Groundwater Quality Conditions and Agricultural Discharges

Current Nitrogen Loading

Item 8

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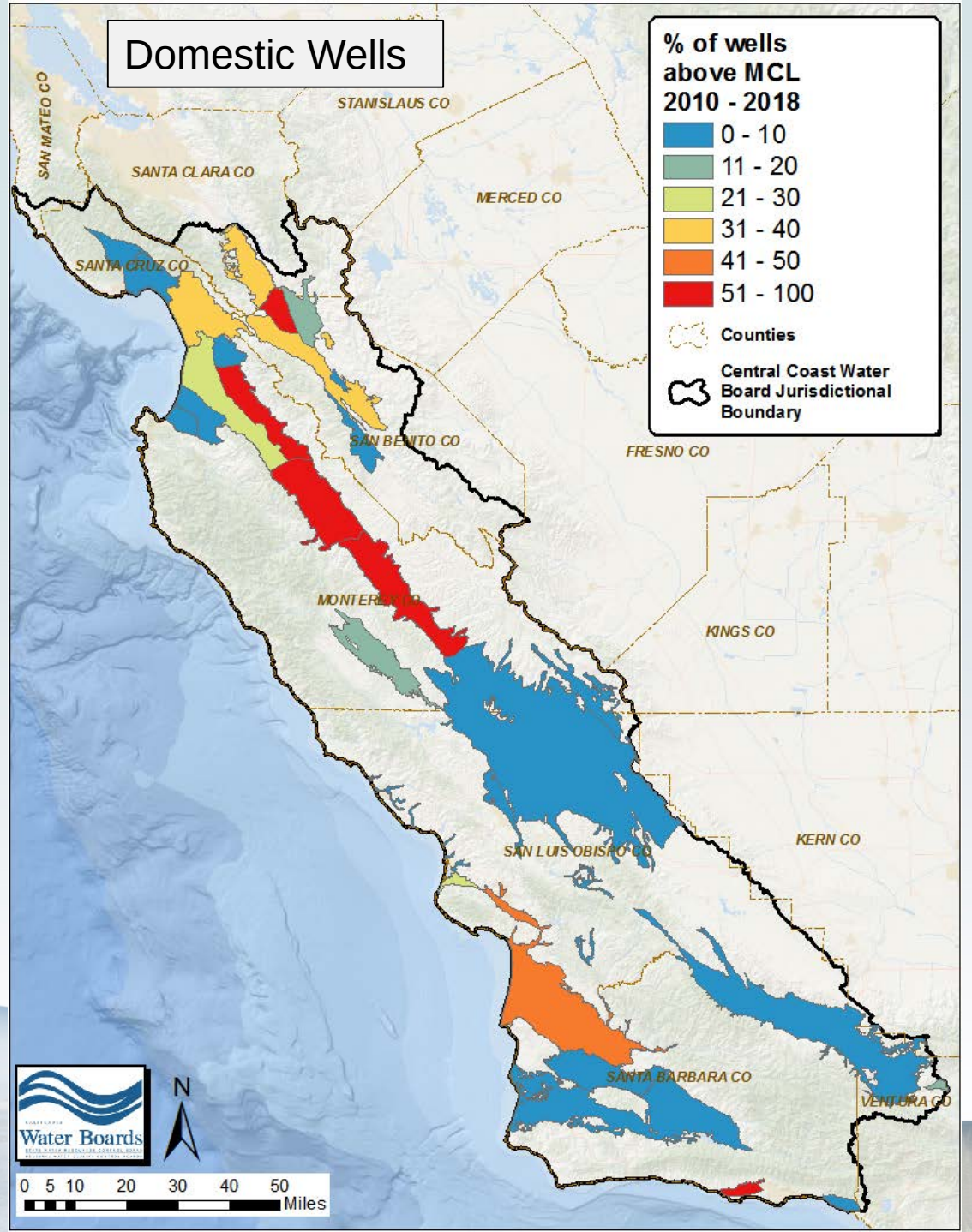
Outline

