Yolo Bypass Salmonid Habitat Restoration & Fish Passage

Environmental Impact Statement
Environmental Impact Report

Status of Fish Behavior Modeling

State of California
Department of Water Resources

U.S. Department of the Interior
Bureau of Reclamation

Preliminary Draft for deliberative purposes only

Fish Behavior Modeling

- What information do we want?
- Evaluation of Approaches
- Collect Field Data (2015 and 2016)
- Develop 2D and 3D Hydraulic models (2015)
- Design Notches and Rating Curves (2015)
- Simulate Hydrodynamics (Animation)
- Model Fish Behaviors
- Document and interpret results
- Next Steps

Likely Results and Metrics

<u>Fish Behavior Modeling</u>

- Proportion entrained
- Proportion within vicinity of notch

<u>Potential</u>

- Position of critical streakline

Others?

FETT Considered Approaches in Winter 2013

- Is the tool compatible with the available hydraulic models that will potentially be used?
- Is the tool open source/proprietary?
- Does the tool and what it measures fit into other analyses with other agencies (i.e. common futures (ACOE))?
- Can the tool provide measure of uncertainty/statistical value of error?
- Is tool's output useful for AM and monitoring?
- Does the tool use relationships from empirical measurement on the Yolo Bypass?
- Can the tool provide behavioral information?

<u>Fish passage tool questions</u>

- Is the tool sensitive to different notch configurations for juvenile entrainment and passage?
- Can the fish passage evaluation tool measure transit time at passage structure?
- Can the tool tell you about the measurement of returning adults?
- Is the tool sensitive to the number and location of fish passage structure?

Field Studies (2015 and 2016)

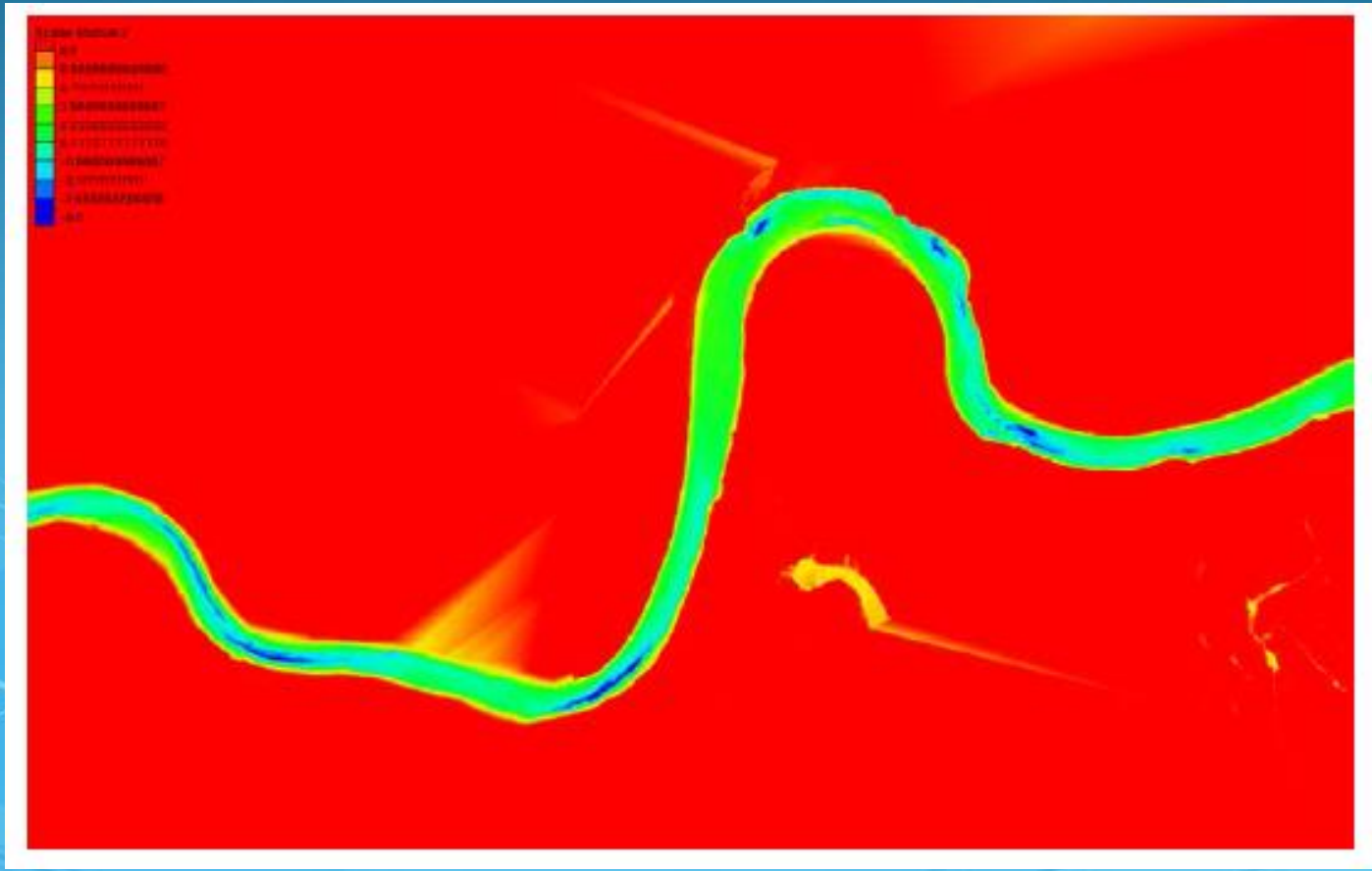
Study Element	Winter 2015	Winter 2016
2D fish movement	• 2 simultaneous releases of each stock • similar conditions	• 2 releases • different conditions
Hydrodynamic measurements	Collected for model calibration and validation	Collected for model calibration and validation
Yolo Bypass Survival	None	1 paired release
Fish stocks used	Juvenile Winter-run and Late-fall run Chinook	Late-fall run Chinook

2D and 3D Flow Modeling along Fremont Weir Section of the Sacramento River in Support of Fish Tracking (Lai 2015)

- Data preparation and processing for numerical modeling
- Numerical model development (2D and 3D)
- Model calibration
- Model validation and application

