Using GeoTracker GAMA to Investigate Nitrate Concentrations in California's Groundwater, 1980-2008

Erik J. Ekdahl, Mariela de la Paz Carpio-Obeso, & John Borkovich

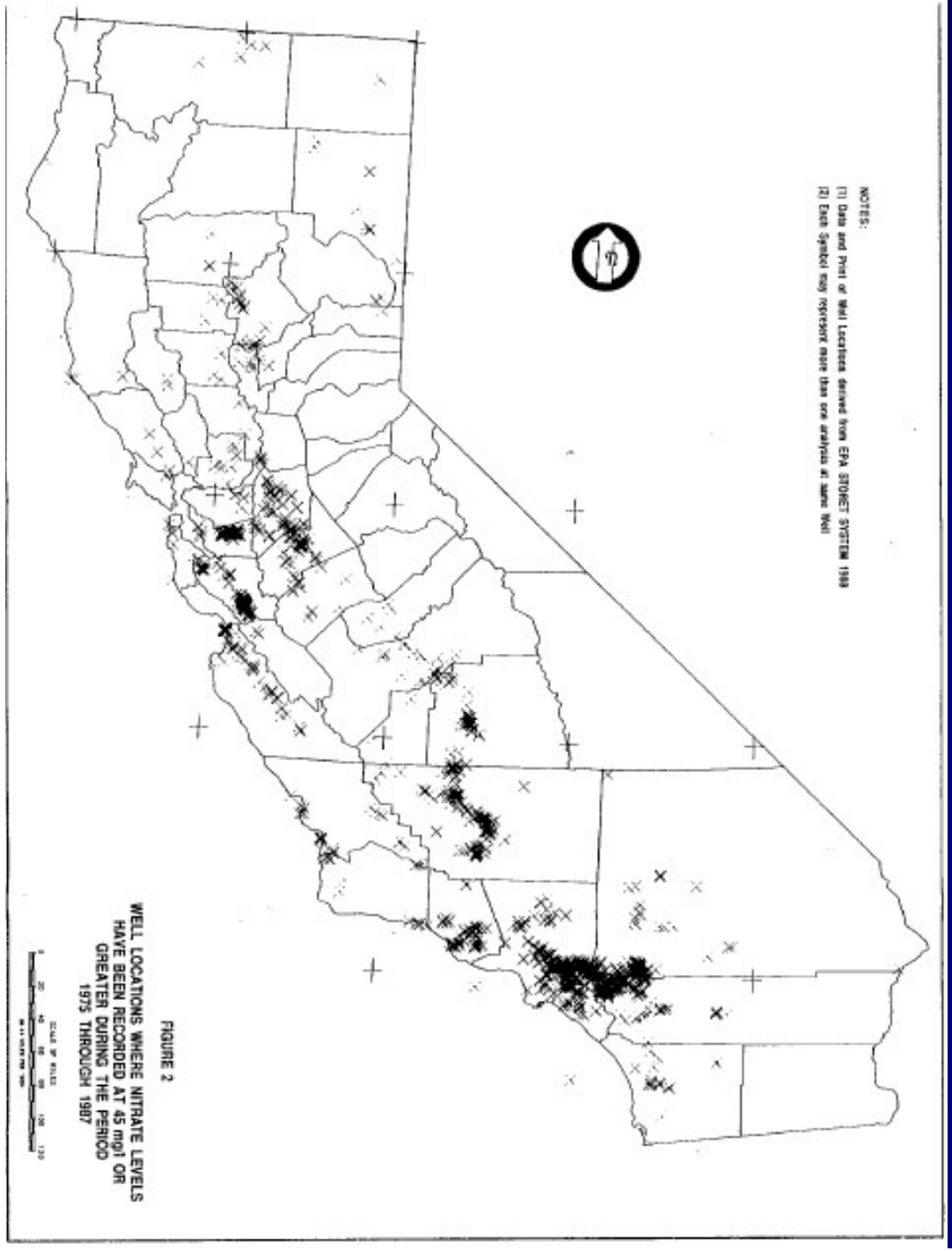
State Water Resources Control Board

Nitrate in California's Groundwater

- GeoTracker GAMA Data
- Statewide Nitrate Concentrations and Trends
- Tulare County

Why Nitrate?

- Easy to measure
- Wide-spread
- Persistent
- Major sources:
  - Fertilizers, septic and wastewater, animal facilities
- May be indicative of other types of groundwater contaminants



- 1988 SWRCB report (Anton et al)
- Shows location of reported nitrate >45 mg/L as NO_3 from 1975-1988
- Data collected from:
  Regional Boards, State Board, DFA, DHS, DWR, USGS, EPA, private consultants, Soil Conservation Service, UC Davis, Met. Water Dist. Of So. Cal., Kern County Water Agency, Monterey County Flood Control and water Conservation District, the Agricultural Research Service, county environmental health directors, and others
- How has groundwater quality changed in last 20 years?
- How has data accessibility changed since publication of the 1988 report?

Datasets

- Data downloaded from GeoTracker GAMA beta site
- From 1980-2000, only CDPH data
- 2001 through 2007 data includes:
  - CDPH sources
    - ~97% groundwater
    - Active, standby, inactive, destroyed wells
  - GAMA Wells (SWRCB and LLNL only)
  - DWR Wells
  - Environmental Monitoring Sites
    - USTs, Land Disposal, DoD

Datasets

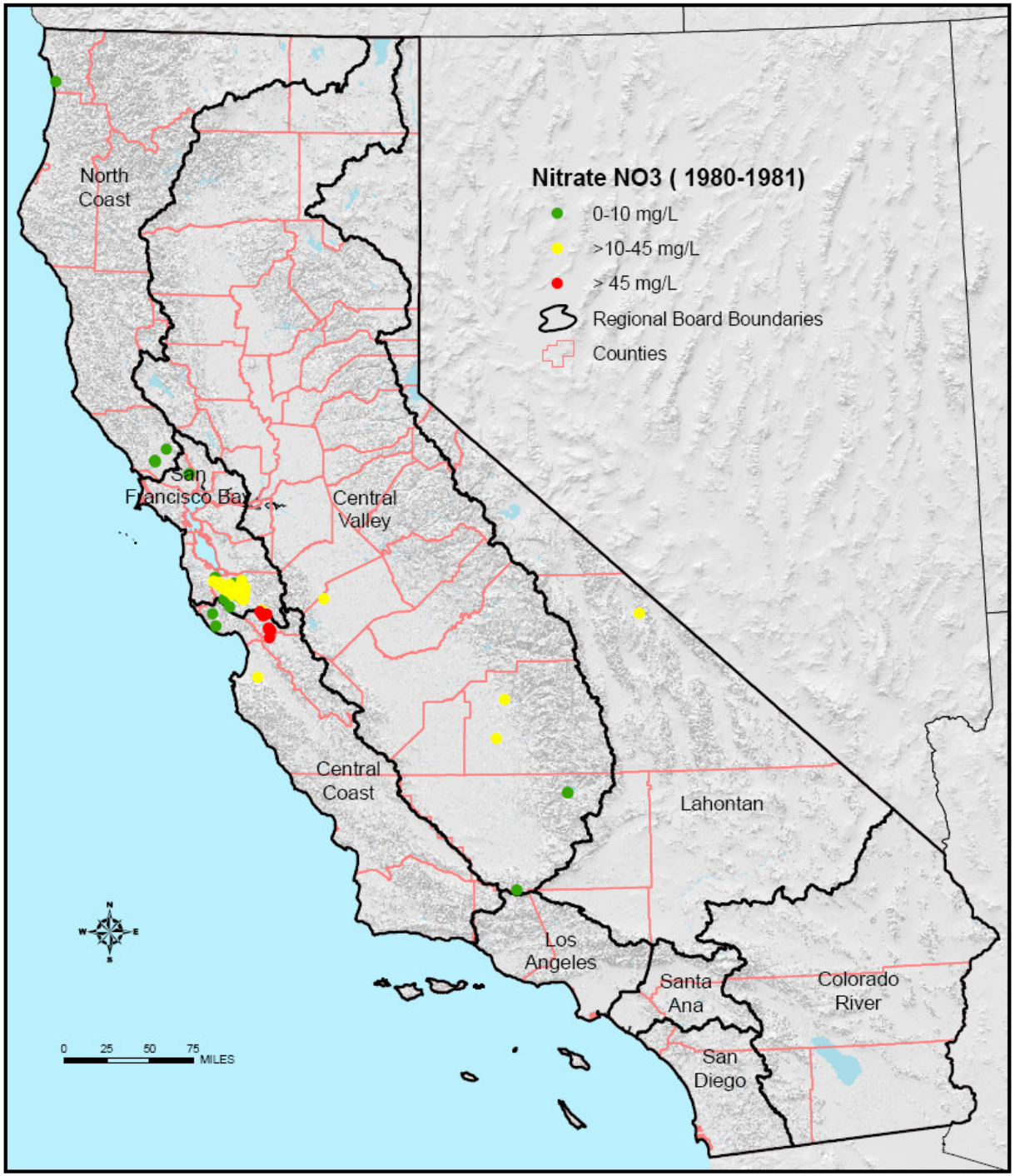
- Raw dataset includes all reported nitrate results over a specified time interval
- Raw data grouped by 1 or 2-year time intervals
- Data sorted so that only the MAXIMUM observed result from any time interval is shown
- Large dataset (raw = 354,000 data points; sorted = 106,000)

Datasets

- Following figures show reported nitrate concentrations (as NO_3)
- Plotted as follows:
  - Greater or equal to 45 mg/L = RED
  - >10 to <45 mg/L = YELLOW
  - Equal to or <10 mg/L = GREEN

N = 168 wells

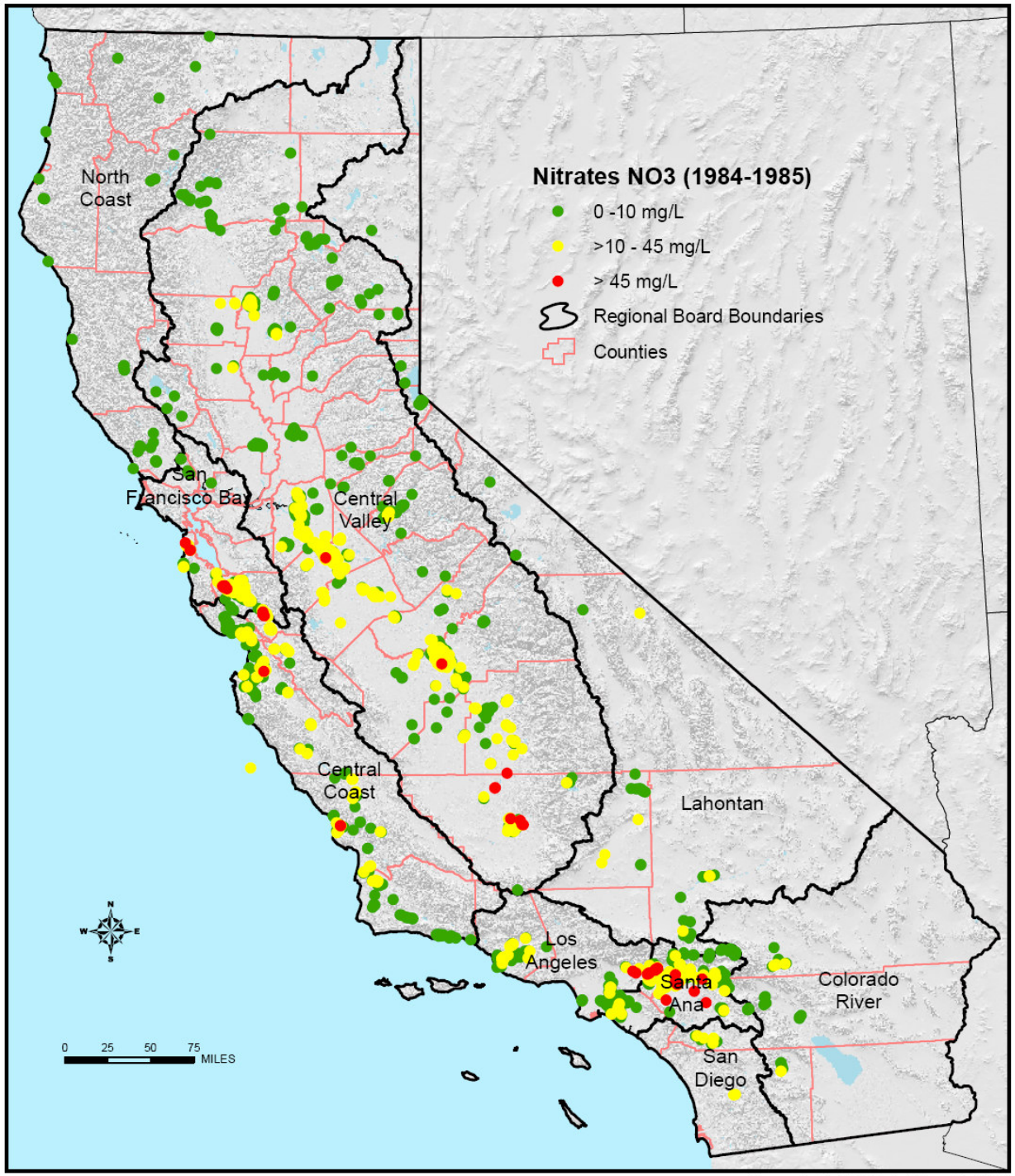
> 45 mg/L = 9
10-45 mg/L = 107
< 10 mg/L = 52



Map created by M.P.Carpio-Obeso, Feb.2009

N = 1714 wells

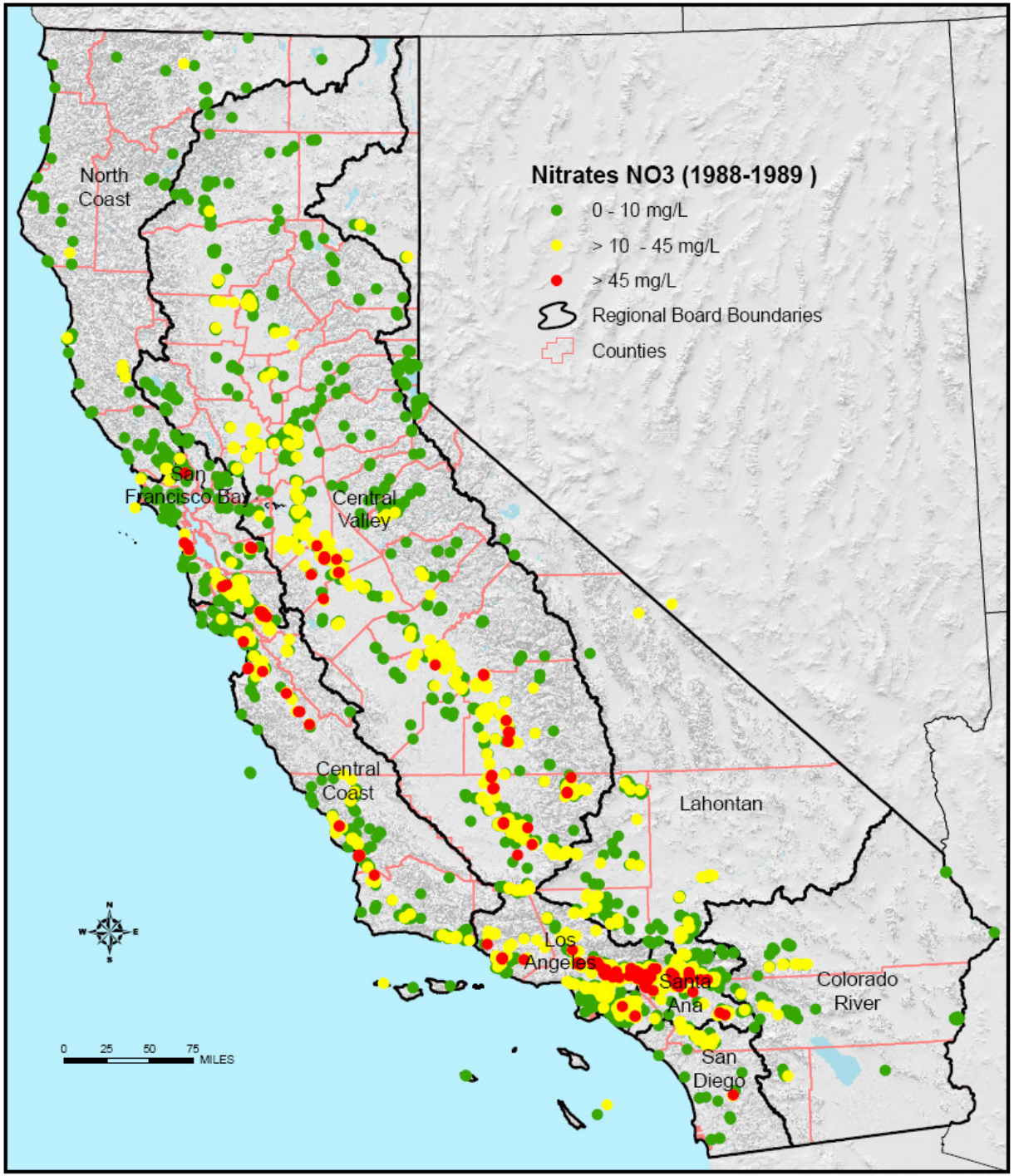
> 45 mg/L = 46
10-45 mg/L = 677
< 10 mg/L = 991