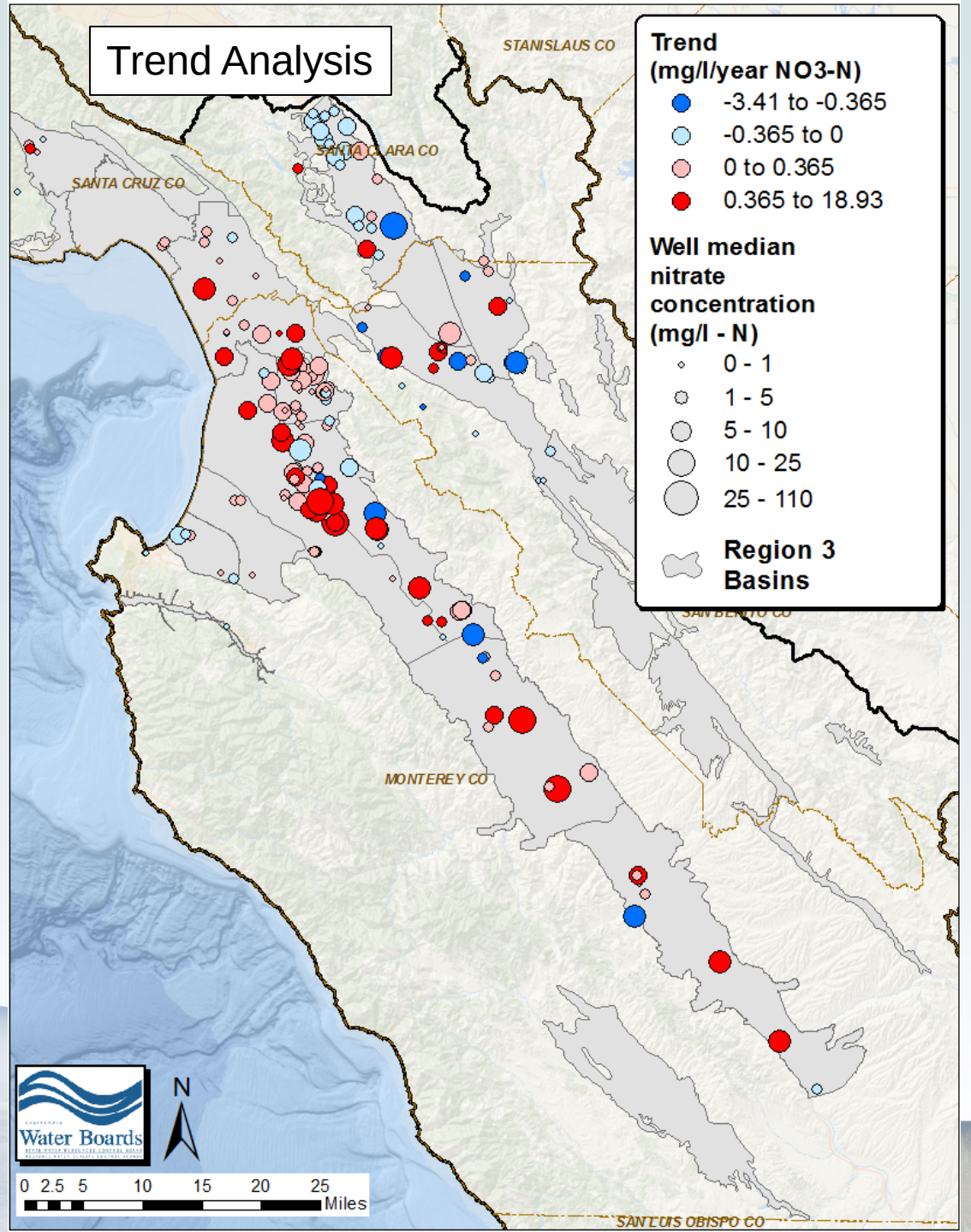
1. Groundwater Quality Conditions Review
2. Key Messages
3. Current Nitrogen Waste Discharge
   - Sometimes referred to as “residual” or “loading”
4. Methods to Reduce Nitrogen Waste Discharge

