

US EPA ARCHIVE DOCUMENT

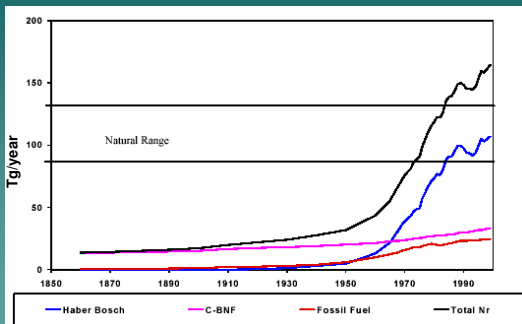
Catalytic converters and checkerspot butterflies: air quality impacts of vehicular ammonia emissions

Stuart B. Weiss
Creekside Center for Earth
Observations

N

The biggest global change
nobody (almost) has ever
heard of

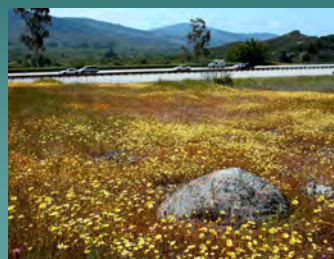
The N-cycle is massively disrupted –
proportionally more than the C-cycle



Galloway et al 2003 Bioscience

The case of the Drive-by Extinction

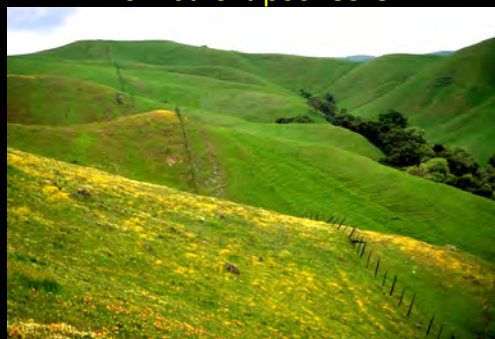
Another episode of CSI Redwood City

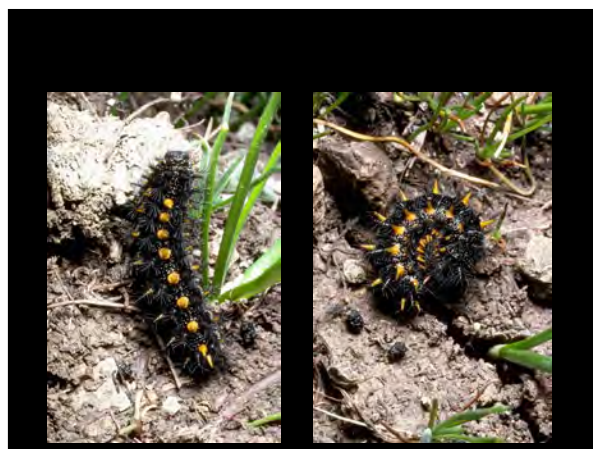
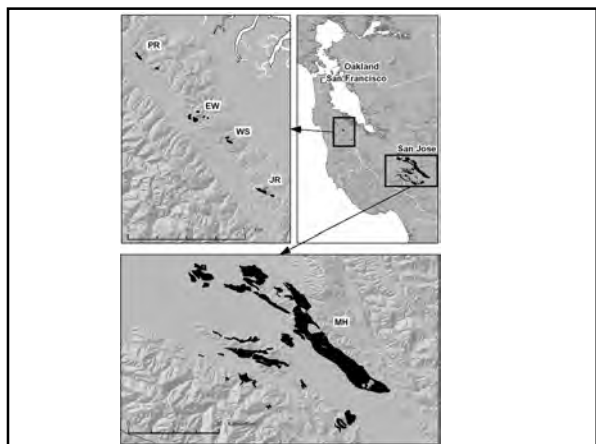


