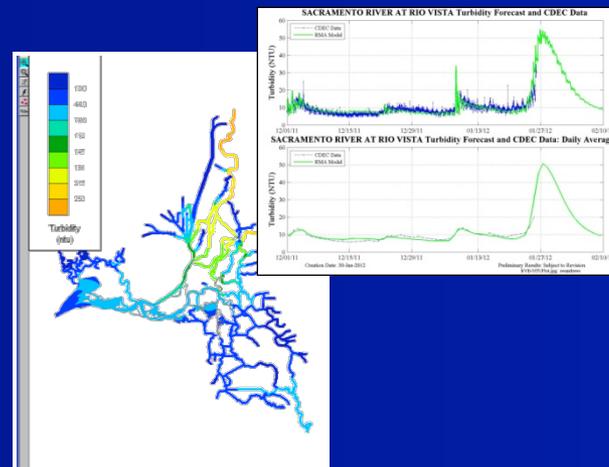


Forecasting Turbidity in the Sacramento-San Joaquin Delta

John DeGeorge, Ph.D.,
Marianne Guerin, Ph.D.
Richard Rachiele
Stephen Andrews, Ph.D.
Stacie Grinbergs, P.E.

Resource Management Associates, Inc.



Acknowledgements

- Funding provided by the Metropolitan Water District of Southern California (MWD)
- Collaborative effort with:
 - Chuching Wang and Paul Hutton, MWD
 - Joel Herr and Scott Sheeder, Systech Water Resources, Inc.
 - Dave and Amye Osti and their staff, 34 North and DeepBlu
- Special thanks to Jon Burau and the USGS for managing the new turbidity monitoring network

Forecasting Objectives

- Use recent observed data, DWR and CNRFC forecasts, and watershed model output to generate three week forecasts of EC, Turbidity, and adult delta smelt (particle) distribution
- Provide weekly forecasts for MWD, Fish and Wildlife Service, Smelt Working group, and others between December and March
- Provide tools for evaluating alternate operations
- This is the third year of the real-time modeling effort

Data Sources

- California Data Exchange Center (CDEC)
 - Recent monitoring data
- California-Nevada River Forecasting Center (CNRFC)
 - 5-day flow forecast
- DWR Operations and Maintenance (O&M) group
 - DSM2 3-week forecast input files
- CIMIS meteorological data
 - Daily and hourly data received weekly

Models and Tools

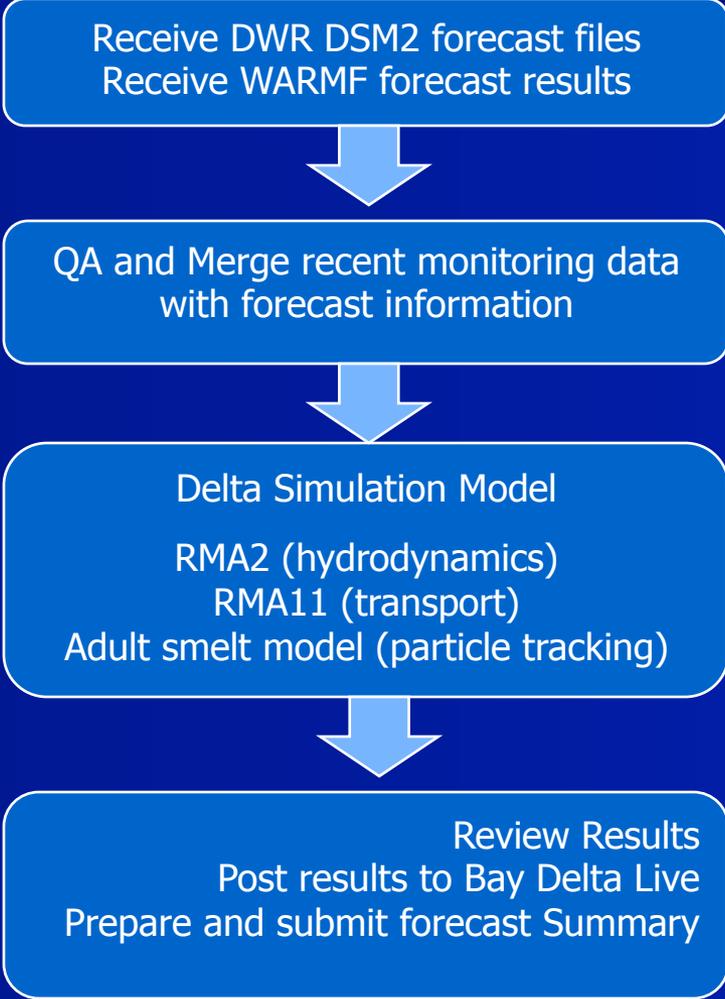
- WARMF –Watershed Analysis Risk Management Framework (WARMF) Central Valley developed and operated by Joel Herr and Scott Scheeder, Systech
- HEC-DSS Tools for Time Series Management
- RMA Delta Model – Hydrodynamics, EC, Turbidity
- RMA Adult Delta Smelt Particle Model
- Information Dissemination through Bay Delta Live developed and managed by Dave Osti and staff, 34North

Process

■ Thursday Afternoon

■ Friday

■ Monday Morning

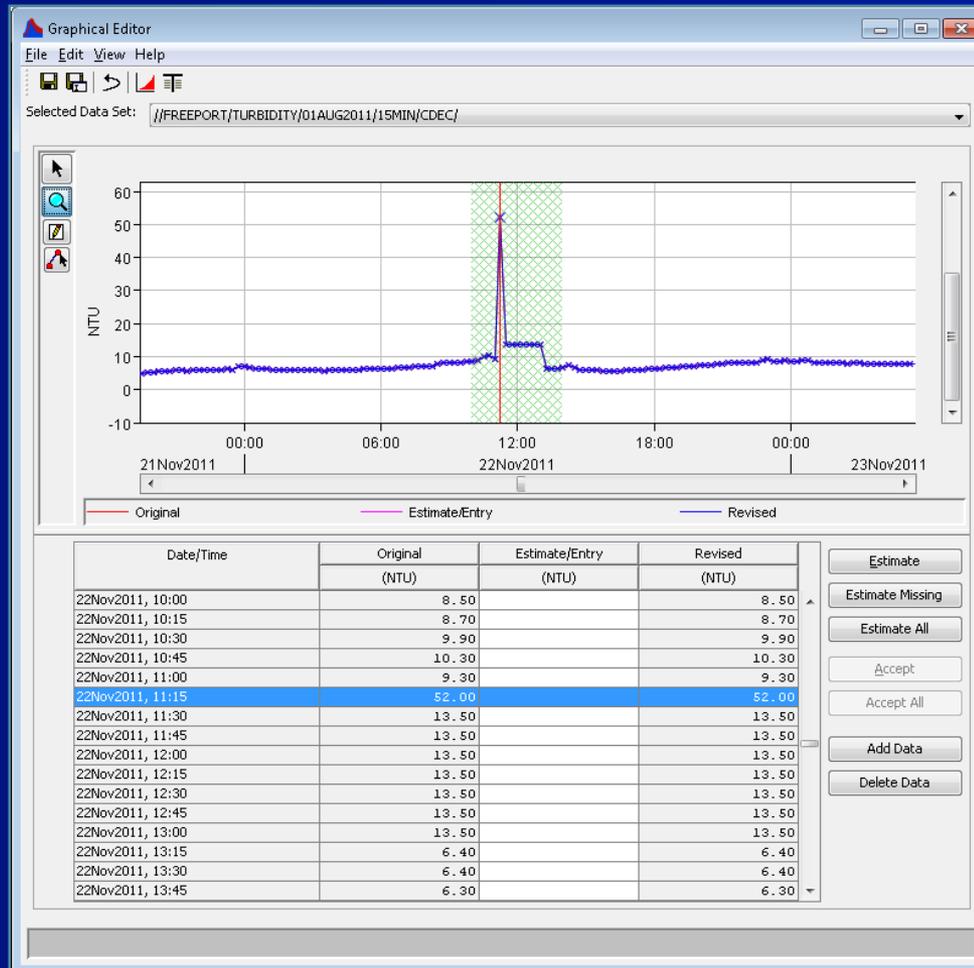


Managing Time Series

- Time Series stored in HEC-DSS format
- Automated download from CDEC web site through “plug-in” utility in HEC-DSSVue*
- QA with HEC-DSSVue Graphical Editor
- Merging of Time Series records with custom software tool
- RMA is a lead software development contractor for the USACE Hydrologic Engineering Center and has contributed extensively to the development of HEC-DSSVue