Lai (2015) Terrain

- 2015 DWR Bathymetry + 2008 DWR Lidar



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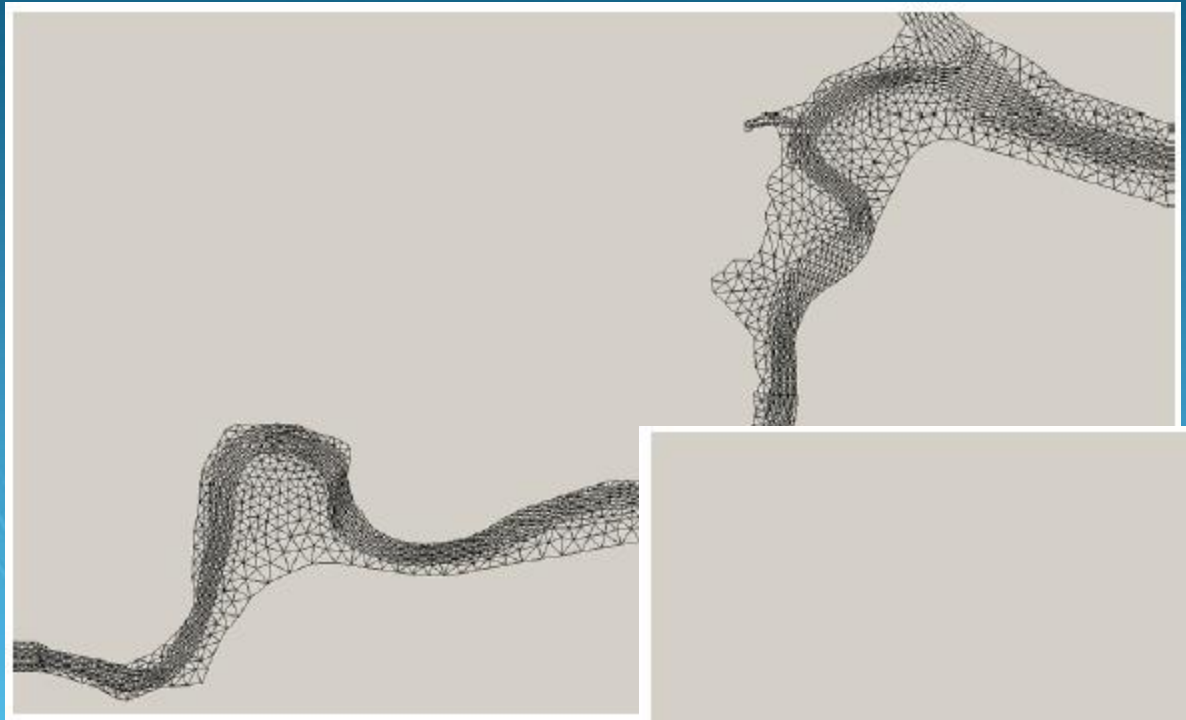
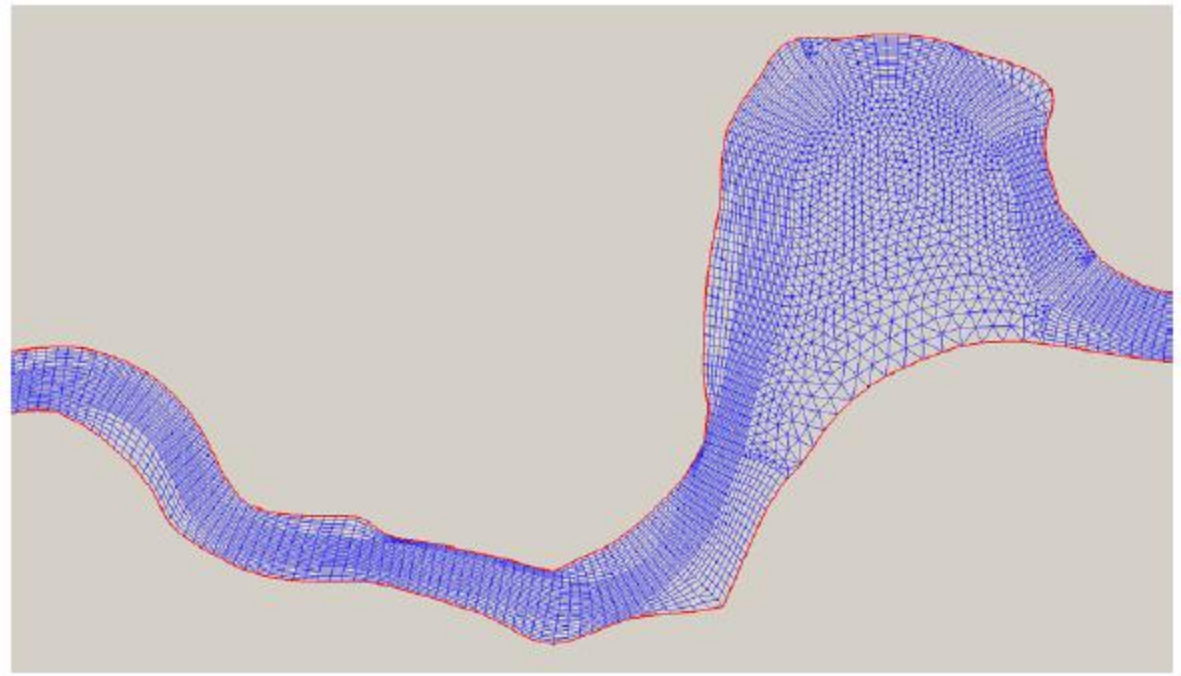
Lai (2015) SHR-2D and U^{2}RANS

