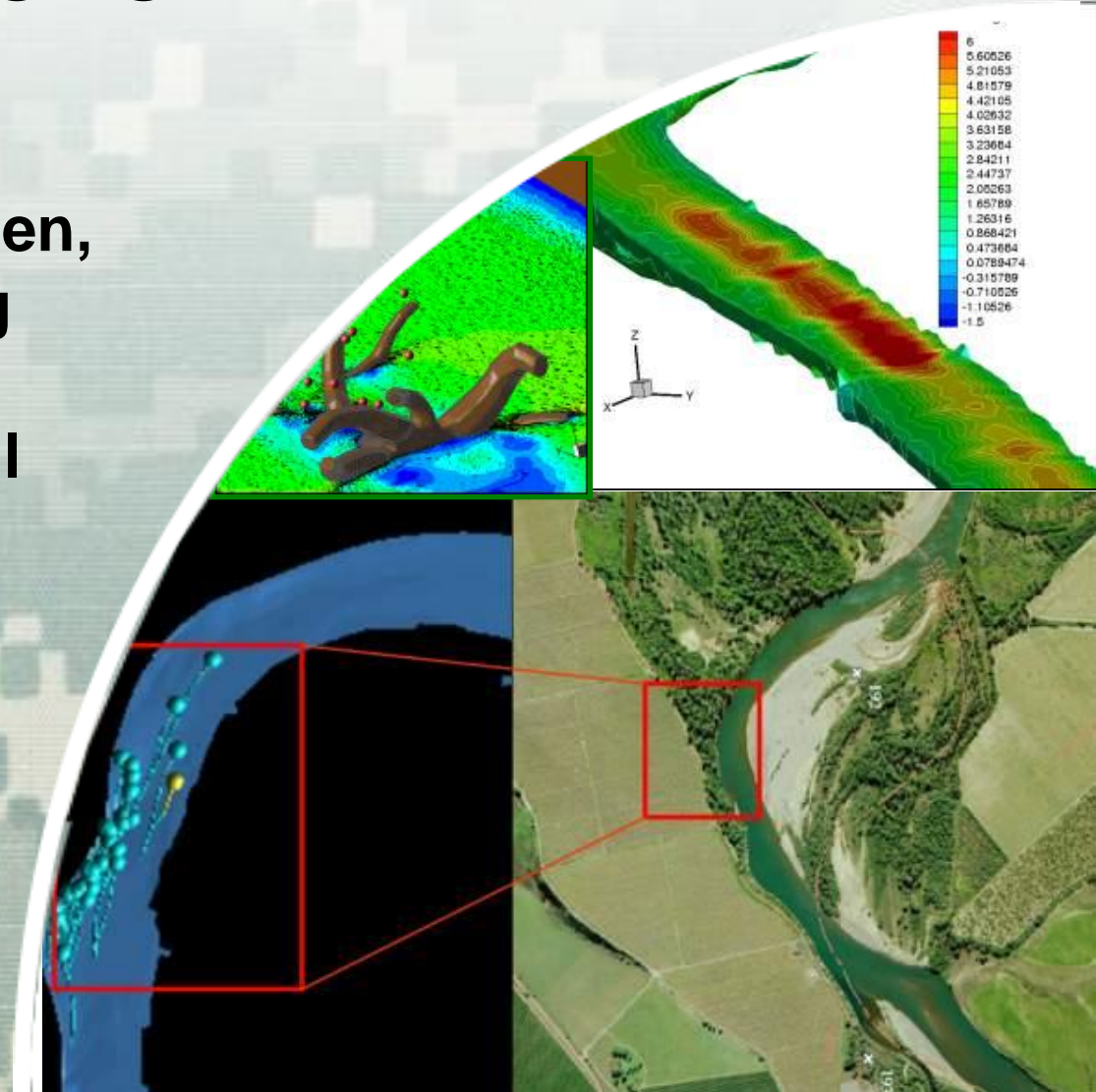# CHOOSING ONE STREAM RESTORATION ALTERNATIVE AMONG MANY
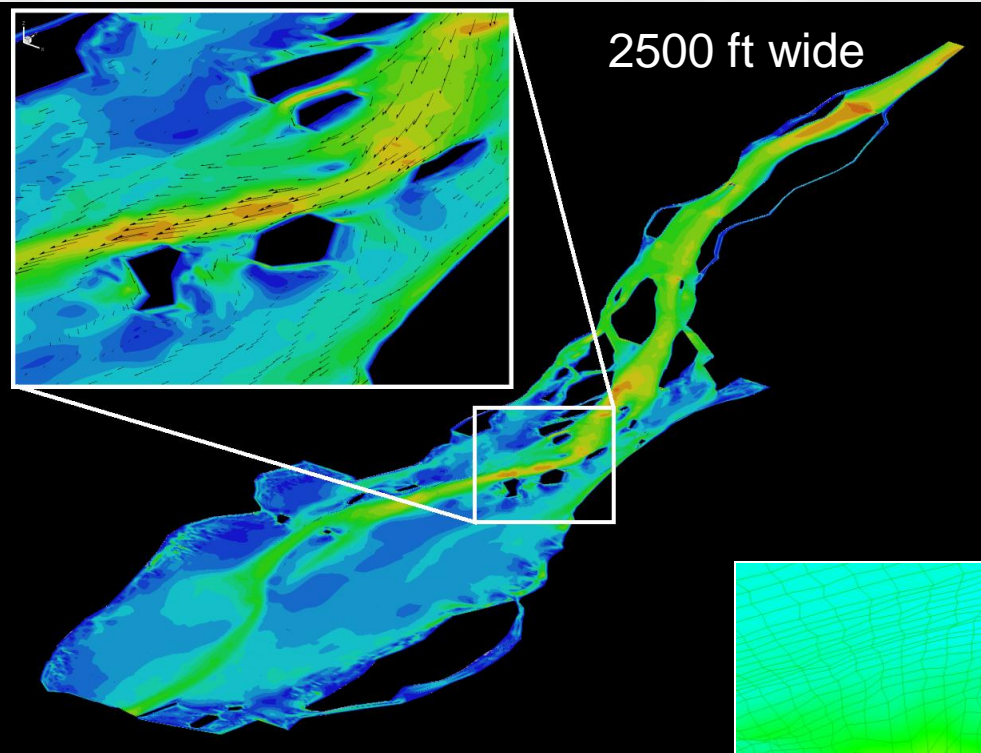
