Using SPARROW to Model Total Nitrogen Sources, and Transport in Rivers and Streams of California

By Dina Saleh and Joseph Domagalski
USGS, California Water Science Center

Outline of Presentation

- What is SPARROW?
- Applications of SPARROW for California
- SPARROW data sets and calibration
- Nitrogen sources and loads
- Further work and model refinement

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What is SPARROW?

▸ **Acronym for: SPAtially-Referenced Regression On Watershed attributes**

▸ Help understand factors affecting water quality;

▸ Predict mean-annual flux and yield and concentration for unmonitored stream reaches and watersheds;

▸ Apportion stream loads to major nutrient sources and upstream watersheds;

▸ Assess effects of hydrological and biogeochemical processes on transport and fate in watersheds;

▸ Simulate water-quality response to climate and land-use change (historical, future);

▸ Constituents modeled successfully : Nitrogen, Phosphorus, Suspended Sediment, and Organic Carbon

Goals of the SPARROW model for California

▸ Understand loads and yields from un-monitored streams throughout the State

▸ Understand factors affecting transport of nitrogen and phosphorus

▸ For specific downstream waterbodies, such as the Delta: Predict source areas and scale to specific contributing watersheds or stream segments
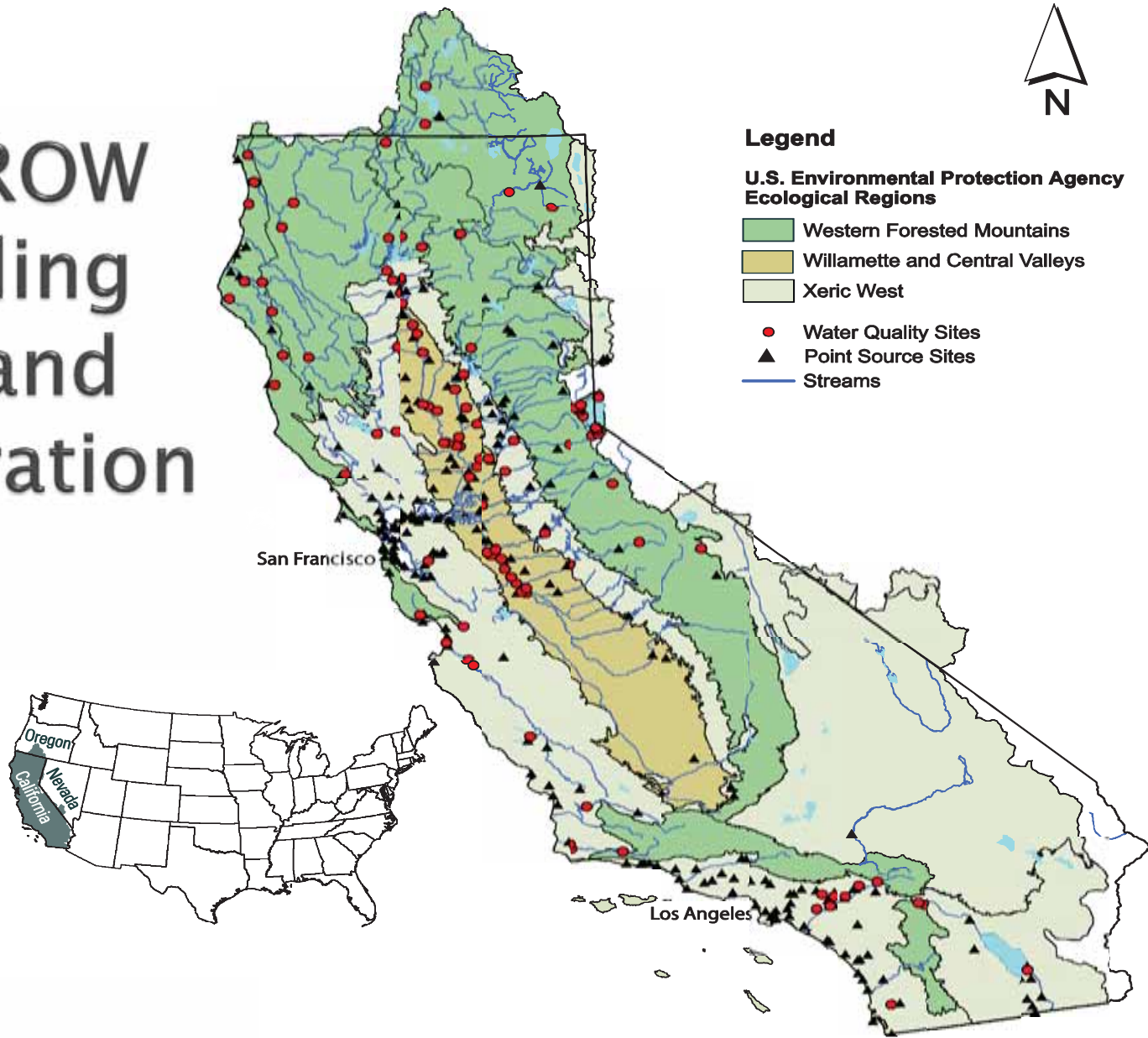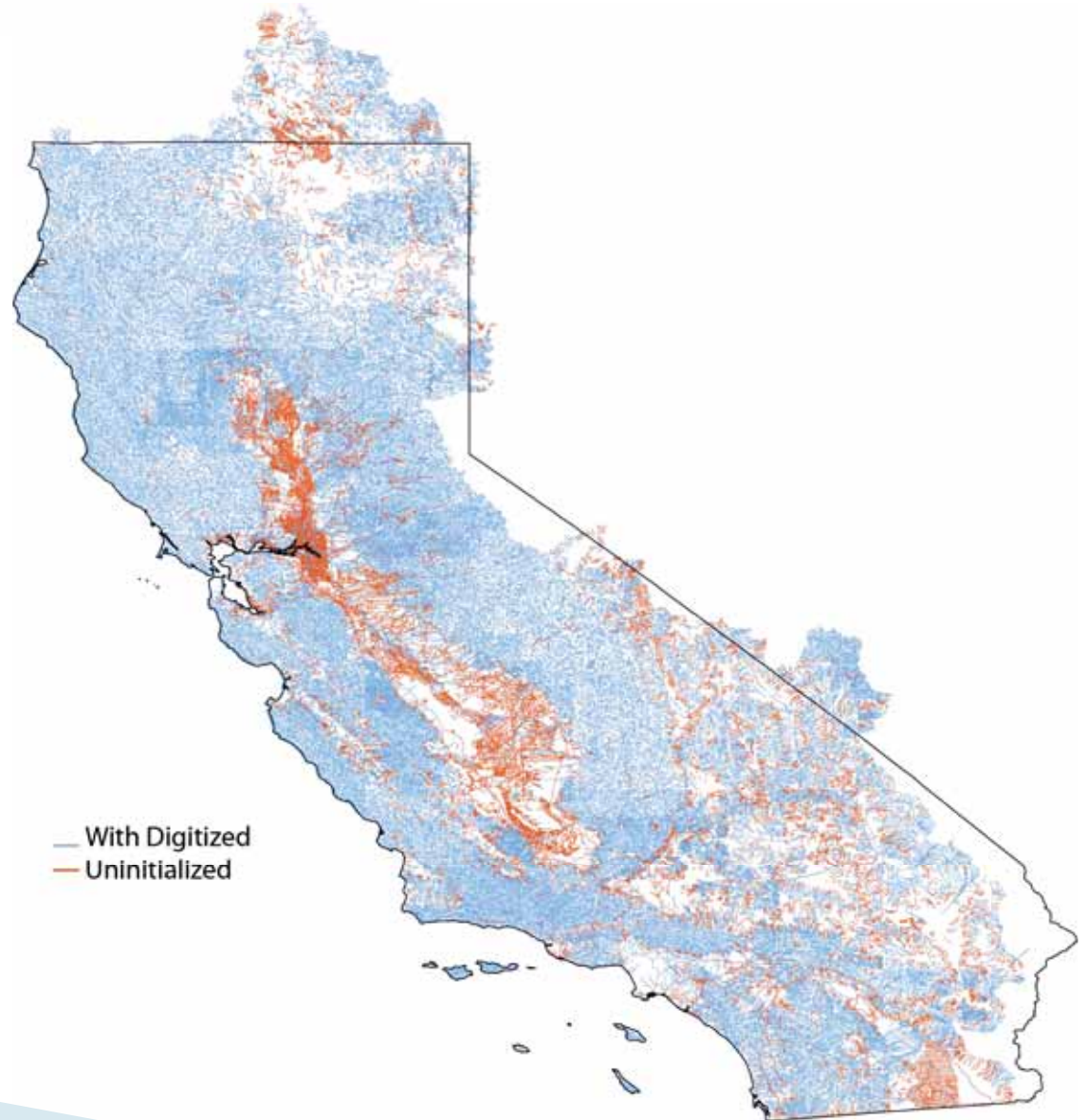
Linkage to Stream Network, National Hydrography Database, version 2
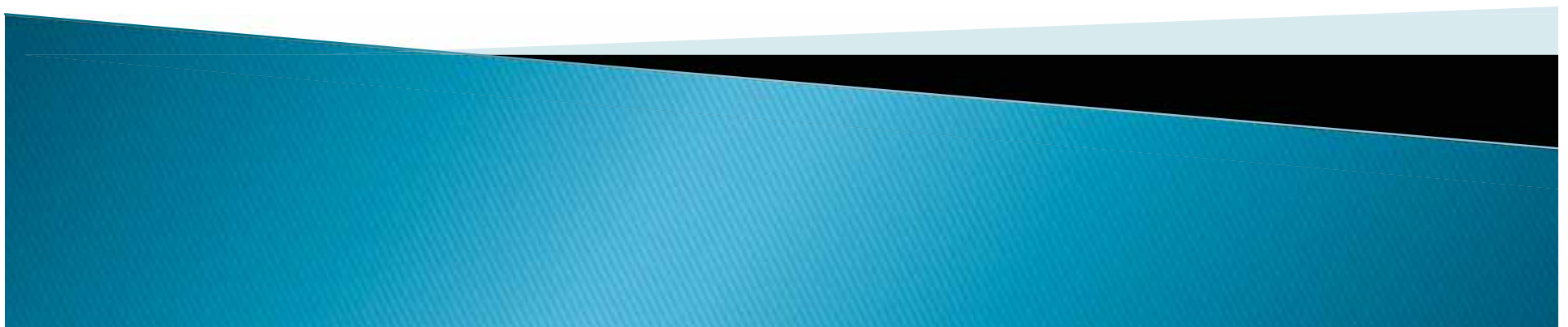
NHDPLUS 18V02_01:

- Scale is 1:100k
- From 30 meter DEM
- Blue lines are streams with defined watersheds (178,000)

- Orange lines are areas with no defined watersheds.

Legend:
— With Digitized
— Uninitialized

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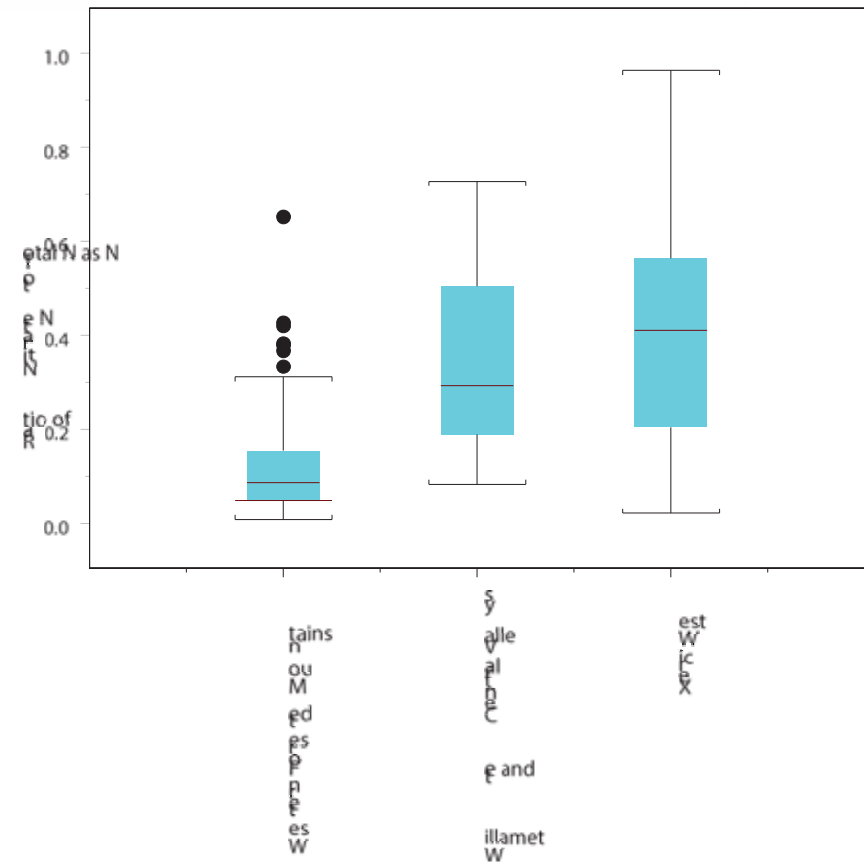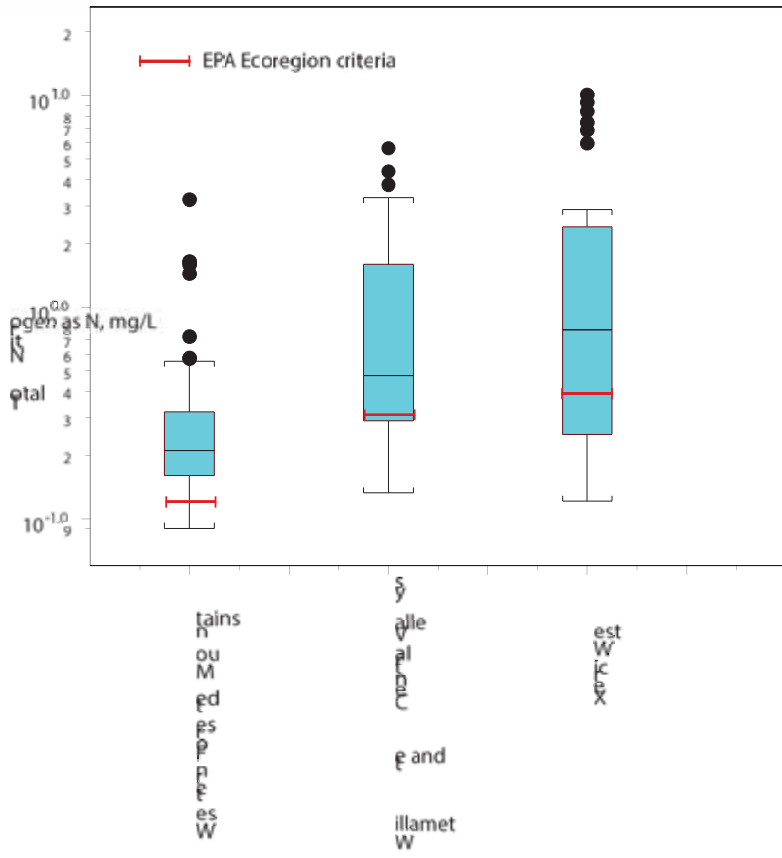science for a changing world

