

# **Two-Dimensional Modeling of the Lower American River and Analysis of Spawning Bed Mobilization**

**Presented to:**

**Lower American River Task Force  
Fish Working Group Technical Subcommittee**

**Presented by:**

**AMRES**

**August 27, 2001**

## **Background**

- Folsom Dam outlet modification project
- Coordination Act Report
- Previous 2-d modeling efforts on the Lower American River (LAR) by SAFCA (lower 12 miles)
- Previous modeling investigations of the upper 10 miles by the USACE

## **Scope of Project**

- Data collection and field review
- Construct and calibrate 2-d model
- 2-d model runs
  - 30,000 cfs
  - 50,000 cfs
  - 80,000 cfs
  - 115,000 cfs
- Analyze potential for mobilization of bed material at spawning locations

## **Presentation Overview**

- Data collection and field review
- Hydraulic modeling discussion
  - benefits of 2-d modeling
  - construction and calibration of model
  - project flow conditions
- Analysis of spawning bed mobilization
  - basic concepts
  - shear stress
  - visualization of results
- Introduction to Habitat Modeling

## **Data Collection and Field Review**

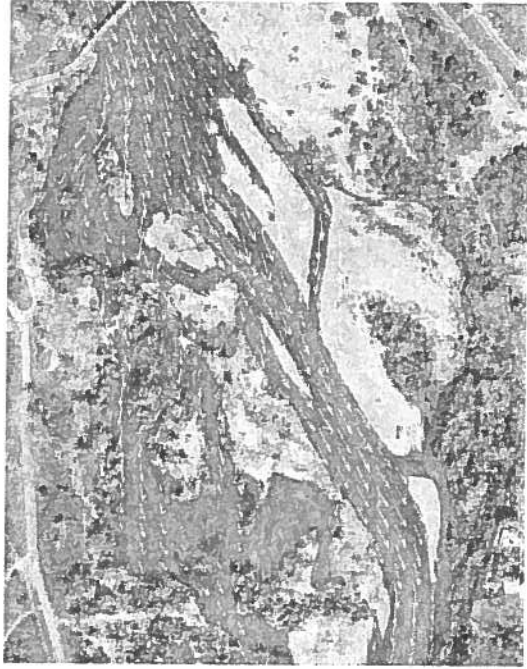
- Boat trip of the upper 10 miles
  - pebble counts on bar surfaces
  - determine trouble spots for modeling
- Spawning data from CDFG
  - pebble count data (1994 and 1997)
  - Redd surveys
  - spawning sites
- Available flow data
  - 1997 HWM from MBK
  - 1997 flood hydrographs from USACE

## Hydraulic Modeling *2-d vs. 1-d Modeling*

- One-dimensional modeling
  - cross section by cross section definition of topography
  - “average” hydraulic values
  - all flow is normal to cross section
- Two-dimensional modeling
  - continuous, spatial definition of topography
  - hydraulic values at any point in space
  - model surface flow patterns

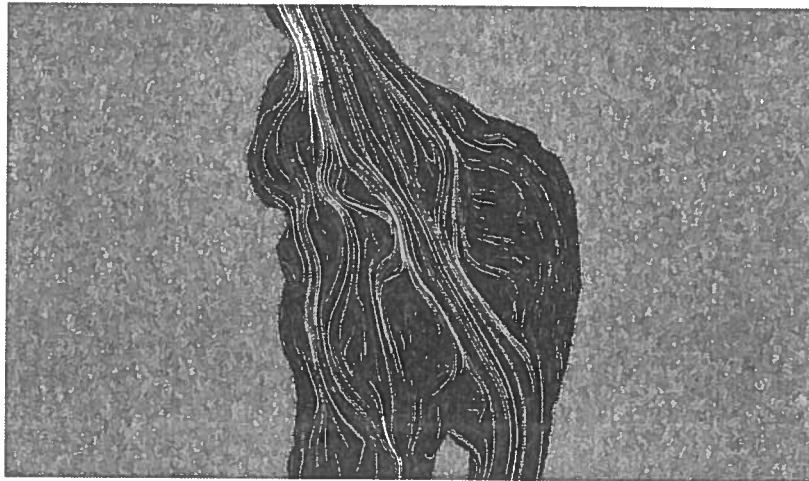


One -  
Dimensional  
Modeling



Two -  
Dimensional  
Modeling

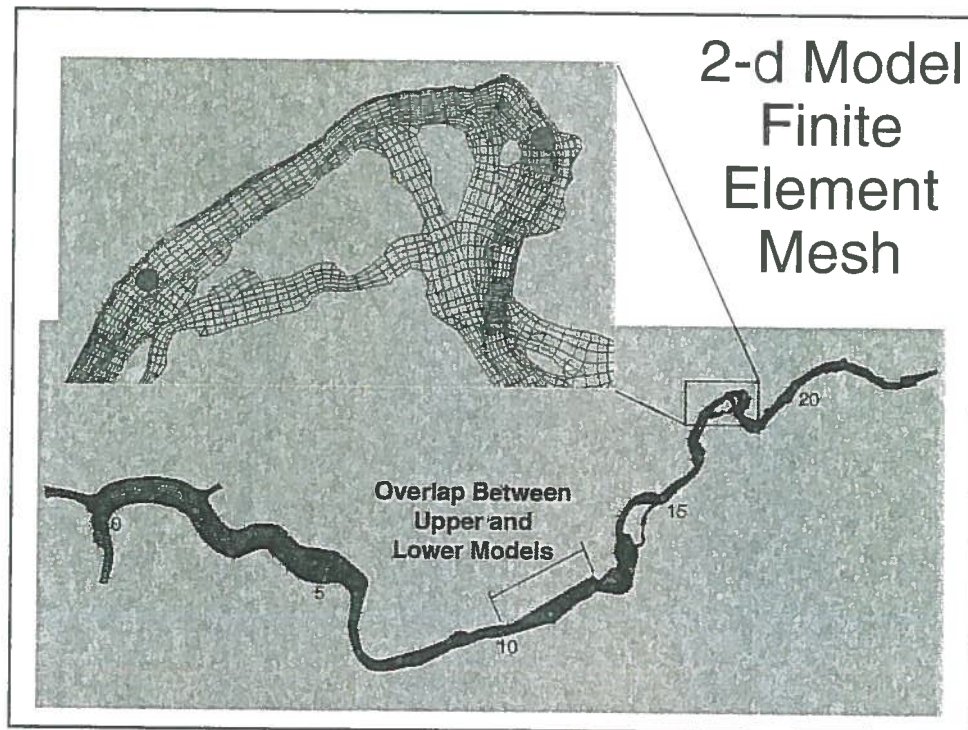
**Hydraulic Modeling**  
*Two-Dimensional Modeling*