Map created by M.P.Carpio-Obeso, Jan 2009

N = 3689 wells

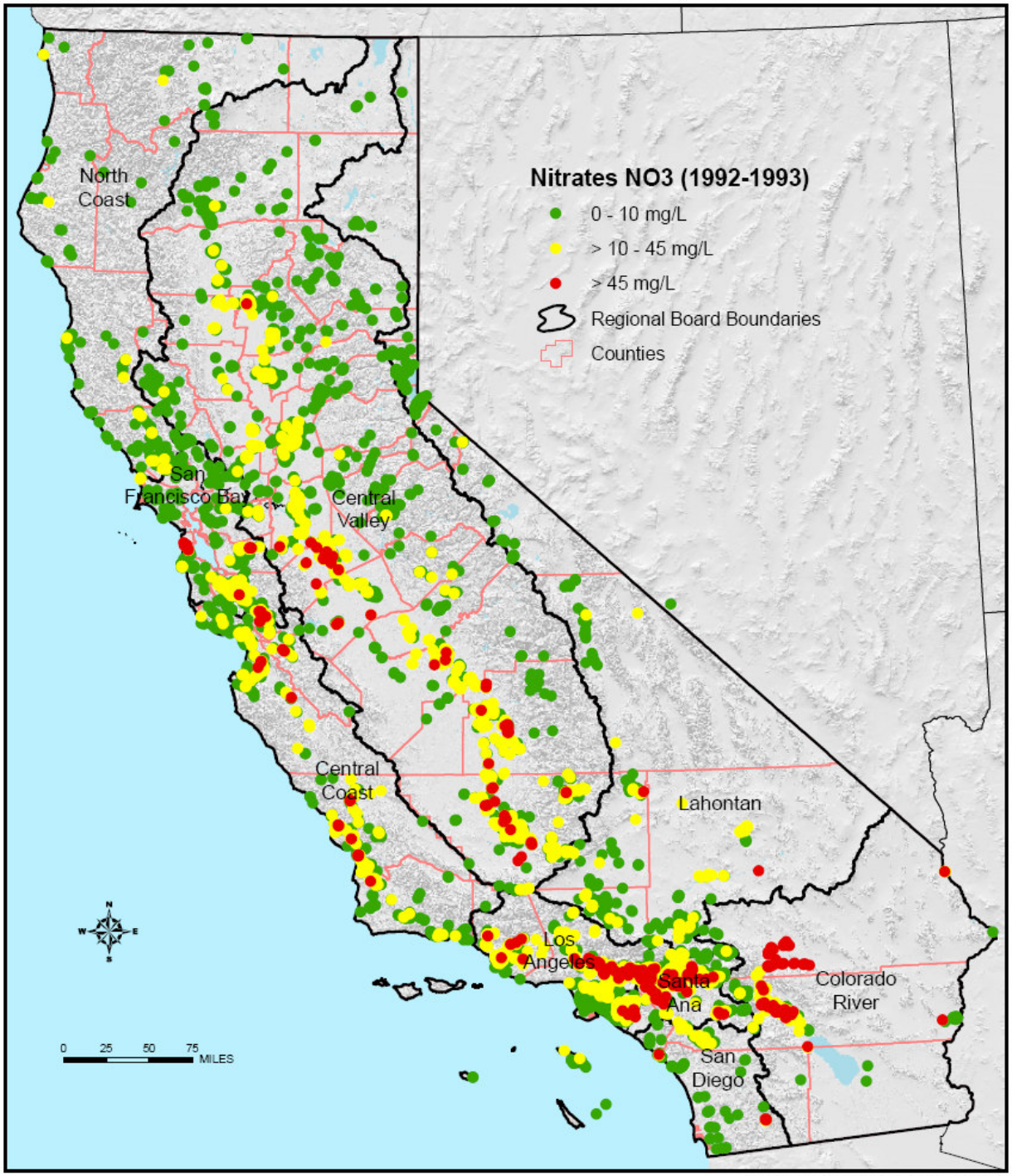
> 45 mg/L = 164
10-45 mg/L = 1355
< 10 mg/L = 2417



Map created by M.P.Carpio-Obeso, Jan 2009

N = 4950 wells

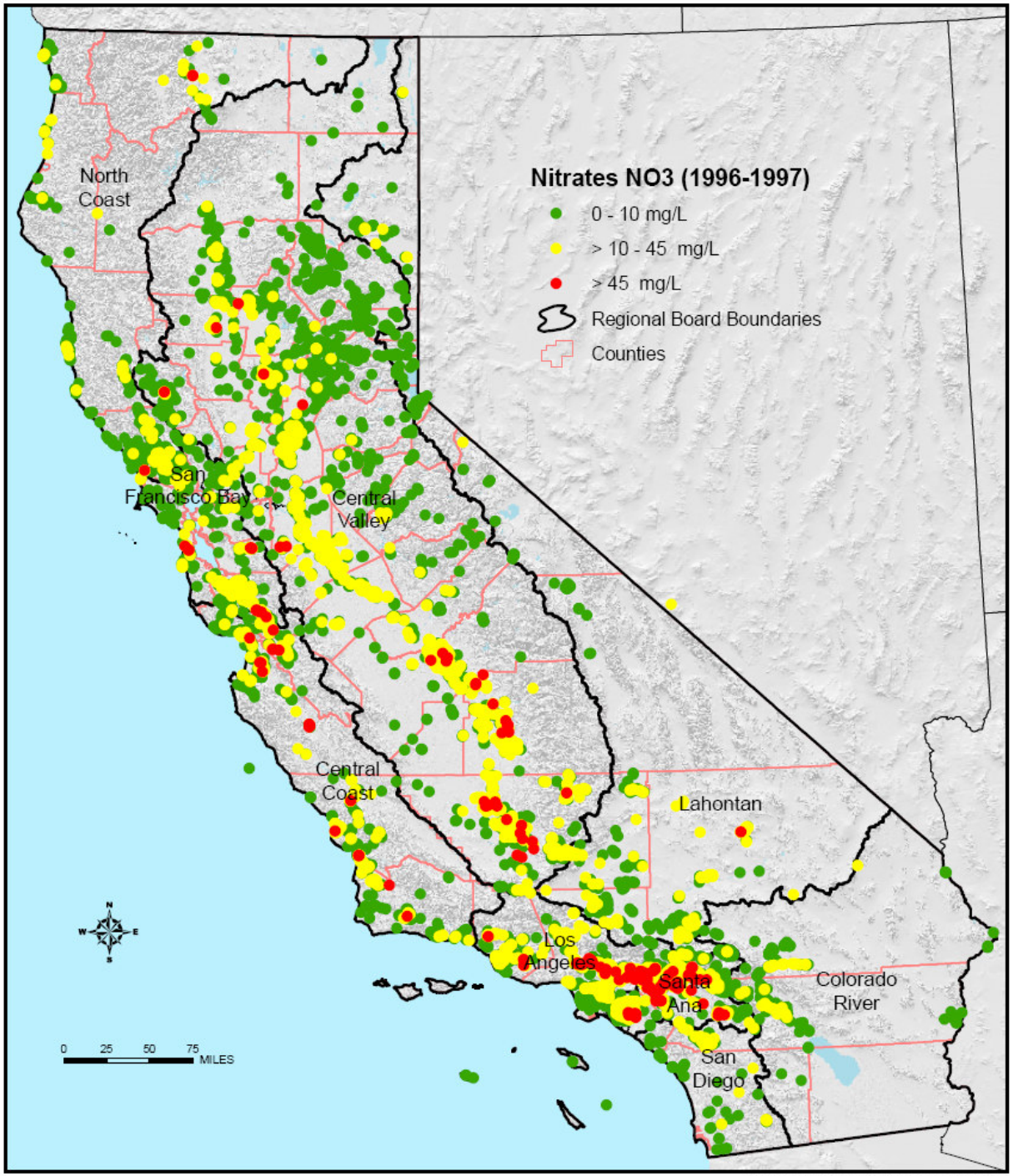
> 45 mg/L = 233
10-45 mg/L = 1679
< 10 mg/L = 3038



