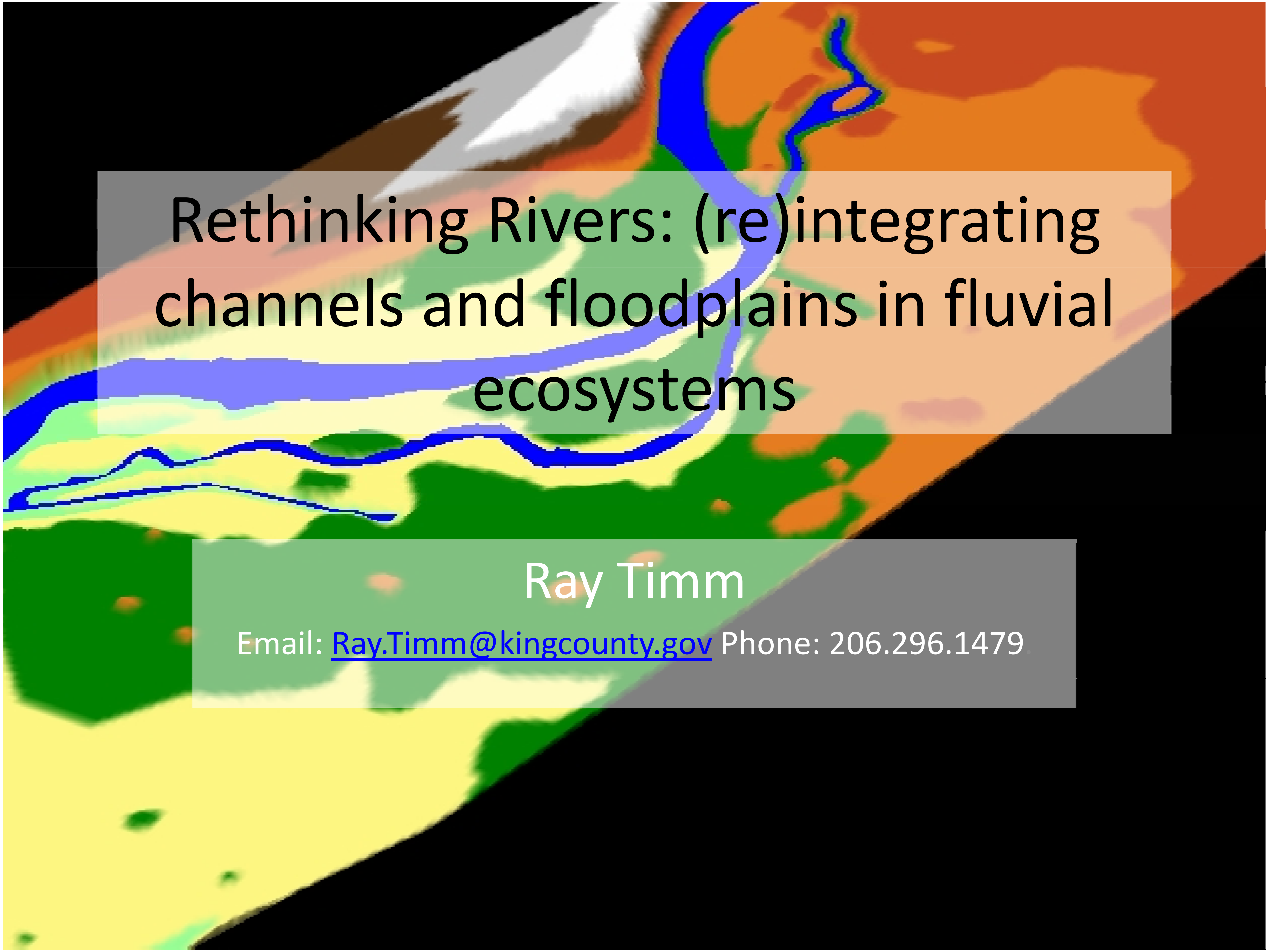

Rethinking Rivers: (re)integrating channels and floodplains in fluvial ecosystems

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An Ecohydraulics Perspective

- Large projects on King County rivers are becoming more common
  - On the order of a mile or more in length
  - Setback or remove hardened banks
  - Changes channel/ floodplain dynamics

- How do we monitor these projects?
  - Adapt our approaches
  - Make sure the technology works for us

Getting the river into the floodplain

- Primary objectives are:
  - Store floodwater
  - Create aquatic habitat
- What else happens?
  - Stage-dependent channels form in the floodplain that ***<u>convey water, sediment, and wood</u>***
  - Habitat volumes change too

Quantifying the response

- Highly precise tools used to measure the physical template
  - LiDAR
  - SONAR
  - More conventional direct measurements

- Facilitates highly precise spatially explicit analyses
  - Geostatistical refinements
  - Ecohydraulics

Technical Considerations

- Data
  - Scale
    - Space
    - Time
    - Radiometry
  - Statistics
    - How do we meet assumptions?
- Phenomena under investigation
  - Ecohydraulics

To what end?

- Understand the new hydraulic regime (changes in effective discharge (ΔQ_e))
- ***<u>Parts of the floodplain become conveyance channels</u>***
- Effective discharge
  - How does ΔQ_e affect flood storage?
  - How does ΔQ_e affect habitat forming processes (and ultimately habitat volumes)?