## Hydraulic Modeling *Construction and Calibration*

- Topo from 1997 mapping (USACE)
- Roughness characteristics
  - material types (1997 aerial photographs)
  - Manning-n values for overbank areas
  - channel Manning-n
- Bridge and infrastructure data from photogrammetry and as-built plans
- Model limits
  - RM 10-22
  - overlap lower model developed for SAFCA

*used one manning-n for the whole river*



## **Hydraulic Modeling *Construction and Calibration***

- Calibrated to 1997 flood event
- High water marks collected by MBK
- Minor adjustments made to the model during calibration
- Calibration results

## **Hydraulic Modeling *Construction and Calibration***

RM	Location	Surveyed HWM Elevation (ft, NGVD)	Calibration Water Surface Elevation (ft, NGVD)	Difference (ft)
10.884	Downstream of Mayhew Drain	49.7	49.8	+0.1
13.465	Goethe Park	53.7	53.1	-0.6
20.123	Sunrise Blvd. (downstream)	88.0*	86.7	*
20.203	Sunrise Blvd. (upstream)	87.9	87.8	-0.1
22.657	Upstream end of model	98.0	97.8**	-0.2

\* This HWM is questionable since it is reported as higher than the HWM upstream of the bridge.

### Calibration Results

## **Hydraulic Modeling** ***Project Flow Conditions***

- Flow conditions
  - 30,000 cfs
  - 50,000 cfs
  - 80,000 cfs
  - 115,000 cfs
- Boundary conditions
  - dependence on Sacramento River conditions
  - obtained from 1997 flood hydrographs (flows for LAR, Sacramento, NEMDC; stage at I St.)
  - lower model run first

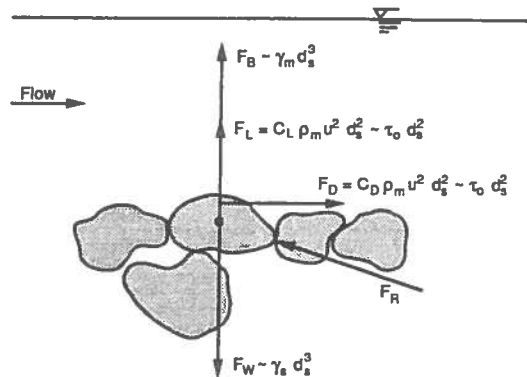
## **Hydraulic Modeling** ***Model Output / Results***

- Hydraulic values at every node
  - bed elevation
  - depth of flow
  - velocity
  - water surface elevation
- Other values / properties can be computed
- Various ways to visualize results



## Spawning Bed Mobilization *Basic Concepts*

- Movement of bed particles



- Incipient motion *-when conditions become right to move a particle*

## Spawning Bed Mobilization *Shear Stress*

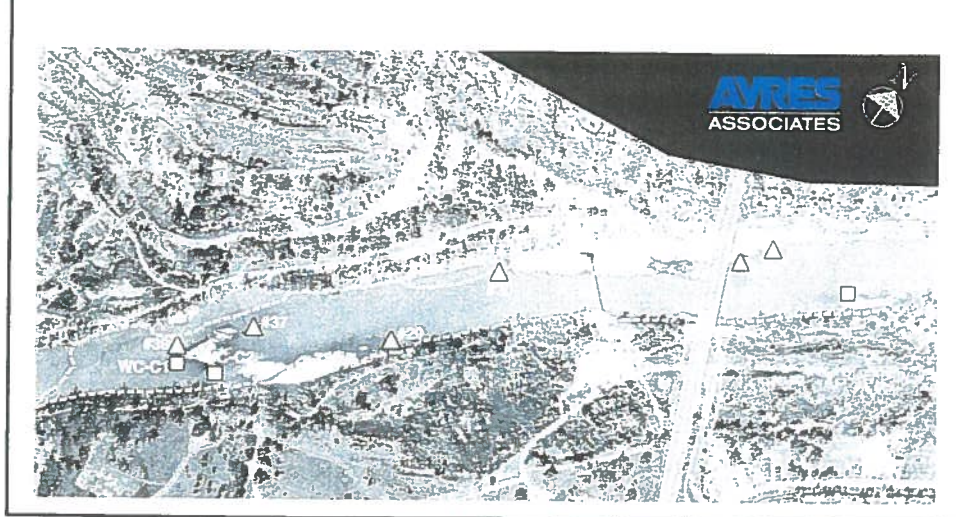
- Primary indicator of potential for motion of bed materials
- Force acting on an area
- Shear stress a function of
  - velocity
  - depth
  - roughness characteristics (Manning-n)
- Existing vs. critical shear stress
- Incipient grain size