Chemistry and Discharge Data

- Chemistry data were obtained from USGS, California DWR, University of California, Davis, the STORET database (USEPA), and others
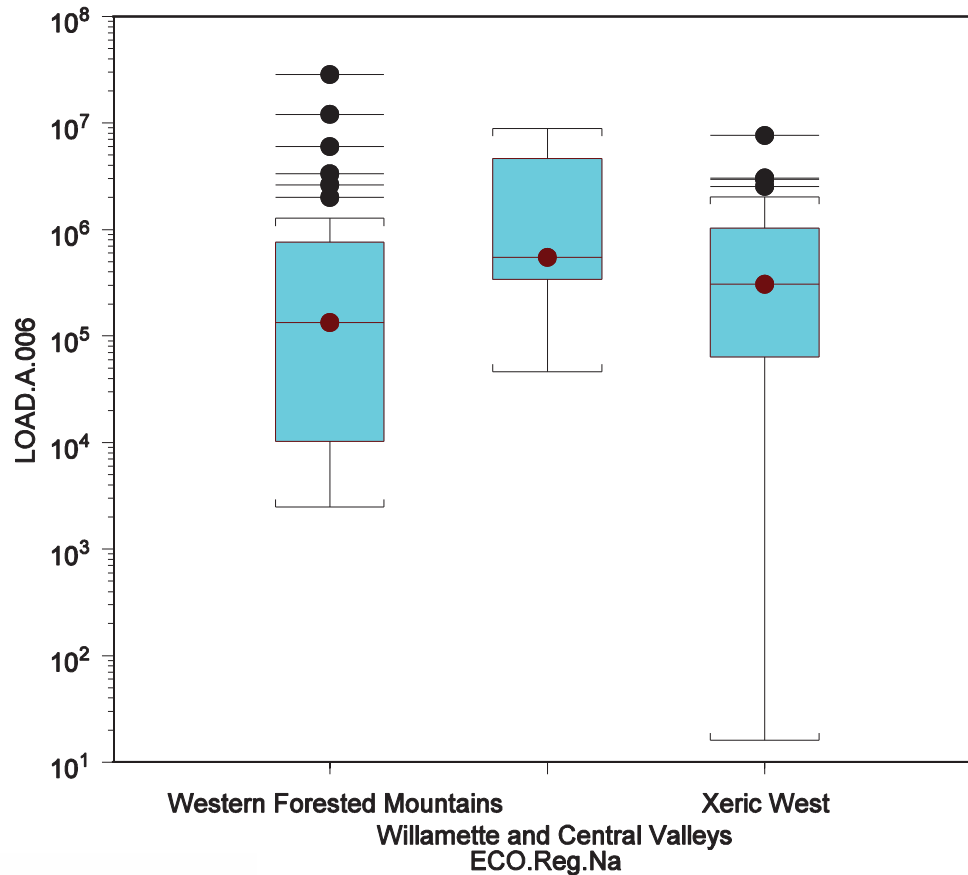- Discharge data were obtained from USGS and California DWR sources

SPARROW Data Layers

- Base Flow Index
- 30 year average Precipitation, 1971 – 2000 (800 meter)
- Climate: Annual Precipitation, 2002 (4,000 meter)(Total precipitation)
- 30 year average Temperature 1971 – 2000 (800 meter)
- 2002 Average temperature
- Bedrock Geology
- Surficial Geology
- Hydrologic Landscape Regions
- Population Density
- Level III EcoRegions
- Nutrient EcoRegions
- NLCD 2001
- 2001 Percent Impervious Surface 2001
- 2001 Percent Canopy
- Mean Annual R-factor, 1971-2000
- Physiography

- STATSGO
- Recharge
- Infiltration Excess Overland Flow
- Saturation Excess Overland Flow
- Atmospheric Deposition
- Normalized Atmospheric Deposition NO3, NH4, Total Inorganic N
- Nutrient Inputs from Fertilizer and Manure (N&P)
- Nutrient Application for Fertilizer and Manure Applied to Crops
- Estimated Area of National Resource Inventory Variables: Tile Drains (1992), Ditches (1992) , Total Artificial Drainage (1992) and Irrigated Area (1997)
- Physical Measures, Drainage area, Basin Shape Index, Sinuosity, Slope, Stream Density, Stream Length, Road Density etc
- Average streamflow (in cfs) for the period WY1975 to WY2007 from NHDPlus estimated using the Unit Runoff Method (UROM).

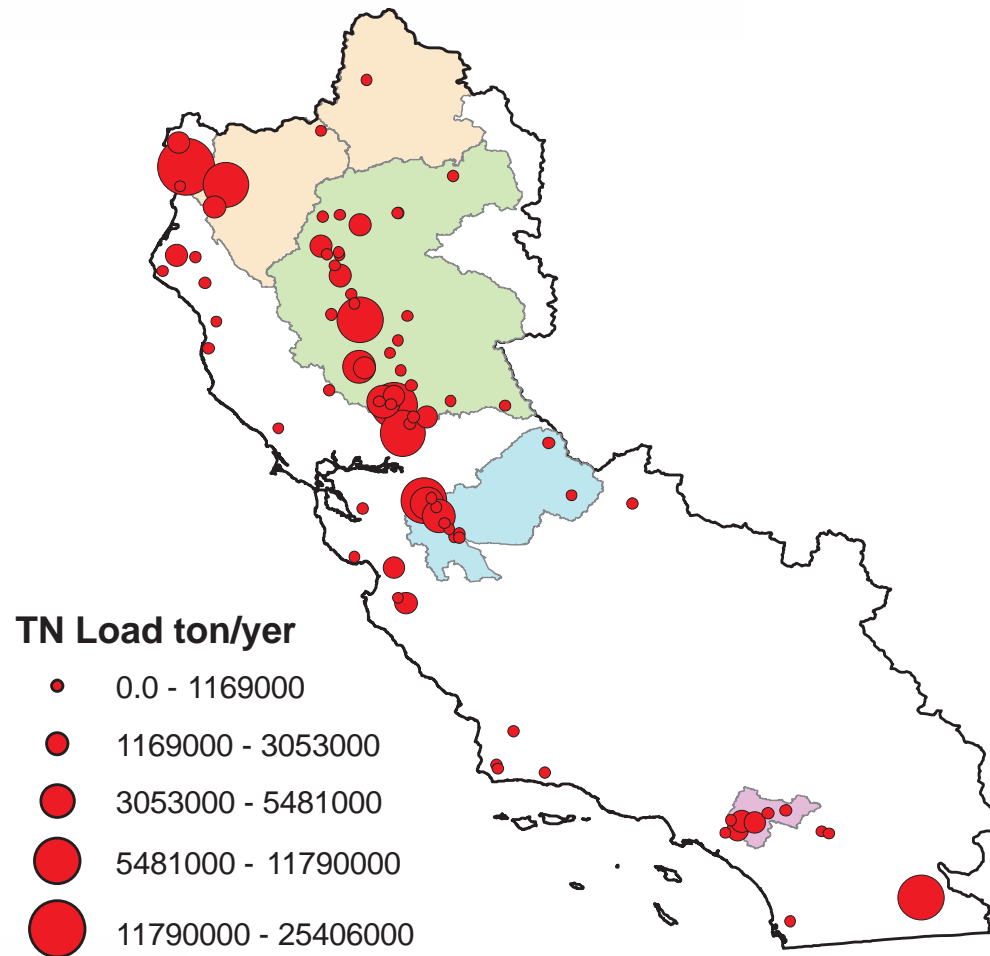# N Concentrations and Types by Eco-Region

TN Loads using Fluxmaster

TN Calibration Sites

TN Load ton/yer

- • 0.0 - 1169000
- ● 1169000 - 3053000
- ● 3053000 - 5481000
- ● 5481000 - 11790000
- ● 11790000 - 25406000

▸ Loads from Fluxmaster

TN Model Calibration Results

Parameter	Probability level (p-value)
Sources	
Fertilizer and Confined Manure (kg/yr)	0.011
Unconfined Manure (kg/yr)	0.052
Forest Land (km^2)	<0.001
Developed land (km^2)	0.058
Point Sources kg/yr	0.078