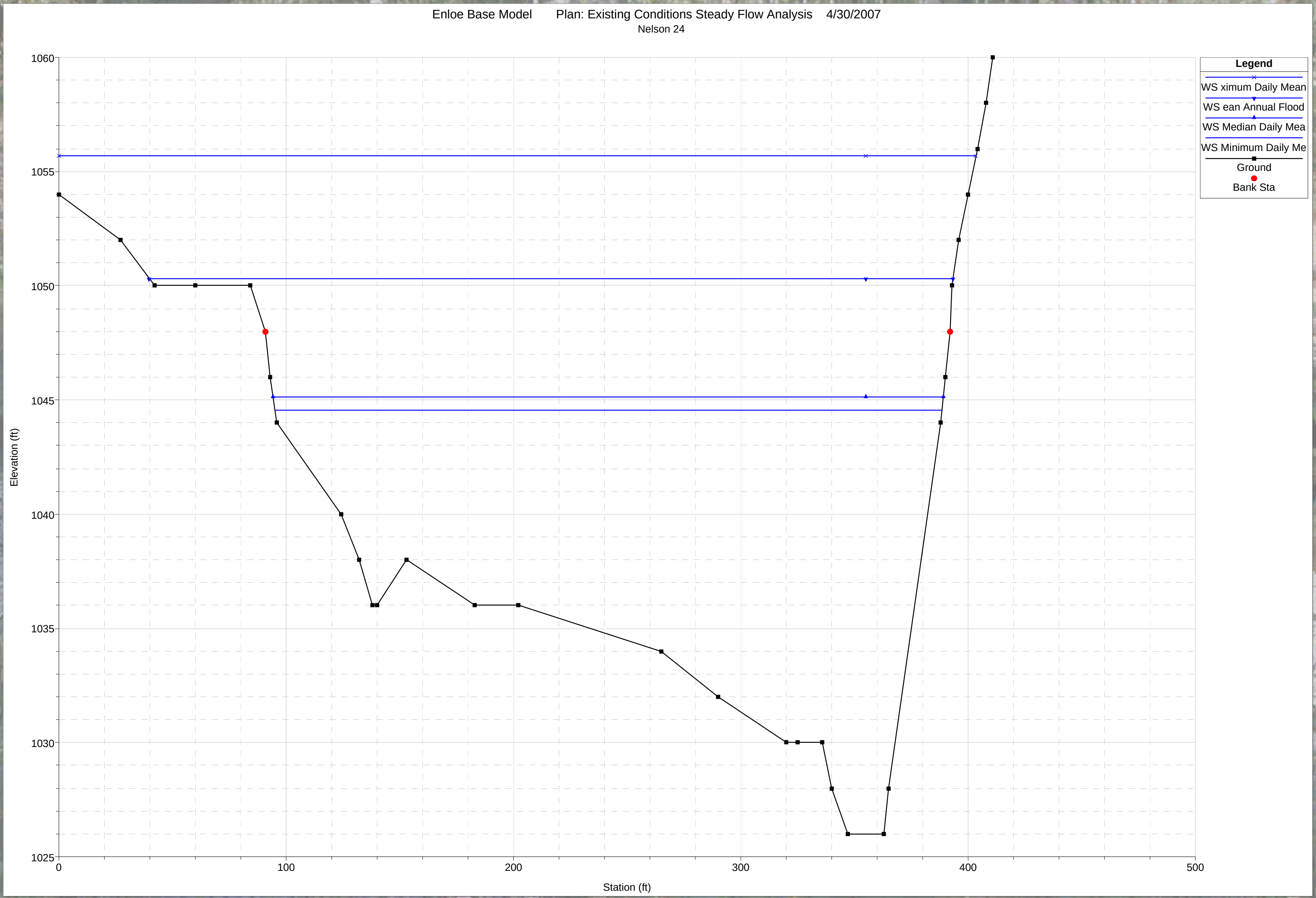
Planning for a discharge

Recurrence interval and exceedance probability

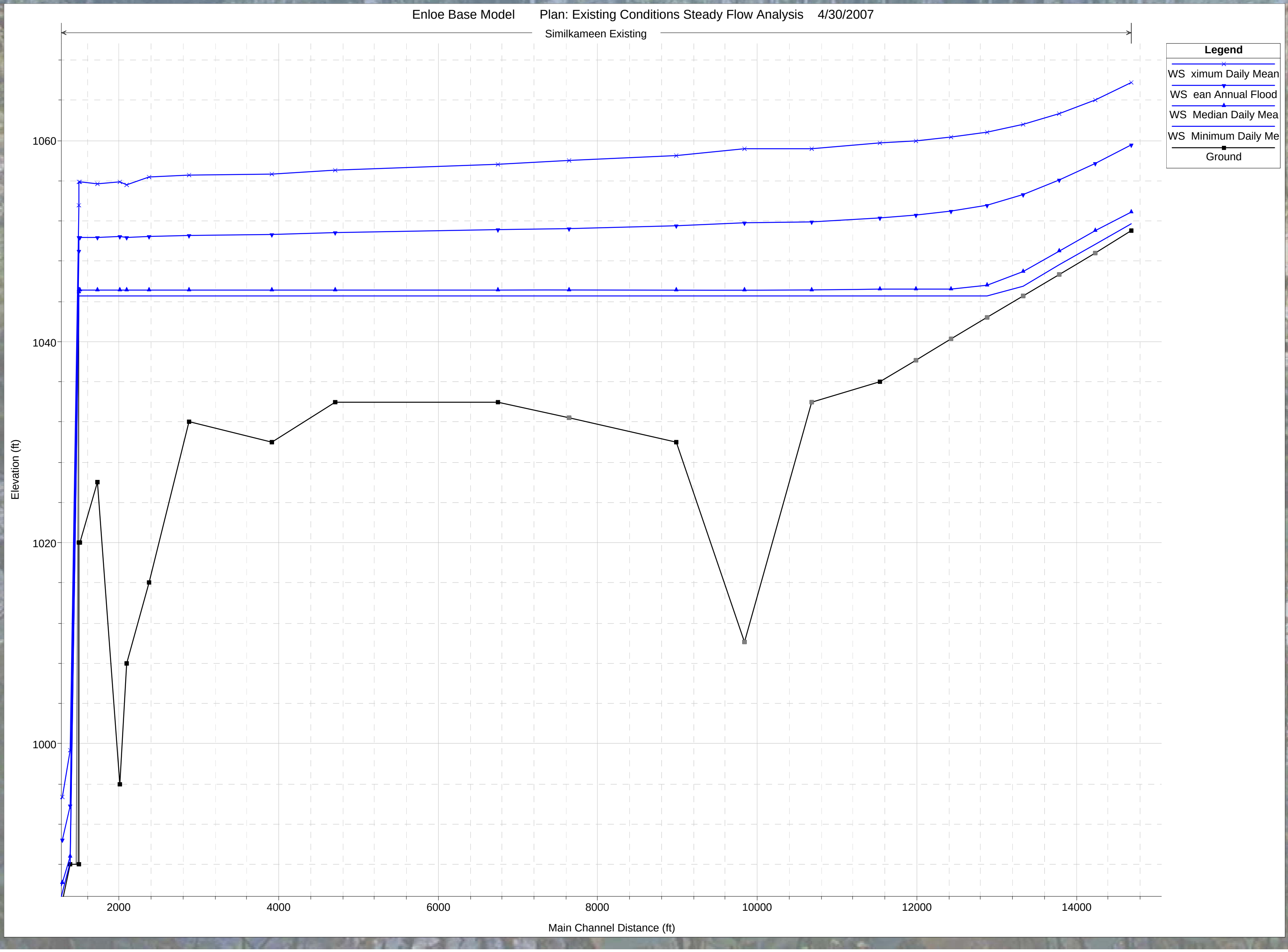
- Recurrence interval T = (n+1)/m
- Exceedance probability P = 1/T

Flow (cfs)	Rank	T	P
864	1	62.00	0.02
434	14	4.43	0.23
354	28	2.21	0.45
281	42	1.48	0.68
76	56	1.11	0.90