David L. Smith, Jeff B. Allen, John Nestler, Ruth Cheng Andy Goodwin, Michele Gomez, Tammy Threadgill
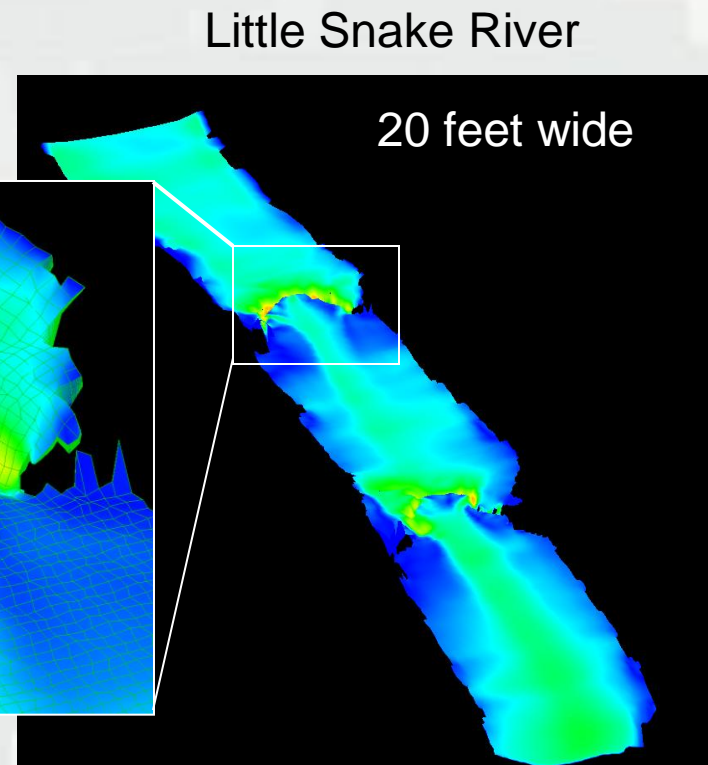
Computational Fluid Dynamics

