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University of California
AGRICULTURE AND NATURAL RESOURCES

Pathogen Reduction and Environmental Impacts Associated with Composting Bovine Mortalities

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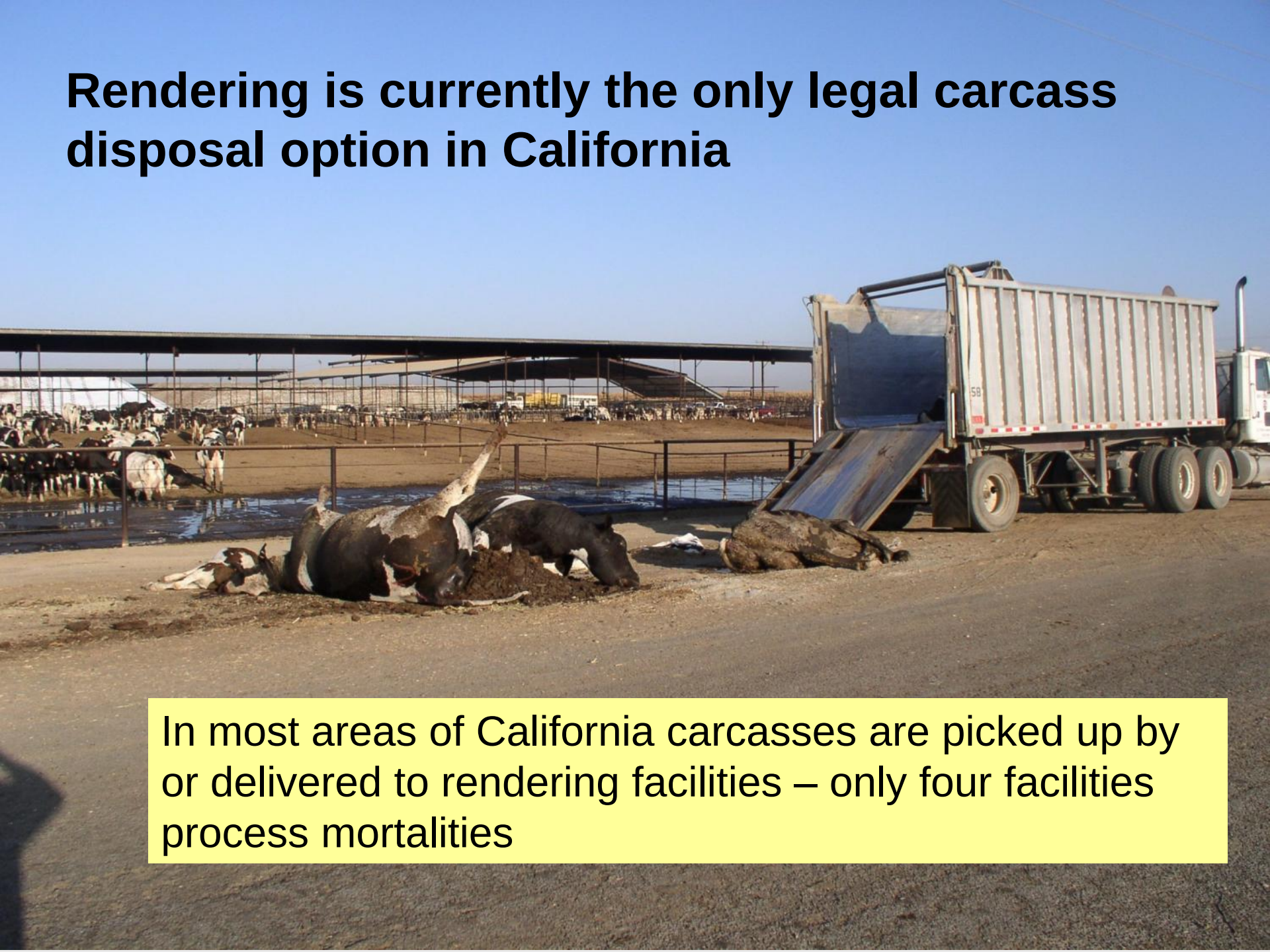
Rendering is currently the only legal carcass disposal option in California