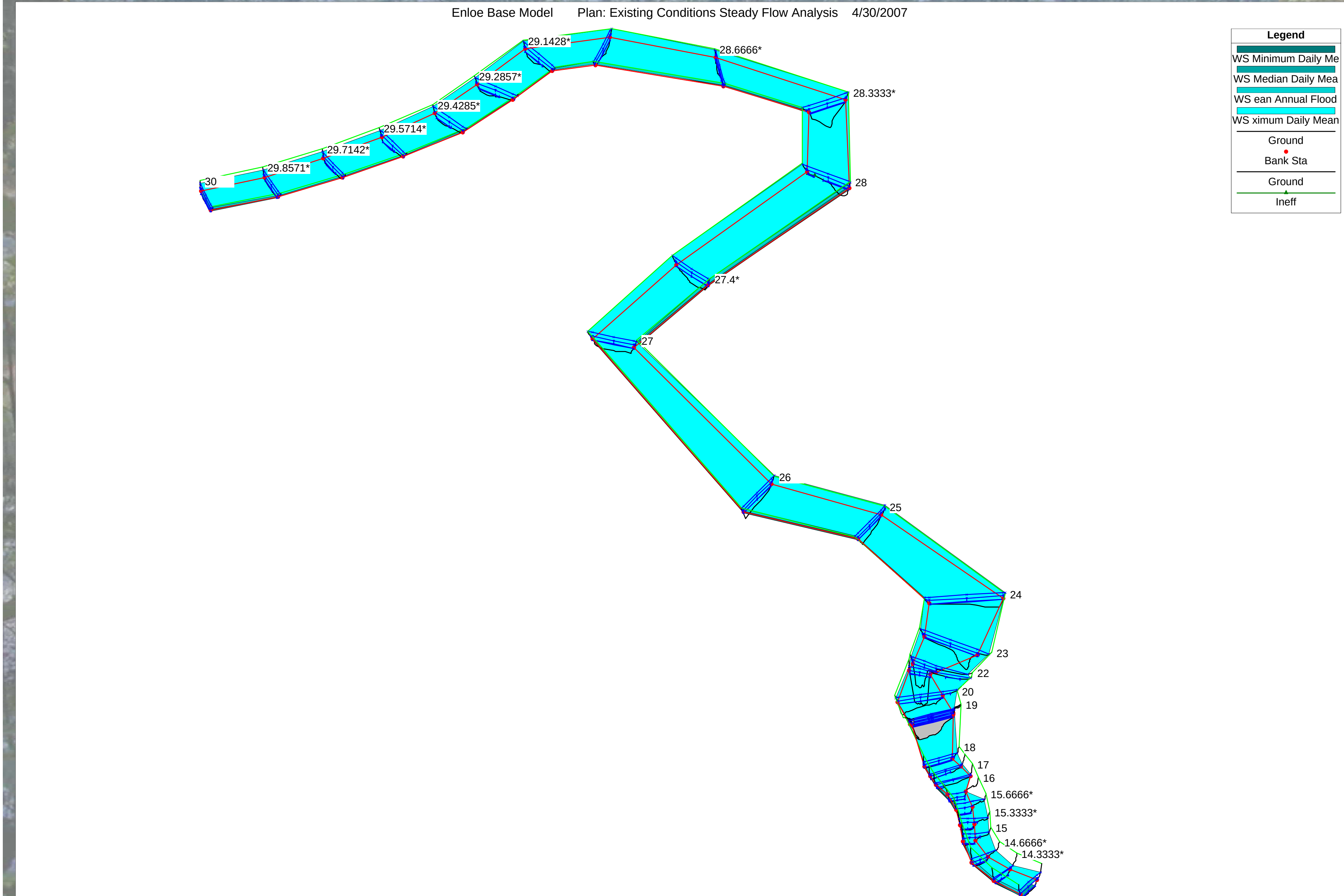
Cross-section Hydraulic Geometry



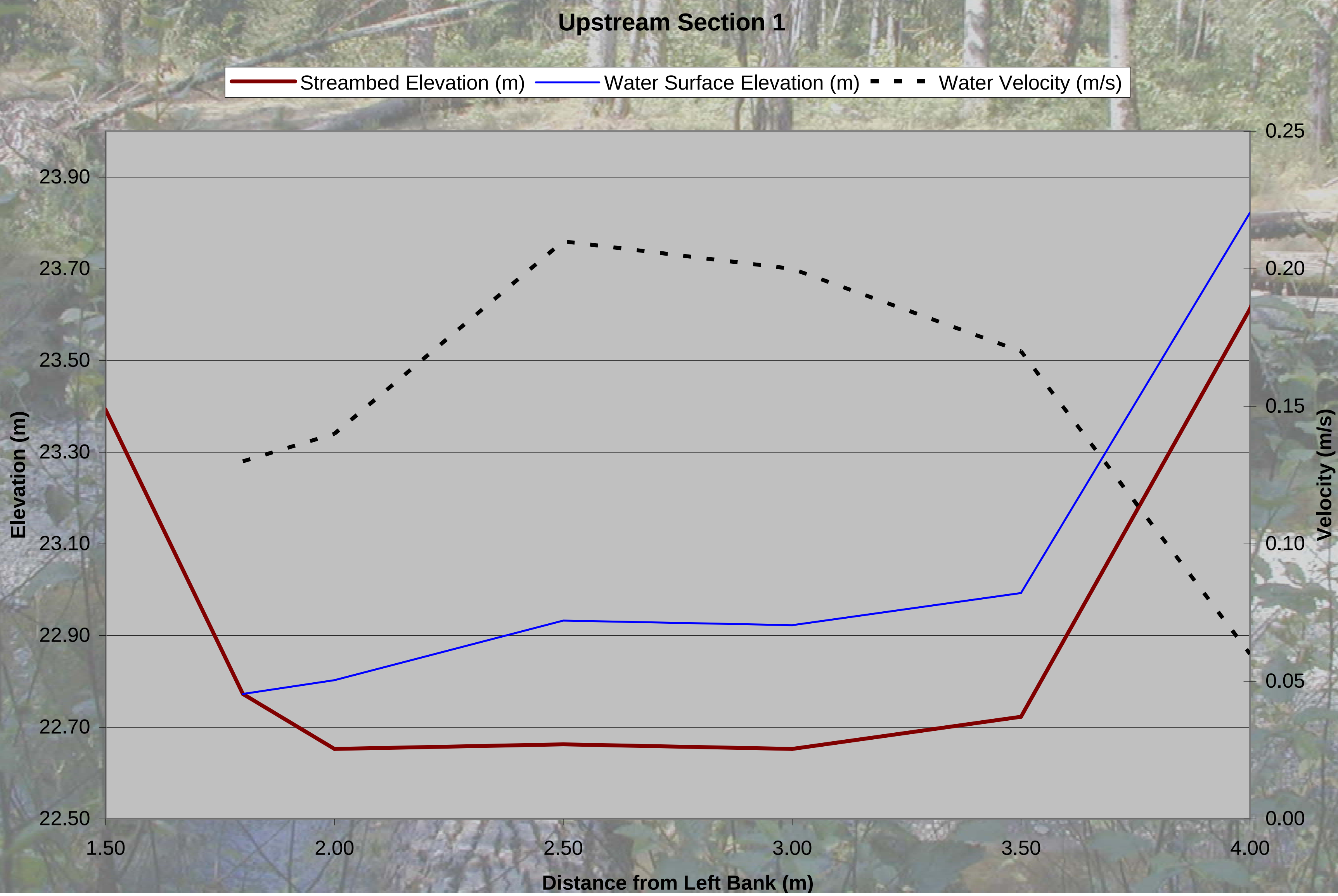
Profile Hydraulic Geometry



Plan Hydraulic Geometry



Q = v * A



Upstream Section 1
Streambed Elevation (m)
Water Surface Elevation (m)
Water Velocity (m/s)
Elevation (m)
Velocity (m/s)
Distance from Left Bank (m)
23.90
23.70
23.50
23.30
23.10
22.90
22.70
22.50
0.25
0.20
0.15
0.10
0.05
0.00
1.50
2.00
2.50
3.00
3.50
4.00

Ecohydraulics examples from Jorde et al. 2001

Unregulated River | **Regulated River**

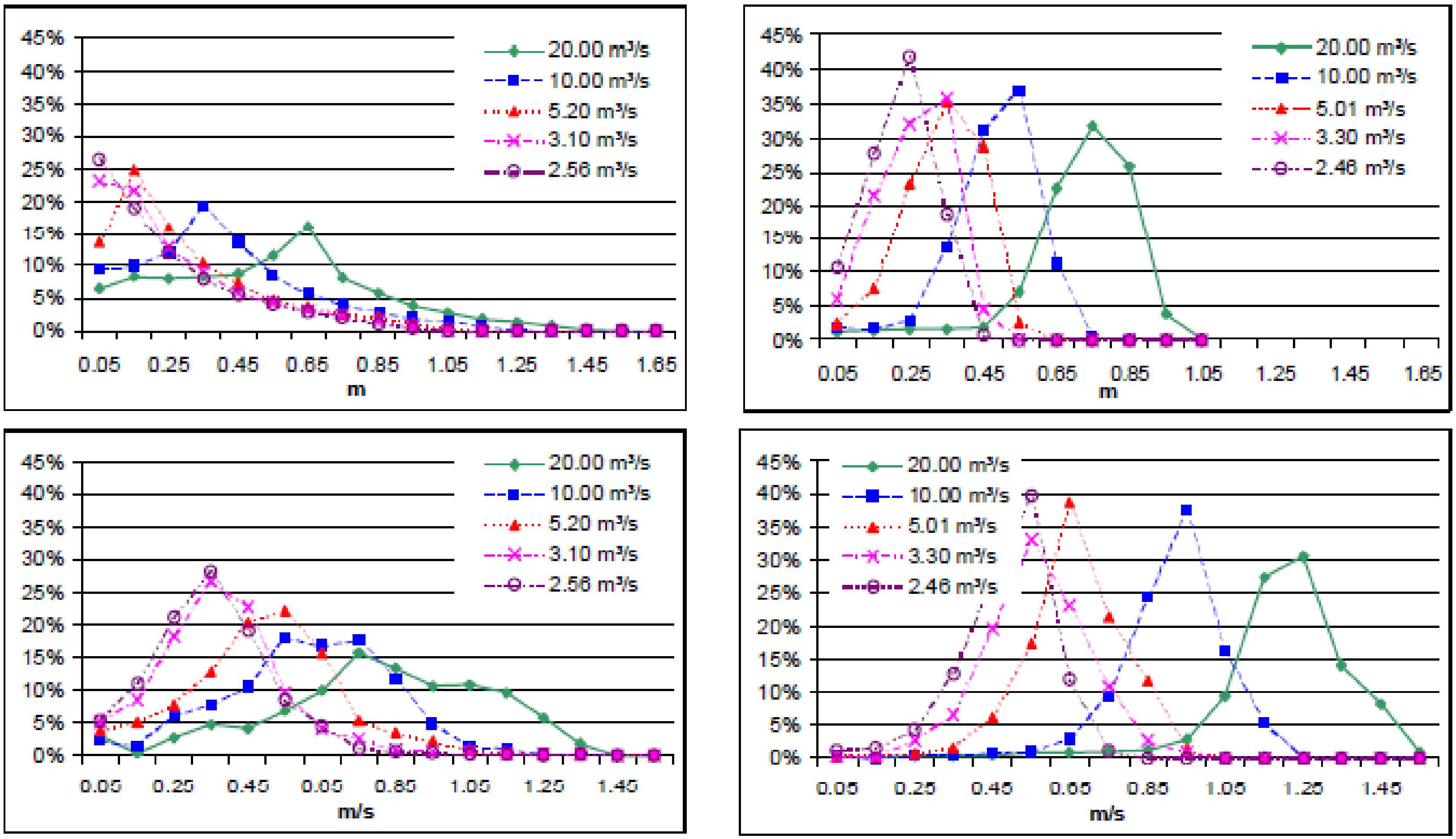
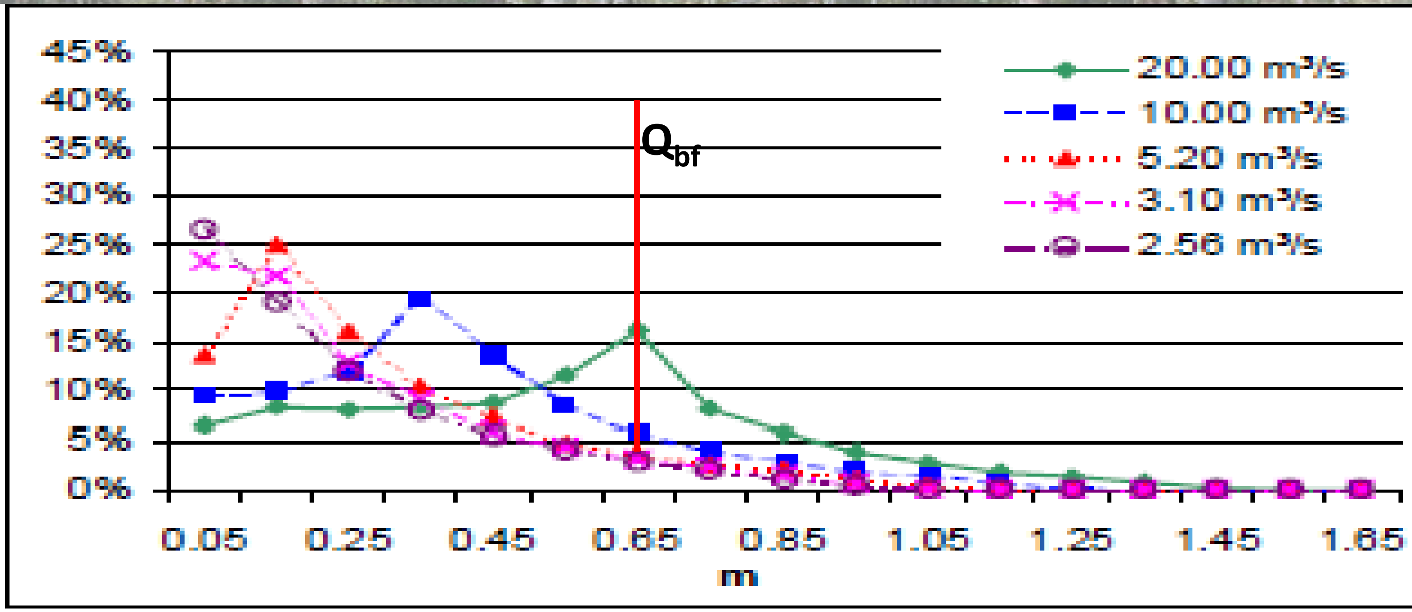
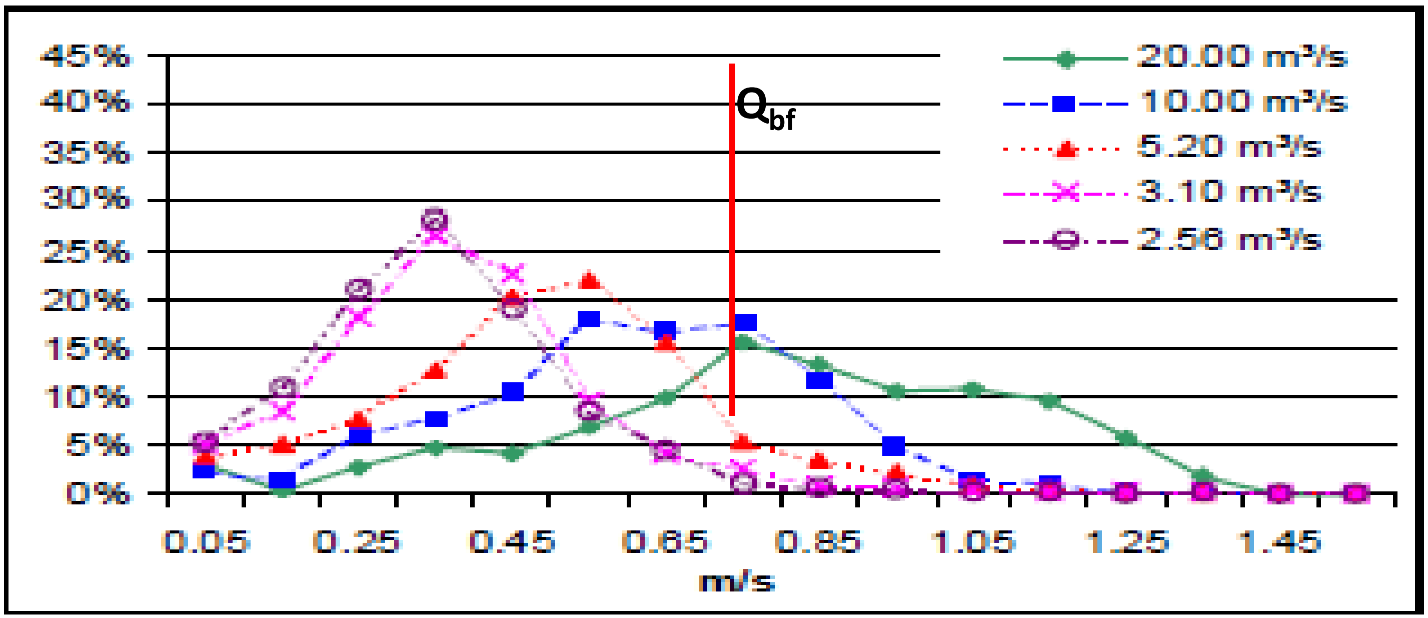