*<http://www.hec.usace.army.mil/software/hec-dss/hecdssvue-dssvue.htm>

DSSVue Graphical Editor



Merging Time Series

Merge Time Series Generator

File Edit Help

DSS Prev-Forecast Input File: C:\work\Real-Time\WY_2012_Forecasting\Compile\hindcast\Step1\Feb02_2012EC.dss

DSS Obs Data-CDEC Input File: C:\work\Real-Time\WY_2012_Forecasting\Compile\hindcast\Step1\hindcast_BC_Long.dss

DSS CNRFC Input File: C:\work\Real-Time\WY_2012_Forecasting\Compile\hindcast\Step1\Mar08_2012_CNRFC_And_I-St_rating_table.dss

DSS Forecast-WARMF Input File: C:\work\Real-Time\WY_2012_Forecasting\Compile\hindcast\Step1\forecast.dss

Stations File: C:\work\Real-Time\WY_2012_Forecasting\Compile\hindcast\Step1\FlowStationsForMerging.csv

Output DSS File: C:\work\Real-Time\WY_2012_Forecasting\Compile\hindcast\DWR\Mar09\final_merged_Mar05_2012.dss

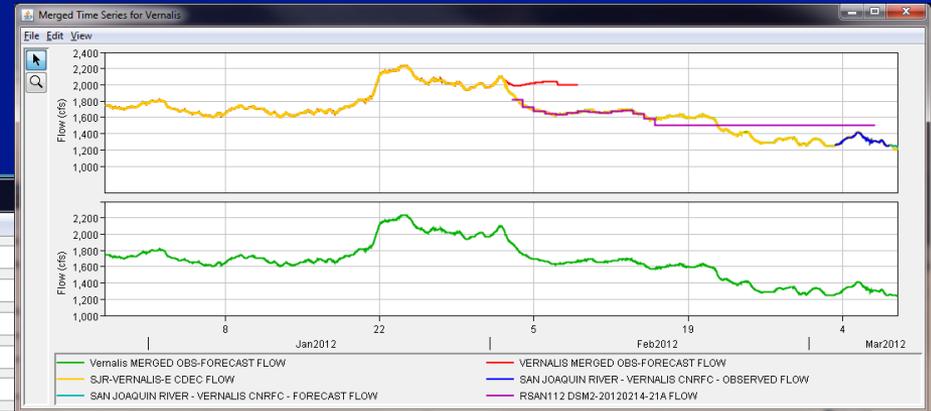
Start Date: 28Dec2011 Start Time: 0000 03MAR2012 09MAR2012

End Date: 08Mar2012 End Time: 2400

Parameter: FLOW

Select	Station Name	Prev-Forecast ID	Obs Data/CDEC ID	CNRFC ID	Forecast/WARMF ID	Merge Option	Time Shift (hrs)	Forecast Fill
<input type="checkbox"/>	Freeport	FREEPORT	CLEANED+FILLED/FREEPORT	SACRAMENTO RIVER - SACR...	FORE+CHAN/RSAC155		0.0	
<input checked="" type="checkbox"/>	Vernalis	VERNALIS	CLEANED+FILLED/SJR-VERN...	SAN JOAQUIN RIVER - VERN...	FORE+CHAN/RSAN112		0.0	
<input type="checkbox"/>	Yolo	YOLO	CLEANED+FILLED/YOLO-LIS...	YOLO BYPASS - LISBON	FORE+CHAN/BYLO040		0.0	
<input type="checkbox"/>	Cosumnes	ALL-OBSERVED/COSUMNES		COSUMNES RIVER - MCCON...	FORE+CHAN/RCSM075		0.0	
<input type="checkbox"/>	Mokelumne	MOKELUMNE			FORE+CHAN/RMKL070		0.0	
<input type="checkbox"/>	Calaveras	CALAVERAS	CLEANED+FILLED/MORMON...		FORE+CHAN/RCAL009		0.0	

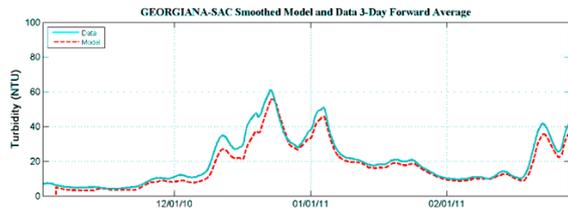
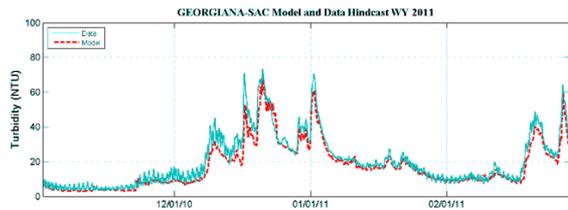
Select All Deselect All Plot Station Time Series Output Merged TS File



Turbidity Model

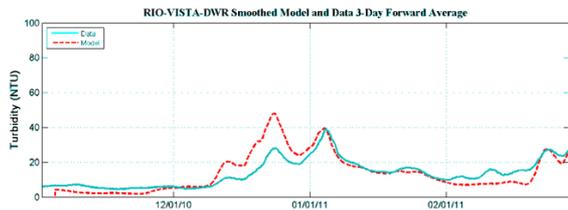
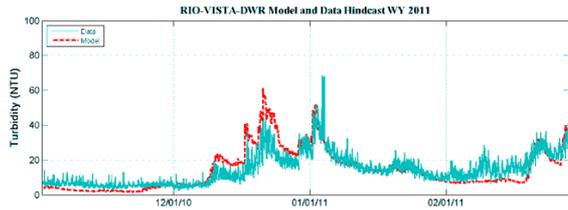
- Simulation of turbidity in the Delta as a function of tributary loading
- Uses a simple first order decay to represent averaged deposition/resuspension of suspended sediments or decay of organics
- An interim approach until a full sediment model is available (work is underway)
- Originally calibrated for 2007 conditions, updated for 2011 conditions
 - Project Reports: Resource Management Associates, Inc. (RMA), 2008. “San Francisco Bay-Delta Turbidity Modeling”, and Resource Management Associates, Inc. (RMA), 2011. Turbidity and Adult Delta Smelt Forecasting with RMA 2-D Models: December 2010 – February 2011, prepared for Metropolitan Water District of Southern California.

2011 Turbidity Hindcast Results



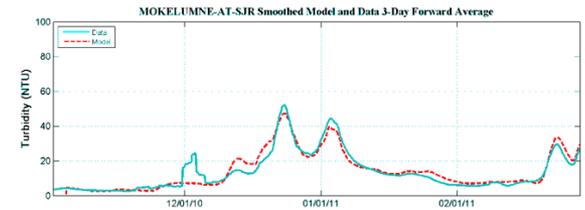
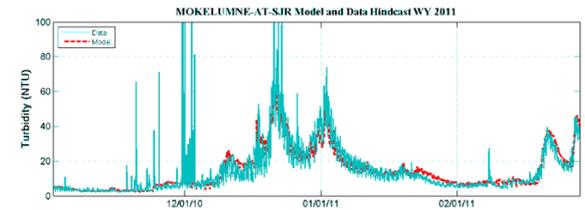
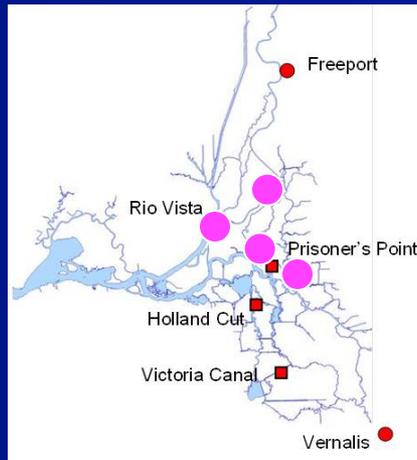
Creation Date: 15-Apr-2011

GEORGIANA-SAC_Turb_exp.mxd



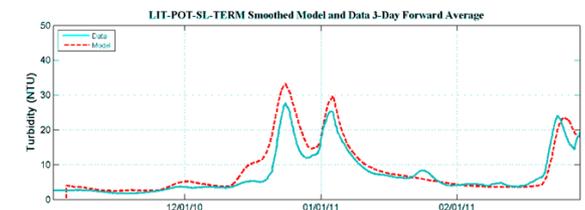
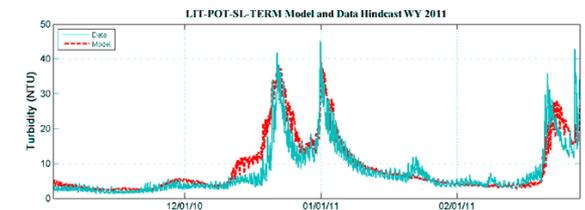
Creation Date: 15-Apr-2011

