OTHER DOCUMENT 7

2D Hydrodynamic Based Logic Modeling Tool for River Restoration Decision Analysis

A Quantitative Approach to Project Prioritization

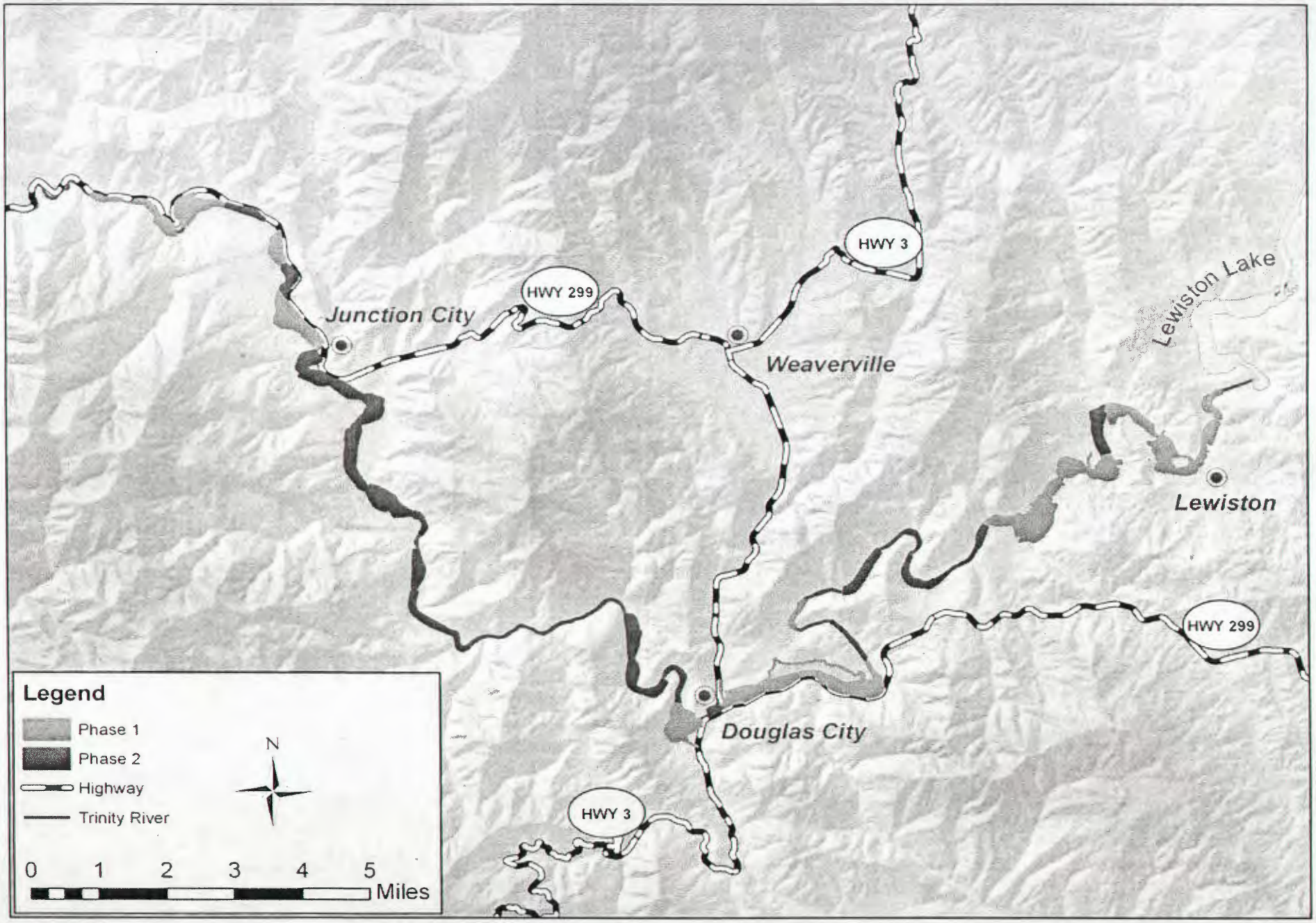
Trinity Adaptive Management Workgroup (TAMWG)
September 9th, 2014

David (DJ) Bandrowski P.E., TRRP
Design Team, Inter-Disciplinary Team, Habitat Team, and
Bureau – Technical Service Center (TSC)

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Trinity River Restoration Program

42 Mile Reach-Scale Approach - Projects Begin in 2005

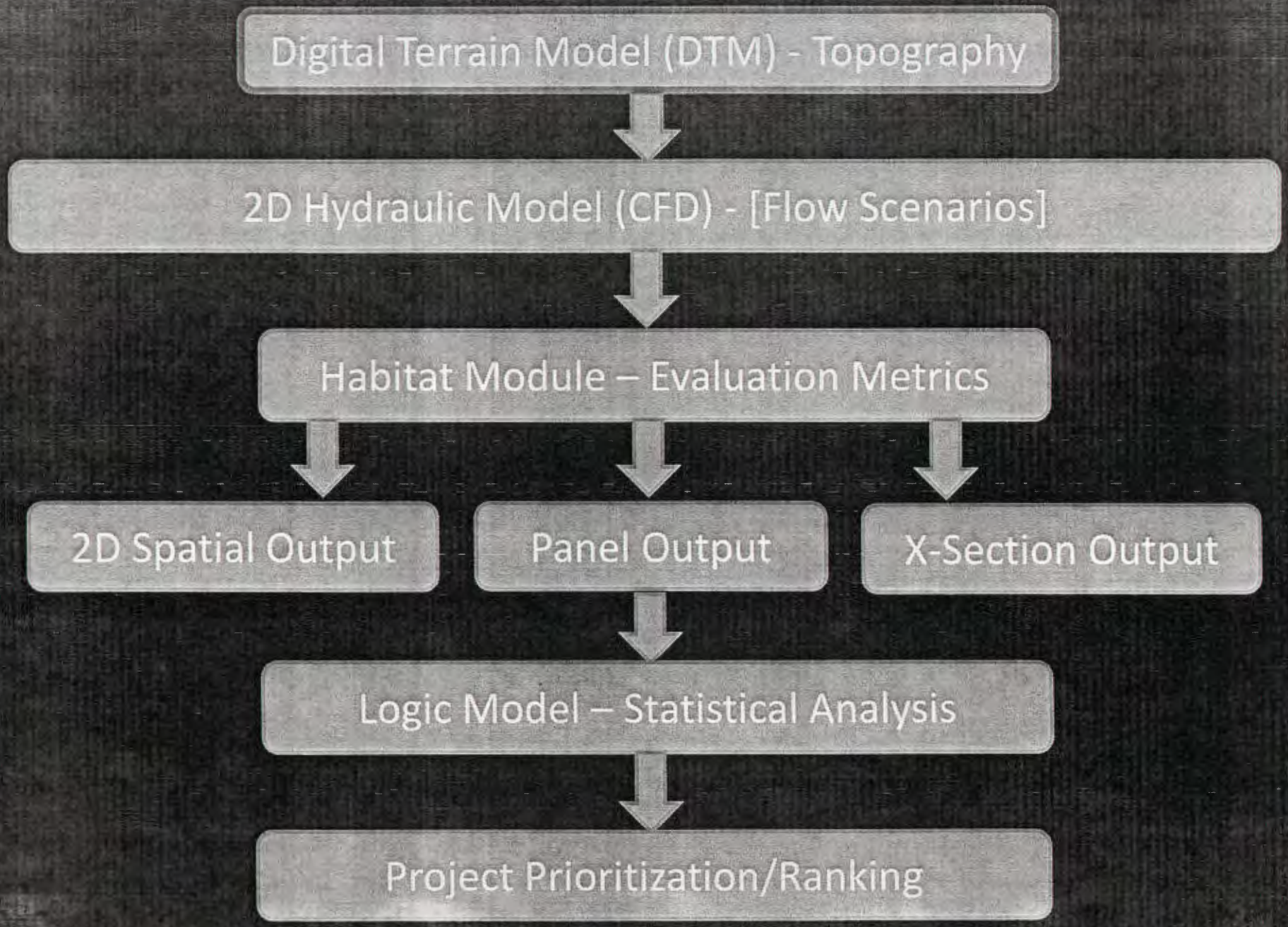


A Decade of Restoration – The Need for Refined Prioritization and Prediction Capabilities is Realized

