Modeling flow and pesticide transport through surface water diversions in the California Central Valley

Presented by:

Lauren Padilla, Stone Environmental Inc.
Michael Winchell, Stone Environmental Inc.
Natalia Peranginangin, Syngenta Crop Protection, LLC
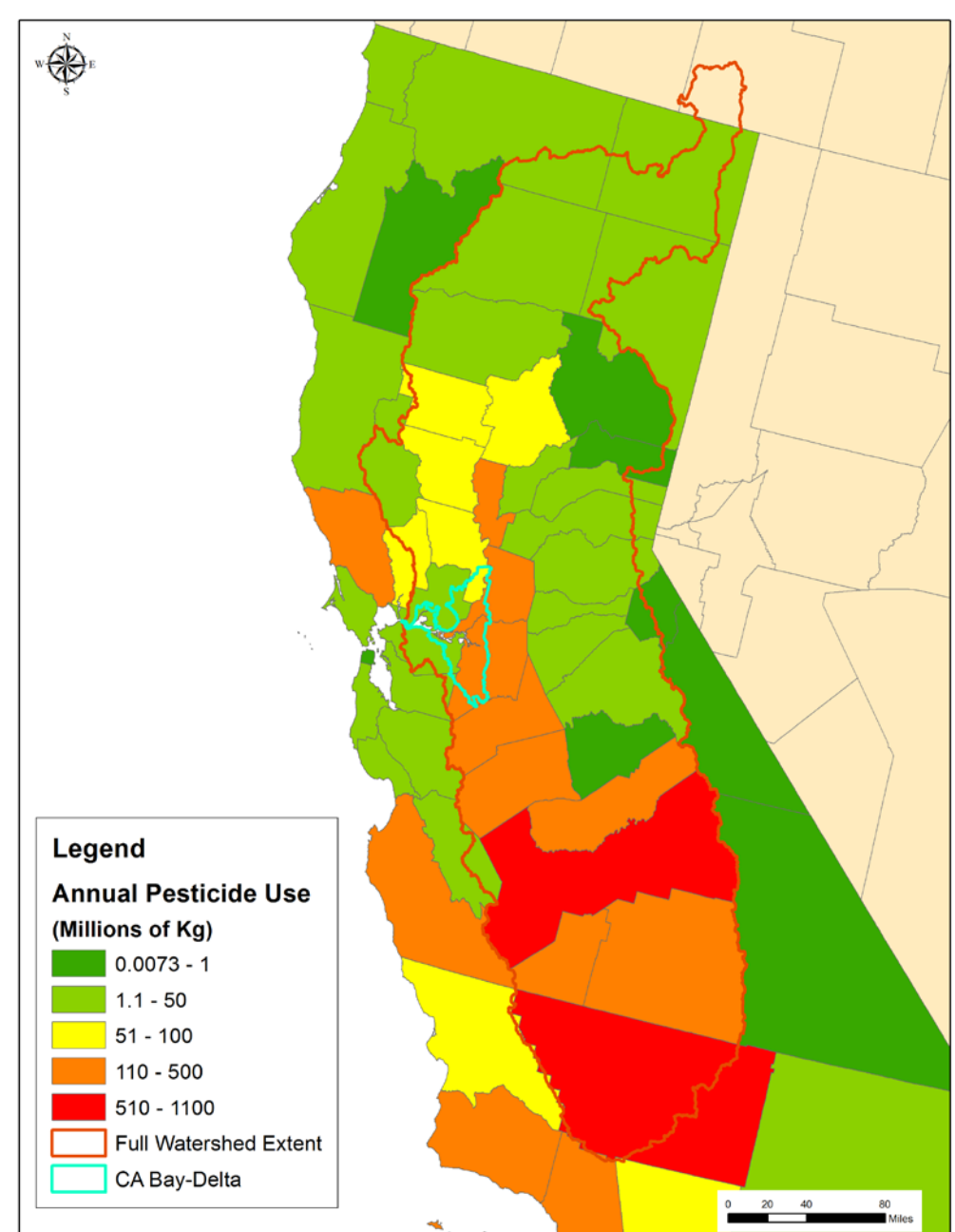July 19, 2013

STONE ENVIRONMENTAL INC
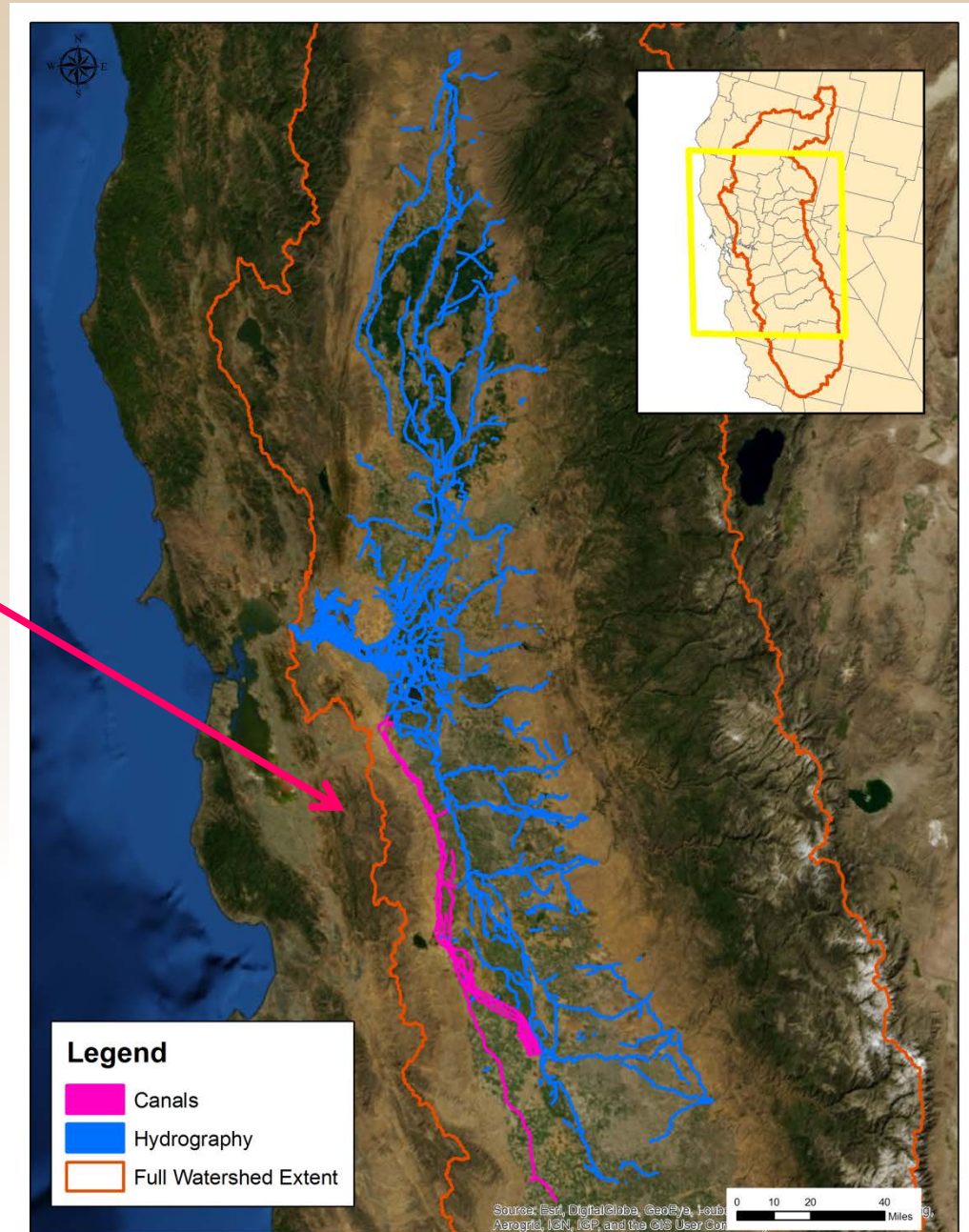
Modeling Goal and Challenges

