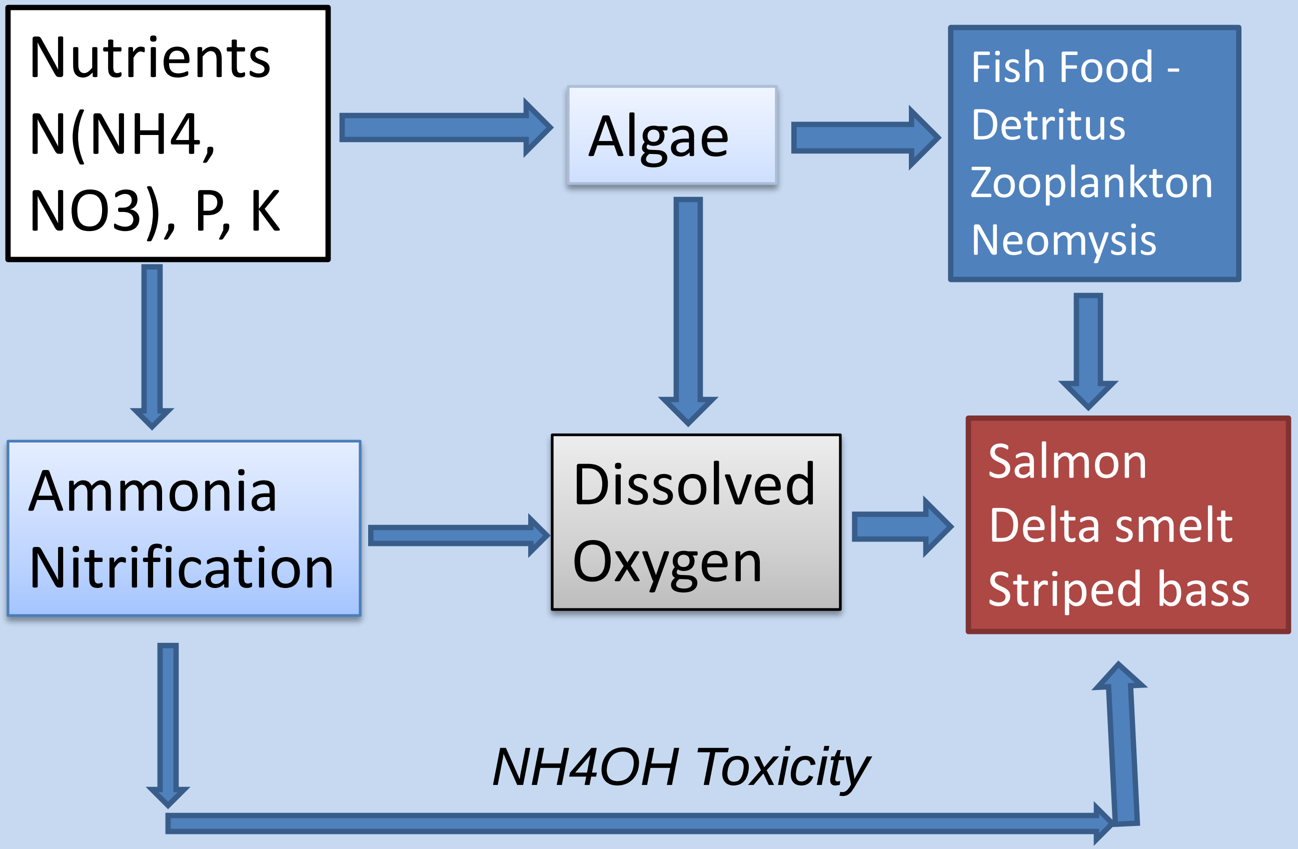
Upstream Sources of Ammonia and Nutrient Dynamics in the Watershed

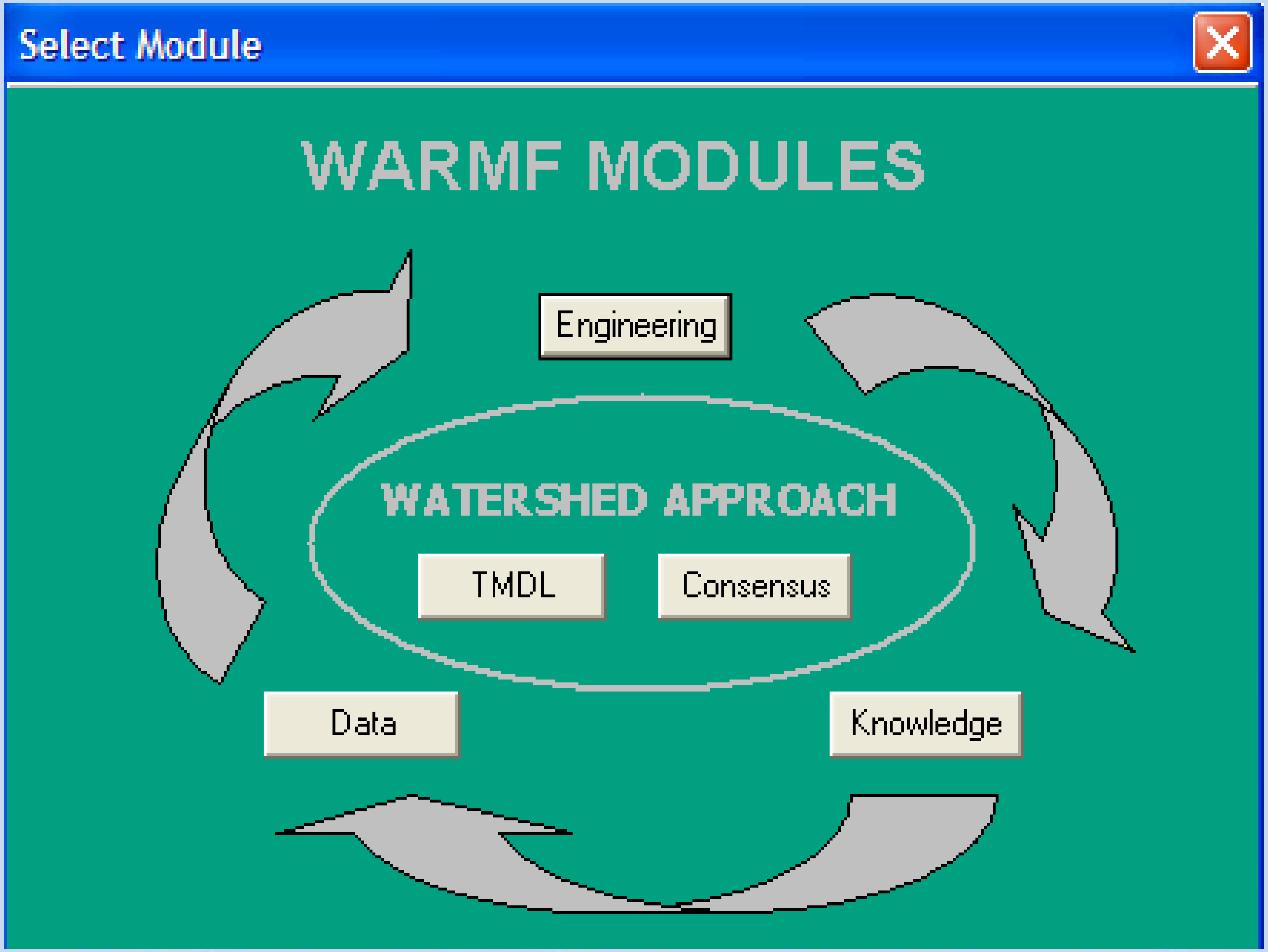
CWEMF Ammonia Technical Briefing
October 28, 2011

Carl Chen and Joel Herr
Systech Water Resources, Inc.

Why Ammonia Is Important



Model Used



Select Module
WARMF MODULES
Engineering
WATERSHED APPROACH
TMDL
Consensus
Data
Knowledge

Data Module

- Import GIS data of DEM, land uses, soil characteristics, septic systems.
- Import time series data of point source discharges and pollutants concentrations.
- Import time series data of meteorology, rain and air quality, managed reservoir releases, diversions, irrigations, fertilizer applications, and animal droppings.

Dynamic Watershed Model

- Use DEM data to delineate land catchments and stream segments and form a network for flow and pollutant routing.
- Input land uses (crop types) and soil data (layers).
- Apply daily irrigation water and fertilizer to crop land.
- Simulate hourly surface and groundwater hydrology resulting from rainfalls, man-made irrigation and flow diversions.
- Simulate hourly water quality by accounting for atmospheric deposition, cation exchange, wash off, leaching, nutrient uptake (plants and alga), and chemical transformation.
- Calibrate model coefficients to match the simulated flow and water quality to available observed data.

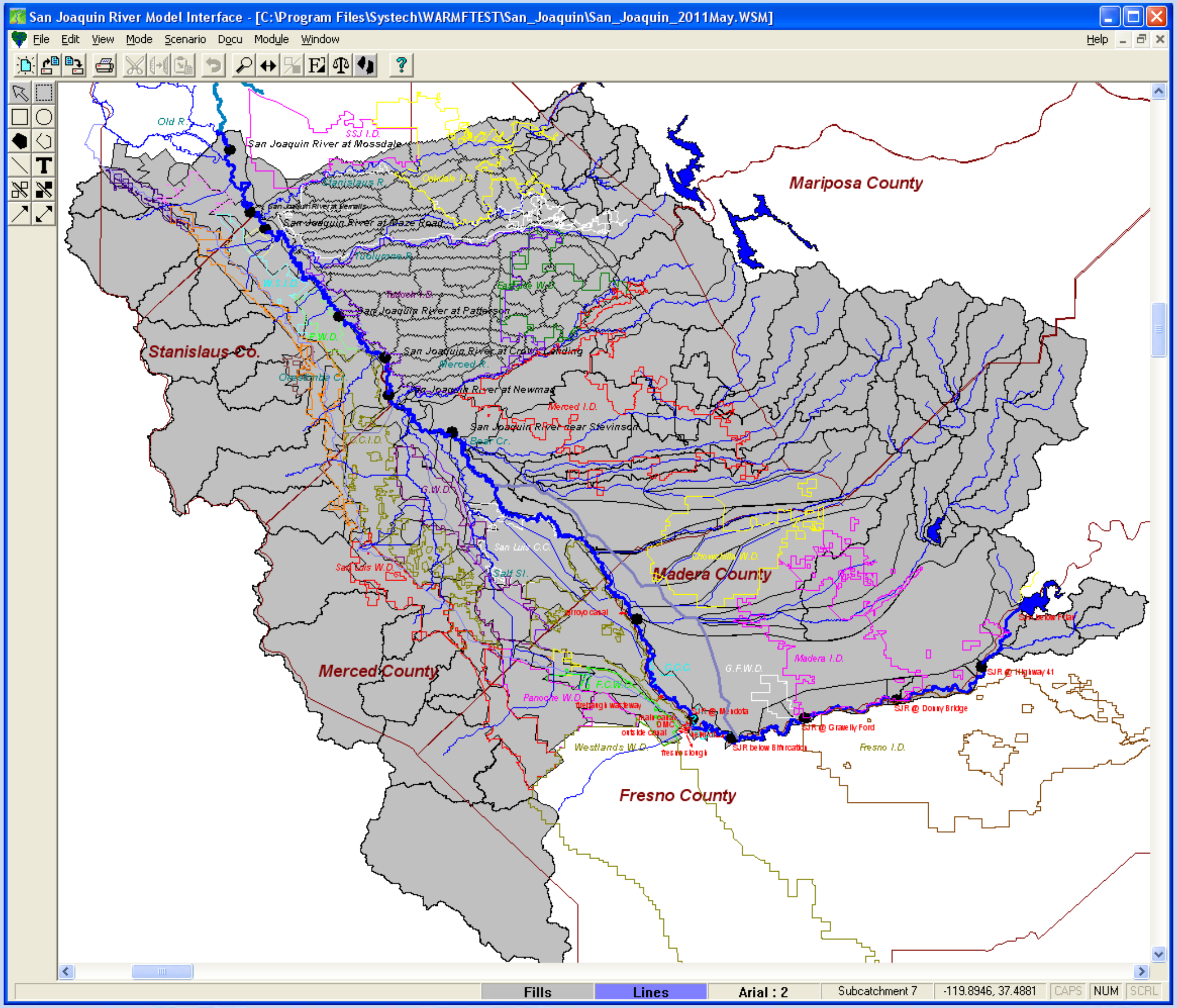
Knowledge Module

- Scientific definitions of model coefficients and their default values.
- Documents of rule and regulations.
- Documents of research findings.
- Documents of knowledge gained in current study.