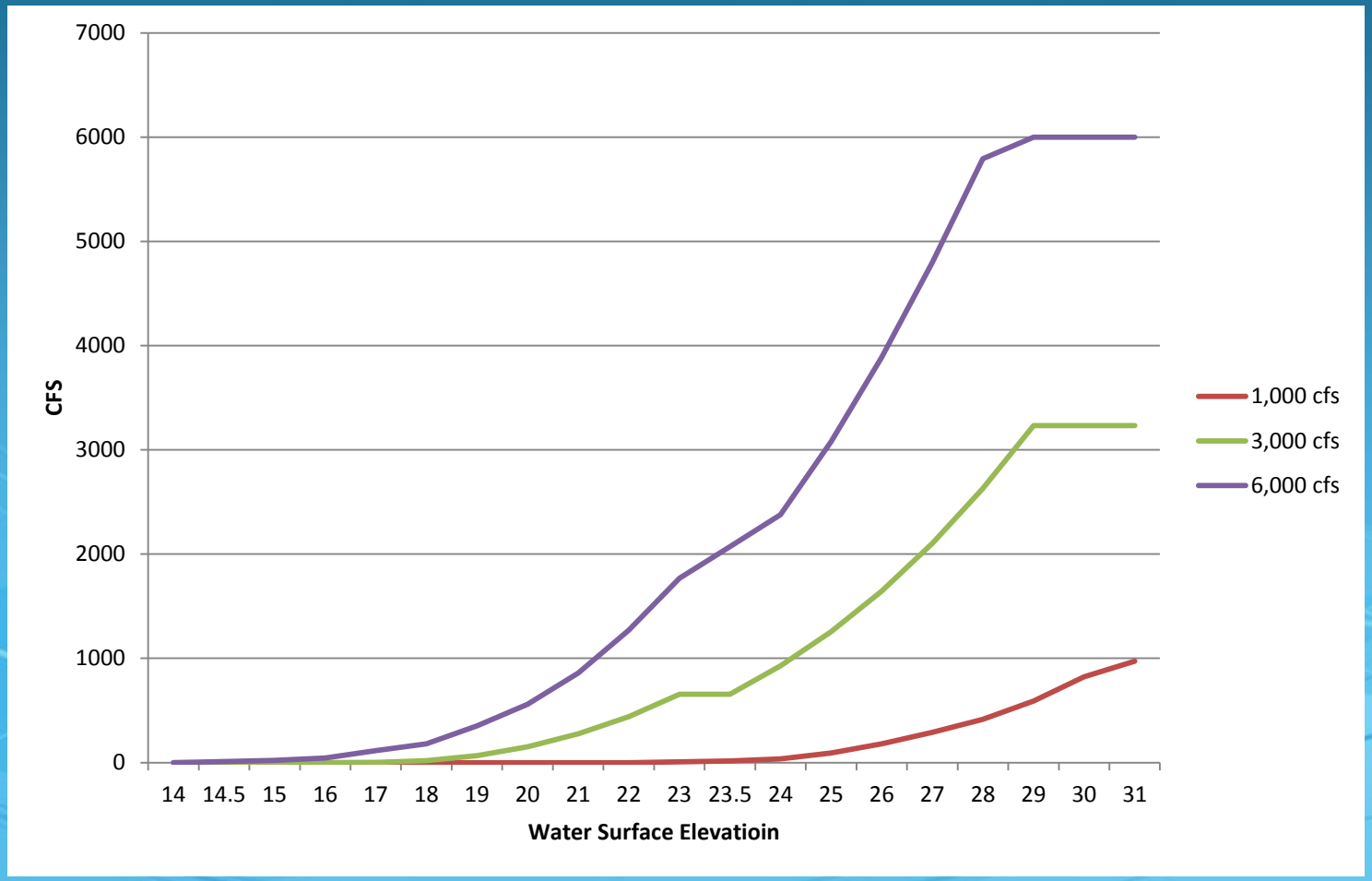




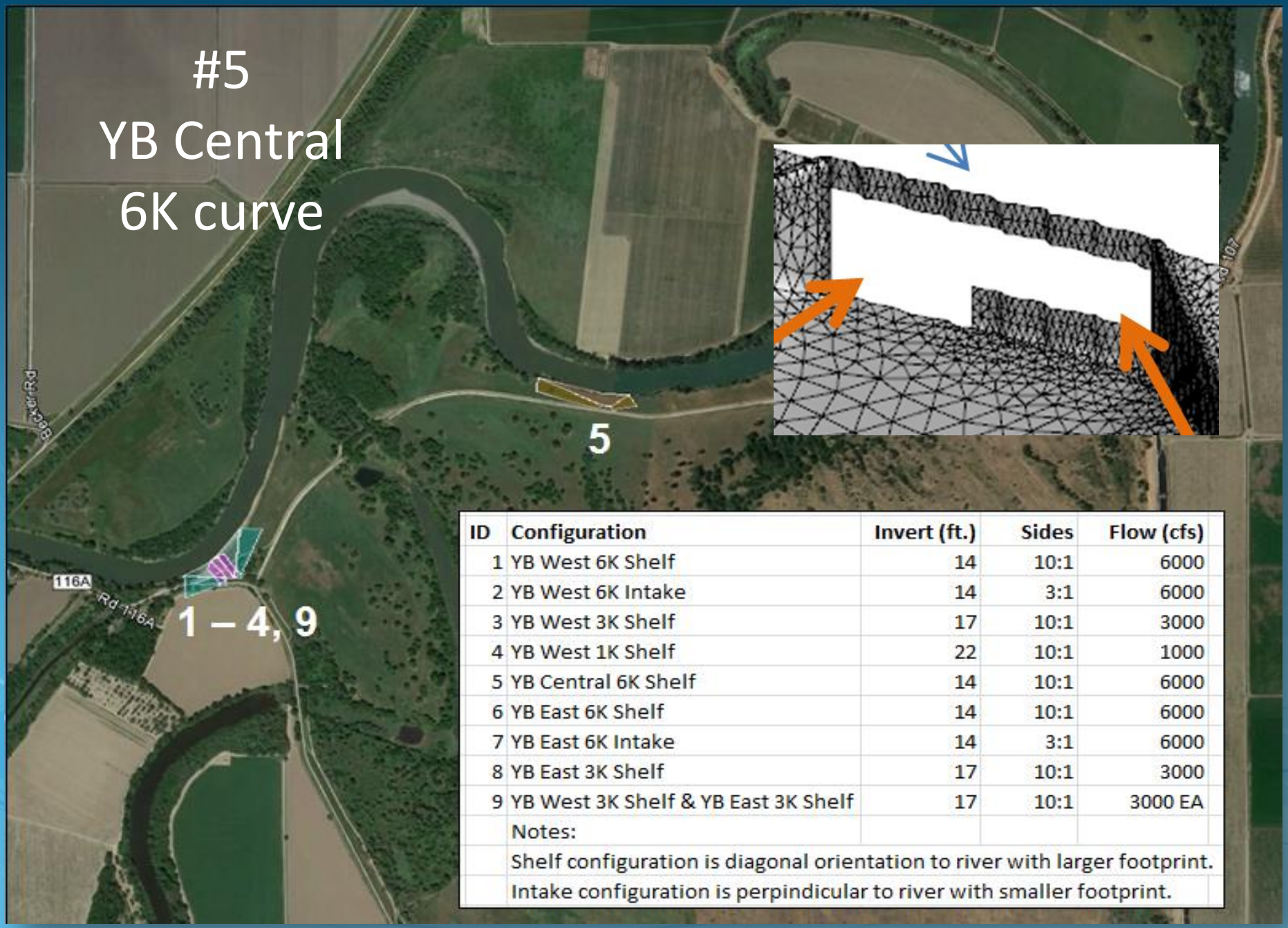
Notch Configurations were considered in FETT

- Objective: Determine sensitivity of modeling approach to variability in notches
  - Configuration
  - Location (West, Central, East)
  - Invert Depth of notch (14, 17, 22 ft.)
  - Flow (1K, 3K, 6K)

