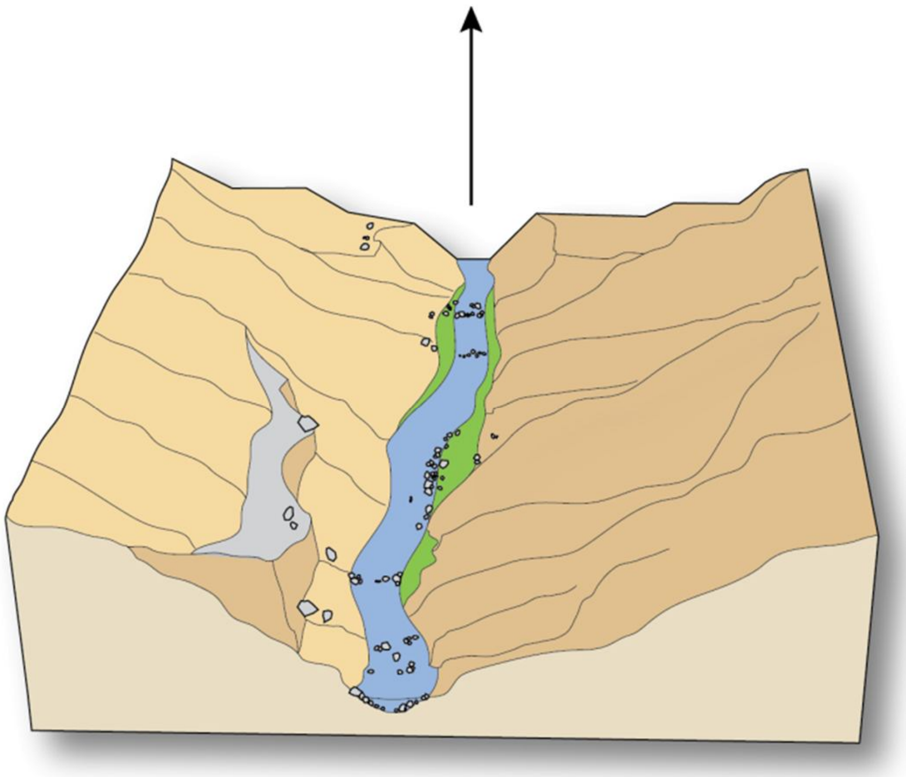


Valley Confinement

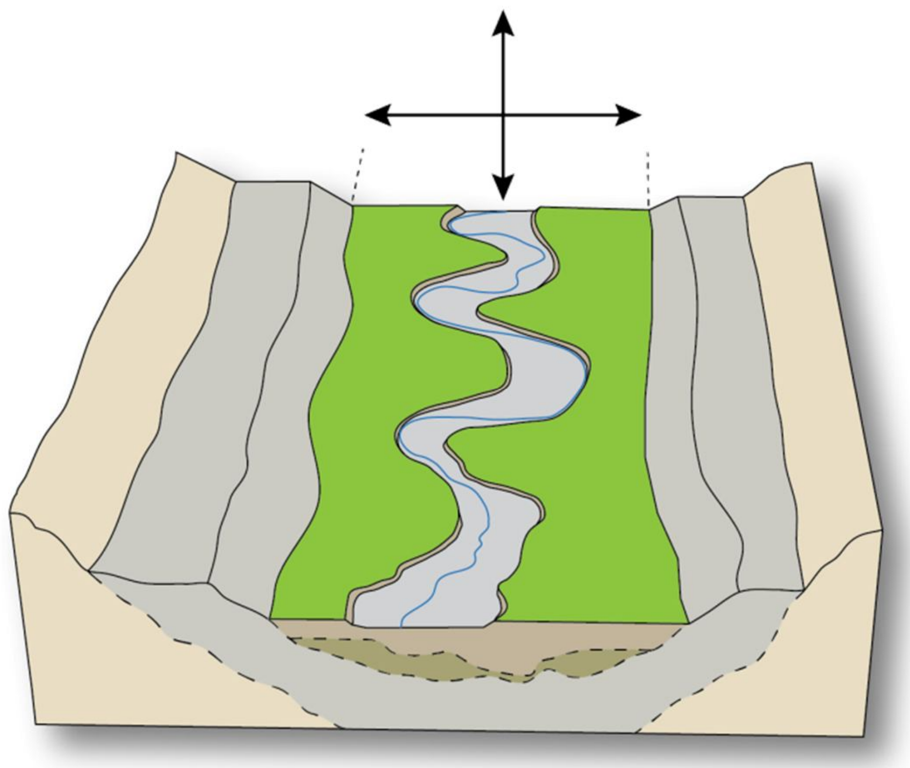


Capacity for Adjustment

Confined Valley Setting

