The image shows a large concrete dam with multiple spillways. Water is cascading over the spillways, creating a misty spray. The dam structure is composed of several large concrete piers. The water is a deep blue-green color. The sky is overcast and grey.

# Characterization of Hydraulic Conditions at McNary Dam Spillbays and Temporary Spillway Weirs (TSWs) in 2007 Using Sensor Fish Devices

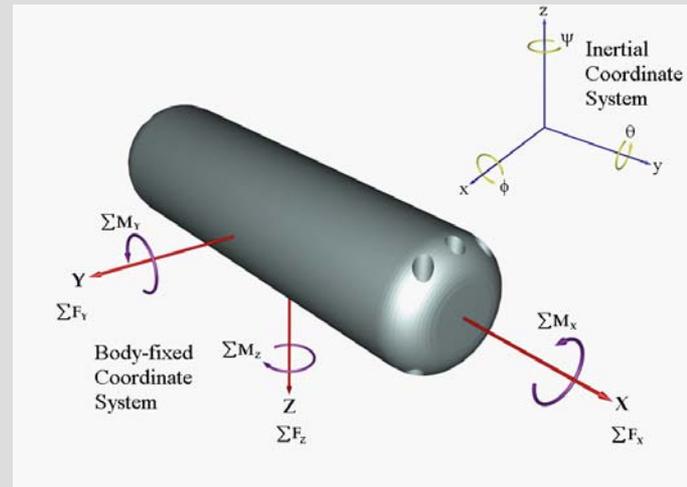
J.P. Duncan and T.J. Carlson

# Primary Objectives

Use the Sensor Fish to:

- Evaluate and compare hydraulic conditions at conventional spillways and spillways outfitted with 2 prototype temporary spillway weirs (TSWs).
- Differentiate passage conditions between “deep” and “shallow” elevation release pathways.
- Identify regions within the passage route that may increase the risk of injury or mortality to fish.

# Sensor Fish Device



- 24.5 mm (0.96 in.) in diameter and 90.3 mm (3.6 in.) in length, weighs 43.4 grams
- Density: 1.006 – 1.02 mg/mm<sup>3</sup>; volume 42,570.6 mm<sup>3</sup>, excess mass 0.8g
- Three linear accelerometers ( $\pm 100g$ )
- Three rate gyros ( $\pm 1080$  degrees/second)
- Pressure sensor
- Temperature sensor
- 2000 Hz Sampling Frequency
- Up to 233 seconds Recording time

# Methods

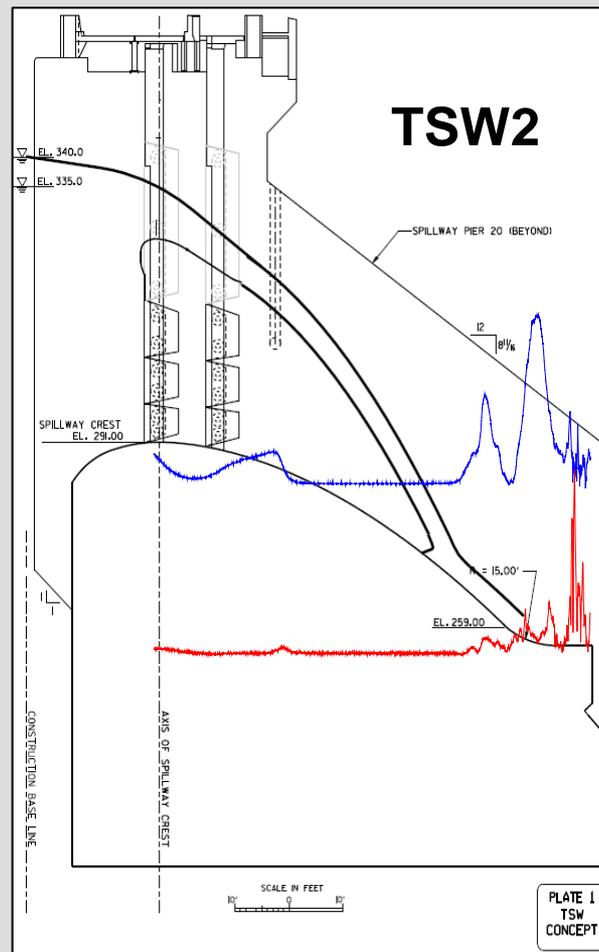
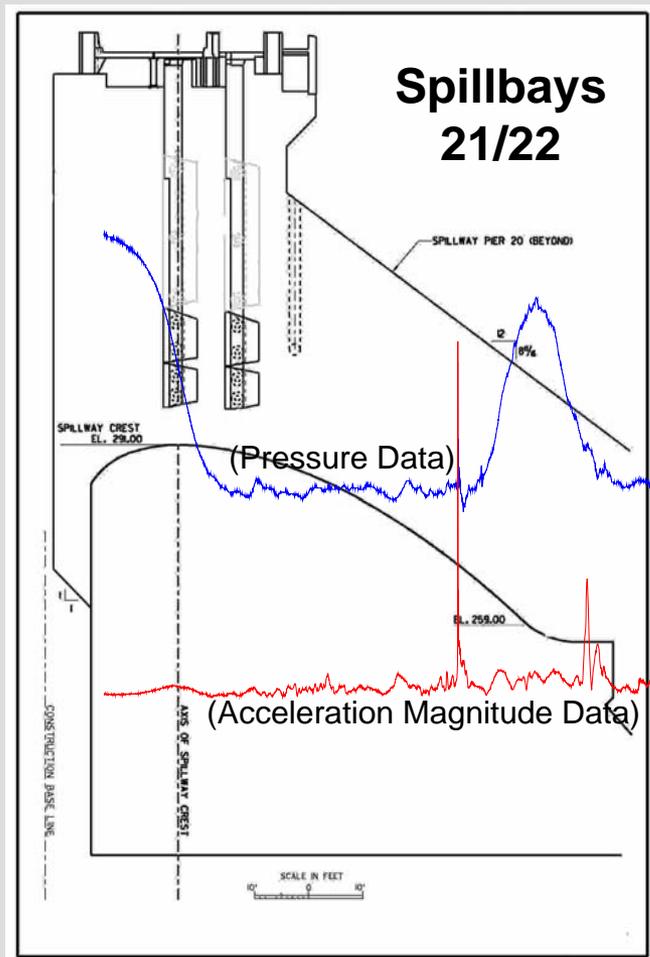
- Sensor Fish Devices were deployed in conjunction with live fish survival studies
- Same methods are used as for live fish for release and recovery:
  - Balloon tags
  - Radio tags
  - Injection pipe release
  - Boat recovery



