Developing Reservoir Operational Plans to Manage Erosion and Sedimentation during Construction – Willamette Temperature Control, Cougar Reservoir 2002-2005

Patrick S. O'Brien, PE CENWP-EC-HY patrick.s.o'brien@usace.army.mil Dr. Terry M Sobecki ERDC-EL-MS Dr. David M. Soballe ERDC-EL-MS Dr. John Hains ERDC-EL-MS

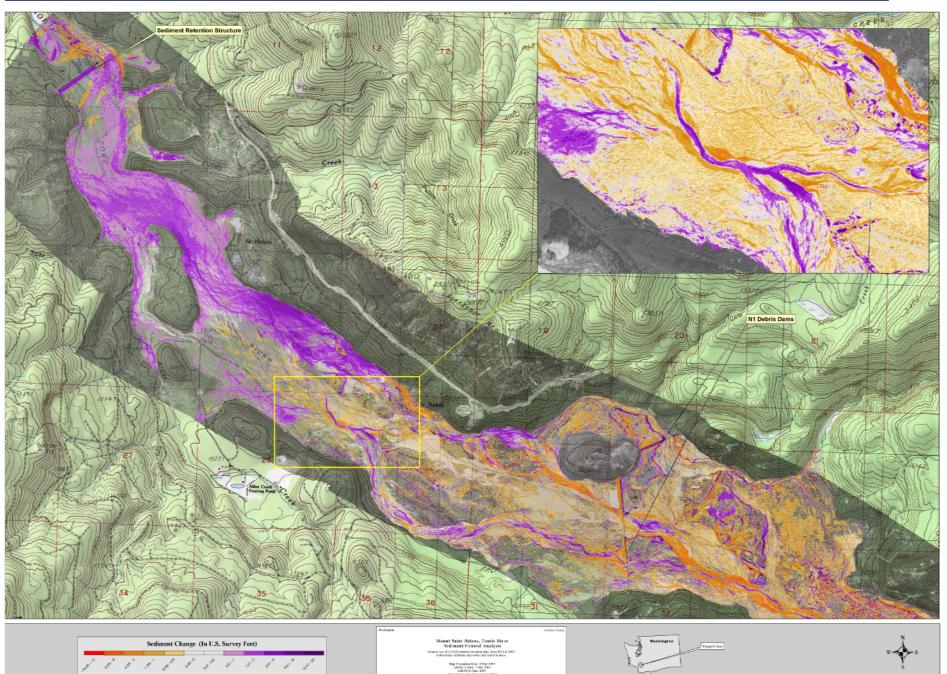


# Sediment Management Below Reservoirs

- Wash load may be a problem when there is too much
- Cougar
- Mount St Helens Sediment Retention Structure

#### Sediment Change 2003 to 2005



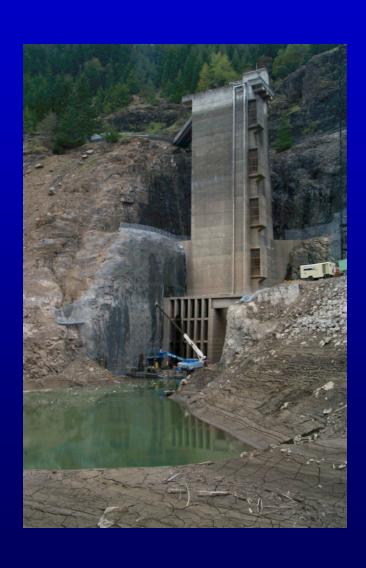


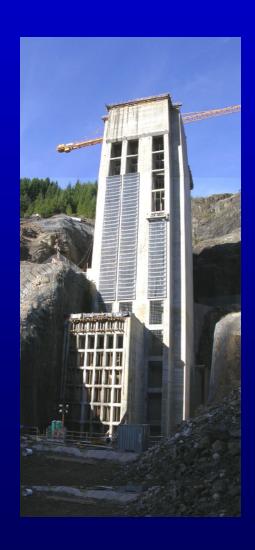


# Need for Temperature Control

- Spring/Summer: High Pool, very cold deep water is drawn from bottom intakes of existing tower, causes downstream cold spikes reducing migration of Spring Chinook
- Fall/Winter: Low Pool, cold reservoir is used up, water becomes mixed, water warmer than pre dam, causes prespawn mortality, premature fry emergence.
- Selective withdrawal operations will restore a more natural temperature cycle.