2500 ft wide

Mississippi River

Little Snake River

20 feet wide

Photo

Plan

Profile

2D/3D representation

riffle

run
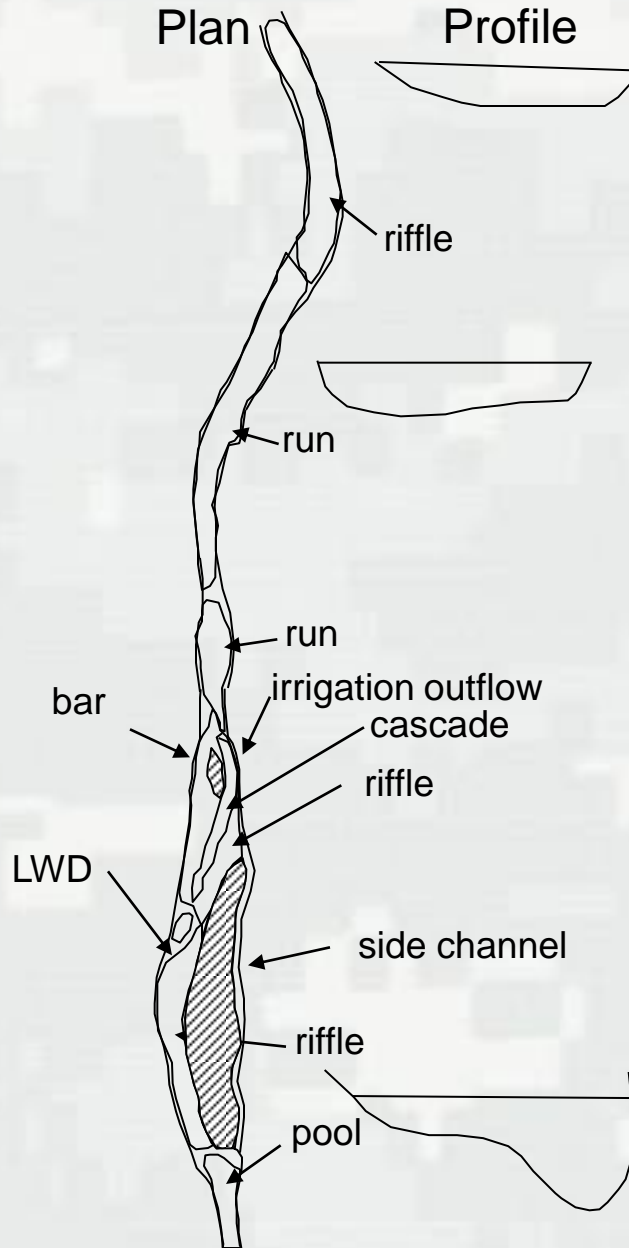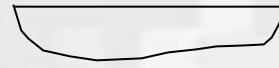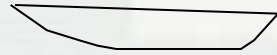
run

irrigation outflow

bar

cascade

riffle

LWD

side channel

riffle

pool
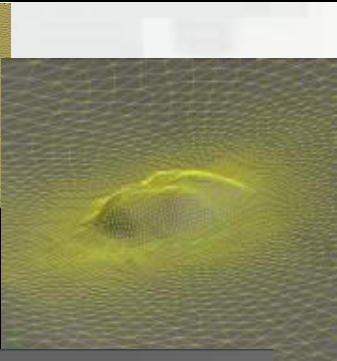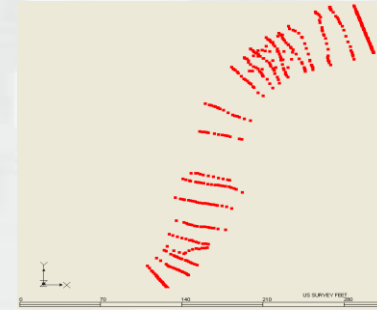
Cameron Run, near Washington D.C.