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Land to Water Delivery	
Percent Sand (km^2)	0.018

Land To Water Delivery

Percent Sand per km²

	0.0 - 22
	22 - 31
	31 - 39
	39 - 57
	57 - 84

TN Model Calibration Results

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Aquatic Loss	
Small Perennial Streams Flow < 500 cfs	< 0.001
Large Perennial Streams Flow > 500 cfs	0.042
Intermittent Streams (cfs)	< 0.001

Aquatic Decay

- Small Perennial Streams Flow < 500 cfs
- Large Perennial Streams Flow > 500 cfs
- Intermittent Streams

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Model Diagnostics	
R^2 /R^2 of Yield	0.89/0.65
RMSE	0.67
Number of observations	79

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Model Prediction

Source and Load

Fertilizer and Manure ton/yr
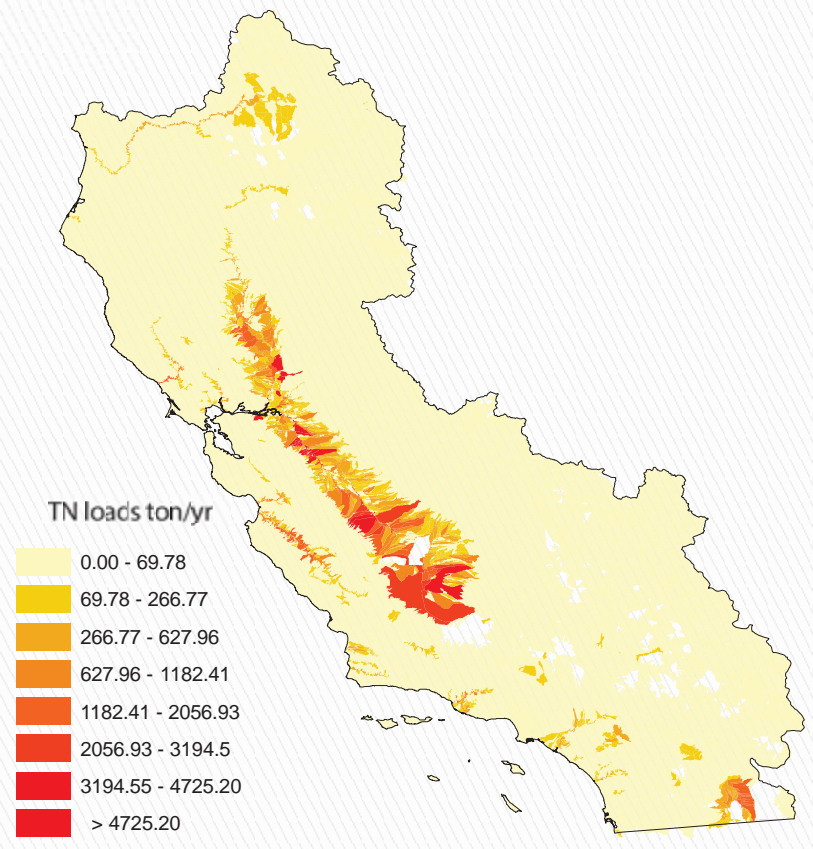
- 0.00- 13.20
- 13.20 - 53.55
- 53.55 - 132.68
- 132.68 - 306.33
- > 306.33

TN loads ton/yr

- 0.00 - 69.78
- 69.78 - 266.77
- 266.77 - 627.96
- 627.96 - 1182.41
- 1182.41 - 2056.93
- 2056.93 - 3194.5
- 3194.55 - 4725.20
- > 4725.20

Farm Fertilizer and Confined Manure

Modeled Load (p-value = 0.011)

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Source and Load

Manure, ton/yr

- 0.00 - 3.20
- 3.20 - 12.32
- 12.32 - 29.77
- 29.77 - 74.61
- > 74.61

TN Load, ton/yr

- 0.00 - 18.89
- 18.89 - 71.52
- 71.52 - 153.63
- 153.63 - 276.52
- 276.52 - 507.28
- 507.28 - 874.65
- 874.65 - 1681.62
- >1681.625

Unconfined Manure

Modeled Load (p-value = 0.052)

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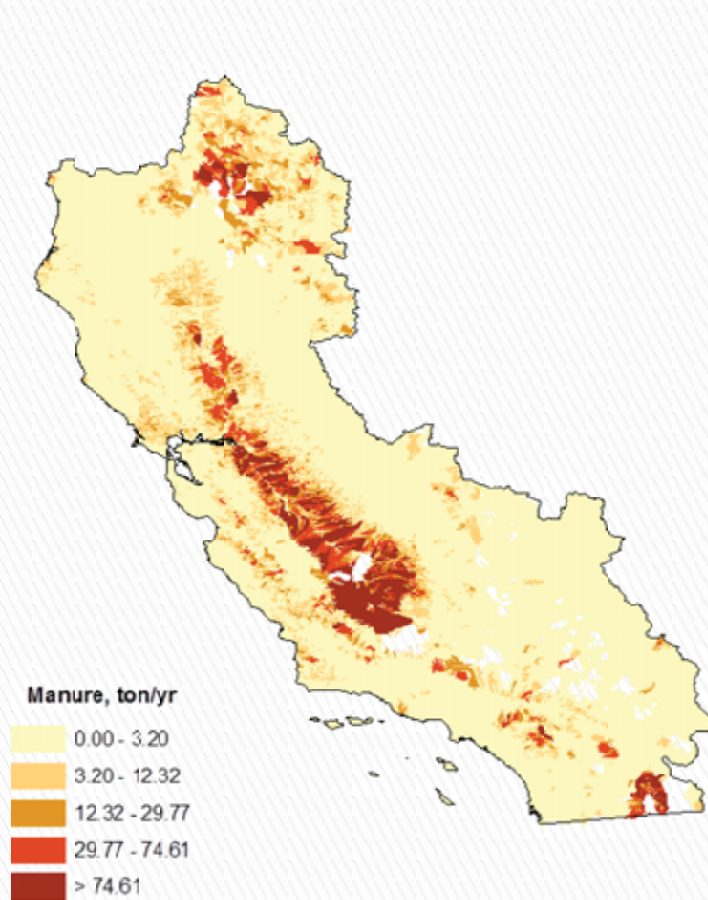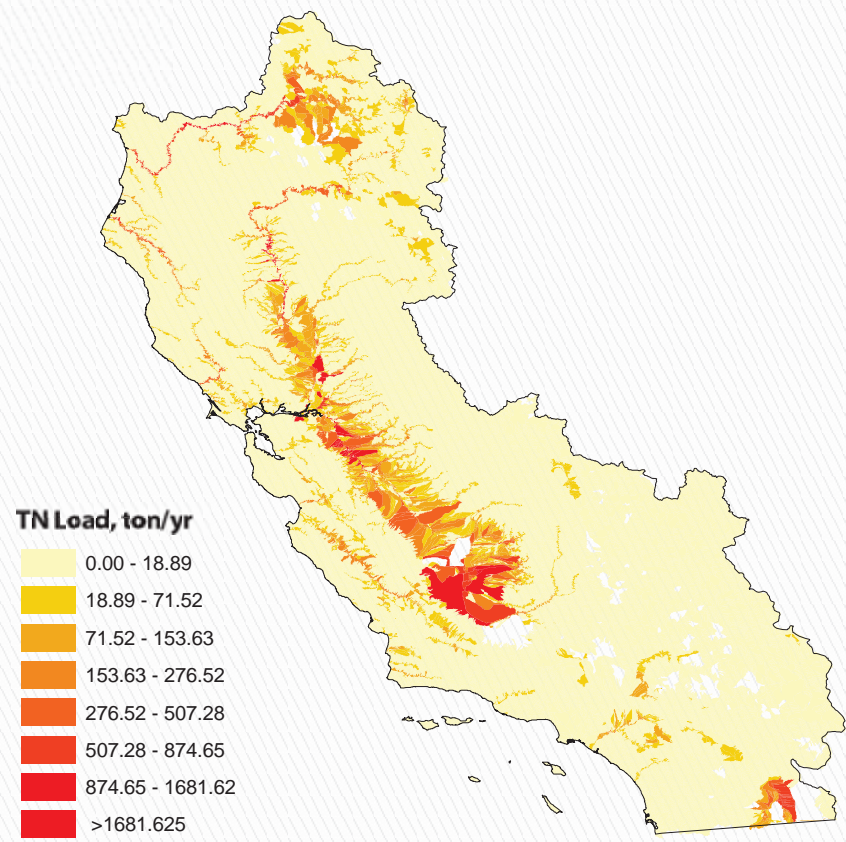
Source and Load