- Background: Agriculturally intensive Central Valley Region in California with need to control pests drains to the California Bay-Delta

- Goal: Characterize pesticide concentrations in the Delta

- Challenges: Modeling the many surface water diversions in and around Delta that have major effects on flow rates and pesticide concentrations

Legend

Annual Pesticide Use (Millions of Kg)

- 0.0073 - 1
- 1.1 - 50
- 51 - 100
- 110 - 500
- 510 - 1100
- Full Watershed Extent
- CA Bay-Delta

# California Bay-Delta Watershed

- Drainage area includes entire Central Valley

- Intensive agricultural region

- Surface water diverted hundreds of miles

  - Delta Mendota Canal
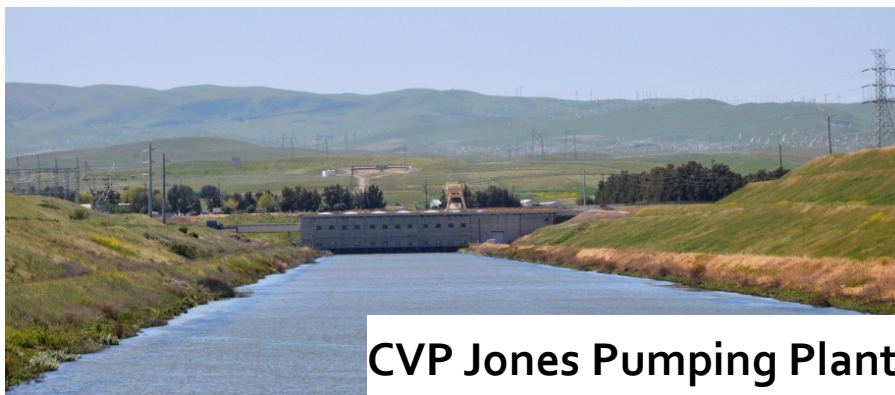 - California Aqueduct

Legend

- Canals
- Hydrography
- Full Watershed Extent

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

0 10 20   40
Miles

Central Valley Surface Water Diversions

- Flood control structures

- Irrigation canals

- Pumping stations
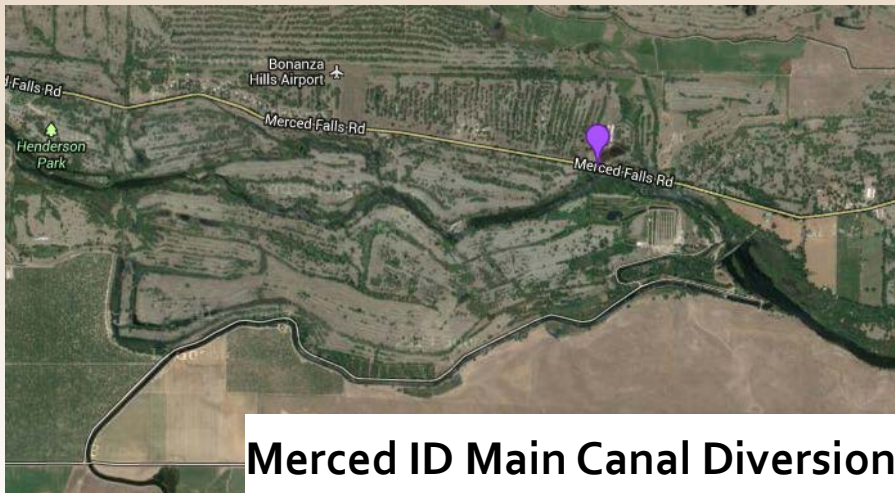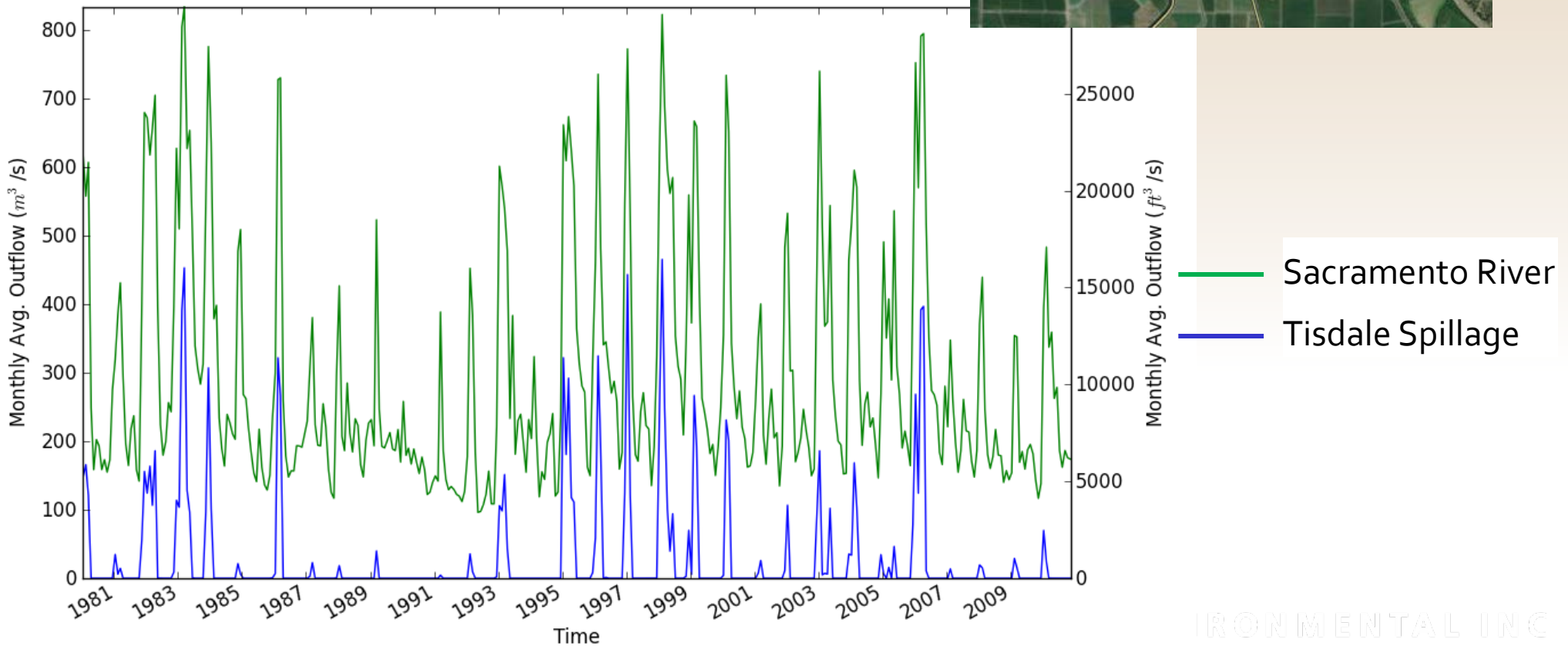