PERSEVERANCE

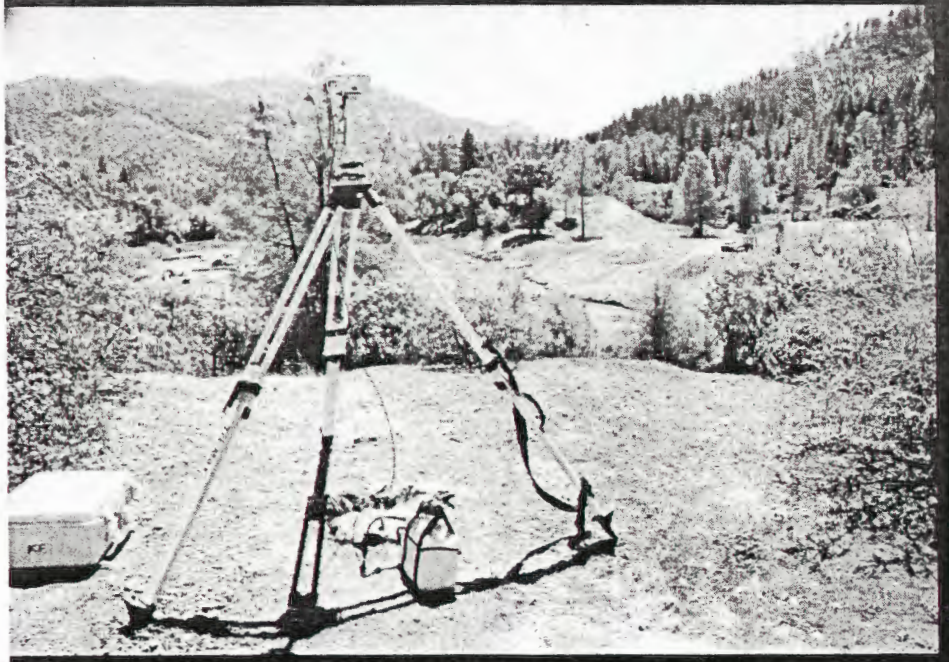
The Courage to Ignore the Obvious Wisdom of Turning Back.

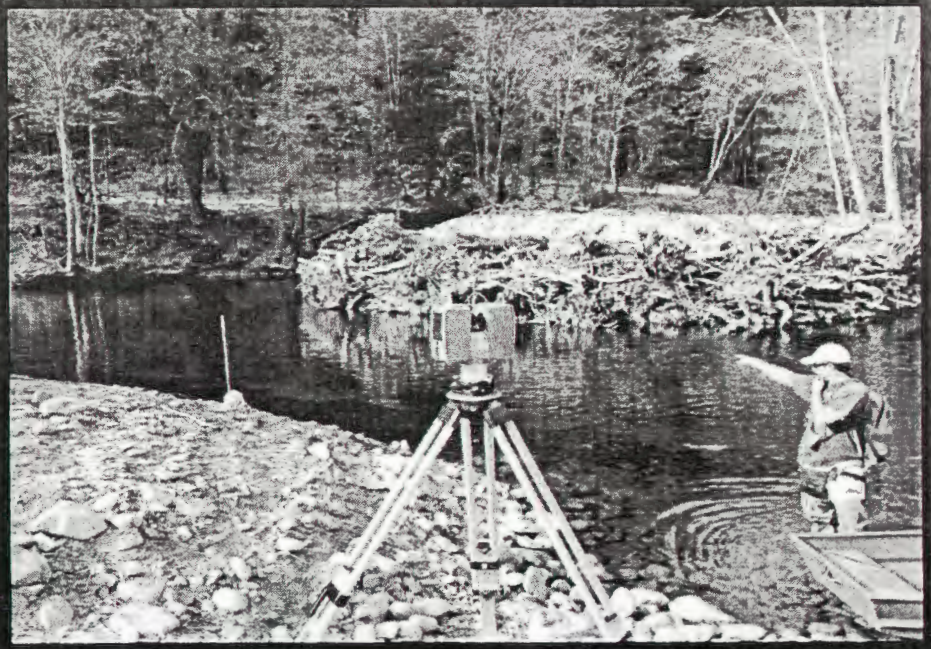
2D Hydrodynamic Based Logic Modeling Framework

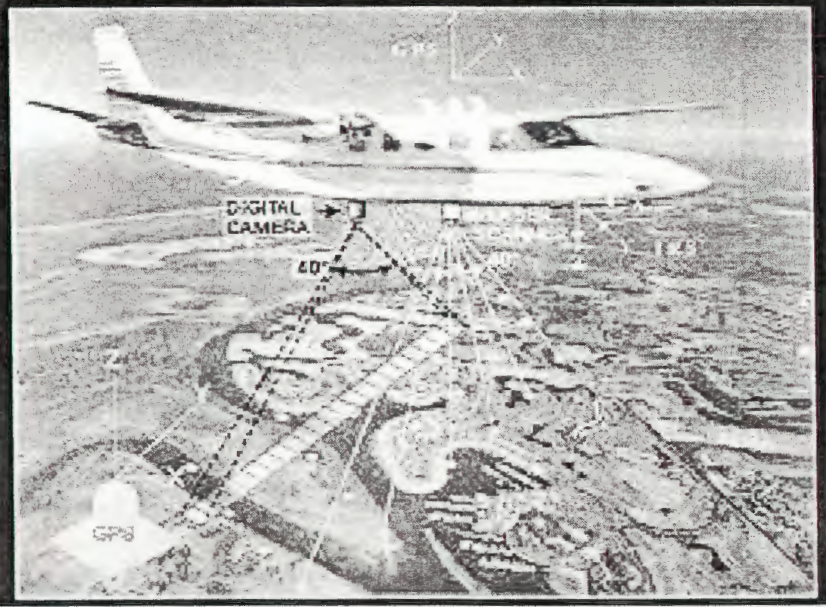


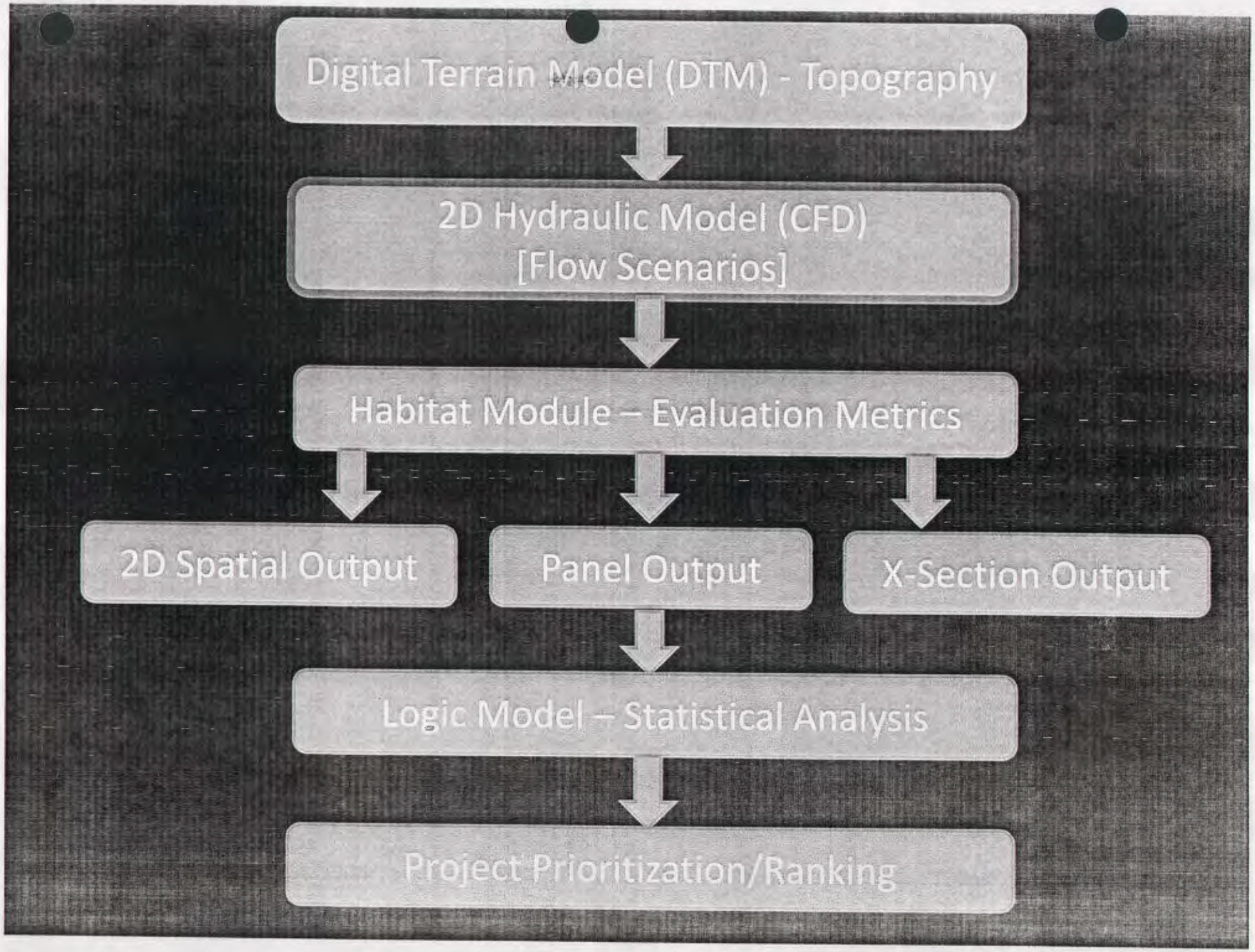
DIGITAL TERRAIN MODEL DEVELOPMENT – BATHYMETRY COLLECTION AND WATER SURFACE CALIBRATION DATA (SONAR AND GPS)