RIO-VISTA-DWR_Turb_exp.mxd



Creation Date: 15-Apr-2011

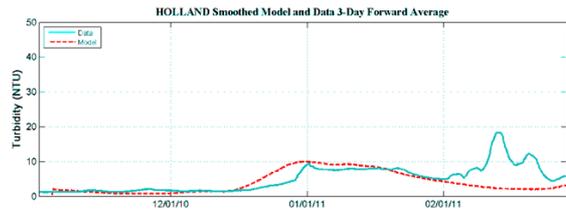
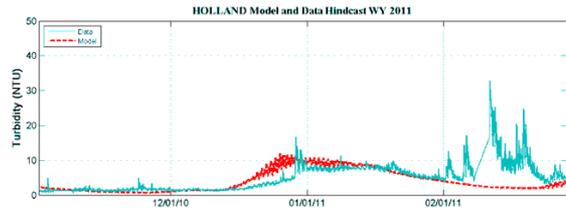
MOKELUMNE-AT-SIR_Turb_exp.mxd



Creation Date: 15-Apr-2011

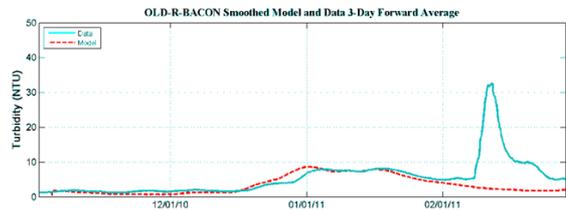
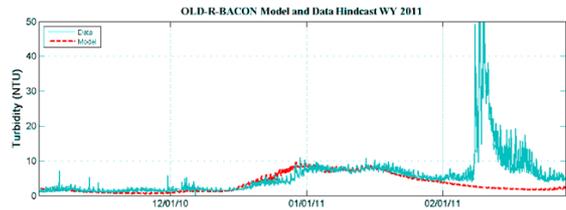
LIT-POT-SL-TERM_Turb_exp.mxd

2011 Turbidity Hindcast Results



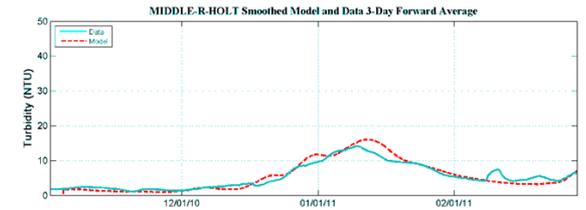
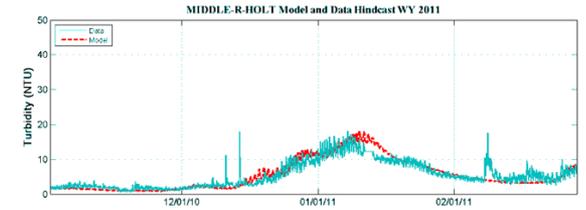
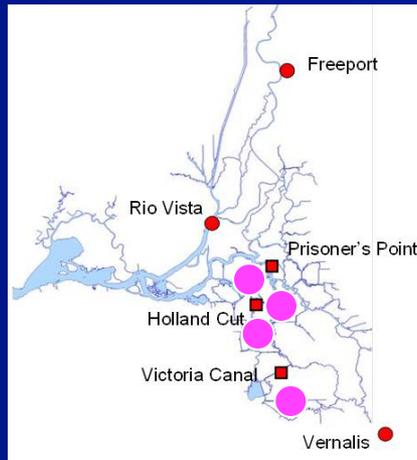
Creation Date: 15-Apr-2011

HOLLAND_Turb.spcrta



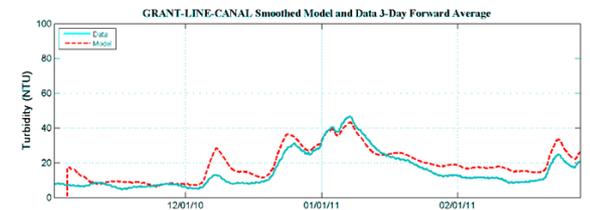
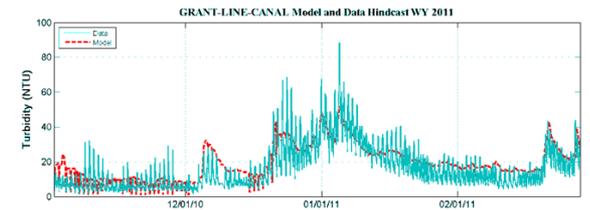
Creation Date: 15-Apr-2011

OLD_R_BACON_Turb.spcrta



Creation Date: 15-Apr-2011

MIDDLE_R_HOLT_Turb.spcrta



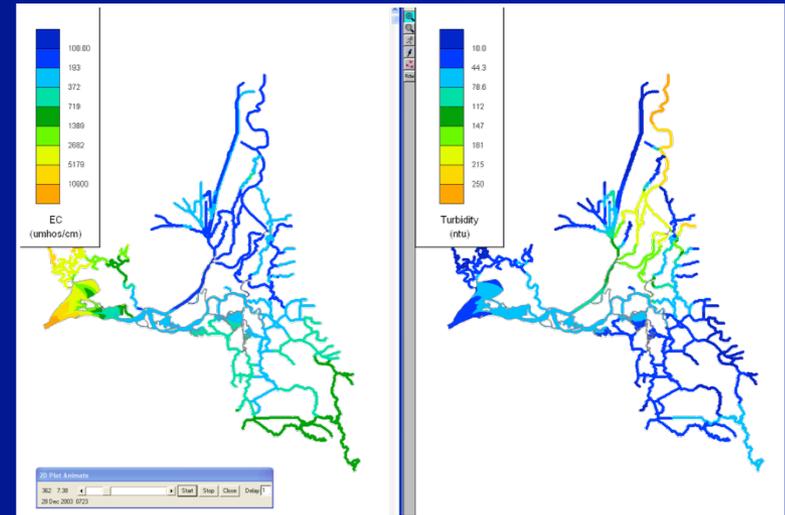
Creation Date: 15-Apr-2011

GRANT_LINE_CANAL_Turb.spcrta

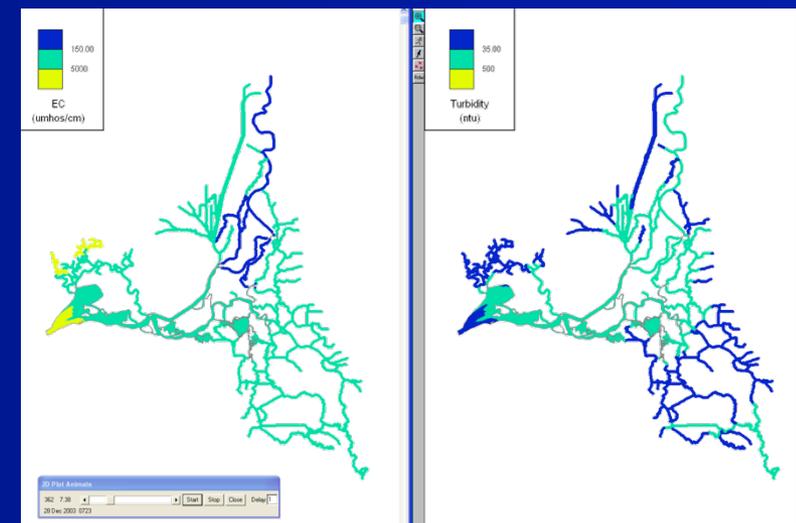
Adult Delta Smelt Particle Model

- All movement is accomplished by “surfing” the tidal flows
- Move away from high EC (representing desire to move upstream)
- Move toward higher (favored) turbidity
- Randomly explore region of acceptable habitat
 - Project Report: Resource Management Associates, Inc. (RMA), 2009a “Particle Tracking and Analysis of Adult and Larval/Juvenile Delta Smelt for 2-Gates Demonstration Project”, prepared for Metropolitan Water District of Southern California.