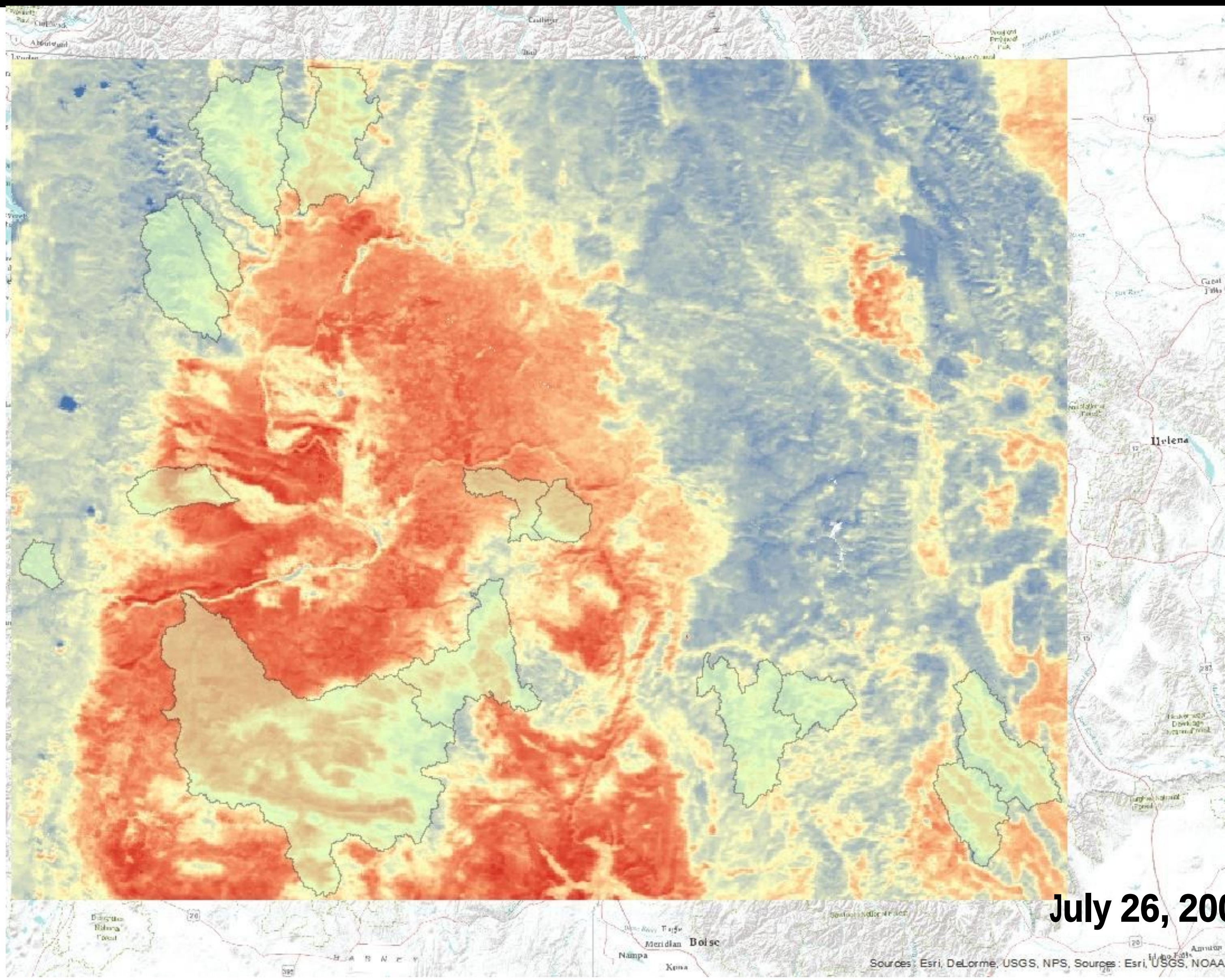


Laterally Unconfined Valley Setting



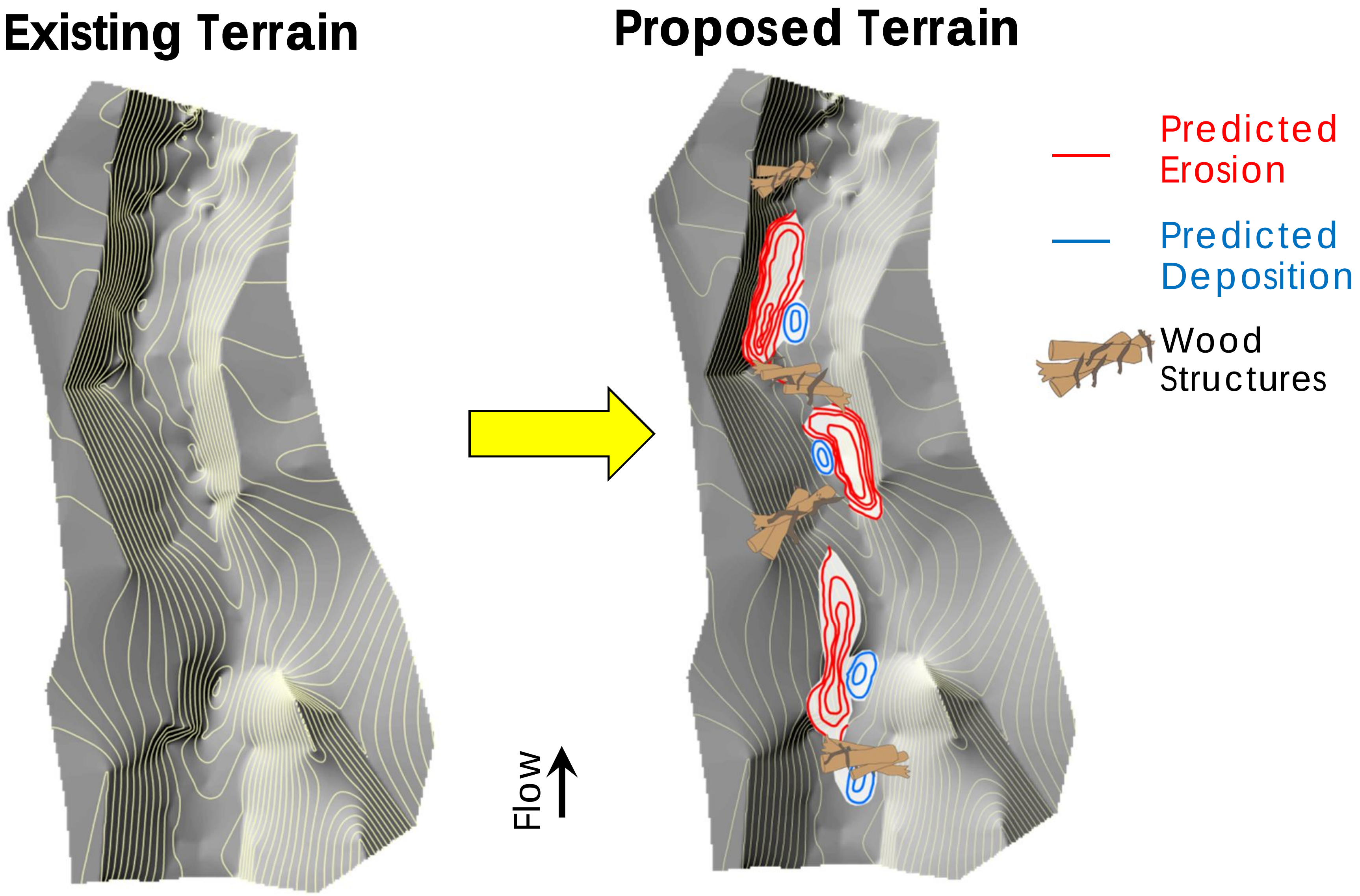
O'Brien, 2014