Developed Land

Developed Land
km²
- 0.00 - 2
- 2 - 10
- 10 - 25
- 25 - 75
- >75

Modeled Load (p-value = 0.058)

TN Load, ton/yr
- 0.00 - 2.22
- 2.22 - 8.83
- 8.83 - 19.40
- 19.40 - 34.49
- 34.49 - 58.75
- 58.75 - 108.37
- 108.37 - 216.96
- 216.96 - 453.45

Source and Load

Forested Land (Km²)
- 0.00 - 3.50
- 3.50 - 15.5
- 15.54 - 45.86
- 45.86 - 105.24
- 105.24 - 1900.62

TN Load, ton/yr
- 0.00 - 45.58
- 45.58 - 185.25
- 185.25 - 405.92
- 405.92 - 698.47
- 698.47 - 1079.87
- 1079.87 - 1659.53
- 1659.53 - 2979.90
- > 2979.90
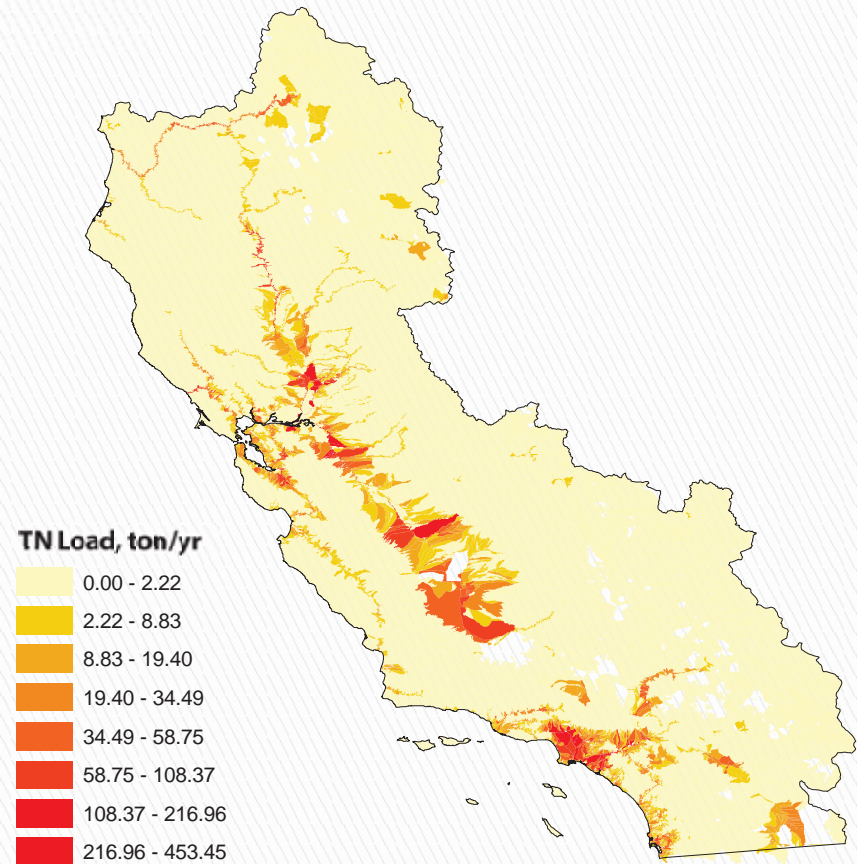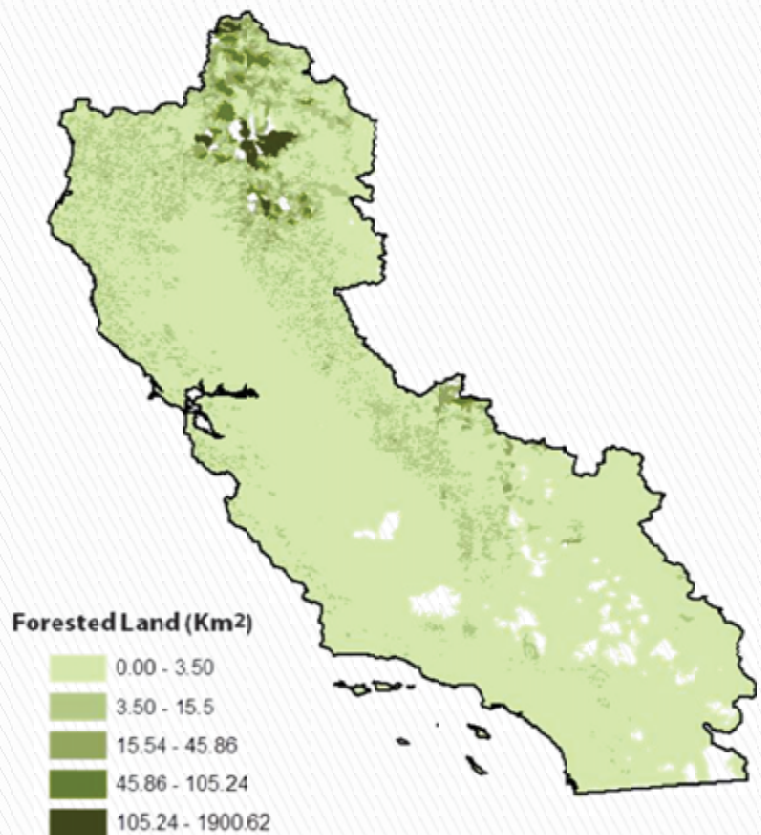
Forest Land
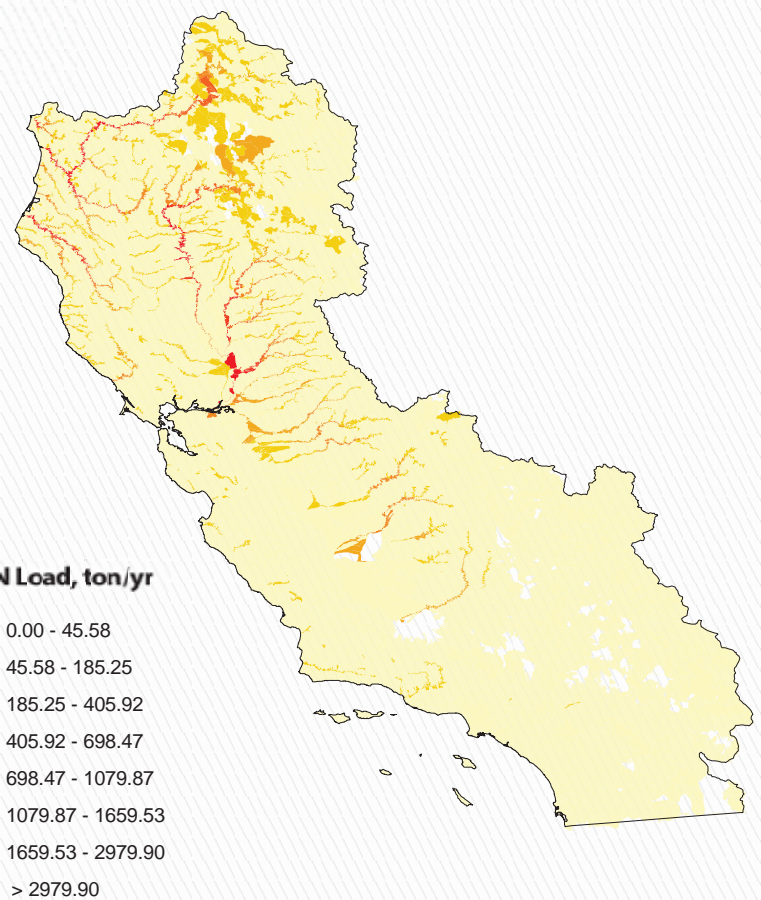
Modeled Load (p-value < 0.001)