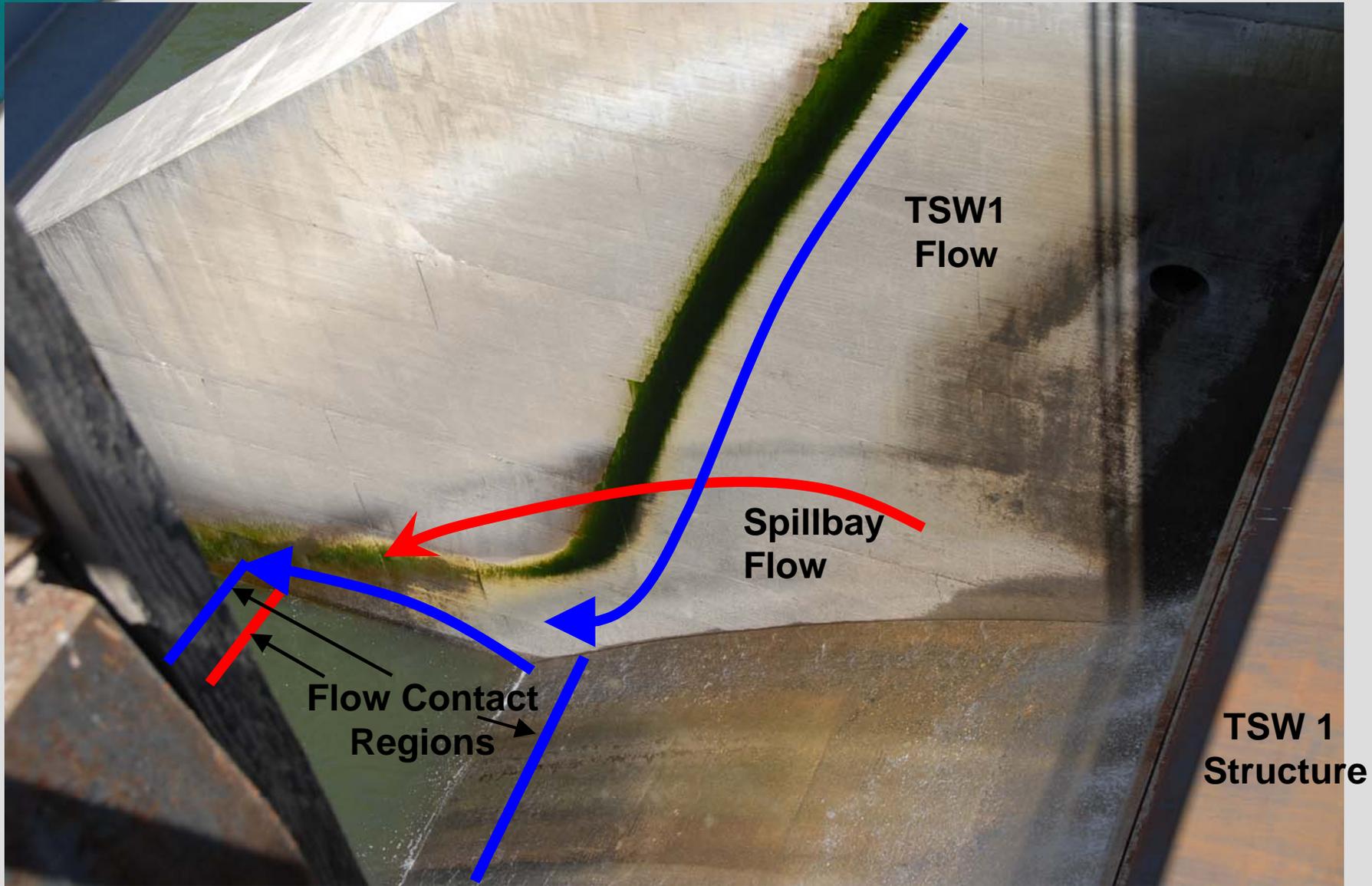


# Preliminary Results

# Sensor Fish Passage – Conventional Spillway and TSW Pressure Signature as Indicator of Passage Location

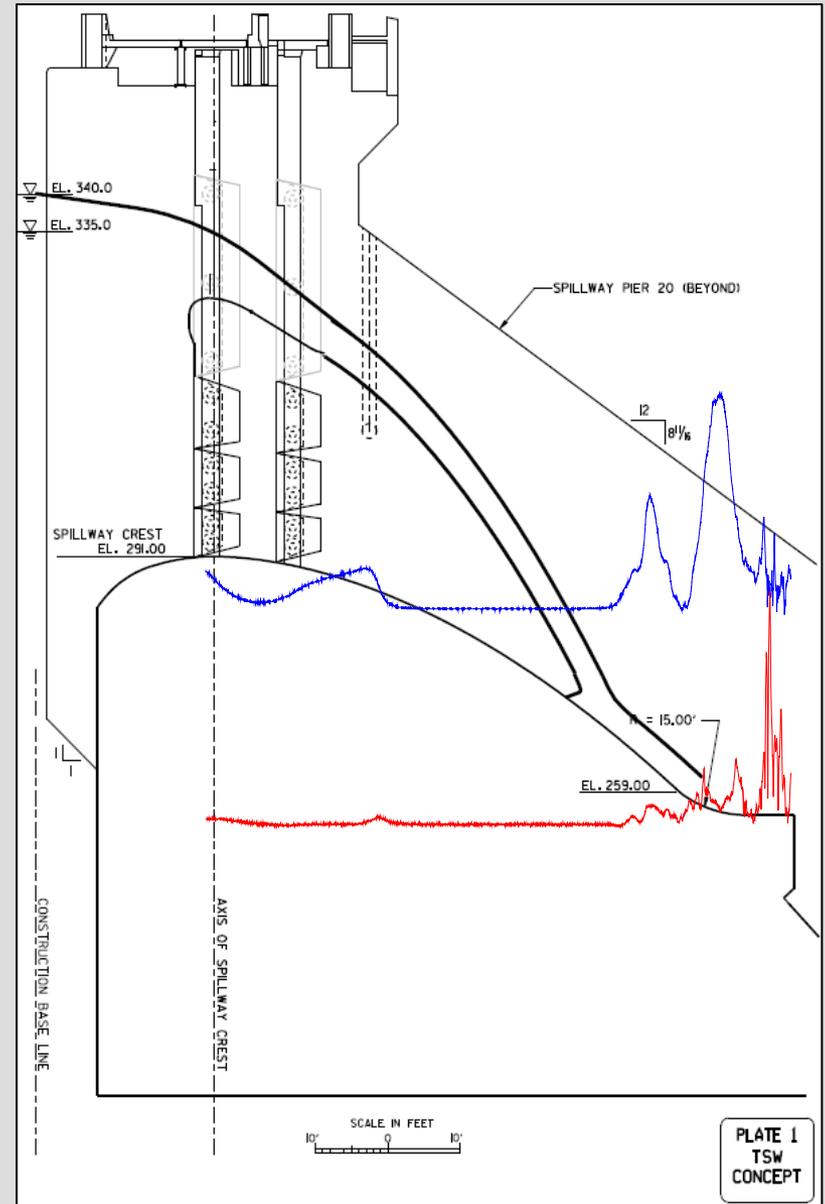
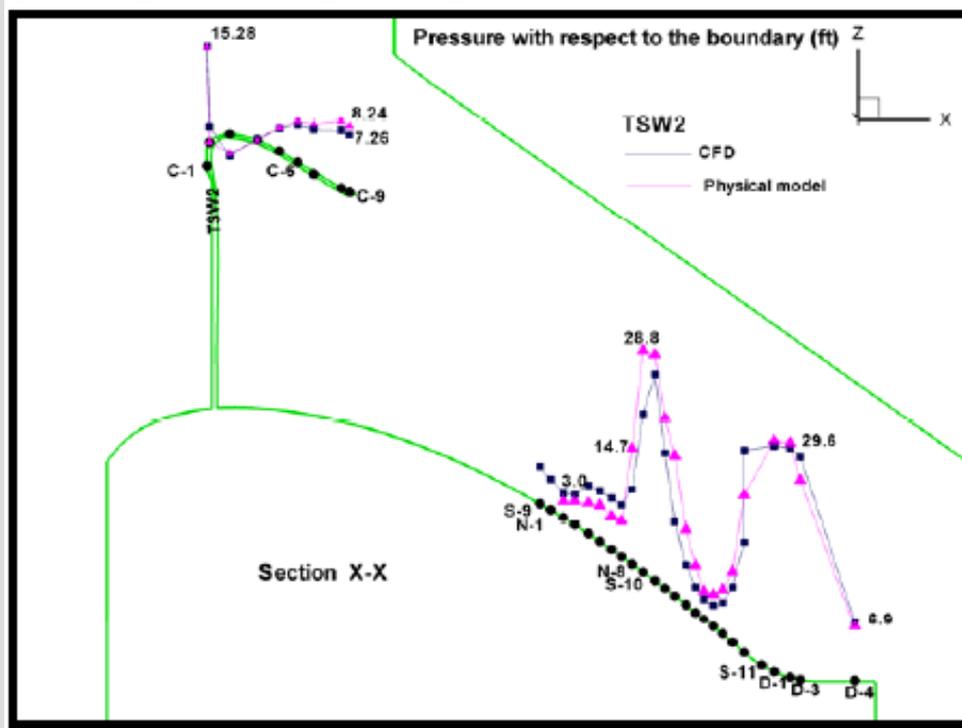