## Old Tower - New Tower





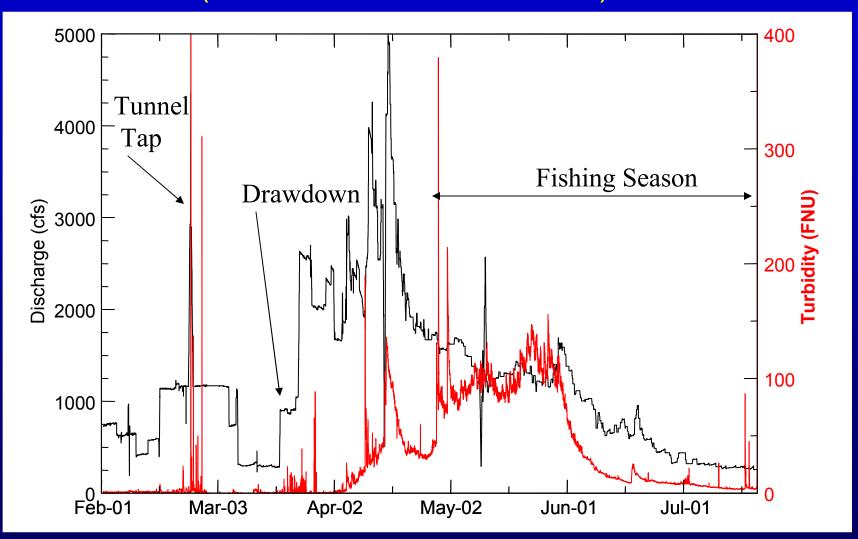


# Initial Drawdown to Construction Pool February – June 2002

- Concrete plug to Diversion tunnel opened on February 23
- Drawdown proceeded at 3 feet/day until May 26
- Reservoir turbidity increased during drawdown, causing high turbidity downstream of the dam
- Projected turbidity averaged 30 NTU, with spikes to 100 NTU
- Actual turbidity averaged 85-100 NTU, peaks of 130 – 225 NTU, spikes ~ 1000 NTU

### Downstream Effect of Drawdown

(Data from S. Frk. McK. Riv.)



# Turbid Water in Mckenzie R, Summer 2002

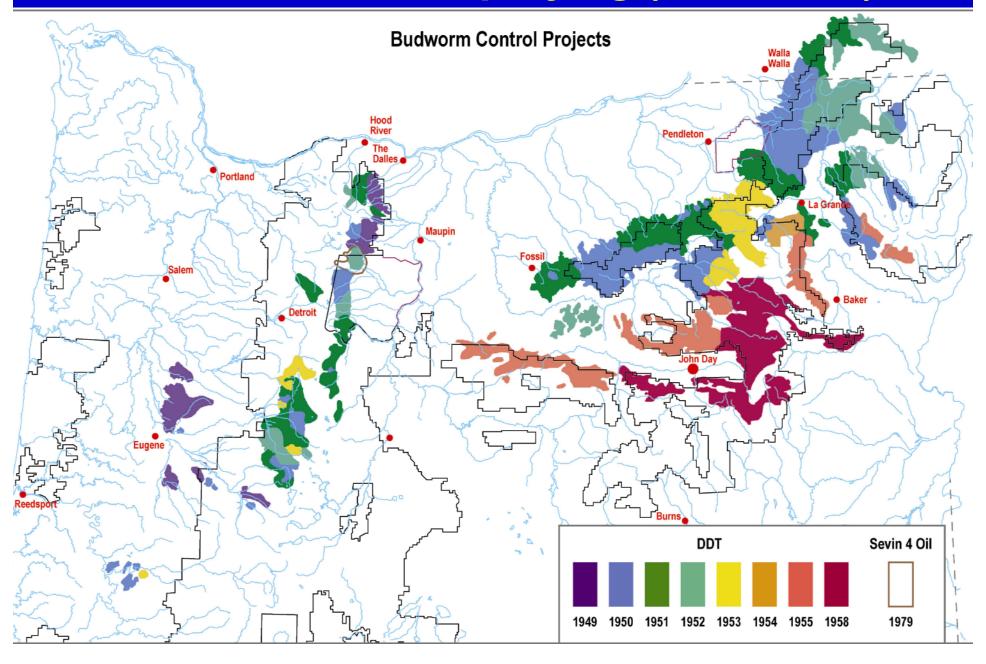


### **Downstream Impacts of Turbidity - Public Concerns**

- Severe impact to fly fishing season
- Impacts to fishery, macro invertebrates, salmonid spawning gravels
- Concerns over volume of sediment released and amount deposited downstream
- Concerns over drinking water quality
- Concerns over the possibility of DDT contamination from Cougar sediment releases
- Comments solicited from public through public meeting process
- Corps regulations for implementing NEPA provide for publishing additional supplemental information documents on long-term or complex Environmental Impact Statements (EISs) to keep the public informed.

Willamette Temperature Control McKenzie River Sub-Basin, Oregon Cougar Dam and Reservoir Draft Supplemental Information Report US Army Corps of Engineers \* Portland District January 2003.