Groundwater Quality Conditions Review

Groundwater contamination by nitrate is widespread and severe



Nitrate concentrations are increasing in many basins

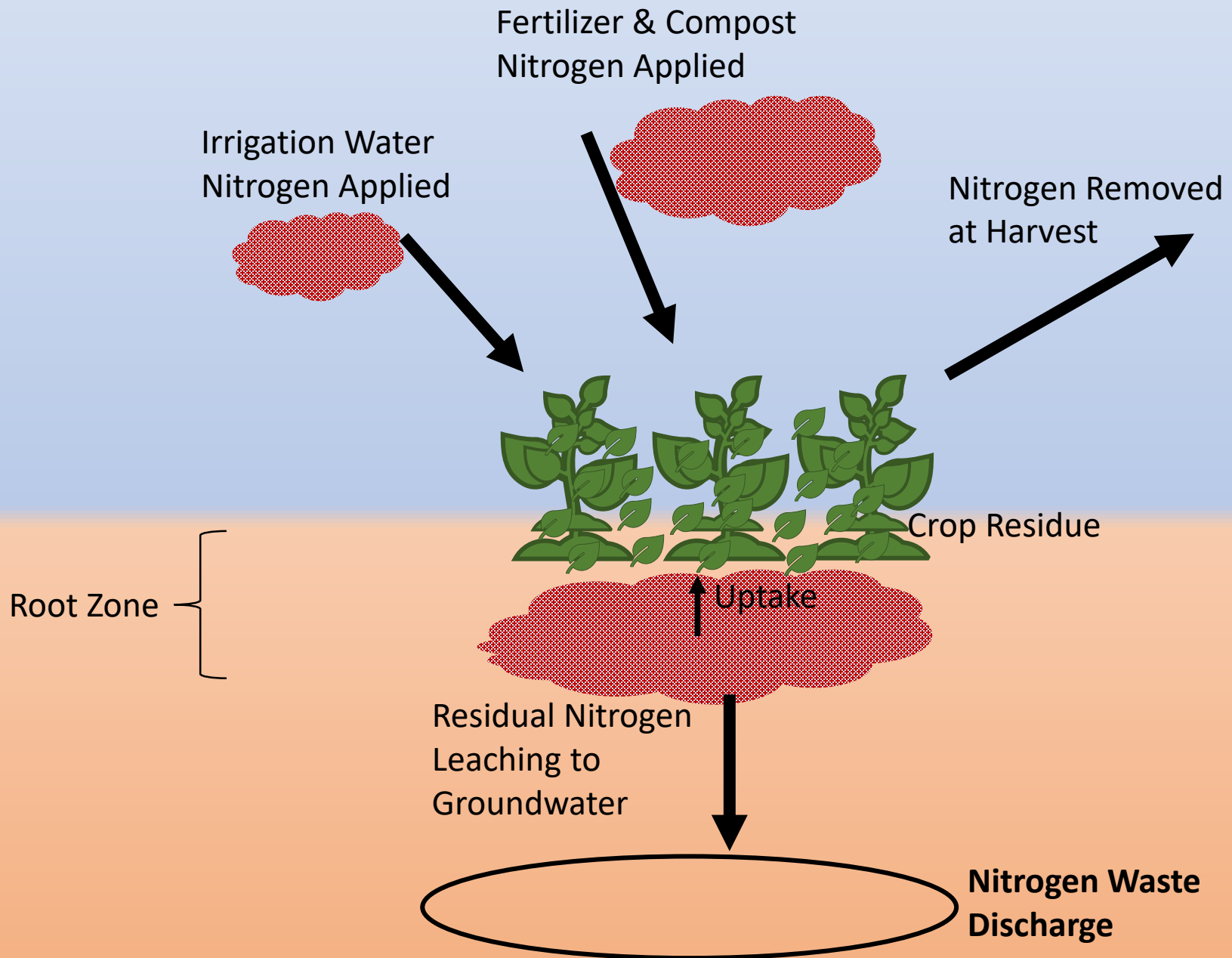


Key Messages

- Nitrogen application data, reported by a subset of ranches largely located in impaired and worsening basins show
  - The average current nitrogen waste discharge is 10x greater than what would be protective of water quality
  - The overall amount of current nitrogen waste discharge is causing and contributing to increasing groundwater degradation
- Significant reductions in nitrogen waste discharge are possible