30 cfs

USGS 01653000 CAMERON RUN AT ALEXANDRIA, VA
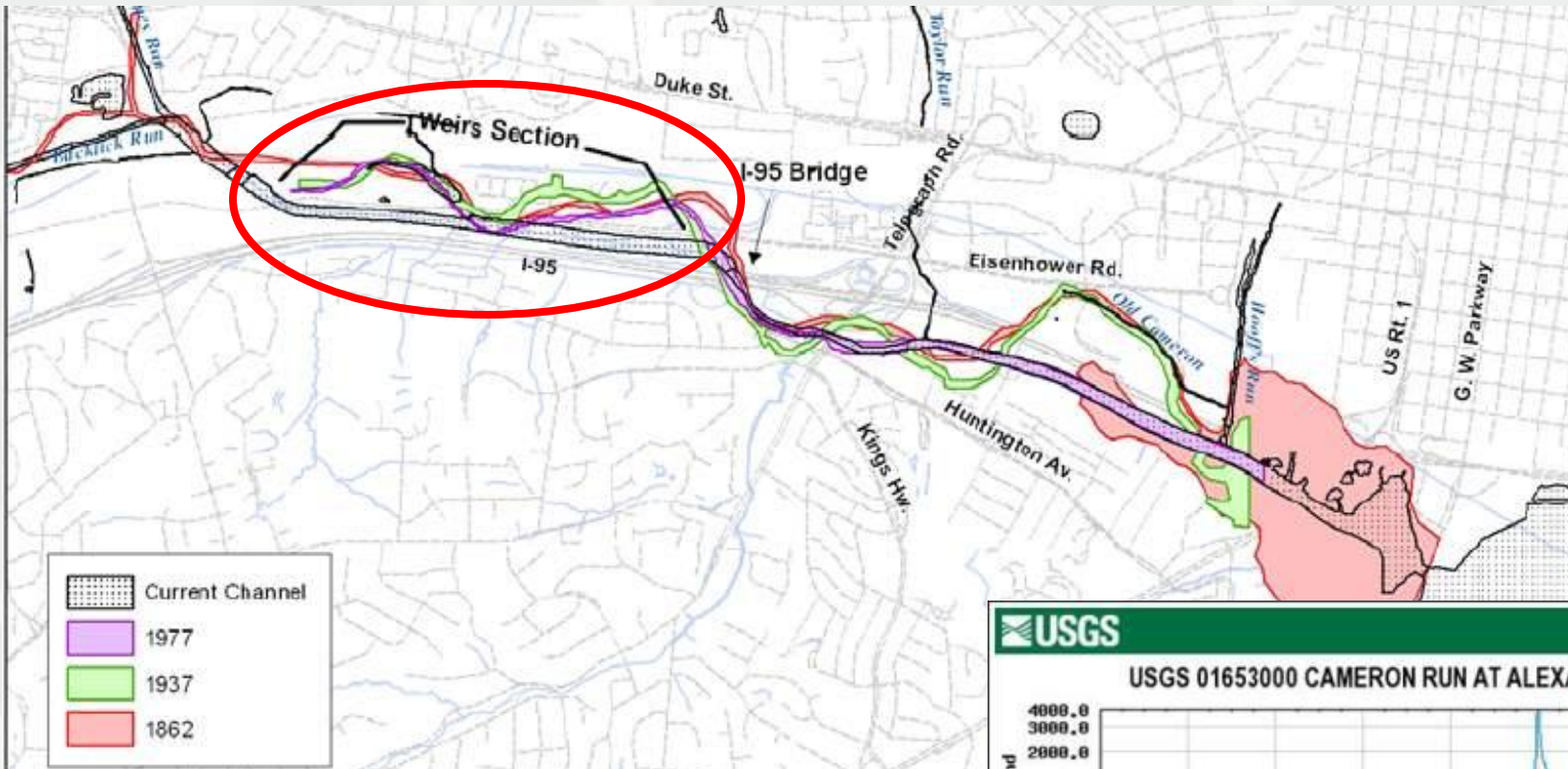
Alternatives considered
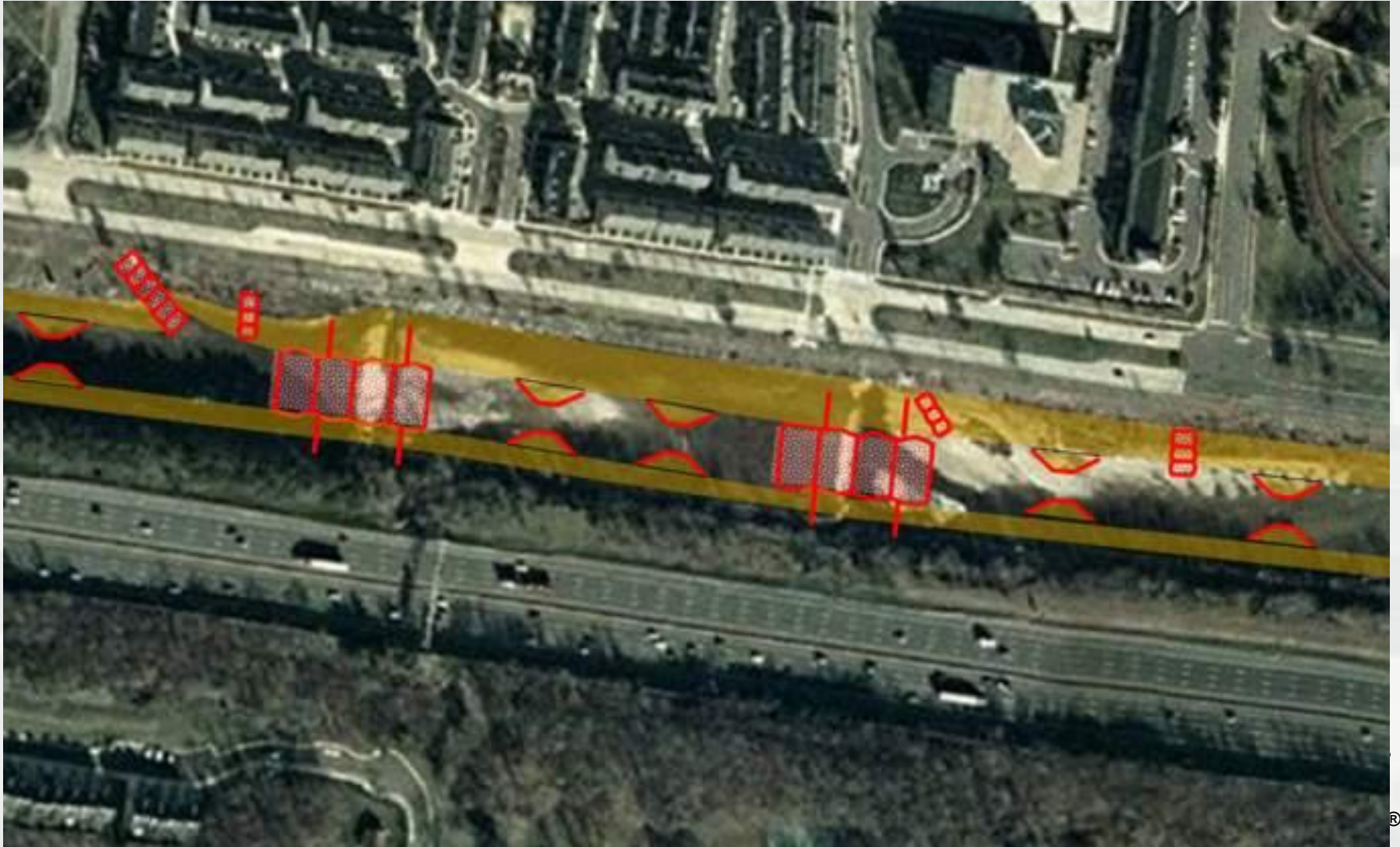
Domain generation