# TSW1 Crest Assembly Prototype Flow Contours

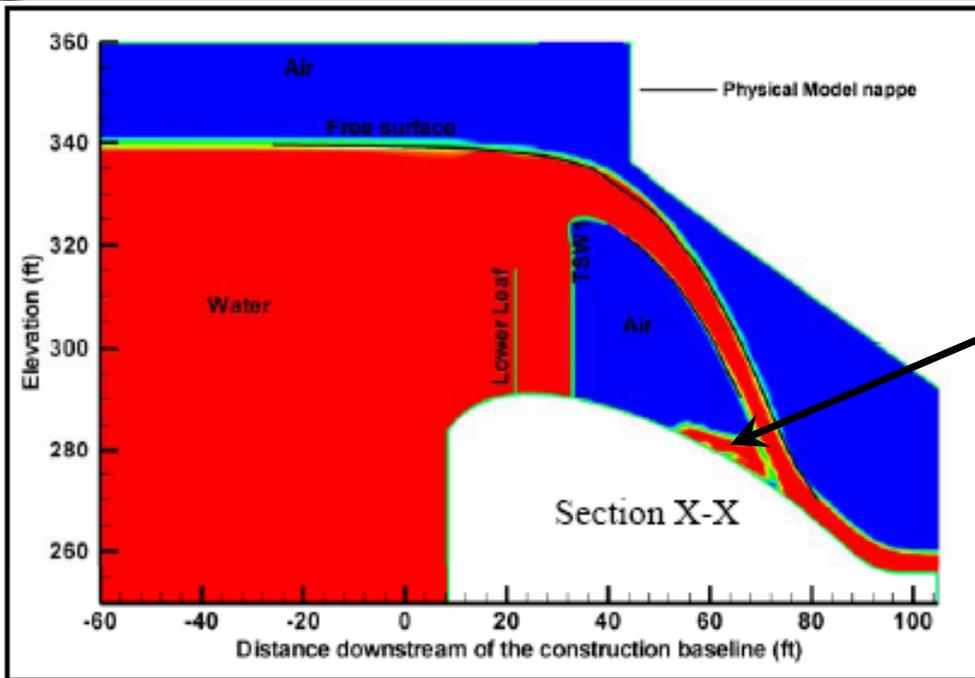


# TSW2 CFD, Physical Model, and Sensor Fish Data

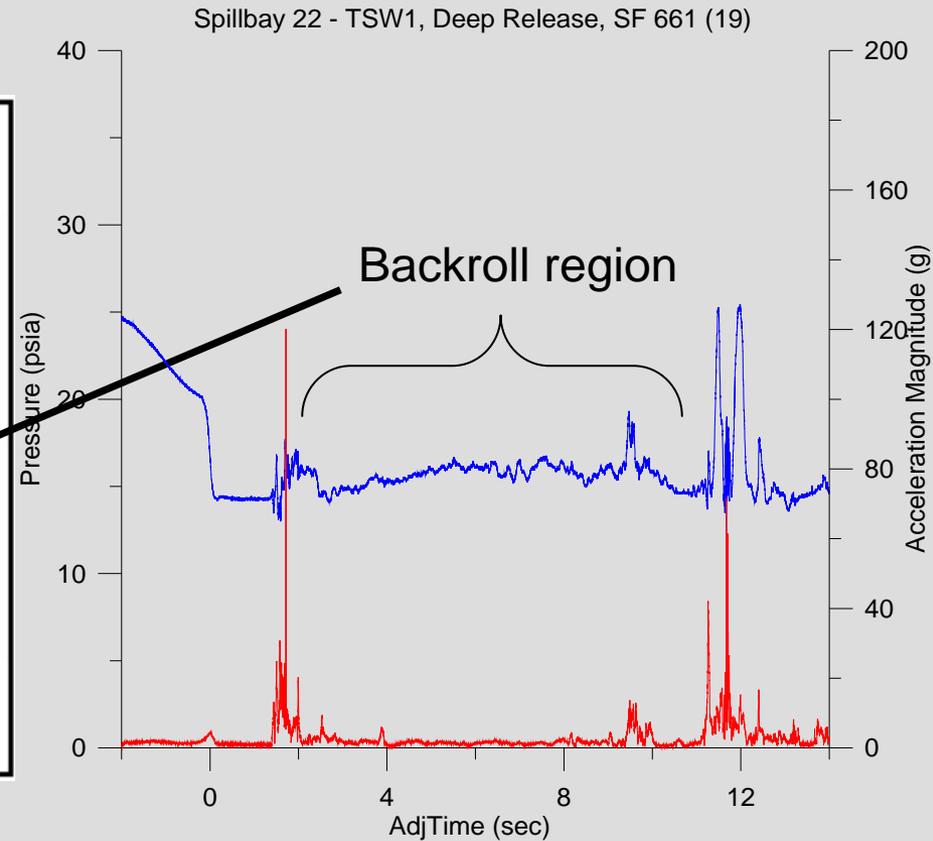
(Courtesy of University of Iowa):



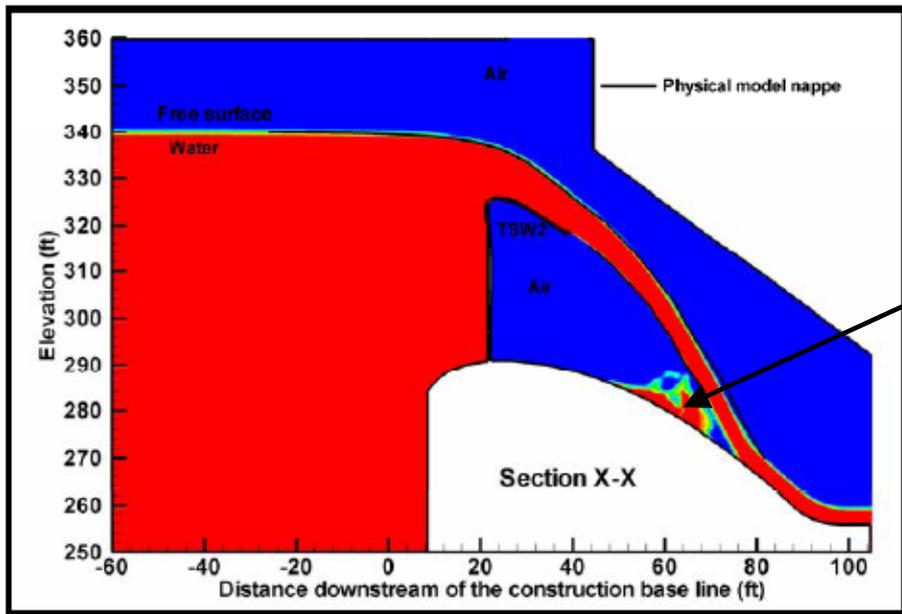
# Sensor Fish Entrained in TSW1 Backroll on Chute (13.3% Occurrence - 4/30 for Deep Releases)



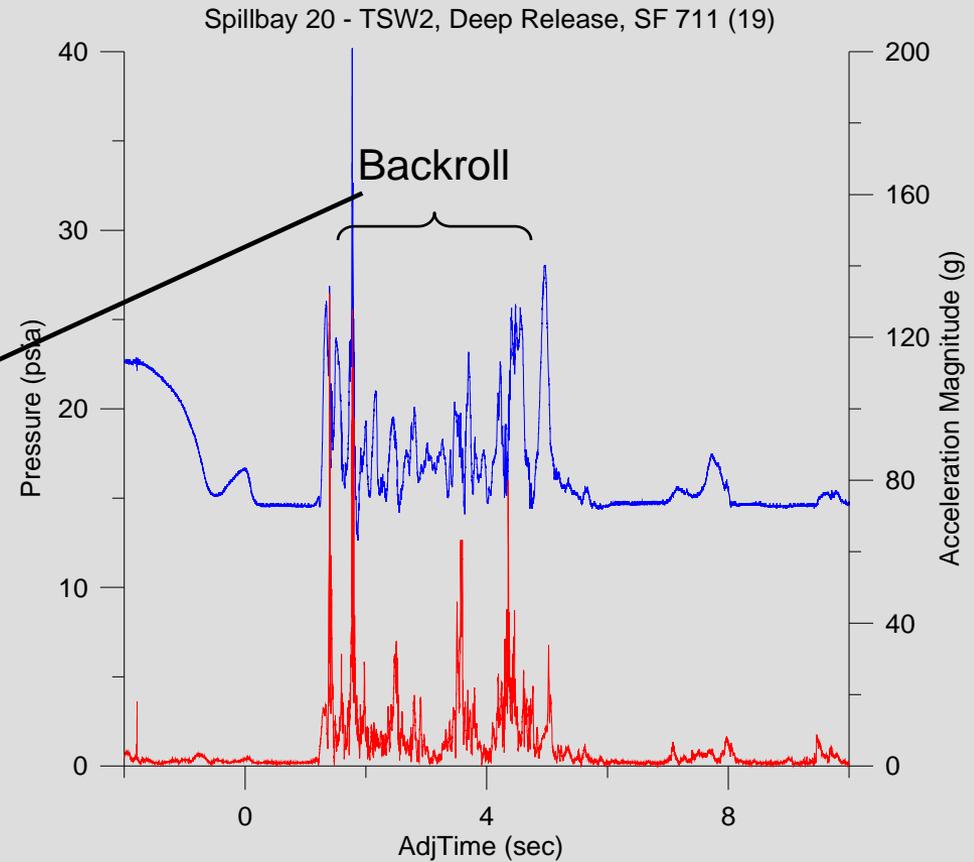
(Courtesy of University of Iowa)