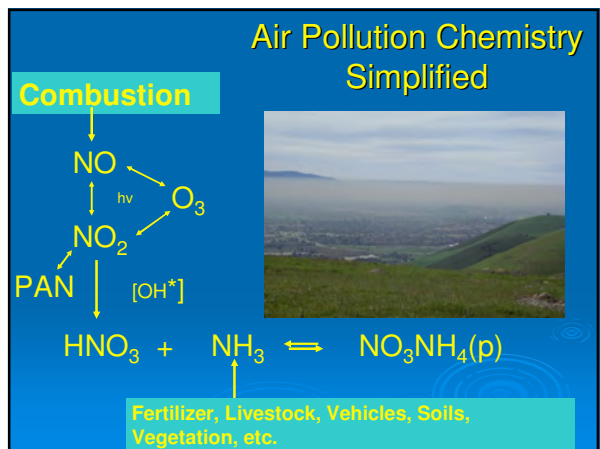
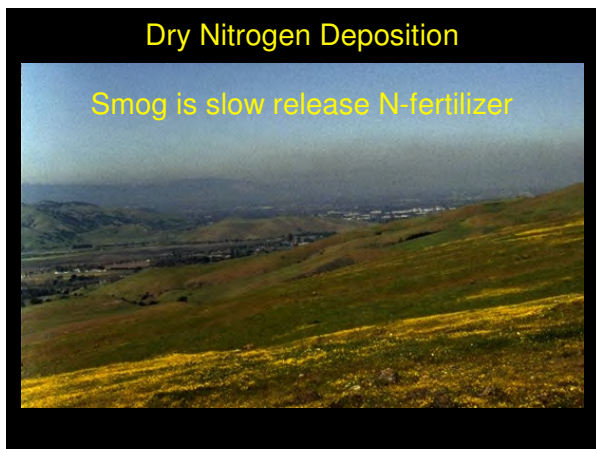
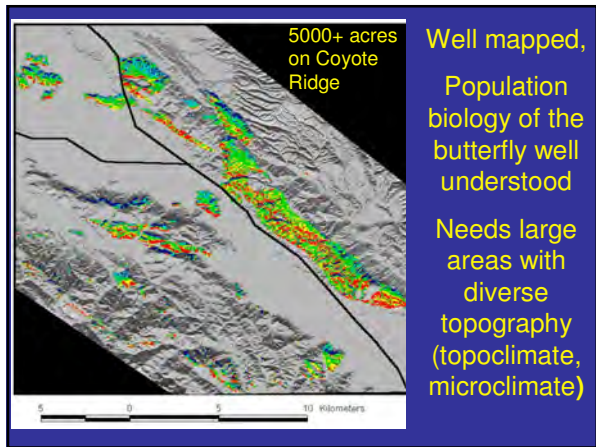
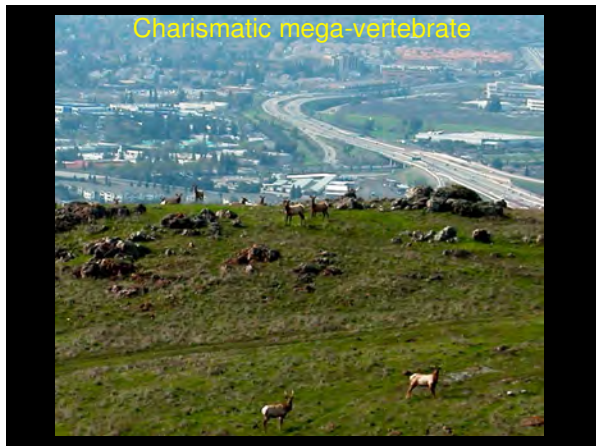
Mesocosm of N-deposition Impacts

- Emissions
- Transport
- Chemical transformations
- Deposition
- Species composition change
- Loss of biodiversity
- Management response