Modules for Stakeholder Process

- TMDL module – road map to calculate total maximum daily load of point and nonpoint source pollution to meet the water quality criteria of intended beneficial uses.
- Consensus module – road map to formulate alternatives, run model, identify scientifically feasible alternatives, refine and vote for a politically acceptable cost-effective plan.

San Joaquin River Basin



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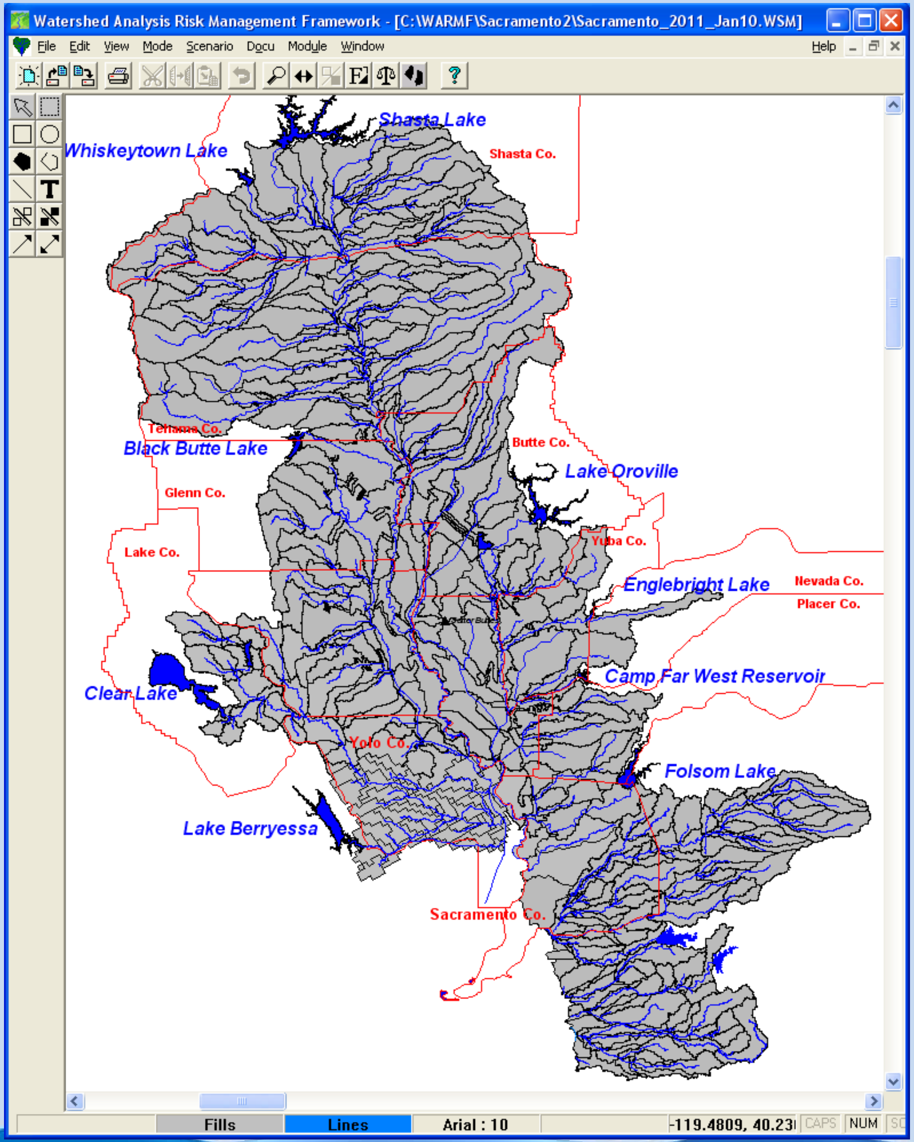
Sacramento River Basin



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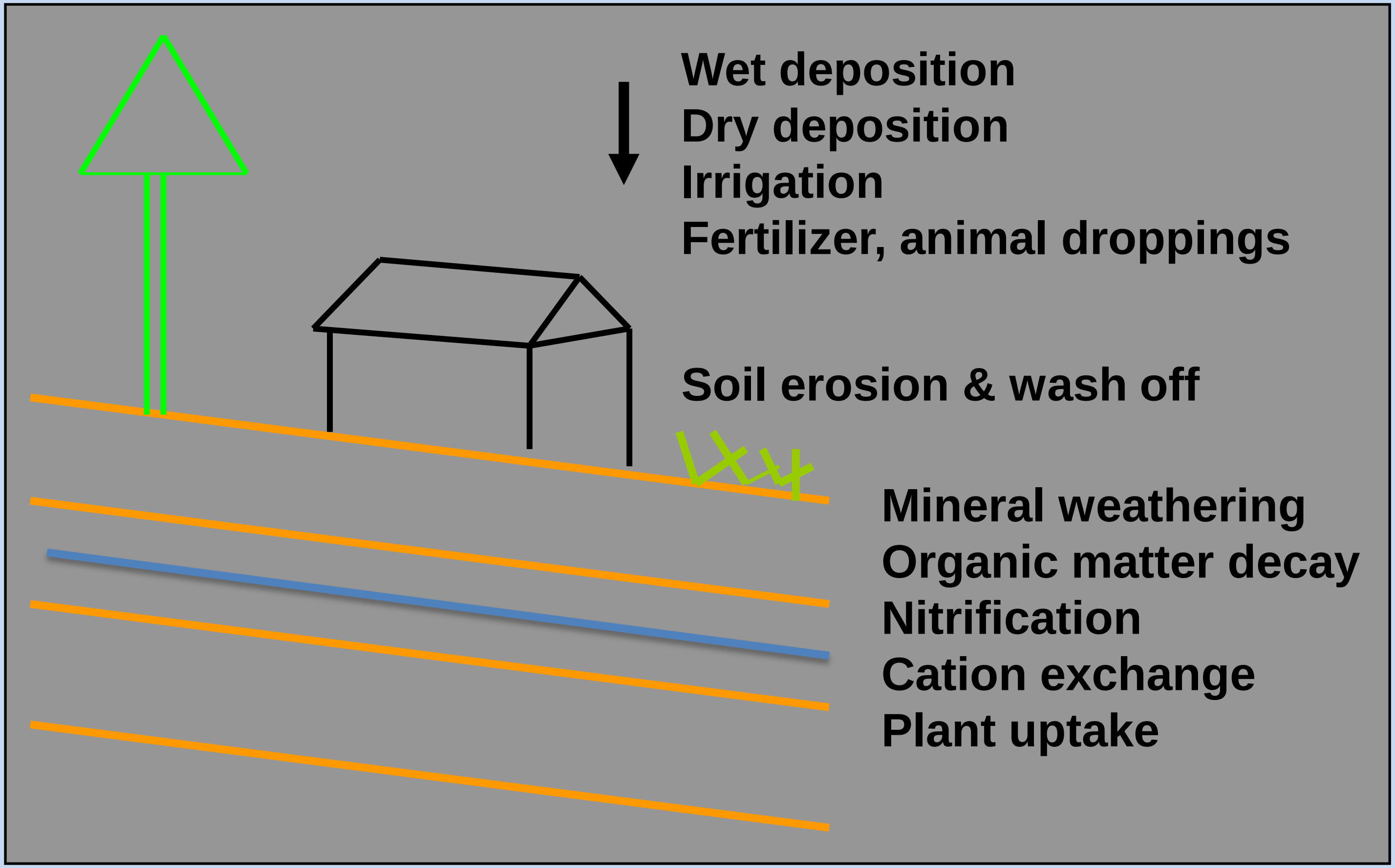
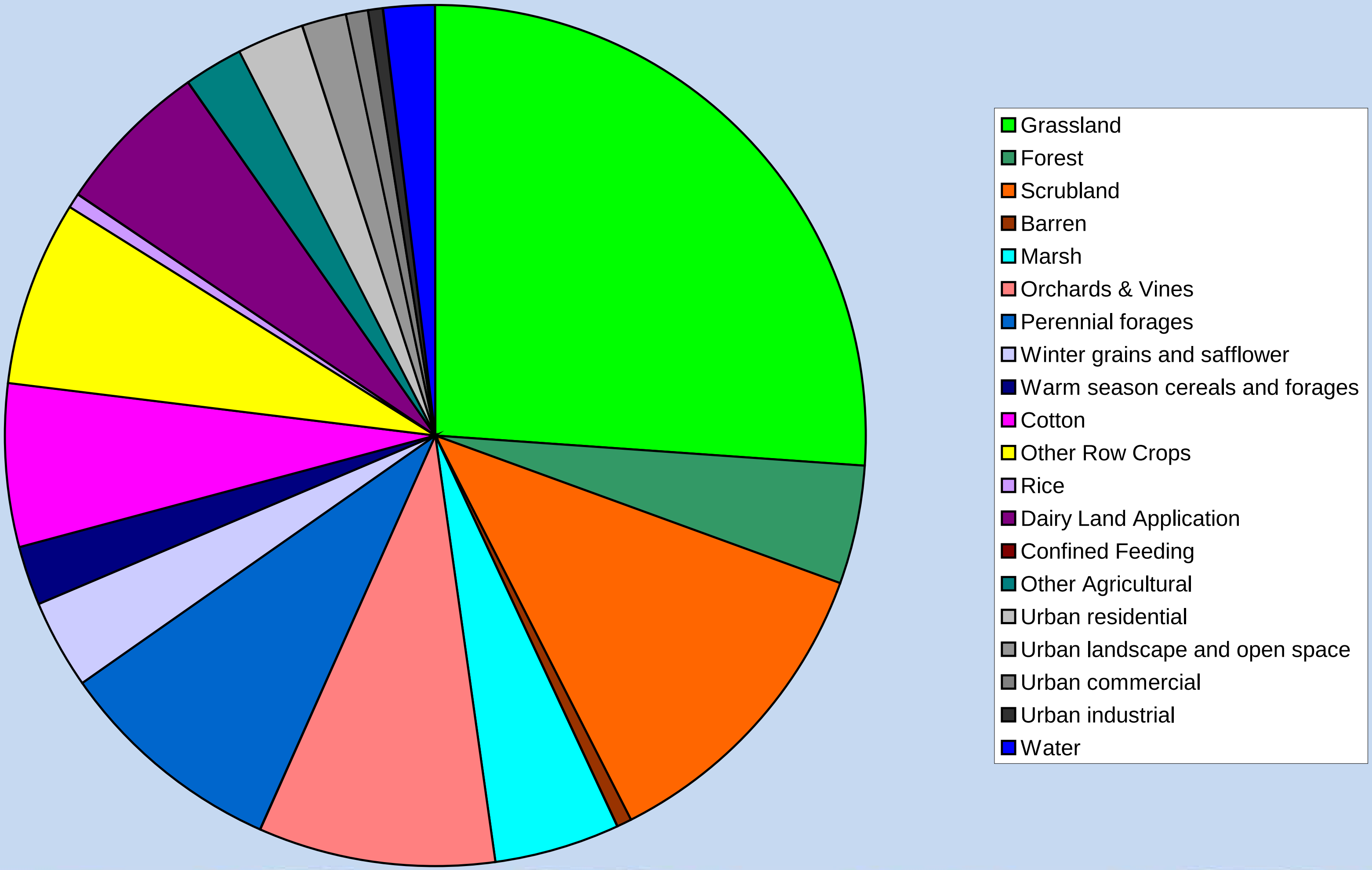
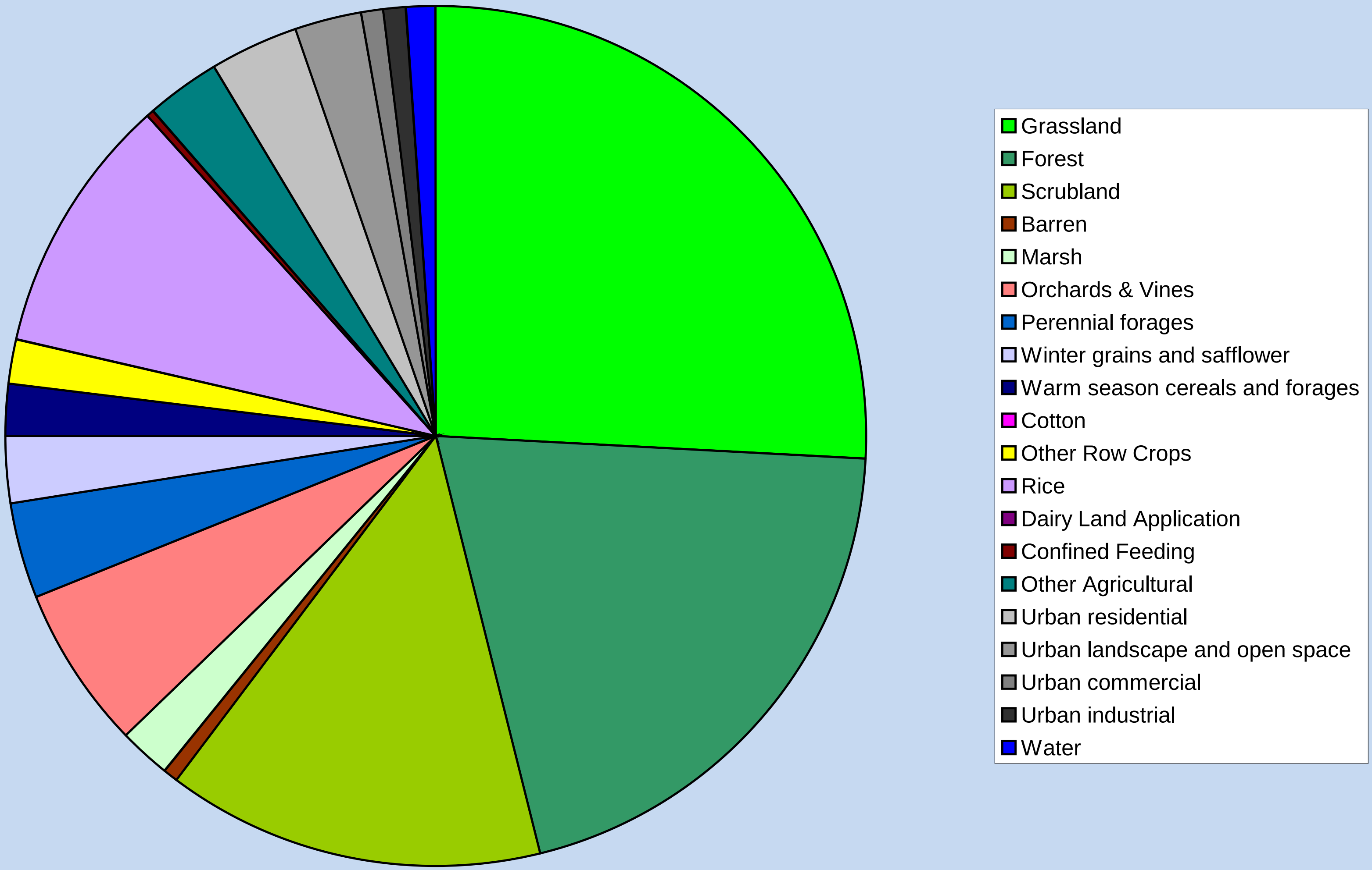
Nonpoint Source Simulation