# Sensor Fish Entrained in TSW2 Backroll (13.3% Occurrence - 4/30 for Deep Releases)

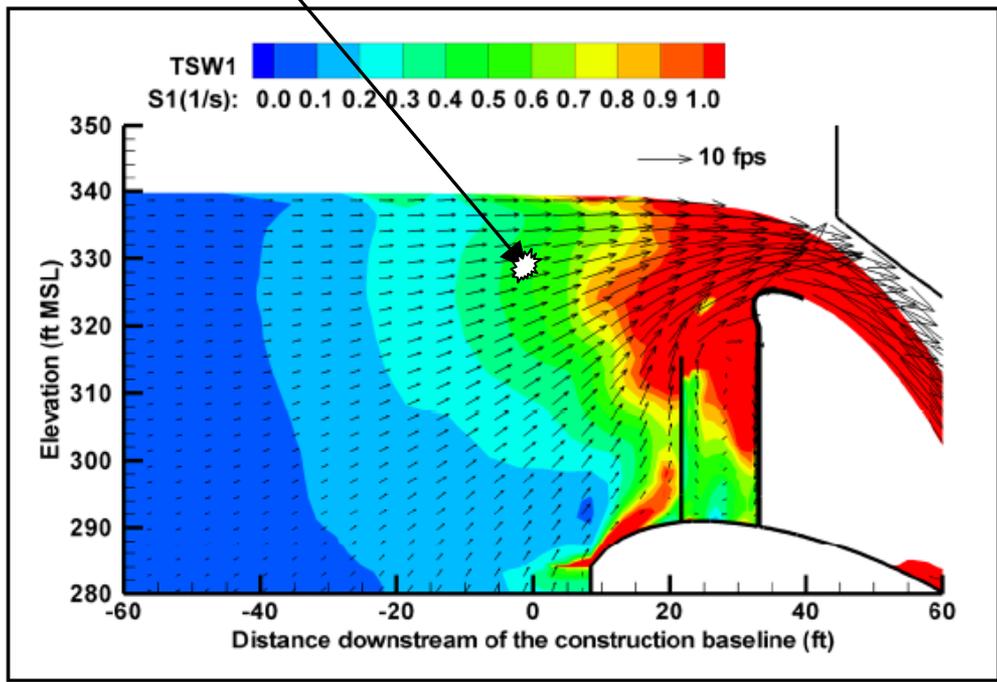


(Courtesy of University of Iowa)



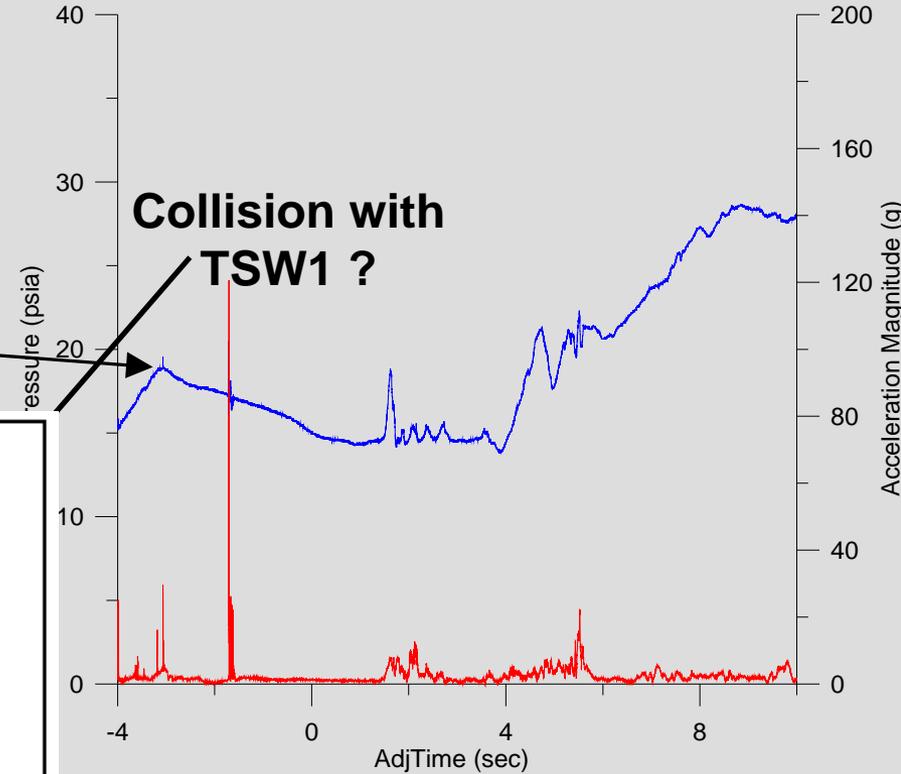
# TSW1 Shallow Release Sensor Fish Event Occurrence After Injection

Injection Elevation ~328'



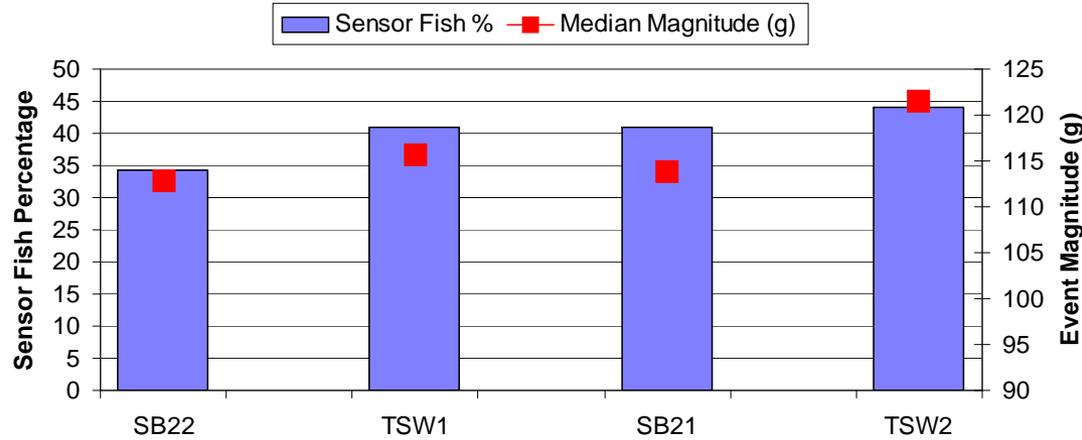
(Courtesy of University of Iowa)

Spillbay 22 - TSW1, Shallow Release, SF 724 (18)



# Acceleration Magnitude Events >95g – Percentage of Sensor Fish Releases having at Least 1 Event and Median Magnitudes By Route