Serpentinite forms discrete patches of nutrient-poor soils

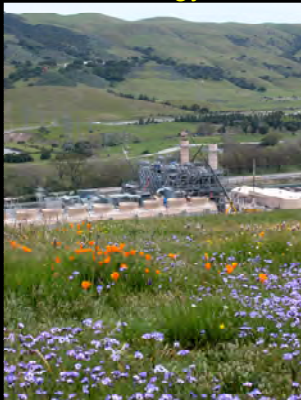






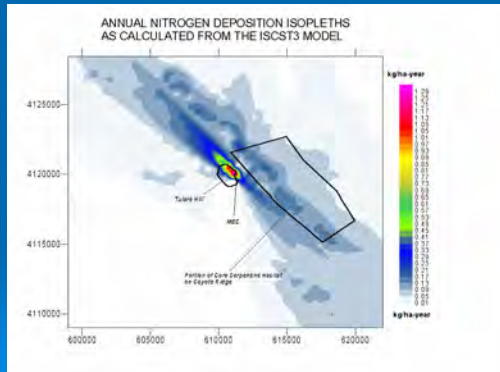
Metcalf Energy Center

124
tons
NO_x
per
year



<116
tons
NH₃
per
year

Worst-case scenario modeling, all emissions as HNO₃



Former-future Cisco World HQ

230 tons NO_x/year, ~20 tons ammonia
Incipient Coyote Valley Urbanization



Widening Highway 101



Conservation So Far


250 acres, Kirby Canyon Trust, long-term lease
131 acres MEC, \$1.4 million management endowment – SVLC
540 acres (2005) for highway mitigation + ~\$700,000 endowment, management by SCCOSA
80 acres (2002-2004) strategic freeway frontage, ~\$650,000 endowment from 2 other power plants - SVLC
Mitigation market
Santa Clara County HCP/NCCP
Coyote Valley Specific Plan

Operation Flower Power





Edgewood Natural Preserve



Proposed for golf course
1981-1994 "Epic" battle to stop it
"Natural Preserve" status in 1994
Hands off management of serpentine grassland

The map shows the Edgewood Natural Preserve with several sampling sites marked with letters: A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z. A scale bar indicates 500, 0, 500 Meters and 1000, 0, 1000 Feet. A north arrow is also present.