Stream Temperature Modeling

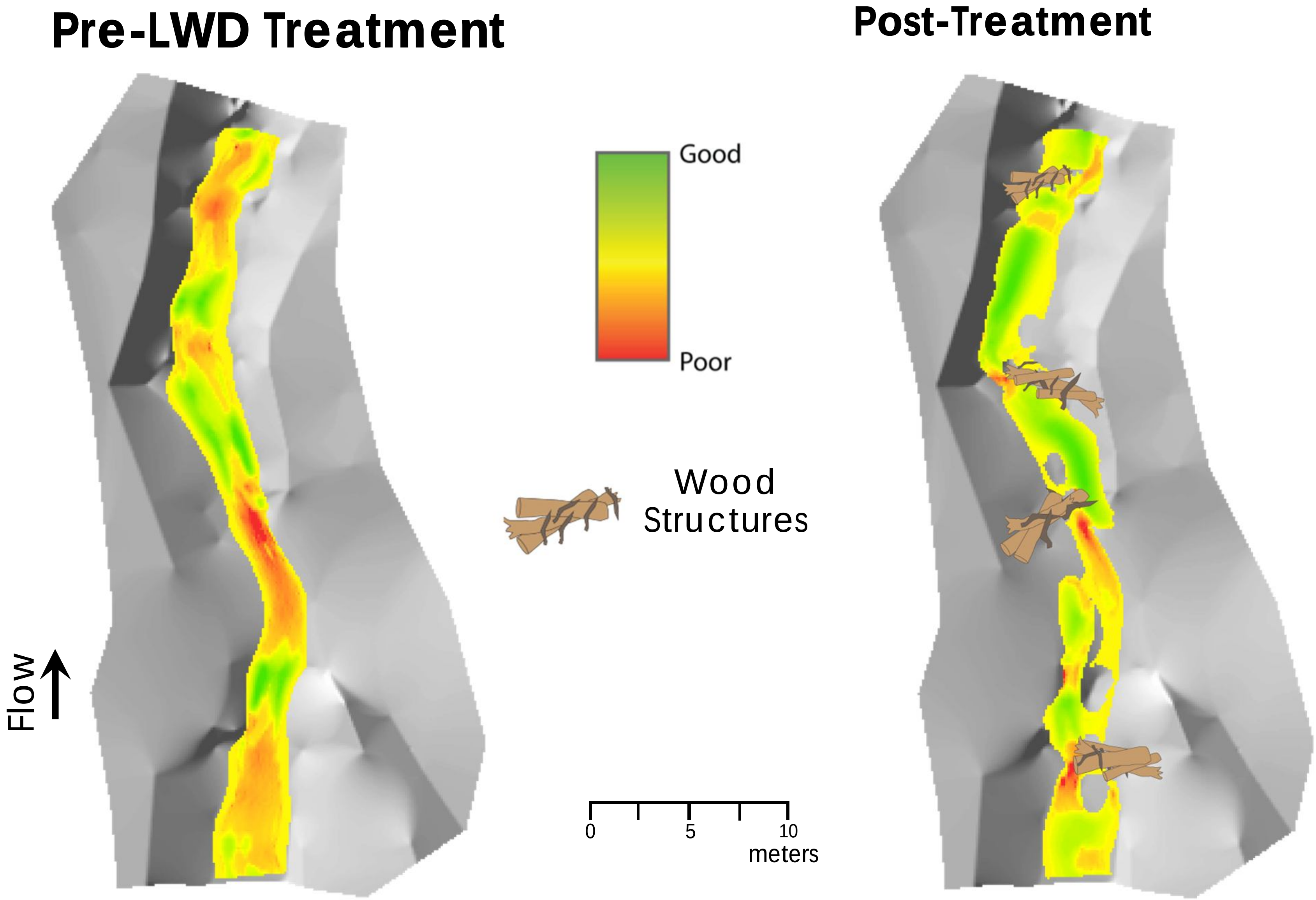


July 26, 2001

Hypothesis Testing – Data Driven Project Design



Project Design – NREI Modeling



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Joe Wheaton, **Utah State University**

Thank you!

Questions?