Source and Load

Calibration Sites

Point Source Sites
Major
Minor

TN Load, ton/yr
- 0.00 - 144.32
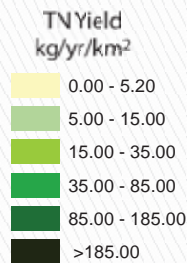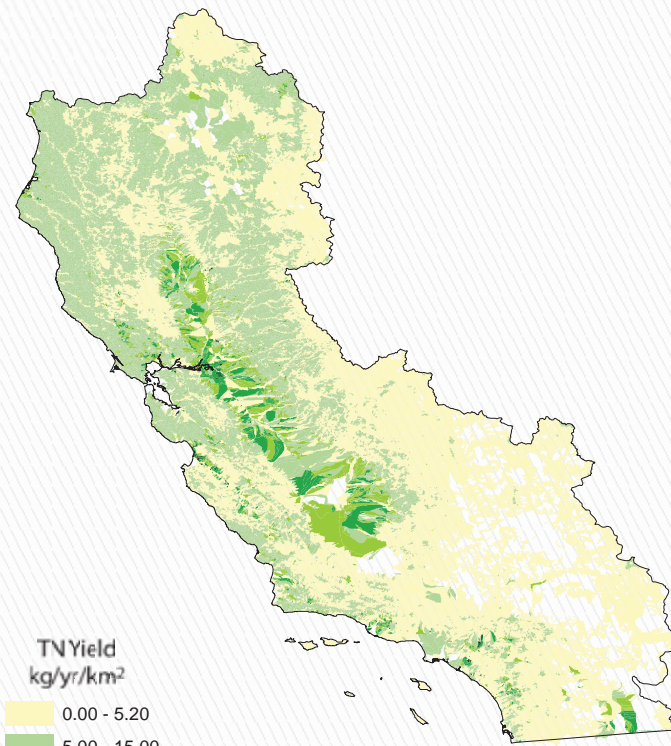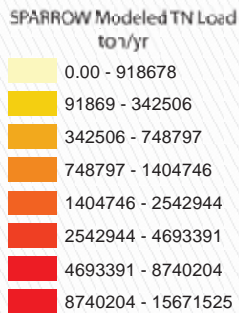- 144.32 - 583.37
- 583.37 - 1545.48
- 1545.48 - 3767.99
- > 3767.99

Point Sources

Modeled Load (p-value = 0.078)
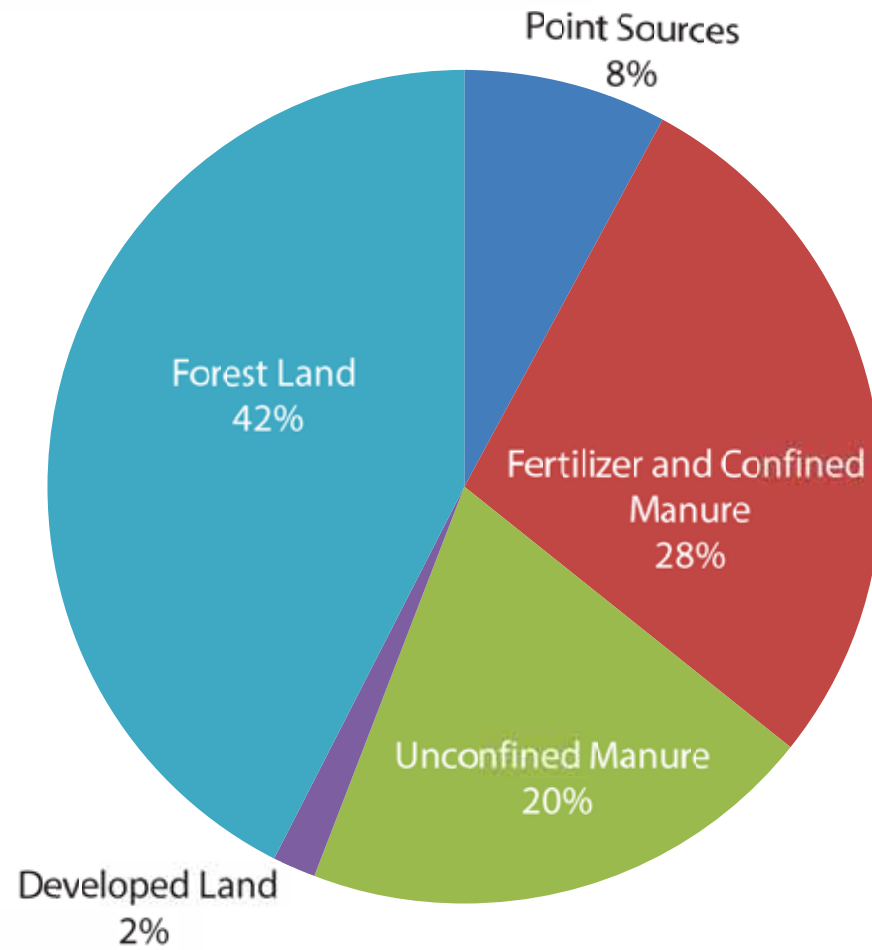
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SPARROW Output

SPARROW Modeled TN Load
ton/yr

- 0.00 - 918678
- 91869 - 342506
- 342506 - 748797
- 748797 - 1404746
- 1404746 - 2542944
- 2542944 - 4693391
- 4693391 - 8740204
- 8740204 - 15671525

TN Yield
kg/yr/km^2

- 0.00 - 5.20
- 5.00 - 15.00
- 15.00 - 35.00
- 35.00 - 85.00
- 85.00 - 185.00
- >185.00