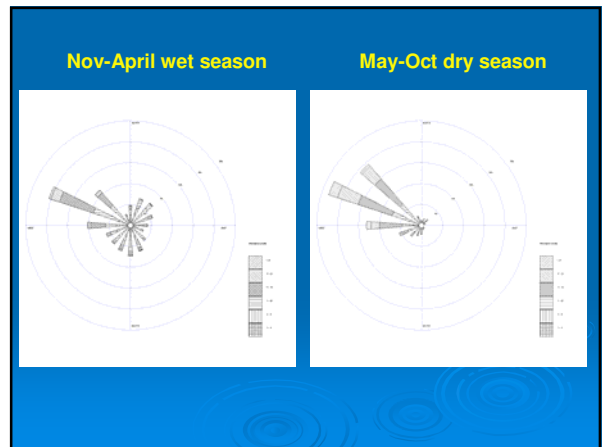


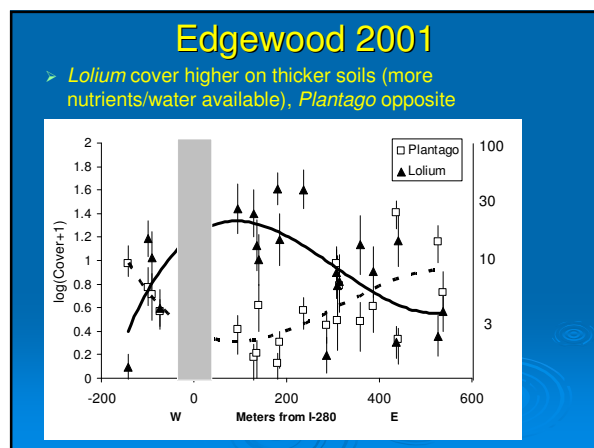
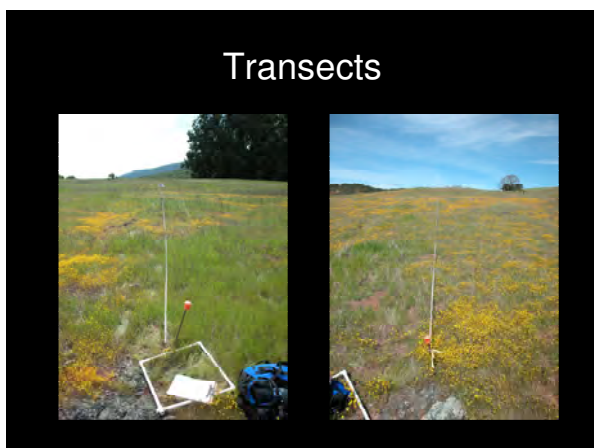
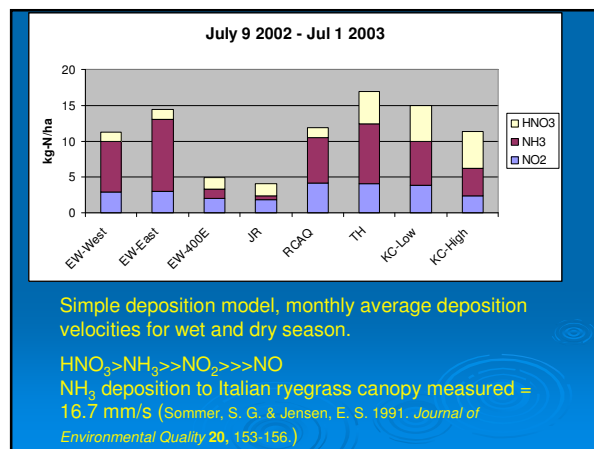
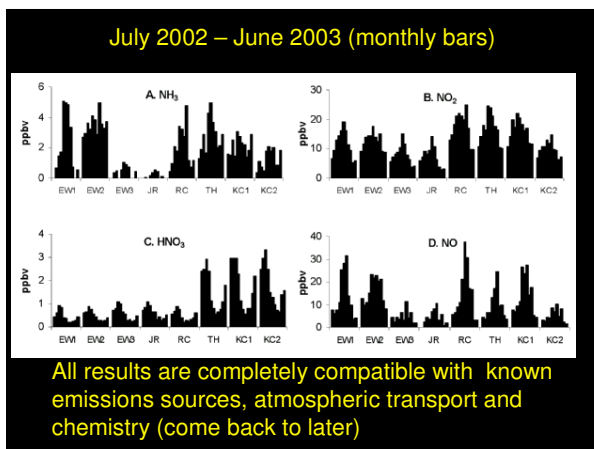
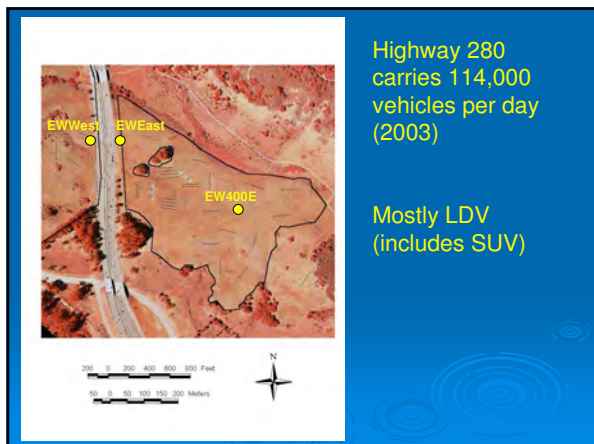
Passive Sampling

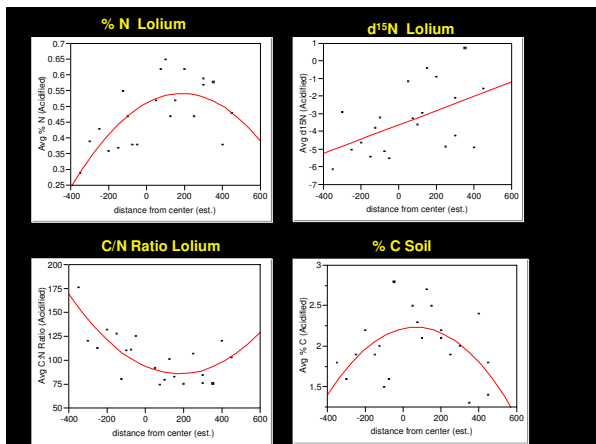


Dr. Andrzej Bytnerowicz,
USDA FS Riverside, CA

The left image shows Dr. Andrzej Bytnerowicz standing in a field of yellow wildflowers. The right image shows a passive sampling station in a field, consisting of a tall pole with several sensors at the top.