## **USFS Insecticide Spraying (1949-1962)**



# Reservoir Operation during Construction

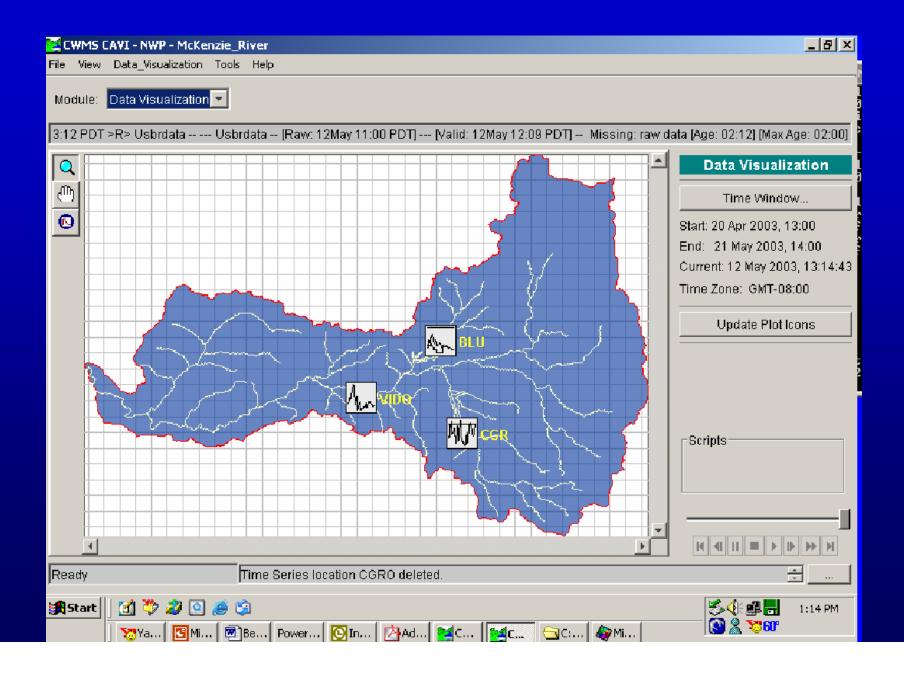
Construction season - October 1 to April 1
Three options available to reduce turbidity

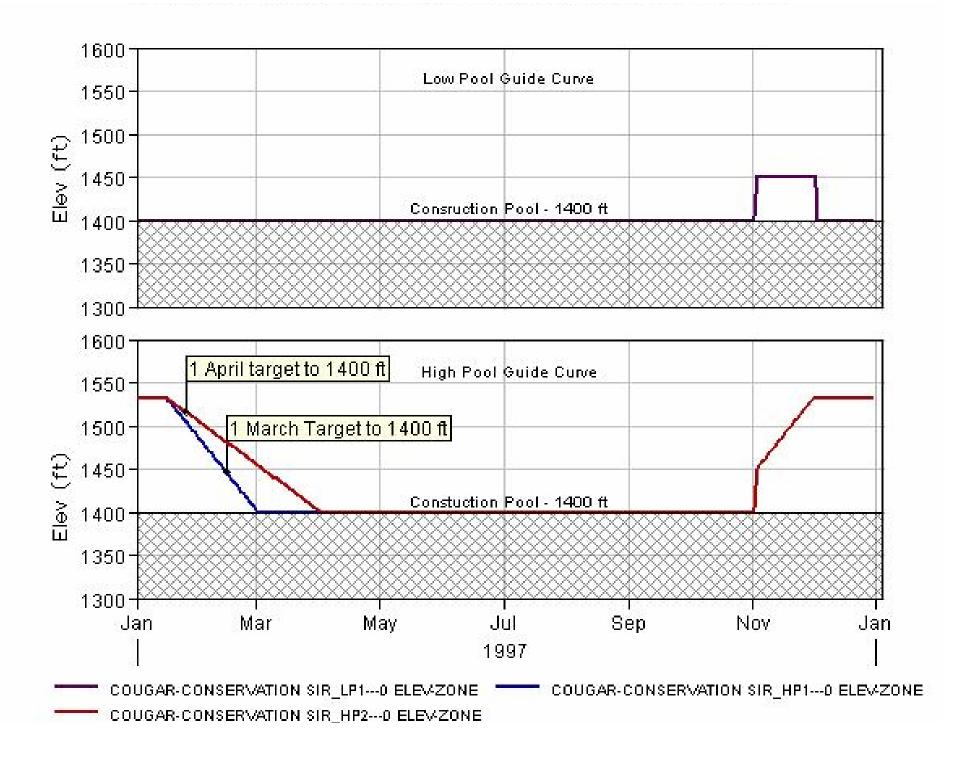
- Increase drawdown rate (3 ft/day to 6 ft/day)
- Non-construction/winter flood control pool level – 1532 ft (high pool option) or hold pool at 1400 ft (low pool option)
- Target date to reach construction pool (high pool option) March 1 or April 1