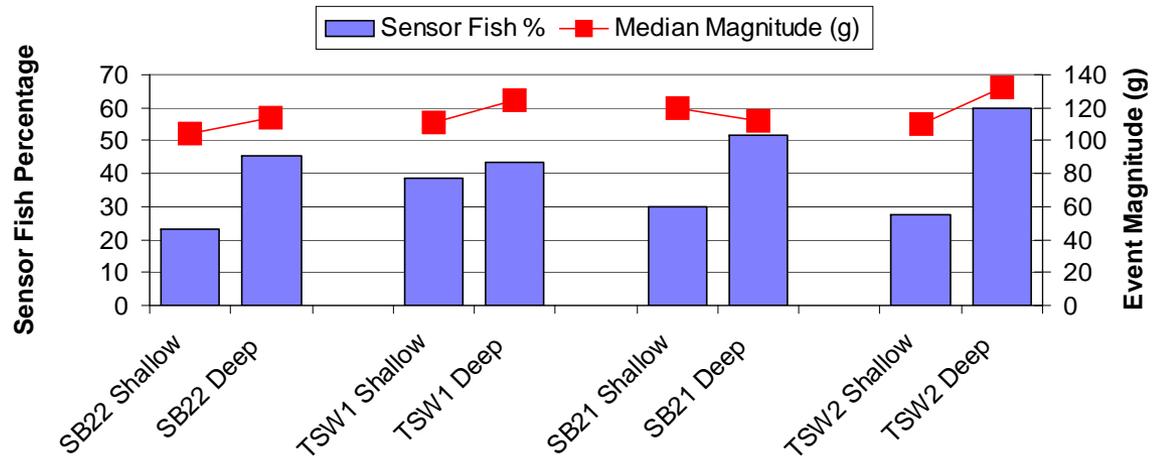
Percentage of Sensor Fish Experiencing a Significant Event and Median Event Magnitude



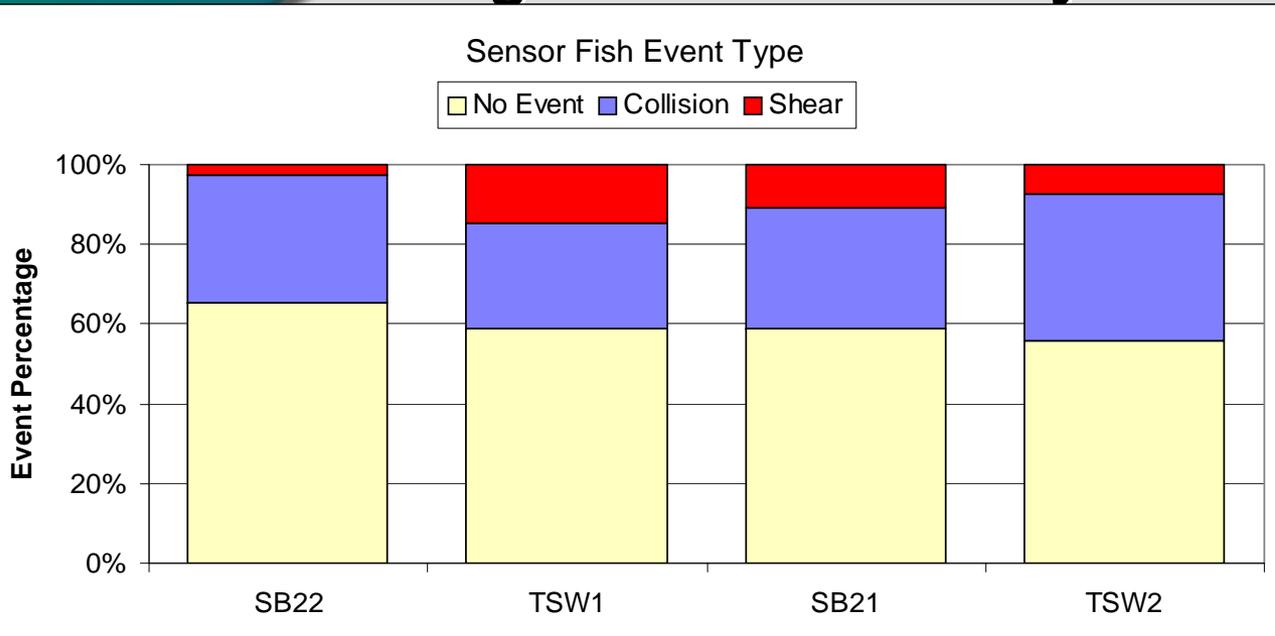
Configuration	Shallow Release Elevation (ft)	Deep Release Elevation (ft)
TSW1	329	314
TSW2	332	319
SB21	307	295
SB22	307	295

## By Route and Depth

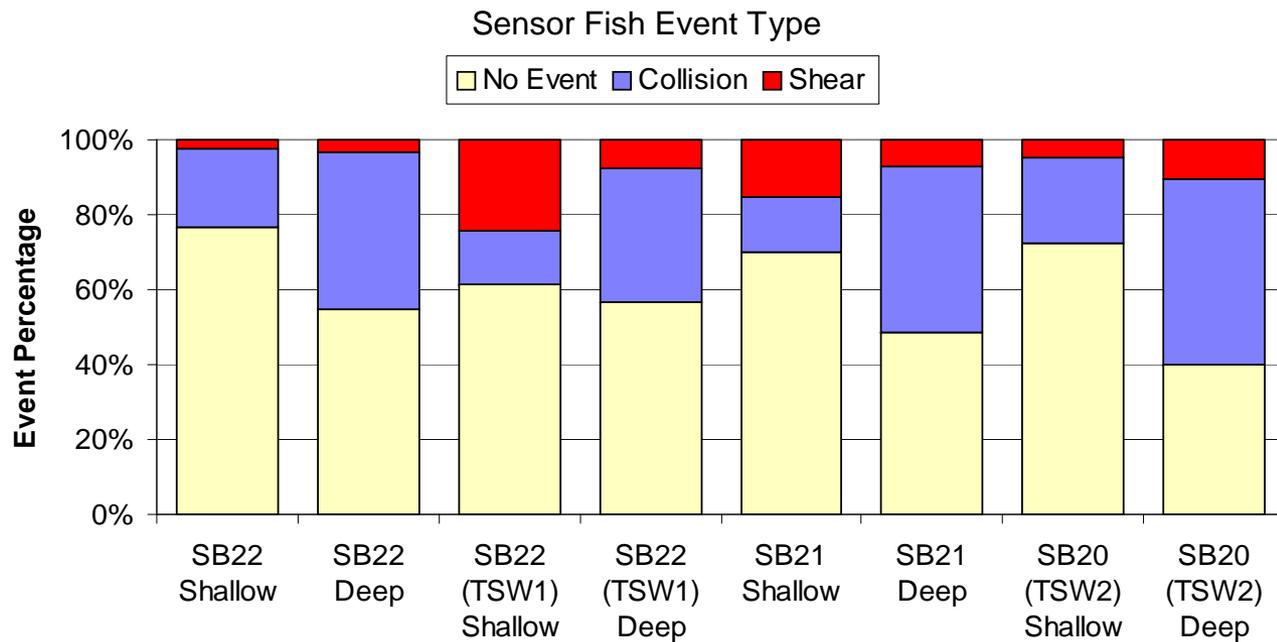
Percentage of Sensor Fish Experiencing a Significant Event and Median Event Magnitude



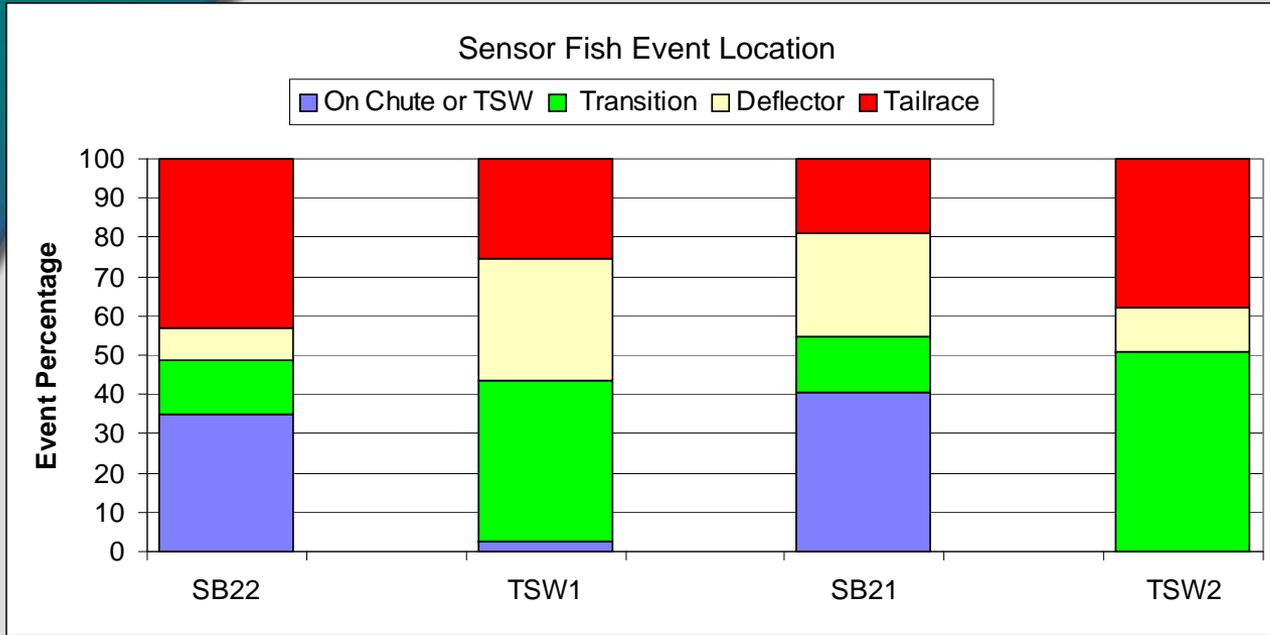
# Significant Events By Route of Passage