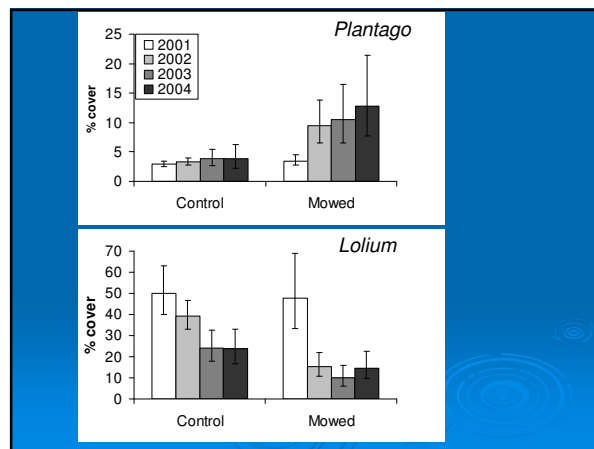


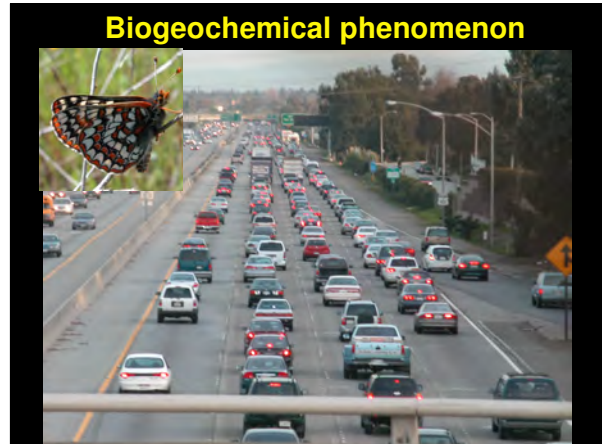
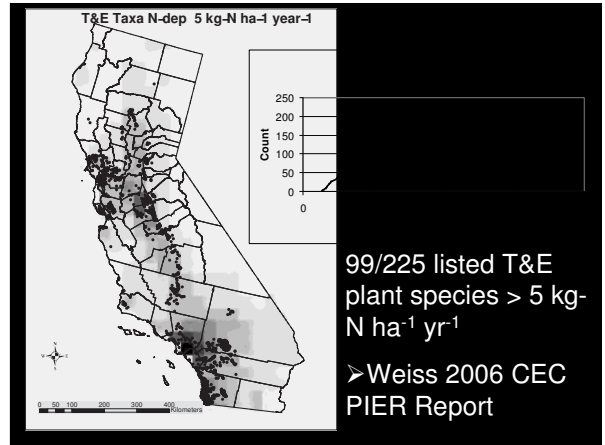
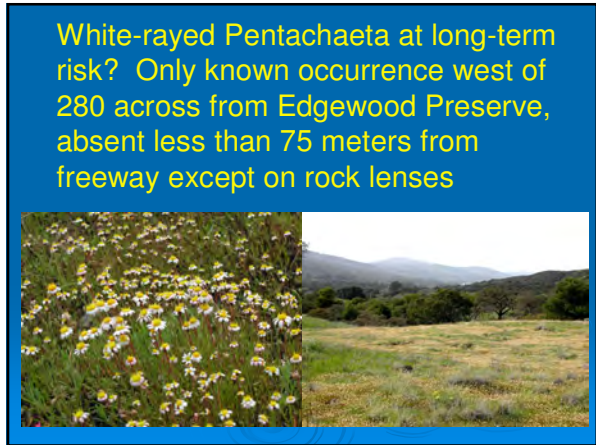
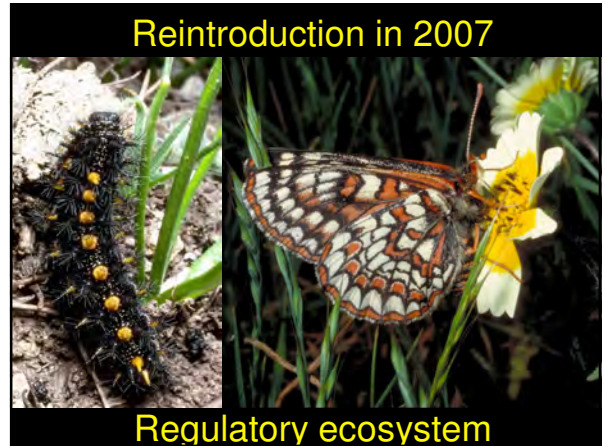