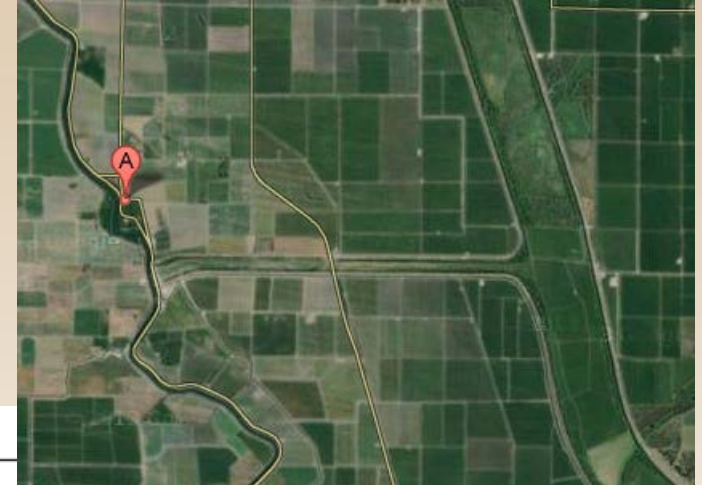**Merced ID Main Canal Diversion**

CVP Jones Pumping Plant

Tisdale Weir

1000 ft
200 m

Topo Demand Media, Inc. - Terms of Use
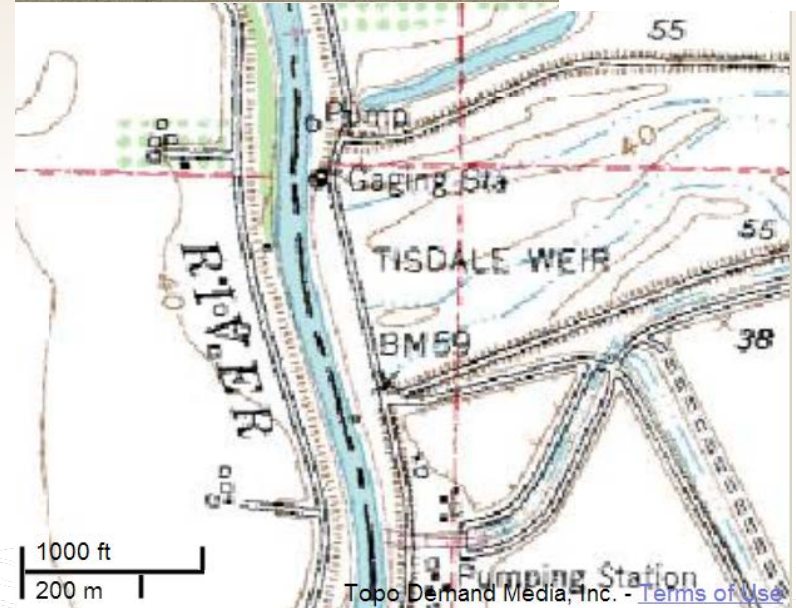
Central Valley Surface Water Diversions

- Time-varying

- High flow rates

- Lack temporal patterns

SWAT Surface Water Transfer Scheme

Currently

- Transfer amount options
  - Constant fraction of flow rate
  - Constant volume
- Constant mass transfer

Improved

- Daily or monthly time-series
- Destinations in or out of watershed
- Daily or monthly pesticide, nutrient, sediment transfer proportional to transferred-flow:total-flow ratio
- Corrected monthly output indices

SWAT Transfer Input Files

- Daily and monthly point source files
  - *##p.dat, ##m.dat*
  - *NEGATIVE* flows
- fig.fig file
- Transfer removed from source after routing
- Destination receives transfer before routing on next time-step
- Transfer codes
  - 1 Constant fraction
  - 2 Minimum flow remains
  - 3 Constant volume
  - 4 Timeseries

fig.fig excerpt

```
route        2  628  181  181
        001810000.rte001810000.swq
recday       10  629   15
Pnt.Source      181p.dat
add          5  630  628  629
transfer     4    1  181    1  185 628.       4  6
        1  12 630
```