Backup slides

Classification Tree (Partly Confined)

(Stage 1)

Valley setting	Partly Confined Valley				
Presence/ extent of floodplain	bedrock-controlled discontinuous floodplain		planform-controlled discontinuous floodplain		
Planform	low-moderate sinuosity	low-moderate sinuosity	low sinuosity	Low-moderate sinuosity active meandering	medium-high sinuosity active meandering
Out-of-channel geomorphic units	terrace, fan, hillslope, bedrock, levee, paleochannel	fan, terrace, hillslope, levee, paleochannel	terrace, fan, paleochannel, island	terrace, fan, bench, island, paleochannel, cutoff	terrace, fan, cutoff, island, paleochannel, anabranch, bench, crevasse splay, oxbow
Instream geomorphic units *	run, rapid, pool, riffle, point bar, cutbank	run, rapid, pool, riffle, point bar,cutbanks	run, rapid, pool, riffle, bar (structural-ly-forced, BA, MC), cutbank	pool, riffle, run,bars (structurally-forced, BA, MC), cutbank	pool, riffle, run,bar (structurally-forced, BA, MC), cutbank
Bed material Texture	cobble, gravel sand, boulder	cobble, gravel sand, boulder	boulder, cobble, gravel, sand	cobble, gravel, sand	cobble, gravel sand, silt, clay
Structural elements *	CS & BA woody debris, talus, rip-rap, bridge abutments	instream wood, talus boulder	CS & BA woody debris, beaver dam, colluvium	CS & BA woody debris, restoration wood structure, rip rap, beaver dam, bridge abutment	CS & BA woody debris, restoration wood structures, rip rap, beaver dams, bridge abutment
River style	**BEDROCK CONTROLLED DISCONTINUOUS FLOODPLAIN**	**FAN/TERRACE CONTROLLED DISCONTINUOUS FLOODPLAIN**	**LOW SINUOSITY PLANFORM CONTROLLED ANABRANCHING**	**LOW-MODERATE SINUOSITY PLANFORM CONTROLLED DISCONTINUOUS FLOODPLAIN**	**MEANDERING PLANFORM CONTROLLED DISCONTINUOUS FLOODPLAIN**

RBT metrics

- Site Length (centerline)
- Site Length (Thalweg)
- Sinuosity
- Wetted width
- Bankfull width
- Bankfull Channel Capacity
- Area Sum
- RP100
- Pool tail crest depth average
- Pool max depth average
- Average Bankfull elevation
- Average channel capacity
- Average cross section area
- Average rectangular cross section area
- Site topographic gradient
- Site water surface gradient
- Site area wetted
- Site area bankfull
- Wetted volume
- Bankfull volume
- Detrended DEM standard deviation
- Water depth standard deviation

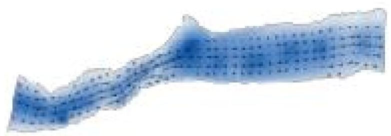
- For Each Channel Unit
  - Area
  - Volume
  - Count
  - Frequency
  - Spacing
  - Percent of site
  - Average Max Depth
  - Average Depth at Thalweg Exit
  - Average Residual Depth
- For Each Tier 1 and Tier 2 Channel Unit Type
  - Area
  - Volume
  - Count
  - Frequency
  - Spacing
  - Percent of site
  - Average Max Depth
  - Average Depth at Thalweg Exit
  - Average Residual Depth

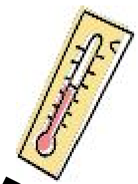
GCD metrics

- Raw area of erosion
- Thresholded area of erosion
- Percent of area of interest with detectable change
- Total net volume of difference
- Total net volume of difference +/- error
- Average net thickness of difference
- Average net thickeness of difference +/- error
- Average net thickness of difference with detectable change
- Average net thickness of difference with detectable change +/- error

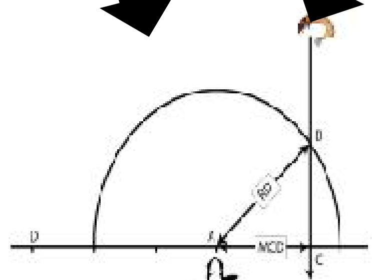
Net Rate of Energy Intake Model

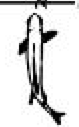
Inputs Hydraulics Drift Temperature Fish Information