In most areas of California carcasses are picked up by or delivered to rendering facilities – only four facilities process mortalities

Farm Animal Population California 2008

Species / Class	Total Number
Dairy, cows	1.9 million [1]
Poultry, layers	19.6 million [2]
Cattle and calves,all	5.5 million [2]
Sheep, all	620,000 [2]
Goats, all	129,000 [2]
Hogs, all	80,000 [2]

[1] California Dept. of Food and Agriculture

[2] United States Dept. of Agriculture

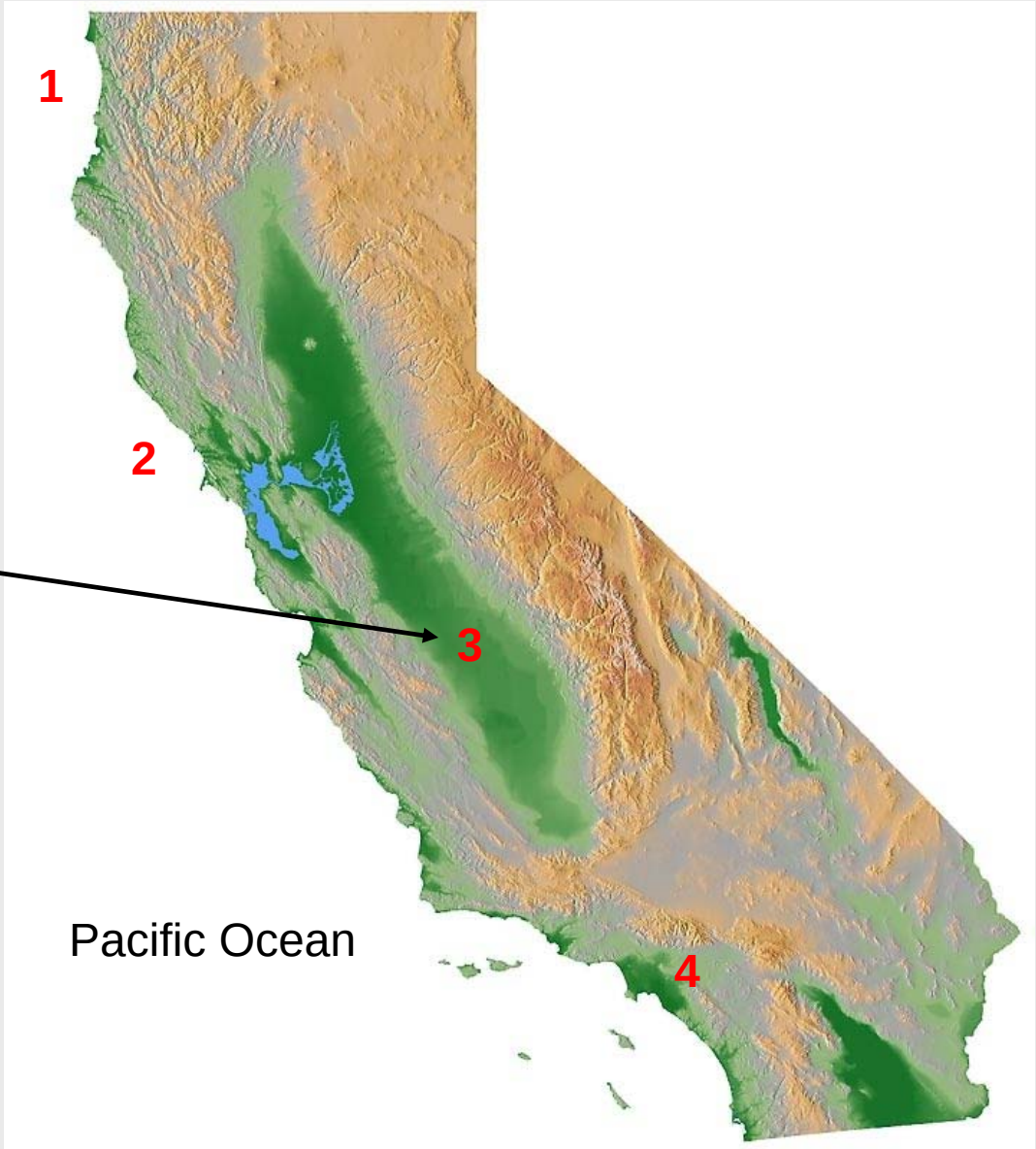
California's milk producing regions:

San Joaquin Valley is largest; >80% of total milk.