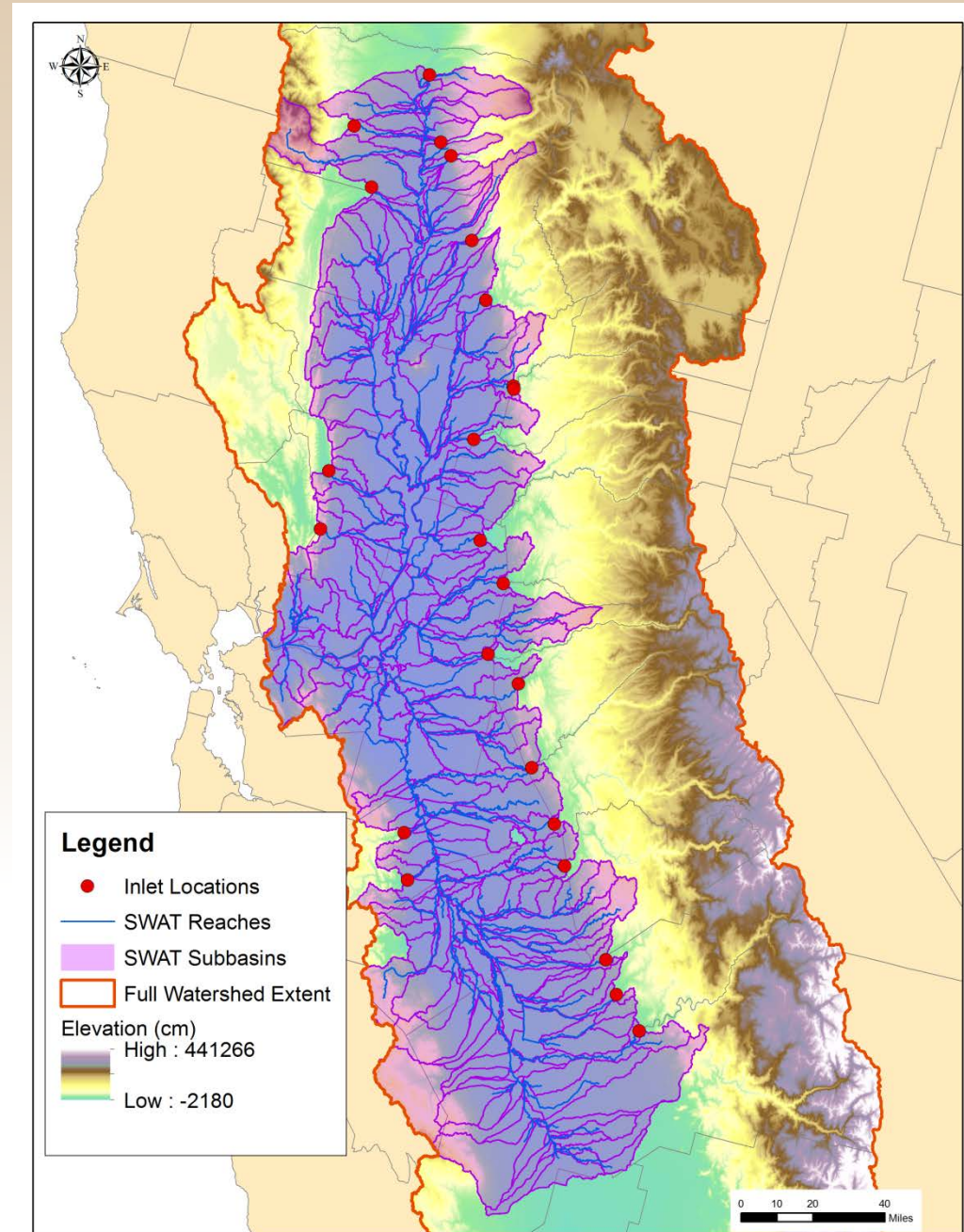**Command**

Source reach

Destination reach

Transfer code

California Central Valley SWAT Model

- Topography: 30-m NHDPlus V2 Hydrologically Conditioned DEM

- Soils Data: Soil Survey Geographic database, 1:25,000 scale

- Land Use Data: Cropland Data Layer (CDL), 30-m, multiple crop classes

- 344 Subbasins
  - Average 140 km² (1000 - .01 km²)
  - 37,041 HRUs

- 24 Point Source Inlets
  - Drain 26,300 square miles or 40% of watershed area
  - 30-year daily average time-series
  - US Geological Survey gage data

Legend
- ● Inlet Locations
- — SWAT Reaches
- ▨ SWAT Subbasins
- ▭ Full Watershed Extent

Elevation (cm)
High : 441266
Low : -2180

0 10 20 40 Miles

Modeled Diversions – Daily time-step

- **Weirs and Channels**

  - Moulton, Colusa, Tisdale Weir transfers to Sutter Bypass

  - Fremont, Sacramento Weirs to Yolo Bypass

  - Delta Cross Channel connection to Mokelumne River

  - Little Potato Slough connection to San Joaquin River

  - All returned to watershed

- **Pumping Plants**

  - Central Valley Project Jones Pumping Plant to Delta-Mendota Canal

  - State Water Project Banks Pumping Plant to CA Aqueduct

  - Contra-Costa Canal

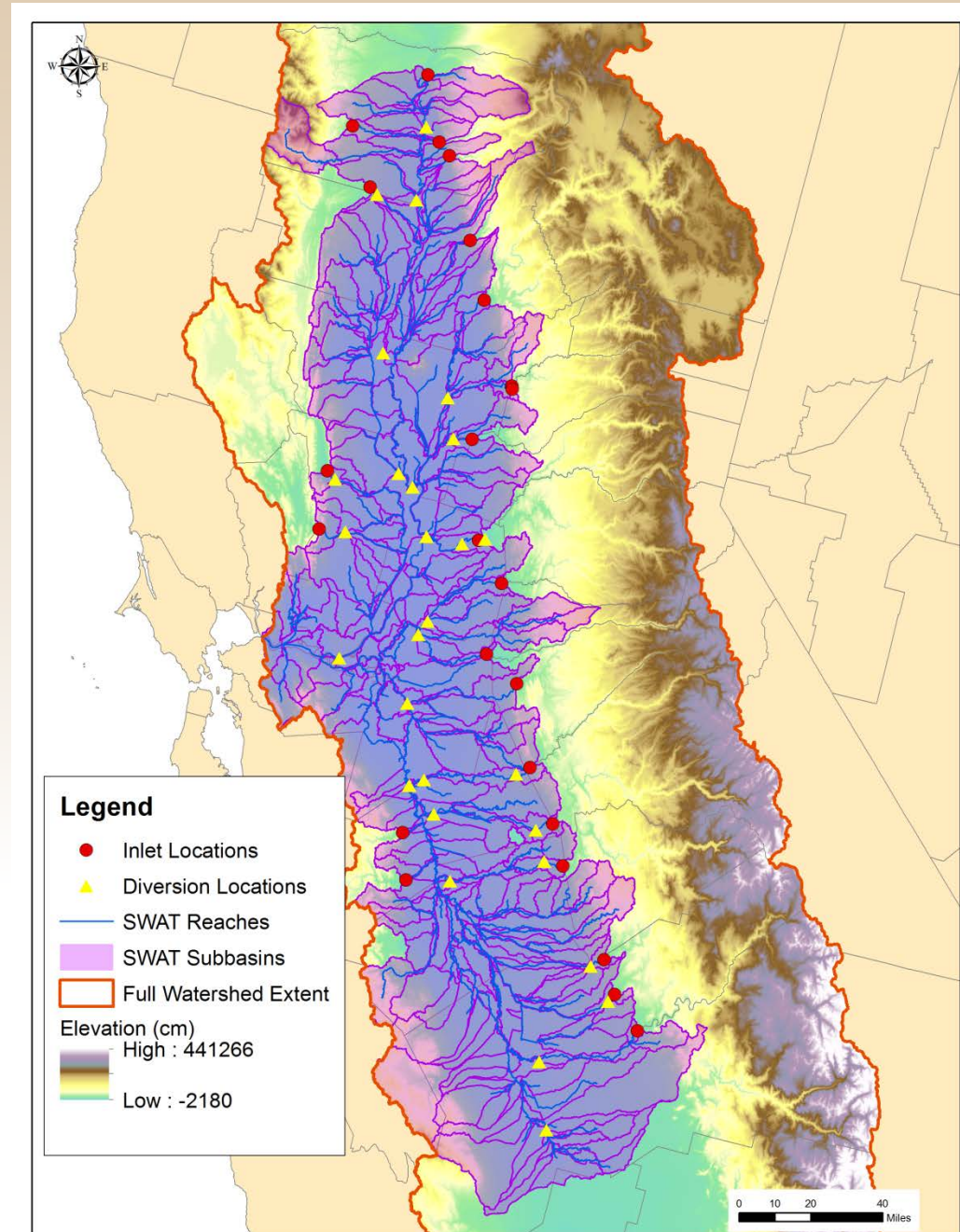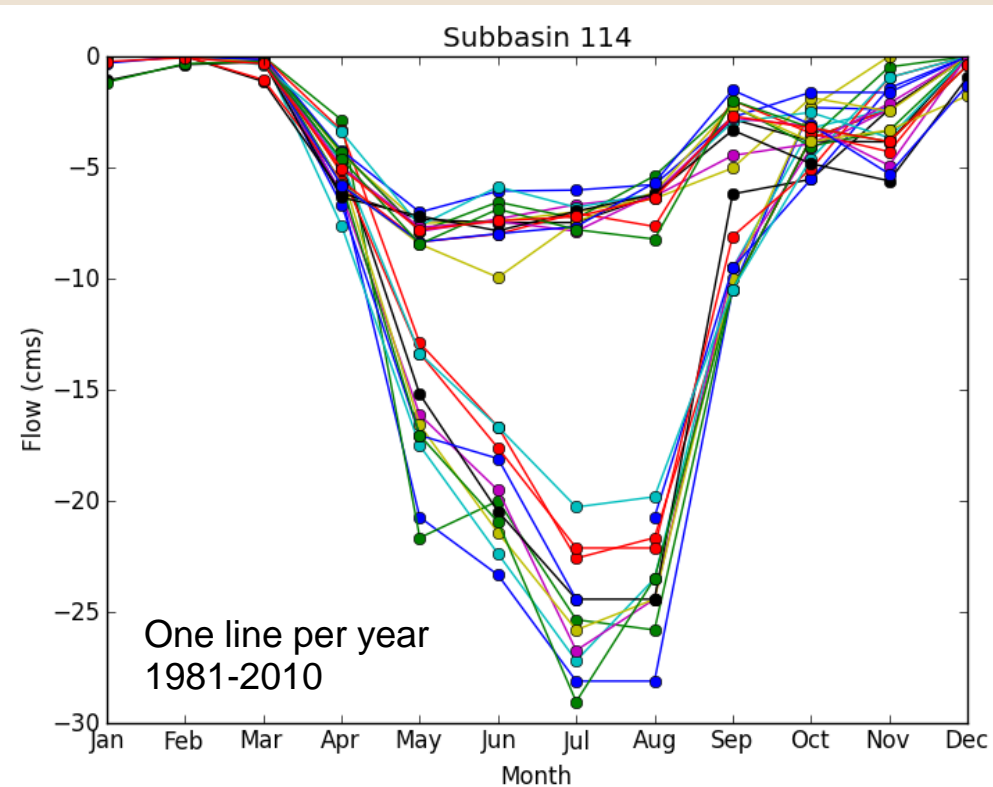 - All exported out of watershed