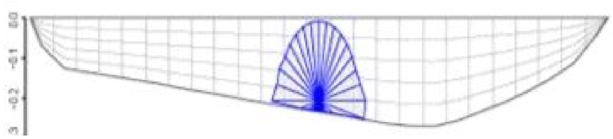


Foraging and Swim Costs



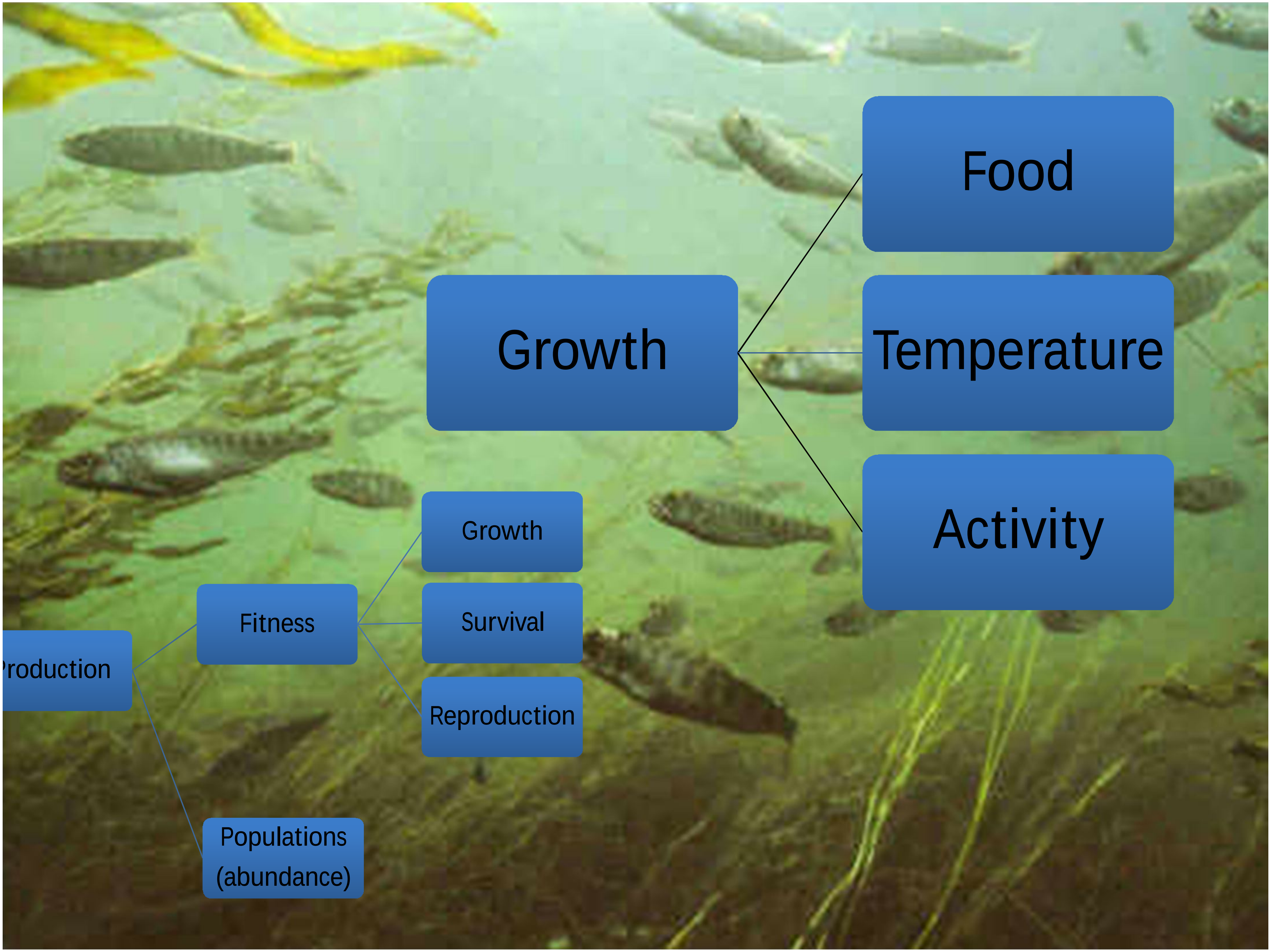


Hughes and Dill (1990)