Current Nitrogen Waste Discharge

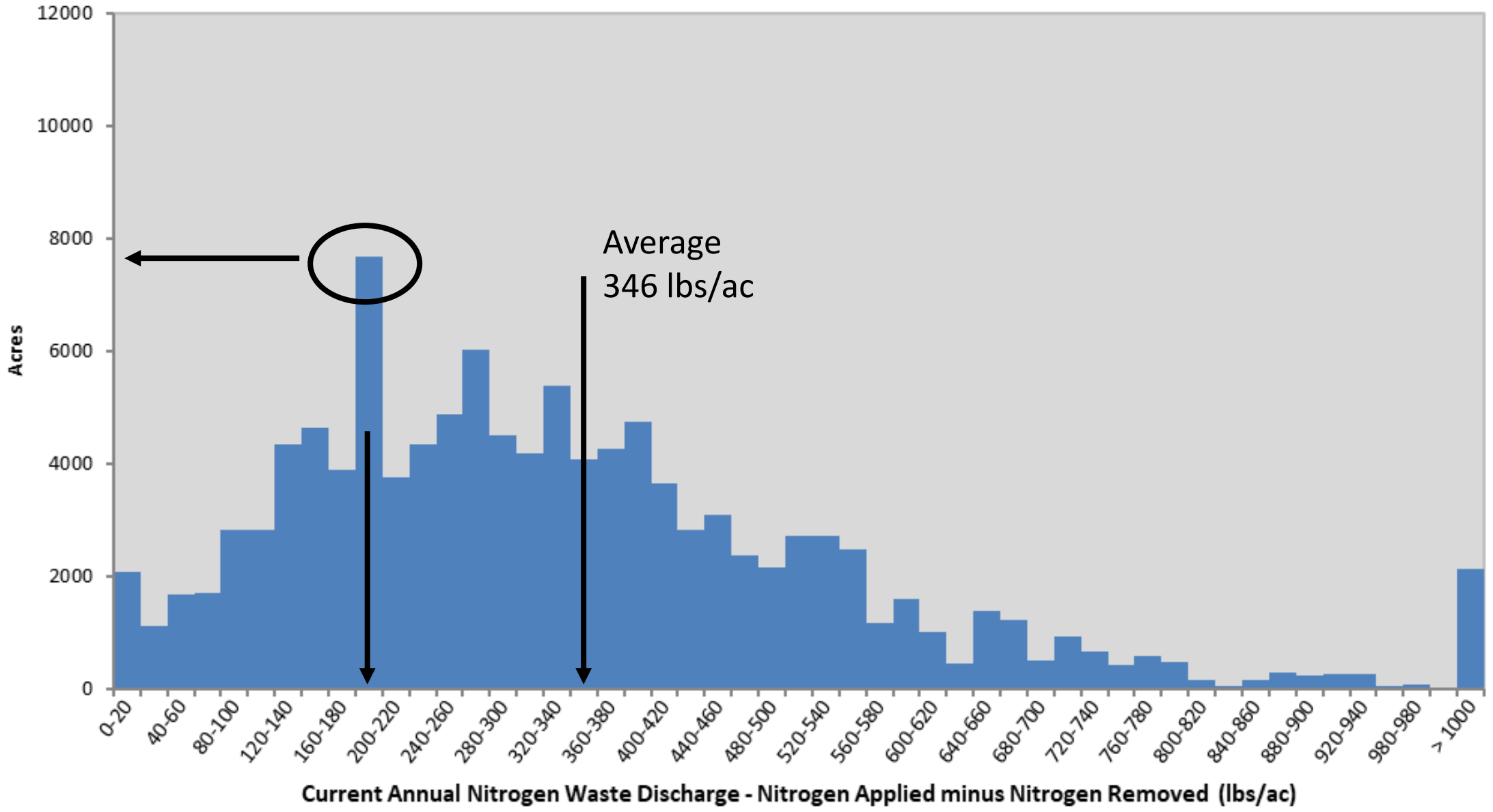
Nitrogen Waste Discharge in Agricultural Systems



**This is not meant to be representative of the full nitrogen cycle; it is meant to convey the concept of nitrogen Applied - Removed, or A-R*