- **Daily Datasets**

  - US Geological Survey, DAYFLOW
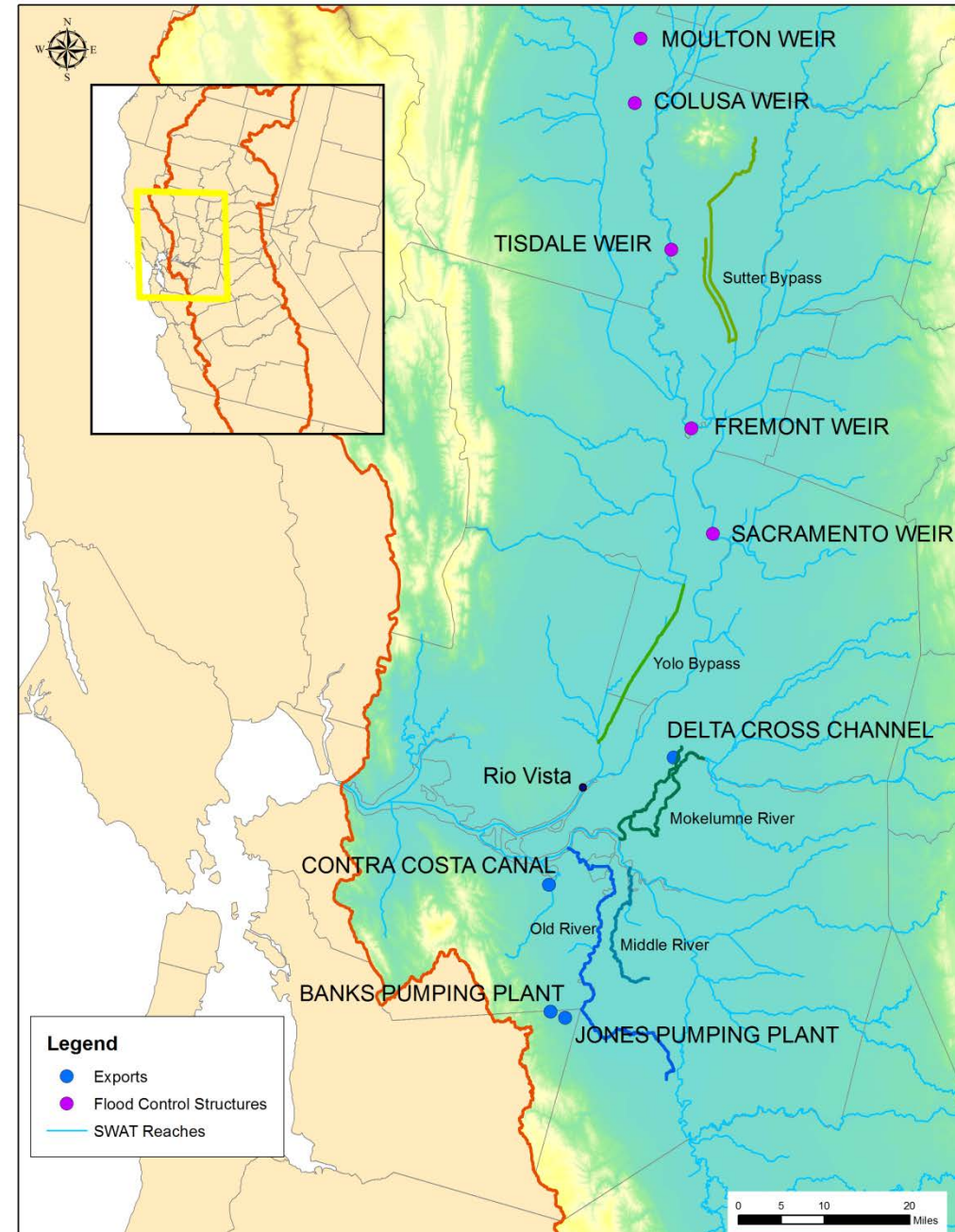
# Modeled Diversions – Monthly time-step

- 33 Irrigation Diversions

- No "Typical Year"

- Monthly datasets

  - CA Department of Water Resources

Subbasin 114

One line per year
1981-2010

Legend
- ● Inlet Locations
- ▲ Diversion Locations
- — SWAT Reaches
- ▨ SWAT Subbasins
- ▭ Full Watershed Extent