## **Spawning Bed Mobilization**

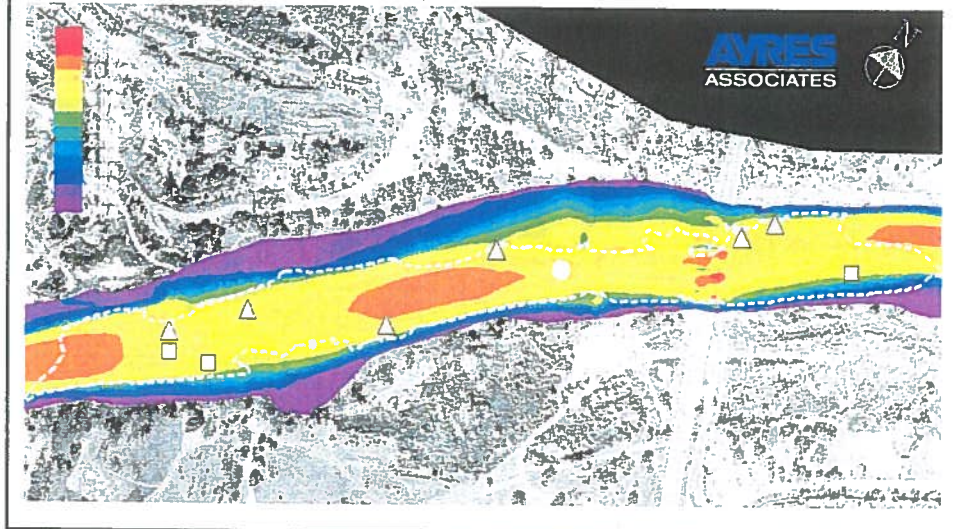
### ***Visualization of Results***

- “Presentation” reach
- Generic - independent of current bed material size
- Contour plots (velocity, shear stress, incipient grain size)
- Cross section and profile plots

# Spawning Bed Mobilization "Presentation Reach"

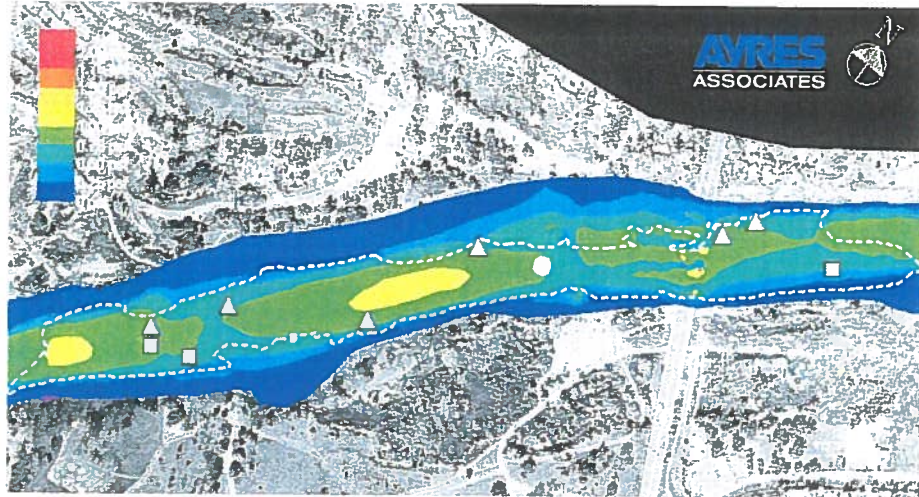


# Spawning Bed Mobilization Velocity Contours 80,000 cfs

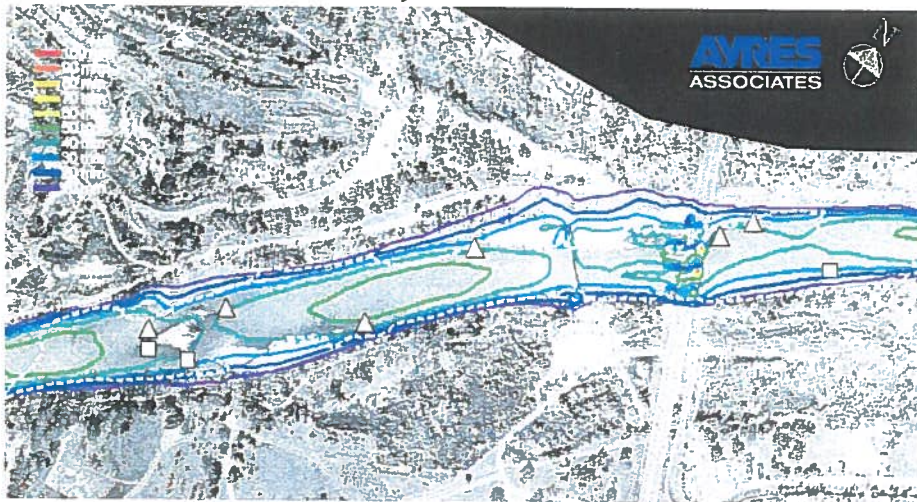




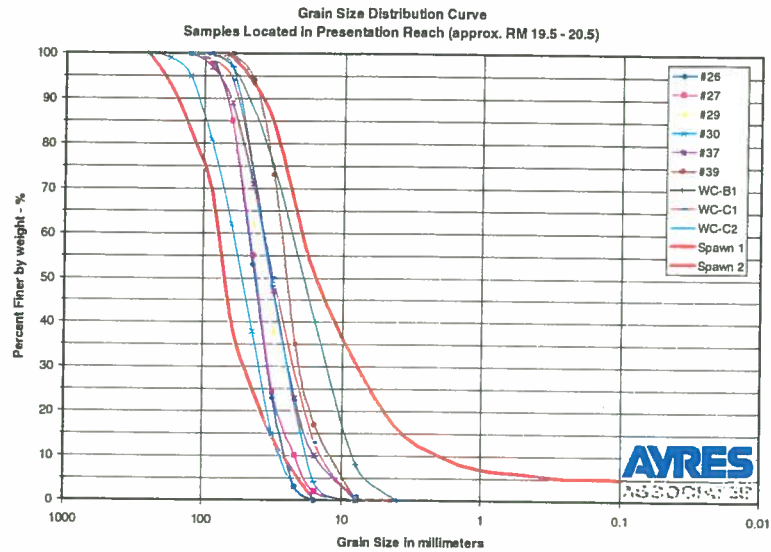
# Spawning Bed Mobilization Shear Stress Contours 80,000 cfs