TN Loads

TN Yield

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TN Load Sources

Point Sources 8%

Forest Land 42%

Fertilizer and Confined Manure 28%

Unconfined Manure 20%

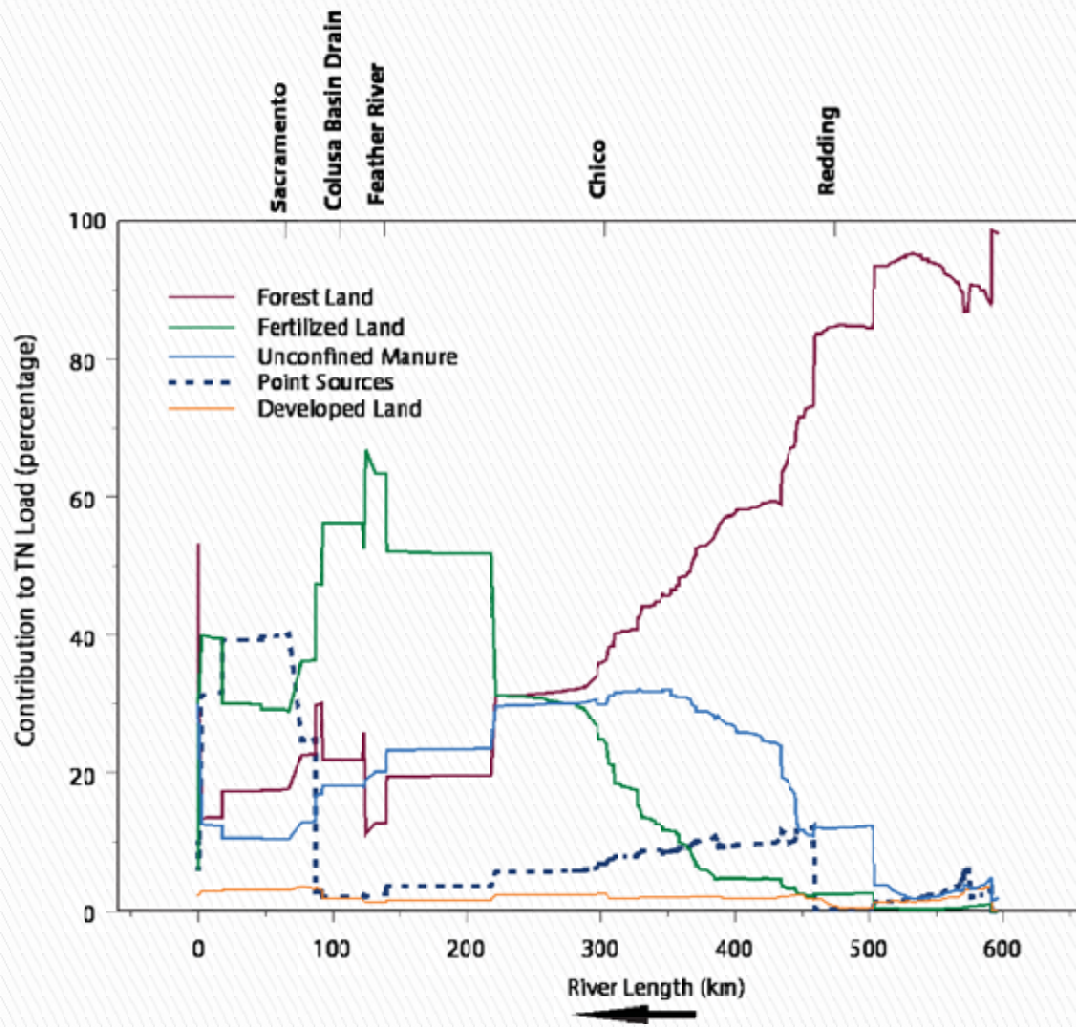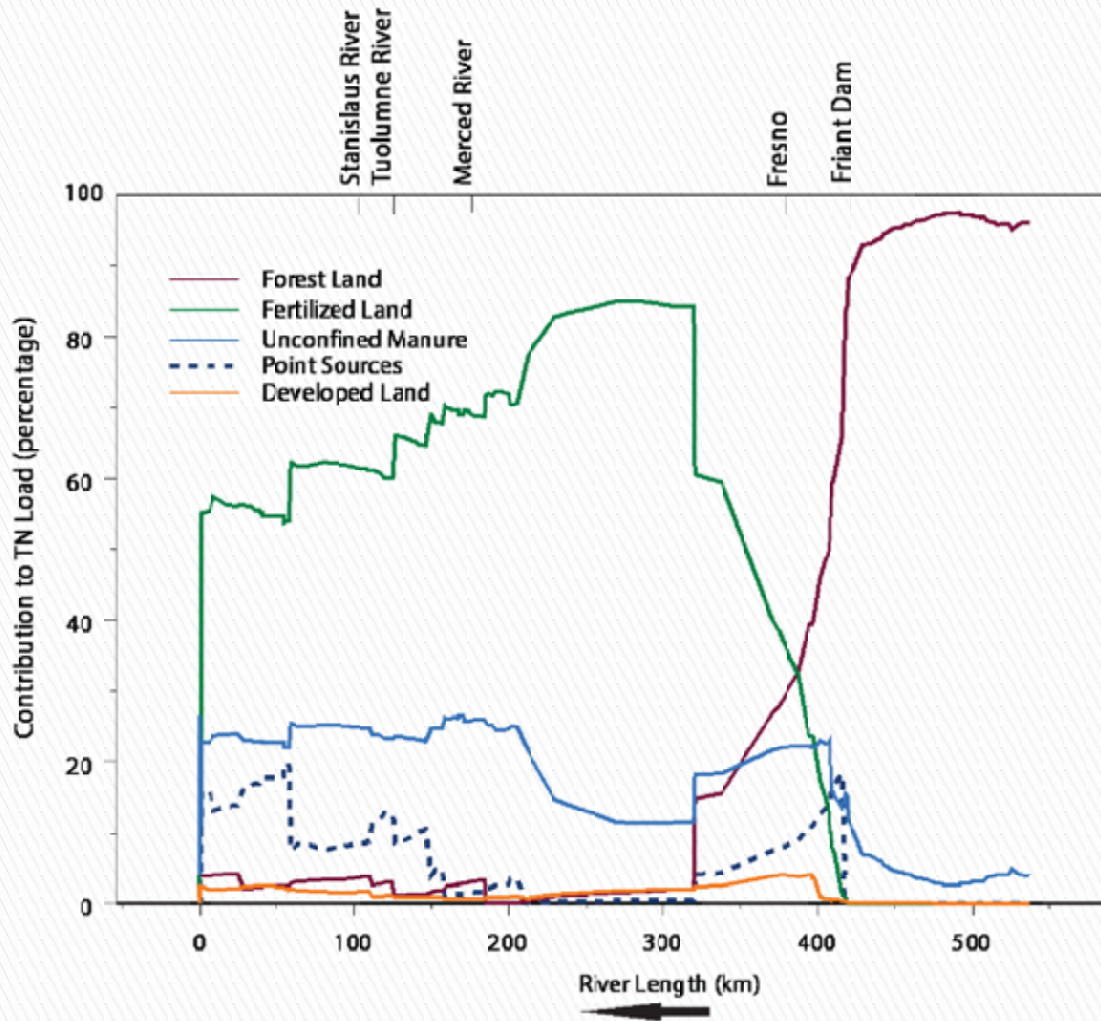Developed Land 2%
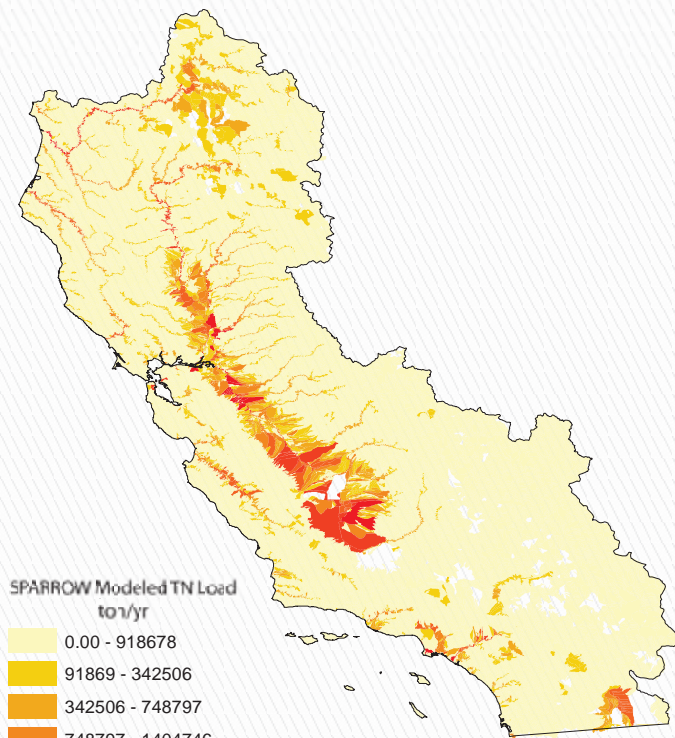
Sacramento River TN Loads
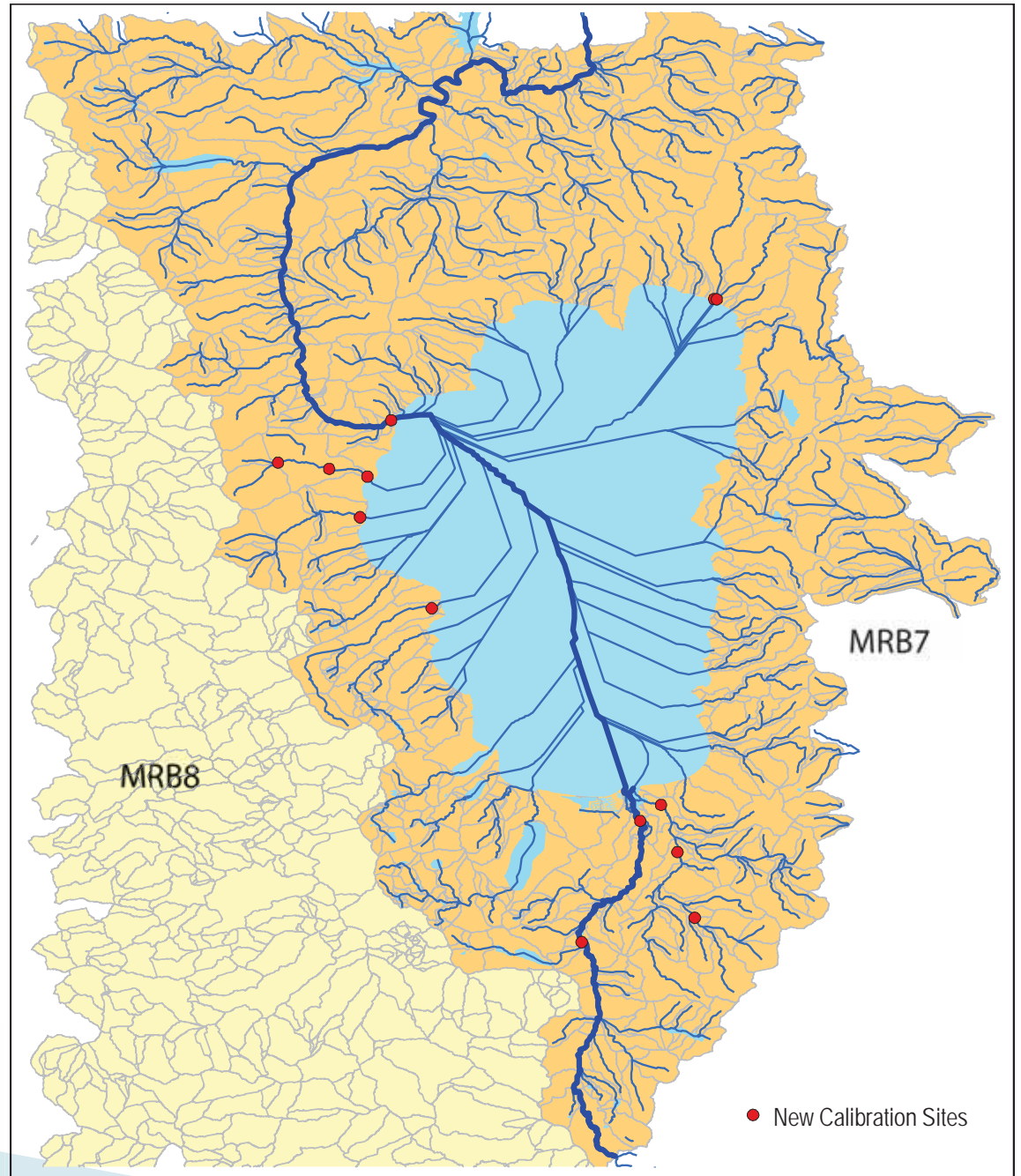
San Joaquin River TN Loads