## Development of Operational Plans

- 6 operational scenarios were created from combinations of the 3 options
- 4 high pool (HP) options / 2 low pool (LP) options
- HEC ResSim model developed for the McKenzie River system. Period of record inflows used (1935 to 1998) to determine reservoir elevations under 6 operational scenarios.
- ResSIM elevation rate of change rule available
- Selected plan becomes part of adopted "Best Management Practices" in SIR

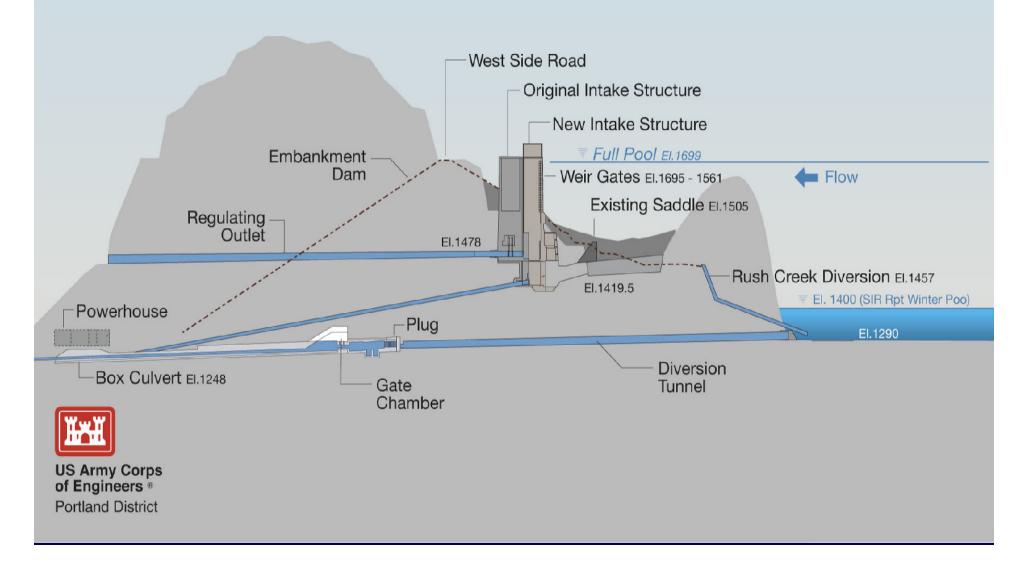
#### Reservoir model - HEC ResSim





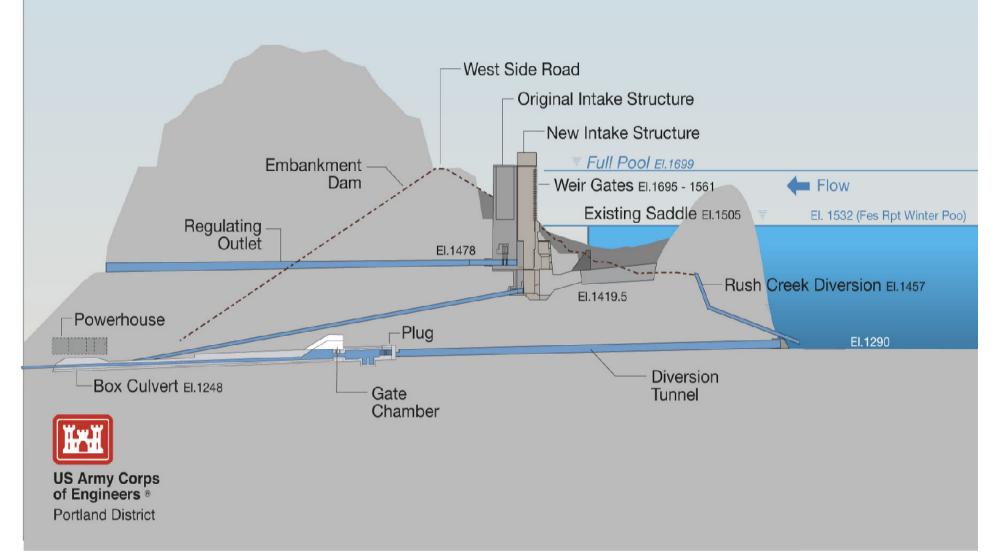
#### Willamette River Temperature Control Project, Oregon