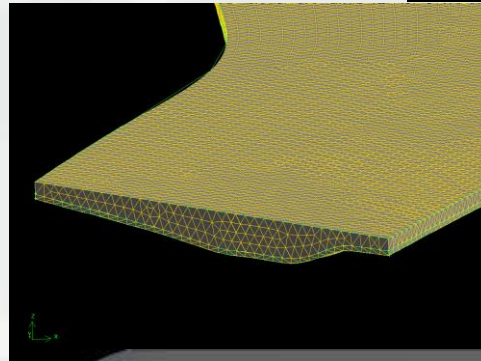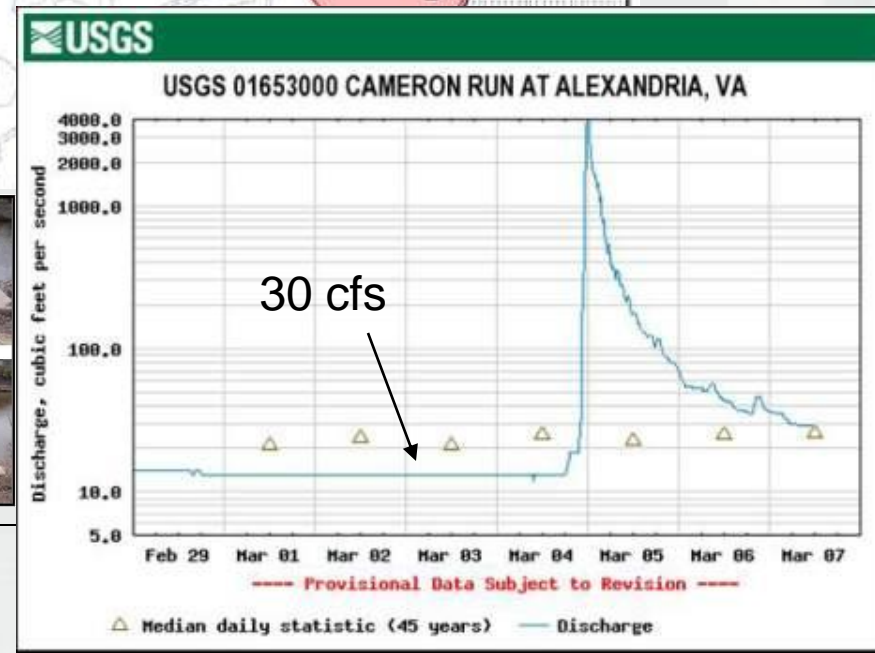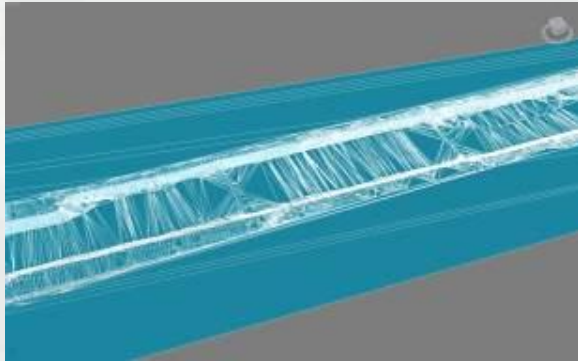2D tessellation from the Terrain Mesh Importer
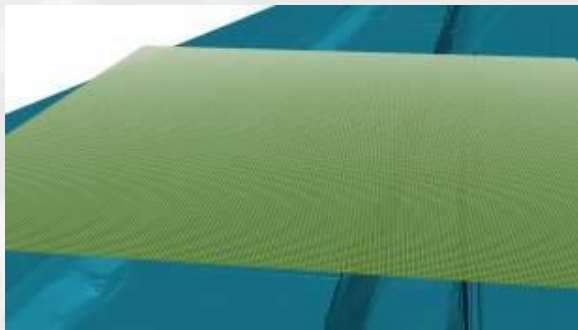
Tessellation Plane, before the Conform 3ds Max Modifier
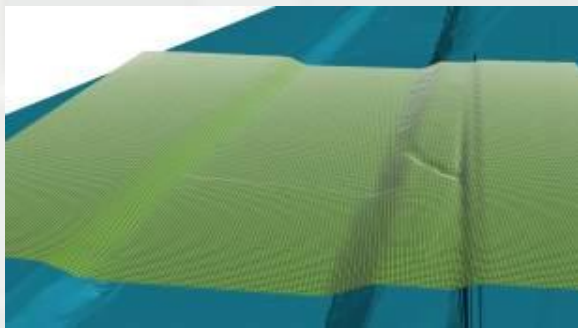
Newly conformed tessellated object, after application of the Conform Modifier
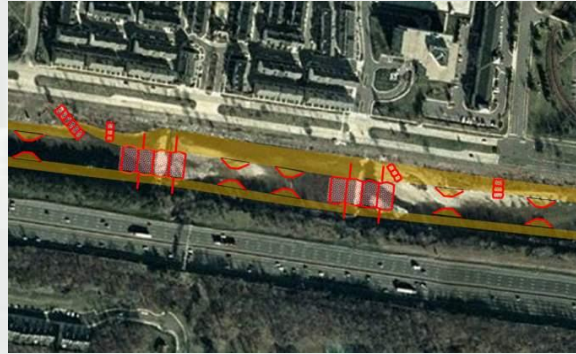
Original Texture, shown with a representative design alternative, before texture map projection.
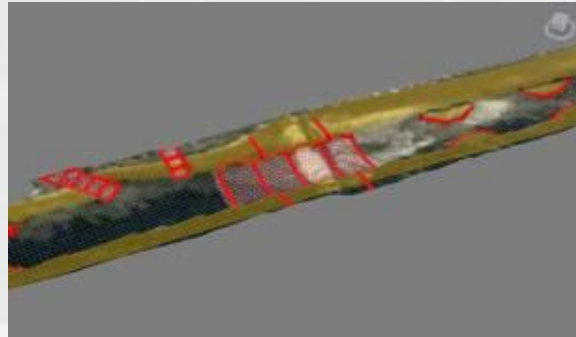
Texture map being projected onto the conformed 3D Surface
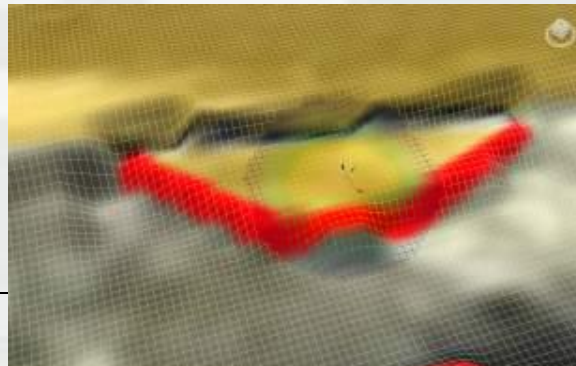
Geometry sculpting of wing deflectors via texture map and NURBS