San Joaquin Watershed Land Use



Sacramento Watershed Land Use



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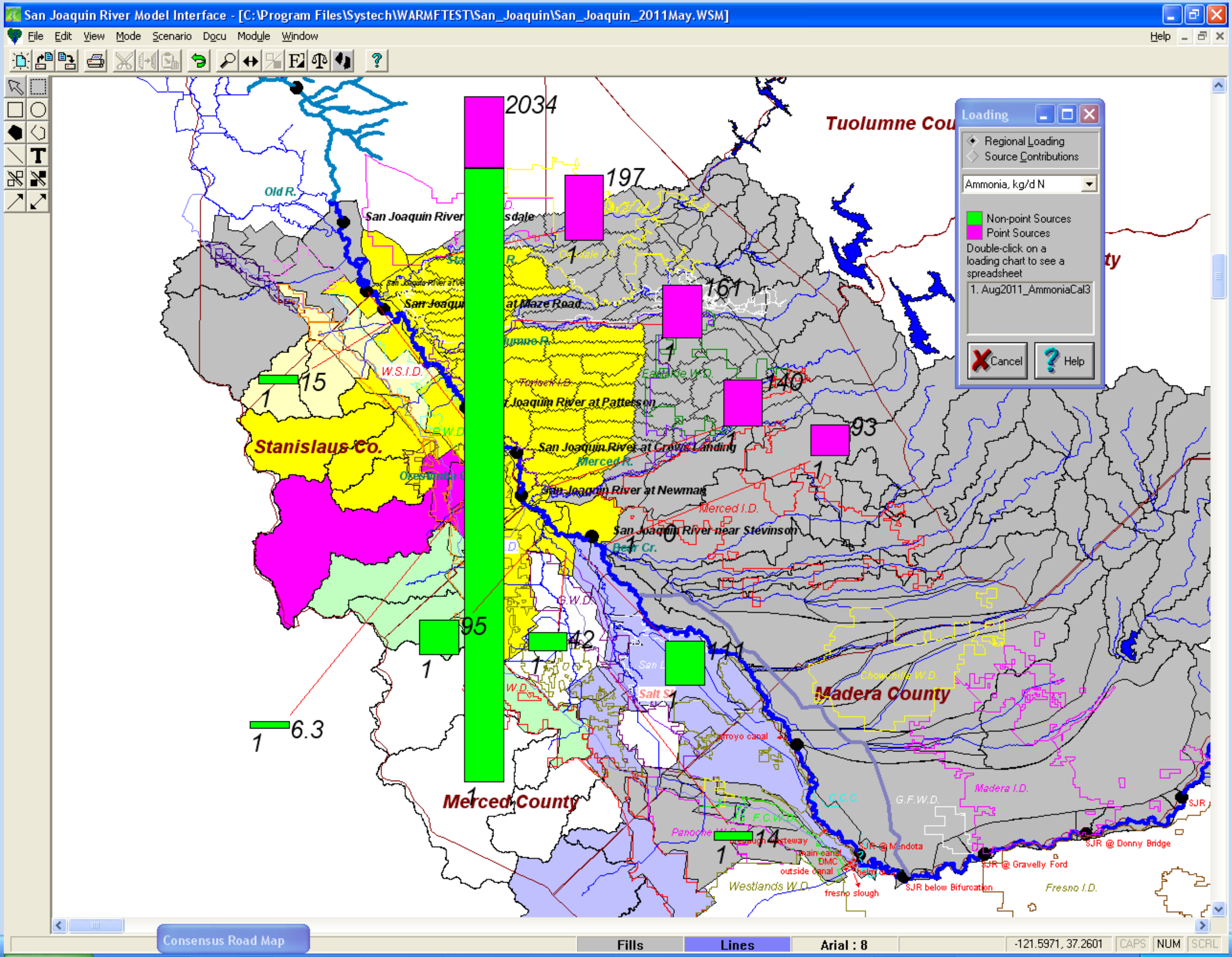
San Joaquin Ammonia Load



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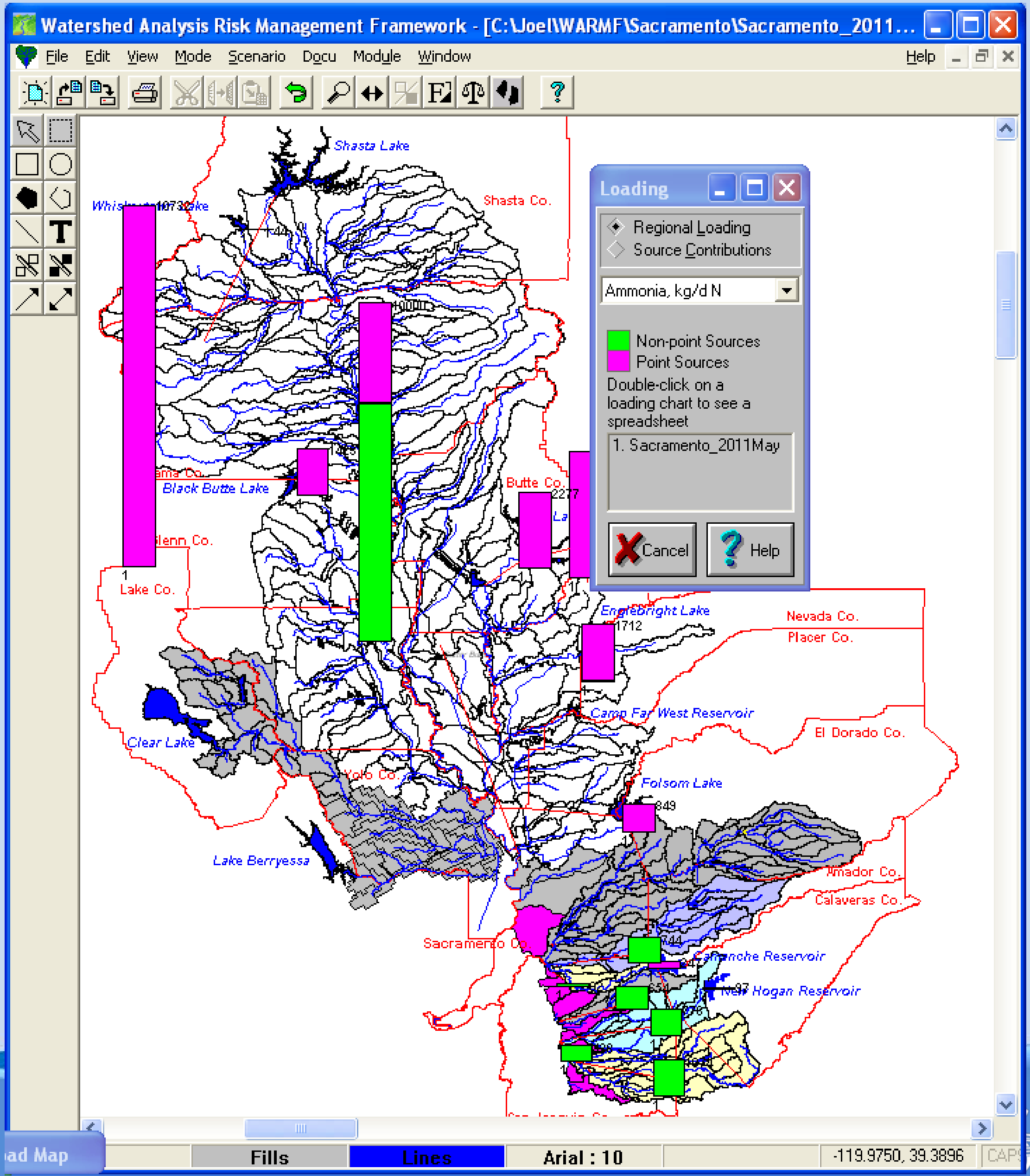