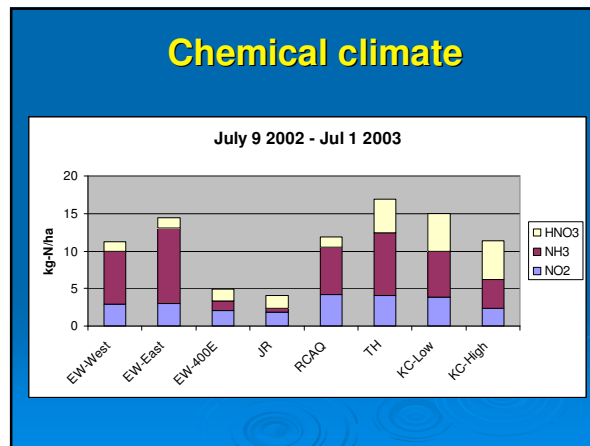
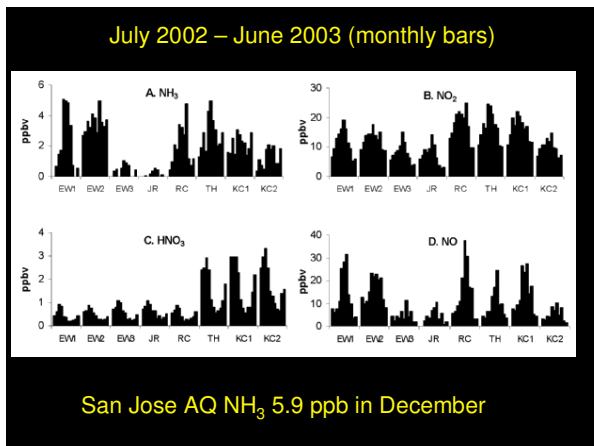
Restoration Experiments

- Small-scale (700 m²), replicated
- Fire – Three strikes and your out...spring burns work
- Goat grazing – Expensive, not selective nor effective
- Mowing – Effective, known costs and technology
- Seeding *Plantago* appears unnecessary

Well-timed weed whacking

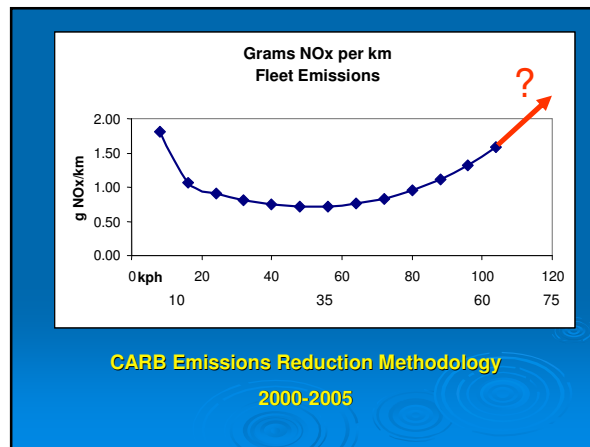






I = PAT

- Impact = Population X Affluence X Technology
- Population: Number of vehicles
- Affluence: speed and size of vehicles
- Technology: emissions systems



Ammonia from Cars?