Map created by M.P.Carpio-Obeso, Jan 2009

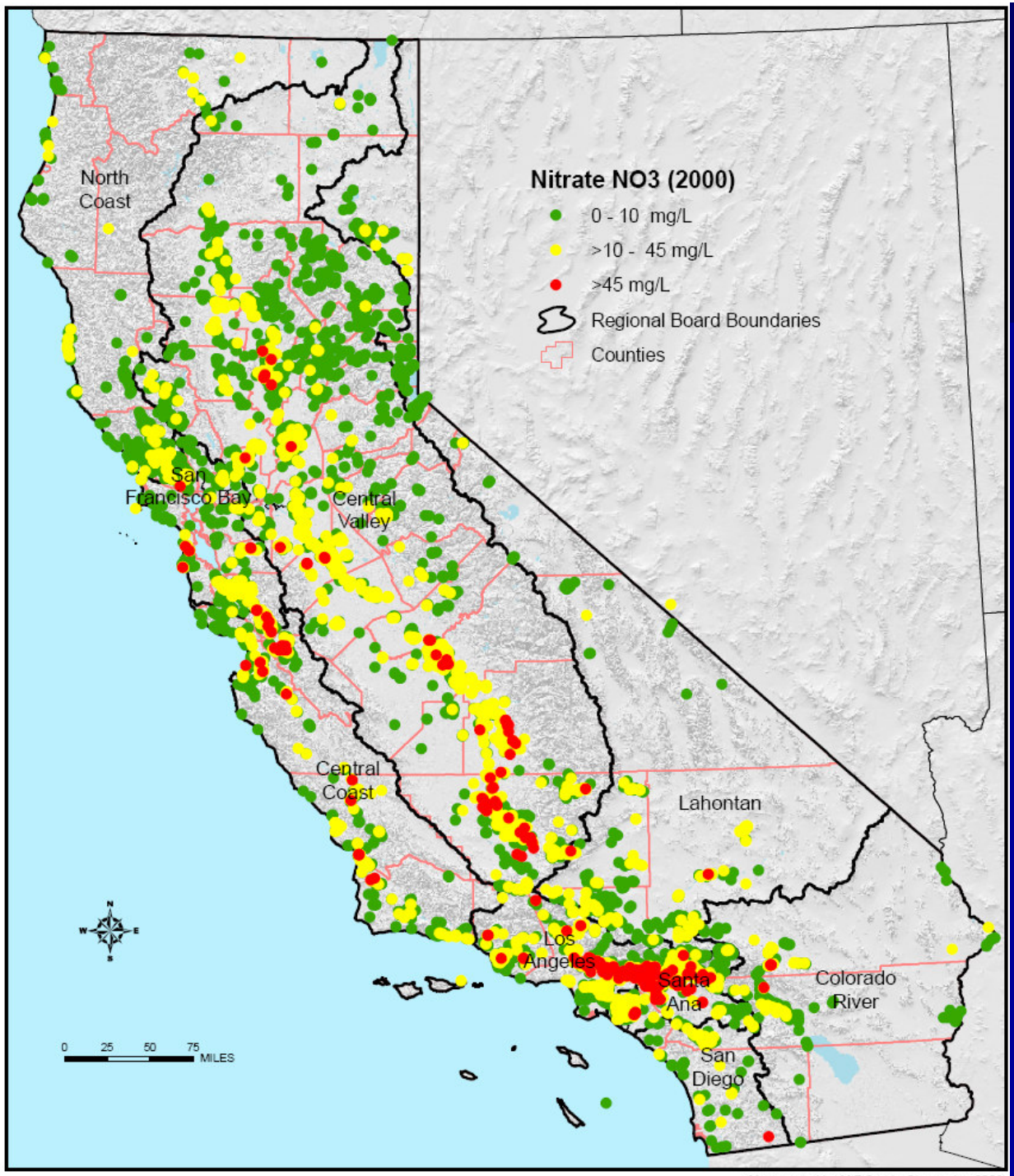
N = 6439 wells

> 45 mg/L = 211
10-45 mg/L = 2322
< 10 mg/L = 3906



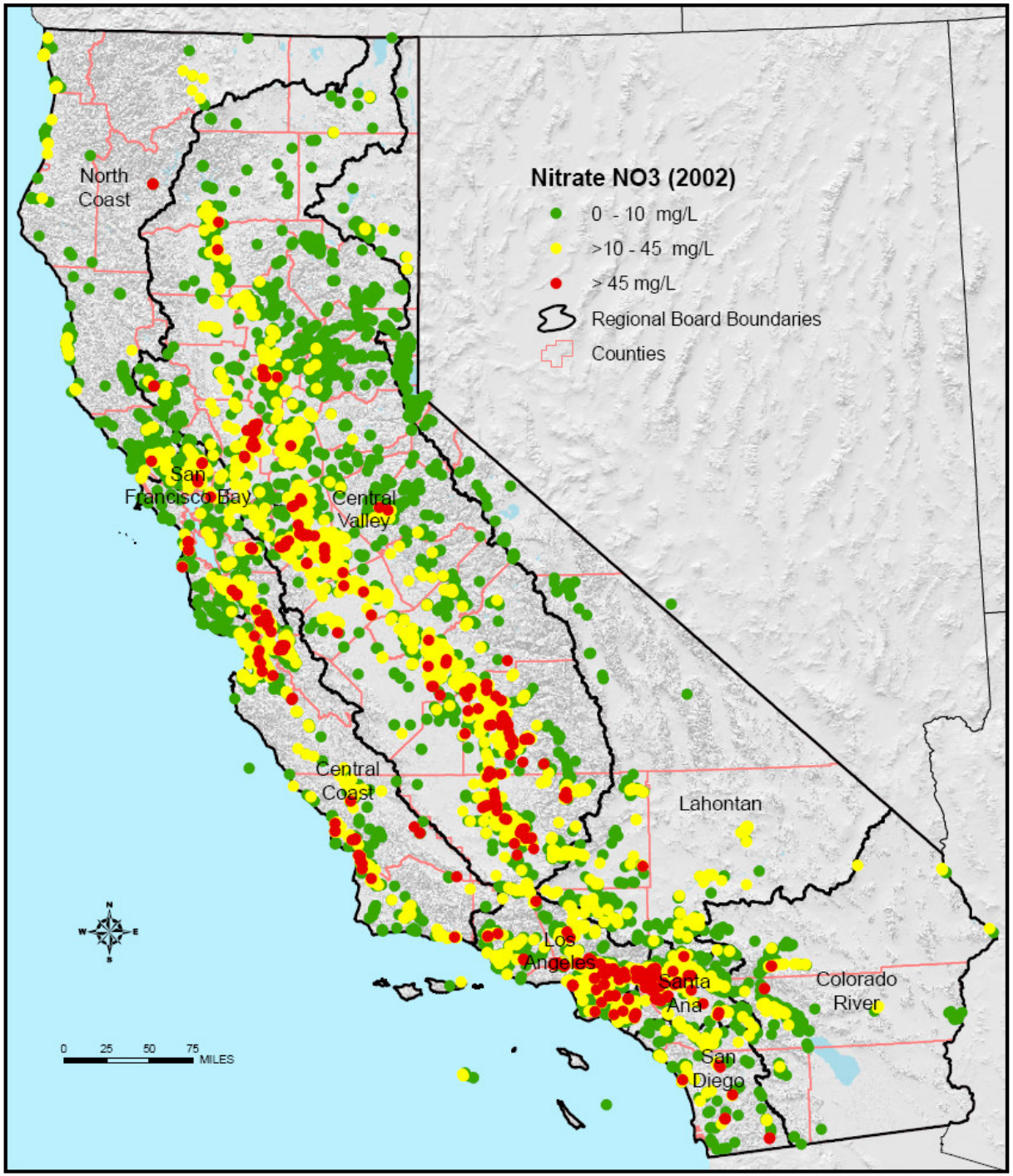
N = 6278 wells

> 45 mg/L = 291
10-45 mg/L = 2342
< 10 mg/L = 3645



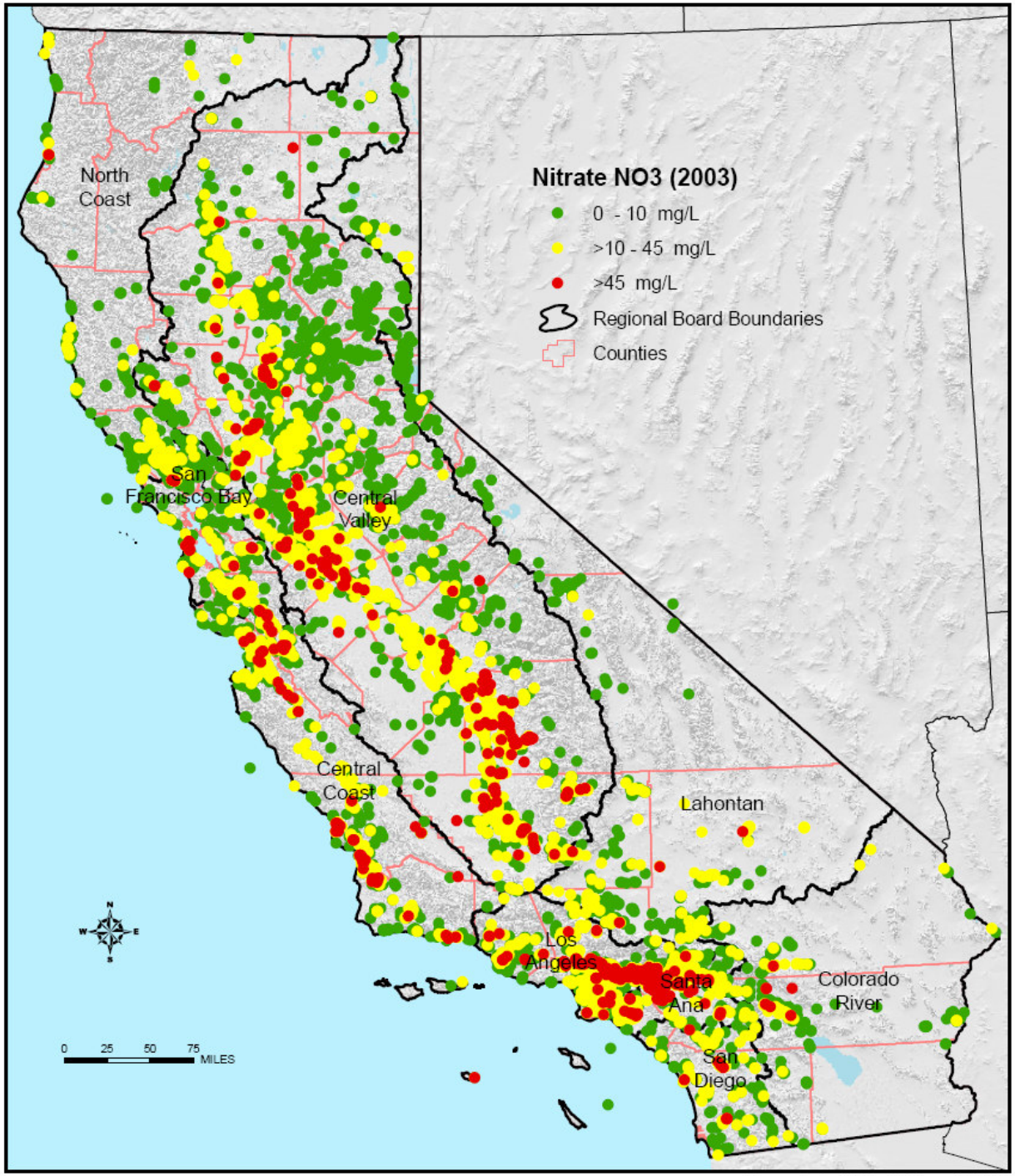
N = 8447 wells

> 45 mg/L = 406
10-45 mg/L = 3256
< 10 mg/L = 4785



N = 8962 wells

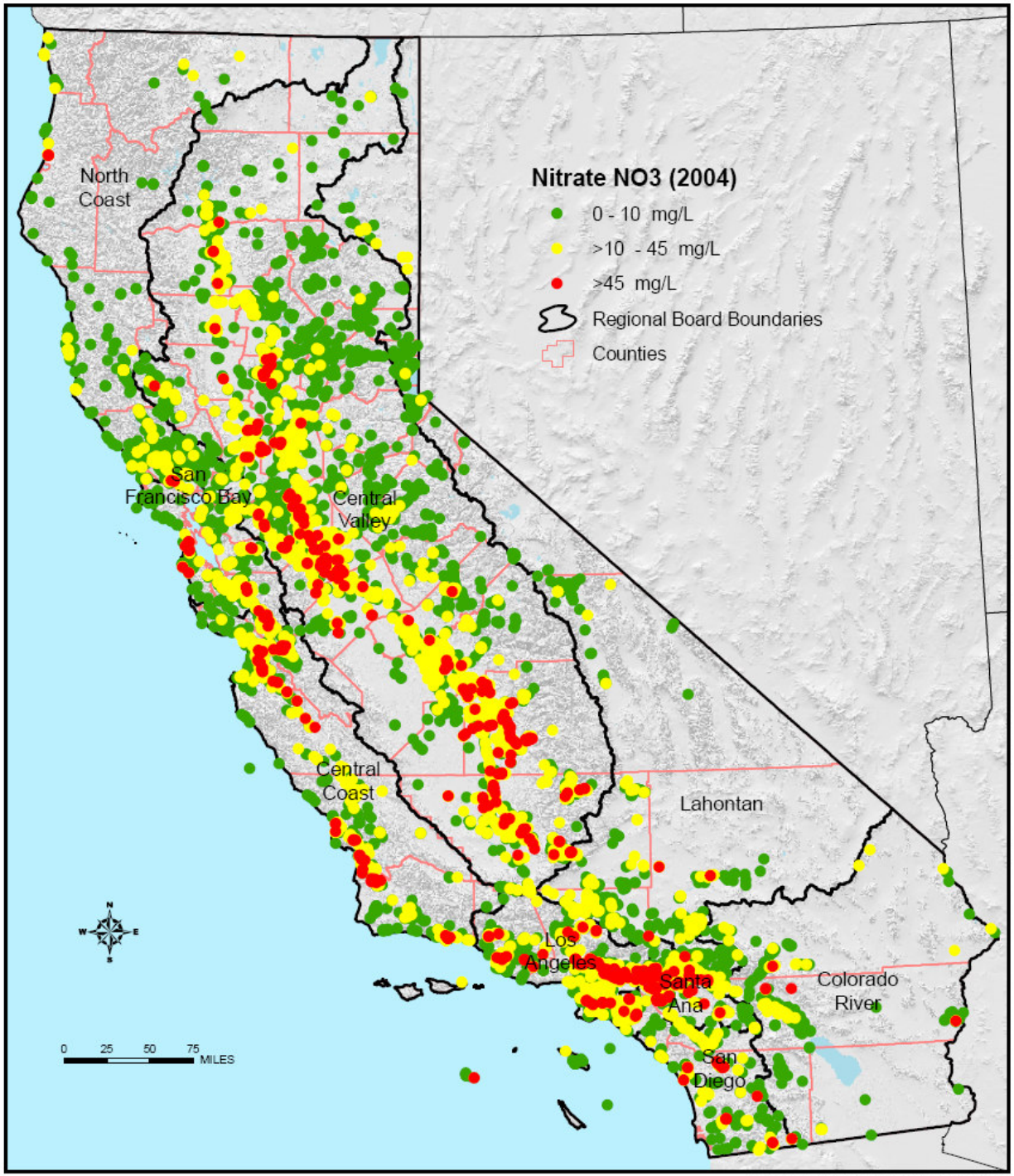
> 45 mg/L = 515
10-45 mg/L = 3468
< 10 mg/L = 4979



Map created by M.P.Carpio-Obeso, Feb.2009

N = 9319 wells

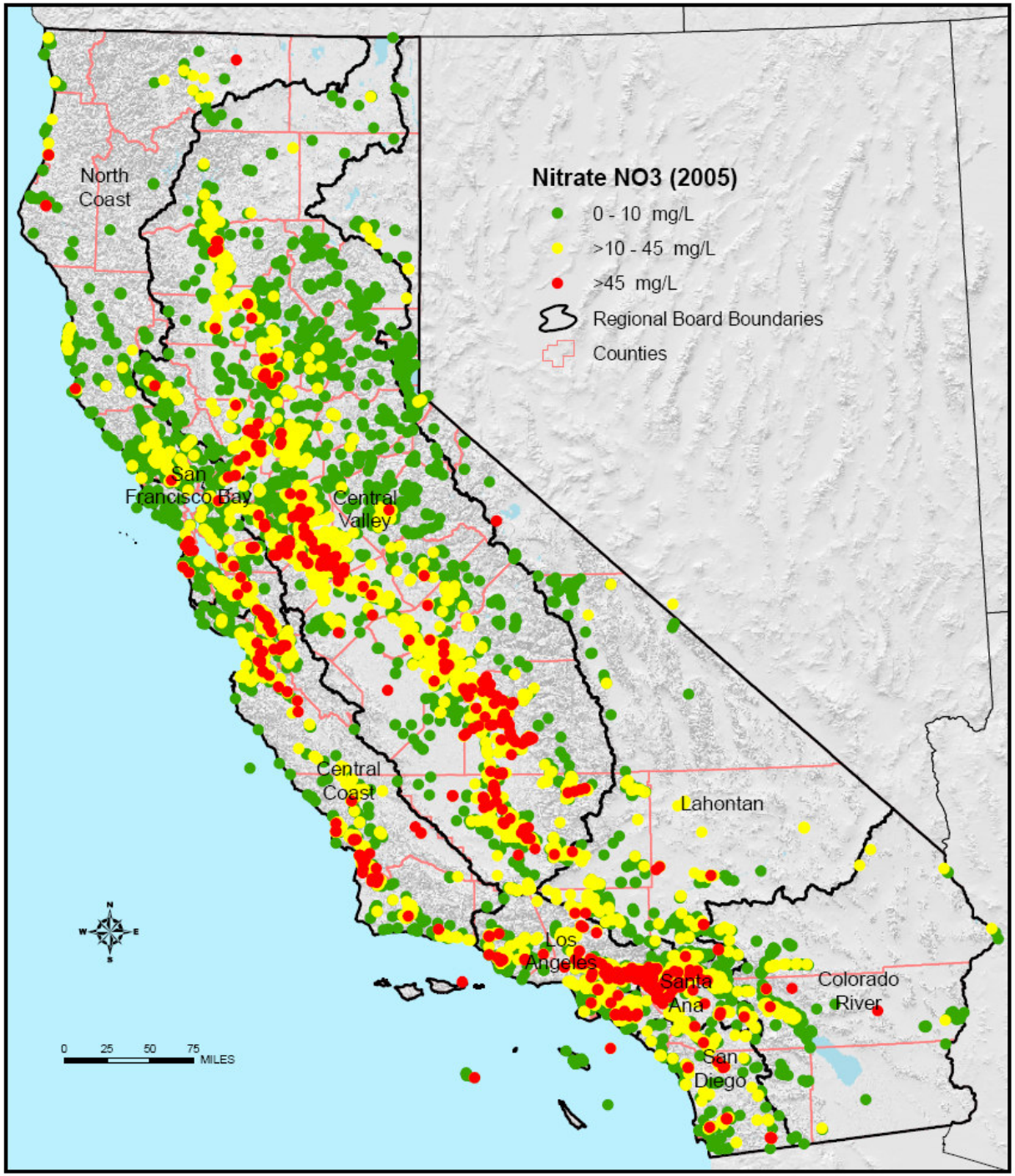
> 45 mg/L = 521
10-45 mg/L = 3473
< 10 mg/L = 5325