Digital Terrain Model (DTM) Development
Terrestrial Topography (Airborne and Ground LiDAR)



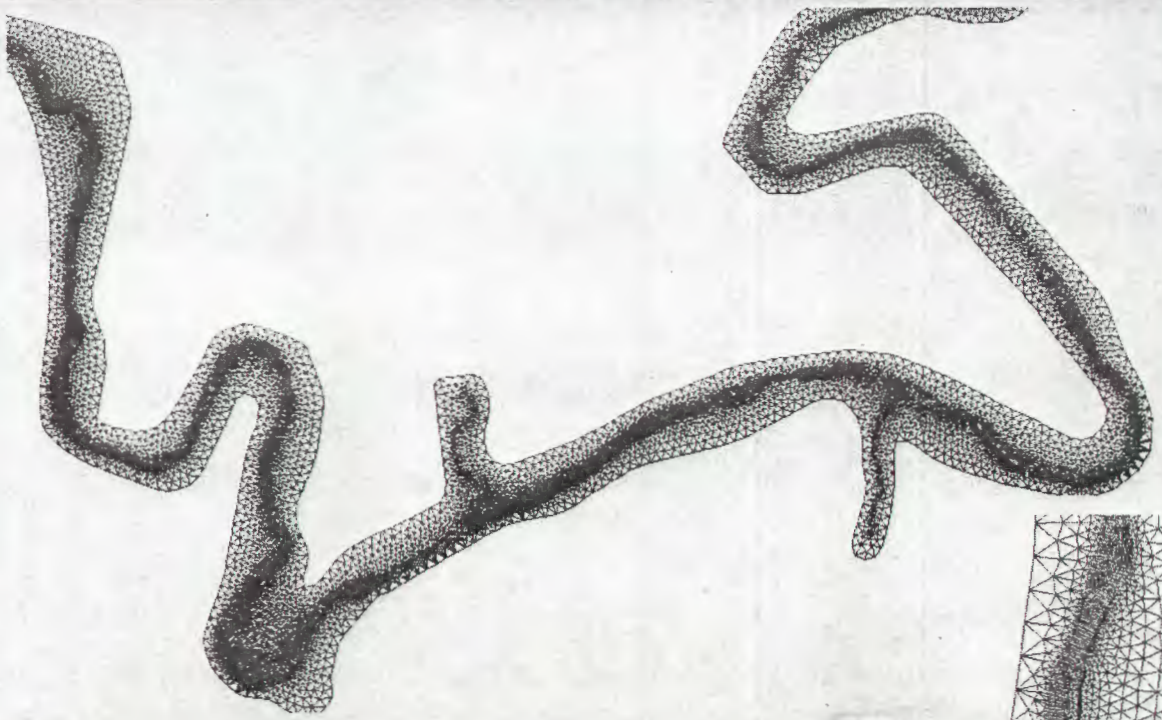


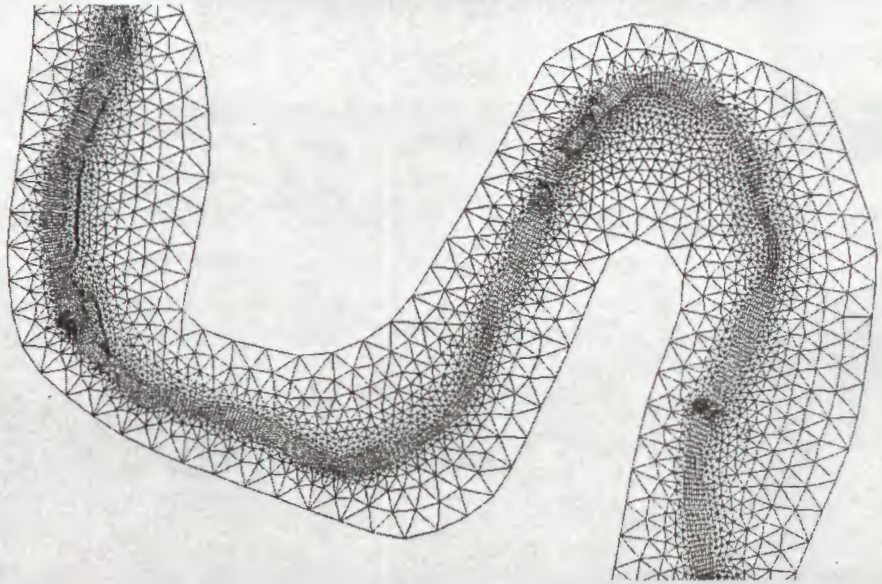



Digital Terrain Model (DTM) - Topography
2D Hydraulic Model (CFD)
[Flow Scenarios]
Habitat Module – Evaluation Metrics
2D Spatial Output
Panel Output
X-Section Output
Logic Model – Statistical Analysis
Project Prioritization/Ranking

2D Hydraulic Modeling Framework - Model Mesh

A mesh discretizes physical space so that the differential equations describing a continuous physical process can be solved numerically between mesh elements.