Crops grown all year.

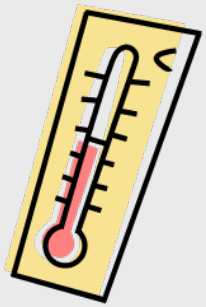
Low rainfall: 7 - 9 inches (18-23 cm) annually, all in winter.

Closed air basin.



Heat Wave July 2006

Enormous carcass disposal crisis was a call to action for stakeholders.



Compost research initiated in 2008

- Multi-disciplinary team convened
- Initial funding from CDFA to evaluate pathogen reduction

California Department of Food and Agriculture

- Other subsequent funding from:

WIFSS

California Integrated Waste Management Board

UCDAVIS VETERINARY MEDICINE

California Dairy Research Foundation

- And support from:

Dairy Food Safety Lab, UCDAVIS School of Veterinary Medicine

UC CE University of California Cooperative Extension

Objectives

- Investigate pathogen reduction (including spores)
- Simulate on-farm conditions
- Assess suitability of different manure sources as composting agent
- Quantify run-off volume and nutrient content, and measure air emissions from piles with or without carcasses
- Describe extent of carcass decomposition
- Consider hot and cool season

Methods

<u>Pathogen reduction</u>:

Salmonella enterica serotype Senftenberg

Bacillus cereus

fecal coliforms

E. Coli

- Sterile amendment inoculated with 1 X 10^7 cfu/gm and sealed in nylon bags.
- Nylon bags were secured within plastic toy balls.
- Balls fastened to rope and placed near head, abdomen and hindquarters.
- Retrieved at 0, 2, 6, 10 and 16 weeks.
- Log killing quantified by Most Probable Number (MPN) of bacteria cultured.

Placing pathogen balls

Methods

Composting process and amendment characterization:

- Measured temperature, oxygen, leachate, air emissions, carcass degradation
- Samples of amendment collected and analyzed for pore volume, air space, water holding capacity, bulk density, C:N ratios, nutrient analysis

Dairy manure sources used:
Screened dairy manure solids
Dry lot scrapings

Temperature - continuous recording data loggers and manual probe

Fresh carcasses and dairy manure provided by local dairies.

Manure sources

Screened dairy manure solids (SDMS)

We selected our SDMS from a local dairy that was composting the material.

Pile footprint 16 X 24 ft (4.9 X 7.3 m)

Pile Construction –
Leachate Collection System

Improved leachate collection system

Pile Construction

Use of cotton scale to weigh manure solids

Kings County Ag Commissioner staff with microbiologist Paul Rossitto from UCD Dairy Food Safety Laboratory

Methods:
Air Emissions

- US Environmental Protection Agency protocols
- Surface isolation flux chambers
- Reactive organic gases (VOC) and ammonia
- Multiple locations on piles with and without cows
- Five separate days: 2, 7, 14, 38 and 66
- Performed by C.E. Schmidt, Ph.D.
- Sample analysis by Almega Environmental Lab