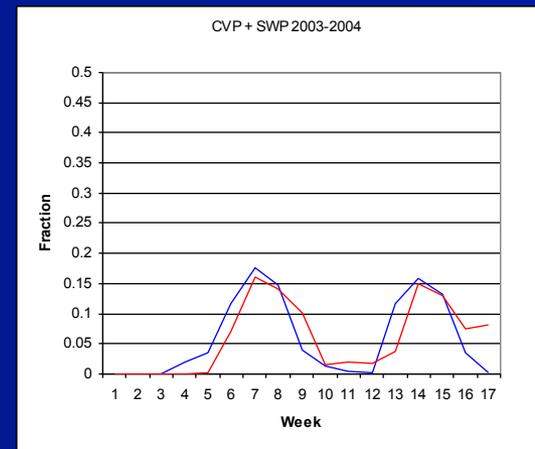
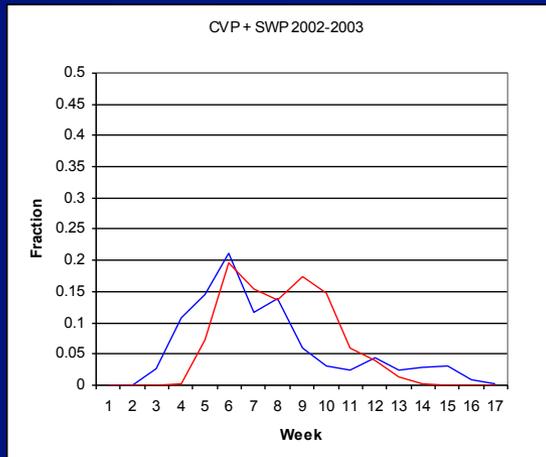
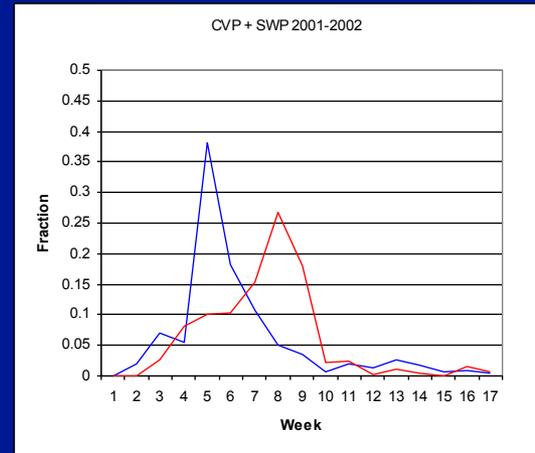
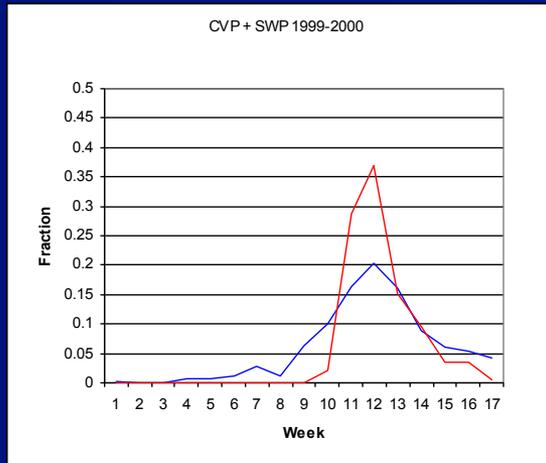
EC and Turbidity Distribution



Favored Range



Comparison of Adult Delta Smelt Particle Entrainment (CVP +SWP) to Observed Salvage (Normalized Weekly counts)



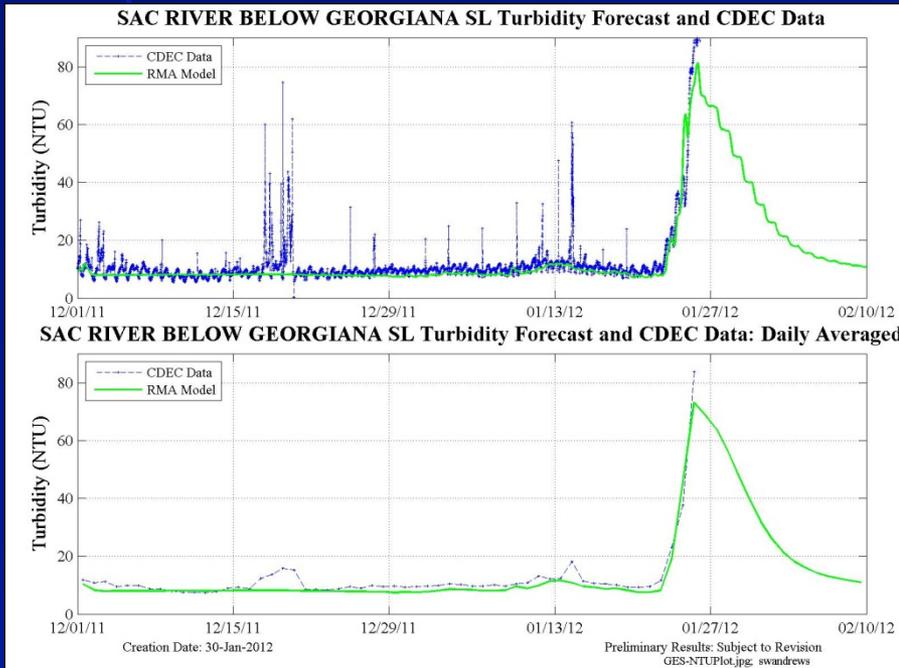
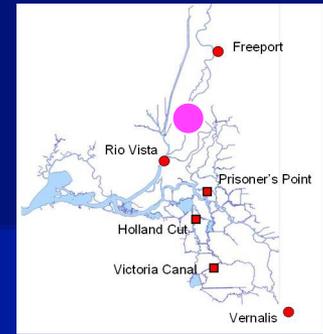
— Predicted — Observed

Forecast Products

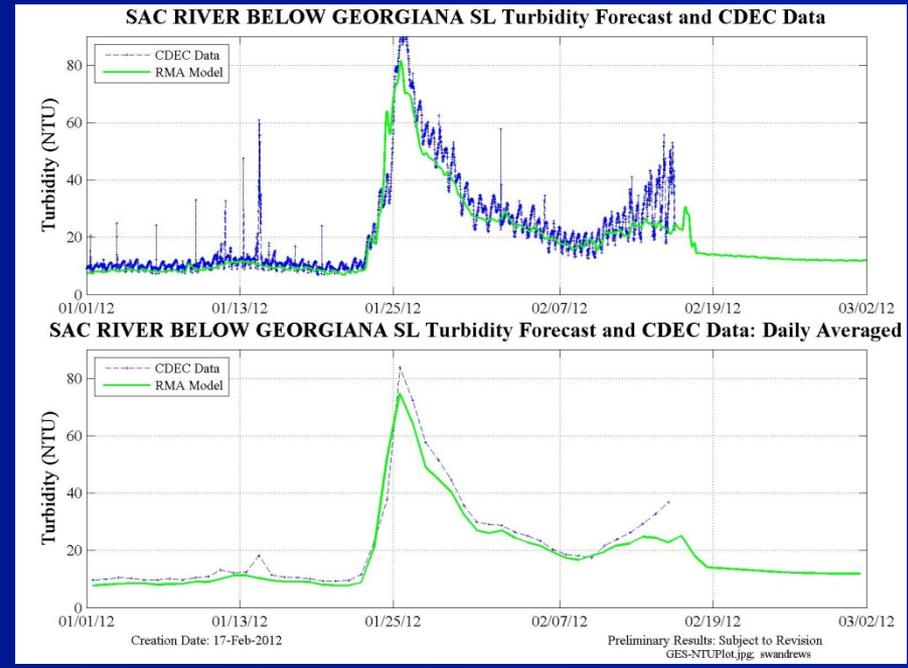
- Summary Assessment
 - Pre-Forecast
 - Turbidity 3-Stations Performance and Summary
 - Smelt (Particle) Movement Summary
- Forecast Boundary Conditions
 - Tributary Inflows and Turbidity
 - Exports
 - Tidal Boundary
- Simulation Output
 - Turbidity time series at 3 compliance stations, SWP, and other in-Delta locations
 - Smelt (particle) distribution at three times during simulation period and time series of estimated particle entrainment at SWP/CVP

Turbidity Forecast Results

Sac River below Georgiana Sl.