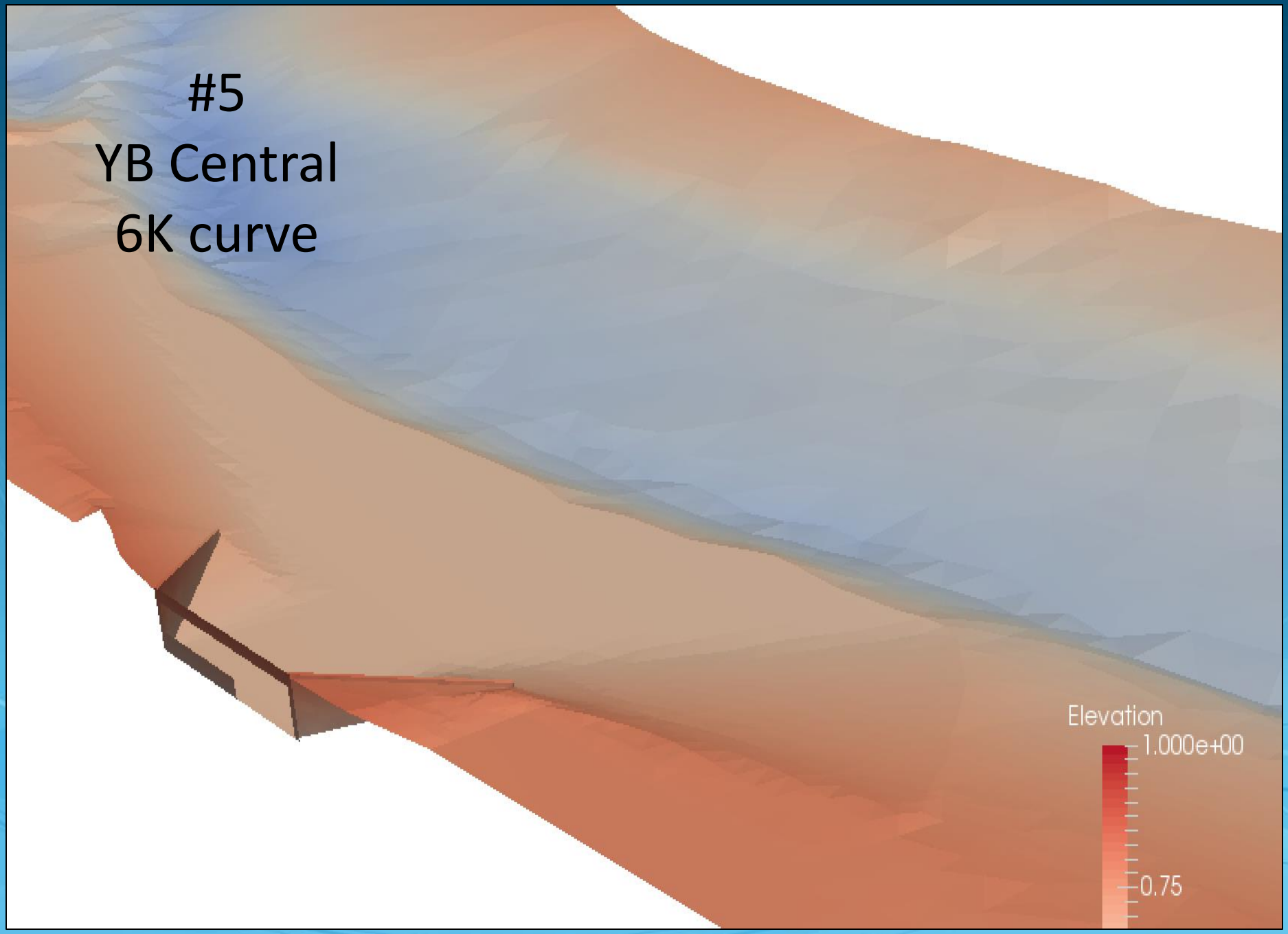
Rating Curves Were Developed by DWR DES



#5
YB Central
6K curve



ID	Configuration	Invert (ft.)	Sides	Flow (cfs)
1	YB West 6K Shelf	14	10:1	6000
2	YB West 6K Intake	14	3:1	6000
3	YB West 3K Shelf	17	10:1	3000
4	YB West 1K Shelf	22	10:1	1000
5	YB Central 6K Shelf	14	10:1	6000
6	YB East 6K Shelf	14	10:1	6000
7	YB East 6K Intake	14	3:1	6000
8	YB East 3K Shelf	17	10:1	3000
9	YB West 3K Shelf & YB East 3K Shelf	17	10:1	3000 EA
	Notes:			