Dr. Chuck Schmidt and Tom Card

Surface Isolation Flux Chamber

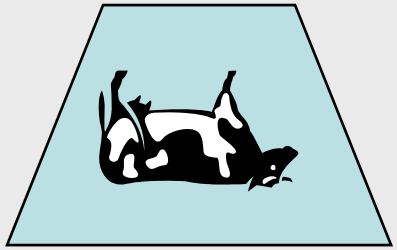
Canisters containing air samples

Assessing extent of carcass decomposition

Overview of work in progress

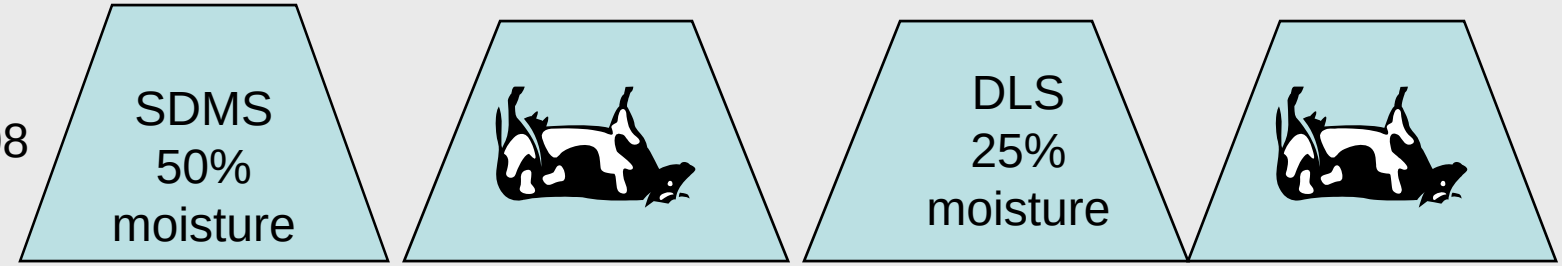
SDMS 70% moisture

Initial pile: April 2008

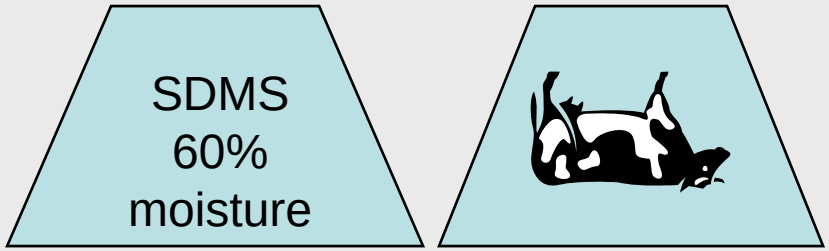


Subsequent piles:

Sept/Oct 2008



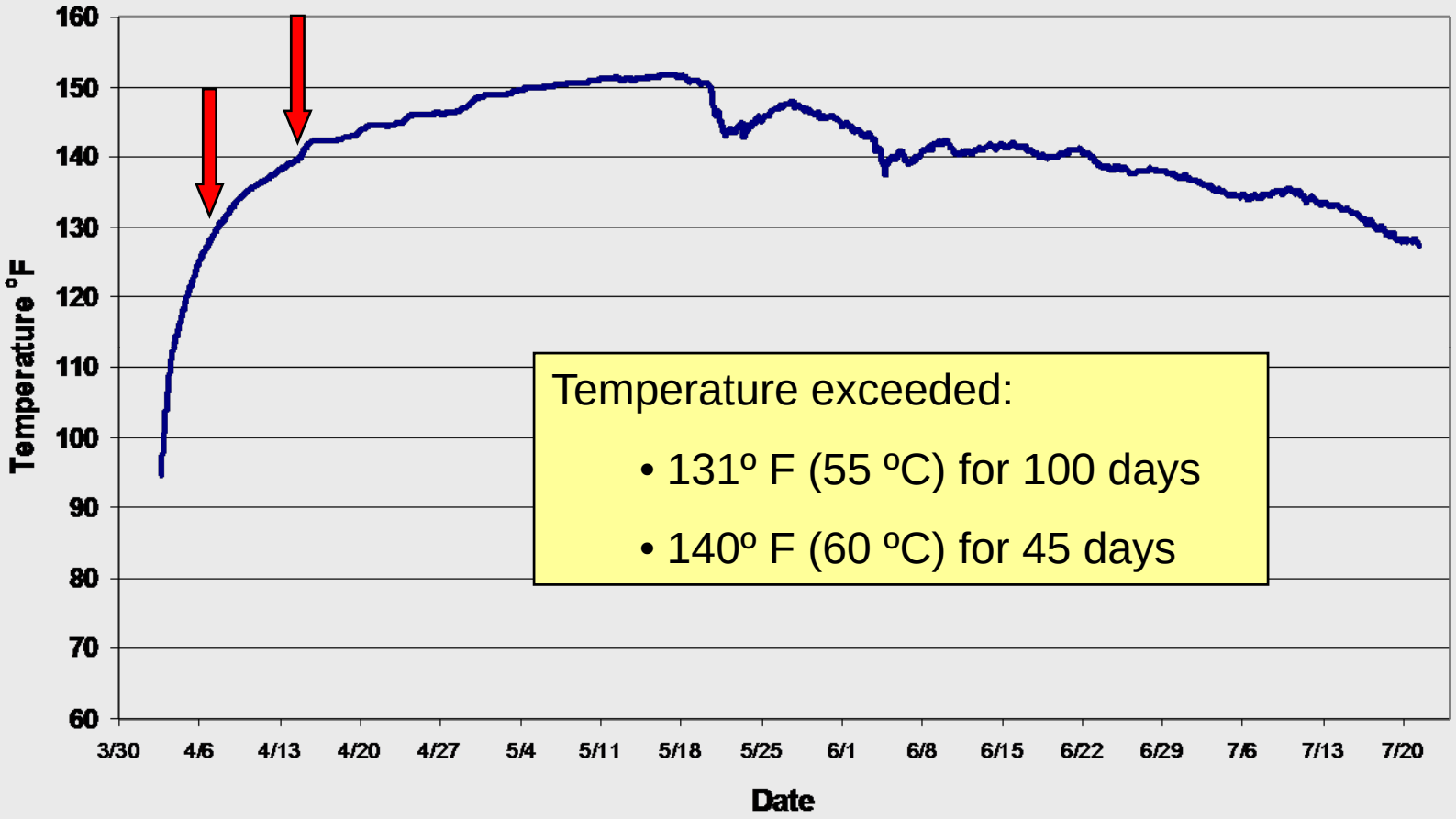
January 2009



Preliminary Results

Initial Pile - Carcass Compost Temperature

(average of 8 buried thermocouples)