# **Cougar Dam Cross-Section Low Pool Option**



## Willamette River Temperature Control Project, Oregon

# **Cougar Dam Cross-Section High Pool Option**

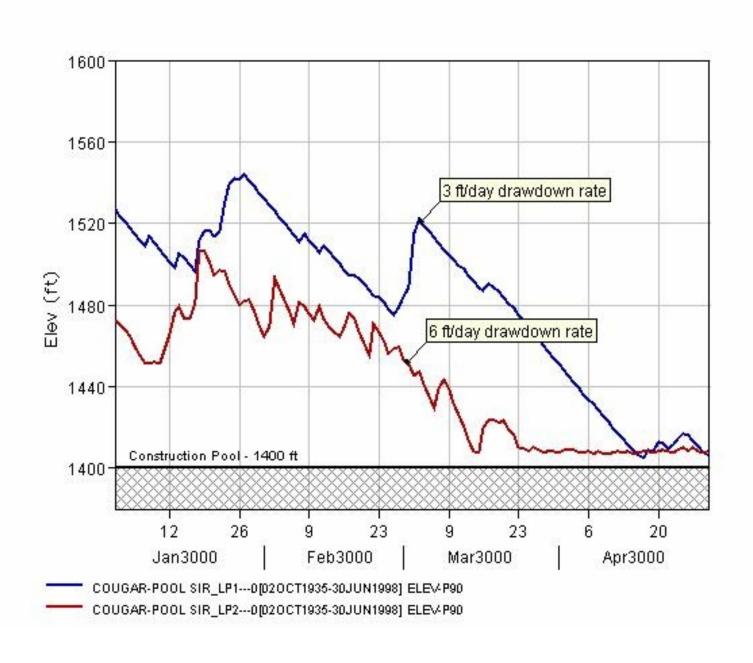


Alternative			Winter Pool Elev.
*** LP2 ***	-	6 ft/day	1400 ft

### March 1 target date - % chance non-exceedance

LP2	1396	1400	1403	1407	1447

### 90 % non-exceedance LP options



### **Erosional processes within Cougar**

- Initial submergence of dried lakebed deposits \*\*
- Mass wasting and slope failures caused by rapidly changing pool levels
- Active erosion of predominantly clay banks
- Lateral migration and downcutting of main inflow tributaries. \*\*
- \*\* cause higher levels of turbidity





# **Slope failures**





### Active erosion of exposed clay banks



# South Fork McKenzie R. Inflow to Cougar

**January 29, 2003** 

**January 30, 2003** 

**January 31, 2003** 





# Rush Creek Drainage Failure

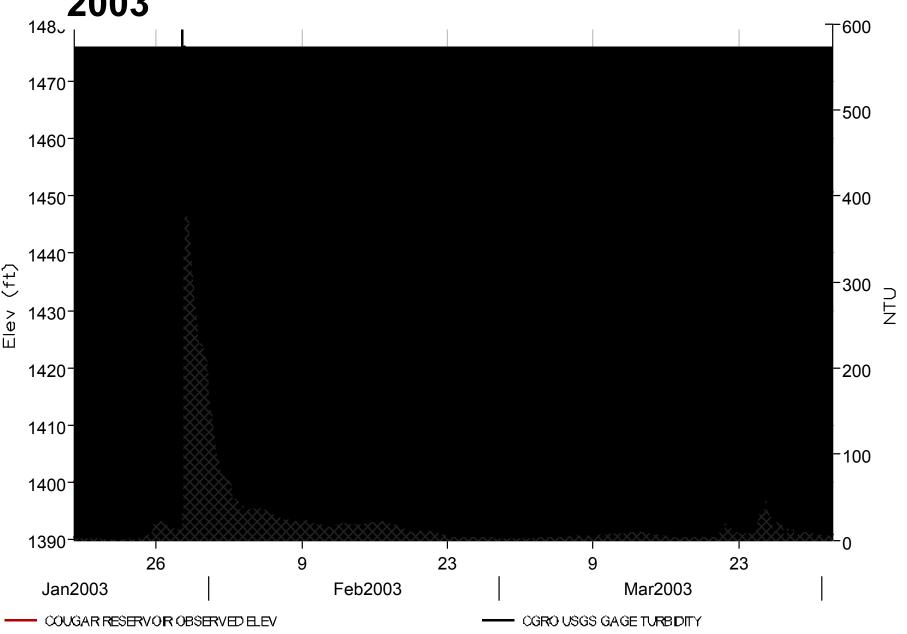
**January 30, 2003** 

**January 31, 2003** 

Pool maintained at 1450 feet to prevent further slope failures



# Elevation vs. Turbidity – January – March, 2003



## **USGS Monitoring Study Objectives**

- Measure deposition of fine materials into spawning gravels
- Deposition of DDT in fine materials
- Compare contributions from Cougar Reservoir construction with other areas
  - 2 reference sites
    - (S. Fork above Cougar, mainstem above S. Fork)
  - 2 sites below reservoirs
    - S. Fork below Cougar, Blue River below Blue River Res.
  - Downstream integrator site
    - McKenzie R at Vida below Cougar & Blue