	Shelf configuration is diagonal orientation to river with larger footprint.			
	Intake configuration is perpindicular to river with smaller footprint.			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YB Central
6K curve
Elevation
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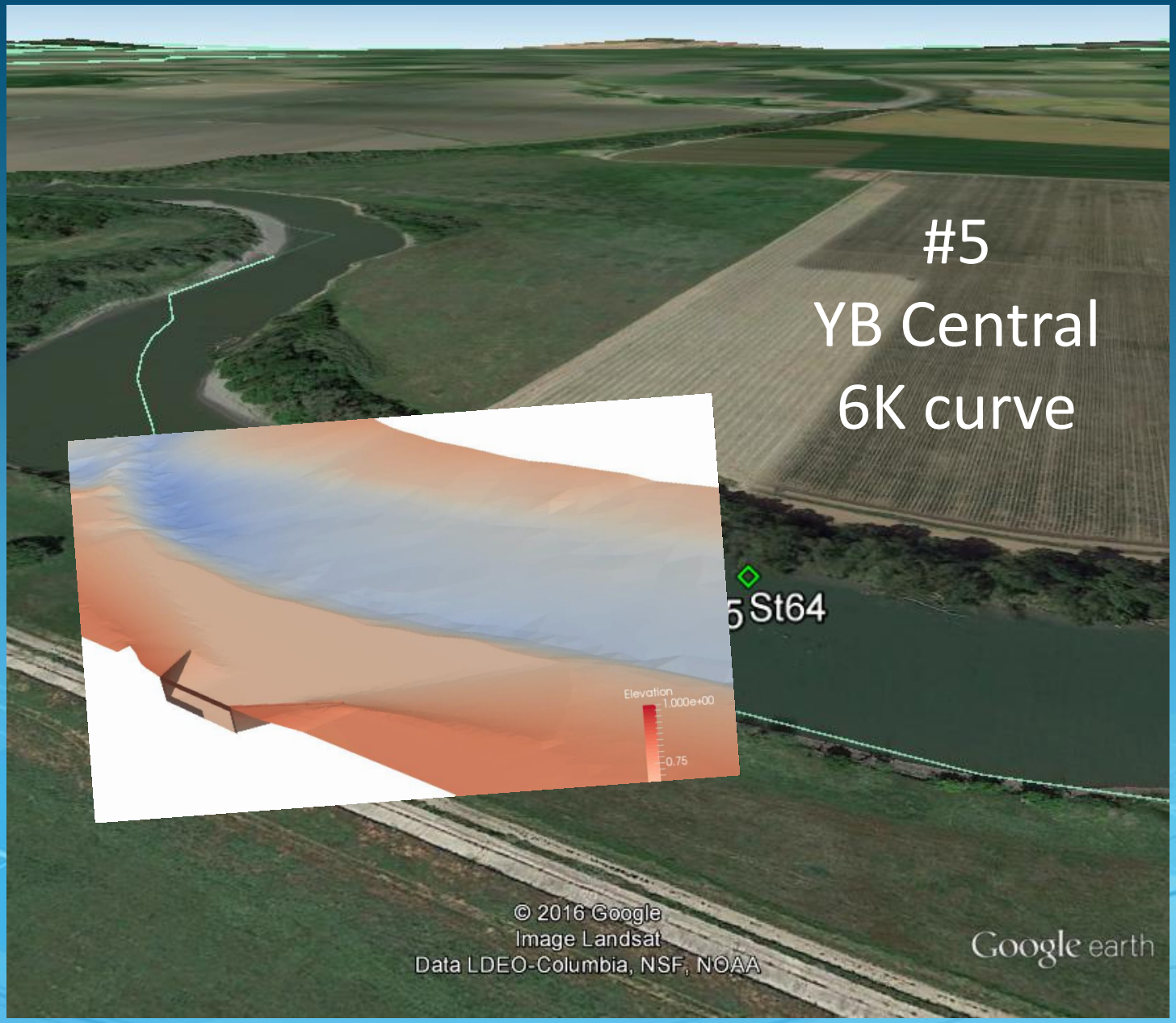
#5
YB Central
6K curve
St64
Elevation
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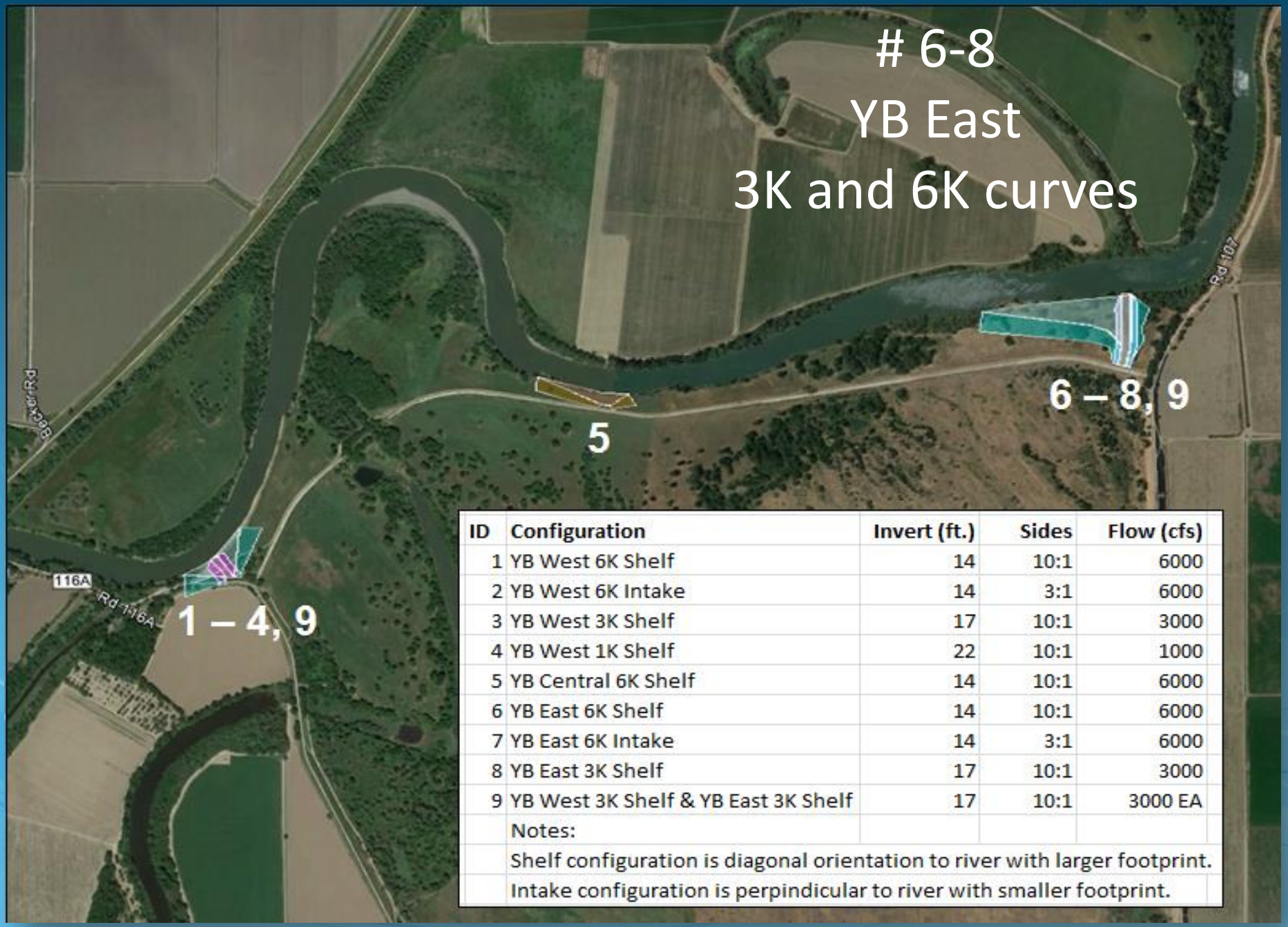
Image Landsat
Data LDEO-Columbia, NSF, NOAA
Google earth