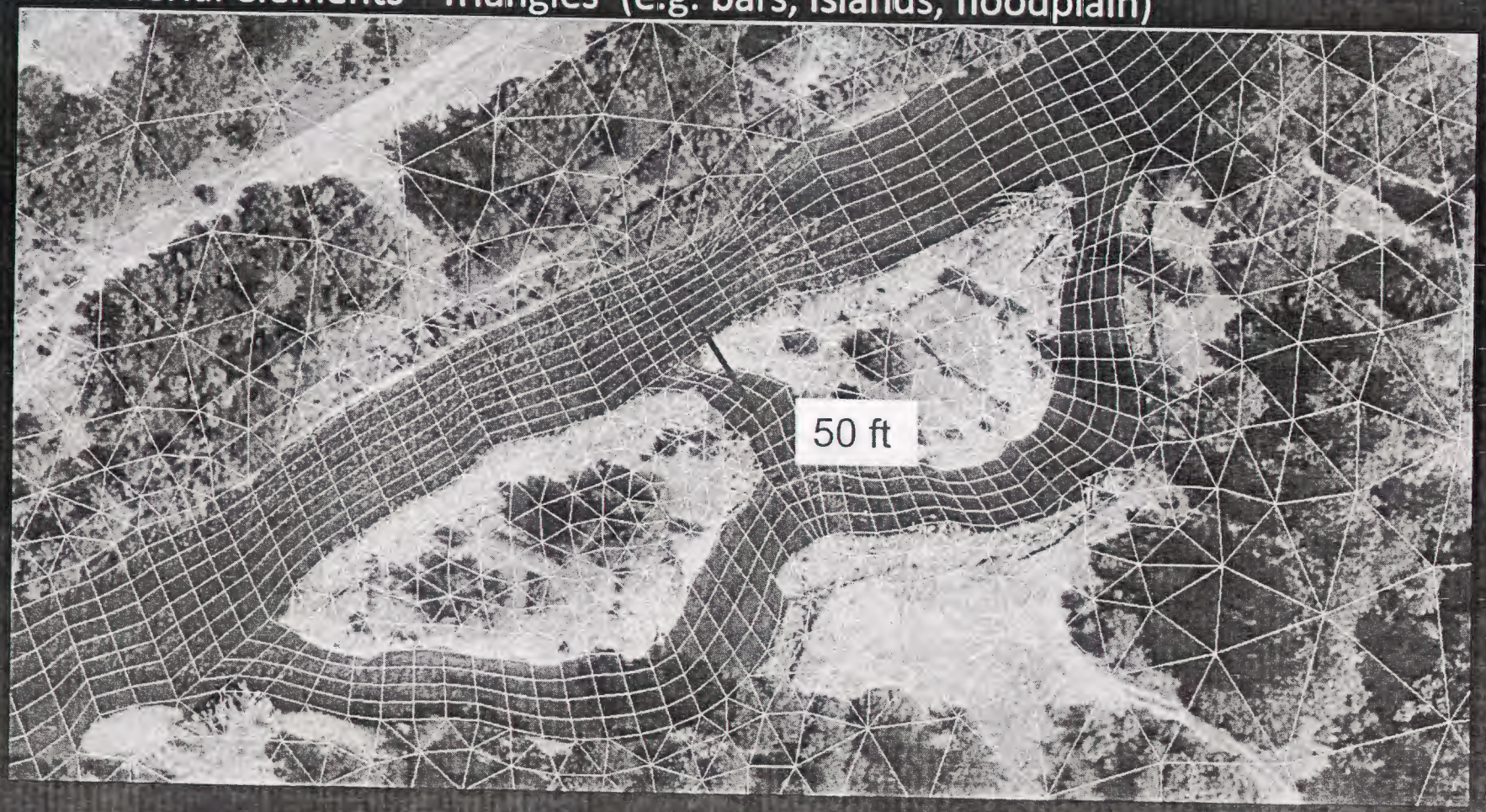


2D Hydraulic Model – Calibration Mesh

224,664 mesh elements across 40 mile restoration reach (Mesh Size = 6-10 ft Wide)

34% channel elements - quadrilaterals (e.g. channel defined at 450 cfs)

66% sub-aerial elements - Triangles (e.g. bars, islands, floodplain)