Map created by M.P.Carpio-Obeso, Feb.2009

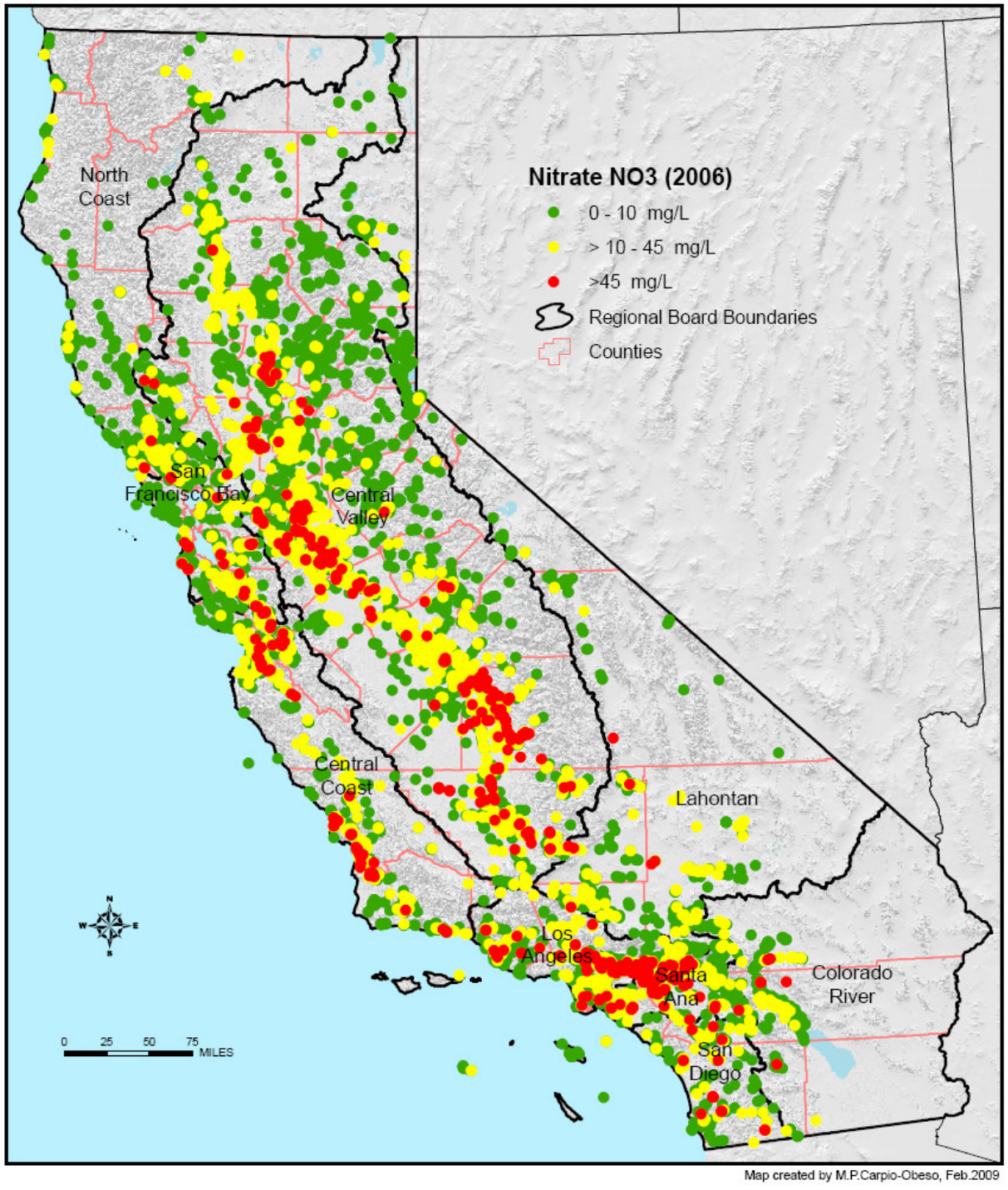
N = 9993 wells

> 45 mg/L = 598
10-45 mg/L = 3697
< 10 mg/L = 5698



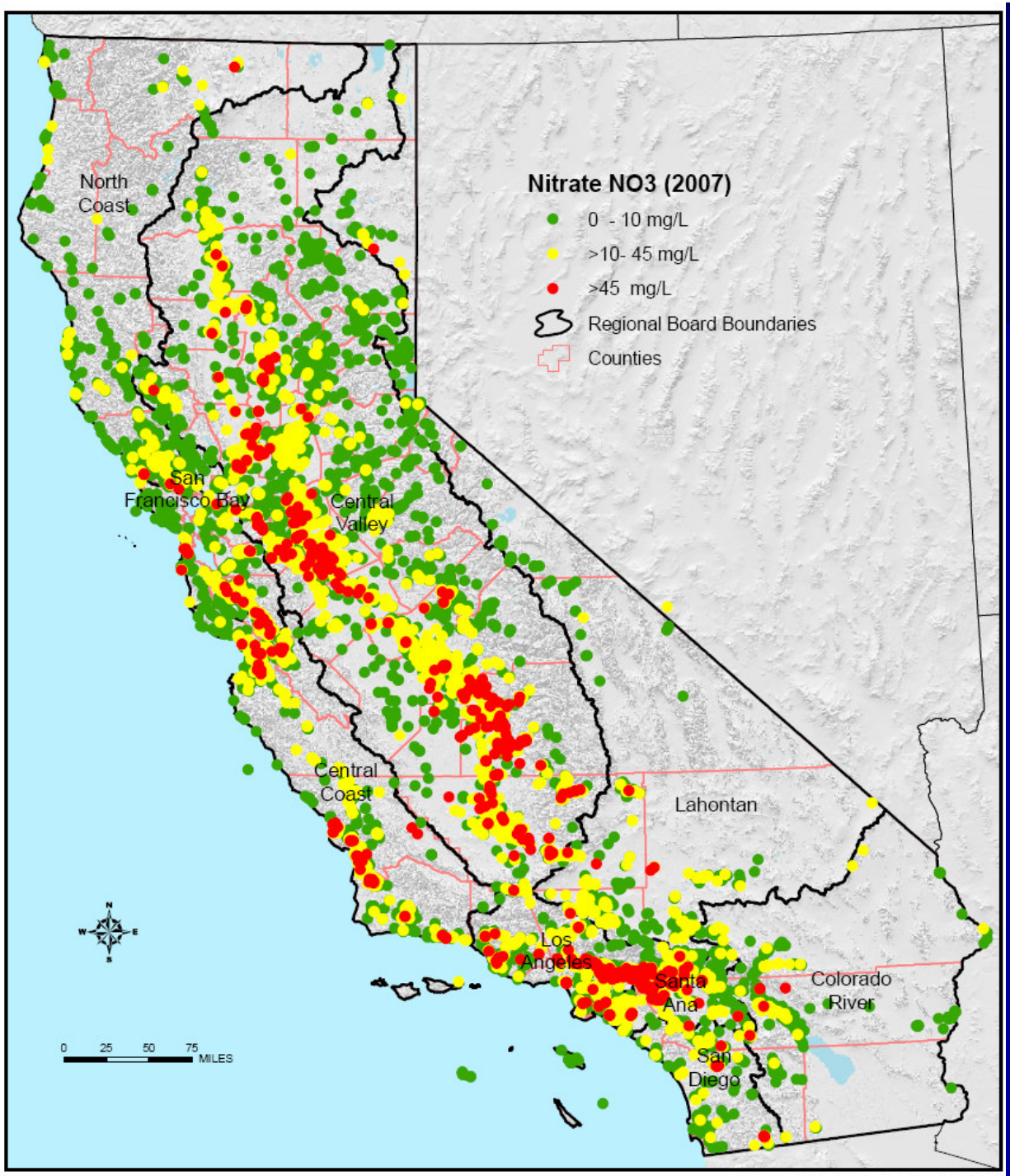
N = 9600 wells

> 45 mg/L = 589
10-45 mg/L = 3514
< 10 mg/L = 5497

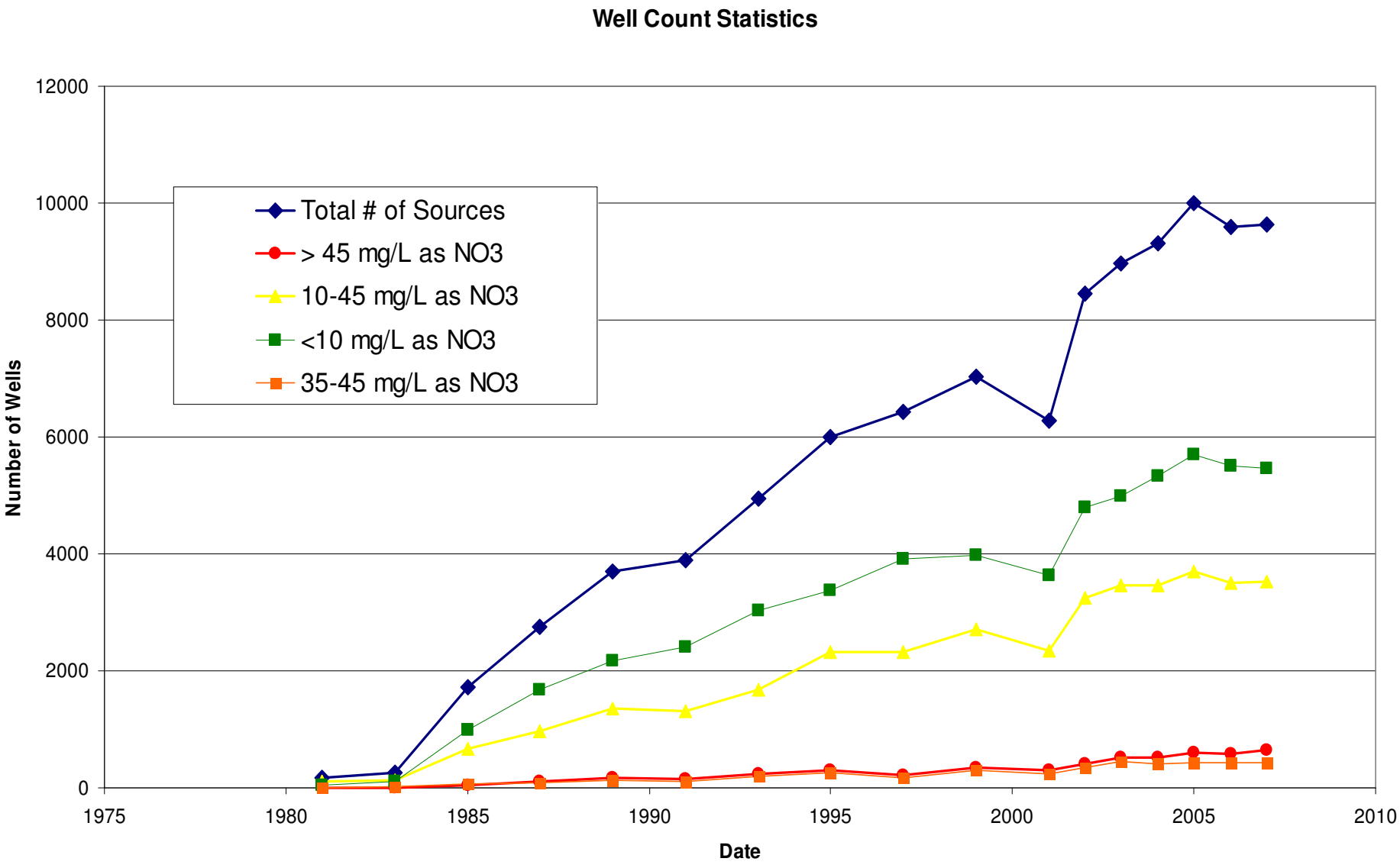


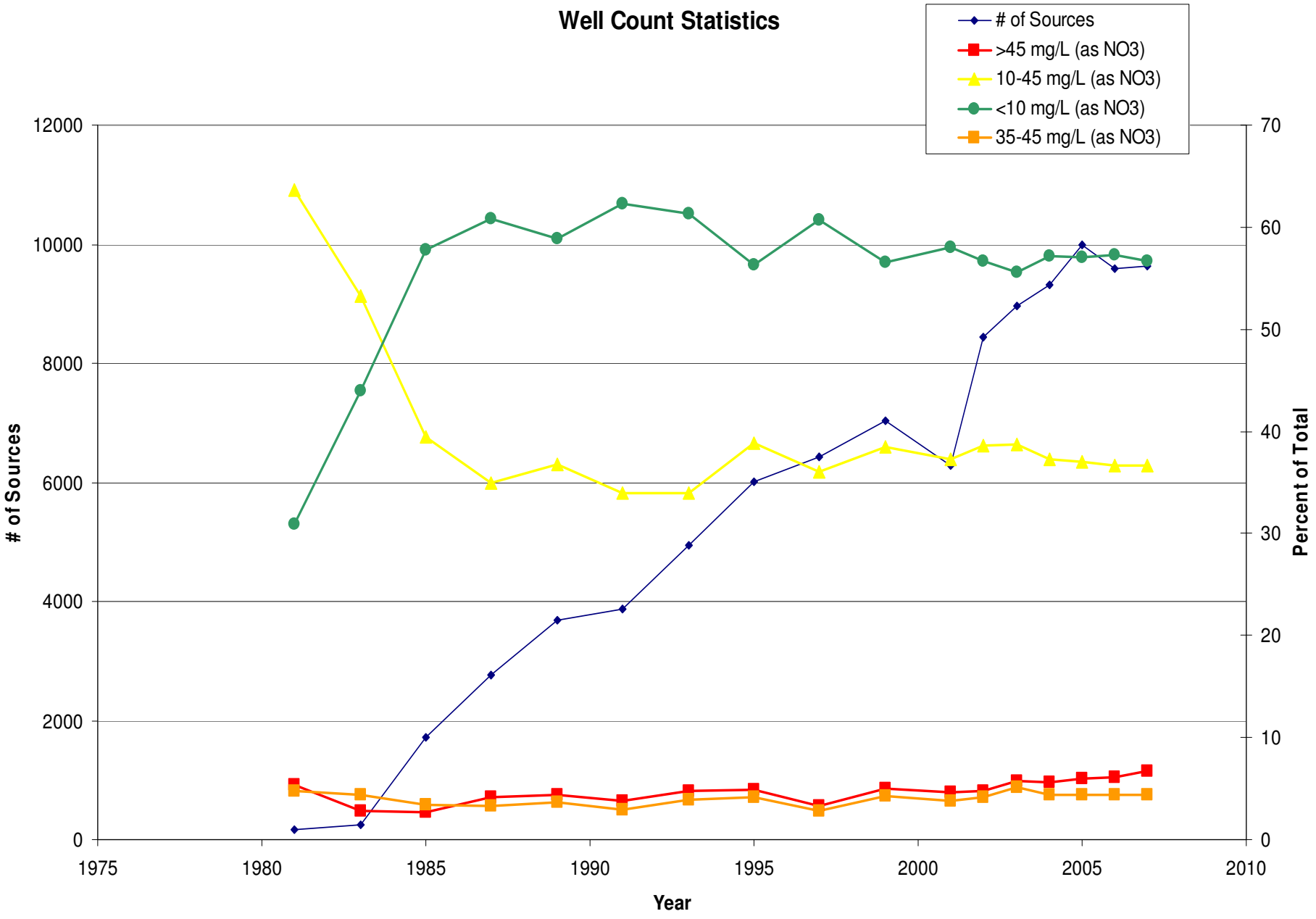
N = 9639 wells

> 45 mg/L = 648
10-45 mg/L = 3533
< 10 mg/L = 5458



Map created by M.P.Carpio-Obeso, Feb.2009


Well Count Statistics
Total # of Sources
> 45 mg/L as NO3
10-45 mg/L as NO3
<10 mg/L as NO3
35-45 mg/L as NO3
Number of Wells
Date
0
2000
4000
6000
8000
10000
12000
1975
1980
1985
1990
1995
2000
2005
2010