#### **Infiltration Bags**

#### Dimensions:

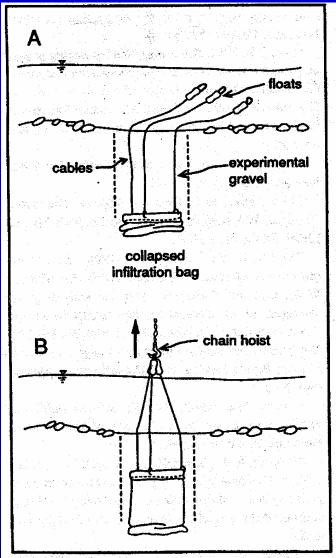
- Width: 30 cm

- Depth: 56 cm

- Volume: 40 L

Teflon liner

- Buried ~40 cm below bed
- Used experimental (non-native) rock
  - Pre-clean rocks
  - Relatively uniform porosity
  - Direct comparisons between sites
- Deployed Aug. 03 July 04
  - 5 sites, 3 traps each
  - Spawning areas with downwelling



(Lisle and Eads, 1990)

Figure 4—Installation (A) and recovery (B) of an infiltration bag.



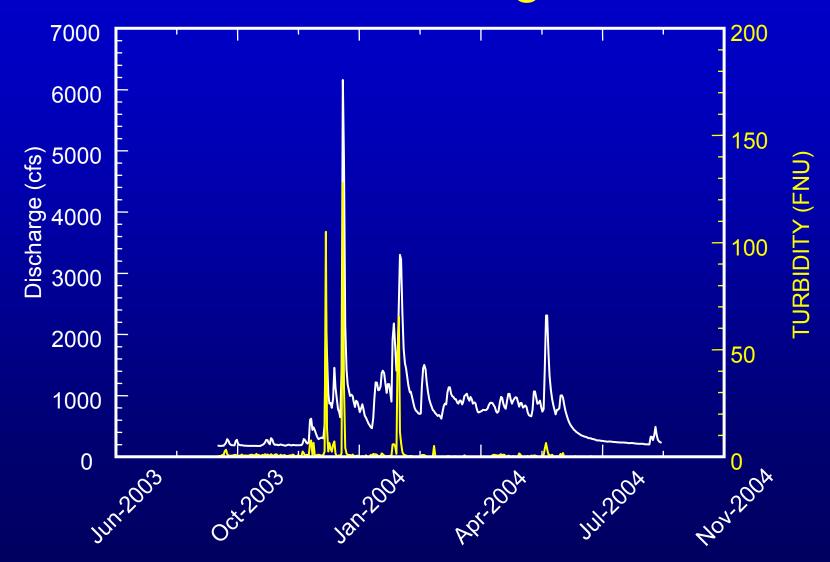




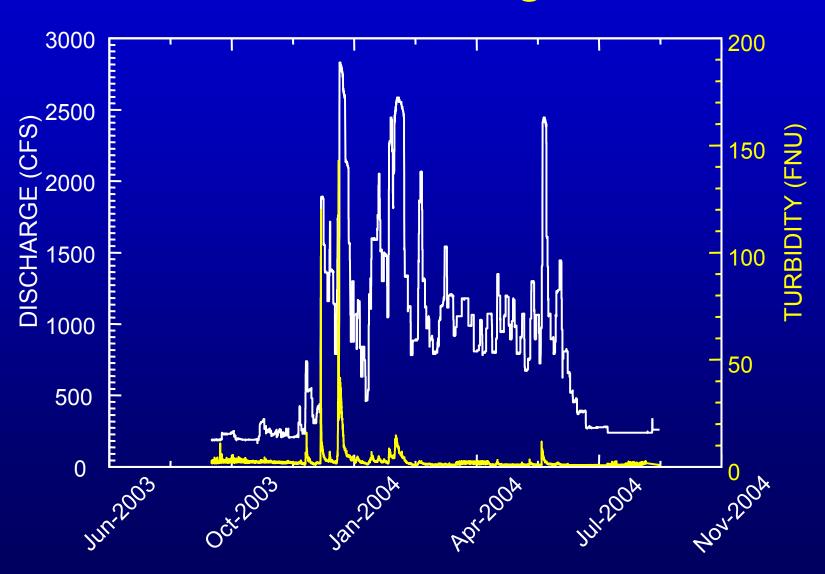




# Winter Storms – Unregulated Sites



### Winter Storms – Regulated Sites



#### Retrieval

- July 2004
  - 3 major events during winter
  - At least one trap lost from background site
- At least 1 good bag retrieval from each site