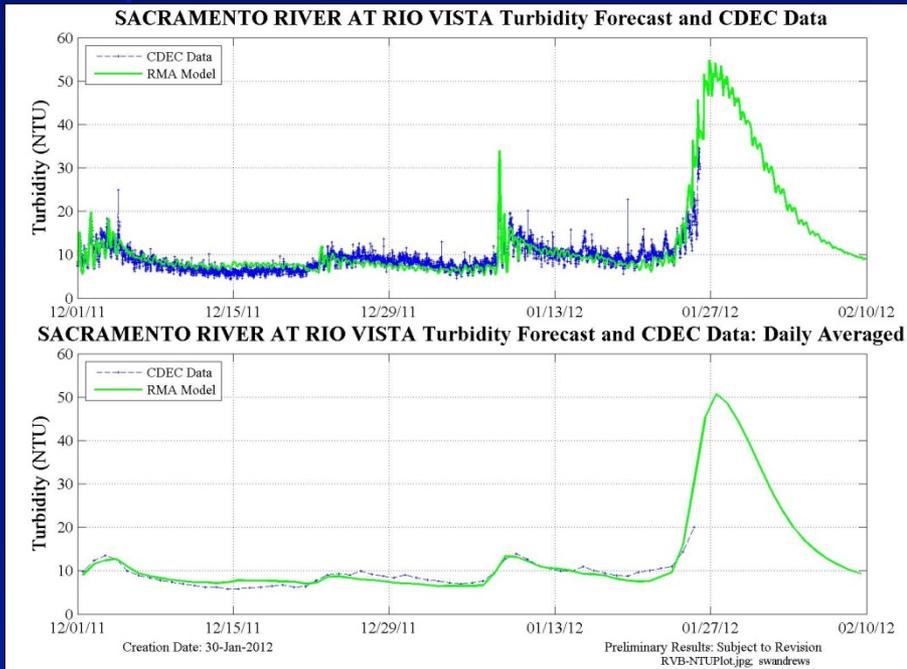
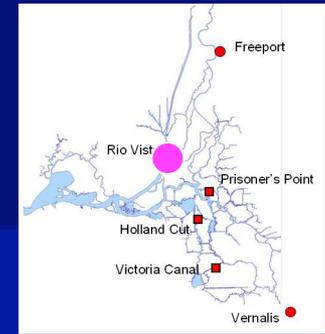


January 26, 2012 Forecast

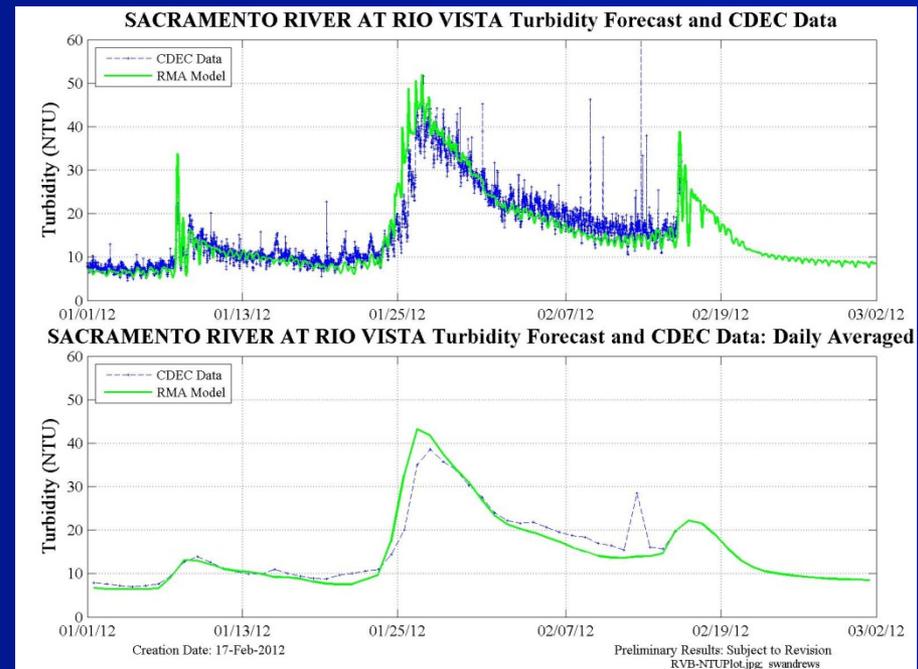


February 16, 2012 Forecast

Turbidity Forecast Results Sac River at Rio Vista

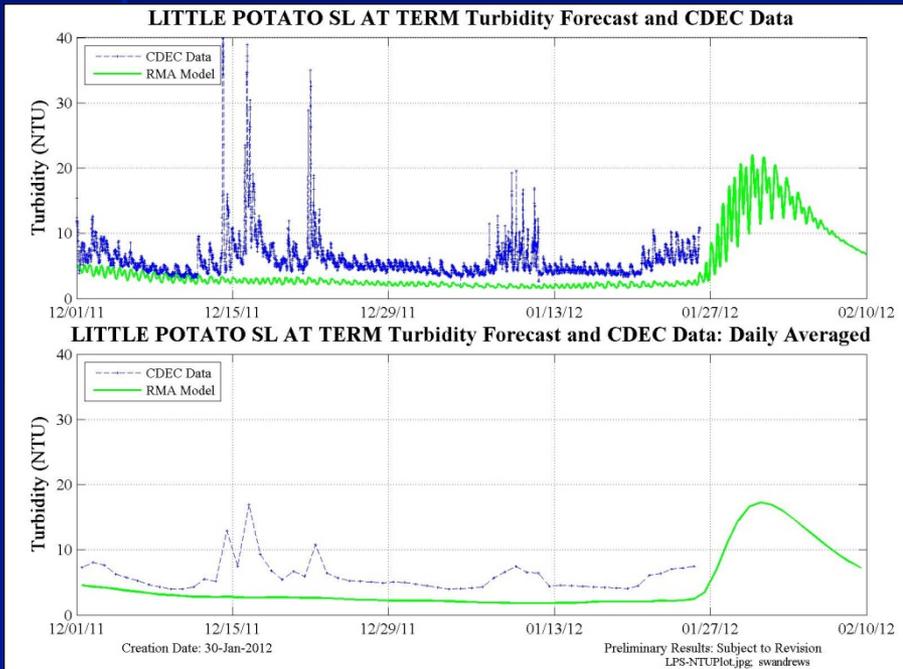
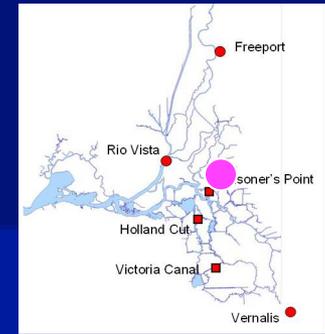