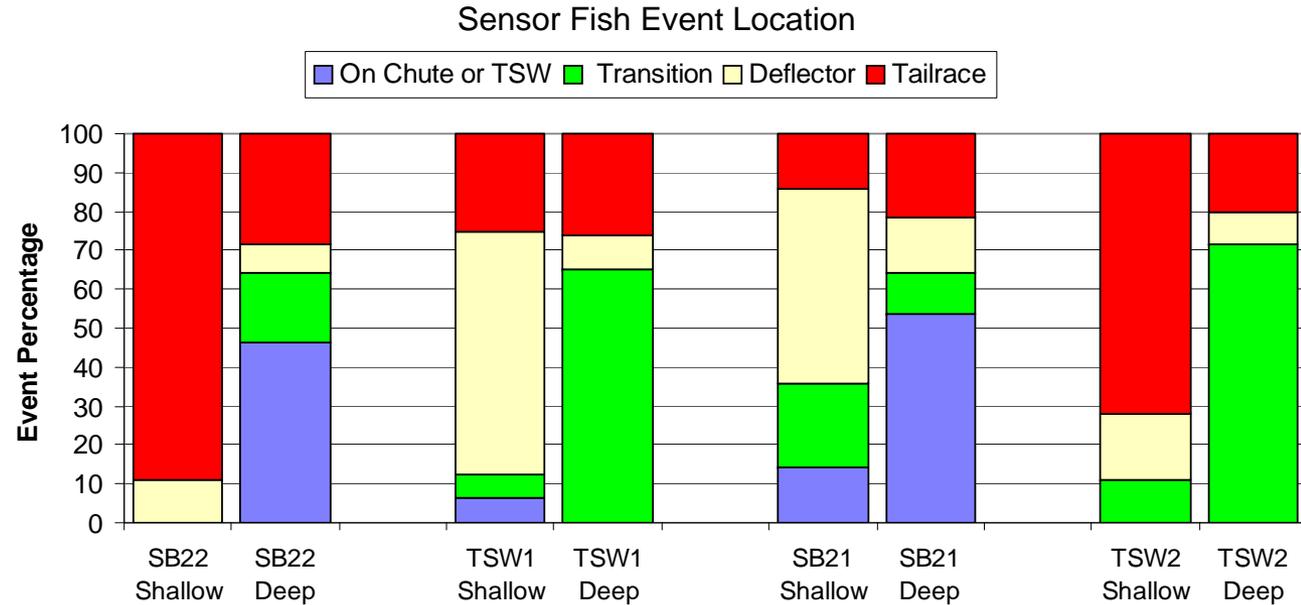
## Events by Route and Depth



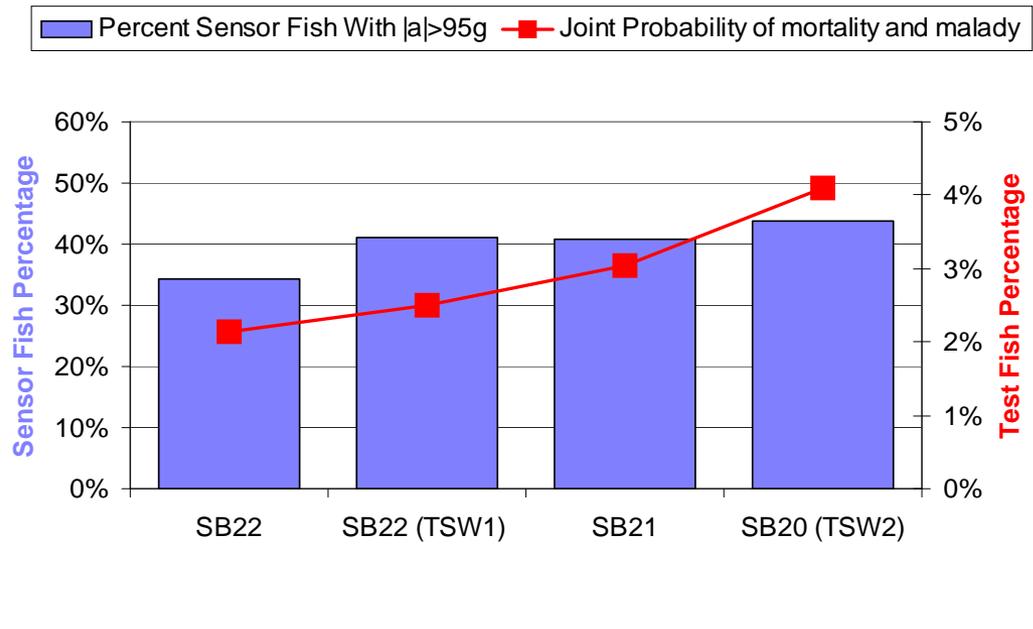
# Significant Event Location by Route



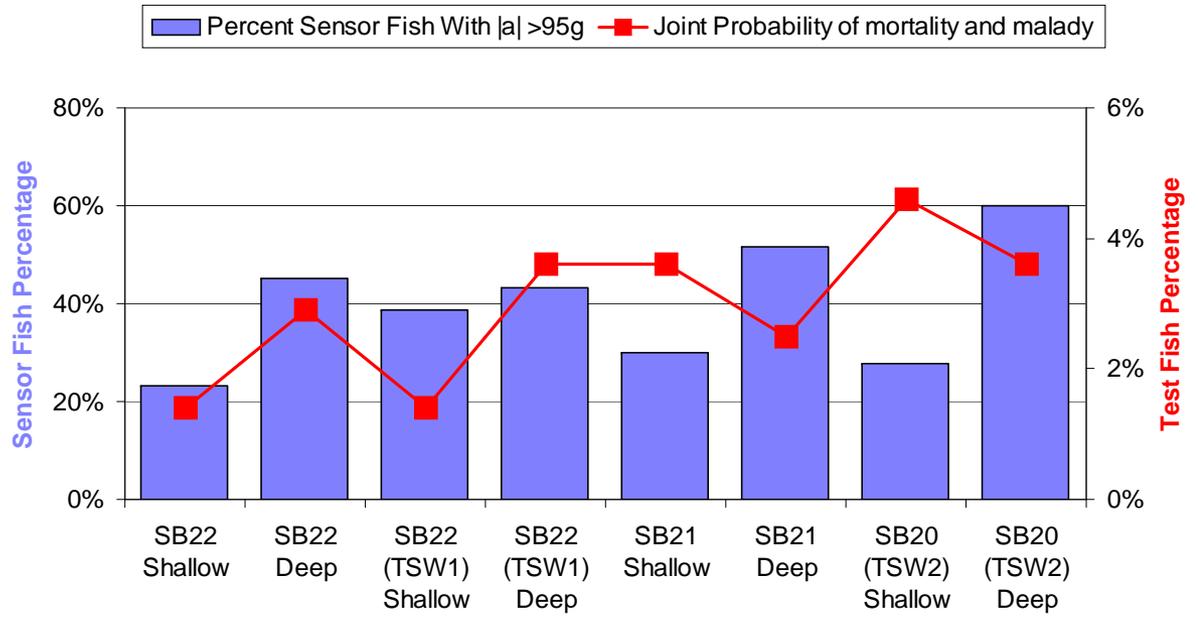
## Events by Route and Depth



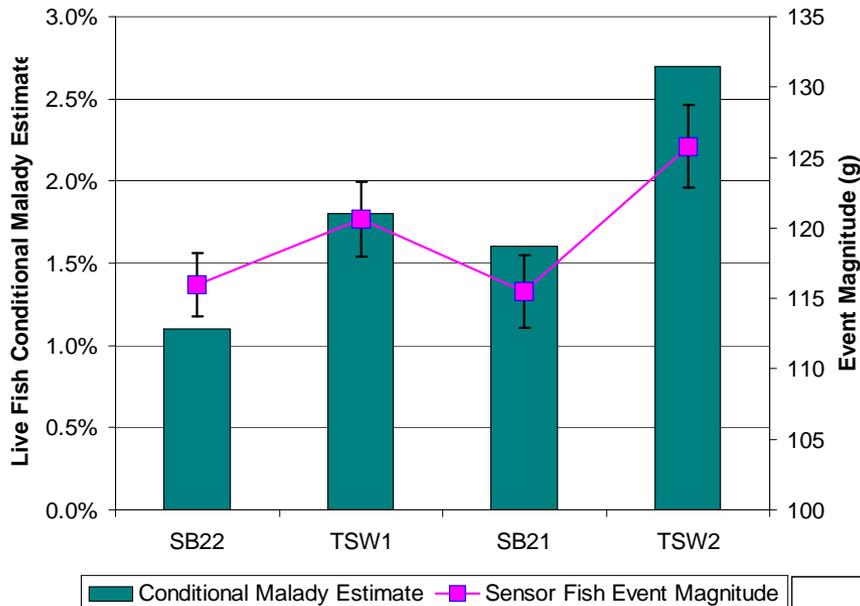
# Percentage of Sensor Fish with at least one significant event compared with live fish joint probability of passage mortality or malady—By Route



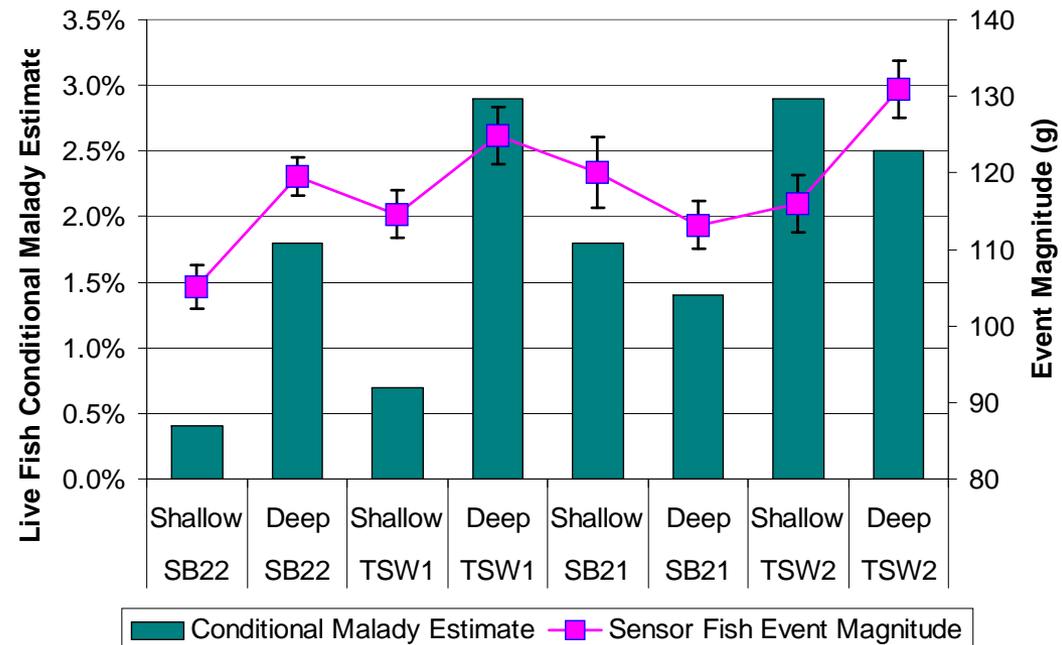
## By Route and Depth



# Sensor Fish mean event magnitudes and fish conditional malady estimates (visible injury, scale loss, or LOE) – by Route



## By Route and Depth



# Findings

- Spillbay 21 and Spillbay 22, while structurally equivalent, exhibit different passage conditions
- Differences in location at entry into spillway flow influence fish exposure to significant shear or collision events.