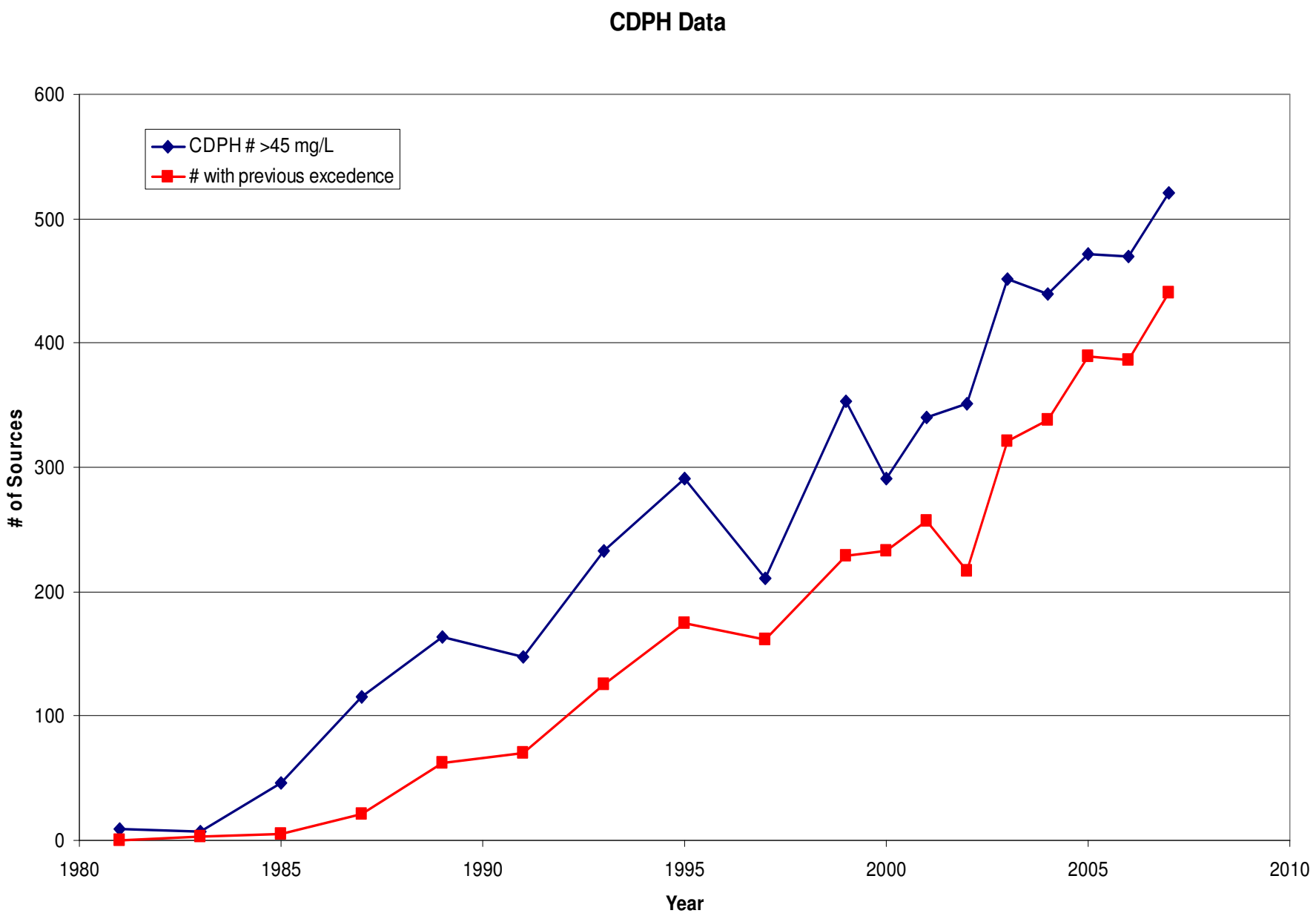

Well Count Statistics
# of Sources
>45 mg/L (as NO3)
10-45 mg/L (as NO3)
<10 mg/L (as NO3)
35-45 mg/L (as NO3)
# of Sources
Percent of Total
Year
0
2000
4000
6000
8000
10000
12000
0
10
20
30
40
50
60
70
1975
1980
1985
1990
1995
2000
2005
2010

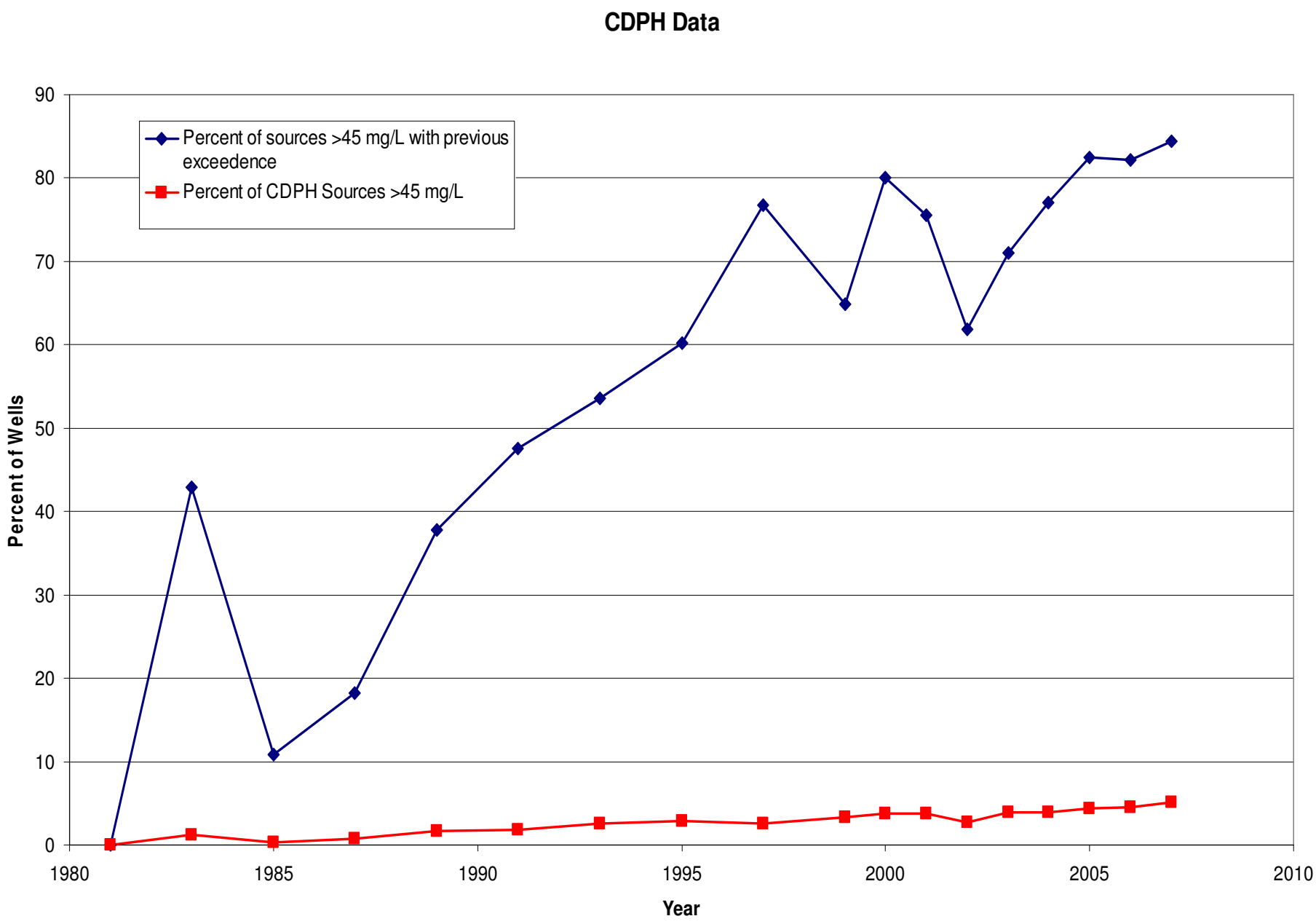
Results

- Results are representative of available data
  - Supply vs. Cleanup/monitoring
  - Well Depth
- How does the inclusion of different data sets affect the summary statistics?

Results

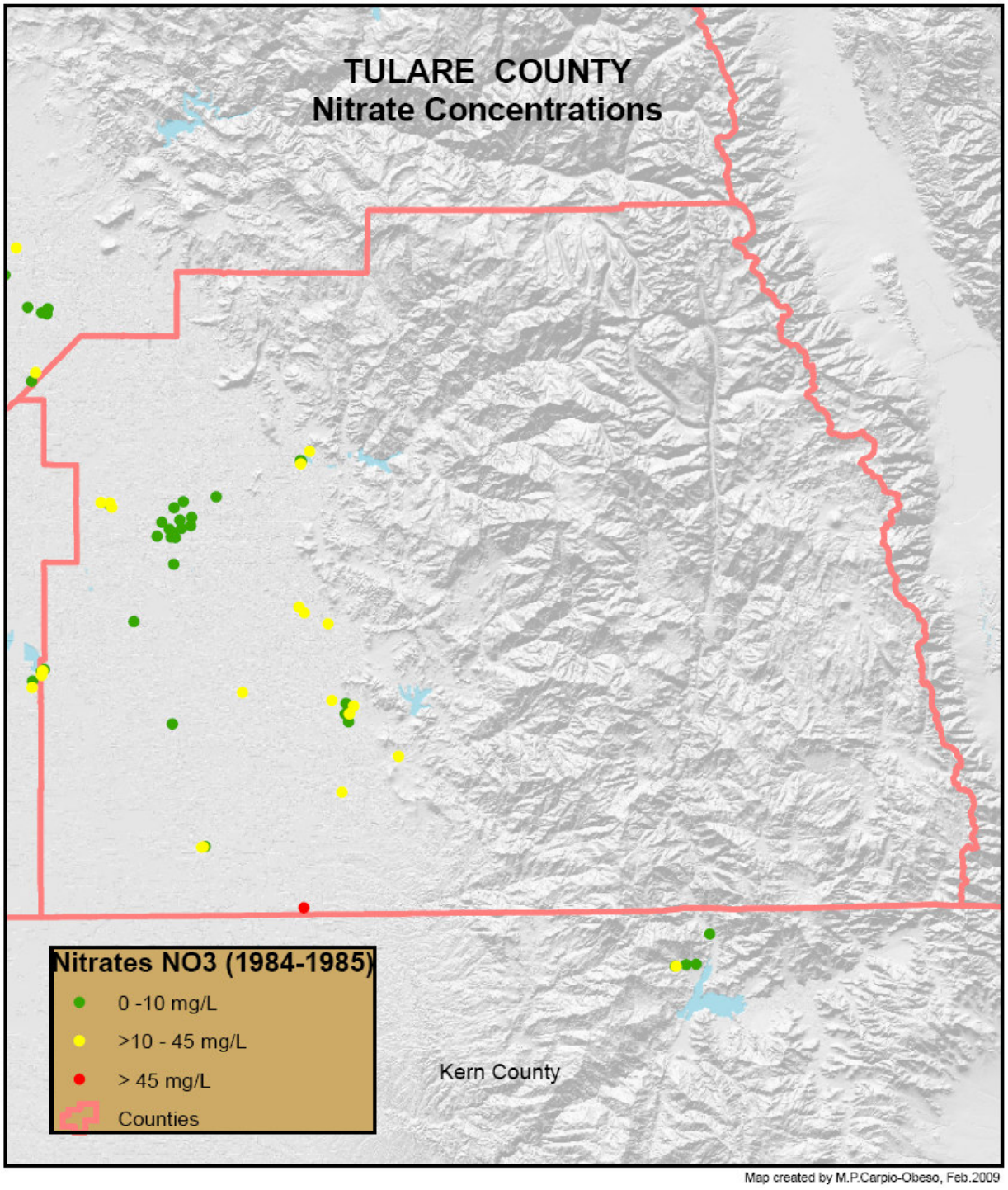
- Averaged over 2001-2007, inclusion of environmental monitoring wells does not increase the relative abundance of detections >45 mg/L
- # of CDPH sources with a previous exceedance of 45 mg/L increases


CDPH Data
CDPH # >45 mg/L
with previous excedence
of Sources
Year
600
500
400
300
200
100
0
1980
1985
1990
1995
2000
2005
2010


CDPH Data
Percent of sources >45 mg/L with previous exceedence
Percent of CDPH Sources >45 mg/L
Percent of Wells
Year
0
10
20
30
40
50
60
70
80
90
1980
1985
1990
1995
2000
2005
2010

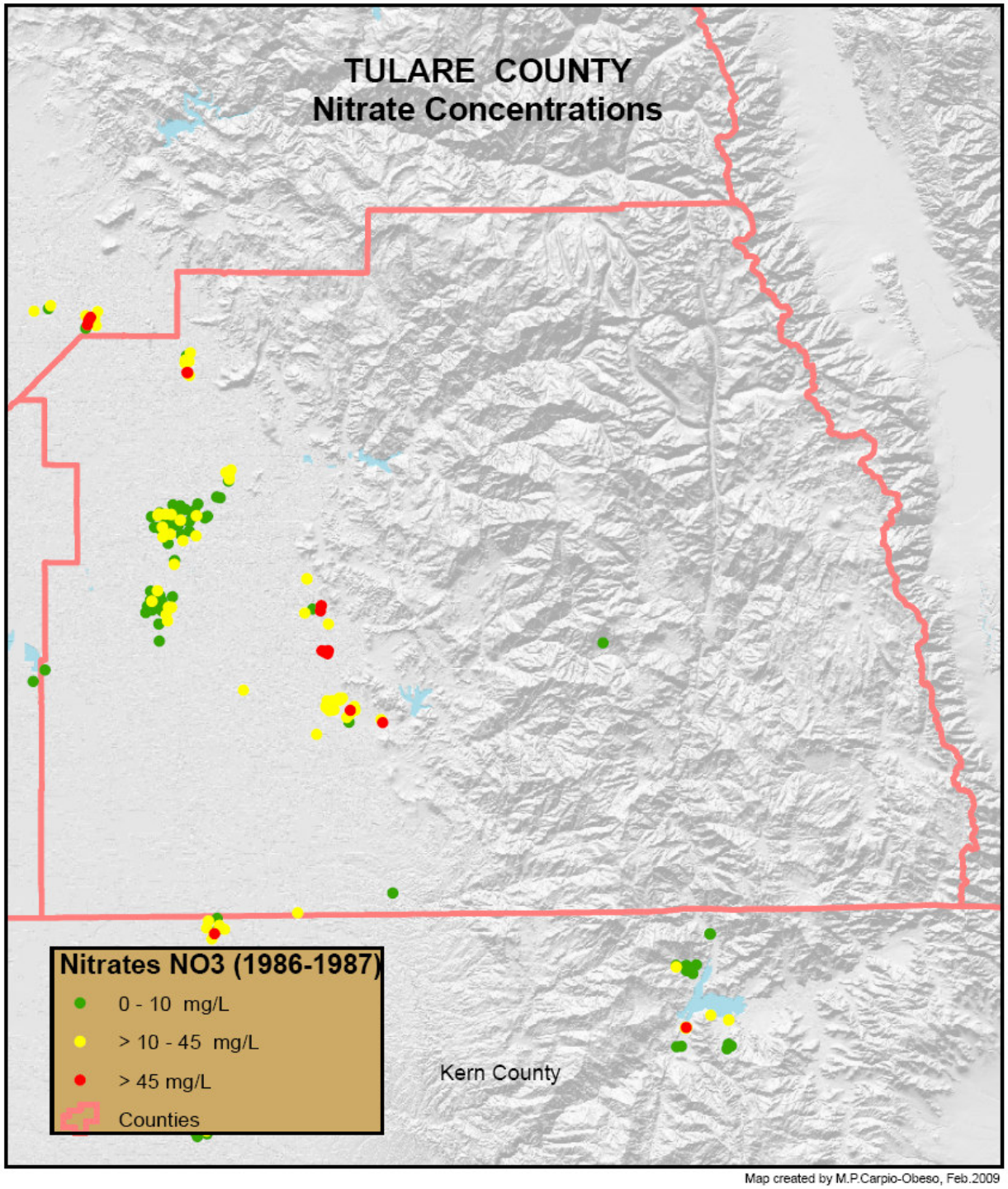
Tulare County

- Can differences in datasets yield contrasting results?
- Tulare County site of GAMA Domestic Well sampling in 2006
- 181 wells sampled
  - 75 > MCL (41%)