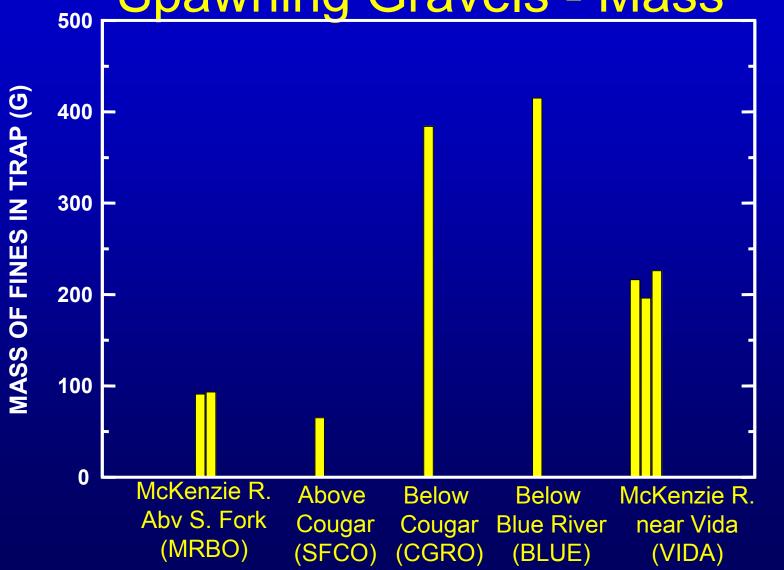




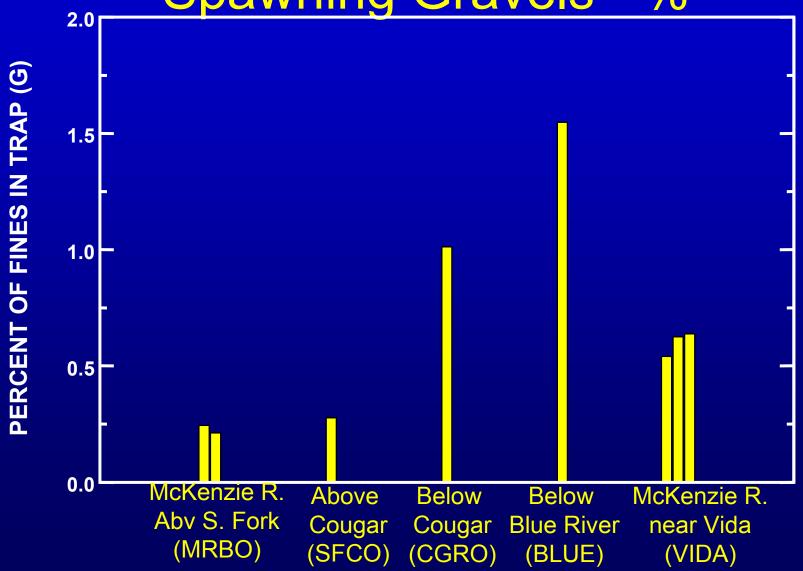




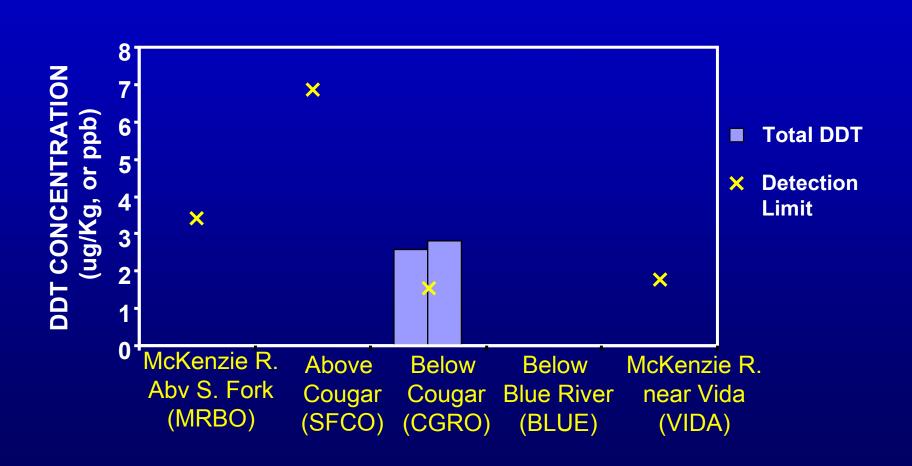
Accumulation of Fine Materials in Spawning Gravels - Mass



Accumulation of Fine Materials in Spawning Gravels - %



# DDT CONCENTRATIONS IN DEPOSITED SEDIMENT



#### Conclusions-Sediment

- Sites below Cougar and Blue River dams had the highest deposition of fine sediment in redds
  - Slightly elevated % clays in fine material
  - Confirms previous study results
  - Contrary to much of the literature indicating coarsening of bed below dams
  - Bed moving events during the winter may allow scouring of fine material from the bed at unregulated sites