Fig. 2: Distribution of water depths and local flow velocities in two structural different river reaches for various discharges

Naturally dynamic channel/ floodplain





Ecohydraulic habitat suitability generated with CASiMir (Jorde et al. 2001)

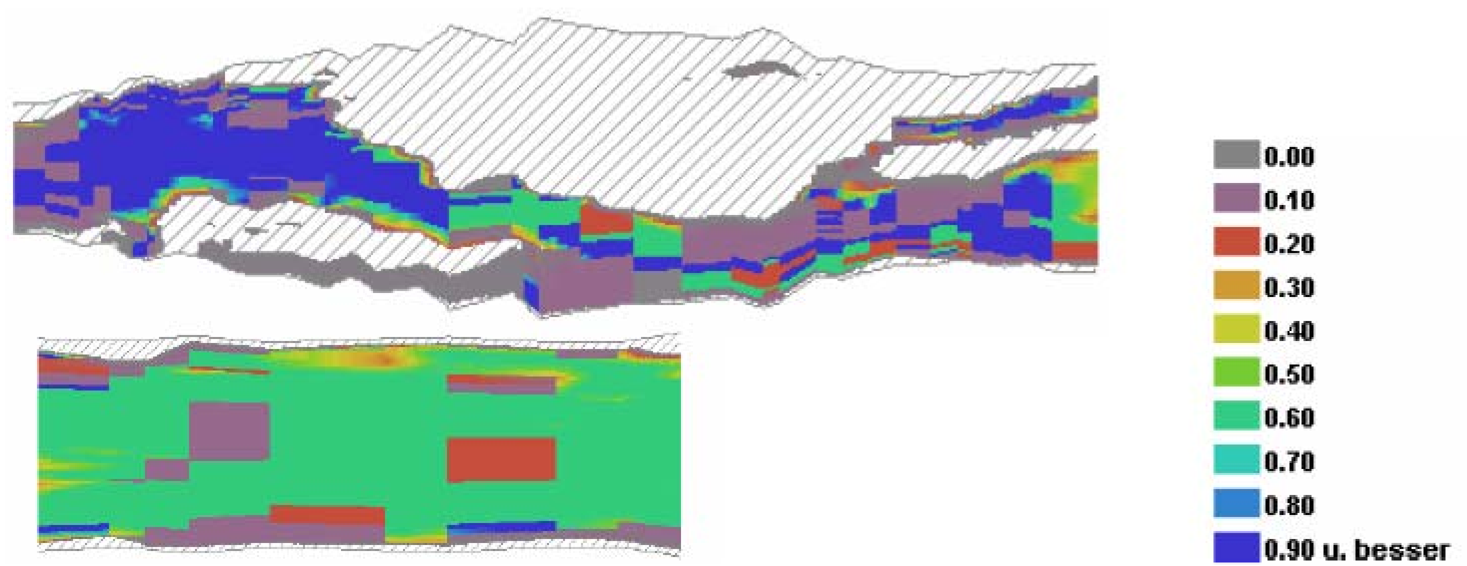
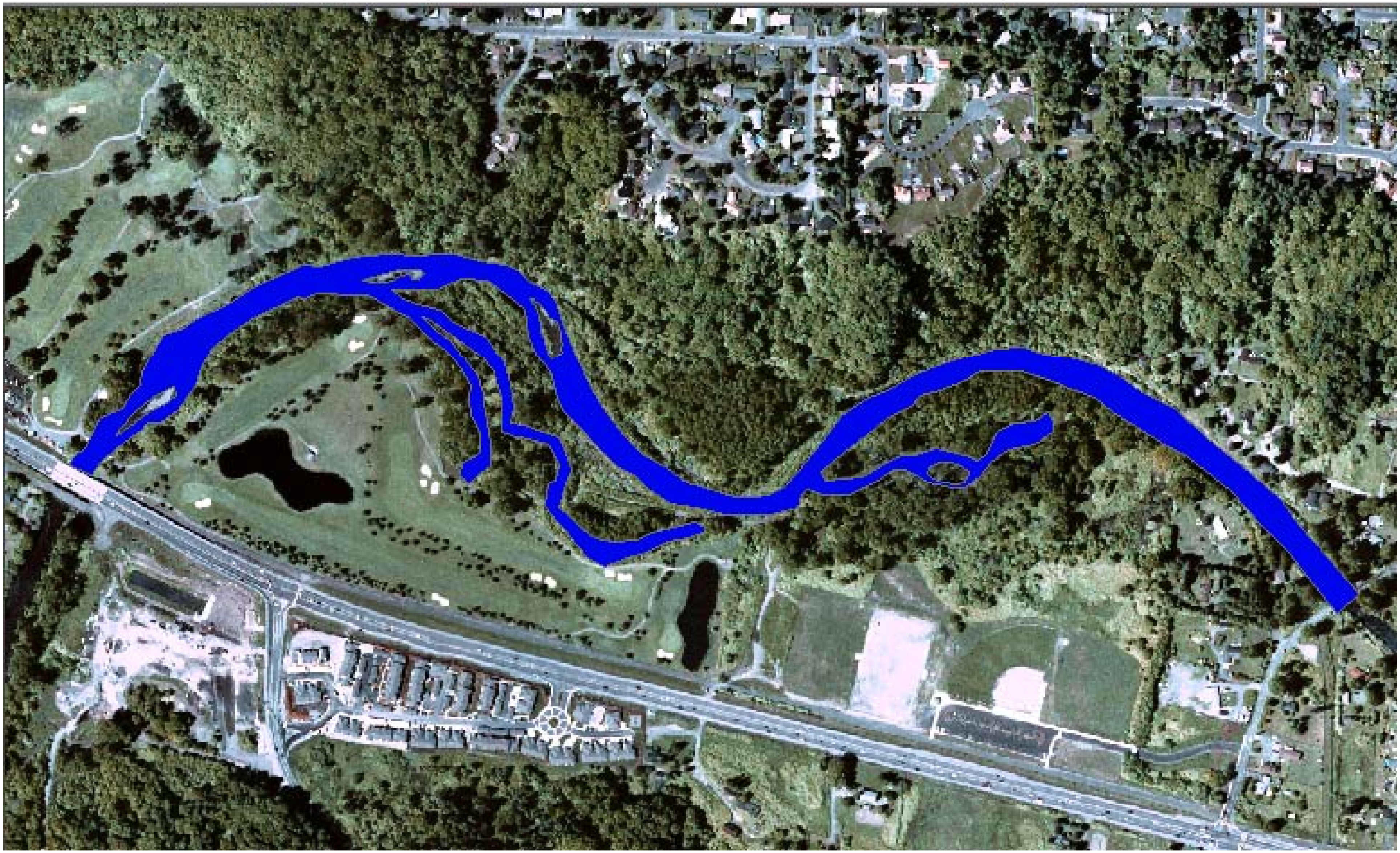
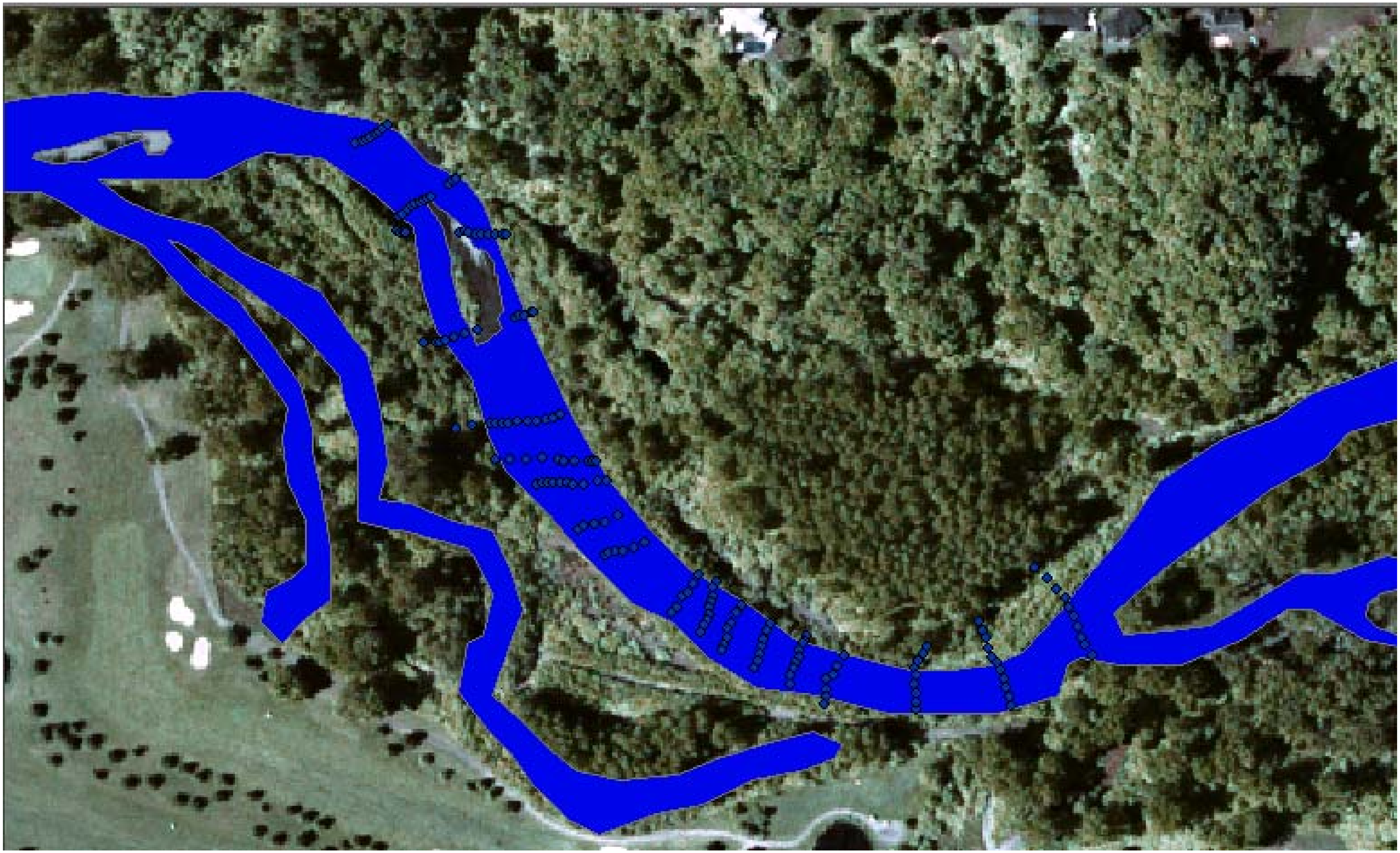
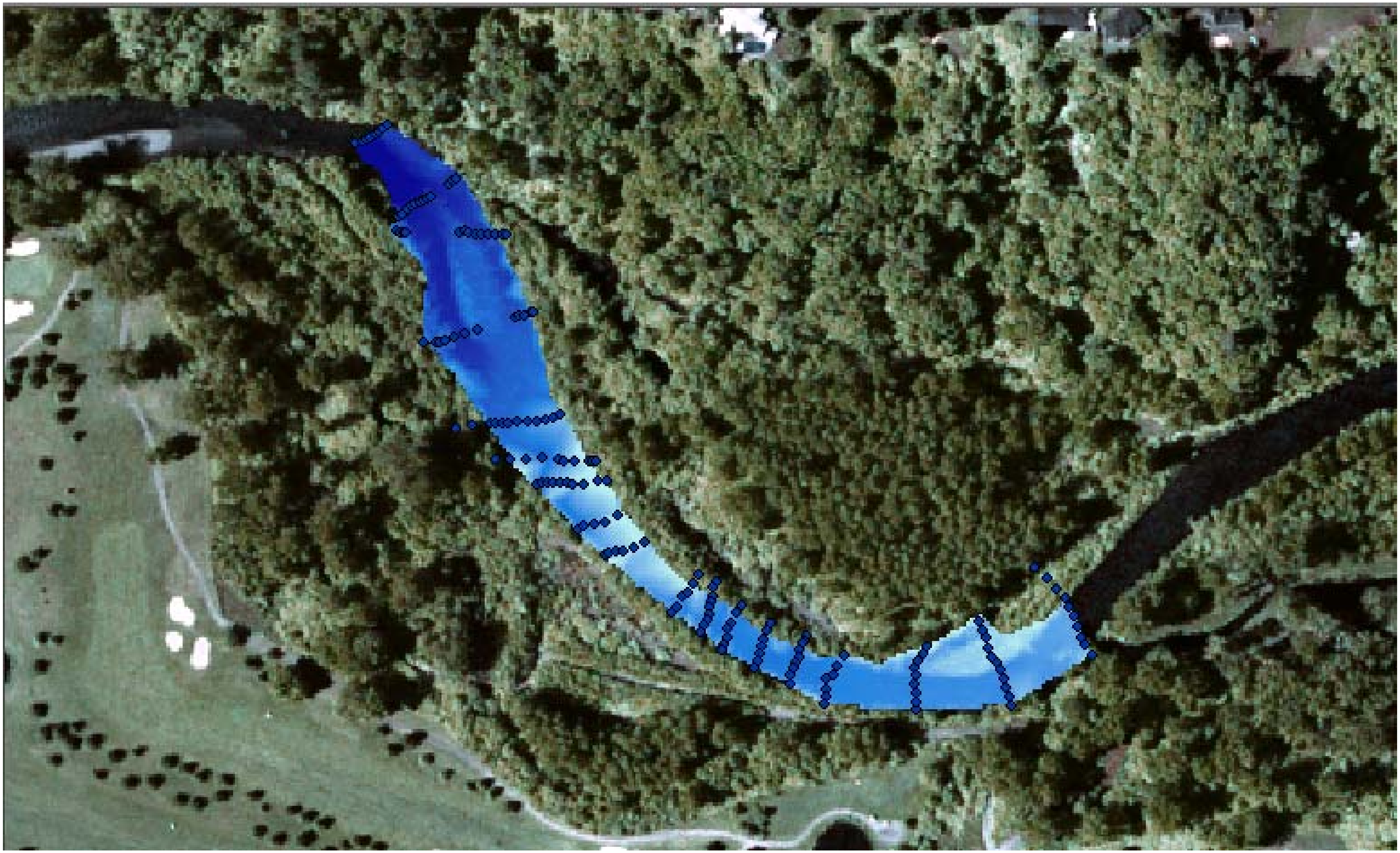
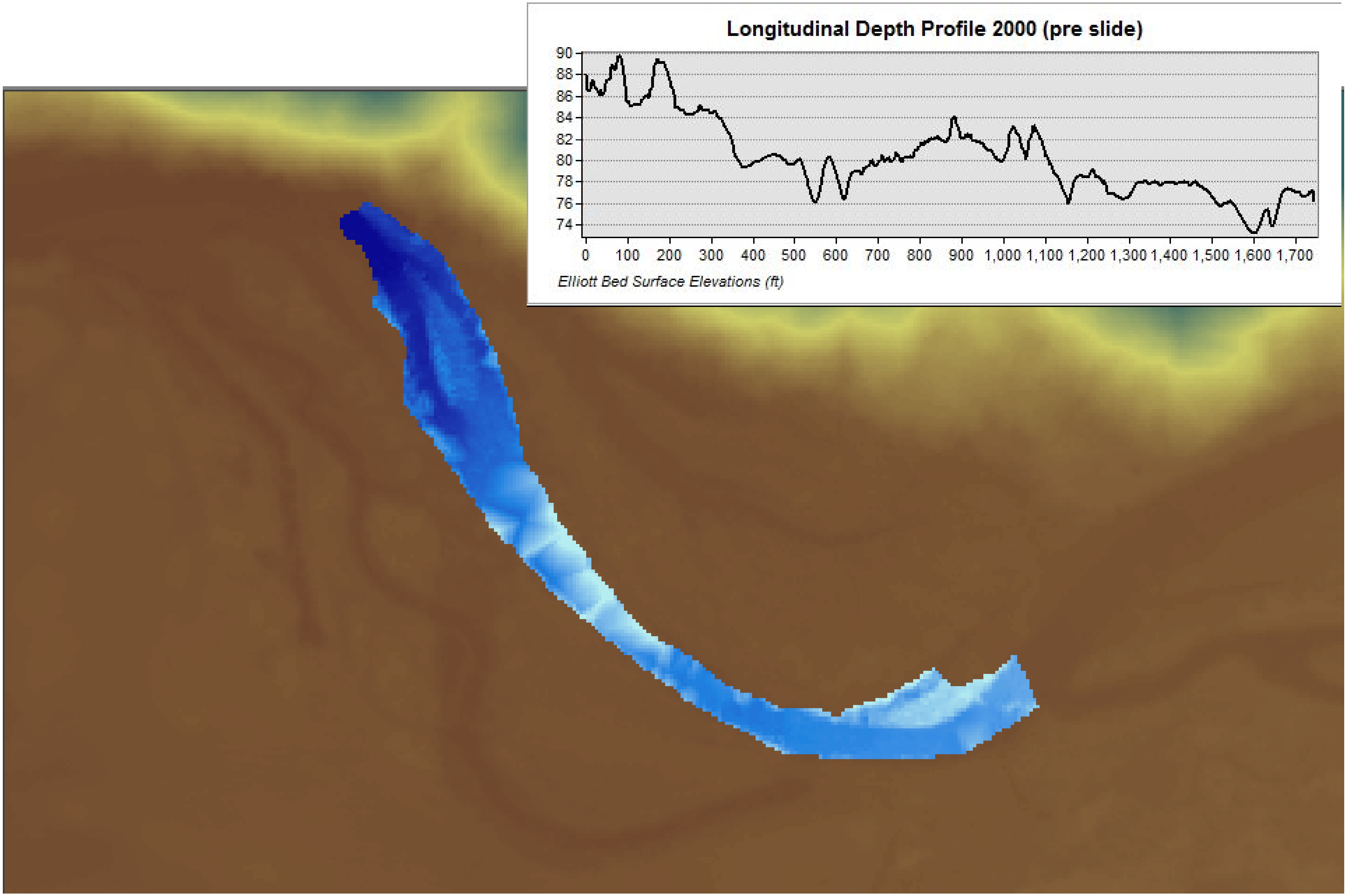