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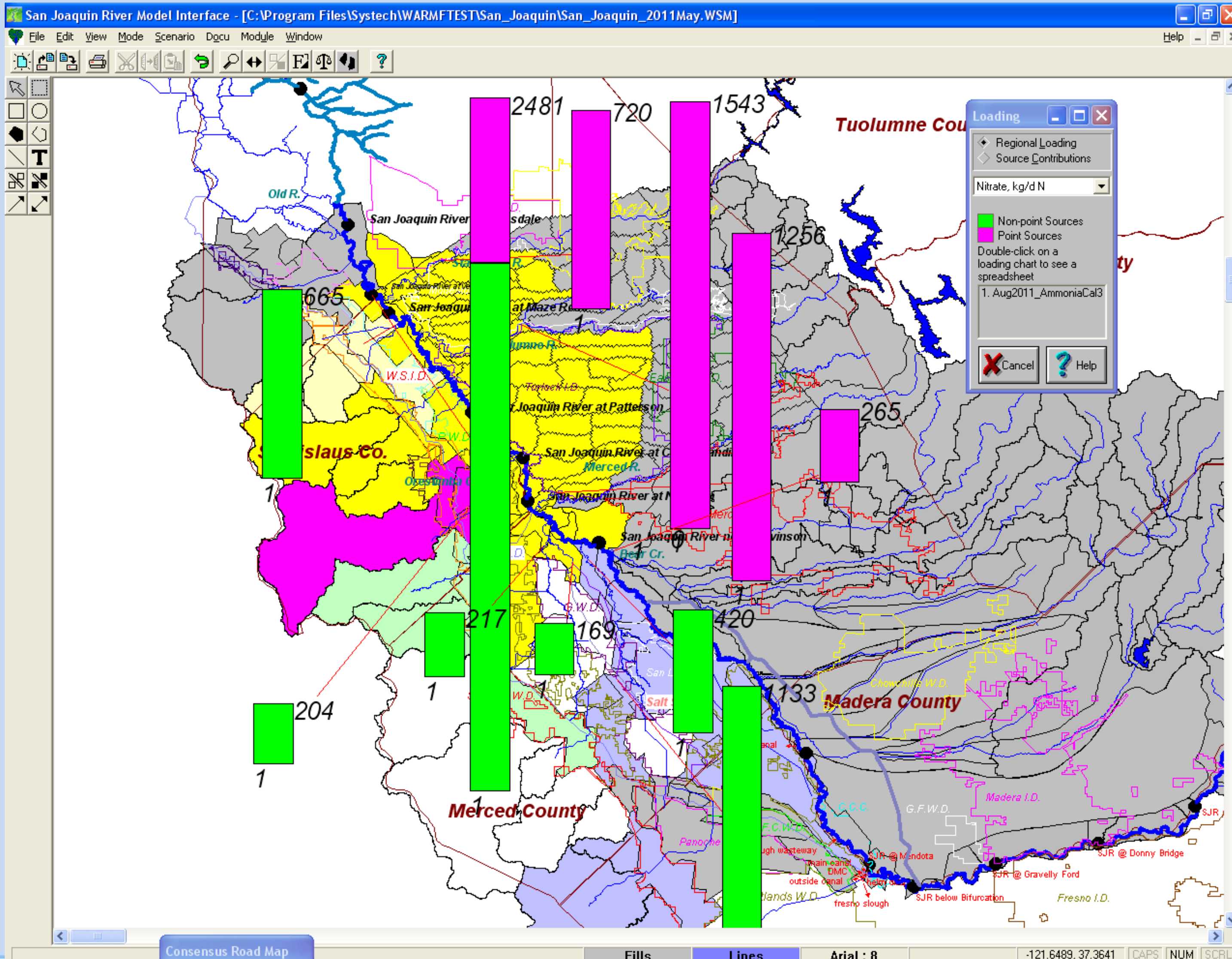
San Jaoquin Nitrate Load



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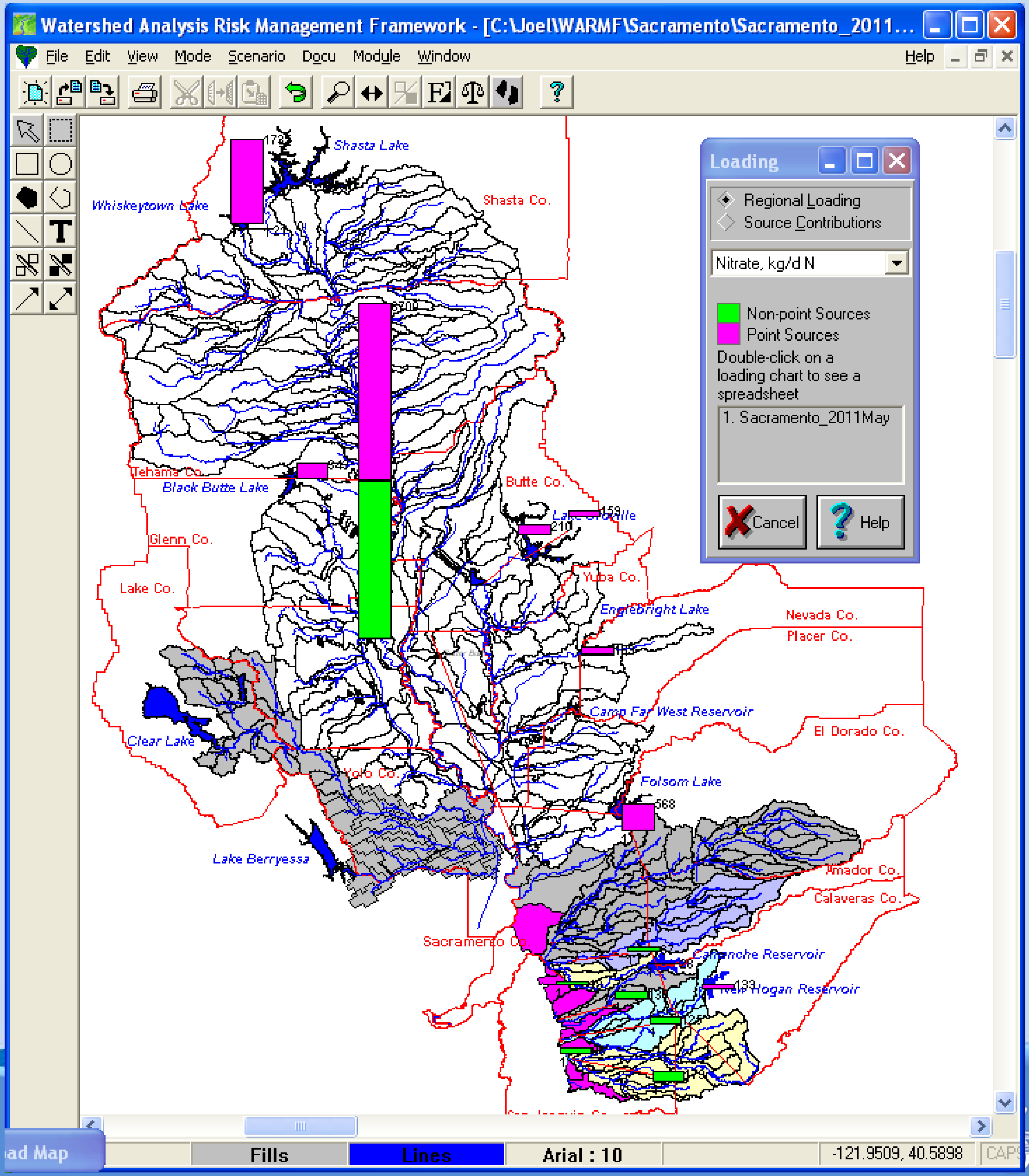
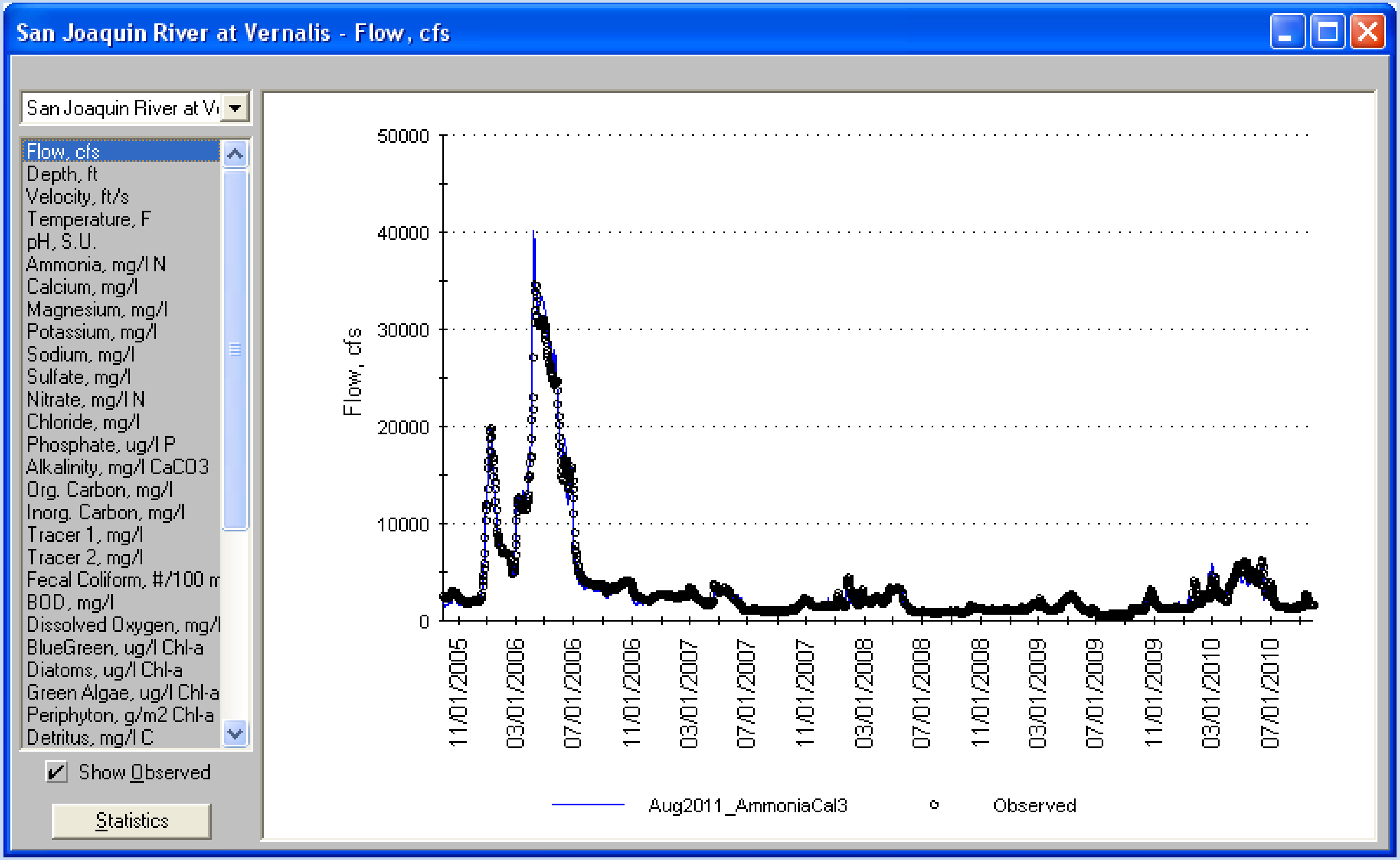
Sacramento Nitrate Load