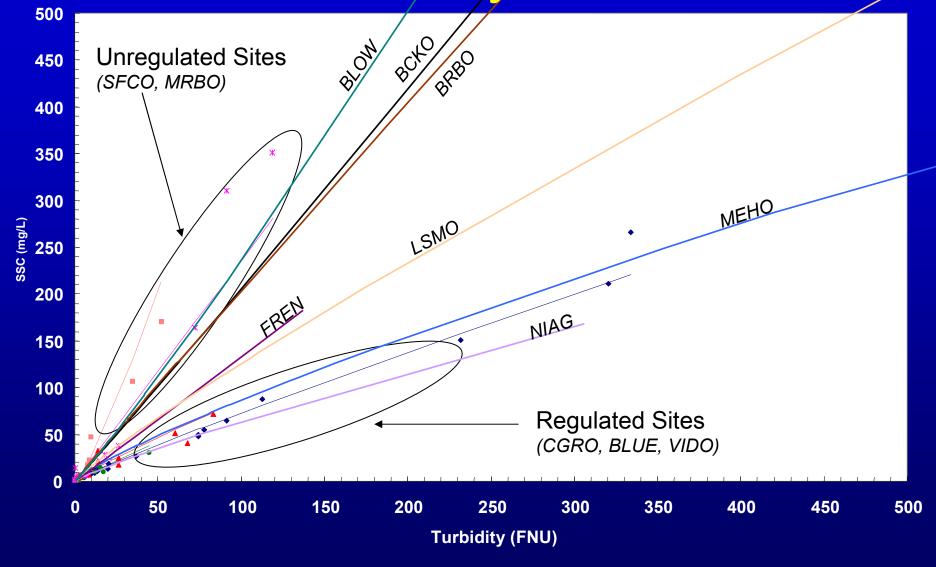
#### Conclusions—DDT

- DDT detected at low levels below Cougar but nowhere else
  - Probably transported downstream also but diluted by upstream sediment sources
  - Analytical issues may have obscured other DDT detections
- Concentration detected in sediment traps is about the same as detected in suspended sediment during storms, and in bank sediment (COE sampling)
- Reservoir may have acted as a sink prior to drawdown but a source during drawdown

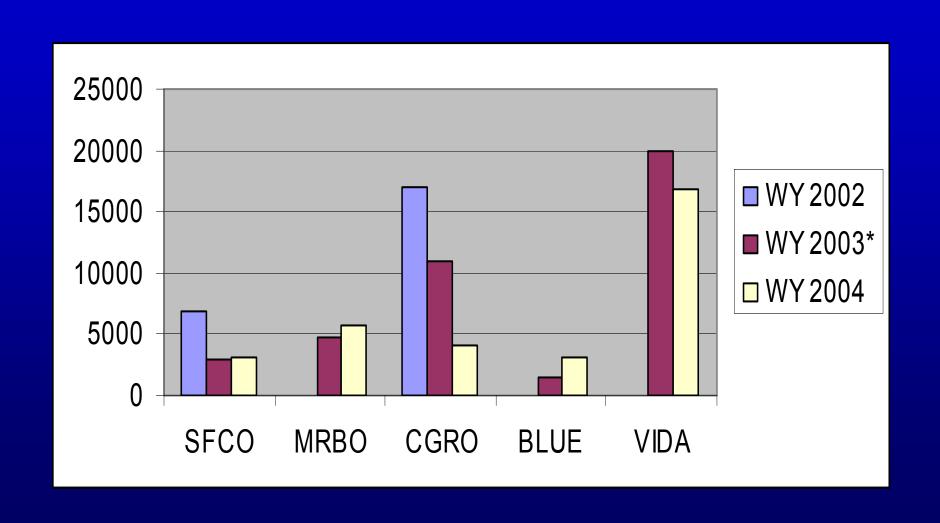
# **SSC-T Relationships**

- Turbidity (T) is a good surrogate for Suspended Sediment Concentration (SSC)
- SSC-Turbidity relationships for Santiam were used to estimate sediment discharge from Cougar in SIR
- Relationships are site specific lots of factors, clays, silts, sands have a different turbidity signature.
- SCC-T relationships are developed using sediment sampling over a range of flows
- Useful sediment management tool

# SSC-Turbidity Relations



## Sediment Management Report Card



#### More Information

- http://www.nwp.usace.army.mil/issues/wrt cp/cms/documents.asp
- Appendix C Reservoir Operational Modeling
- Appendix D Sediment (Estimated sediment released based on measured turbidity)