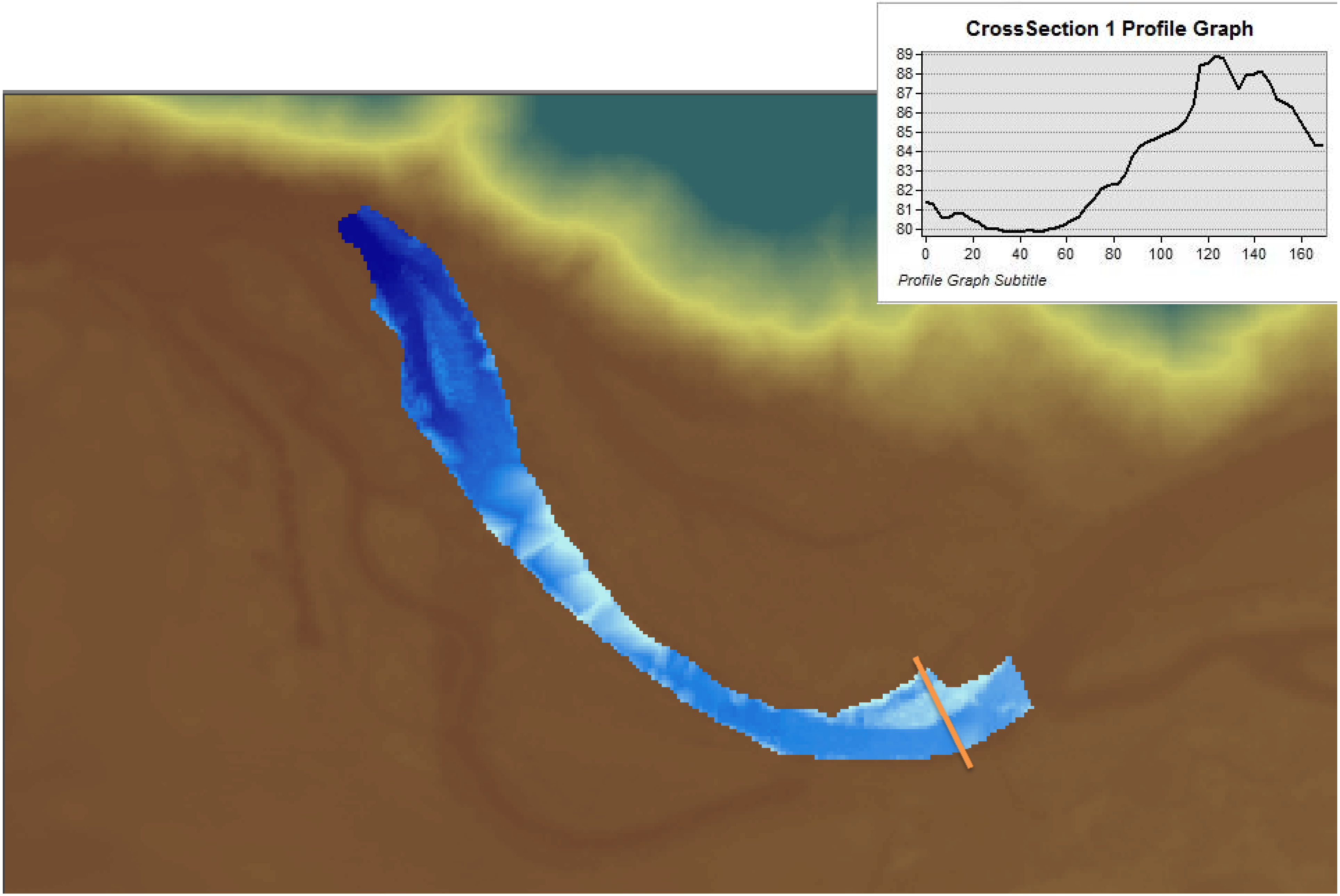
Fig. 4: Habitat suitability maps for brown trout (*Salmo trutta*) in Loderio Floodplain and Loderio Channel, 5200 l/s, derived by preference functions