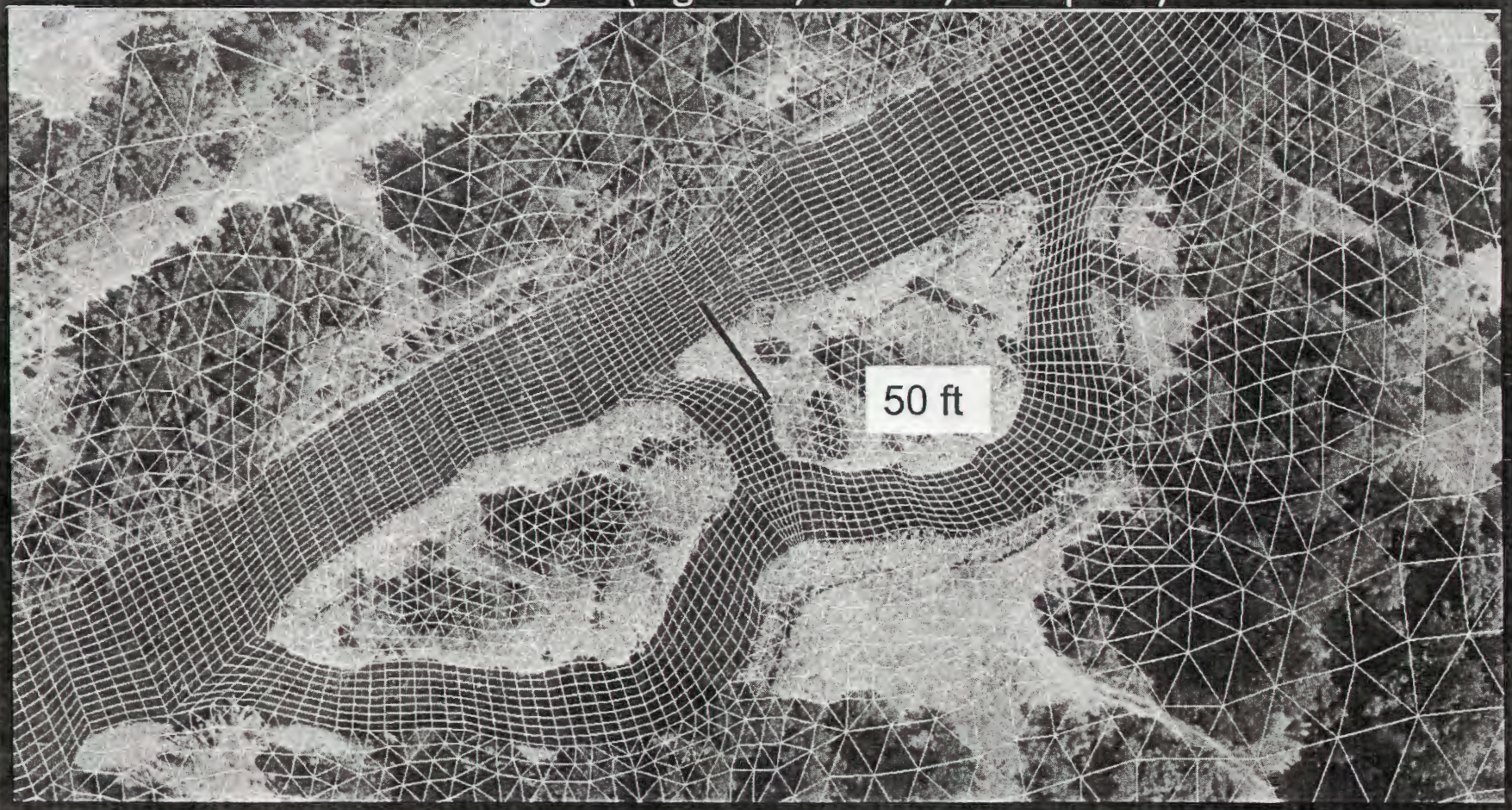


2D Hydraulic Model – Habitat Mesh

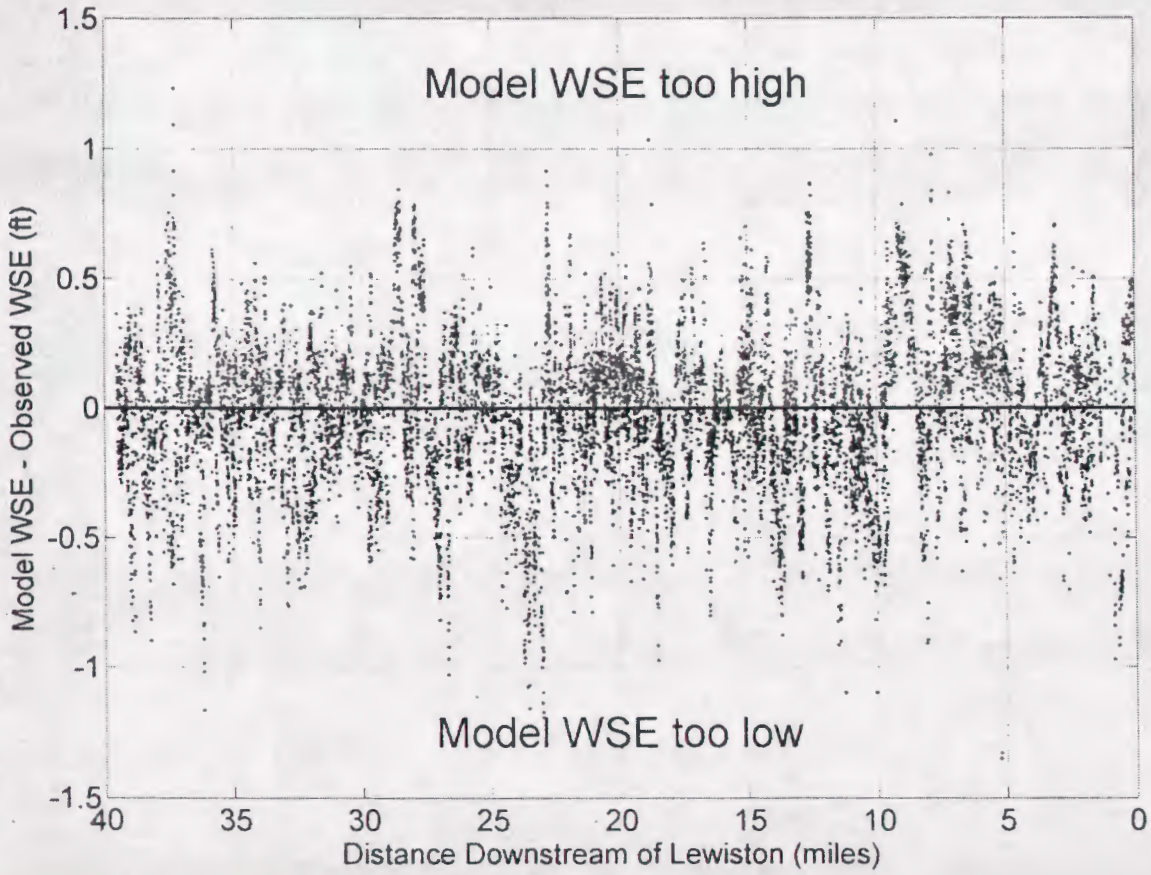
898,656 mesh elements across 40 mile restoration reach (Mesh Size = 2.5 – 4 ft Wide)

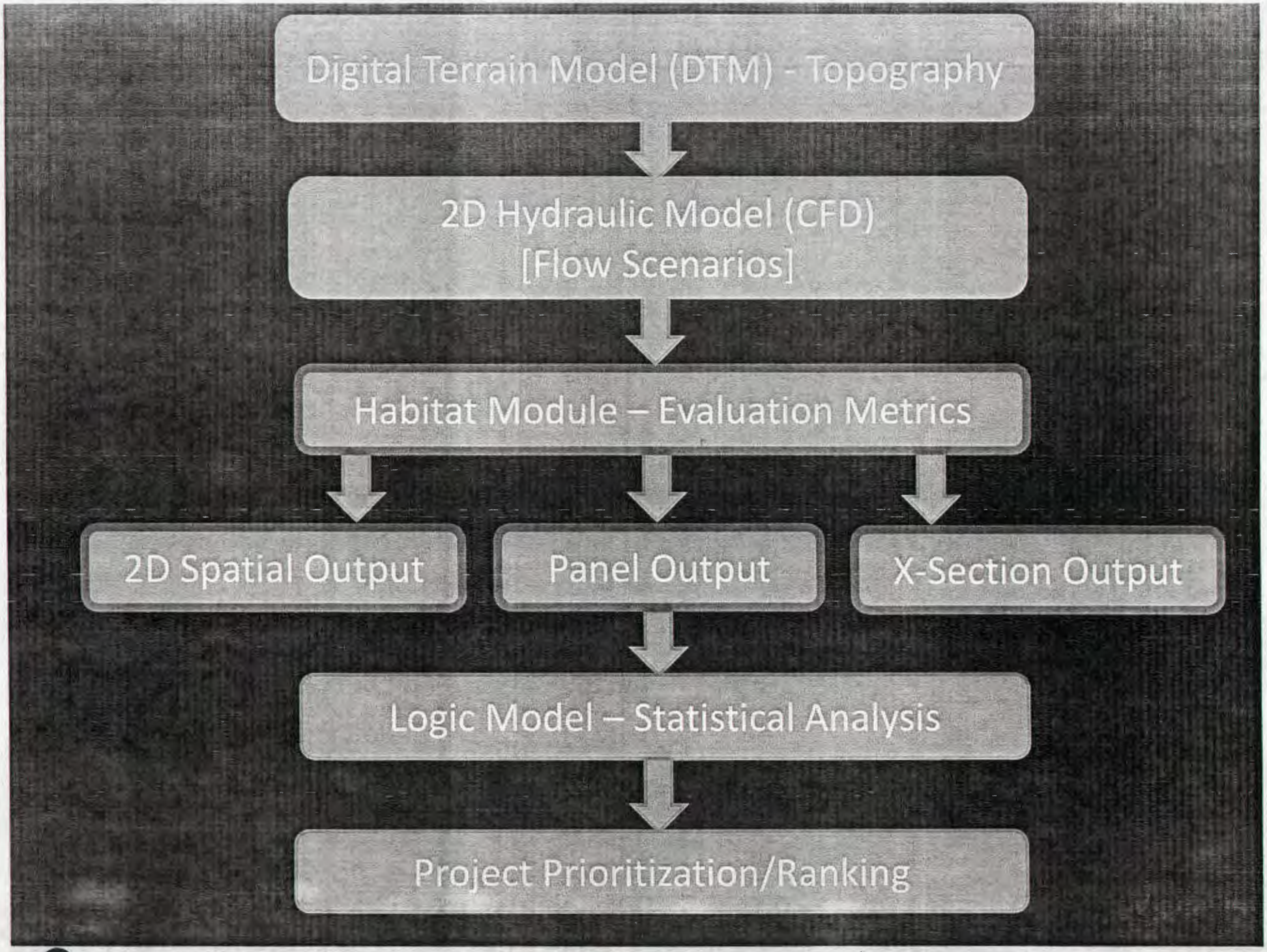
34% channel elements - quadrilaterals (e.g. channel defined at 450 cfs)

66% sub-aerial elements - Triangles (e.g. bars, islands, floodplain)



2D Model Calibration Results – Modeled vs. Observed Water Surface Elevation Data at Various Discharges

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HABITAT MODULE – SPATIAL OUTPUT FRAMEWORK