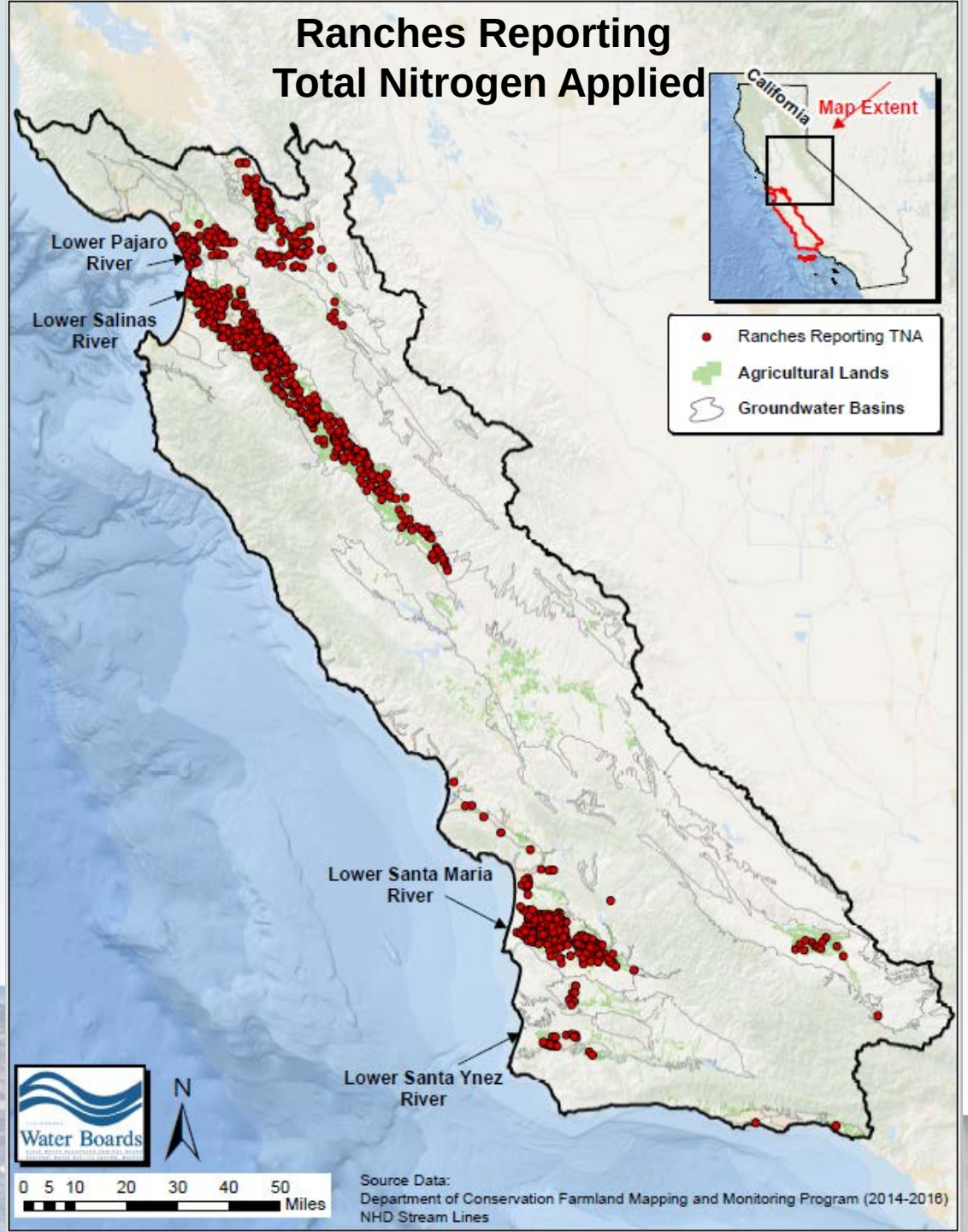
Current Annual Nitrogen Waste Discharge

Nitrogen Applied minus Nitrogen Removed



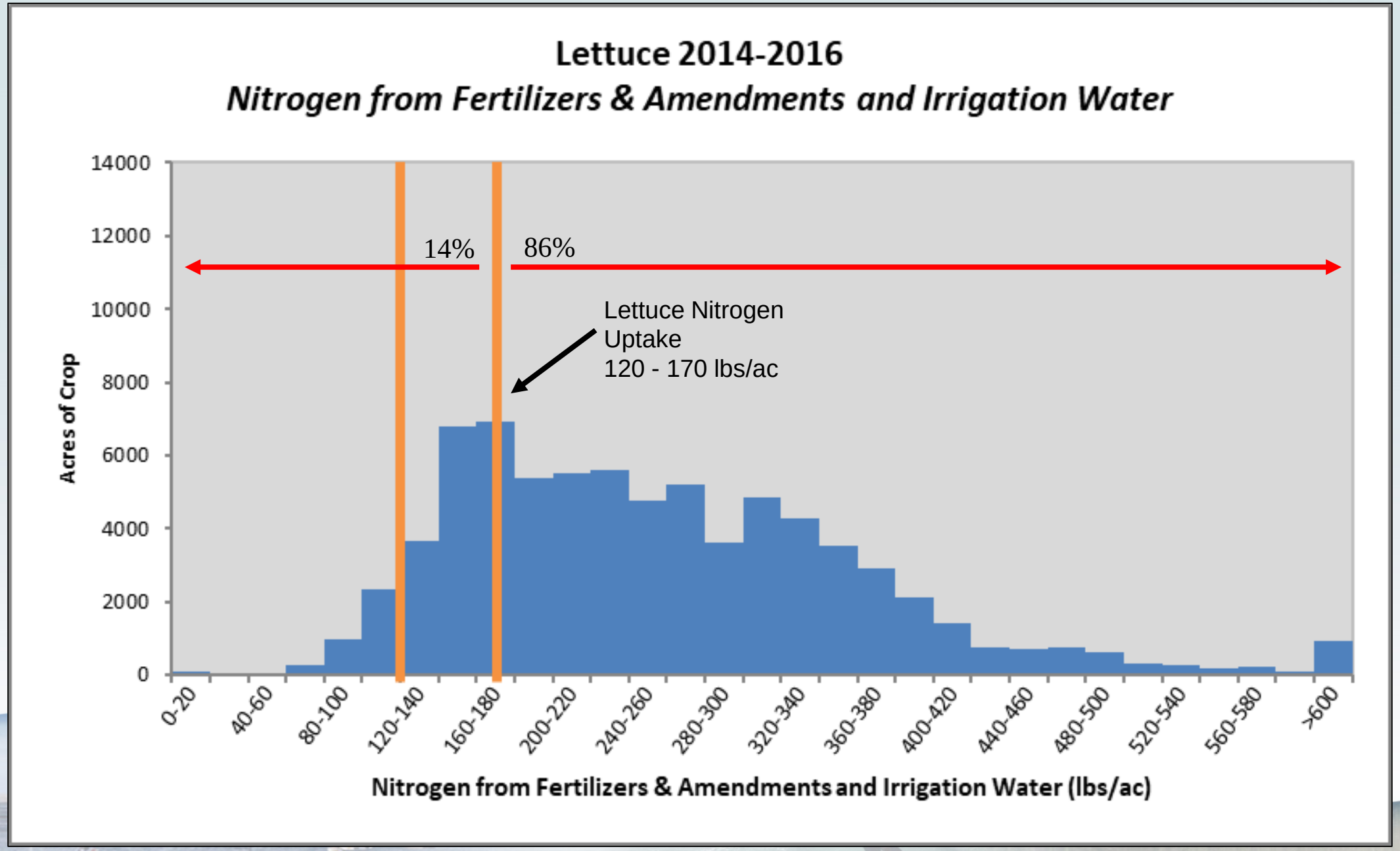
Total Nitrogen Applied Reporting

- Reported annually since 2014
- Over 600 ranches representing over 117,000 acres
  - Expanded in Ag Order 3.0 to ~1800 ranches
- Reports have covered primarily high risk crops
  - Lettuce, broccoli, cauliflower, spinach, celery, strawberries, etc.
- Grower-reported information on fertilizer, compost, amendments, irrigation water
- Harvest removal values not reported


Ranches Reporting
Total Nitrogen Applied
California
Map Extent
Ranches Reporting TNA
Agricultural Lands
Groundwater Basins
Lower Pajaro River
Lower Salinas River
Lower Santa Maria River
Lower Santa Ynez River
Water Boards
N
0 5 10 20 30 40 50
Miles
Source Data:
Department of Conservation Farmland Mapping and Monitoring Program (2014-2016)
NHD Stream Lines