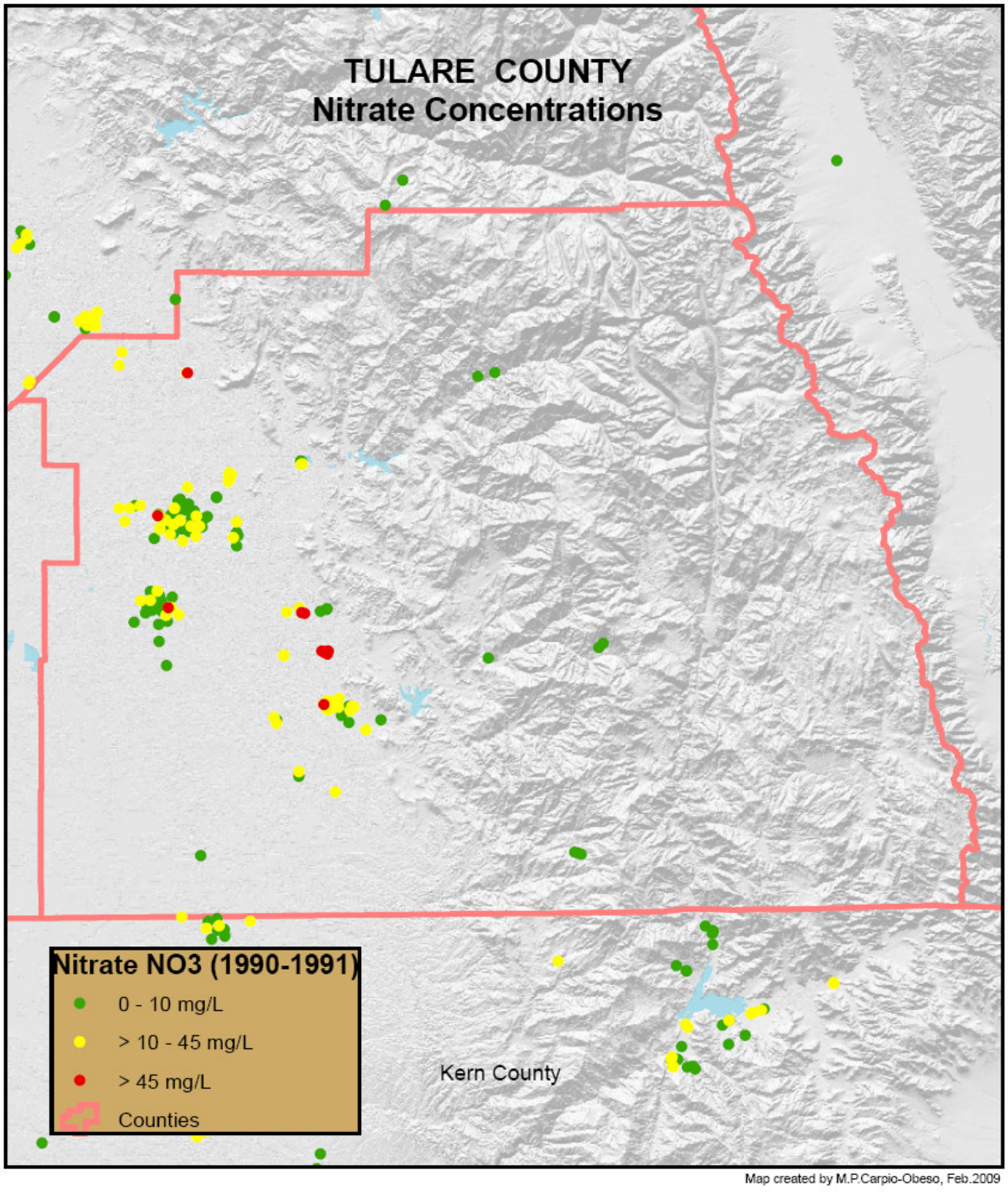
N = 49 wells

> 45 mg/L = 1
10-45 mg/L = 21
< 10 mg/L = 27



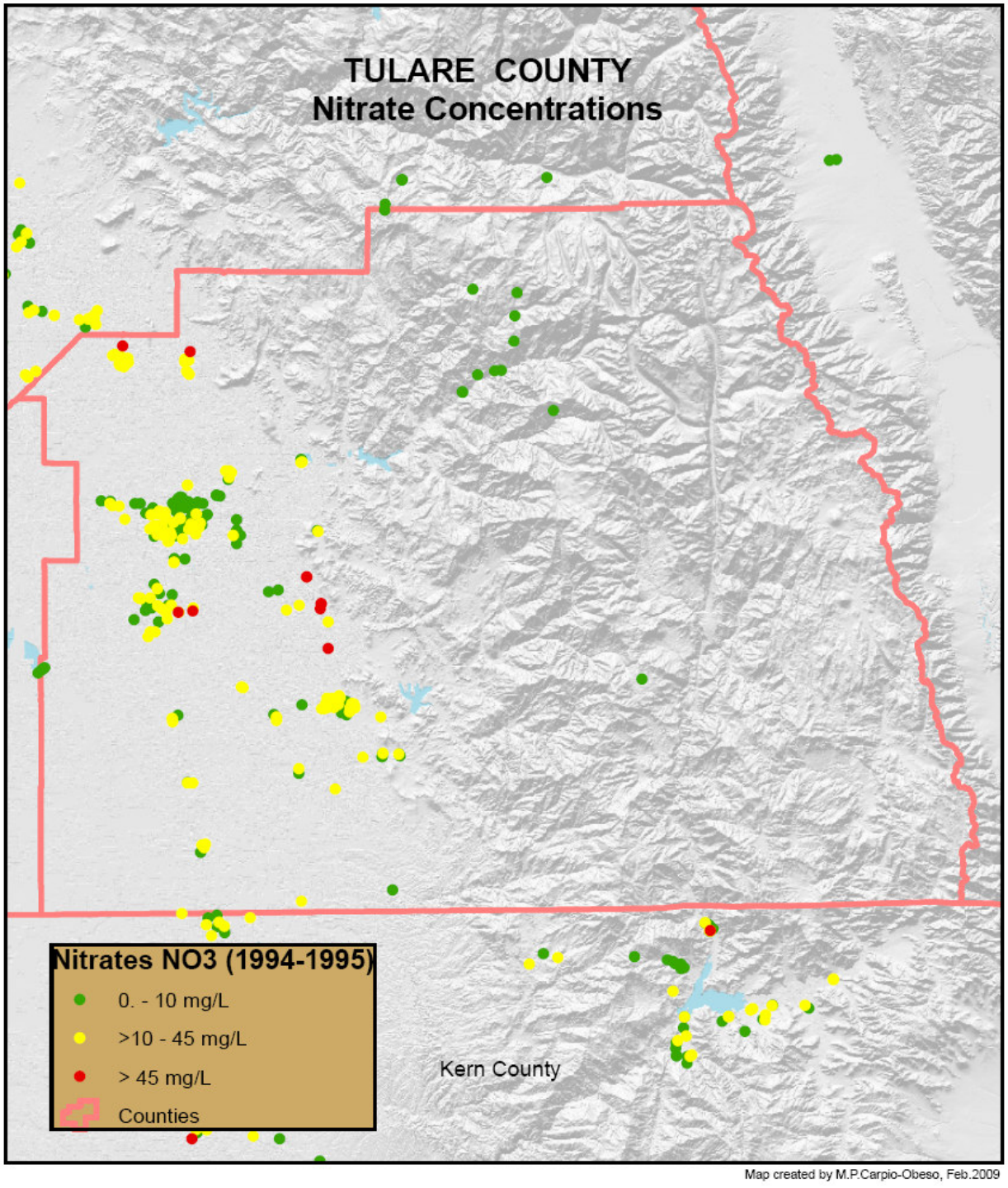
N = 117 wells

> 45 mg/L = 11
10-45 mg/L = 55
< 10 mg/L = 51



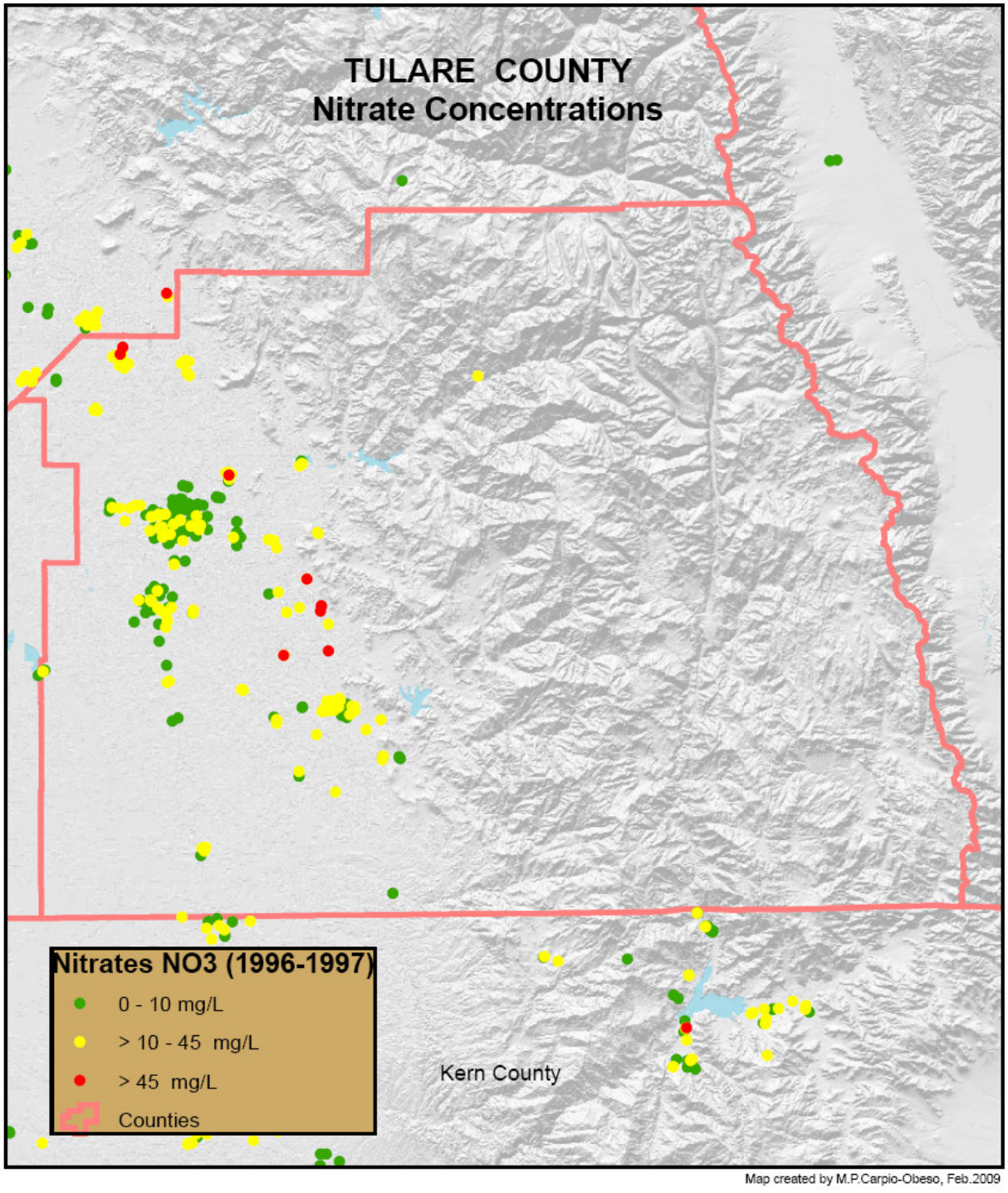
N = 141 wells

> 45 mg/L = 10
10-45 mg/L = 65
< 10 mg/L = 66



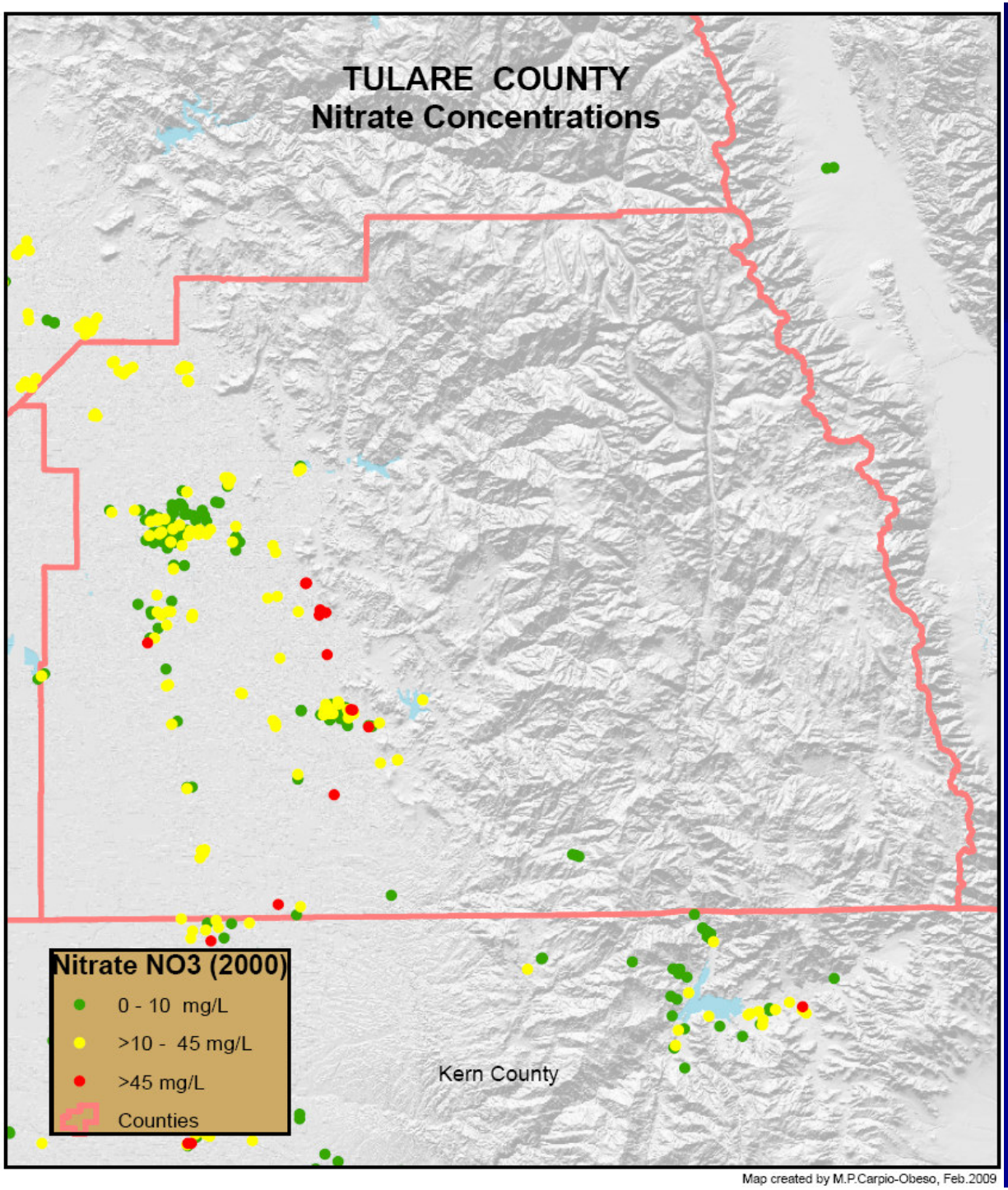
N = 223 wells

> 45 mg/L = 6
10-45 mg/L = 105
< 10 mg/L = 112



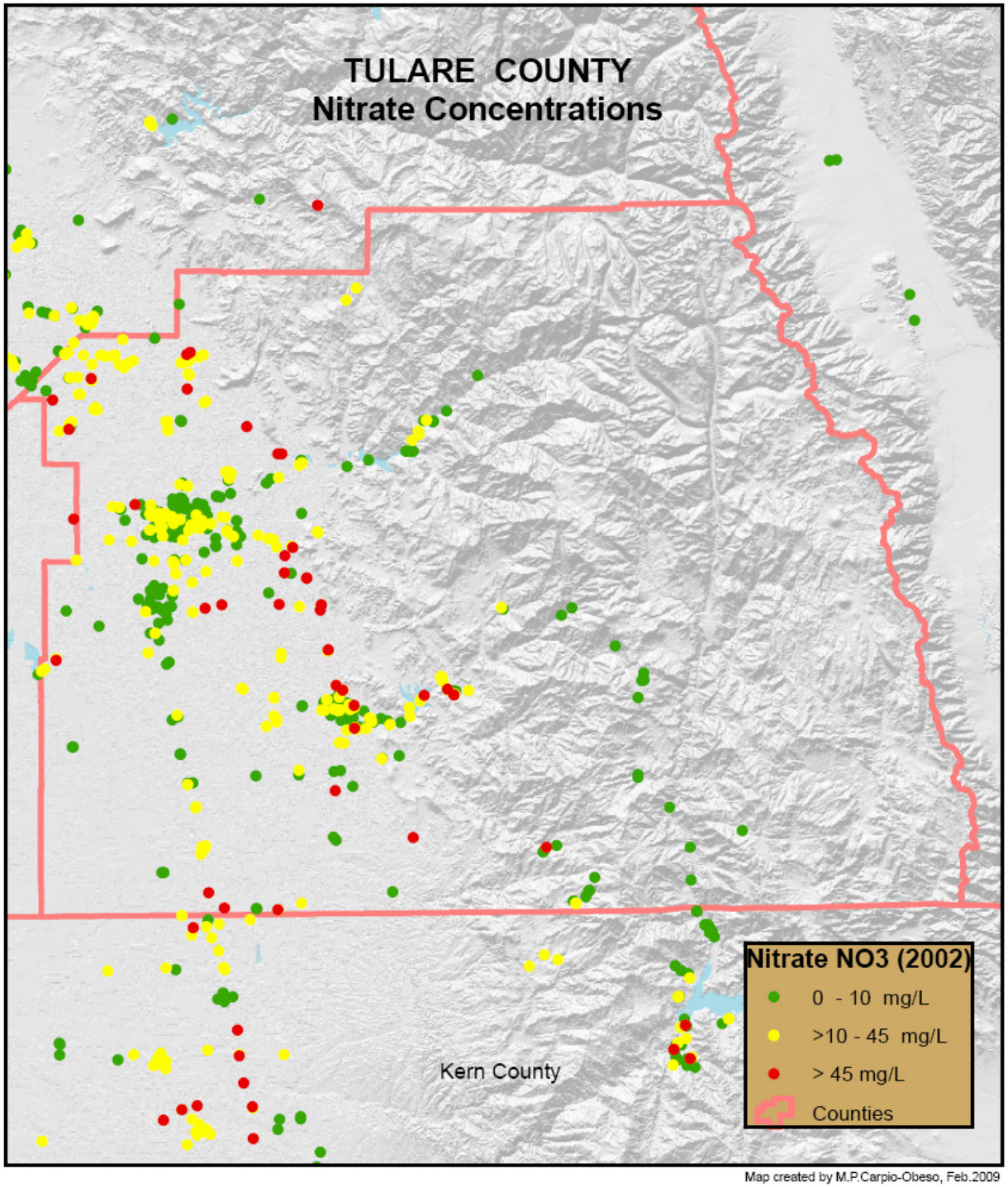
N = 228 wells

> 45 mg/L = 9
10-45 mg/L = 115
< 10 mg/L = 104



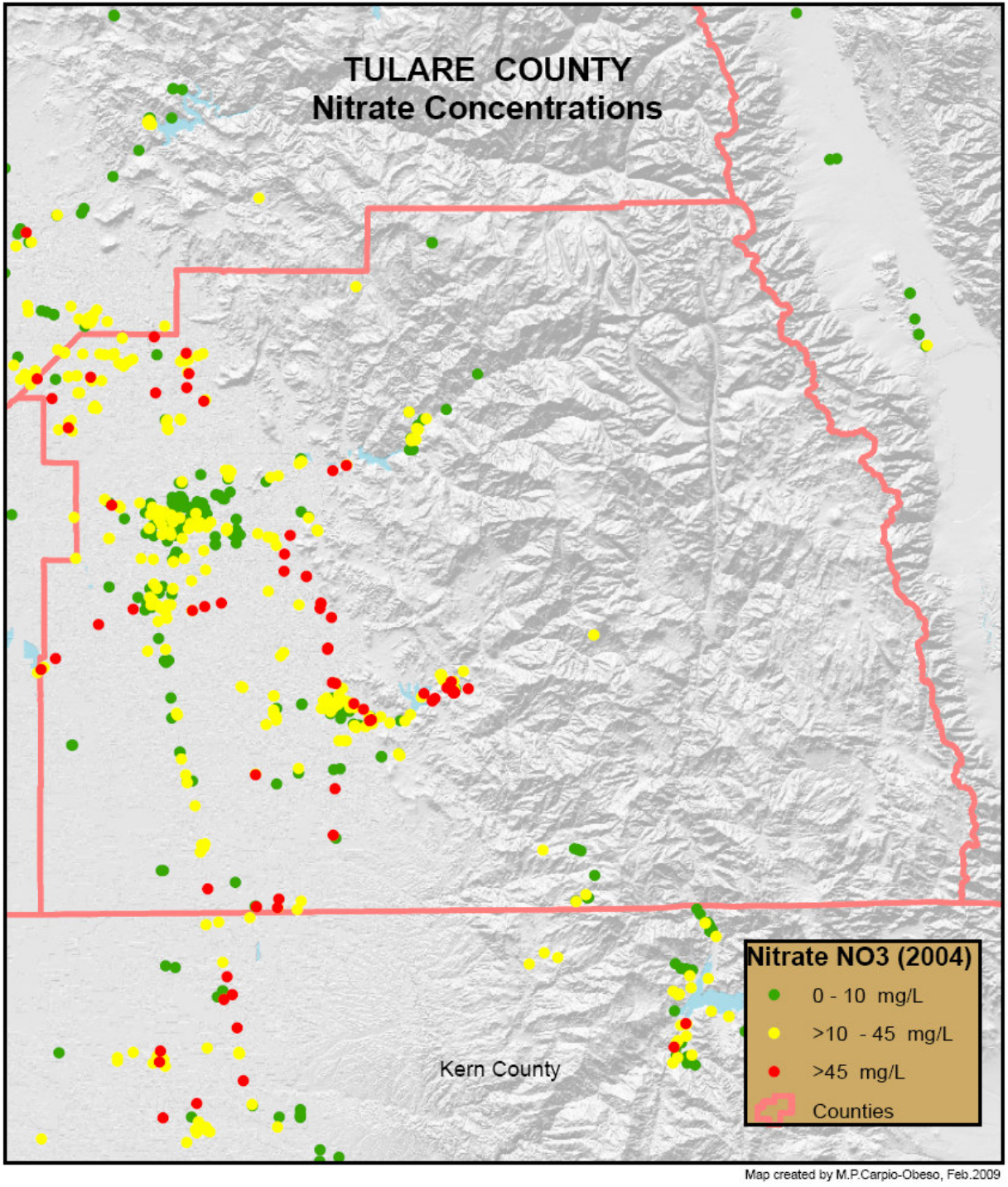