Future plans

- Building the California TP model

Future plans

- Building the California TP model
- Incorporating the Tahoe Basin into the California SPARROW model

Incorporating the Tahoe Basin into the California SPARROW model:

- ▶ Adding 13 more calibration sites in the forested area
- ▶ Compare model results to ongoing research in the Tahoe basin

MRB7

MRB8

● New Calibration Sites

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▸ Building the California TP model
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▸ Klamath River: adding new calibration sites and river diversions

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▸ **Refining watersheds adding more diversions**

Future plans

- Building the California TP model
- Incorporating the Tahoe Basin into the California SPARROW model
- Klamath River: adding new calibration sites and river diversions
- Refining watersheds adding more diversions
- Linking loads to Delta to upstream sources

Future plans

▸ Building the California TP model
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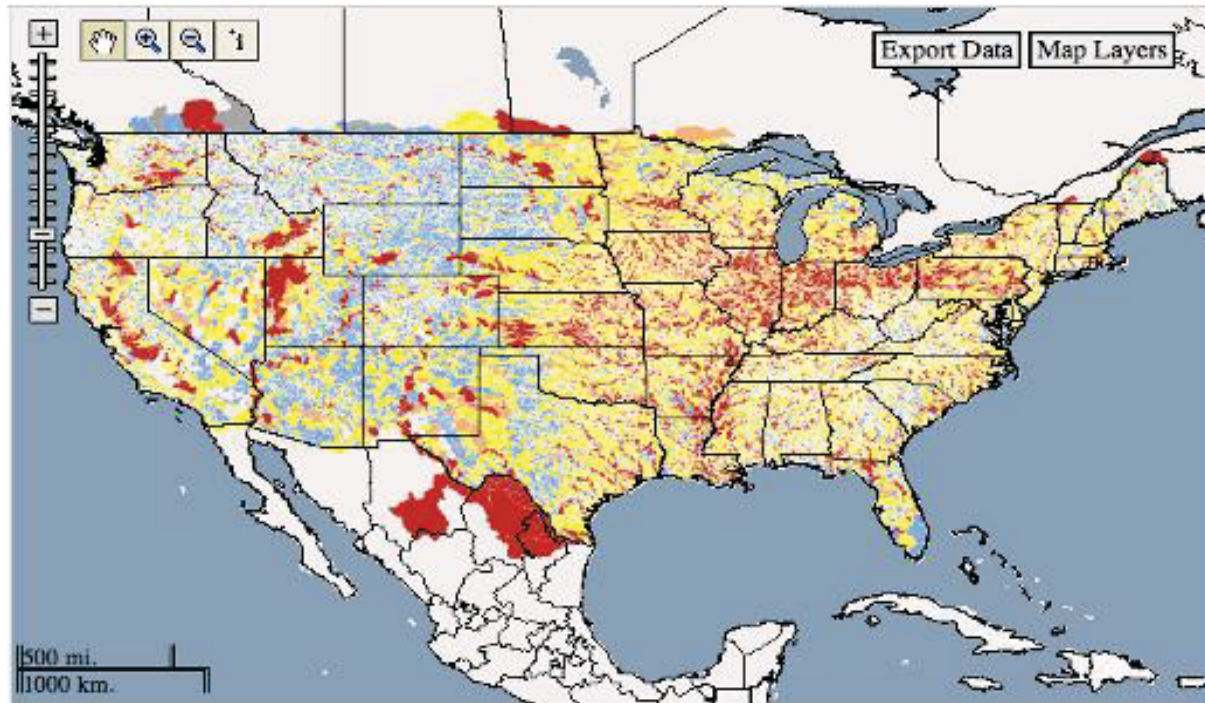▸ Interpretations of results (publications)

Future plans

- Building the California TP model
- Incorporating the Tahoe Basin into the California SPARROW model
- Klamath River: adding new calibration sites and river diversions
- Refining watersheds adding more diversions
- Linking loads to Delta to upstream sources
- Interpretations of results (publications)
- Developing the <u>CA SPARROW Decision Support System</u>

▸ What is the SPARROW Decision Support System?

SPARROW Decision Support System

Improved transparency and access to the model to inform management decisions

Future plans

▸ Building the California TP model
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▸ Interpretations of results (publications)
▸ Developing the CA SPARROW Decision Support System
▸ **Presenting results from the SPARROW model in the Bay Delta Conference**

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QUESTIONS?