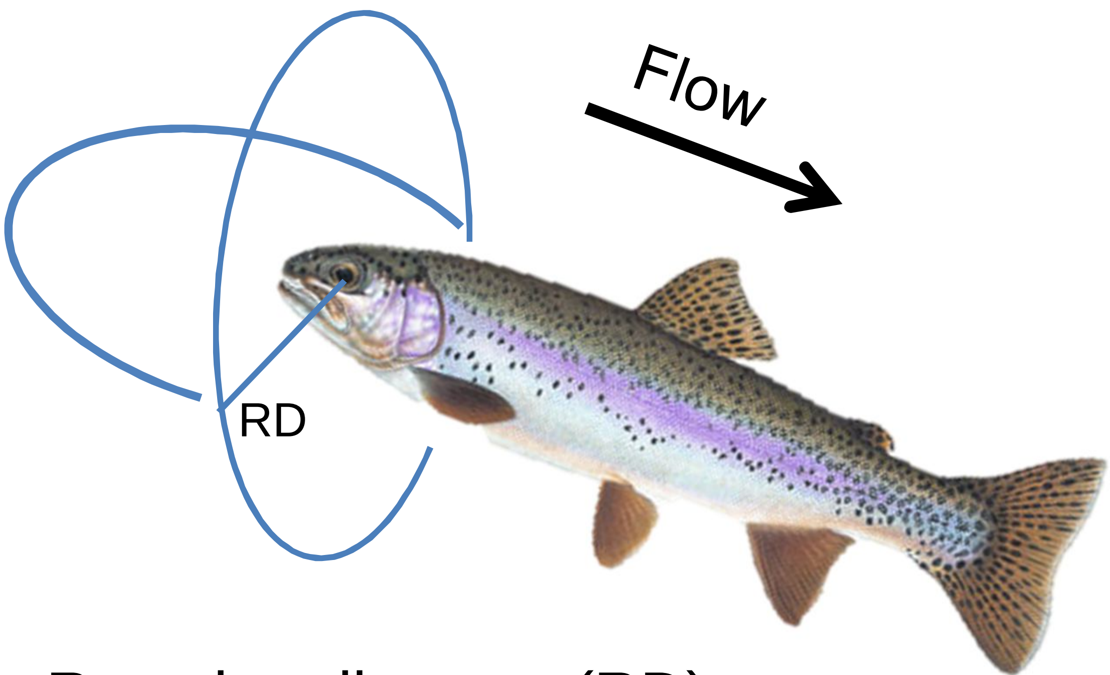


NREI calculation

GREI – SC = NREI


Food
Growth
Temperature
Activity
Growth
Fitness
Survival
Production
Reproduction
Populations (abundance)

Encounter rate:
drift density (*f*(water velocity, invertebrate abundance))
foraging volume (*f*(reaction distance, water velocity, ...))



Reaction distance (RD)

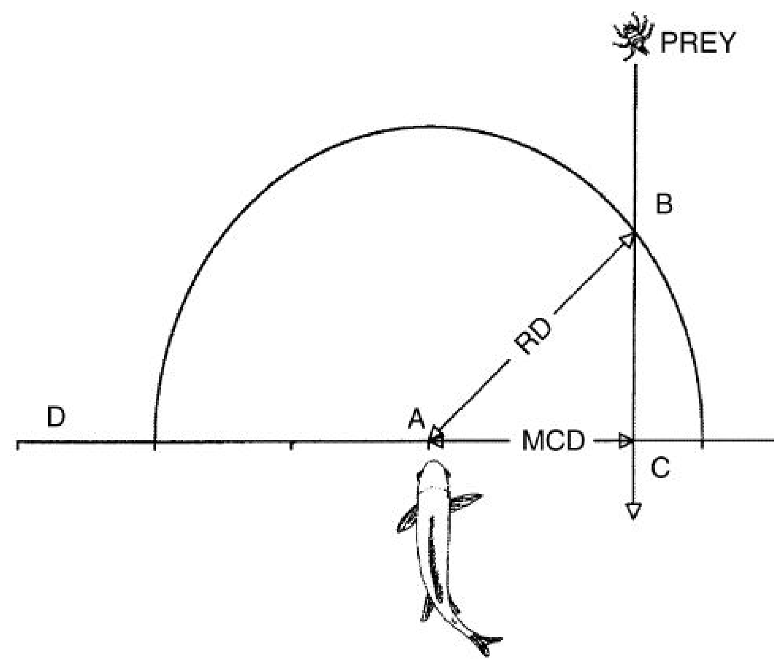


Fig. 3 – Plan view of the foraging model showing the geometry of prey interception. The fish is assumed to