January 26, 2012 Forecast

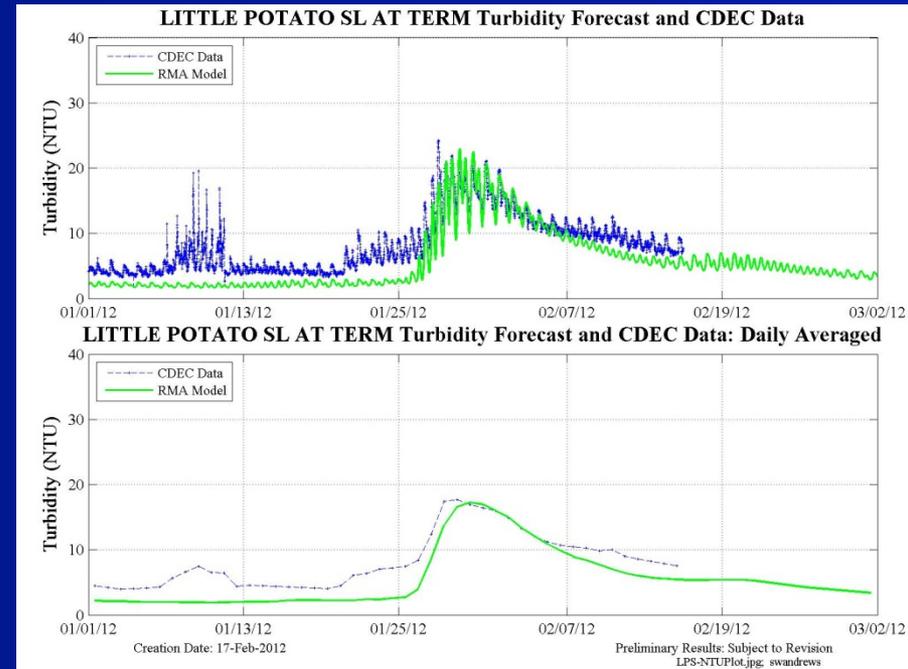


February 16, 2012 Forecast

Turbidity Forecast Results Little Potato Sl. At Terminous

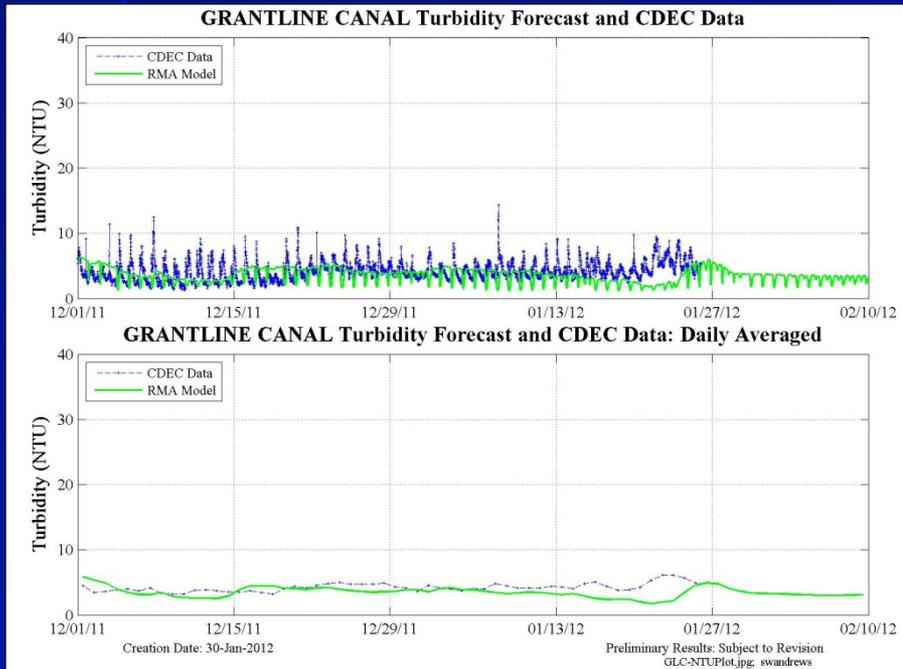
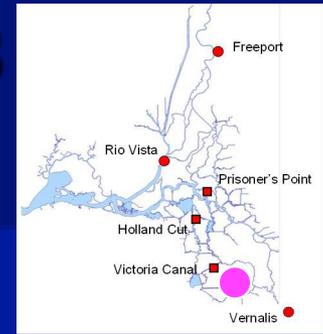


January 26, 2012 Forecast

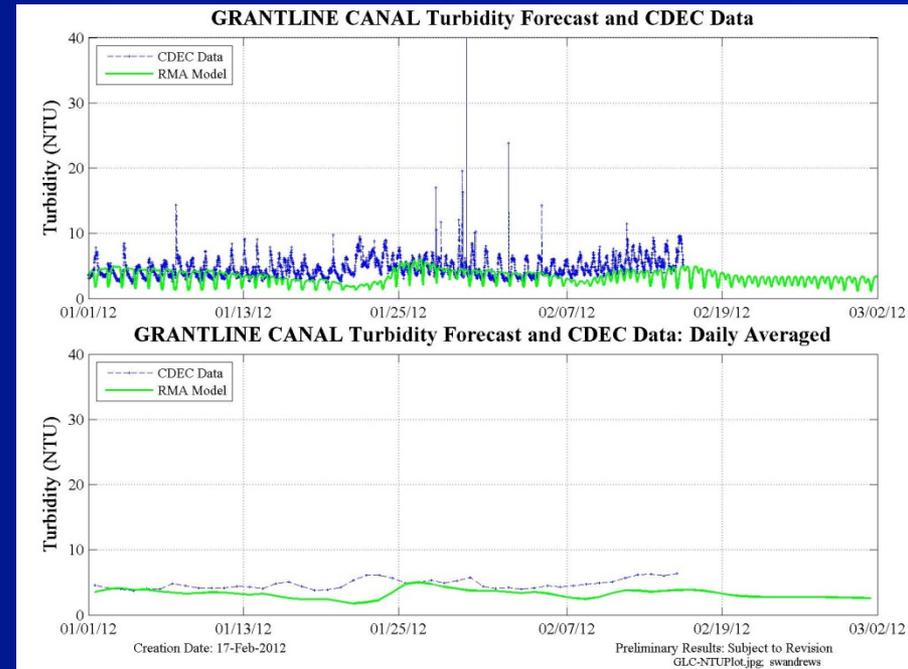


February 16, 2012 Forecast

Turbidity Forecast Results Grant Line Canal

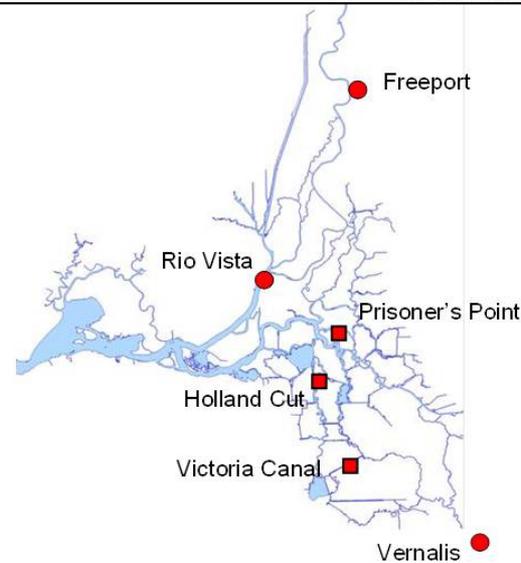
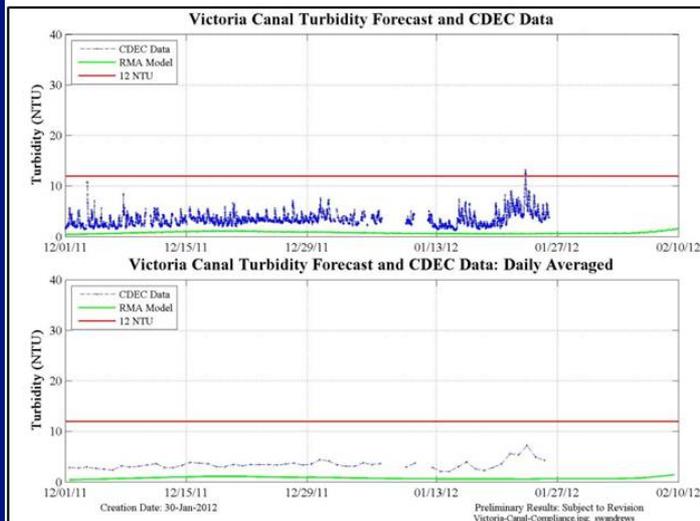
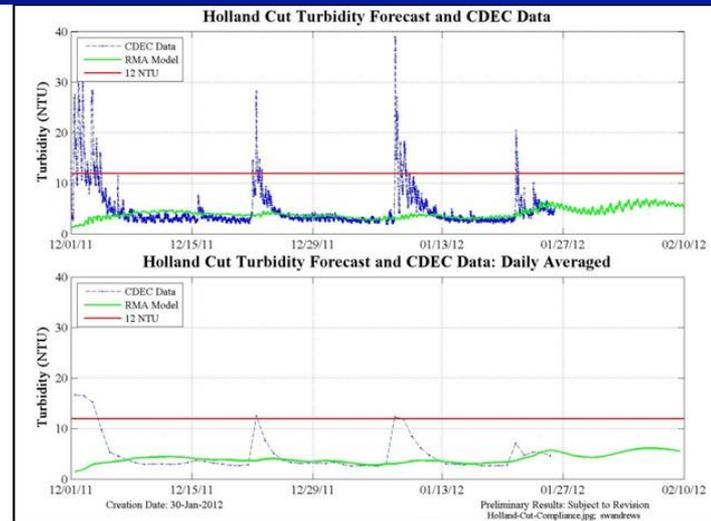
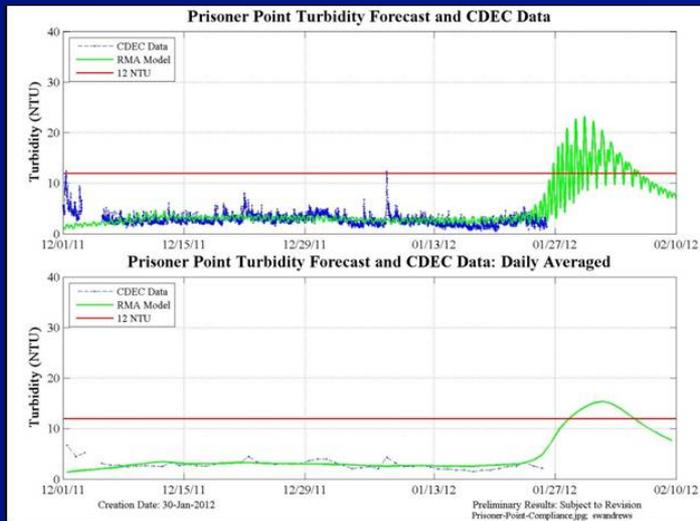