San Jaoquin River Results



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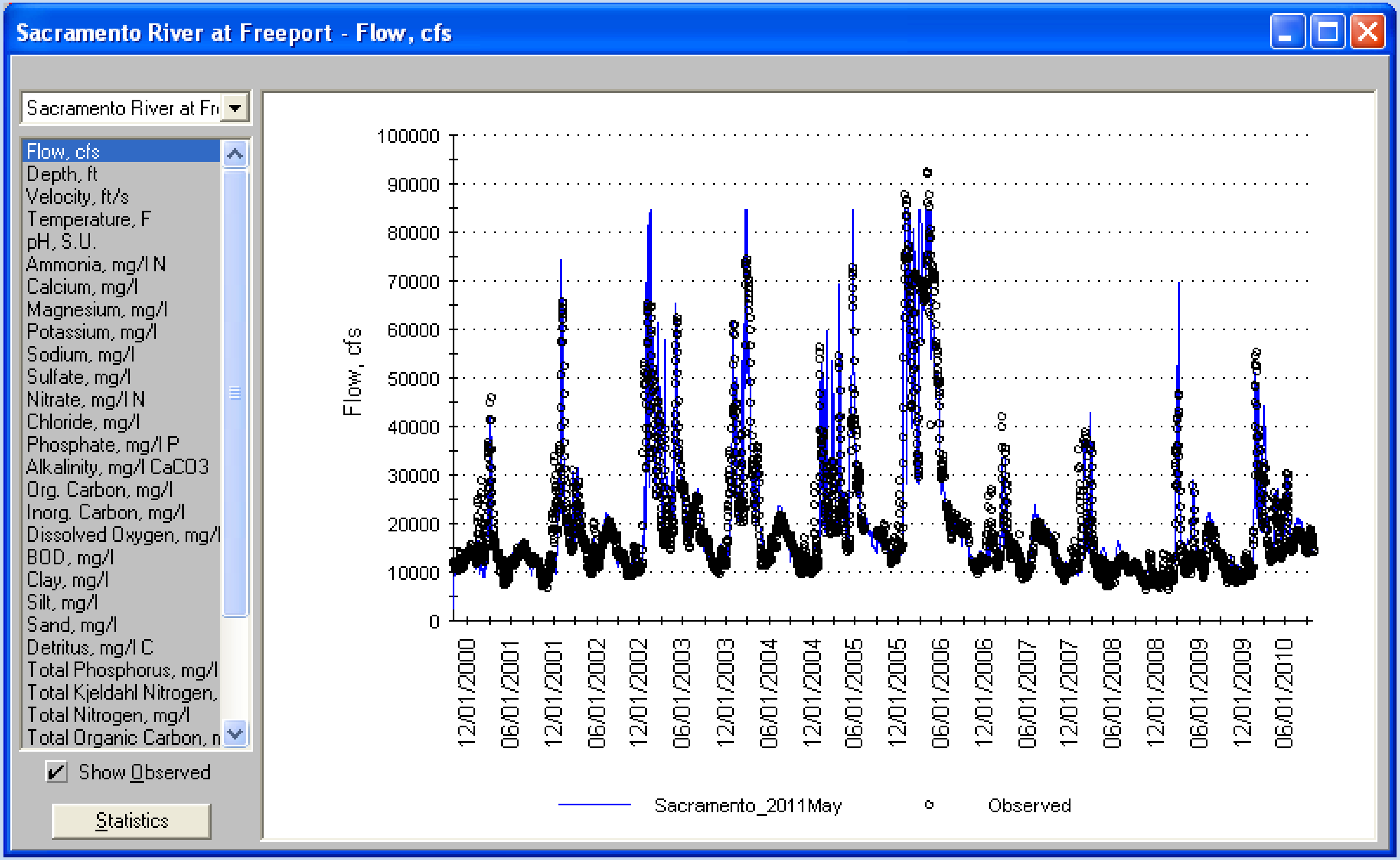
Sacramento River Results



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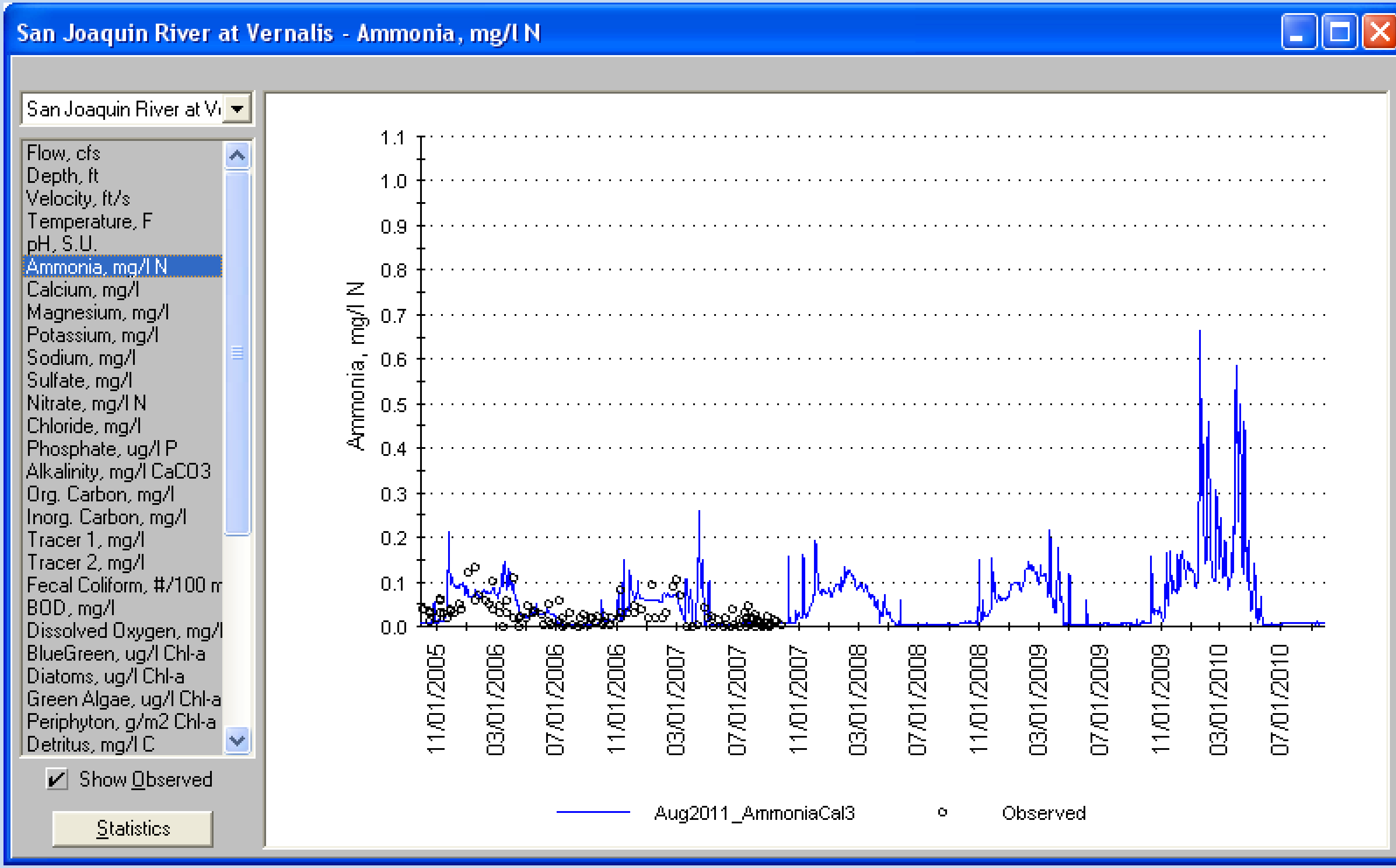
San Joaquin River Results



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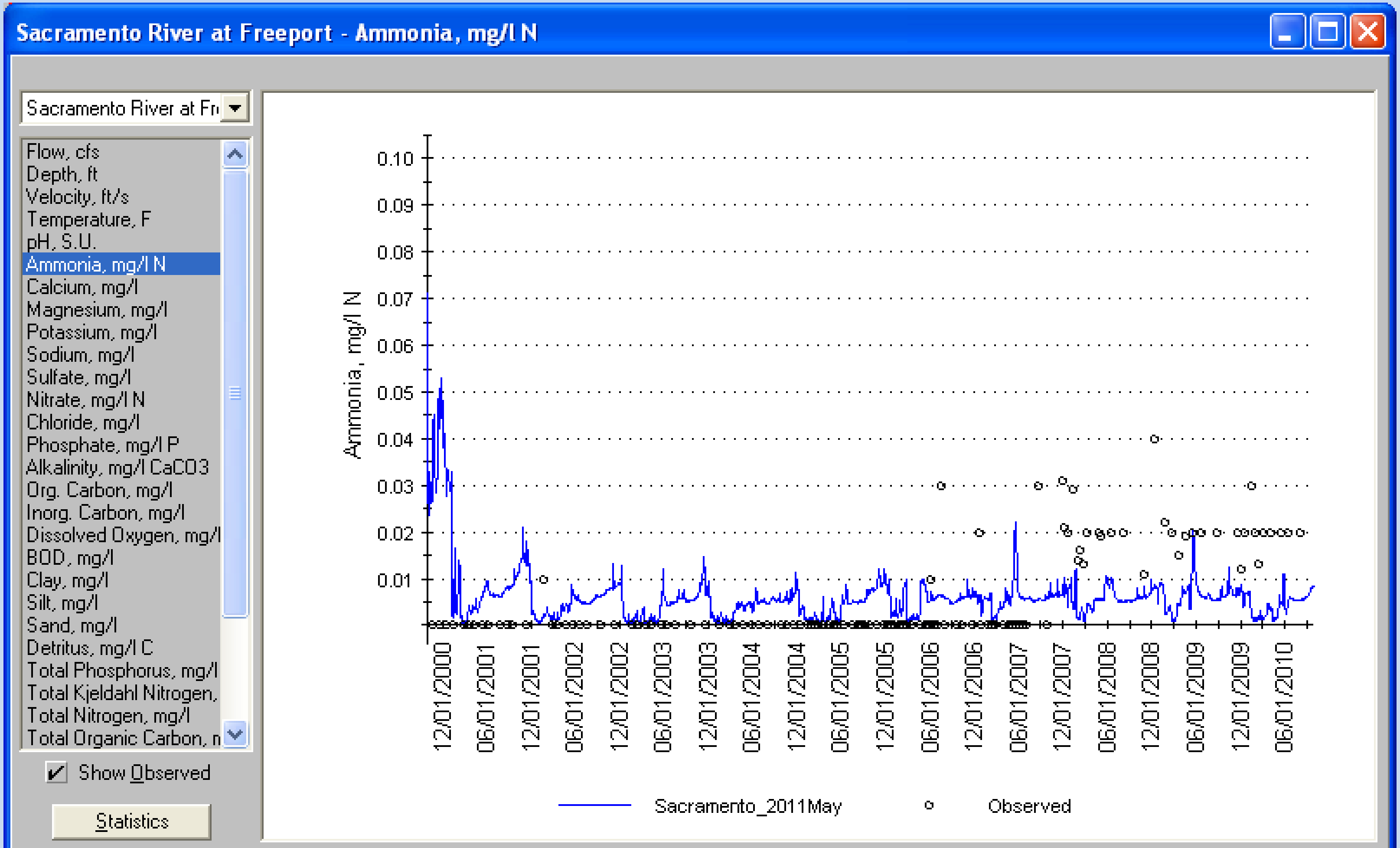
Sacramento River Results



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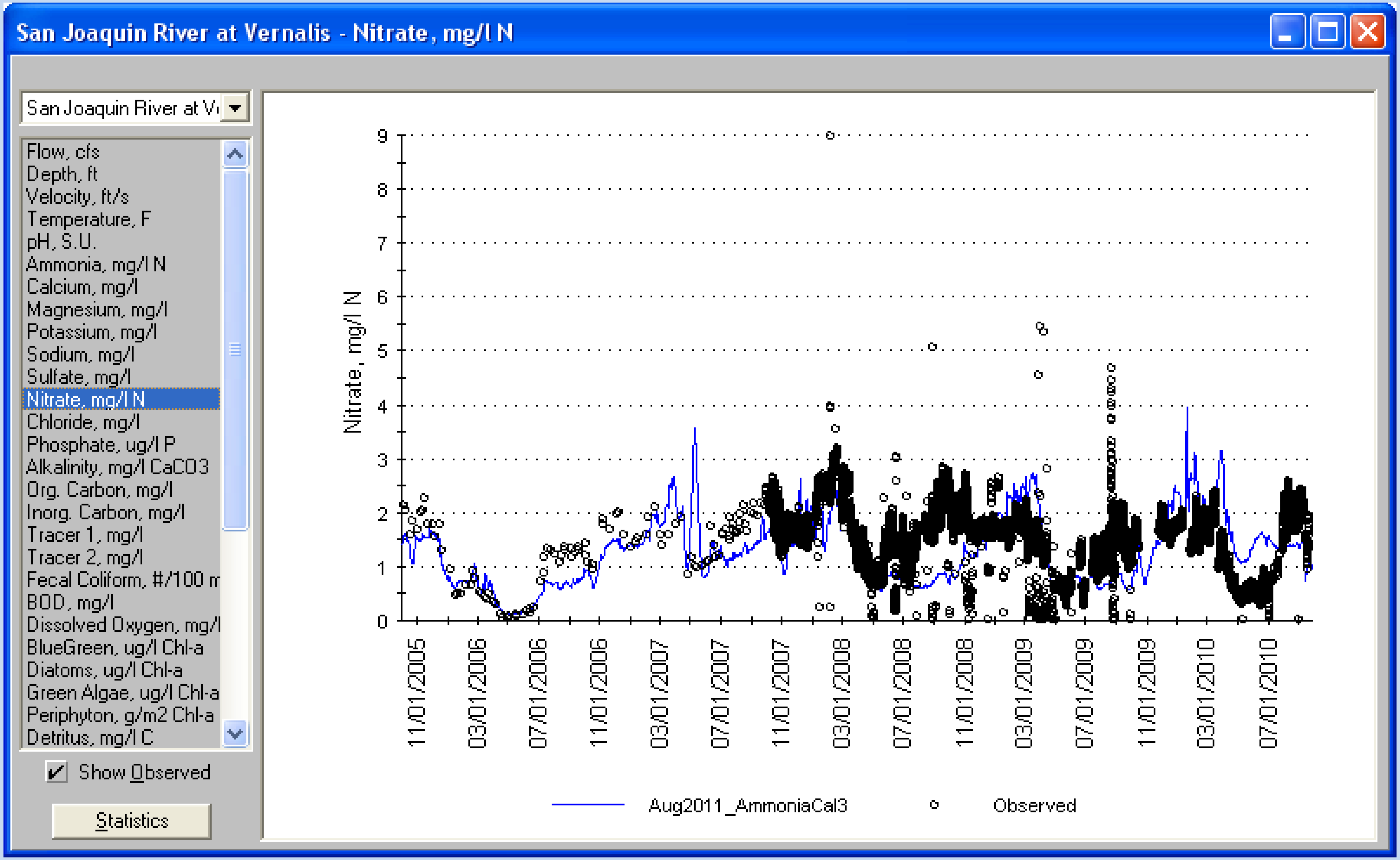
San Jaoquin River Results