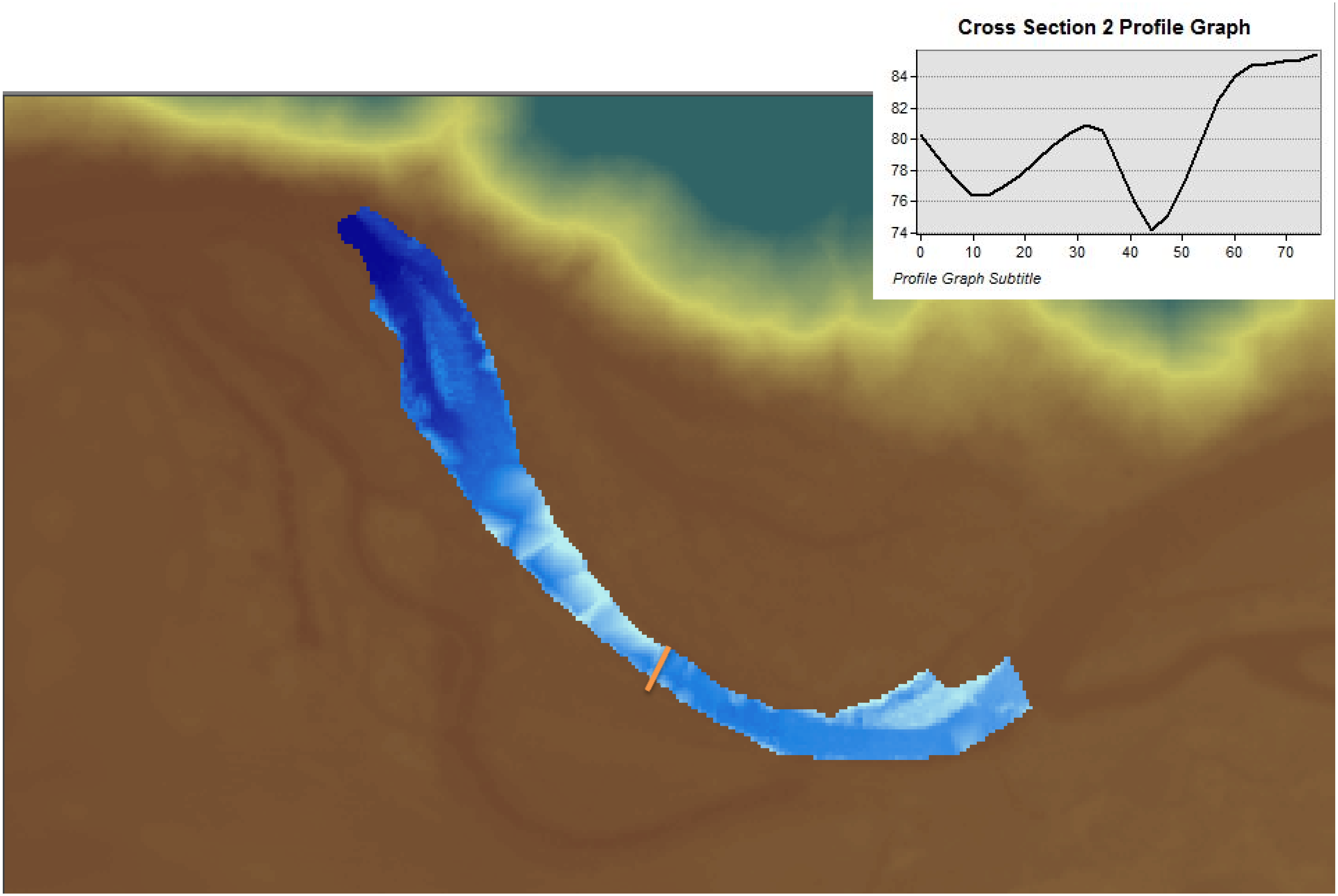




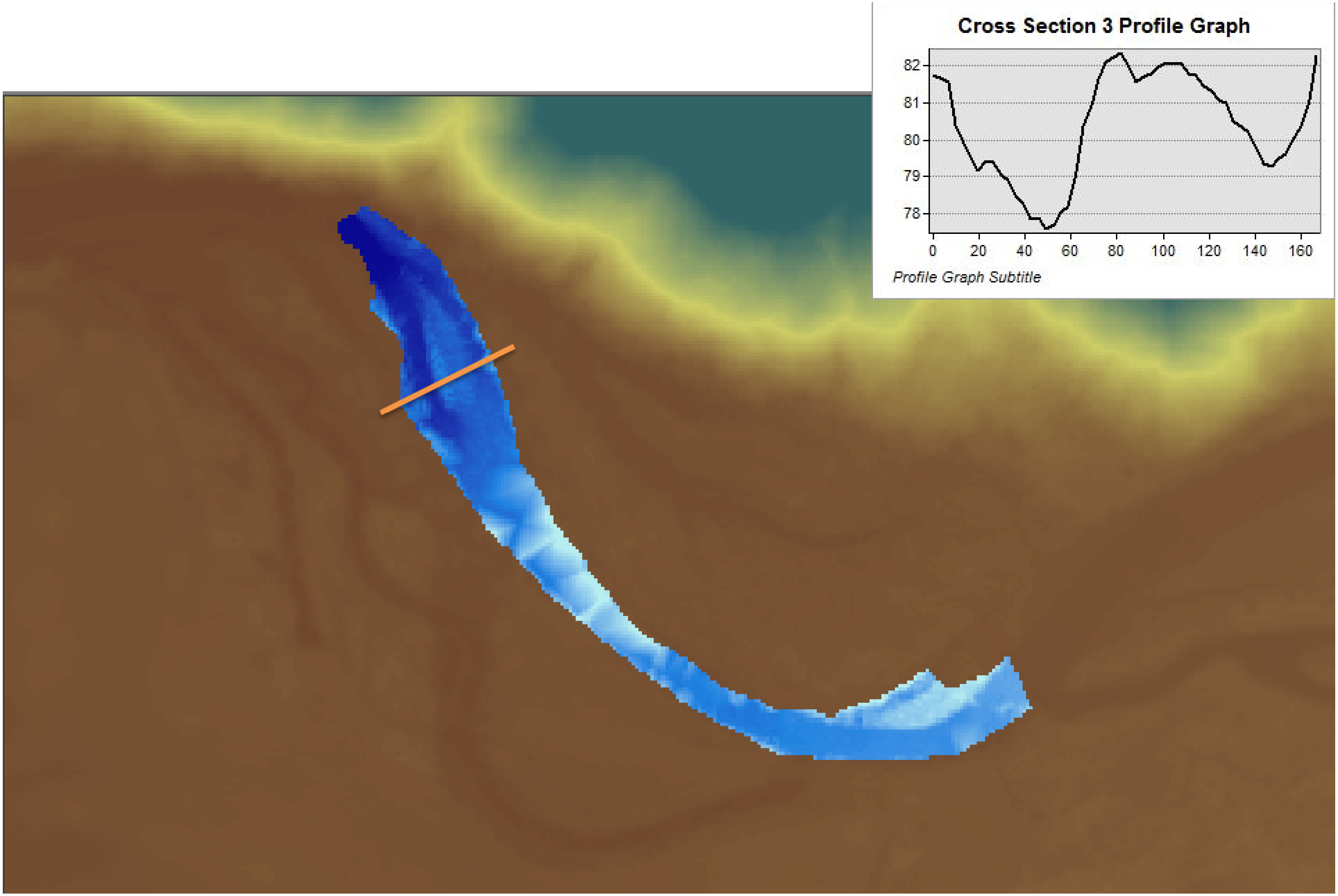

Longitudinal Depth Profile 2000 (pre slide)
90
88
86
84
82
80
78
76
74
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
Elliott Bed Surface Elevations (ft)

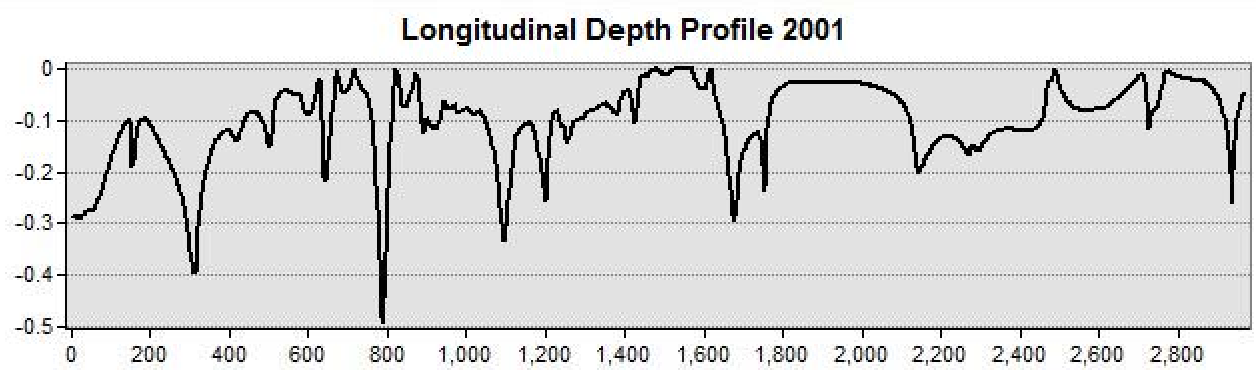


CrossSection 1 Profile Graph
89
88
87
86
85
84
83
82
81
80
0
20
40
60
80
100
120
140
160
Profile Graph Subtitle