6-8
YB East
3K and 6K curves



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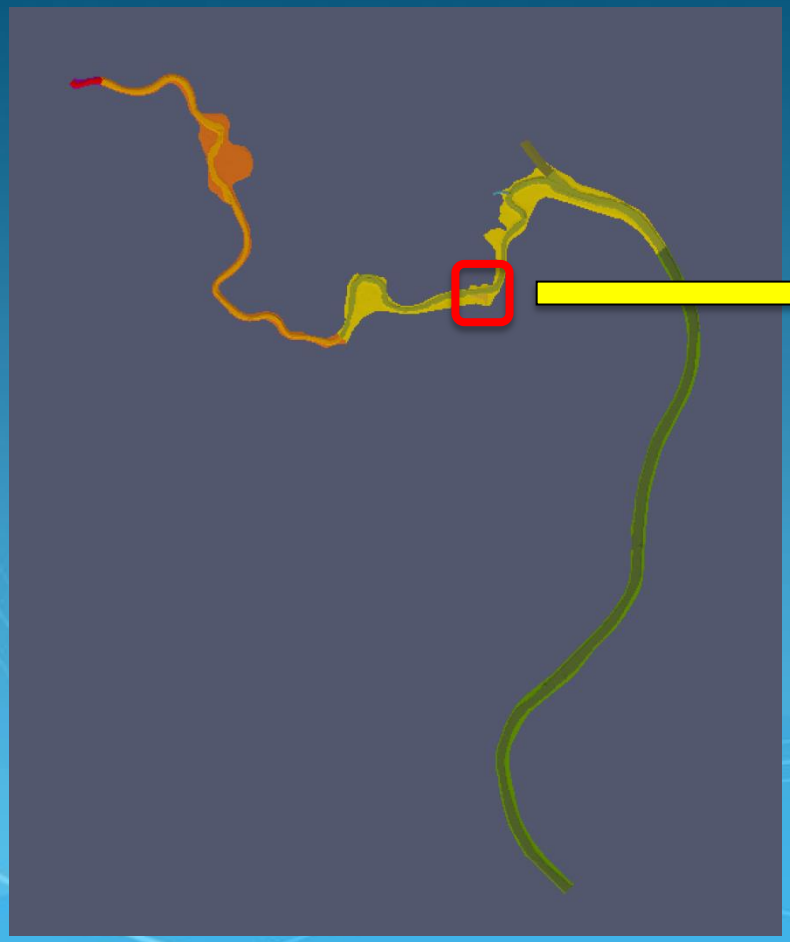
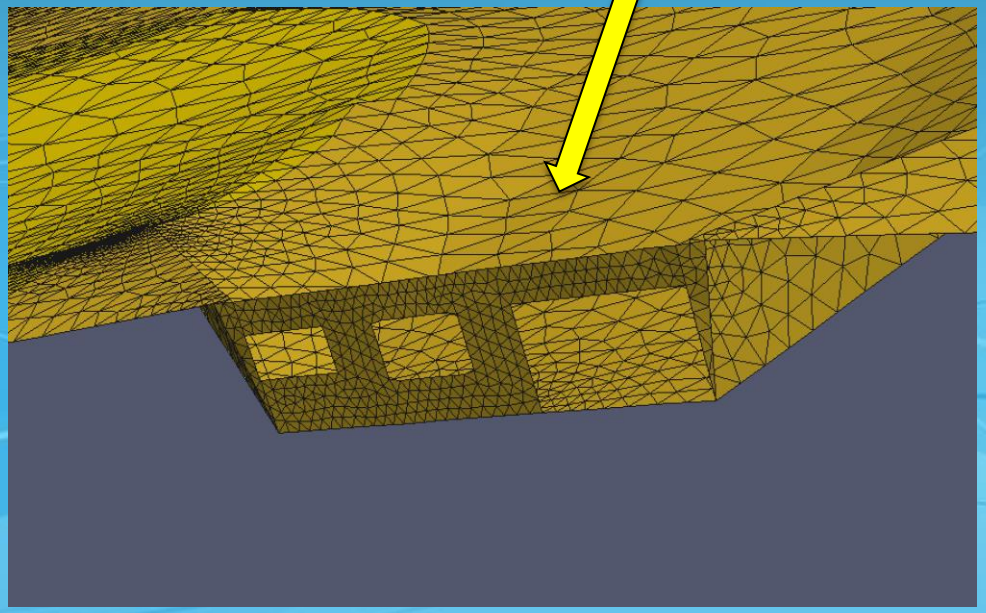
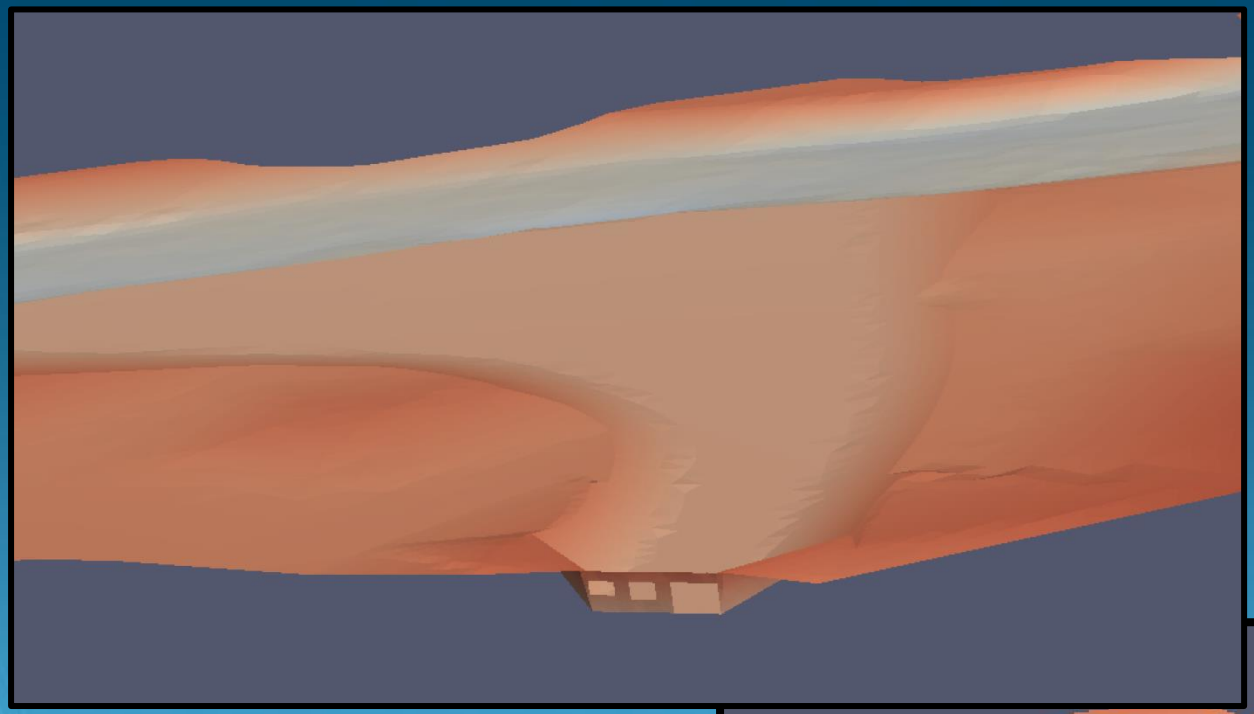
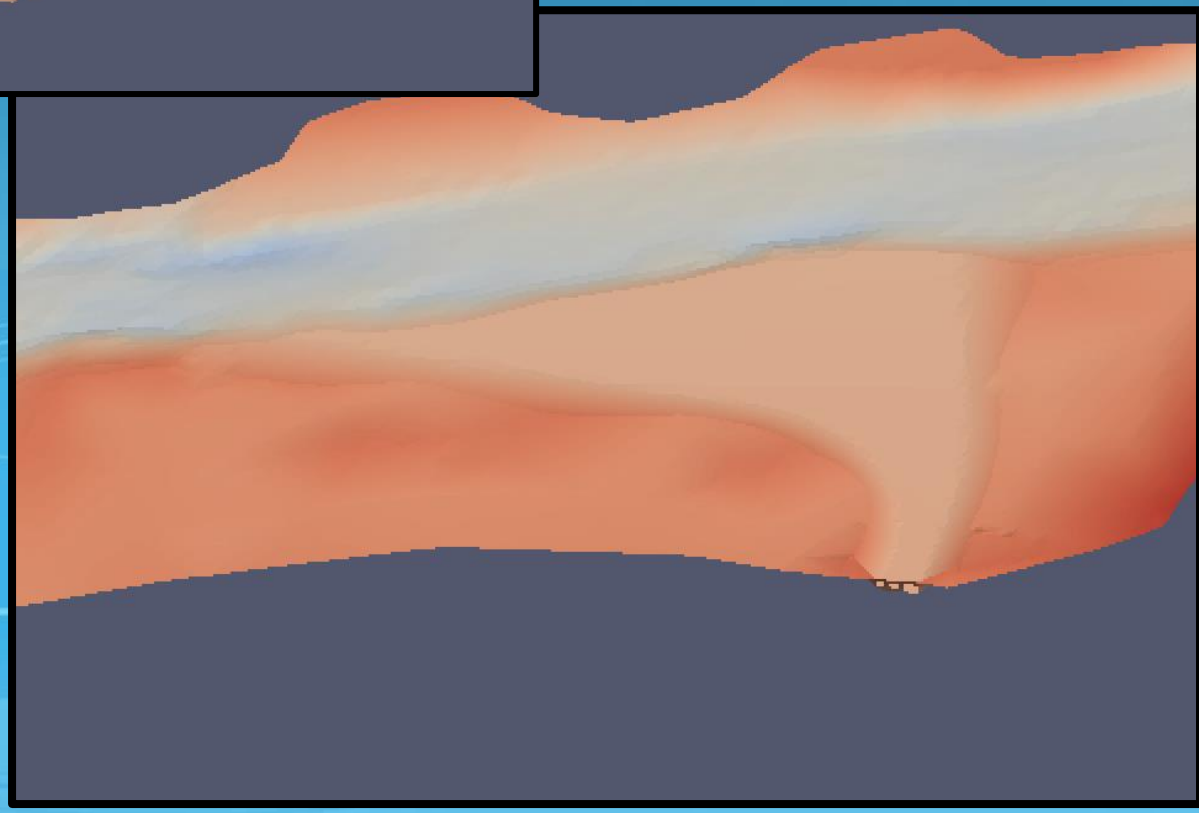