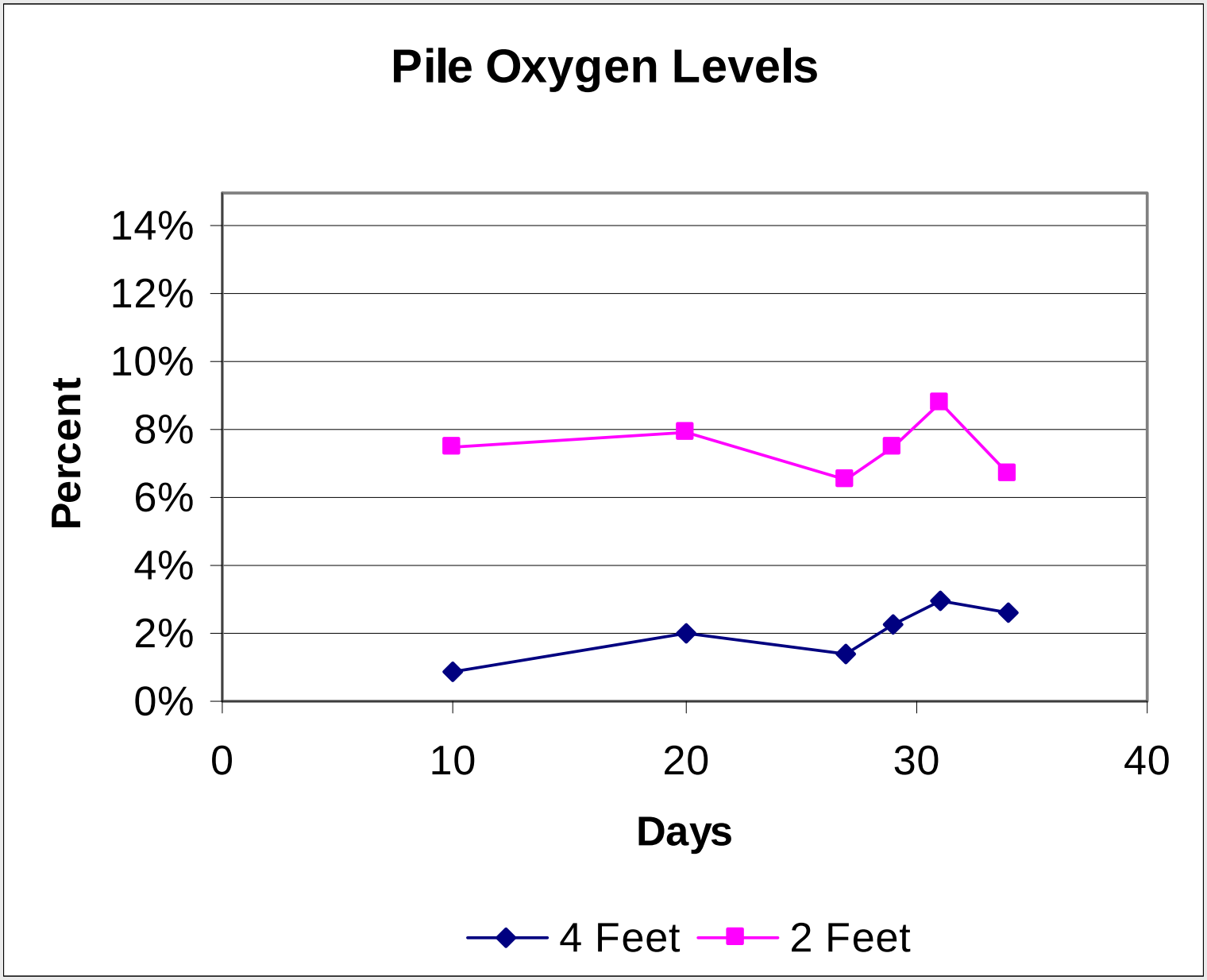


Temperature exceeded:

- 131º F (55 ºC) for 100 days
- 140º F (60 ºC) for 45 days

Peak temperature was 153º F (67ºC)