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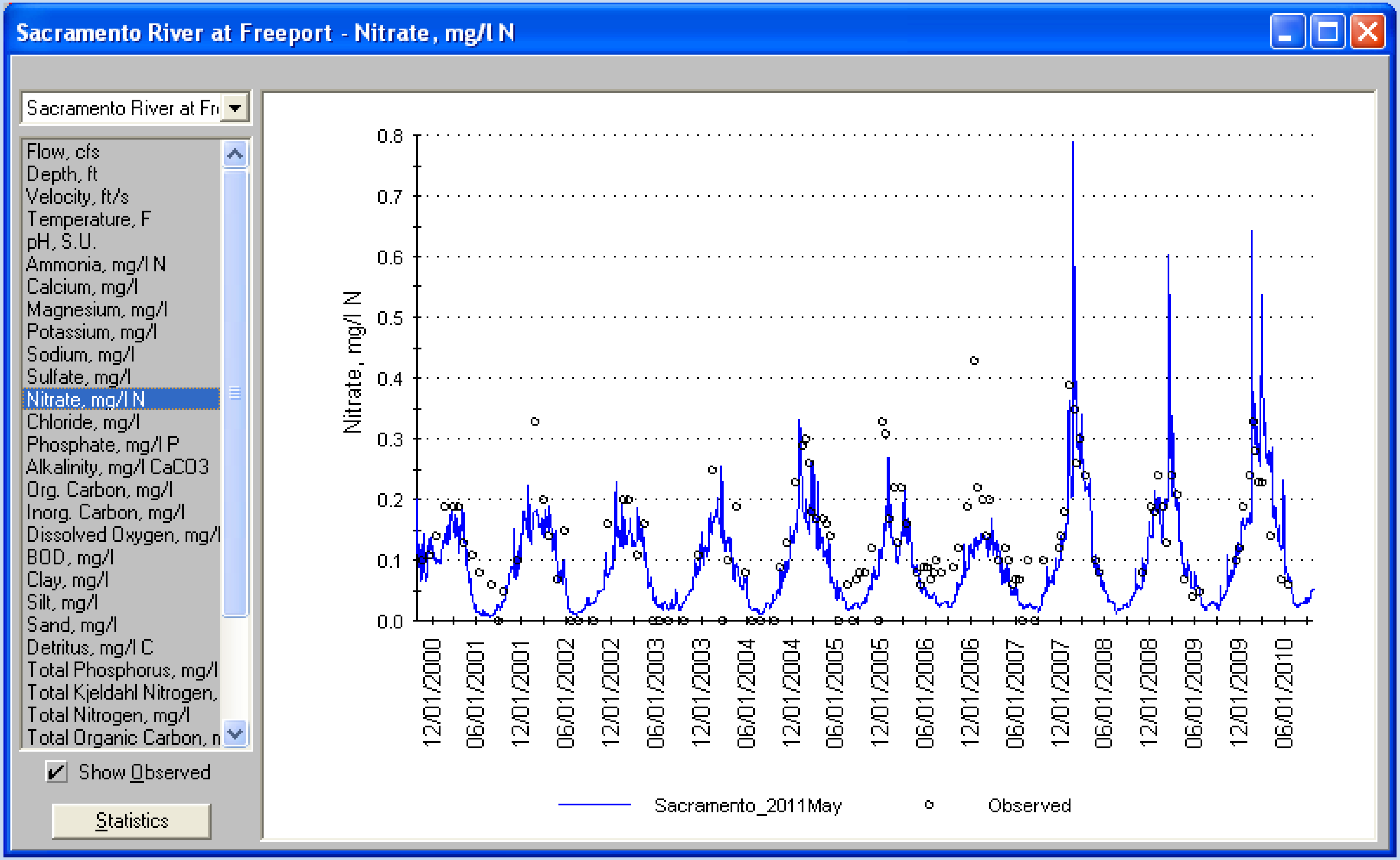
Sacramento River Results



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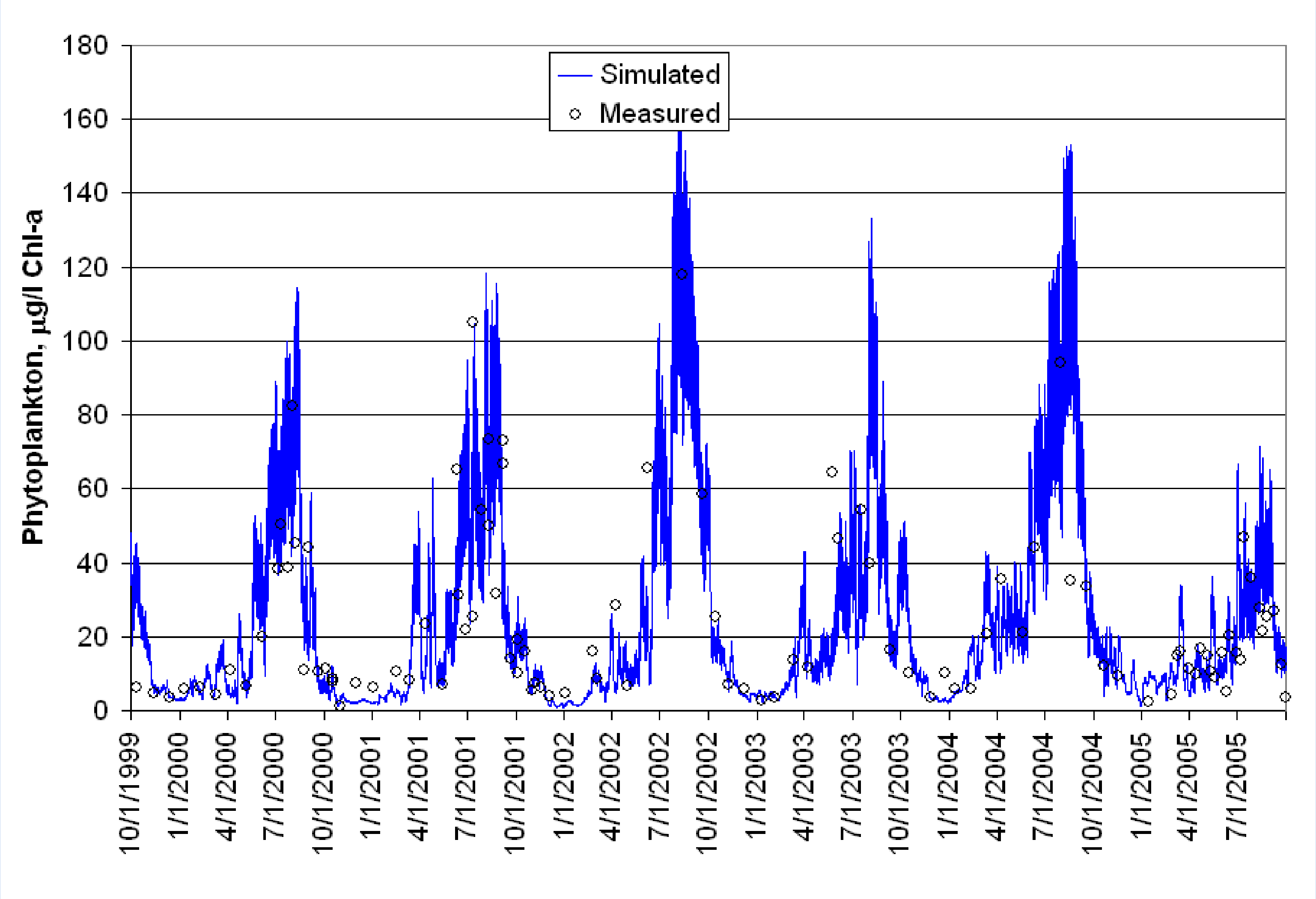
San Jaoquin River Results



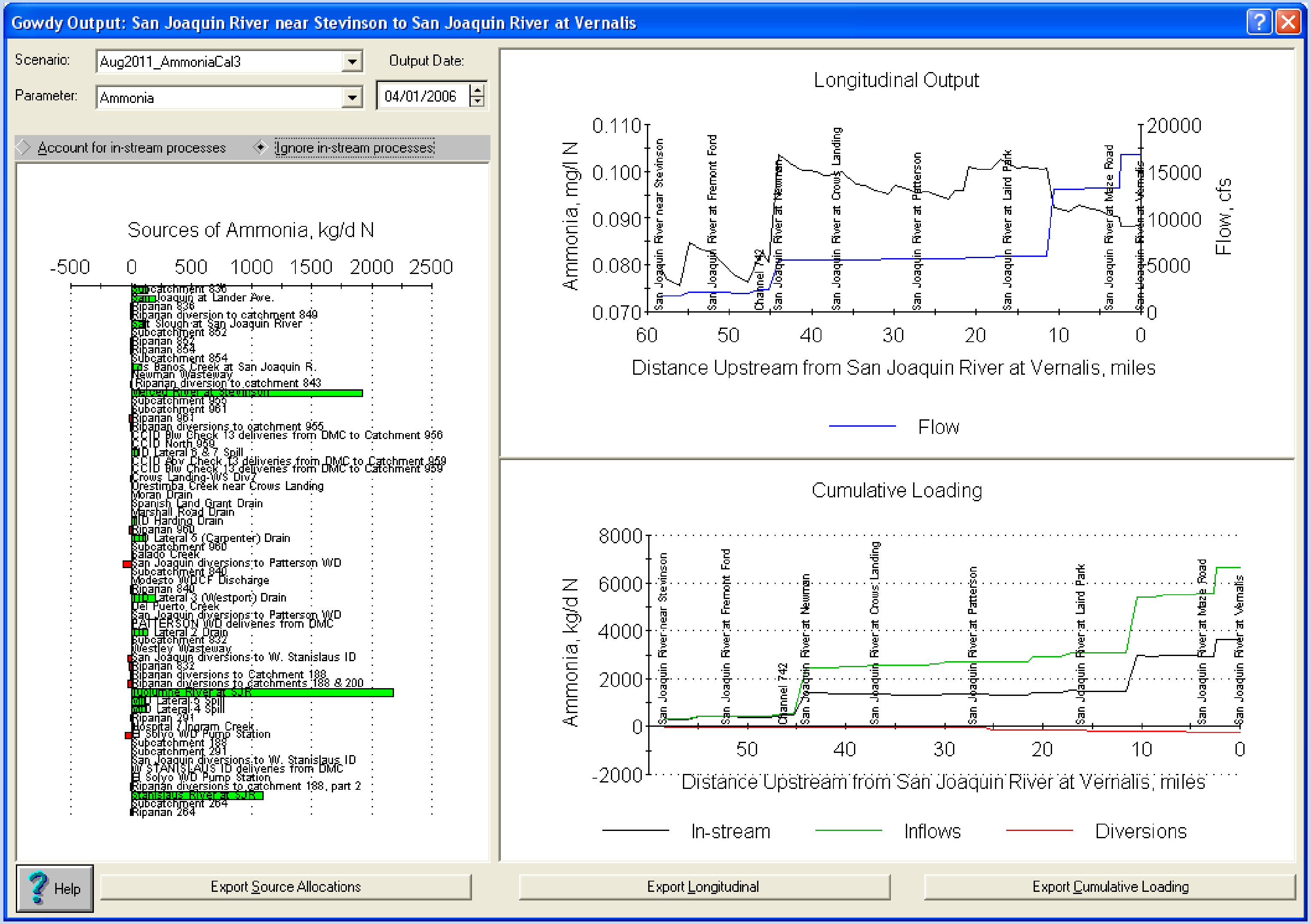
San Jaoquin Ammonia Load

	kg/d	kg/ha/yr
Natural Land Cover	32	0.04
Orchards	85	0.56
Grains and Forages	66	0.27
Row Crops	106	0.45
Dairy Lands	1,611	16.10
Farmsteads	118	3.16
Urban	86	0.92
TOTAL	2,103	1.23