Domain features

Cameron Run
Alternative E

Information from CFD – there is lots of it!

N = 1257
Mean = 0.749 m/s
S.D. = 0.514 m/s
Min = 0 m/s
Max = 2.542 m/s

N = 414
Mean = 0.793 m/s
S.D. = 0.363 m/s
Min = 0 m/s
Max = 1.238 m/s

V_{mag} (m/s)

V_{mag} (m/s)

Forecast movement

Important Attributes of the ELAM
- temporal & spatial scaling of each process optimally simulated,
- information transformed as needed to meet requirements of linked
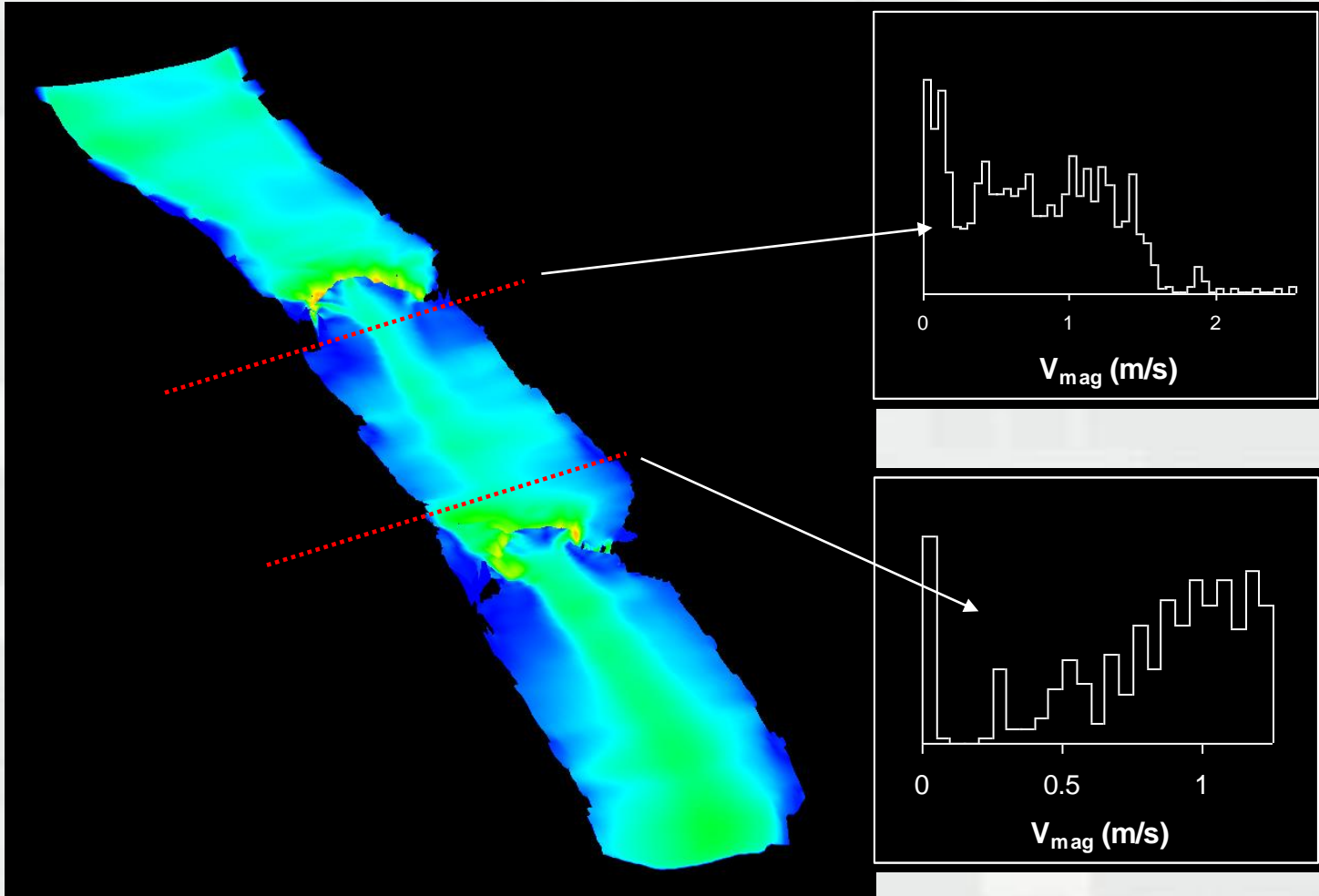   processes,
- distribution of processes to frameworks partially function size of
    domain
- venue for inter/trans-disciplinary education & integration, and
- maximum fidelity to "real world" using "first principles".

Eulerian mesh node

Eulerian mesh

Sensory Ovoid

Sensory Point

z

y

x
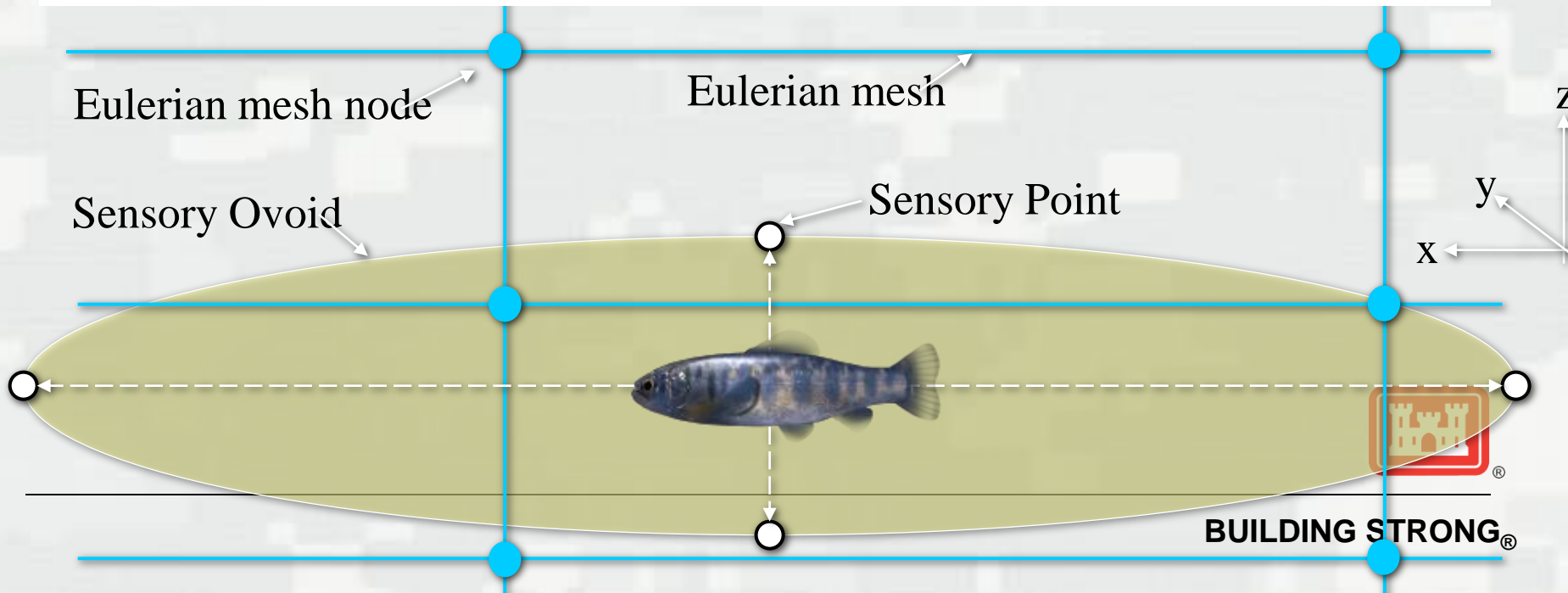
Biological model basis – translating high fidelity model output into decision metrics