Elevation (cm)
- High : 441266
- Low : -2180

Estimation of Missing Data

- Few days to few years of missing observations

- Estimation strategies
  - Linear interpolation
  - Average or similar year

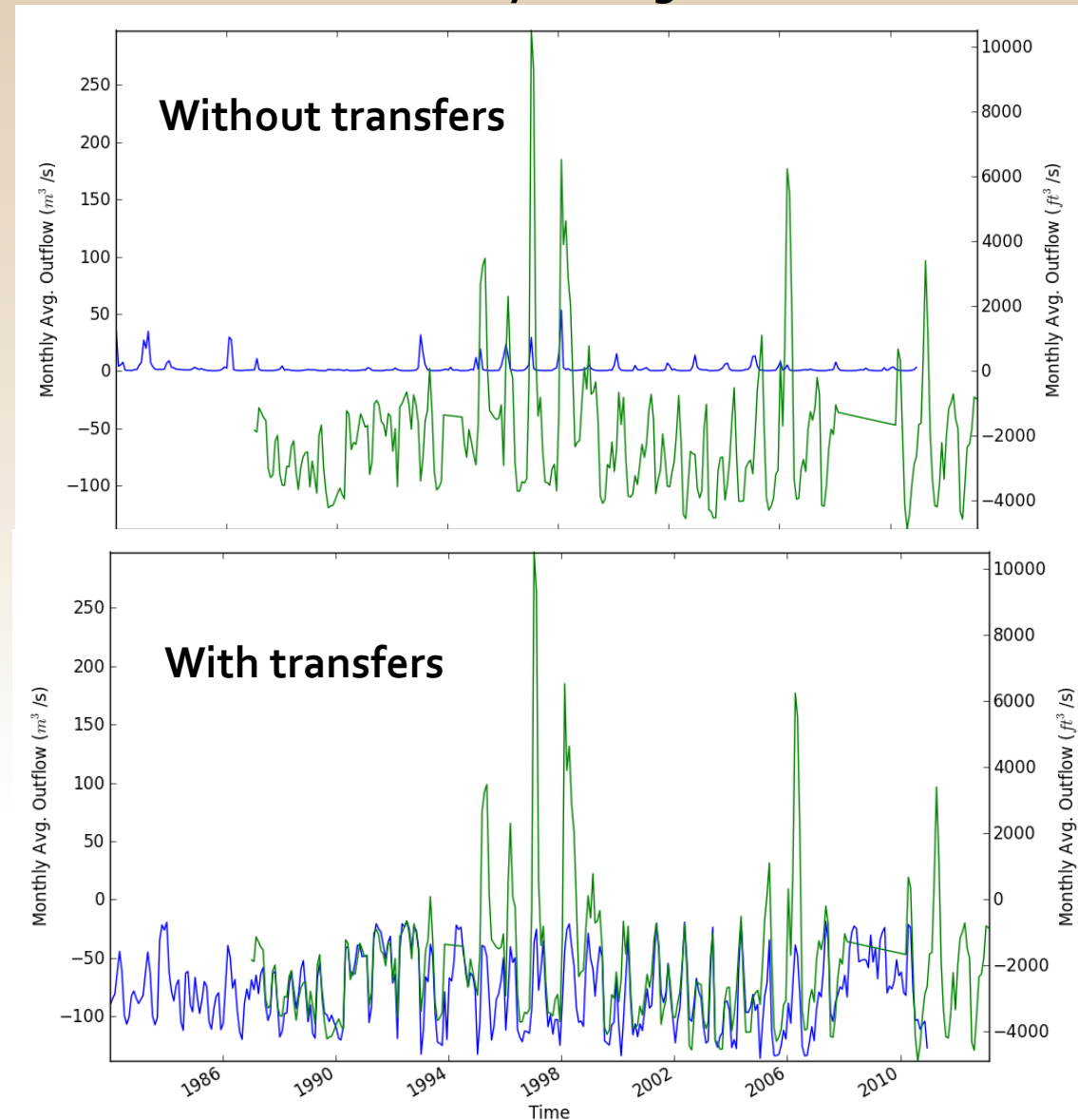Middle River Monthly Average Flow Rate
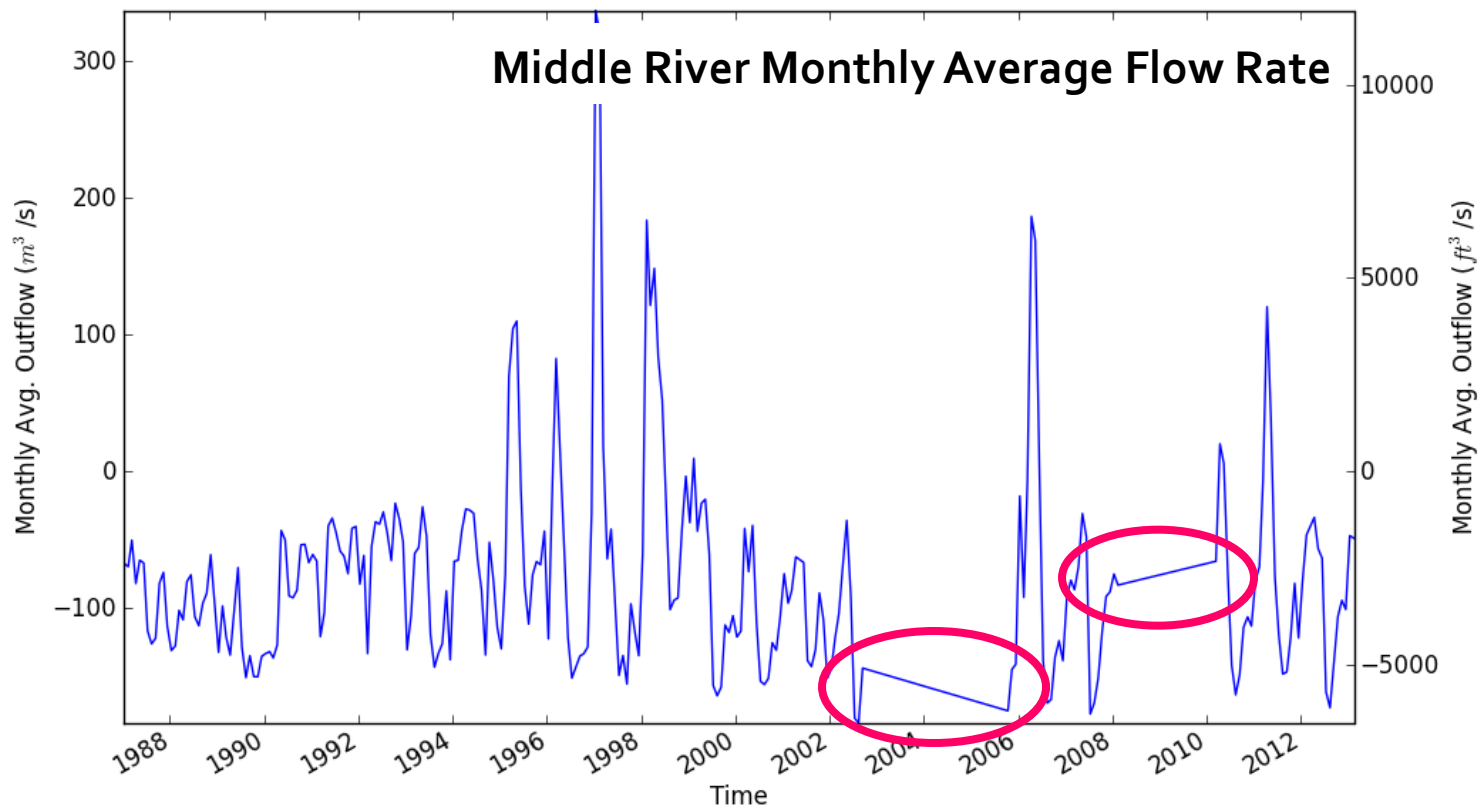
Improved SWAT Results: Magnitude and Timing