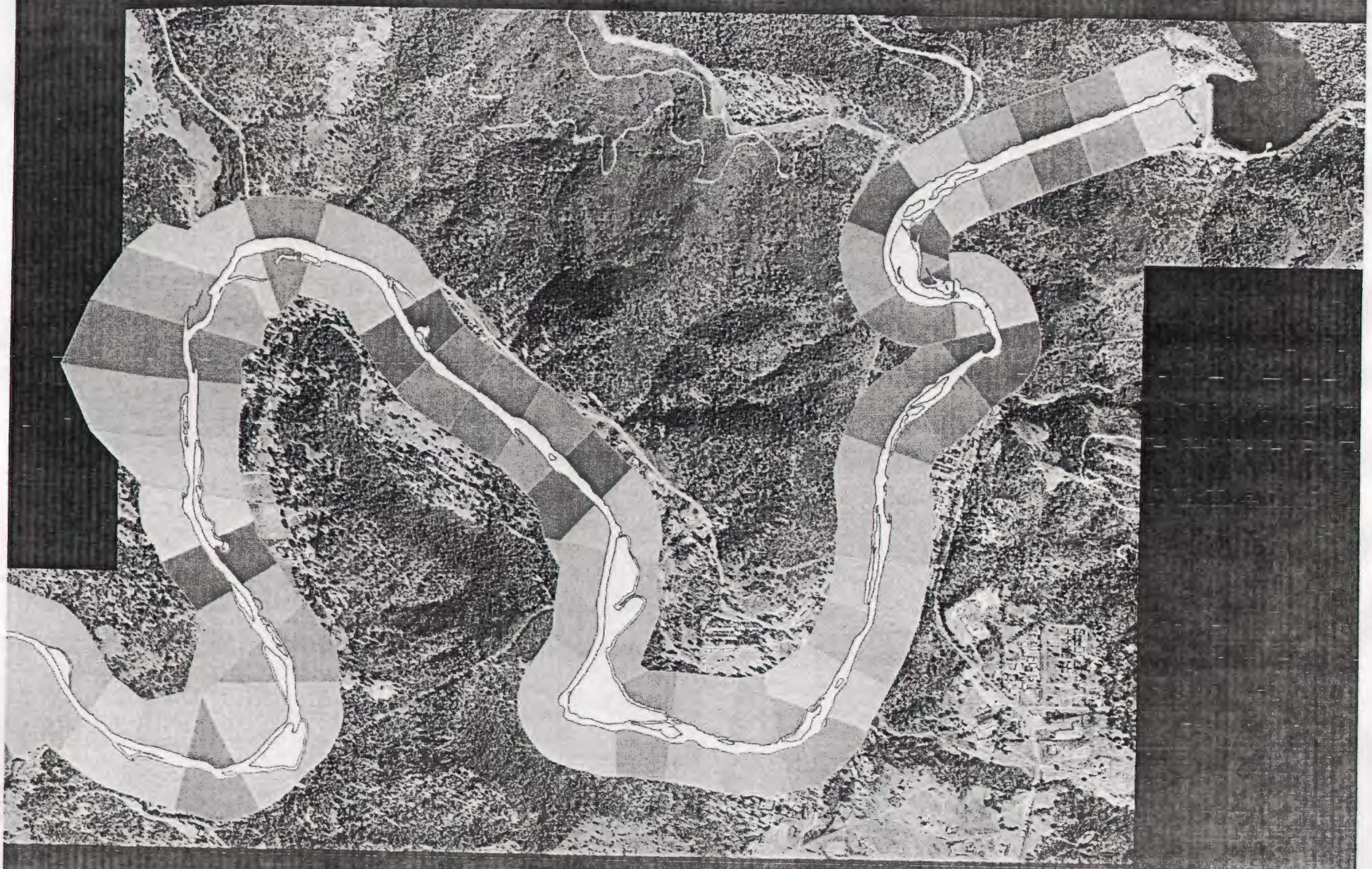
Habitat Module – Hydraulic Parameters/Evaluation Metrics

Panel Metrics

Per User Defined Boundary (Averaged to Panel- Tabular)

- Panel Centroid - Northing/Easting – Distance from Dam
- Water Depth (Average; Standard Deviation and Max)
- Width to Depth Ratio (Standard Deviation)
- Velocity (Average; Standard Deviation)
- Sheer Stress (Average; Standard Deviation)
- Water Surface Slope and Wetted Edge Length
- Sinuosity and Hydraulic Cross-Over
- Stream Power
- Vorticity
- Topographic Difference (Between Wet and Dry Elements)
  (Average; Standard Deviation; Volume – River Right/Left)
- Area of Juvenile Salmonid Habitat (Depth /Velocity/Cover)
- Area of Suitable Vegetation (Area of dry land within an applicable elevation threshold from the water surface)
- Derivative of Sheer Stress Along a Flow Direction (average) (Metric of Sediment Transport - Erosion vs. Deposition)

HABITAT MODULE – PANEL OUTPUT FRAMEWORK



Lowden Ranch Example – Aerial Image 2009 (450 CFS)

LOWDEN RANCH EXAMPLE – AERIAL IMAGE 2011 (450 CFS)

Lowden Ranch Example – Modeled Velocity at 450 CFS

Lowden Ranch Example – Modeled Velocity at 450 cfs
Animation of Velocity Vectors

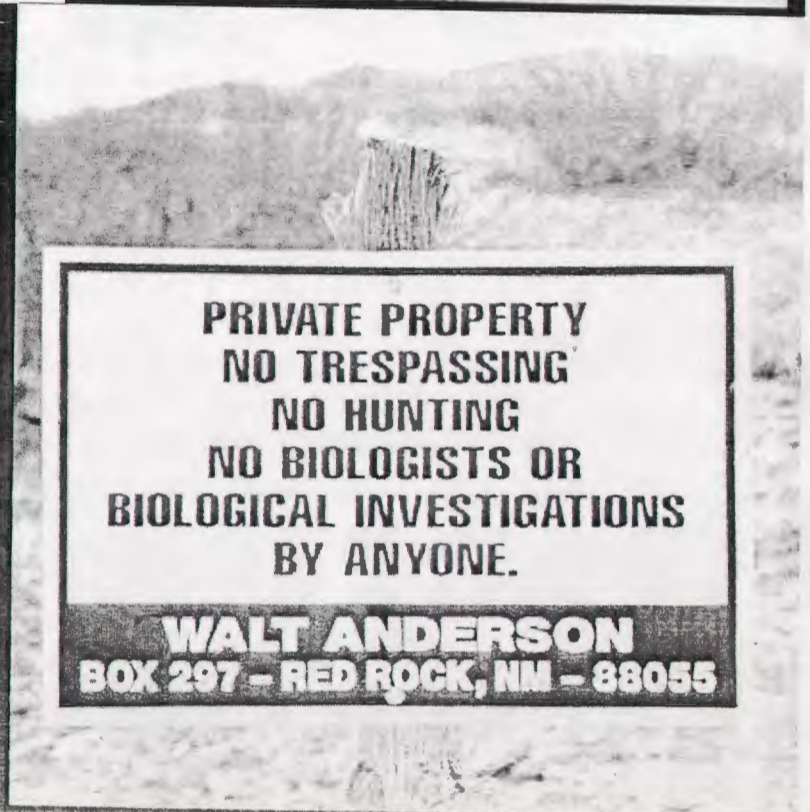
Lowden Ranch Example – Modeled Pre Smolt Salmonid Habitat at 450cfs (Habitat Suitability Criteria – HSC)