January 26, 2012 Forecast

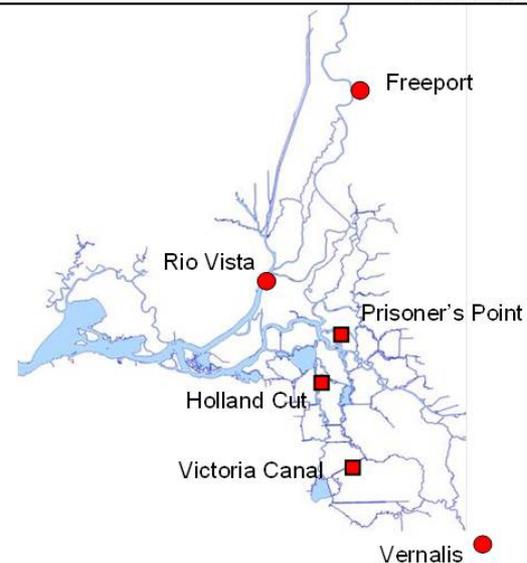
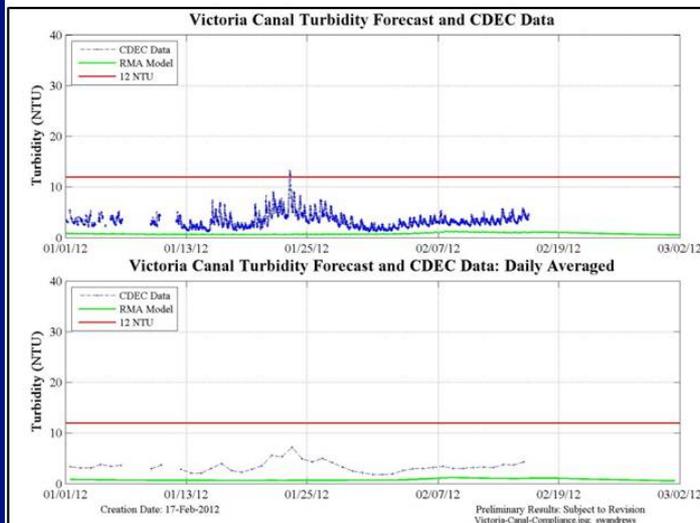
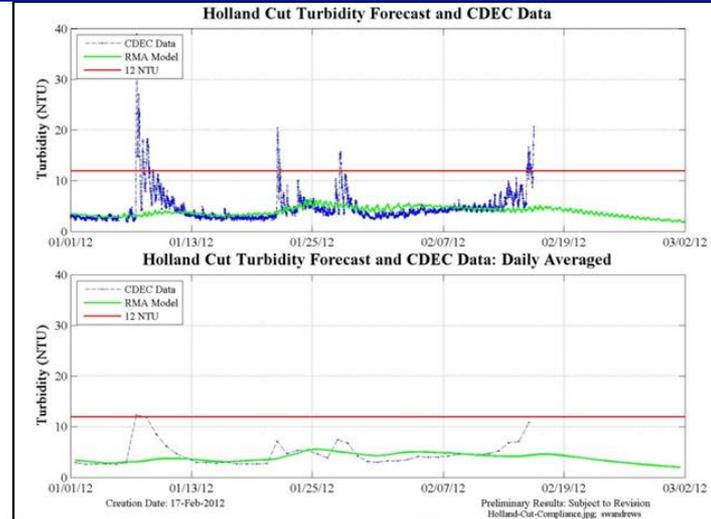
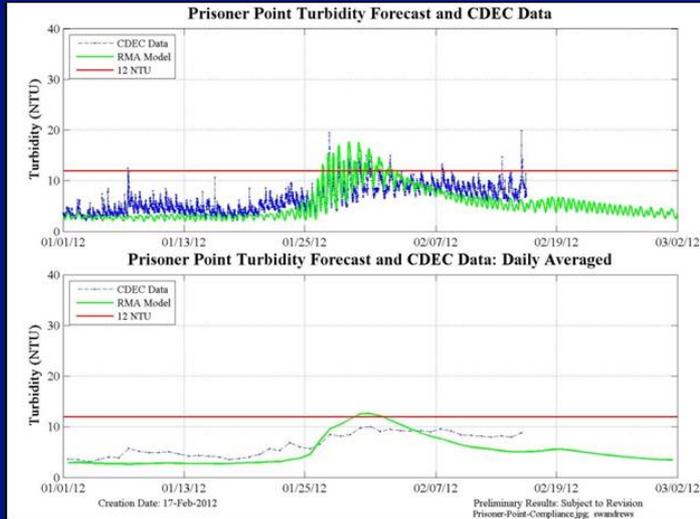


February 16, 2012 Forecast

Turbidity Forecast Results Three Compliance Locations



Turbidity Forecast Results Three Compliance Locations



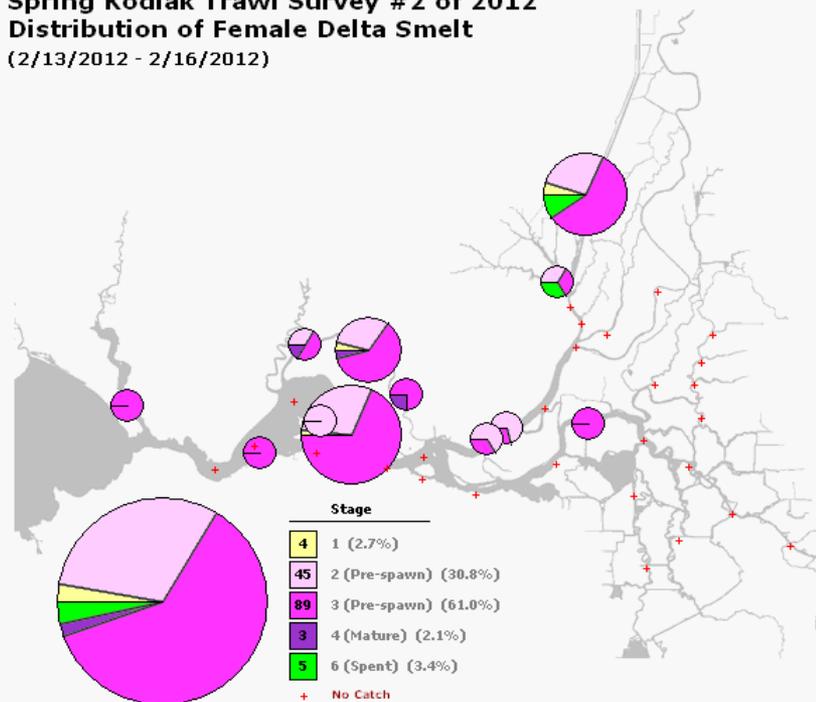
Kodiak Trawl Survey and Particle Distribution Maps