- Increased potential for injury occurs where flow curves (transition zones).
- Installation of TSW1 into Spillbay 22 increased the frequency of occurrence of shear and increased the magnitude of significant events.
- Only shear events occurred at the deflector for all spillbays and release elevations.
- Sensor Fish pressure data and CFD pressure data were similar.

# Questions?

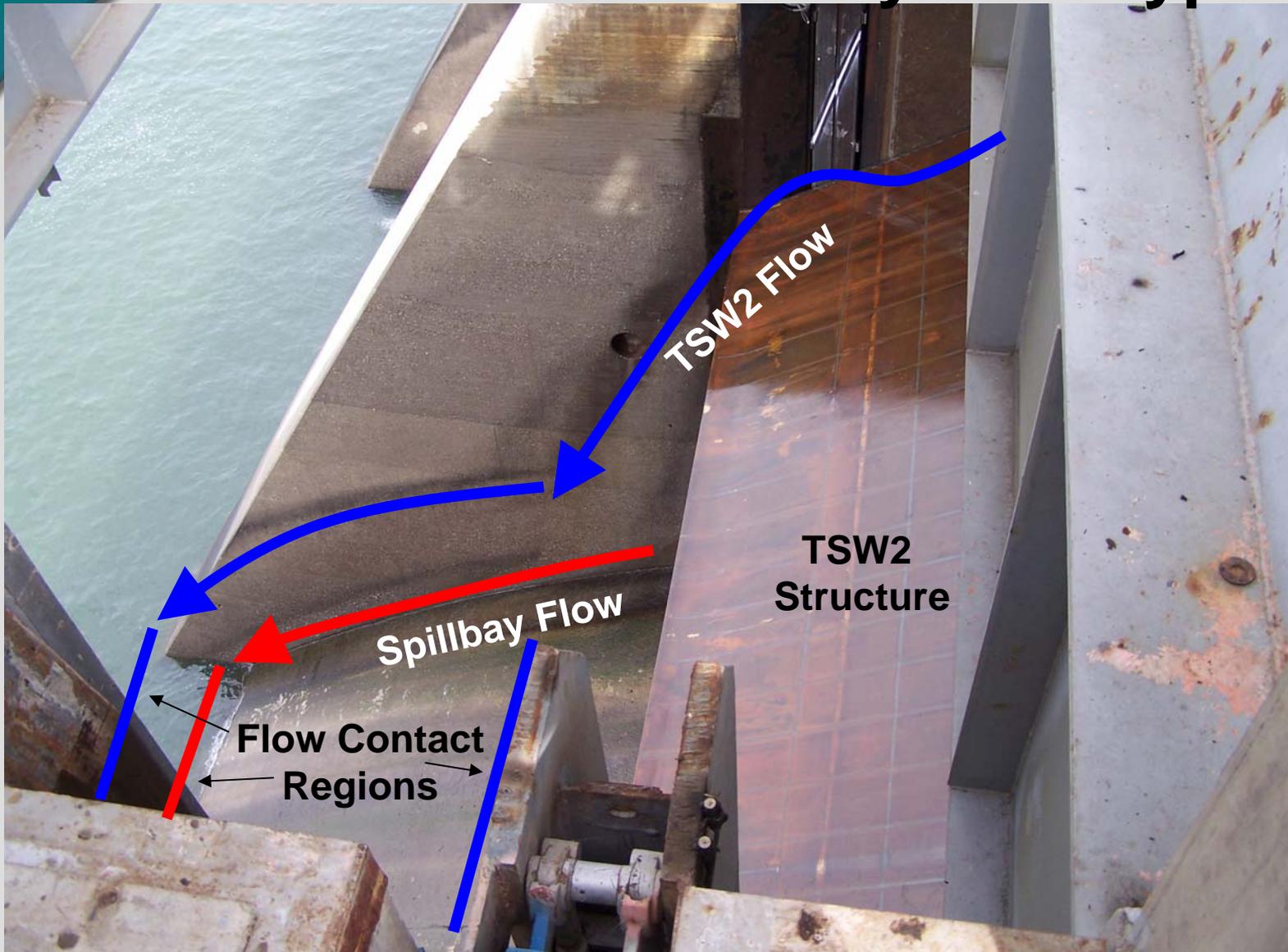
A wide river flows from the background towards the foreground. In the distance, a dam with several towers is visible against a clear blue sky. The water in the foreground is turbulent, creating white foam. A metal railing runs across the bottom of the frame, suggesting the viewer is on a bridge or walkway overlooking the river.