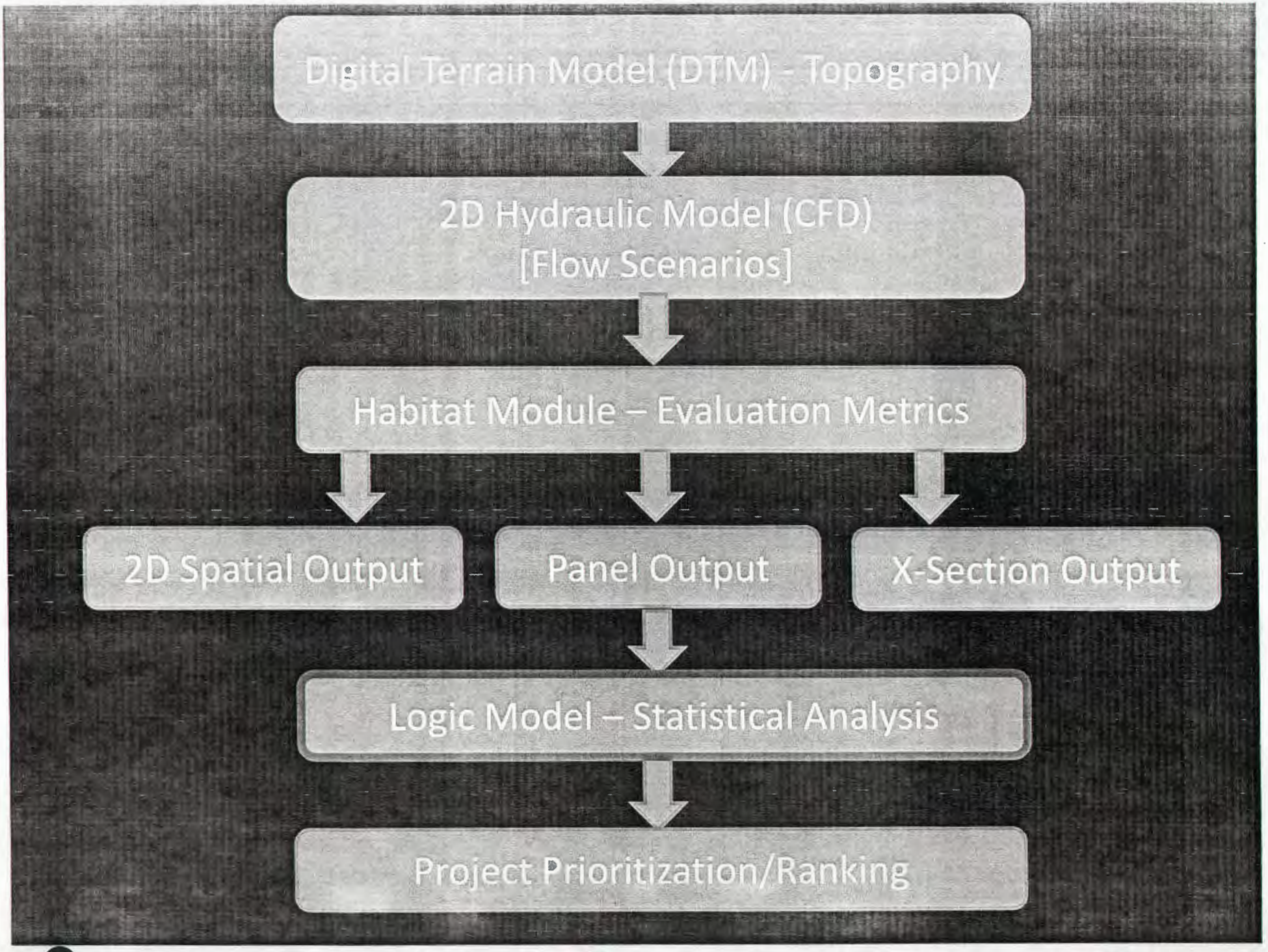
COMPARISON BETWEEN FIELD OBSERVED AND MODEL PREDICTED

HOOPA VALLEY TRIBE
P.O. Box 417
Hoopa, CA 95546

U.S. FISH AND WILDLIFE SERVICE
1655 Heindon Road
Arcata, CA 95521

YUROK TRIBE
2500 Hwy. 96
Weitchpec, CA, 95525

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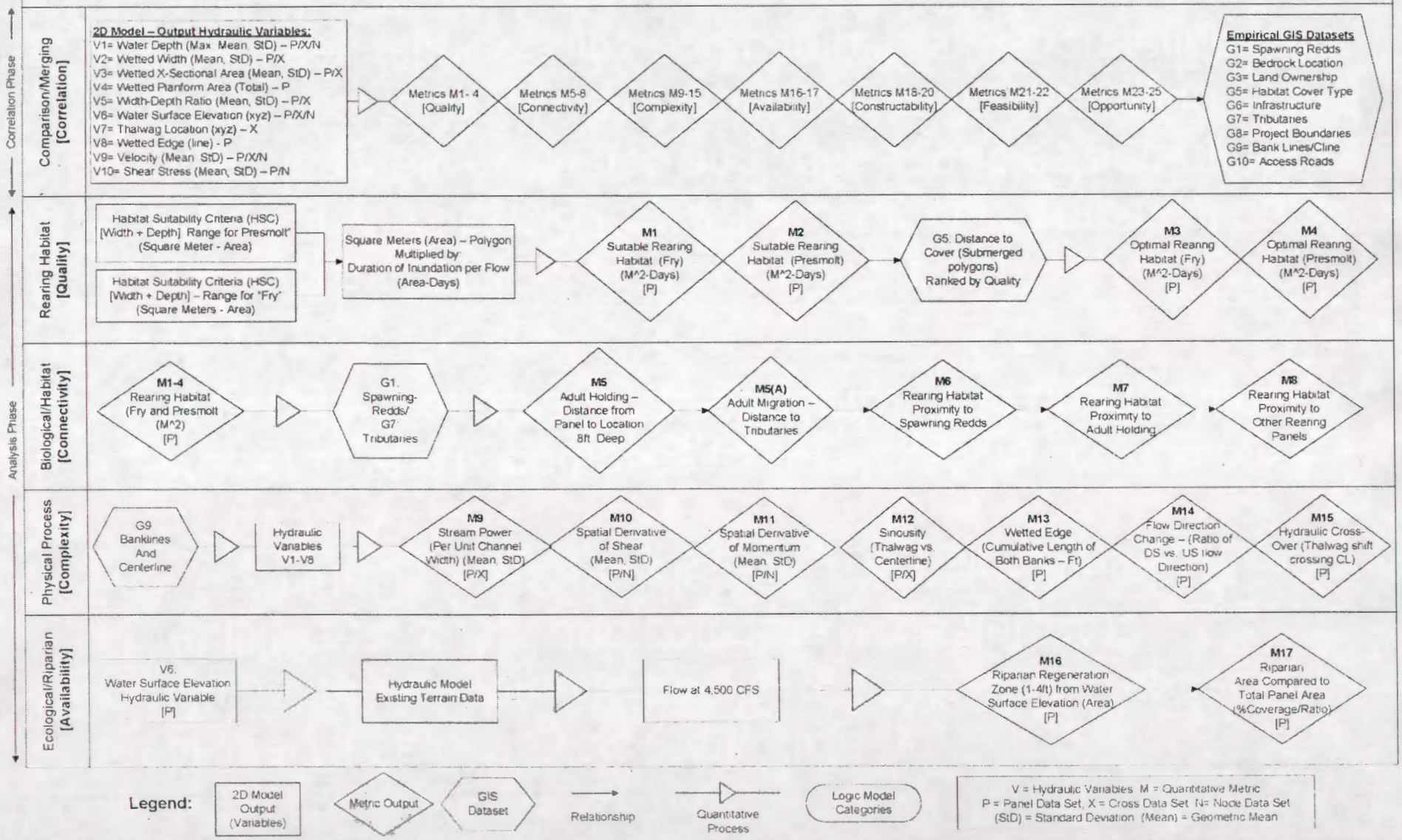
TRRP Phase II Analysis – 2D Hydrodynamic Based Logic Modeling (2D-HBLM) Framework – Conceptual Model Diagram – Sheet 1 of 2



Logic Model Framework

- Statistical Based Analysis Methodology
  - Quantitative Approach that is defensible and repeatable
  - Ability to evaluate and compare large datasets
    - 20 Flows x 319 panels x 35 (variables/metrics)= 223,300
  - Power to test hypotheses using statistical correlations
  - Non-biased and transparent approach to prioritization

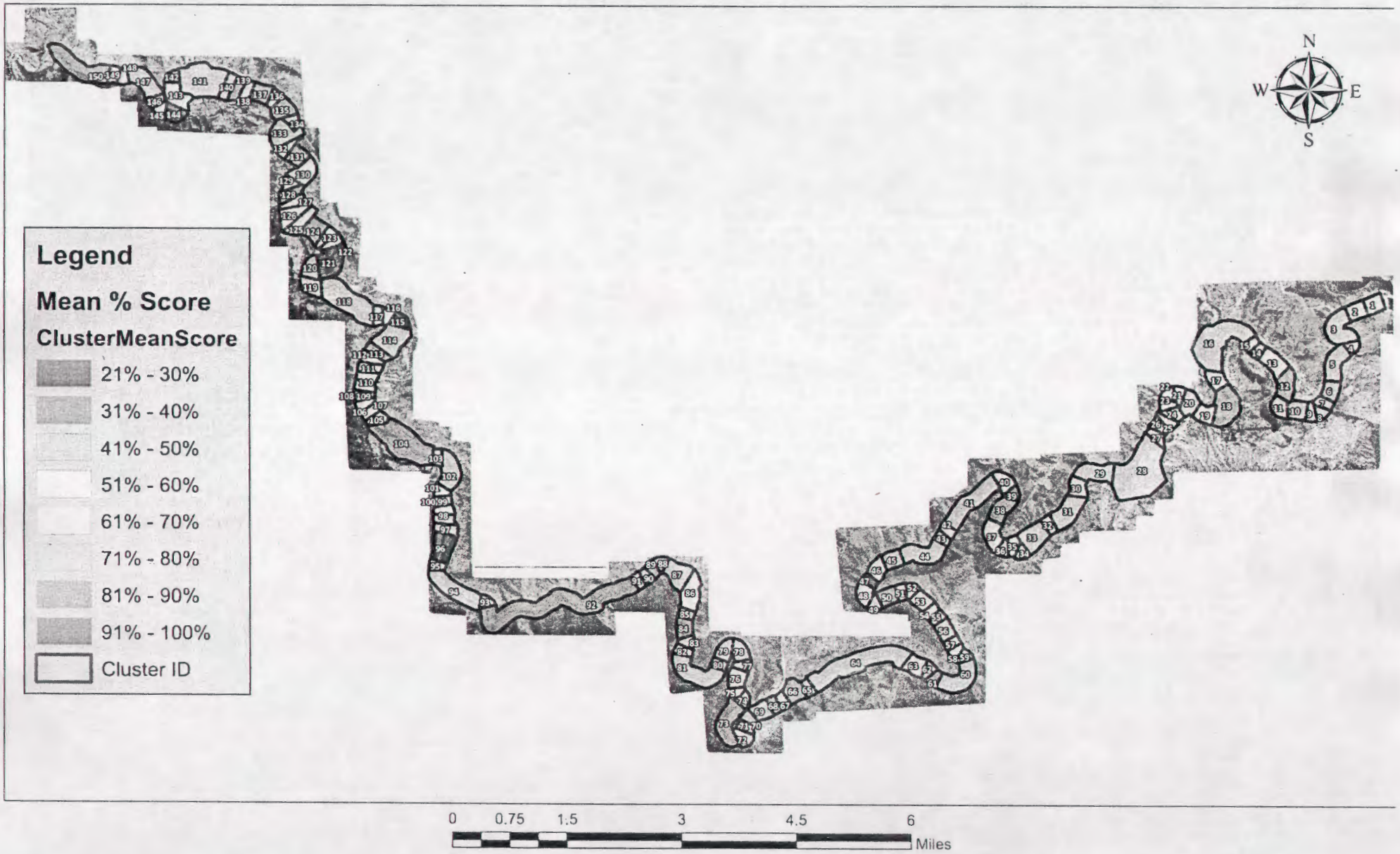
- 2D-HBLM (Hydraulic Based Logic Modeling)
  - Strategically links 2D-Hydraulic output to empirical data
  - Quantitatively evaluates and links variables and metrics
  - Statistical techniques of univariate/mulivariate analysis
  - Analyzes relationships and compares response/indicator variables (quality, connectivity, complexity)