Sacramento Ammonia Load

	lb/d	lb/acre/yr
Natural Land Cover	1,502	0.15
Orchards	2,157	2.15
Grains & Forages	736	0.58
Row Crops	1,419	4.73
Rice	6,483	4.19
Dairy Land App	401	14.65
Farmsteads	314	0.64
Urban	2,491	2.13
TOTAL	**15,502**	**0.96**

Gowdy Output of Ammonia



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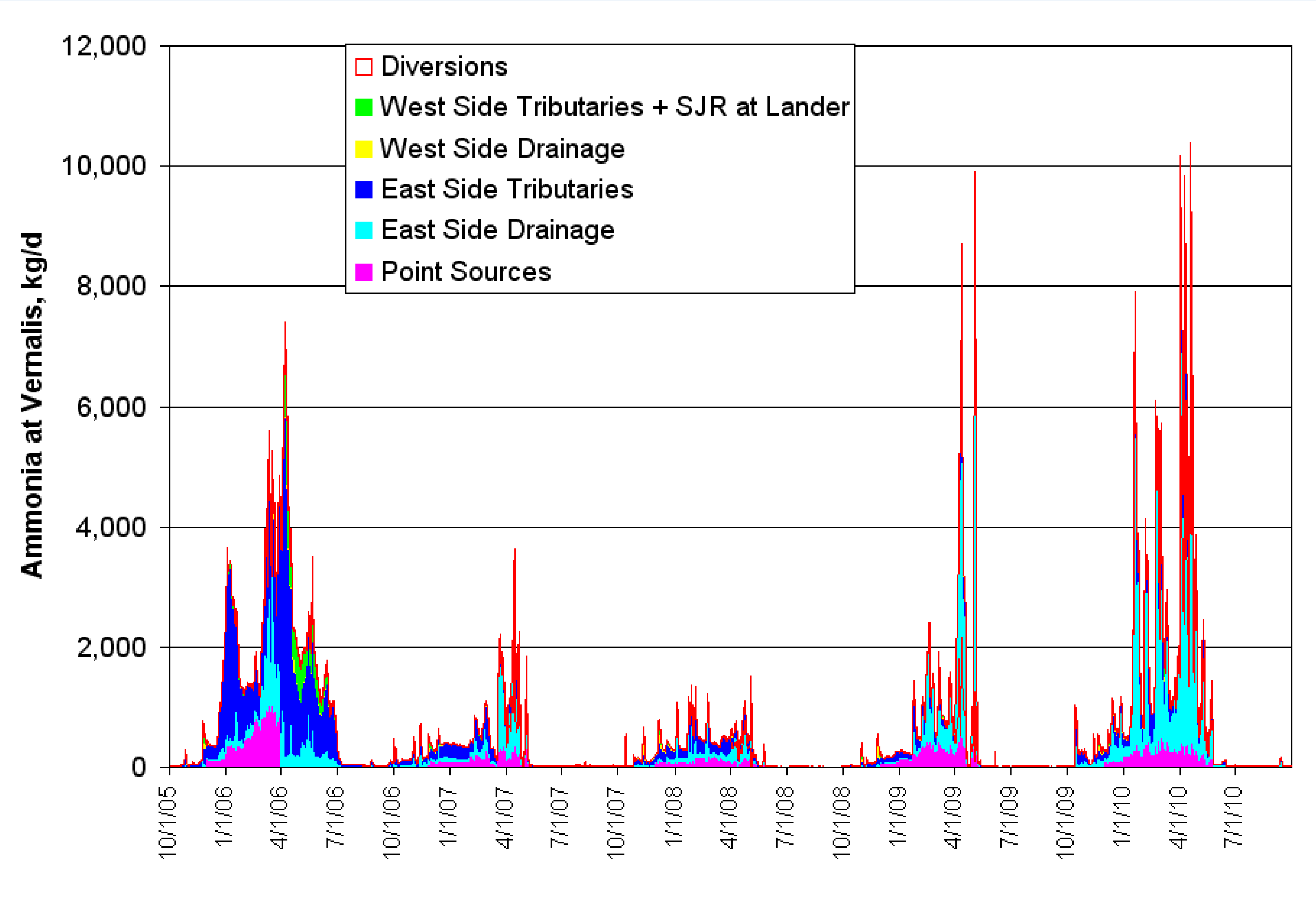
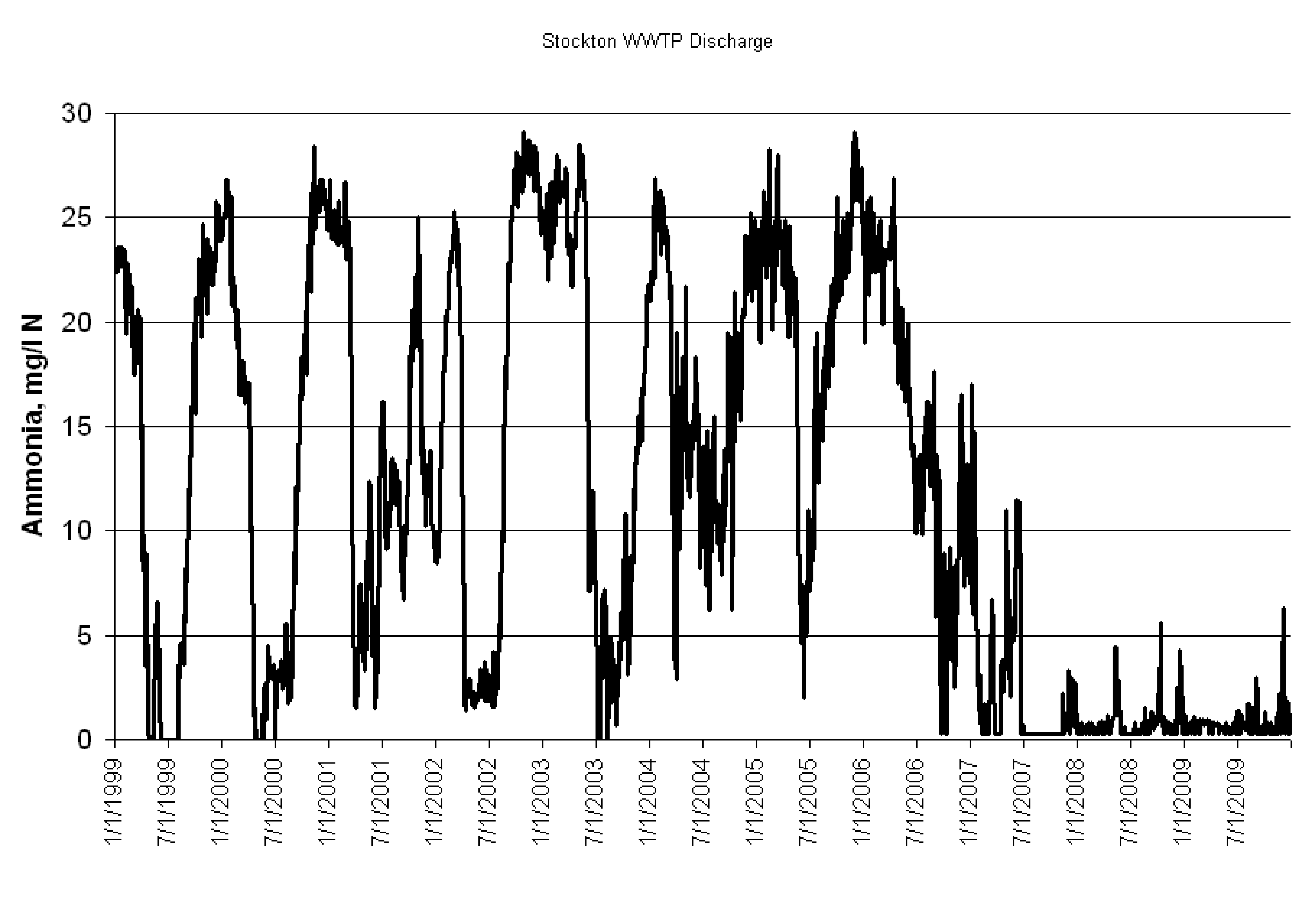
Gowdy Ammonia Output 2006-2010



Nutrients Effects on DWSC

Ammonia in Stockton Discharge



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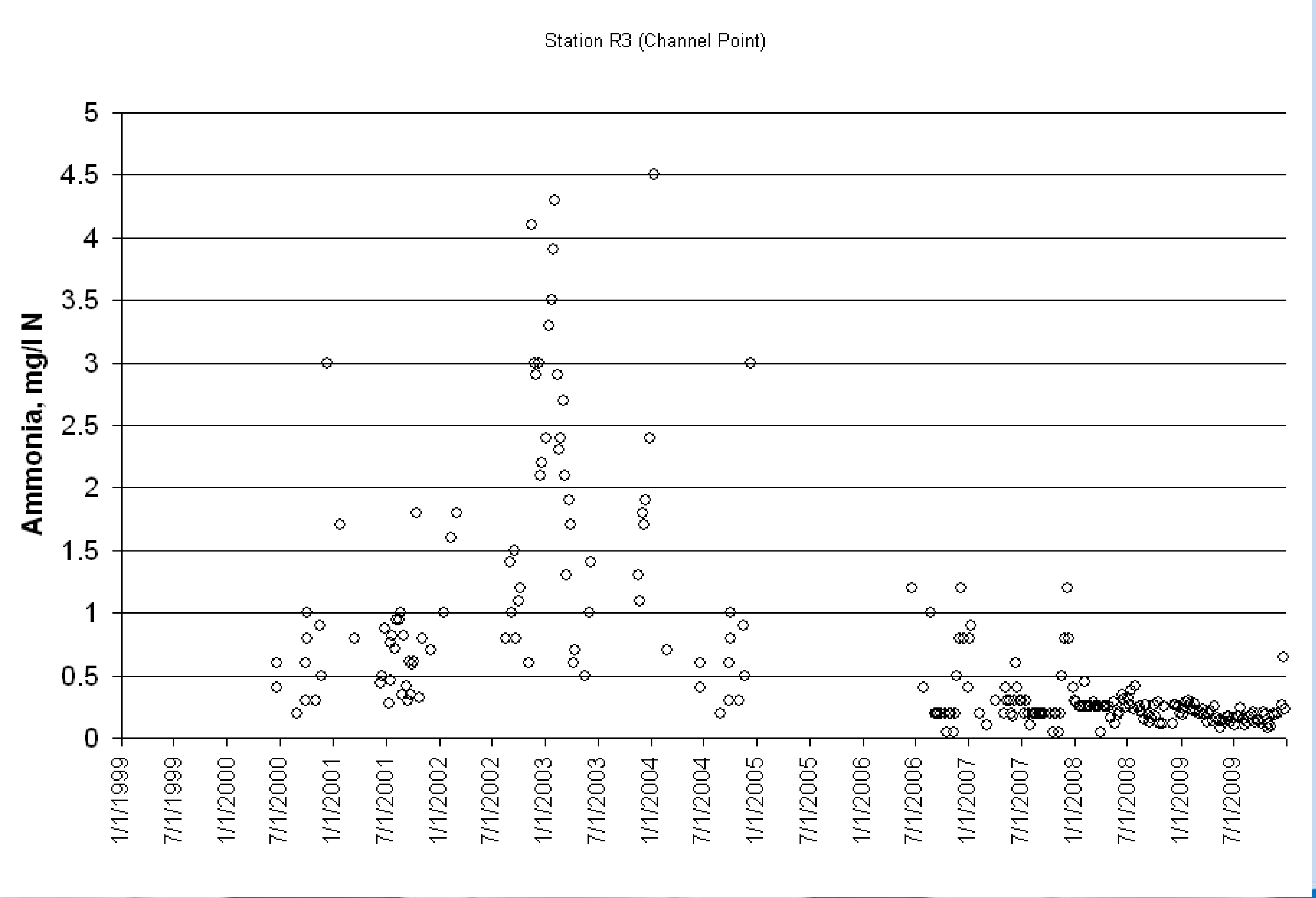
Observed Ammonia in DWSC