Delta Smelt Distribution Maps

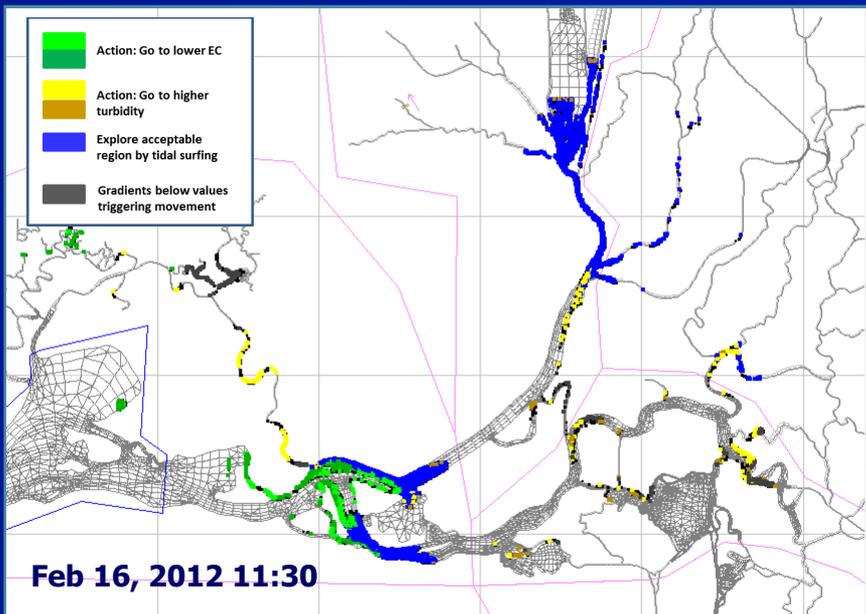
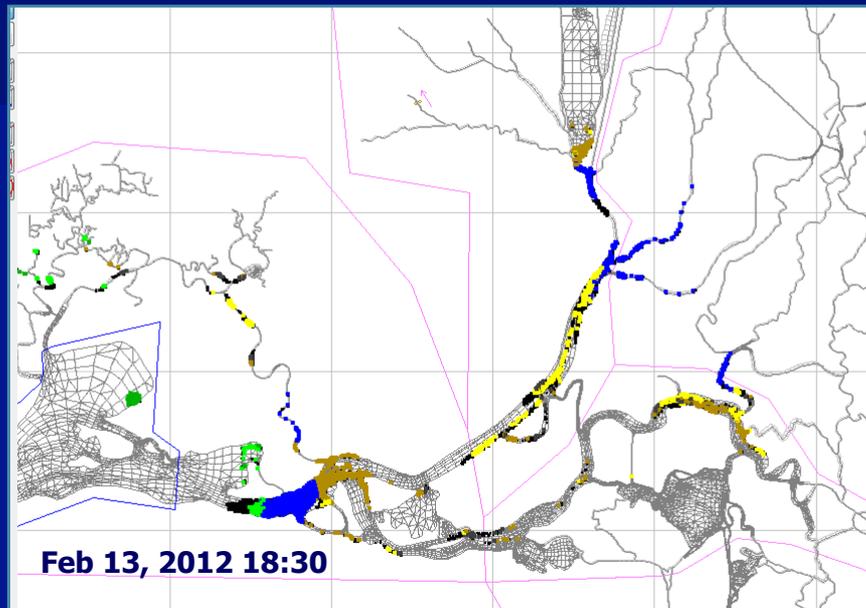
Year	Survey	Report Type	Show	Zoom	
2012	2	Females	Normal	1x (Normal)	Display Map

To view station details, move mouse over center of pie chart.

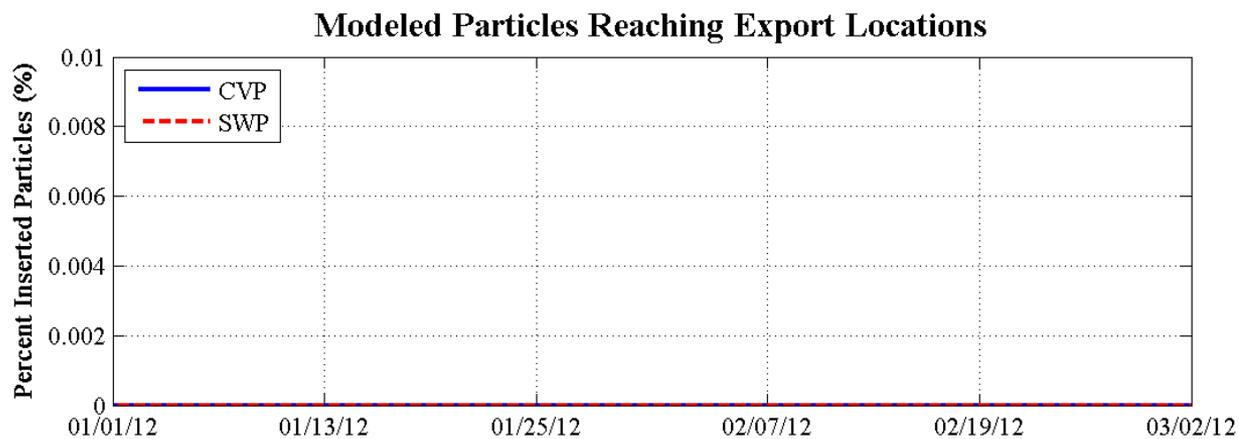
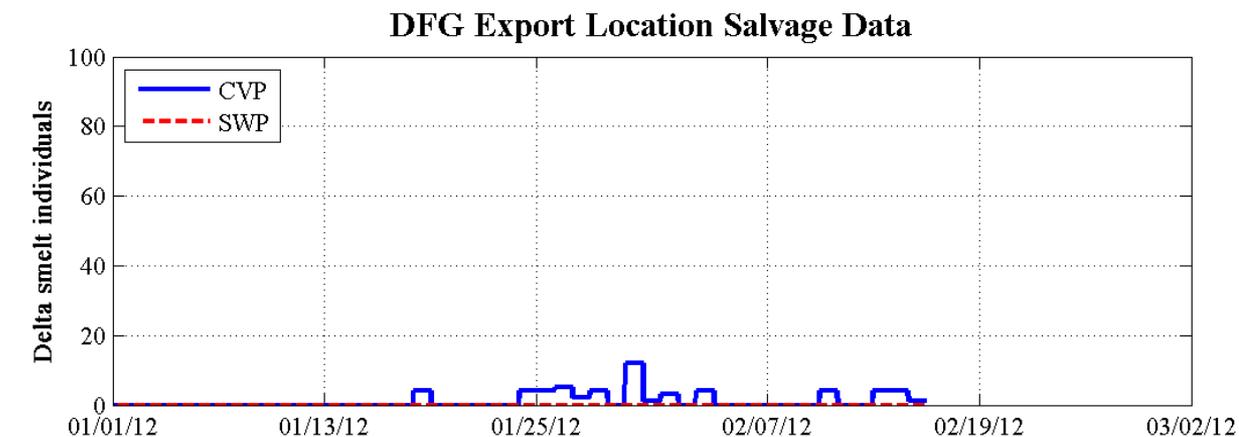
Spring Kodiak Trawl Survey #2 of 2012 Distribution of Female Delta Smelt (2/13/2012 - 2/16/2012)



www.dfg.ca.gov/delta/data/skt/DisplayMaps.asp



Comparison of DFG export salvage data and simulated particle entrainment



Creation Date: 17-Feb-2012

Preliminary Results: Subject to Revision
part-Results.jpg, swandrews

Bay Delta Live – Color Contour Map Display

www.baydeltaalive.com

The screenshot shows the Bay Delta Live website interface. At the top, there is a navigation bar with tabs for Live Conditions, Operations, Data Visualizations (highlighted), Map Builder, Photos/Video, Projects, Wiki, and Login. Below this is a search bar and a weather widget for Rio Vista, CA (53.6°). The main content area features a sidebar on the left with a 'Main' tab and a 'Search' tab. The central part of the page displays a color contour map of the Bay Delta region, showing various locations and waterways. The map is overlaid with a color scale ranging from 1.2 (dark blue) to 100.0 (magenta). Below the map, there are controls for 'Start Date' (2012-2-7), 'End Date' (2012-2-29), 'Duration' (1 hour), and 'Increment' (1 hour). A 'Map Menu' is visible on the right side of the map. The bottom of the page includes a 'Related Maps' section.

Map Controls

Animation Controls

Bay Delta Live – Supporting Documents

www.baydelta.com

The screenshot shows the Bay Delta Live website interface. The main content area displays a document titled "RMA Turbidity and Adult Delta Smelt Behavioral Model Covering the Forecast Period February 16, 2012 to March 1, 2012". The document includes a date of February 17, 2012, and lists authors: Chuching Wang, Paul Hutton, Marianne Guerin, and Steve Andrews. A "Summary Assessment" section follows, detailing the forecast period and providing a "PRE-FORECAST SUMMARY" and "TURBIDITY 3-STATIONS PERFORMANCE & SUMMARY EVALUATION". A "SMELT MOVEMENT SUMMARY" is also present. The page features a navigation menu with tabs for PDF, Article, Maps, Images, and Related Docs / Results. A map of the Delta region is shown on the left side of the document. The website header includes navigation links for Live Conditions, Operations, Data Visualizations, Map Builder, Photos/Video, Projects, Wiki, and Login. The page also includes a search bar and a "load now" button.

Model
Methodology
And
Assumptions

Model
Calibration
Report
Links

Smelt
Distribution
Map

Forecast
Summary
(shown)

Conclusions

- Successfully implemented a near real-time forecasting procedure for flow, EC, turbidity, and particle distribution
- Excellent progress integrating with the WARMF model for improved forecasting
- Produced weekly reports and results for dissemination through the Bay Delta Live web site
- Future efforts
 - Working toward transition to sediment modeling for turbidity simulation
 - RMA has performed temperature modeling with DSM2 and RMA Delta model for BDCP that could be included as part of real-time work

Contact Information

- John DeGeorge, Ph.D.
- Resource Management Associates, Inc.
- 4171 Suisun Valley Road, Suite J
- Fairfield, CA 94534
- 707 864-2950
- jfdegeorge@rmanet.com
- www.rmanet.com