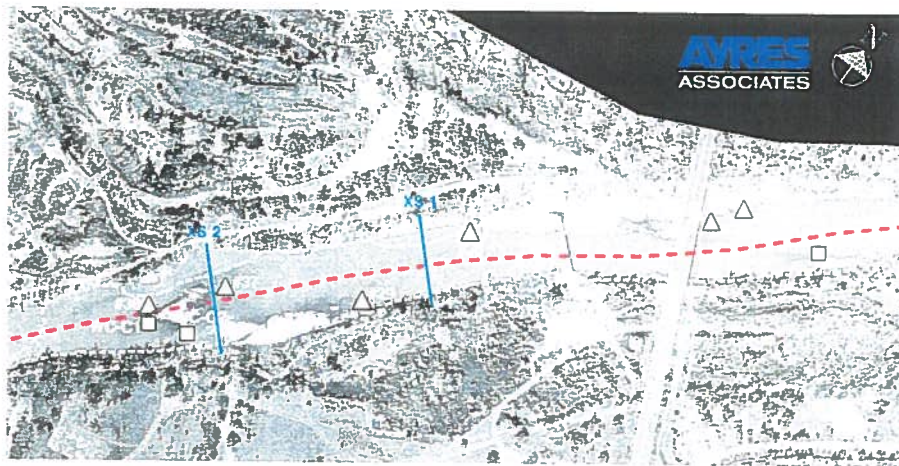
# Spawning Bed Mobilization Incipient Grain Size Contours 80,000 cfs