- 38 species with two broad behaviors – migratory and foraging

- Metric – path length (in meters)
  - ► Migratory – best movement behavior is direct and path length is short
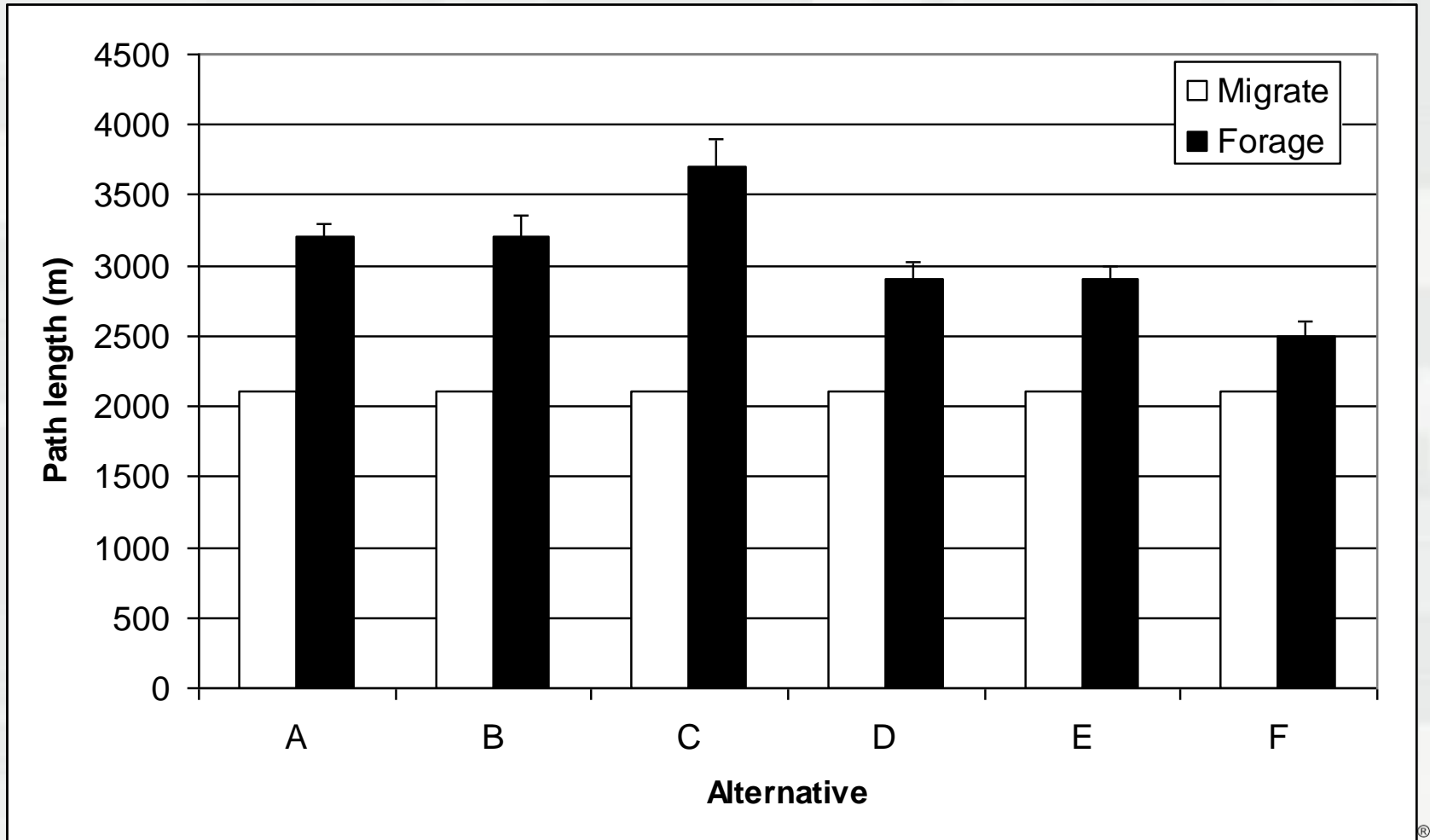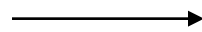 - ► Foraging – best movement behavior is indirect and path length is long