Cross Section 2 Profile Graph
84
82
80
78
76
74
0
10
20
30
40
50
60
70
Profile Graph Subtitle


Cross Section 3 Profile Graph
82
81
80
79
78
0
20
40
60
80
100
120
140
160
Profile Graph Subtitle

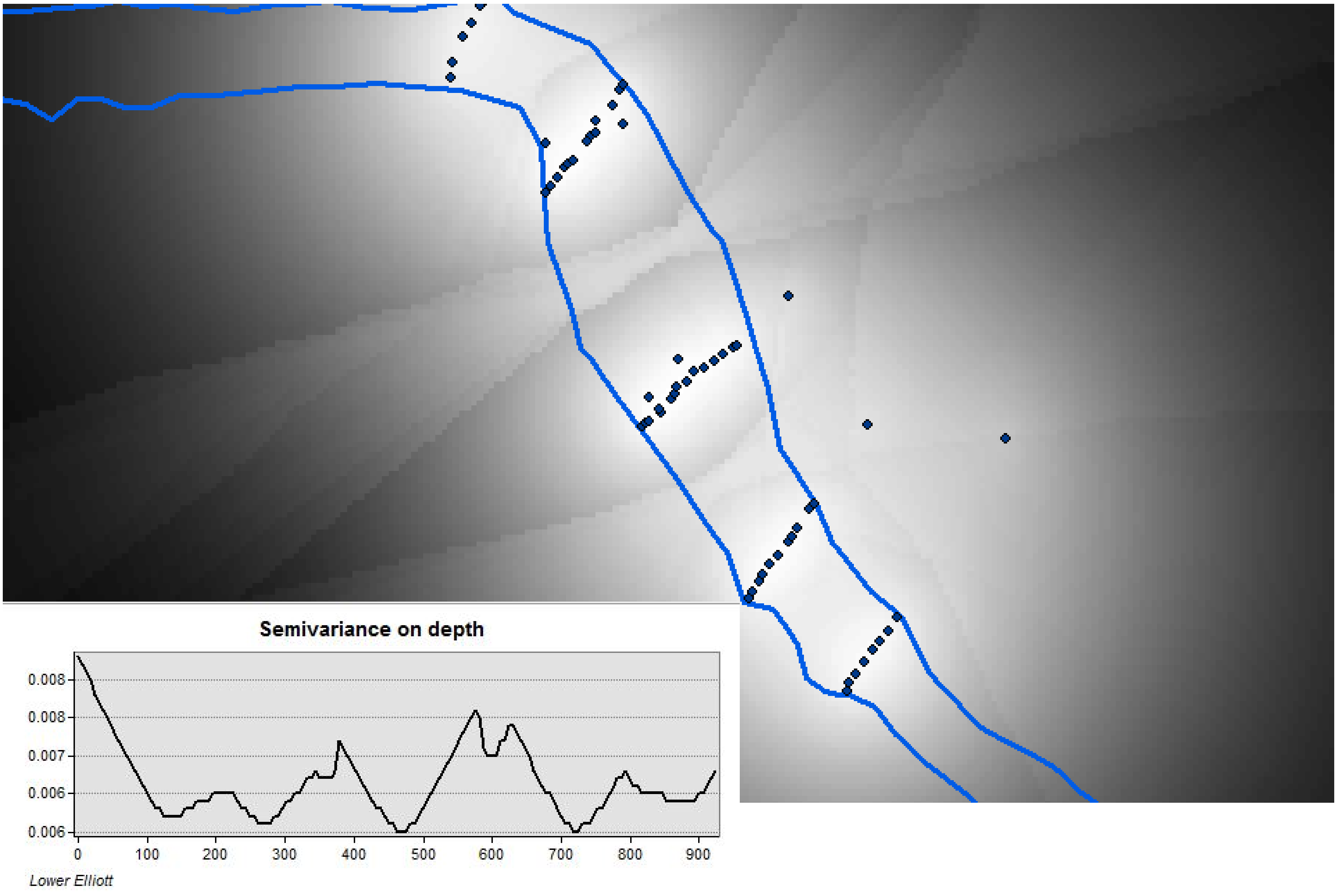


Elliott through the landslide reach

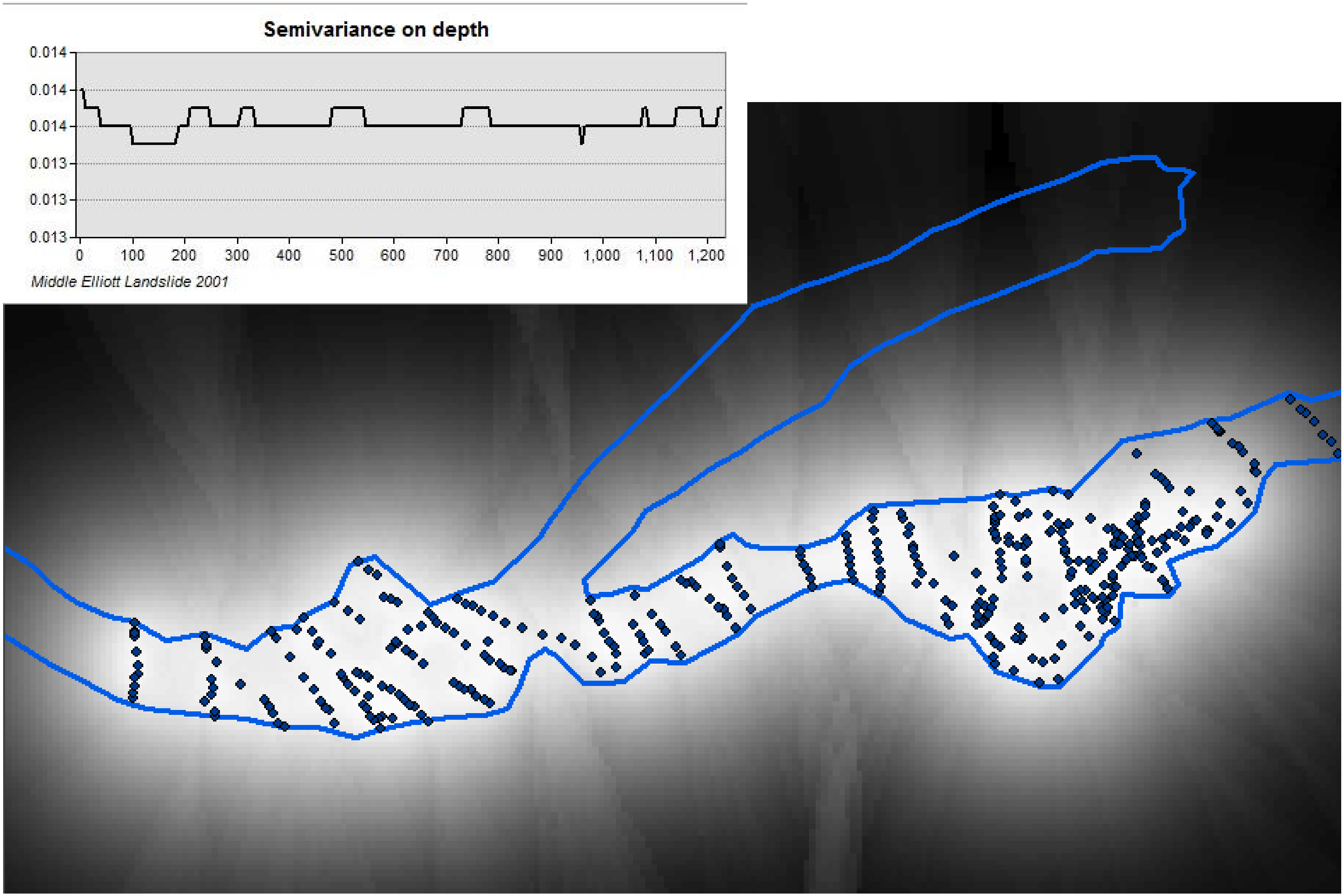
Spatial statistics underpinnings

- Semivariance and Covariance
- Used to determine lag distance (*h*)
- Informs the sampling density necessary to support a desired spatial resolution

$$\gamma(h) = \frac{1}{2N(h)} \sum_{i=1}^{n(h)} (x_i - y_i)^2$$



Semivariance on depth
0.008
0.008
0.007
0.006
0.006
0
100
200
300
400
500
600
700
800
900
Lower Elliott


Semivariance on depth
0.014
0.014
0.014
0.013
0.013
0.013
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Middle Elliott Landslide 2001

What’s it all mean?

- Supply and transport of sediment and wood are related to stochastic processes (i.e., flooding).
- Connectivity between channels and floodplains is necessary for the creation and destruction of geomorphic features which in turn is governed by river management (i.e. bank hardening).
- Unhardening alluvial river banks changes wood and sediment dynamics that affect patch dynamics and habitat heterogeneity – locally and in downstream reaches.