- More accurate estimation of flow rates

- Mass transport, ex. pesticides

- Old River – natural flow overwhelmed by export flow

- Still missing some diverted floodwater

Old River Monthly Average Flow Rate

Without transfers

With transfers

— Observed Flow

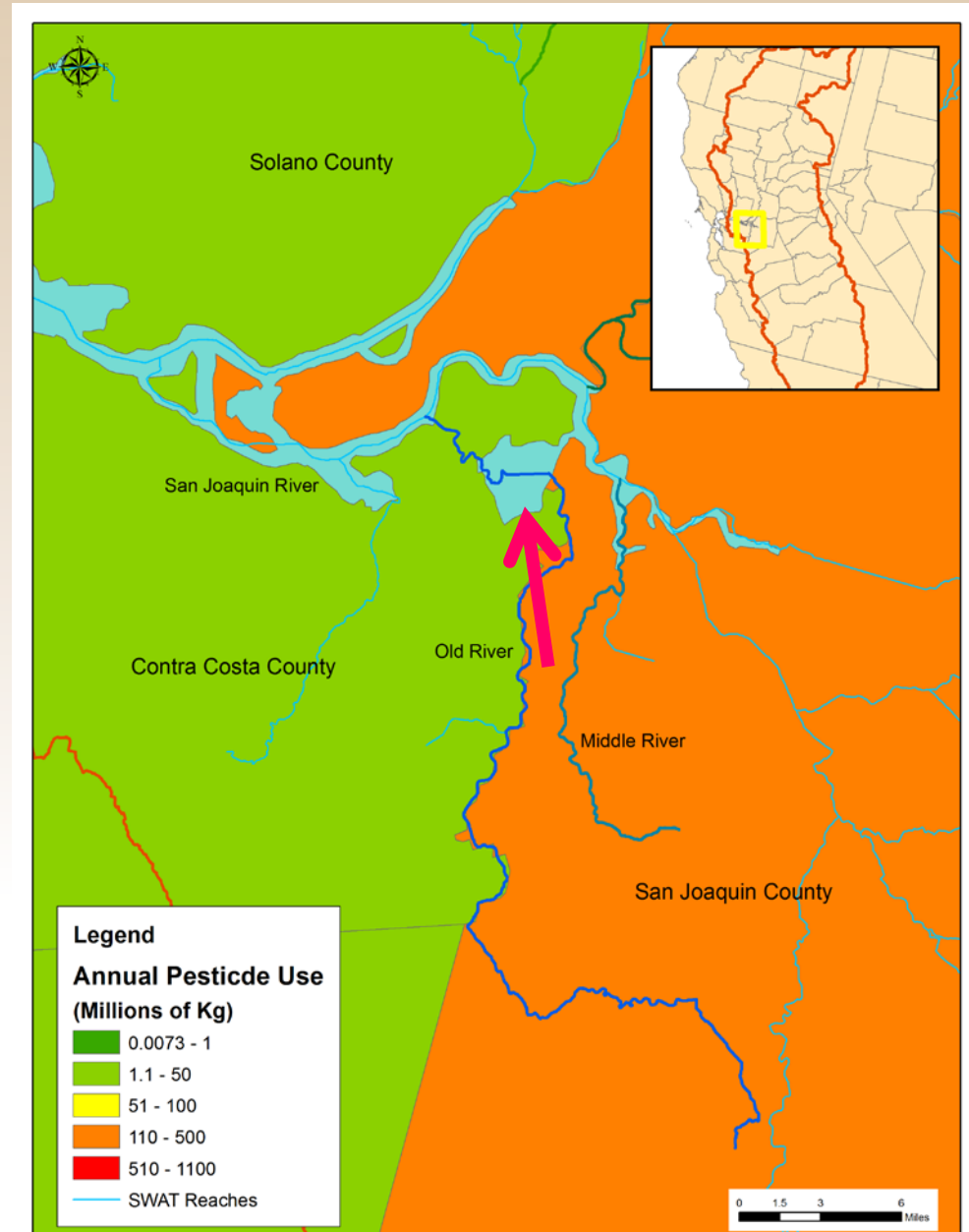— Modeled Flow

Improved SWAT Results: Spatial Extent

- Improved spatial distribution of pesticide mass

- Natural flow would move San Joaquin County mass toward San Joaquin River

# Improved SWAT Results: Spatial Extent

- Improved spatial distribution of pesticide mass

- Natural flow would move San Joaquin County mass toward San Joaquin River

- Actual flow due to Pumping Plants dilutes mass and exports out of watershed
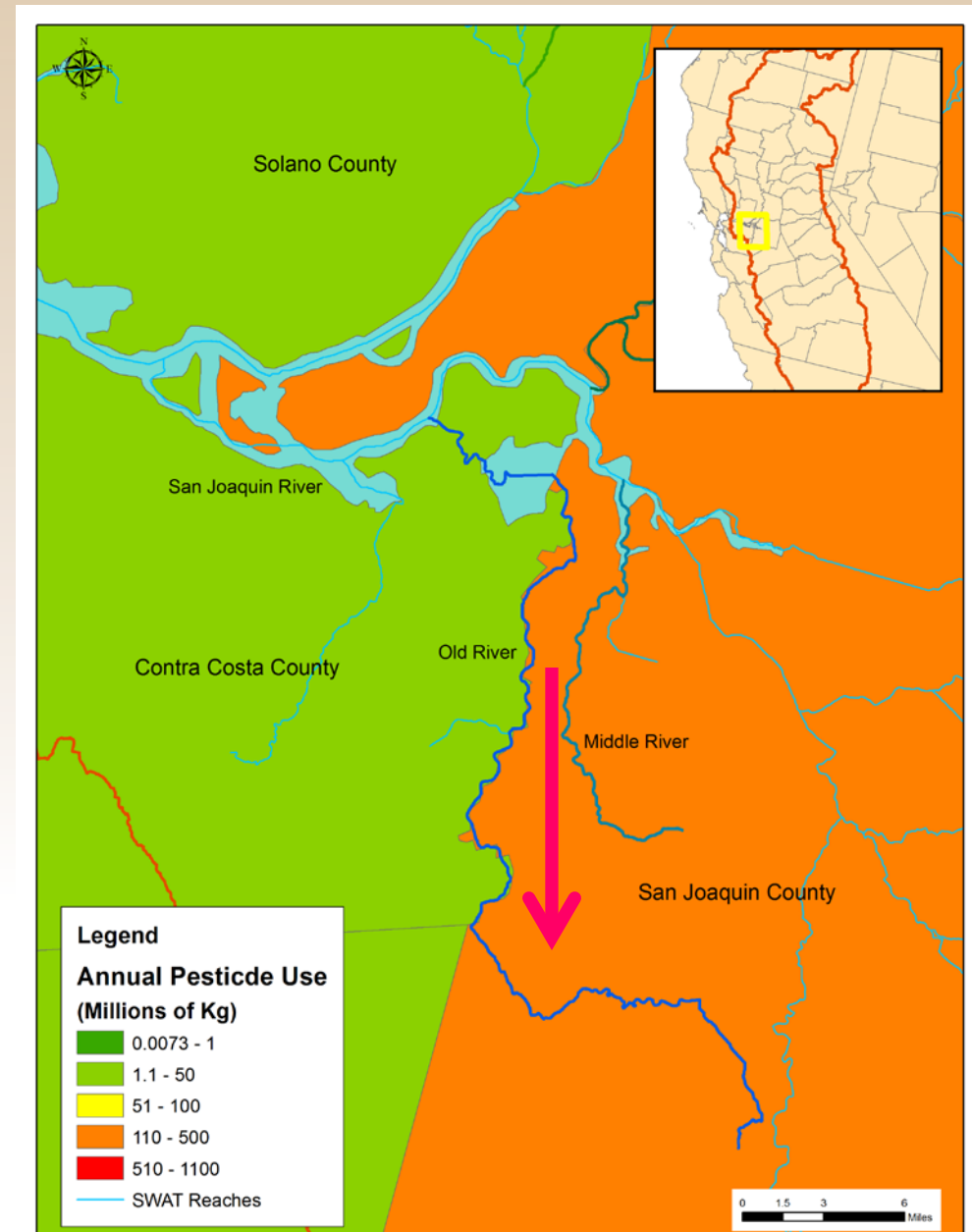
Improved SWAT Results: Calibration