Total Nitrogen Applied Analyses

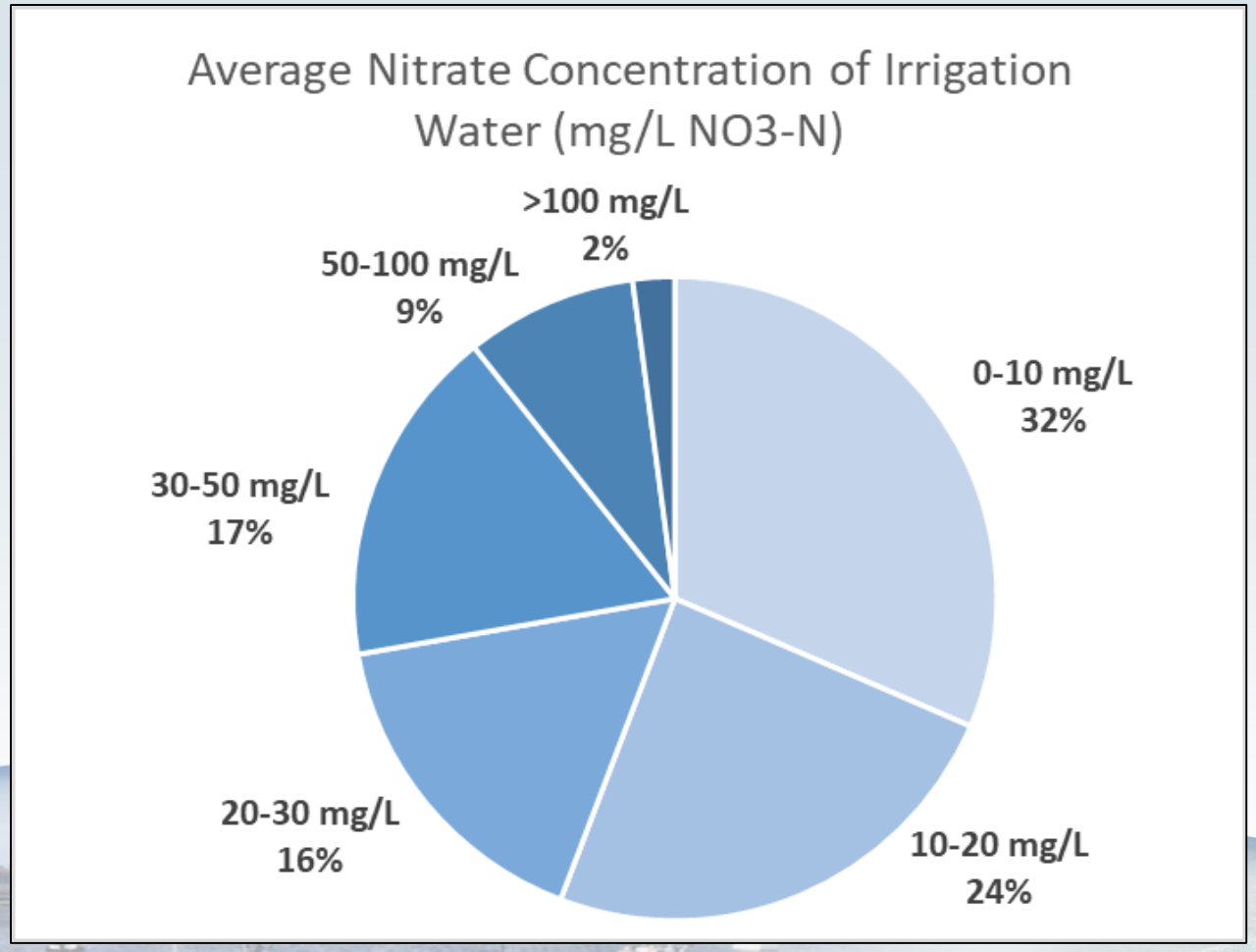
- Comparison of N applied versus crop uptake
  - Research-based values for uptake ranges
  - Crop-specific
  - Nitrogen applied from all sources
- Comparison of N applied versus harvest removal
  - Calculation of waste discharge
  - Research-based values for harvest removal
  - Calculated for entire ranch
  - Nitrogen applied from all sources


Lettuce 2014-2016
Nitrogen from Fertilizers & Amendments and Irrigation Water
14000
12000
10000
8000
6000
4000
2000
0
Acres of Crop
14%
86%
Lettuce Nitrogen Uptake
120 - 170 lbs/ac
0-20
40-60
80-100
120-140
160-180
200-220
240-260
280-300
320-340
360-380
400-420
440-460
480-500
520-540
560-580
>600
Nitrogen from Fertilizers & Amendments and Irrigation Water (lbs/ac)

Irrigation Water Nitrogen

- Michael Cahn presentation from December 2017
  - *“The 2015 trials clearly demonstrated that irrigation water NO3-N was at least as effectively used by the crop as fertilizer N.”*
  - Irrigation water nitrogen is bioavailable
- Pump and fertilize is feasible
  - Feasibility depends on irrigation water nitrate concentration

Irrigation Water Nitrogen



Mass of Nitrogen Applied (lbs/ac)			
	Volume		
Conc.	**1 ac-ft**	**2 ac-ft**	**3 ac-ft**
10 mg/l	27	54	82
20 mg/l	54	82	163
30 mg/l	82	163	245
50 mg/l	136	272	408
100 mg/l	272	544	816

Calculation of Applied - Removed

- A-R: Nitrogen Applied minus Nitrogen Removed
  - Basic calculation based on the State Board metric
  - Nitrogen applied (A) is reported through TNA
  - Removal (R) is not currently reported
  - Use maximum research-based values for harvest removal