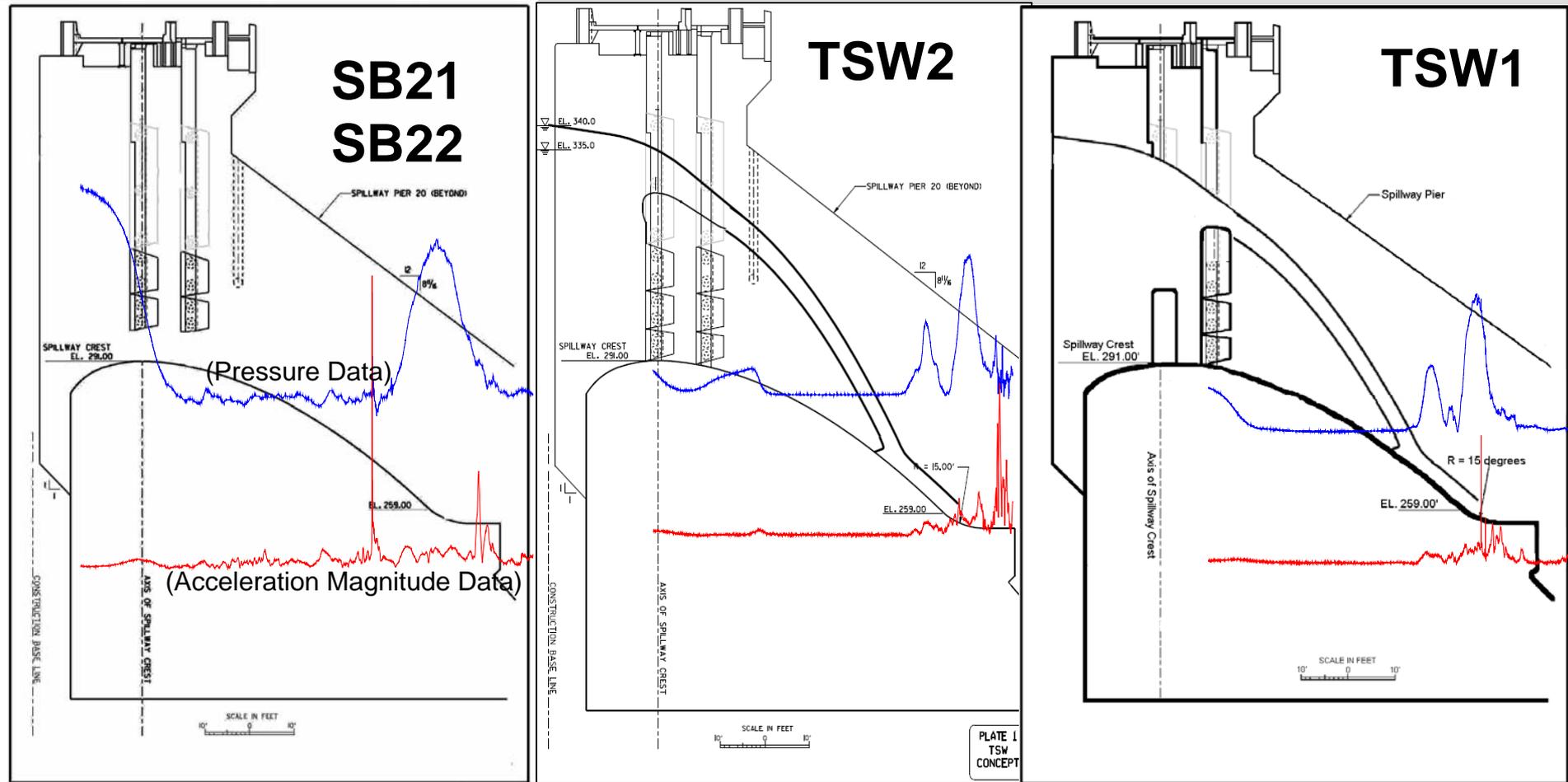


<b>Configuration</b>	<b>Crest Elevation (ft)</b>	<b>Impact Elevation (ft)</b>	<b>Shallow Release Elevation (ft)</b>	<b>Deep Release Elevation (ft)</b>	<b>Avg. Q (kcfs)</b>	<b>Deflector type</b>
TSW1	325	271.6	329	314	9.55	Radius
TSW2	326	270	332	319	9.52	Flat
SB21	291	256	307	295	10.39	Radius
SB22	291	256	307	295	10.39	Radius

# TSW2 –Leaf Assembly Prototype

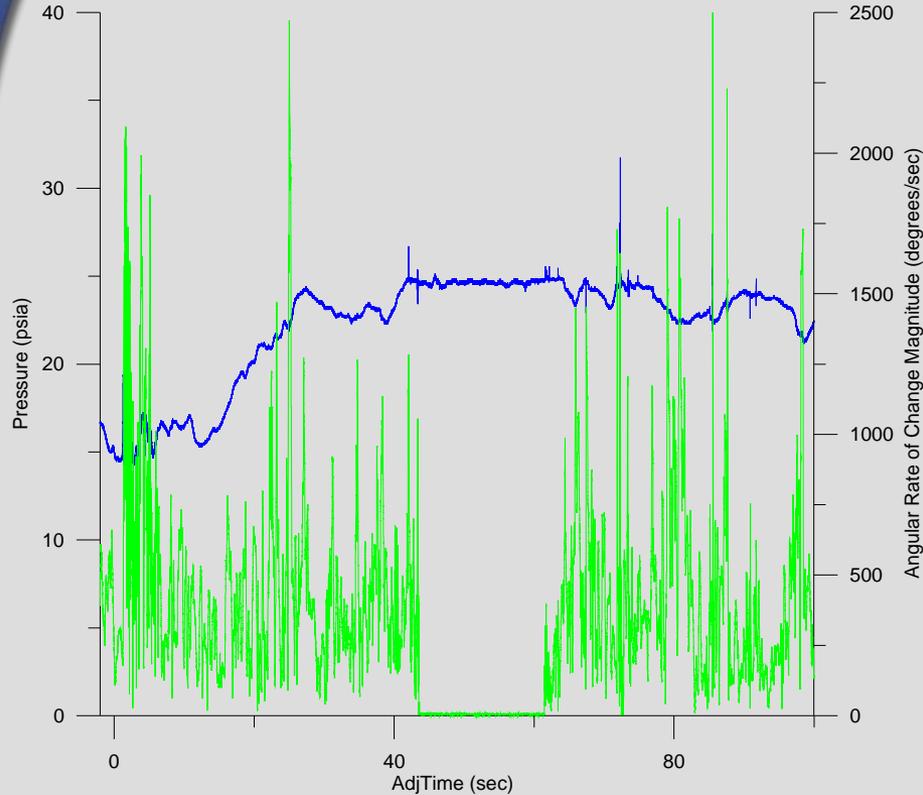


# Sensor Fish Passage – Conventional Spillway and TSW Pressure Signature as Indicator of Passage Location



## 2 Shallow-released Sensor Fish through TSW2 stationary at ~244 ft MSL (~40-50 seconds after injection)

Spillbay 20 - TSW2, Shallow Release, SF 729 (9)



Spillbay 20 - TSW2, Shallow Release, SF 711 (4)