- 1990+ catalytic converters over-reduce NO_x when running fuel rich
- Function of Vehicle Specific Power
- 1.8 - 6+ Mg/km/year for Highway 280
- Highly variable from vehicle to vehicle, 10% of vehicles produce 50% of emissions

Baum et al. 2001 Env. Sci. Tech 35: 3635-3741

Roadside laser on freeway on ramp, 46-55 mph

94 +/- 8 mg-NH₃ km⁻¹

SoCAB tons/day
Vehicles: 44
Livestock: 27-30
All Sources: 165-218

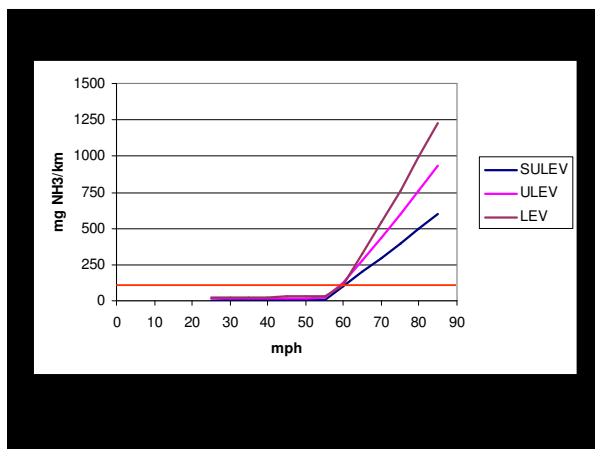
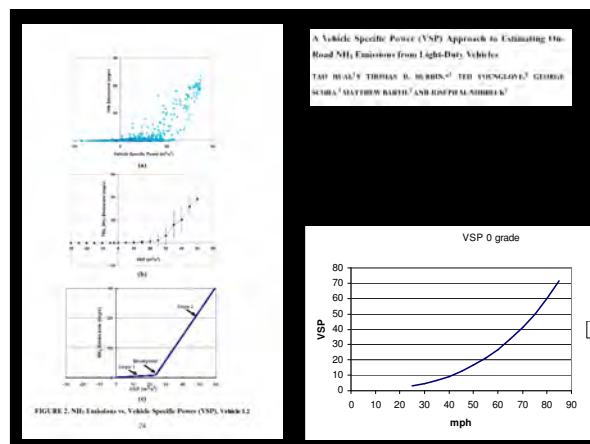
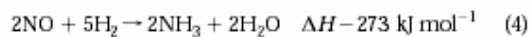
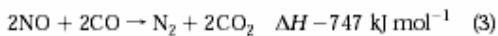
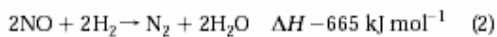
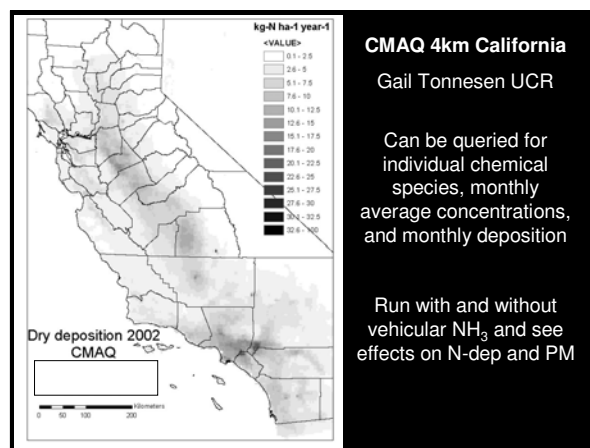
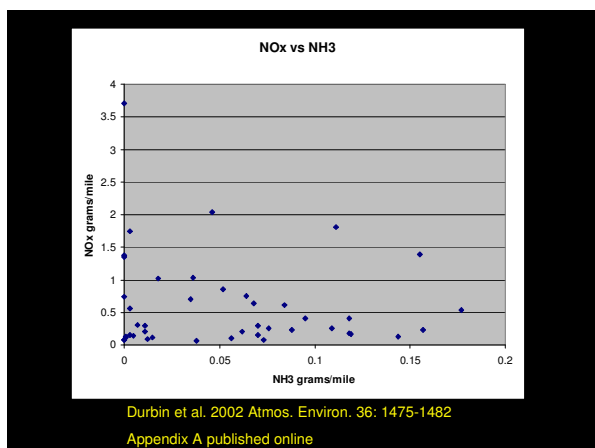
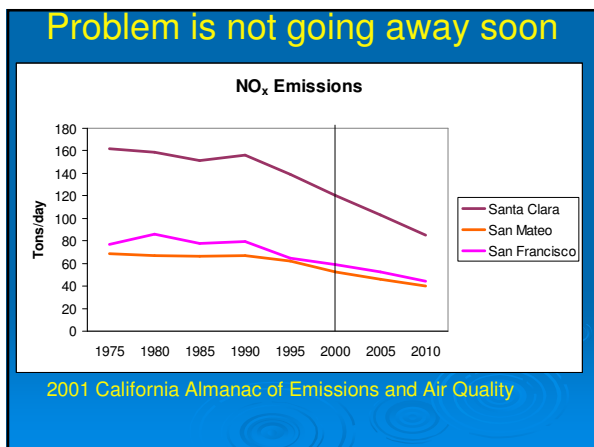
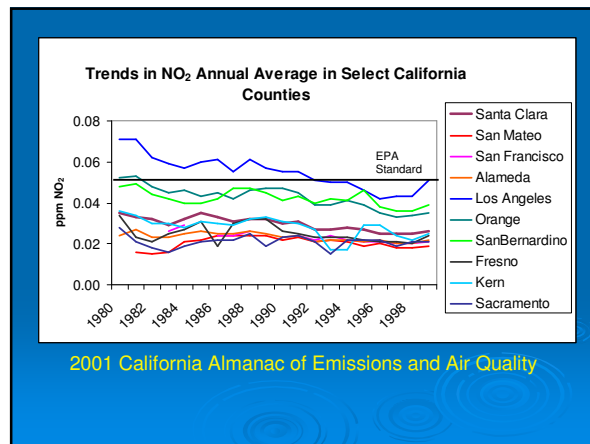
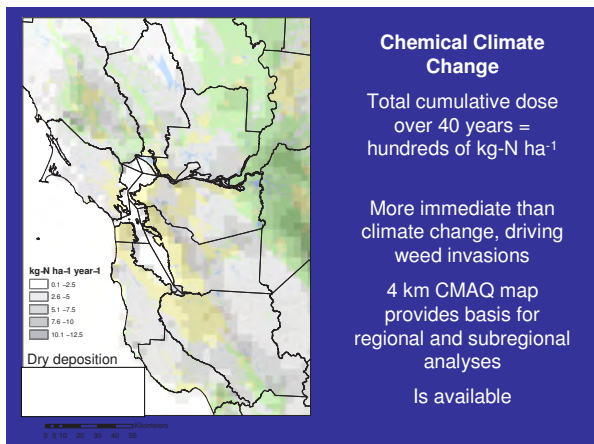


TABLE 5. Modeling Results of NH₃ Emissions from Gasoline Vehicle in SoCAB

Year	Elev.					Elev. (mg/mi)	VMT per day (10 ⁶ mi)	NH ₃ Emissions (ton/day)
	4-mg/mi	8-mg/mi	21.8-mg/mi	34.8-mg/mi	97.6-mg/mi			
	C ₁	C ₂	C ₃	C ₄	1-C ₁ -C ₂ -C ₃ -C ₄			
2000	0.0%	0.0%	1.5%	18.2%	80.2%	34.99	314.6	26.7
2005	3.2%	4.1%	5.0%	32.0%	54.8%	66.57	333.5	22.2
2010	24.2%	13.0%	4.0%	60.0%	31.8%	67.07	558.0	15.0





- ### Agenda: Make it better
- CARB study – meeting with Jerry Hill
 - How did we get here, what is current impact on health and welfare, and where are we going?
 - EPA funding?
 - Run CMAQ w/o vehicular ammonia, effect on N-deposition and PM
 - Ammonia monitoring network (passive)
 - Detailed freeway study along I-280, modeling, measurement, and calibration
 - Other freeway sites, CAFOs, etc.