# Spawning Bed Mobilization Grain Sizes in Presentation Reach

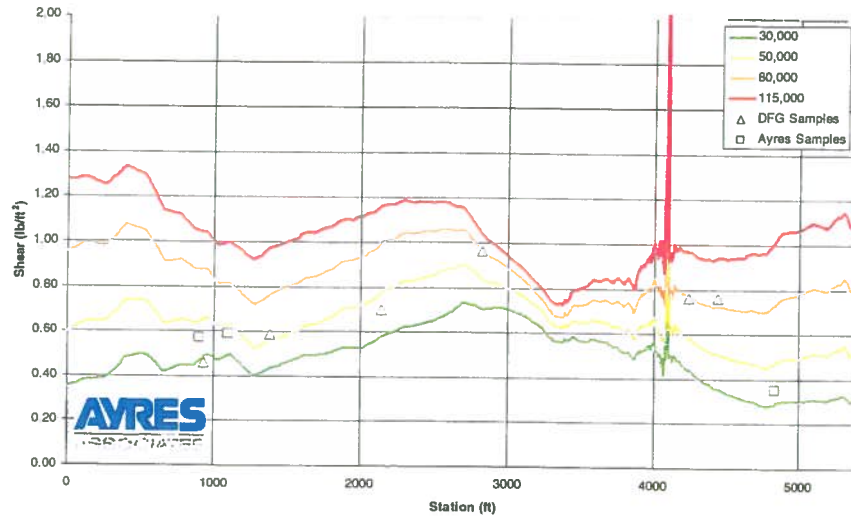


# Spawning Bed Mobilization Visualization of Results Profile and Cross Section Plots



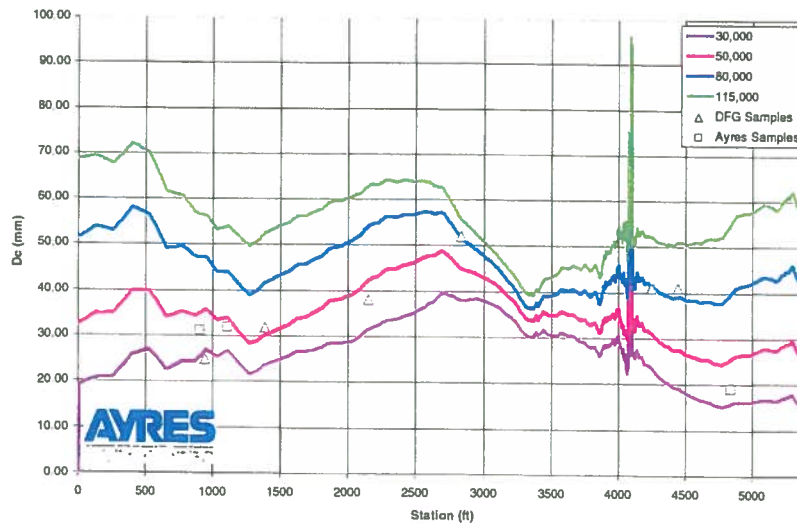
# Spawning Bed Mobilization

## Profile - Shear Stress



# Spawning Bed Mobilization

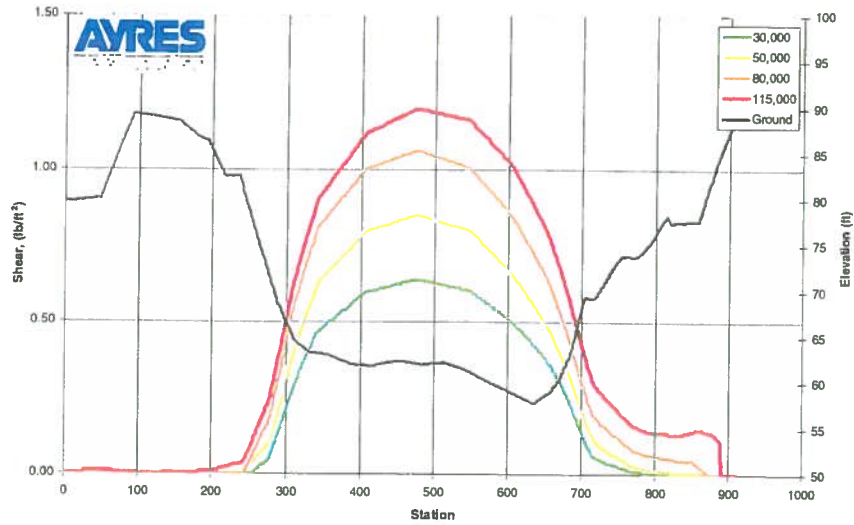
## Profile - Incipient Grain Size





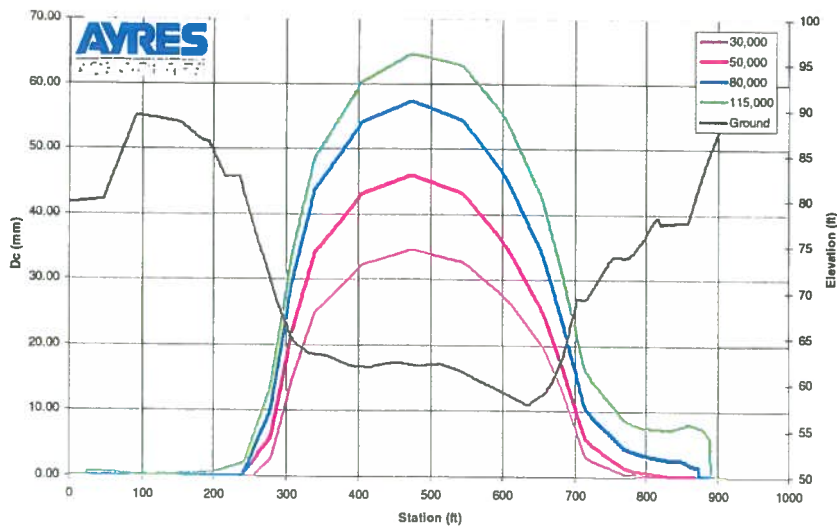
# Spawning Bed Mobilization

## Cross Section 1 - Shear Stress



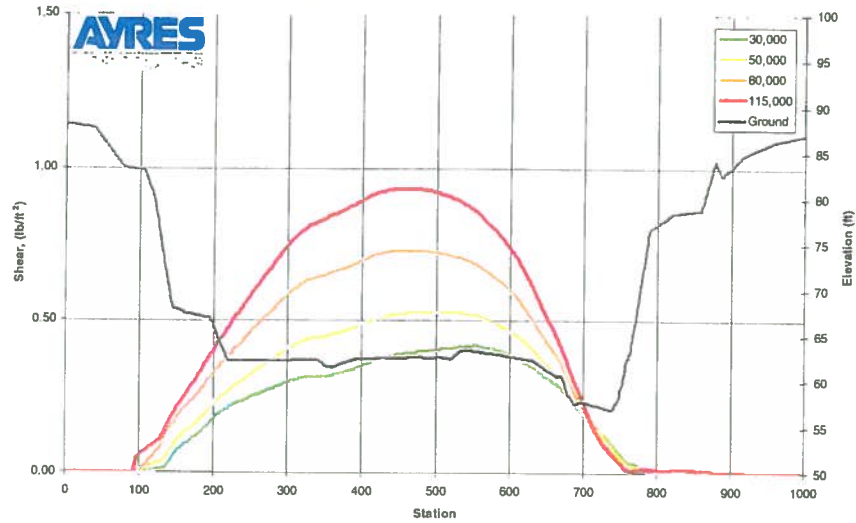
# Spawning Bed Mobilization

## Cross Section 1 - Incipient Grain Size



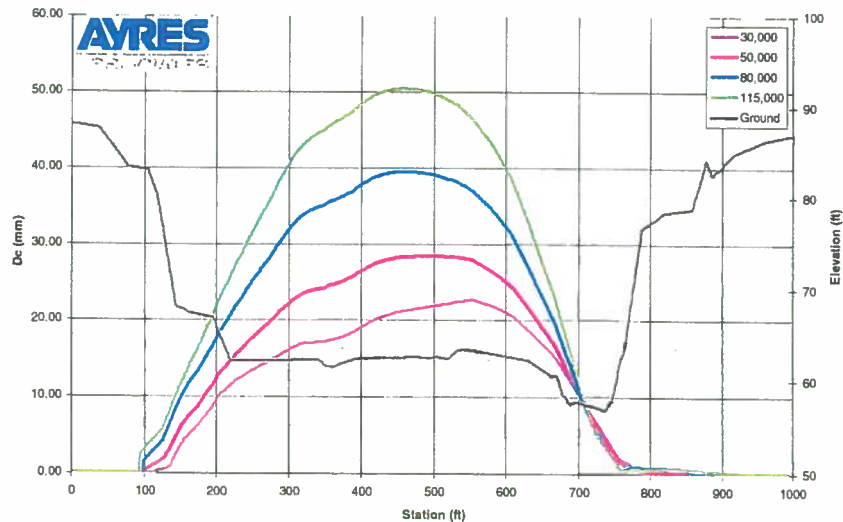
# Spawning Bed Mobilization

## Cross Section 2 - Shear Stress



# Spawning Bed Mobilization

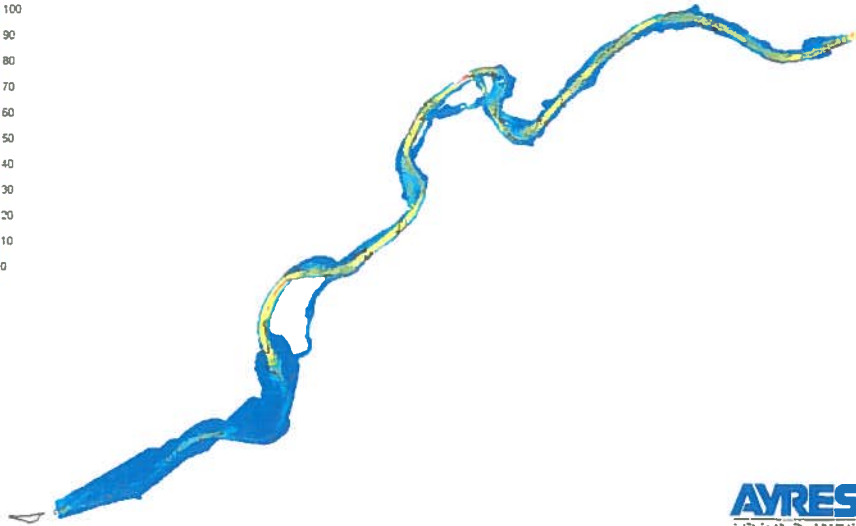
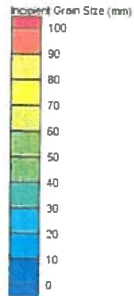