Foraging Migratory
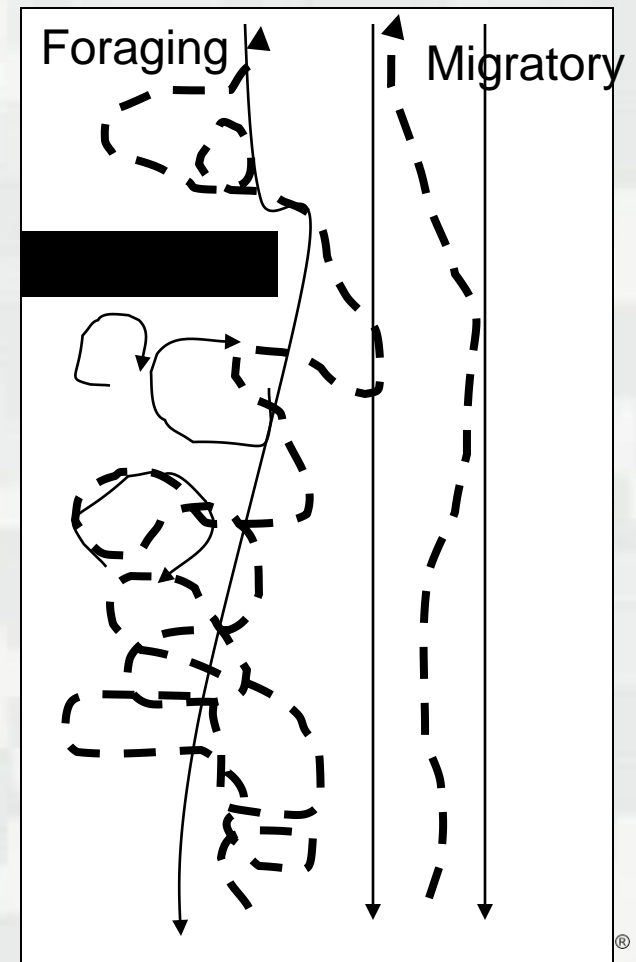
animation

Results

Implementation of SHAPE for stream restoration design - Baltimore District
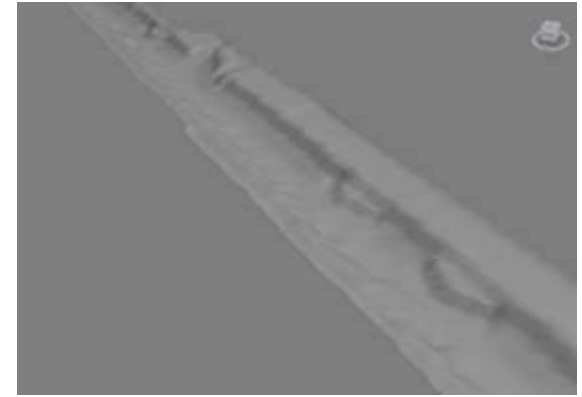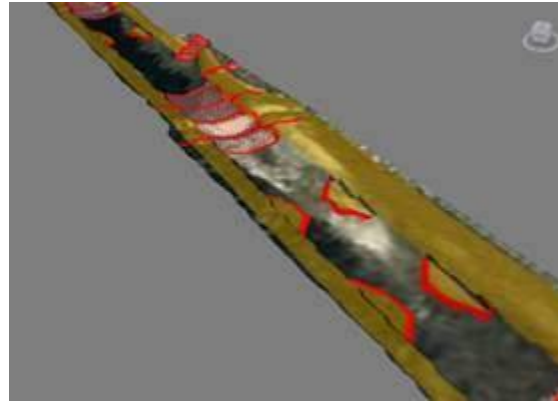
Project site $\longrightarrow$ Conceptual design (one of six alternatives) $\rightarrow$ Model domain with features from conceptual design
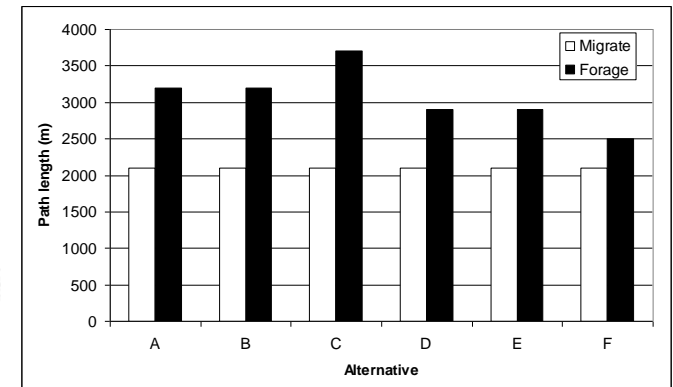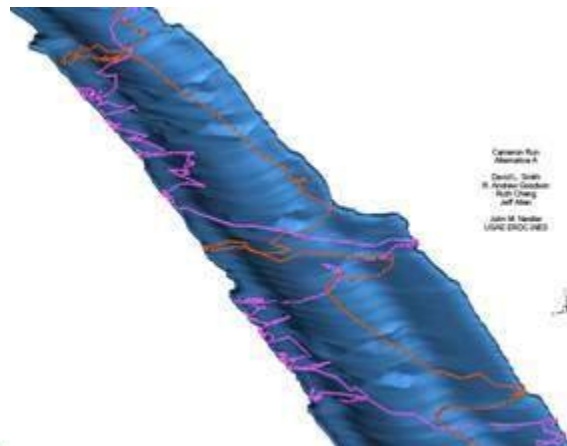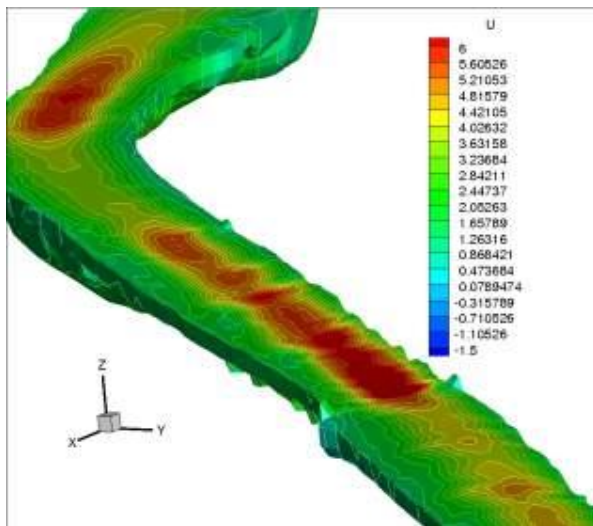

Hydrodynamic output $\longrightarrow$ Fish movement in CFD $\longrightarrow$ Fish movement analysis as function of CFD and selection of an alternative

Key Takeaway Points

- 10% conceptual designs with no bathymetry, CAD designs or biological data were the basis of a mechanistic model
- Similar alternatives produced measureable differences in output
- Very limited assumptions or judgment required in analysis
- Clear options for improving model accuracy and precision
- Cost effective and able to be completed on a schedule
- Stakeholder briefing and acceptance at project beginning
- Developing a virtual reference condition would allow comparison of model outputs at Cameron Run with other studies on different systems