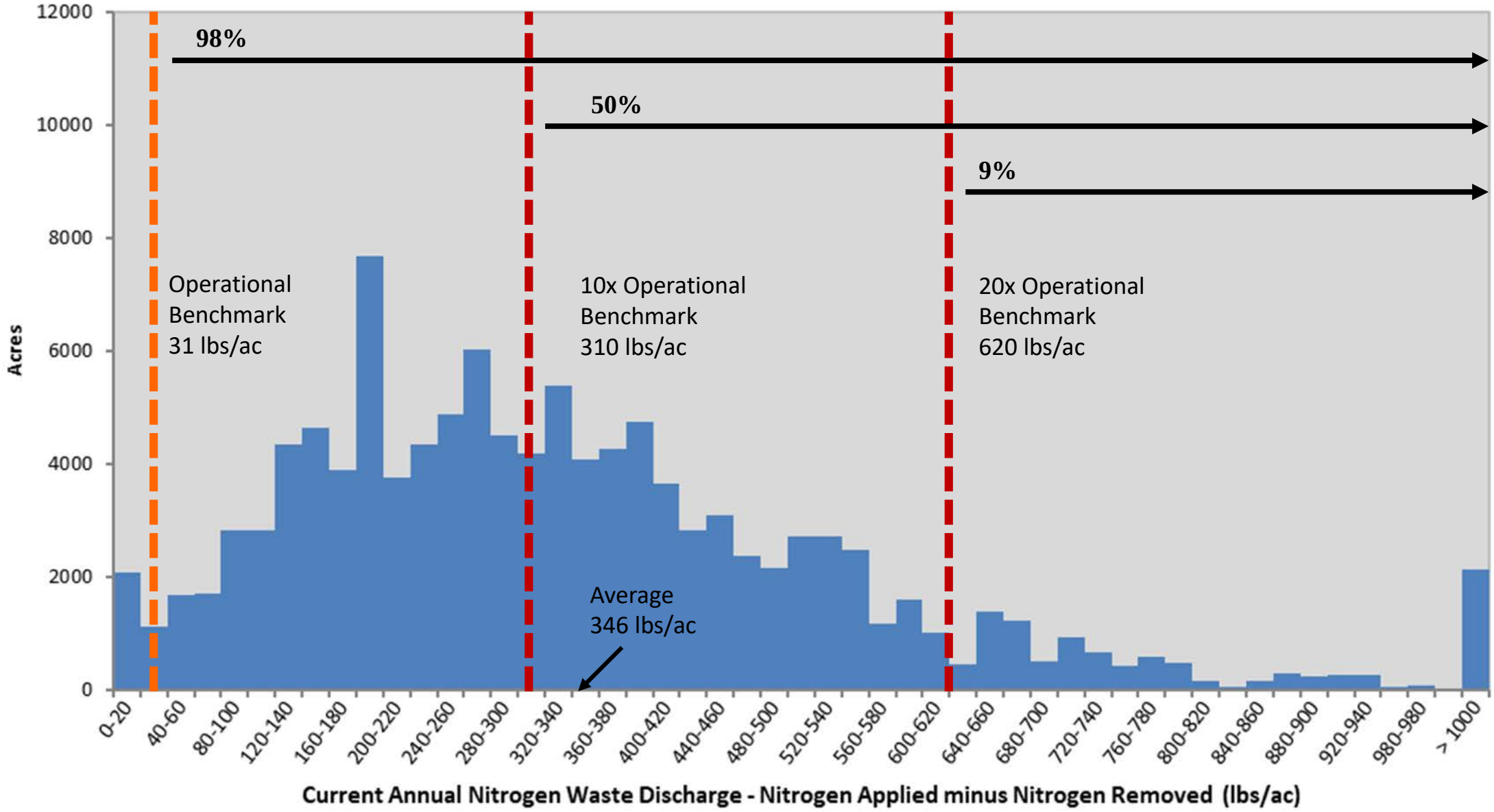
- Example: lettuce crop
  - 170 lbs/ac is applied in fertilizers, 100 lbs/ac is applied in irrigation water
    - Applied (A) = 170 + 100 = **270 lbs/ac**
  - 80 lbs/ac is removed during harvest
    - Removed (R) = **80 lbs/ac**
  - A-R = 270 - 80 = **190 lbs/ac** nitrogen waste discharge

Operational Benchmark

- 2012 UC Davis Nitrate Report “Operational Benchmark”
  - Identified loading value protective of water quality
  - **31 lbs/ac** nitrogen waste discharge
  - Provides context for understanding nitrogen waste discharge
- From lettuce example, 190 lbs/ac is about 6x operational benchmark

Current Annual Nitrogen Waste Discharge

Nitrogen Applied minus Nitrogen Removed



Methods to Reduce Nitrogen Waste Discharge

1. Match nitrogen application with crop uptake
2. Pump and fertilize
3. Account for residual nitrogen left in the field after previous crop
4. Manage irrigation water scheduling to minimize nitrogen lost through leaching
5. Other site-specific management practices

Conclusion

- Groundwater nitrate contamination is widespread and severe, and degradation is increasing in many areas
- Nitrogen application data, reported by a subset of ranches largely located in impaired and worsening basins show
  - The average current nitrogen waste discharge is 10x greater than what would be protective of water quality
  - The overall amount of current nitrogen waste discharge is causing and contributing to increasing groundwater degradation
- Significant reductions in nitrogen waste discharge are possible
- Developing regulatory options for Ag Order 4.0