N = 201 wells

> 45 mg/L = 14
10-45 mg/L = 105
< 10 mg/L = 82



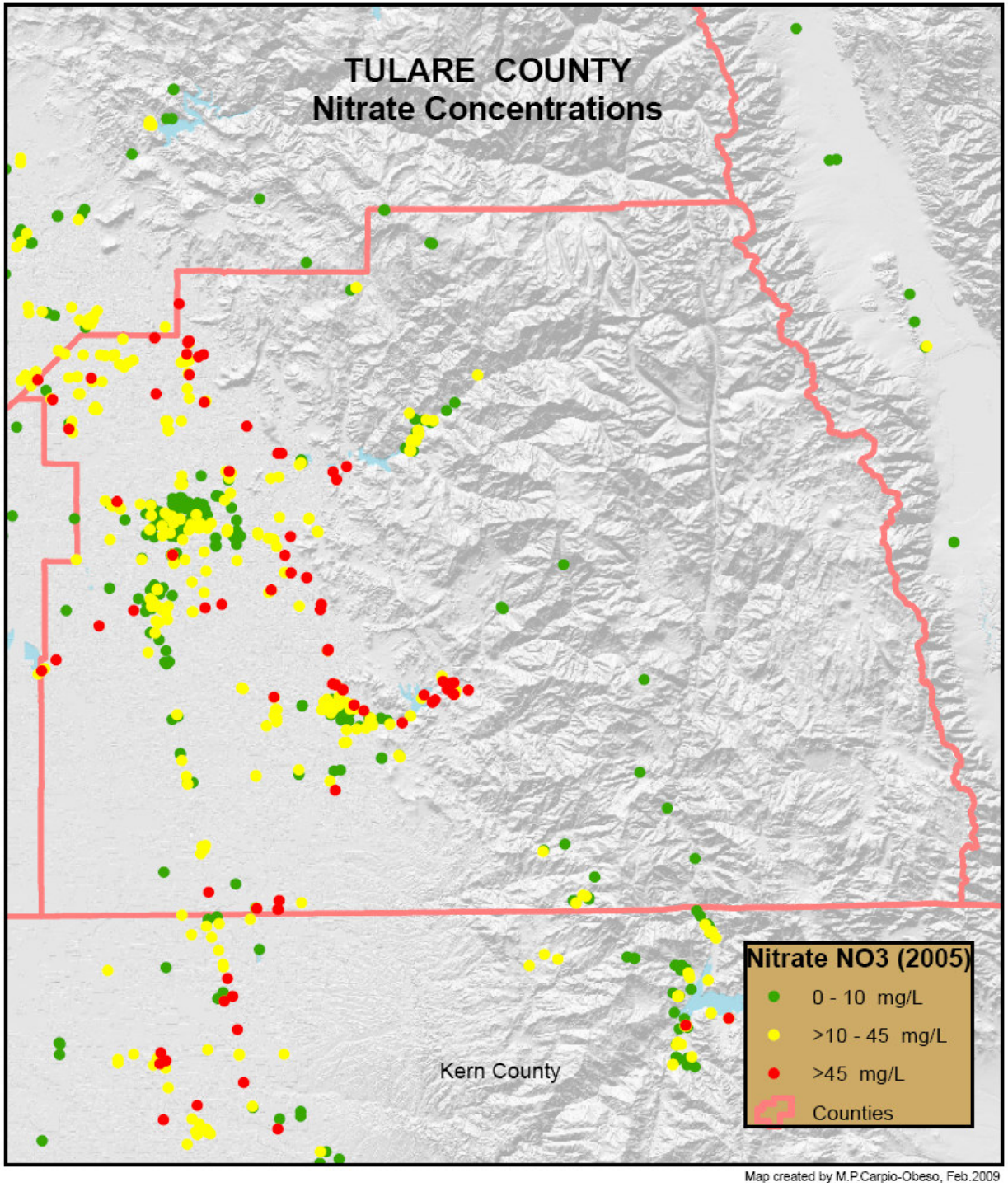
N = 427 wells

> 45 mg/L = 38
10-45 mg/L = 198
< 10 mg/L = 191



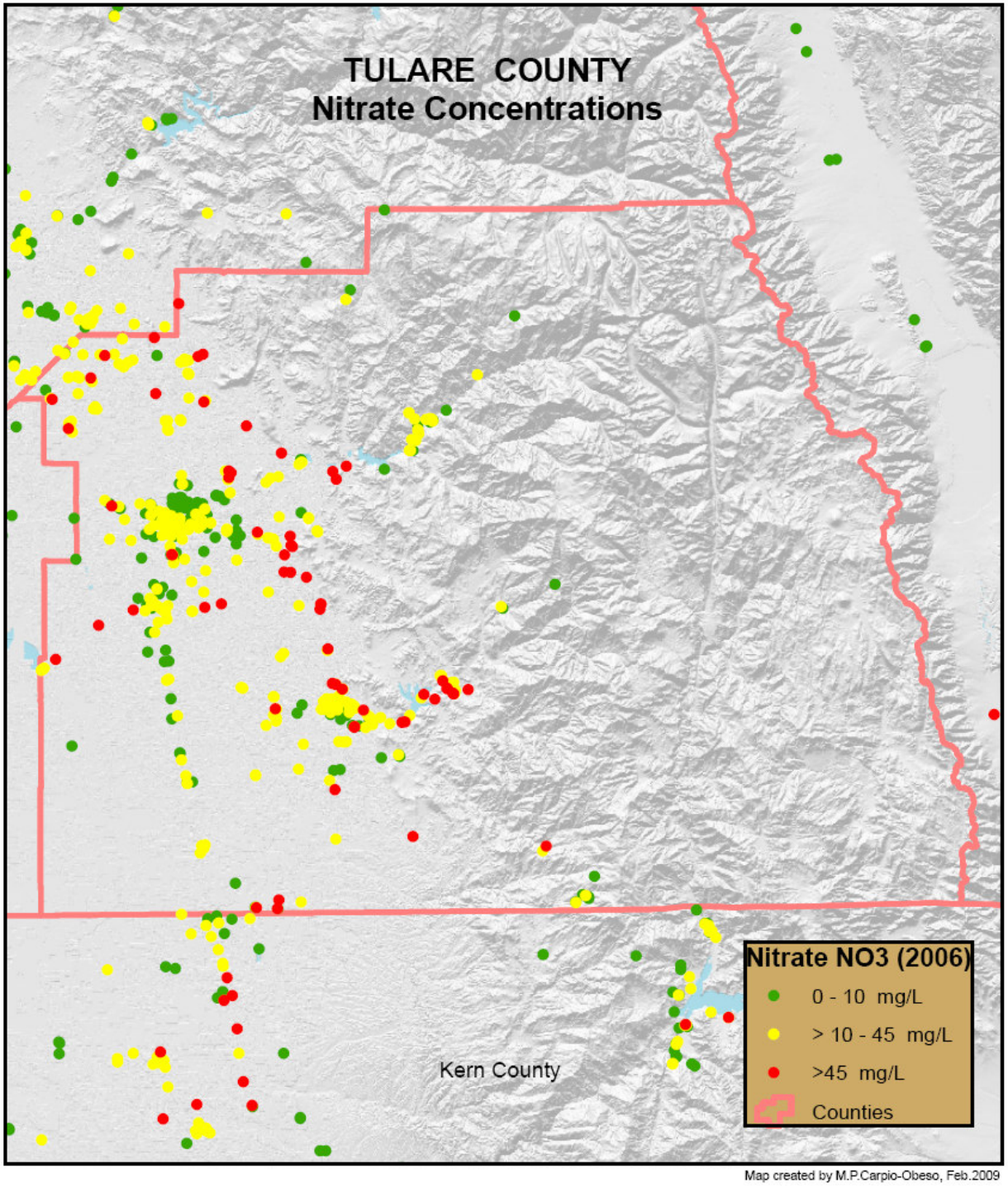
N = 424 wells

> 45 mg/L = 46
10-45 mg/L = 219
< 10 mg/L = 159



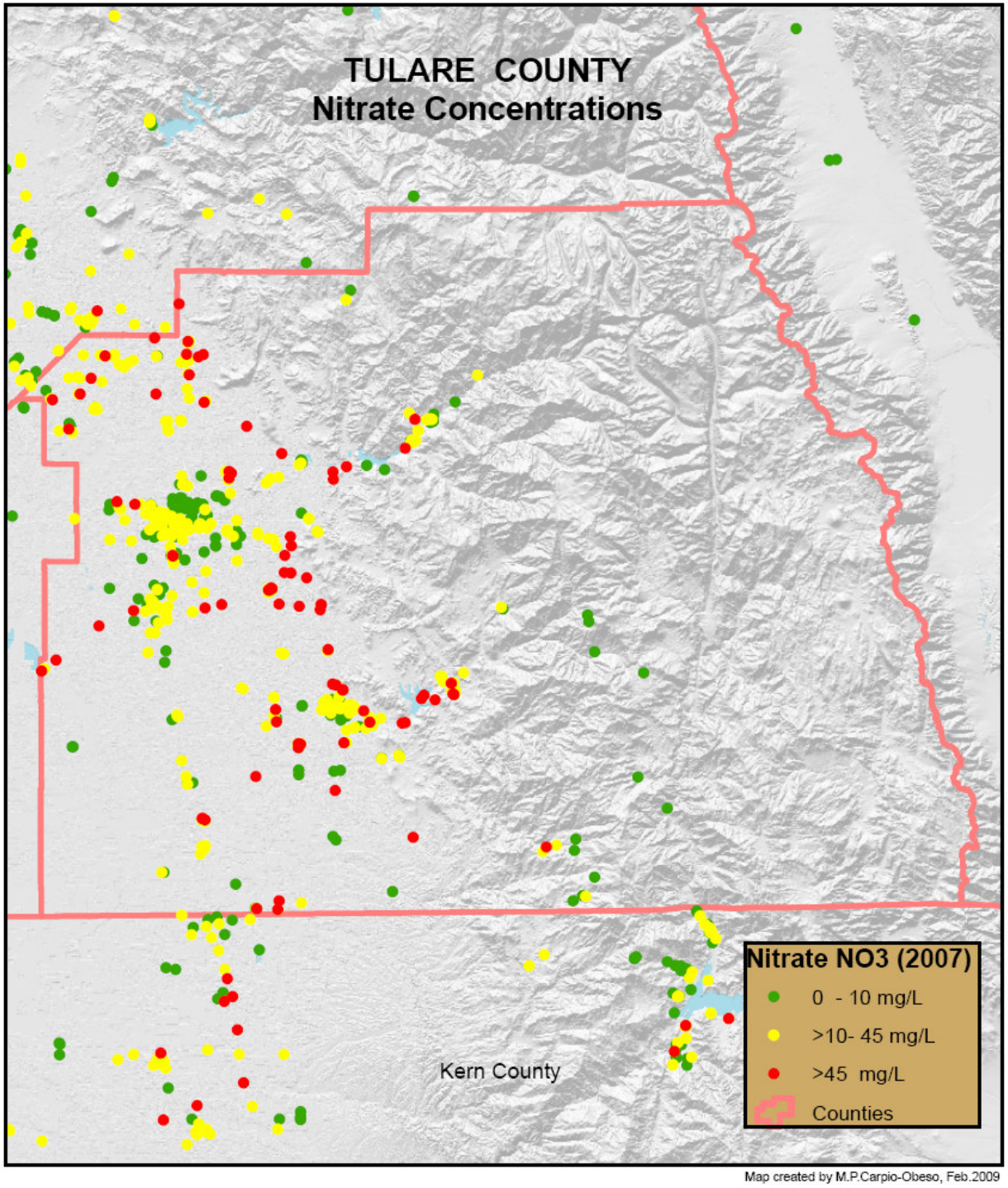
N = 444 wells

> 45 mg/L = 53
10-45 mg/L = 227
< 10 mg/L = 164



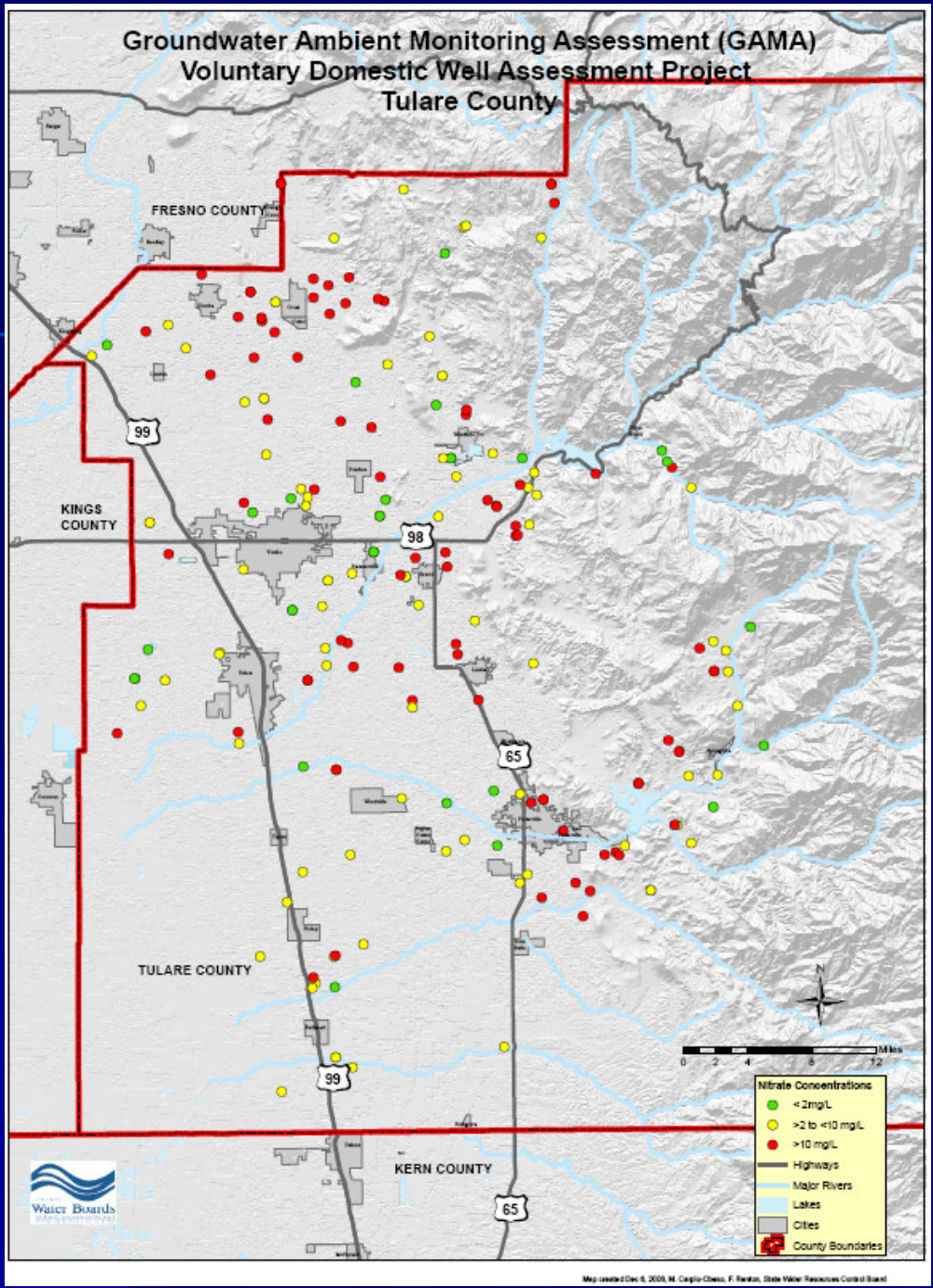
N = 424 wells

> 45 mg/L = 47 (11%)
10-45 mg/L = 241 (57%)
< 10 mg/L = 136 (32%)



N = 456 wells

> 45 mg/L = 65 (14%)
10-45 mg/L = 252 (55%)