#8
YB East
3K



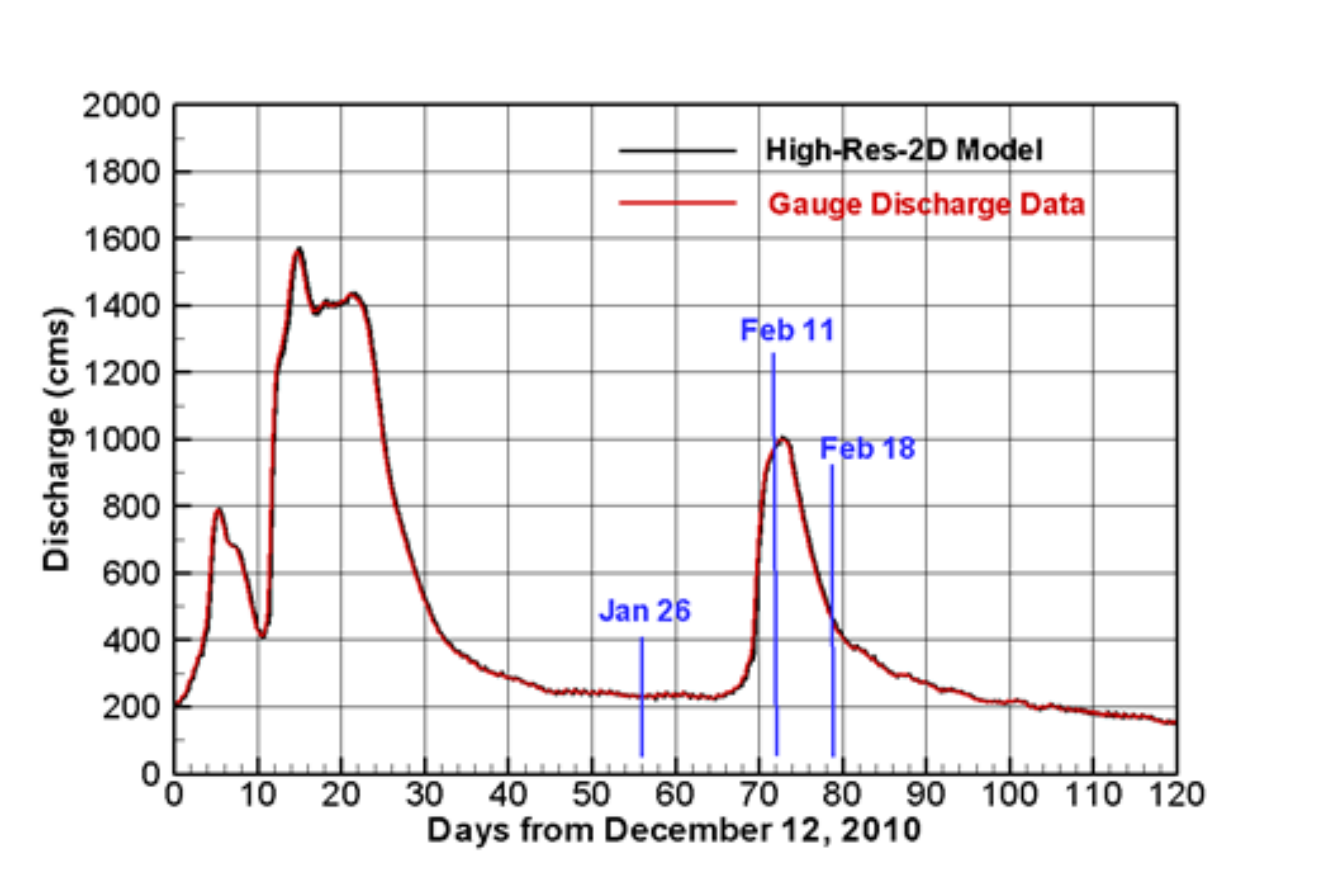




#8
YB East
3K

Animation

- 6 Hour Intervals
- December 1, 2014 through March 30 2015



River Animation

- 6 Hour Intervals
- December 1, 2014 through March 30 2015
- 2:25 in length

Animation_Velocity#1.avi

Notch Animation

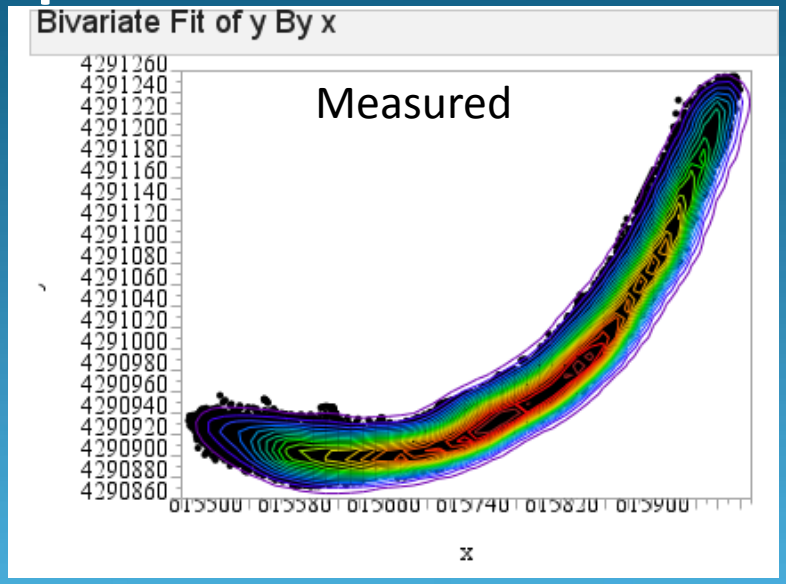
- 6 Hour Intervals
- December 1, 2014 through March 30 2015
- 2:25 in length
- Rapid flow, short exposure time and few streamlines being entrained likely will show low entrainment rates