ESL Name	Habitat (300 cfs TA 0.50)	Habitat (1500 cfs)	Total redds (2011-2013)	SD of bed elevation (m)	SD of unit stream power (8,500 cfs)	Percent public ownership	Road length (feet)	Bedrock area	Topography (cubic feet × 106)	Geomorphic potential
Chapman Ranch	[illegible]	77	[illegible]	[illegible]	[illegible]	71%	2,570		4.52	-0.46
Below Pear Tree	10	63	[illegible]	[illegible]	10	100%	2,795		13.59	-1.32
Below Lorenz (the canyon)	70	59	[illegible]	[illegible]	[illegible]	58%	2,675	1,084	15.74	1.96
Dutch Creek	23	[illegible]	[illegible]	[illegible]	[illegible]	72%	723	181	7.57	-0.38
Pear Tree Gulch	8	64	[illegible]	[illegible]	[illegible]	100%	1,354	166	11.95	0.29
Deep Gulch	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	41%	2,066		10.26	-0.56
Soldier Creek	[illegible]	82	[illegible]	[illegible]	[illegible]	87%	1,151		12.39	0.05
Evans Bar	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	77%	3,485	257	4.68	-0.68
Lower Steiner Flat (not built)	[illegible]	83	[illegible]	[illegible]	[illegible]	100%	1,683	327	8.38	1.00
Trinity House Gulch	83	[illegible]	[illegible]	[illegible]	[illegible]	69%	1,859		6.33	0.23
Lorenz Gulch	82	76	[illegible]	[illegible]	[illegible]	80%	2,683	17	6.20	0.46
Indian Creek (Vitzthum Gulch)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	64%	2,201		7.87	-1.54
Sky Ranch	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	55%	4,464	45	6.34	0.83
Below Steel Bridge	72	[illegible]	[illegible]	[illegible]	[illegible]	38%	3,481		9.11	-0.05
Tom Lang Gulch	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14%	4,426		14.59	-0.44
Cableway	[illegible]	[illegible]	10	[illegible]	[illegible]	44%	5,015	6	6.99	-1.22
Upper Junction City	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	38%	5,760	208	5.43	0.66
Oregon Gulch	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	60%	3,182		3.80	-0.45
Middle Steiner Flat	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100%	2,048	471	11.50	1.56
Sheridan Creek	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	73%	2,401		7.91	-1.27
Below Tom Lang Gulch	[illegible]	[illegible]	[illegible]	[illegible]	-5	29%	7,396		14.46	-1.84
Below Evans Bar	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	83%	3,300		10.39	0.54
Elkhorn	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44%	2,402	374	12.83	0.61
China Gulch	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	53%	2,213		12.49	0.12
Lower Steiner Flat (built)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100%	2,413	1,294	10.36	1.30
Lower Junction City	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6%	4,575		8.99	0.85
Hatchery	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100%	113,816		4.55	0.35
Upper Conner Ck	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	61%	2,309	326	7.06	1.00
Hoadly Gulch	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	44%	6,122		4.31	-0.78
Below Limekiln Gulch	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100%	1,632		10.42	-0.11
Douglas City	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	58%	5,734		3.40	-1.03
Valdor Gulch	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9%	4,096		7.16	0.38
Upper Steiner Flat	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100%	2,604	271	10.71	1.29

RESULTS - A total of 150 spatially-related clusters of similar scores were identified. The top ten clusters of ascending desirability for restoration are shown in the table below, including all clusters (top) and clusters including a minimum of three panels (bottom).

All cluster sizes				
Cluster ID	Number of panels	Mean Score		Associated upstream ESL
96	3	28.7%	Dutch Creek	
68	1	31.0%	Douglas City	
108	1	33.0%	Sheridan Creek	
84	2	34.5%	Lorenz Gulch	
92	19	35.2%	Below Lorenz (the canyon)	
104	7	35.6%	Chapman Ranch	
39	1	36.0%	China Gulch	
150	7	38.6%	Pear Tree Gulch	
50	2	39.5%	Below Steel Bridge	
128	1	40.0%	Hocker Flat	

Clusters including at least three panels				
Cluster ID	Number of panels	Mean Score		Associated upstream ESL
96	3	28.7%	Dutch Creek	
92	19	35.2%	Below Lorenz (the canyon)	
104	7	35.6%	Chapman Ranch	
150	7	38.6%	Pear Tree Gulch	
60	5	40.2%	Indian Creek (Vitzthum Gulch)	
102	4	40.5%	Soldier Creek	
114	3	41.3%	Oregon Gulch	
94	6	42.7%	Dutch Creek	
118	7	45.4%	Sky Ranch	
31	4	46.8%	Tom Lang Gulch	


Legend
Mean % Score
ClusterMeanScore
21% - 30%
31% - 40%
41% - 50%
51% - 60%
61% - 70%
71% - 80%
81% - 90%
91% - 100%
Cluster ID
N
W
E
S
0
0.75
1.5
3
4.5
6
Miles

Logic Model Framework

- See Logic Model Results from 9-5-14 Document - Attached

- *Design Team Consensus Technical Recommendation: Out of the top ten cluster areas we recommend the following 4 clusters for 2016 designs: 96/97, 102, 104, and 114 (Evans Bar, Soldier Creek, Chapman Ranch, and Oregon Gulch former ESL Areas). We recommend these clusters based on their quantitative scores/ranking from the Logic Model, design synergy of all falling within the same river reach, and potential increase of efficiency on construction logistics due to contiguous projects.*

COMMUNICATION – COLLABORATION – COMMITMENT
"MULTI-DISCIPLINARY APPROACH"

TRINITY MANAGEMENT COUNCIL

THE GREAT SEAL OF THE HOOPA VALLEY TRIBE

RESOURCES AGENCY CALIFORNIA DEPARTMENT FISH & GAME

Trinity River Restoration Program
Restore • Adapt • Improve

TRINITY COUNTY
TIMBER MINERALS WATER
CALIFORNIA

DEPARTMENT OF WATER RESOURCES STATE OF CALIFORNIA

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE

FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

Tell me and I'll forget. Show me, and I may not remember. Involve me, and I'll understand.

- Native American Saying -

DJ Bandrowski P.E., Implementation Branch Chief
530-623-1811 / www.trrp.net