< 10 mg/L = 139 (30%)

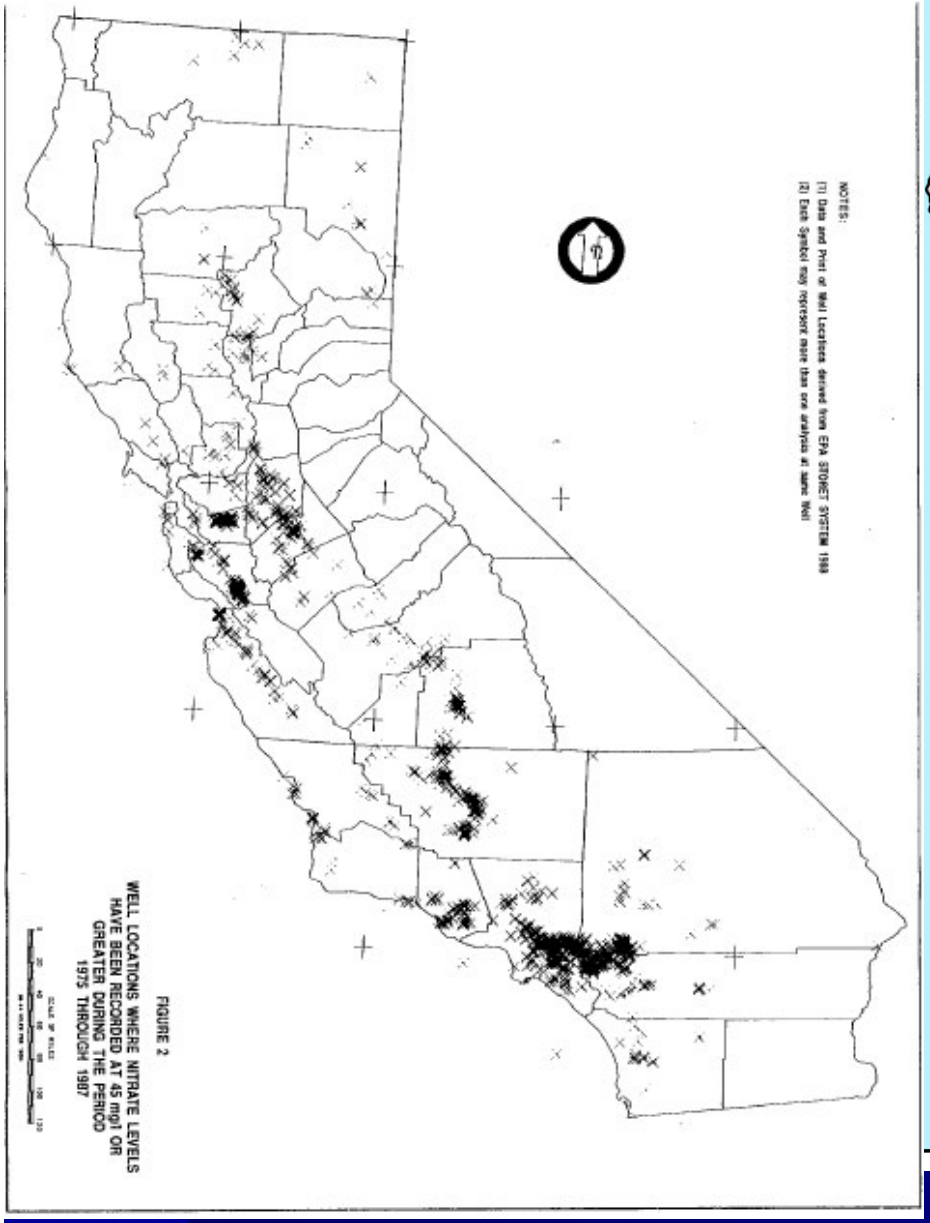


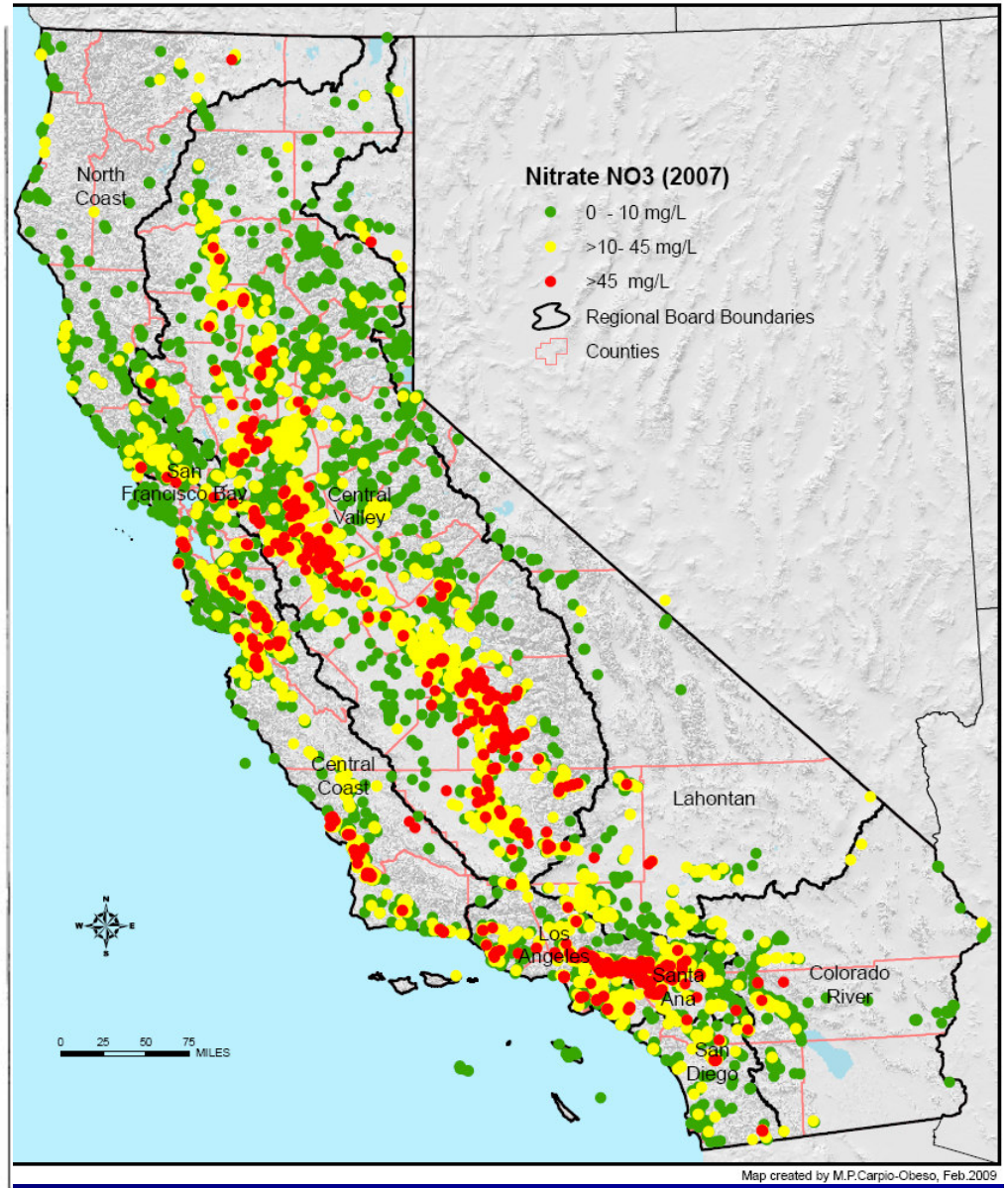
Tulare County, Private Domestic Well Nitrate Concentrations

- = > 45 mg/L (41%)
- = 10 to 45 mg/L (46%)
- = < 10 mg/L (13%)

Summary

- GeoTracker GAMA (Beta) will provide unprecedented access to groundwater quality data in California
- Public supply sources can tap different aquifers than environmental monitoring wells
- GeoTracker GAMA integrates datasets that sample different portions of aquifer
- Nitrate still a concern for much of California





1975-1987

2007