## Cross Section 2 - Incipient Grain Size





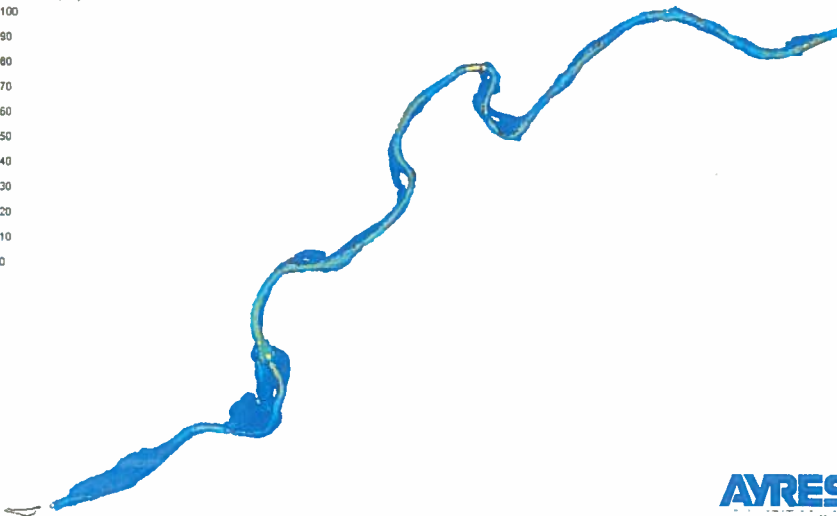
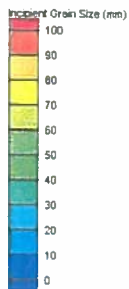
# Spawning Bed Mobilization

## *Incipient Grain Size - 115,000 cfs*



# Spawning Bed Mobilization

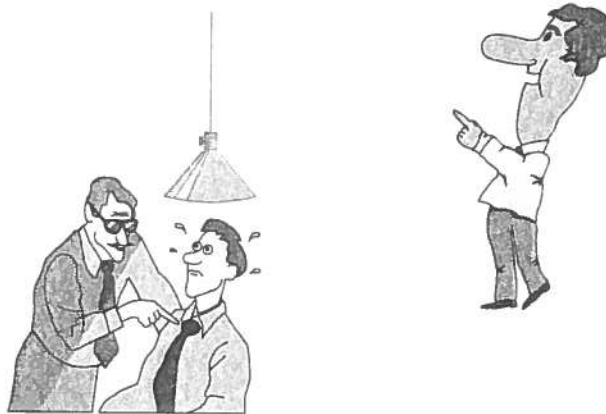
## *Incipient Grain Size - 30,000 cfs*



## Conclusions

- Value of 2-d model of upper LAR
- Use of results
- Bed generally immobile for flows  $< 50,000$  cfs
- Change in conditions at Goethe Park
- Other uses for model
  - modeling other flows
  - impacts on water surface and flood conveyance due to actions taken within floodplain
  - bank erosion potential
  - delineating habitat (spatial relationships b/w hydraulics)

## Discussion / Questions



# Introduction to Habitat Modeling Using Results from Two-Dimensional Hydraulic Modeling

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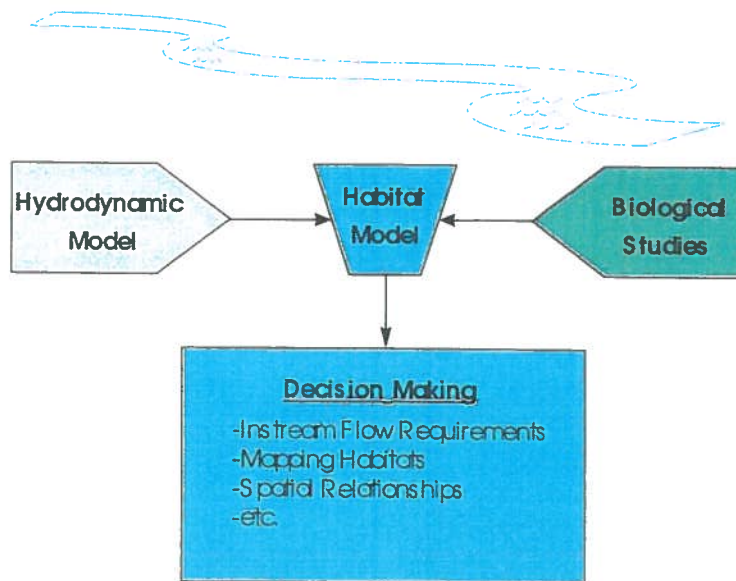
Presented by:

**AYRES**

ASSOCIATES

August 27, 2001

## Components of a Habitat Assessment Model





**Guadalupe River**  
(Outside of Seguin, Texas)

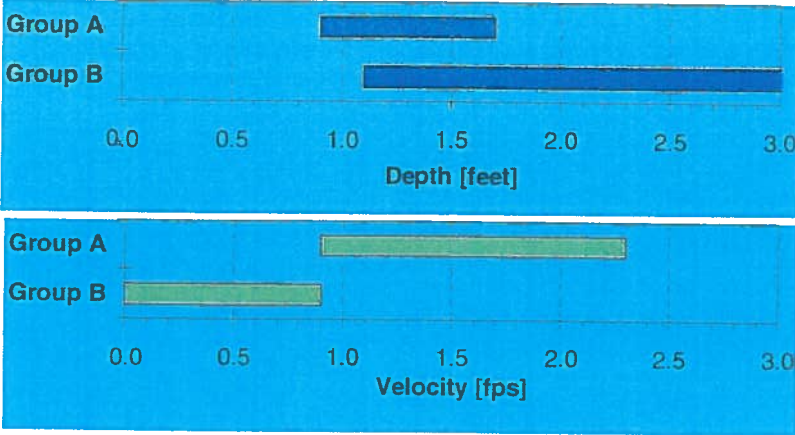


**Finite Element Mesh**

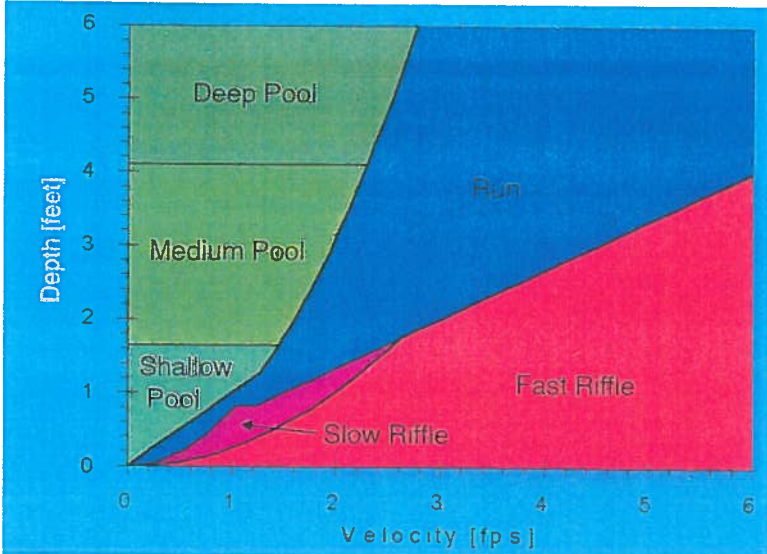




# Fish Habitat Criteria

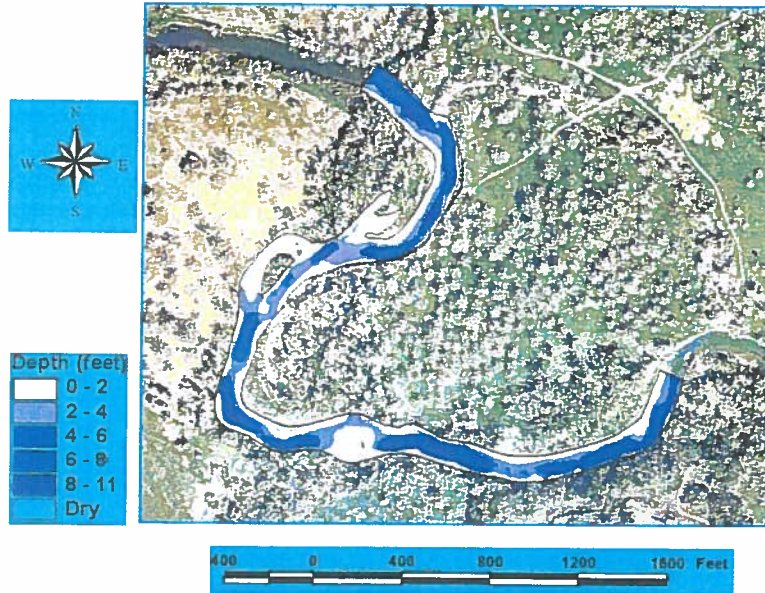


# Mesohabitat Criteria

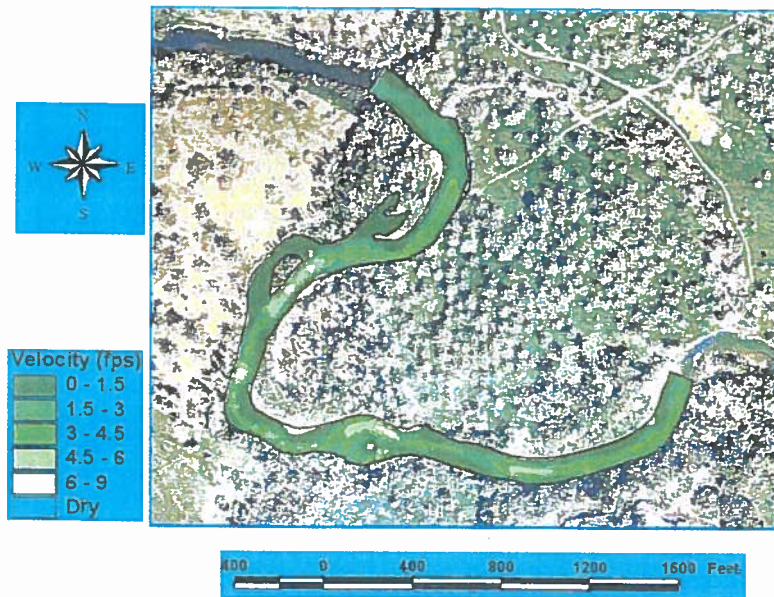


(from Vadas & Orth, 1998)