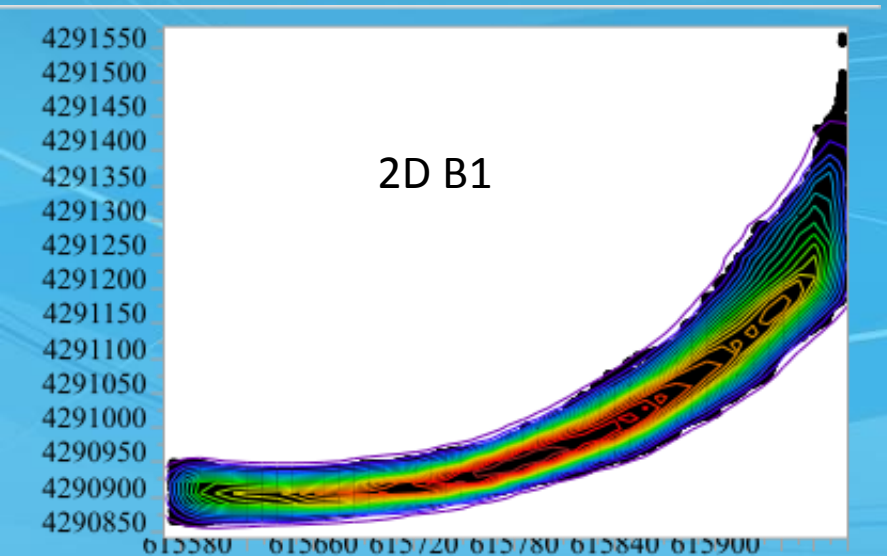
Alt_5.avi

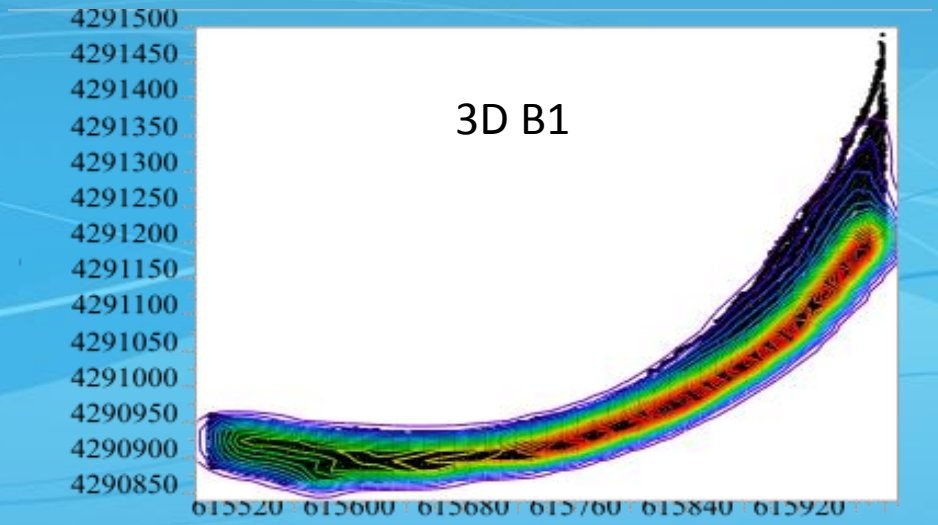
Agent Based Modeling of Fish Behavior

- Simulate fish movement adjustments to flow fields
- Model based on 14 years of investigation with 47 flow conditions
- Four behaviors (Goodwin et al 2014)
- Validation to WRCS and LFCS 2015 results
- Validation to LFCS 2016 results

Observations & simulated movement patterns and rates







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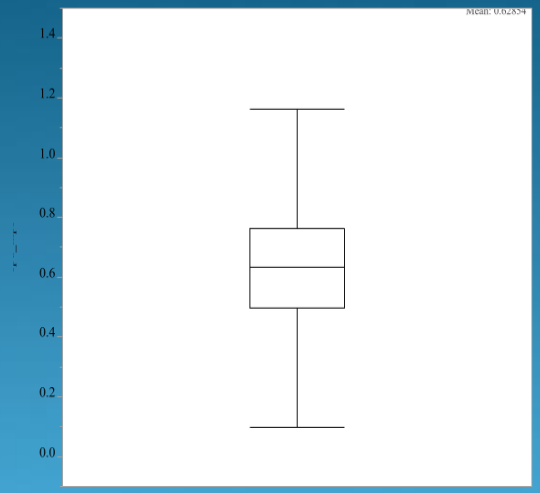

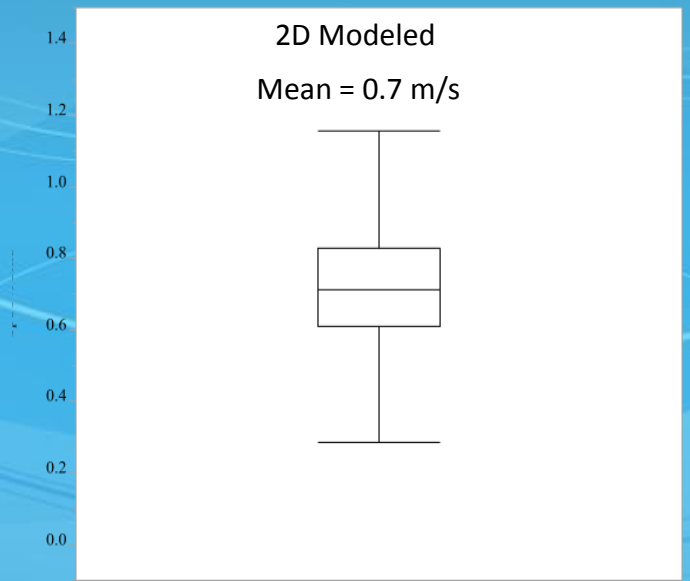

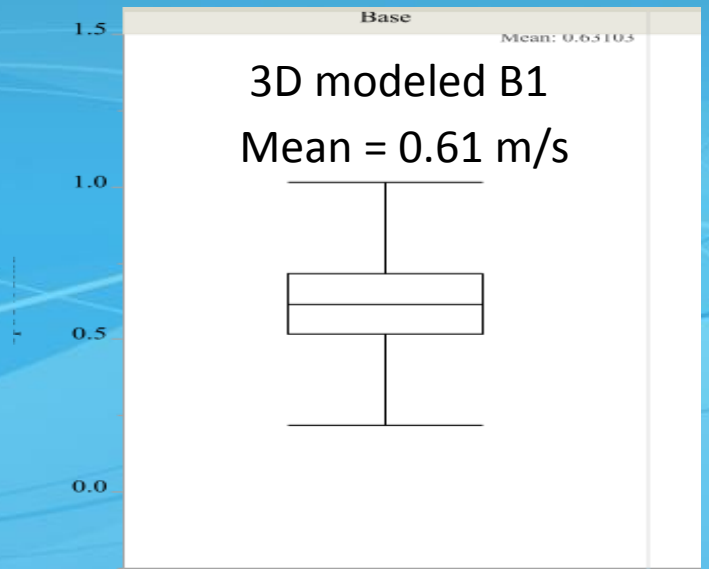

Next Steps

ACOE completing preliminary evaluation of entrainment proportion

- Complete remaining 2D model runs for alternatives
- Refine calibration in 2D and 3D based on validation add behaviors
- Validate at RM 85.6
- Provide entrainment estimates for all alternatives
- Rerun with smaller fish – exploratory
- Rerun with different behaviors (habitat seeking with small fish for example)

Next Steps

- USGS presented streakline analysis approach to FETT in April
- USGS detailing evaluations questions on streakline analysis approach for interagency consideration