Initial Pile – % O_2 with Manual Probe



Pathogen Reduction

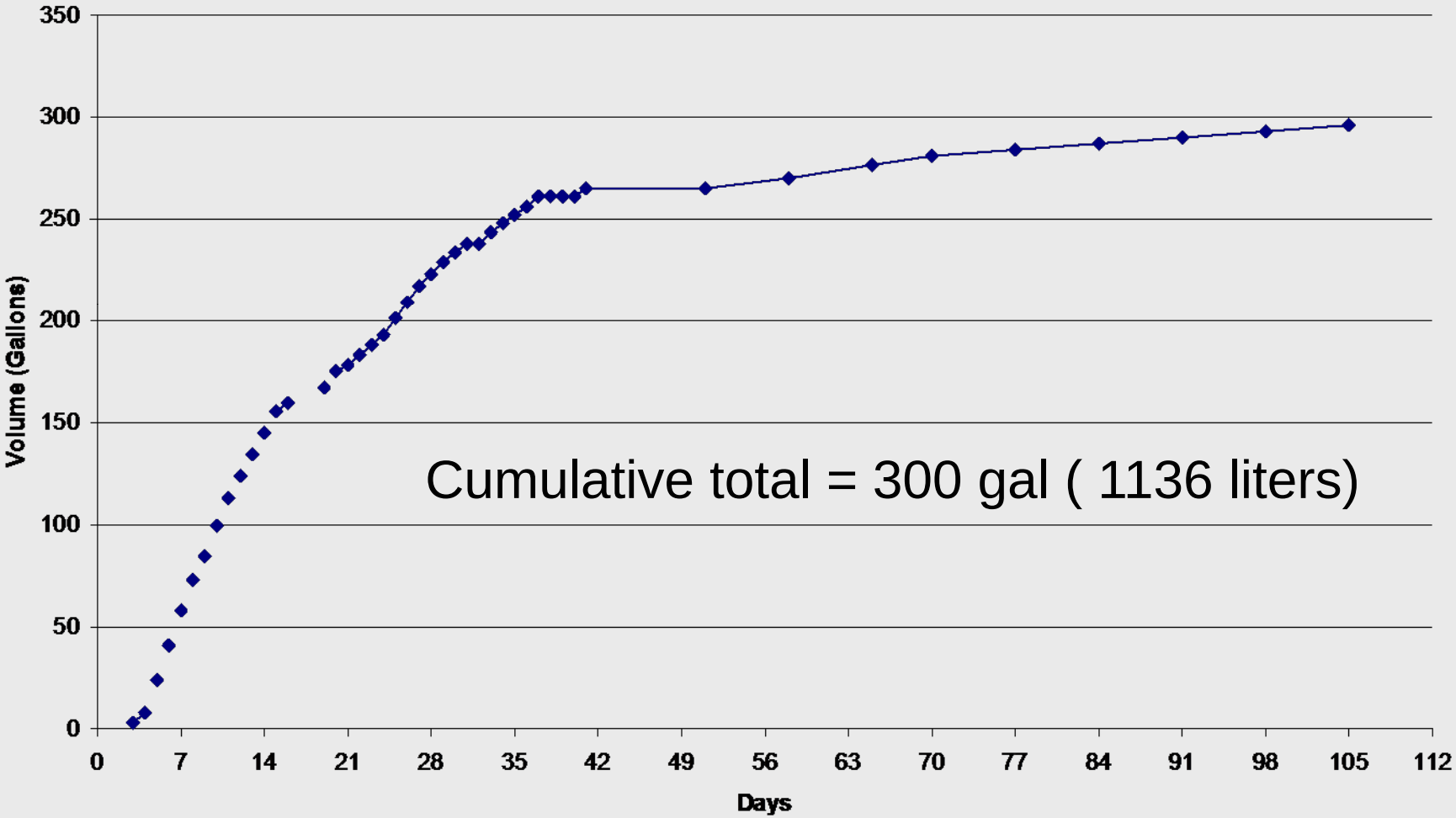
Retrieving inoculated pathogen balls

Initial Pile

Most **P**robable **N**umber Enumeration Bacteria from Retrieved Pathogen Balls

	MPN average log 10 value ***Week***				
Bacteria	0	2	6	10	16
Bacillus cereus (Vegetative)	6.09	1.15	-0.77	<0.16	-0.78
Salmonella enterica	8.91	-0.45	0.00	<0.16	<-0.27
Fecal Coliforms	7.89	2.18	-0.56	<0.16	<-0.27
E. Coli	7.12	-0.64	0.00	<0.16	<-0.27

Initial Pile Leachate Volume (Gallons)



Leachate analyses

	April 2 to 15	April 16 to end
pH	7.2	8.5
Conductivity (Ec)	12,650	8,380
Nitrate-N mg/L	1.0	1.0
Ammonium-N mg/L	789	1,001
TKN mg/L	1,130	1,105
Phosphorus (P) mg/L	108	23
Potassium (K) mg/L	1,960	1,130

VOC and Ammonia Emissions

- Slight elevation of VOC and NH_3 with addition of carcasses to composting manure.
- Emissions are low compared to composting of green waste.

CSI – Tulare

Dr. Rob Moeller, Calif. Animal Health and Food Safety Lab
Paul Rossitto, UC VMTRC Dairy Food Safety Lab
Jim Sullins, UCCE Tulare
MF 246

Decomposed carcass after 17 weeks

September 2009

Deconstructing piles after 12 months.

Compost weighed in feed wagon with scale.

Remaining carcass tissue removed.

Cleaned to liner and then inspected beneath.

Weighing bones and remaining tissue

Finally finished!

Preliminary Results Summary

- Carcass decomposition
  - extensive after 4 months – 90 to 95%
- Temperature
  - Heating rapid and prolonged - exceeded Class A Biosolids (131° F)
- Pathogens
  - Salmonella, Bacillus, fecal coliforms, and E. coli in carcass region and leachate not detected after 6 -10 wks

Conclusion

- Composting is an effective method of carcass disposal during emergencies
- Experience with dairy manure from 25% to 70% moisture suggests that significant heating, pathogen reduction and decomposition can occur in less than ideal conditions
- Completed report will be helpful for policy makers to weigh risks vs. benefits of alternative disposal technologies