## Depth Conditions (1000 cfs)

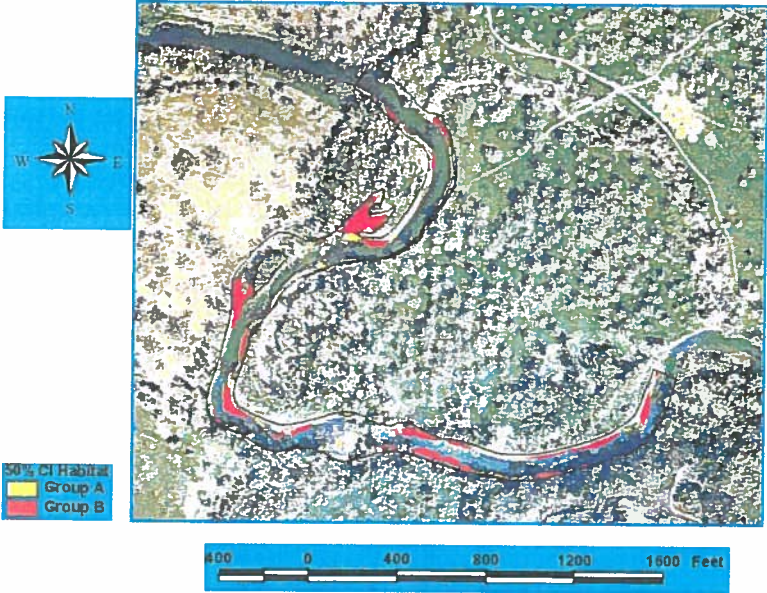


## Velocity Conditions (1000 cfs)

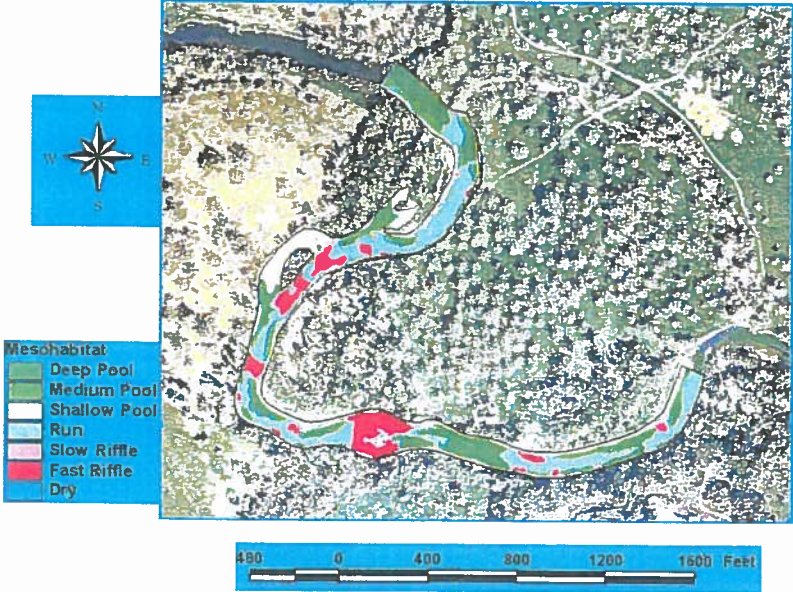




# Habitat Delineation (1000 cfs)

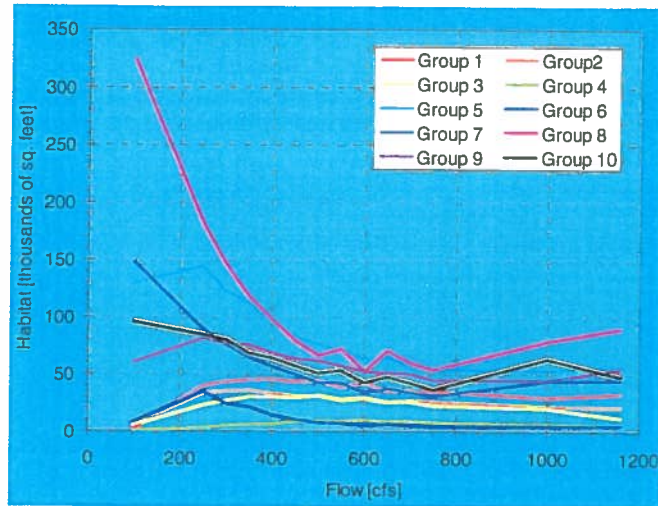


# Mesohabitat Delineation (1000 cfs)



**Decision Making  
Instream Flow  
Requirements**

## Fish Habitat vs. Flow Curves



## Conclusions

- 2-d model assembled for entire lower river
- Additional “fish flows” can be modeled
- Uses for habitat modeling
  - mapping habitat
  - instream flow requirements
  - mapping predator habitat
  - creation of favorable habitat (i.e. overbank areas)
  - quantify spatial relationship of habitat areas (dis-jointedness, distance to cover, etc.)
  - determine impacts of channel or floodplain activity on fish habitat
  - others...



## **Discussion / Questions**