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DO Deficit at 250 cfs (yr 2000)

Alternative Loading Condition	DO Deficit in DWSC, kg O_2
100% Stockton load and 100% river load	1360
100% Stockton load and 75% river load	600
100% Stockton load and 50% river load	200
100% Stockton load and 25% river load	60
100% river load and 75% Stockton load	640
100% river load and 50% Stockton load	430
100% river load and 25% Stockton load	300

DO Deficit at 1000 cfs (yr 2000)

Alternative Loading Condition	DO Deficit in DWSC, kg O_2
100% Stockton load and 100% river load	30
100% Stockton load and 75% river load	0
100% Stockton load and 50% river load	0
100% Stockton load and 25% river load	0
100% river load and 75% Stockton load	16
100% river load and 50% Stockton load	7
100% river load and 25% Stockton load	1

DO Deficit Without DWSC
YR 2000 River and Stockton Loads

UVM Flow At Stockton	DO Deficit in DWSC, kg O_2
250 cfs	120
500	49
750	0
1000	0
1500	0
2000	0

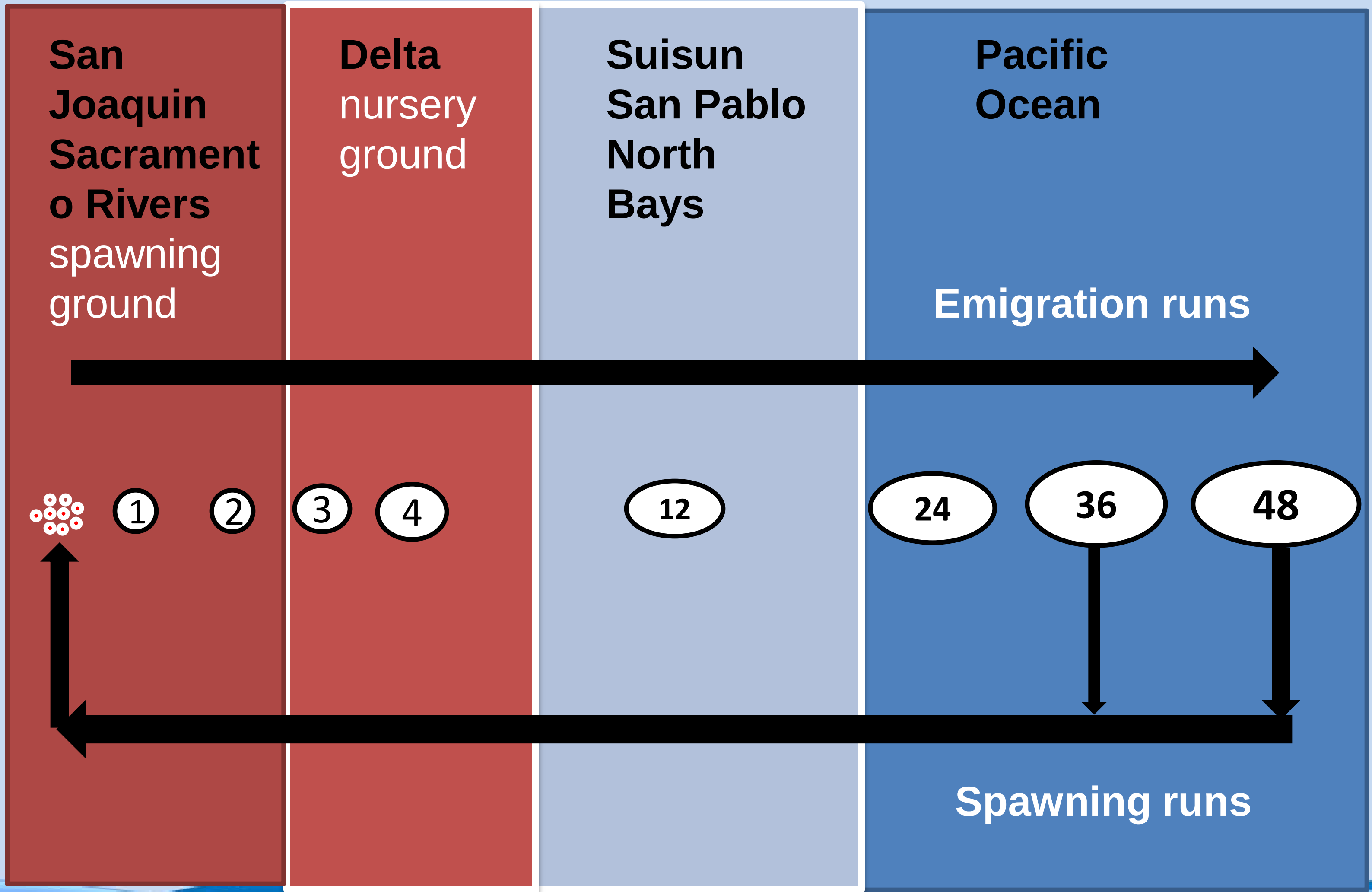
Nutrients Effects on Delta Fish

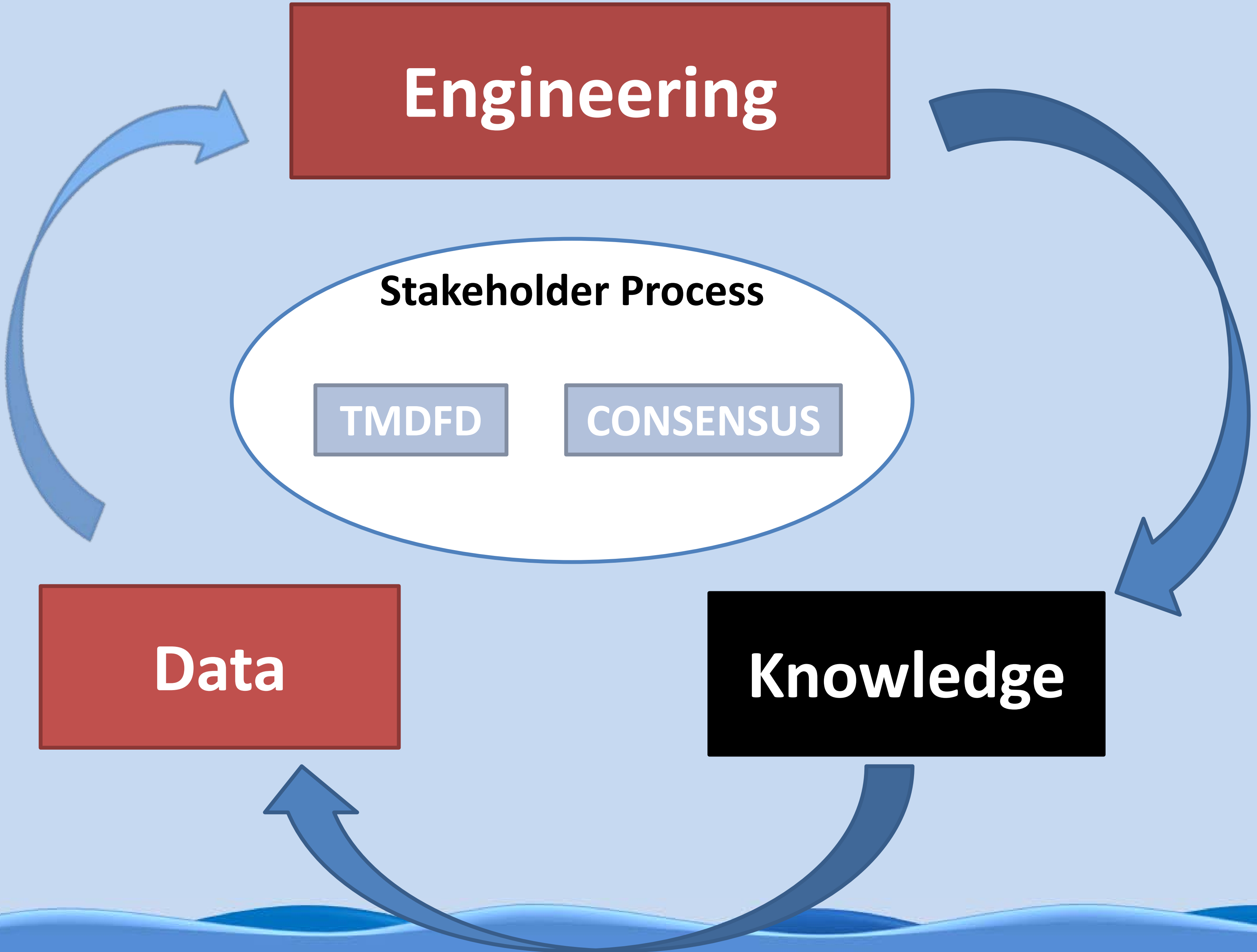
- Toxicity to fish is a function NH4OH at high pH, both simulated by WARMF.
- Nutrients help produce food for fish to grow faster and bigger, which can compensate for the loss of their young to fresh water diversions from the Delta.
- How do we manage nutrients and diversions to prevent fish decline and extinction?

Extension To Model Fish!

- Use monthly cohort fish life cycle model to simulate the number, fork length, and weight of the monthly cohorts of salmons, delta smelt and striper bass.
- Use WARMF watershed model to simulate Q, T, DO, TDS, TSS of spawning river segments (SJR & Sacramento), and to affect the success of eggs to become first month cohort.
- Use link-node model to simulate T, TDS, algal productivity per fish of nursery delta "nodes" and to affect the distribution, growth, predation and entrainment loss of juveniles to the diversion pumps.
- Use WARMF graphical user interface to integrate the three models into a DSS to facilitate the stakeholder process.

Monthly Cohorts Life Cycle Model





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Total Maximum Daily Flow Diversion (TMDFD) Module

1. Specify Daily Flow Diversions

Pump Name: Tracy Pump A

Daily Diversion File: Tracy pump A.xla

2. Specify Alternative Name for Simulation: AAA

3. Run Model: Watershed | Estuary | Fish

4. View Results: Salmon

TMDFD, cms

Population Number, #

Population Biomass, Kg

Fish Decline, #

CONSENSUS Module

Salmon

Alternative Name	Ave Annual Export, cms	TMDFD, cms	Fish Number	Fish Decline	Vote yes/no

Conclusions

- Plants consume almost all ammonia in the fertilizer applied to crop land.
- Dairy lands contribute the highest nonpoint source load of ammonia per unit area.
- Major point source loads of ammonia are from Modesto and tributary inflows to the SJR basin.
- Most ammonia are transformed to nitrate and organics (algae & detritus) in the SJR before reaching Vernalis for outflow to the Lower SJR estuary.

Conclusions

- Elevated NH4 in DWSC was from Stockton discharge, not from river load of NH4 & organics (algae, detritus).
- DO deficit in DWSC was caused by reduced river inflow, increased water depth (DWSC), river load of organics, and Stockton discharge (nitrification upgrade in 2007).
- WARMF can be extended to address the fish decline and extinction issues by stakeholders.

Thank you very much