- Better model calibration
- Avoids compensating for transfer error with calibration parameters

Stone Environmental Inc
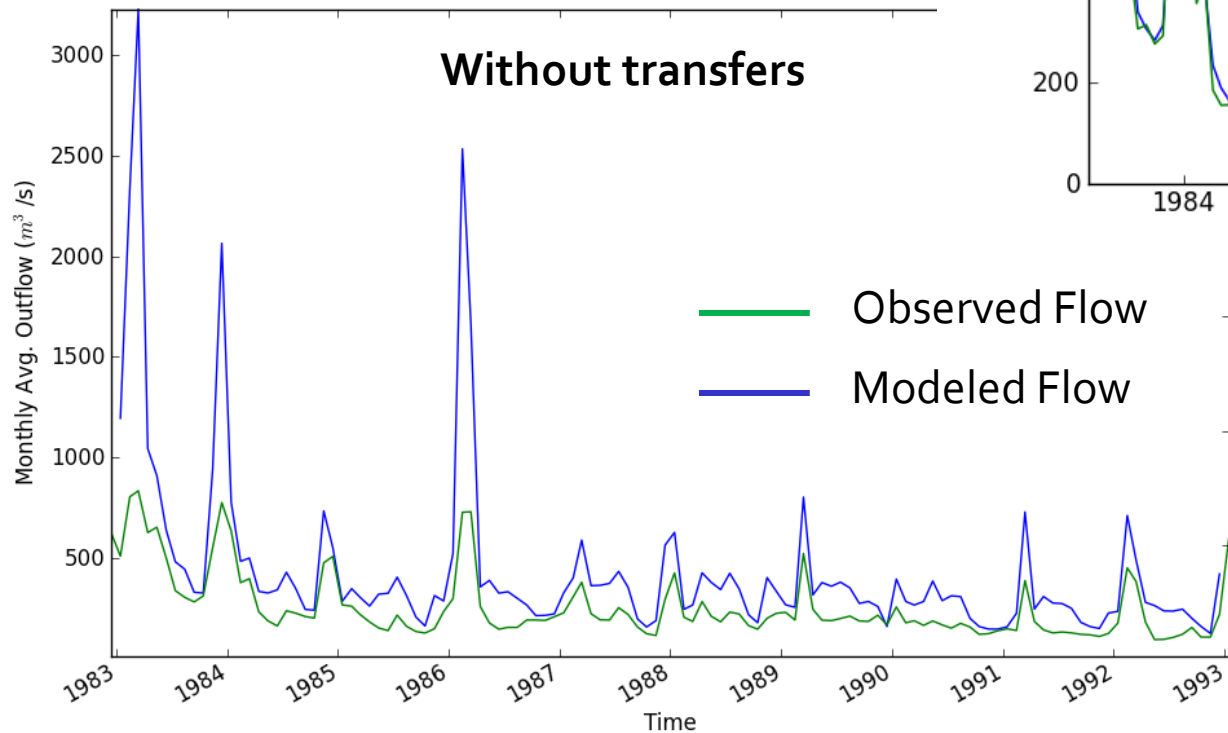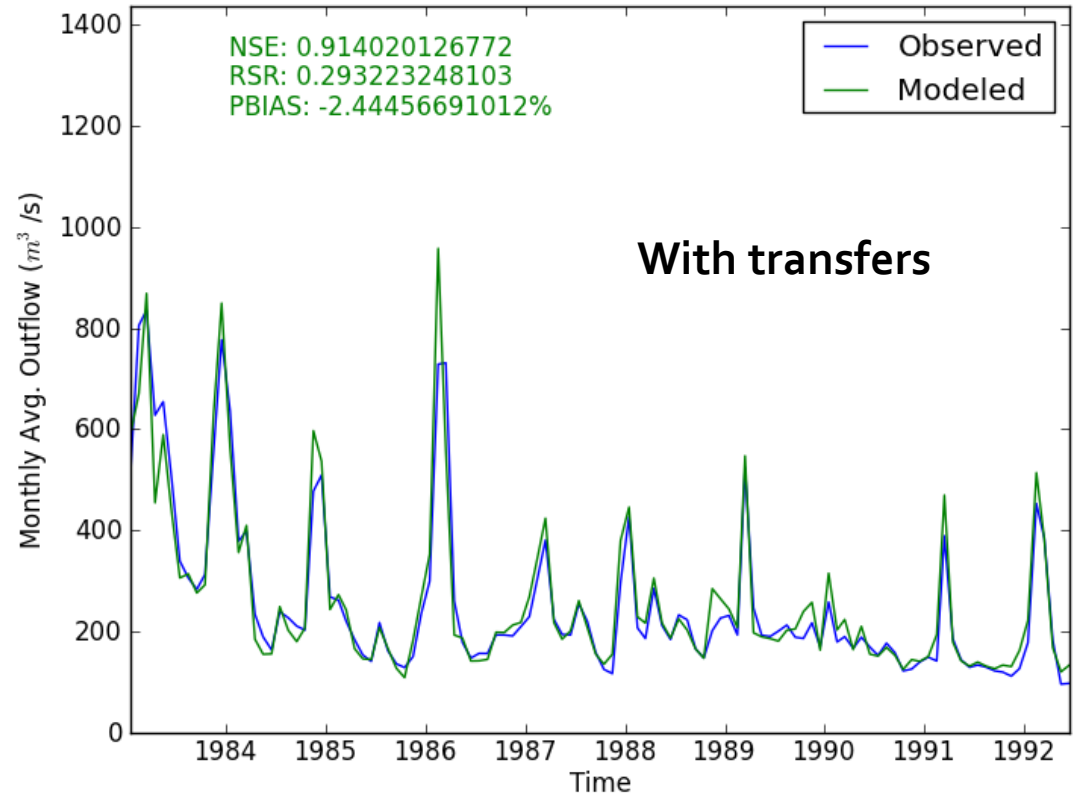
Summary

- Improved scheme: time-varying transfer of water, pesticide, nutrient, sediment mass

- Daily or monthly options

- More accurate magnitude and spatial distribution

- Fig.fig and point source input files

- Useful in large watersheds like Central Valley with many engineering controls on surface water

- However, not a dynamic model – only as good as input data

Flooded Yolo Bypass