Analysis of Herbicide Detections and Use from 1996 - 2008

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Introduction – Presentation Objectives

- CA Herbicide Use 1996 – 2008
  - Trends in use data
- Herbicide Detections in Surface
  - 1997 – 2006
- Herbicide Detections vs. EPA Aquatic Benchmarks
- Herbicide Detections and Surface Water Regulations

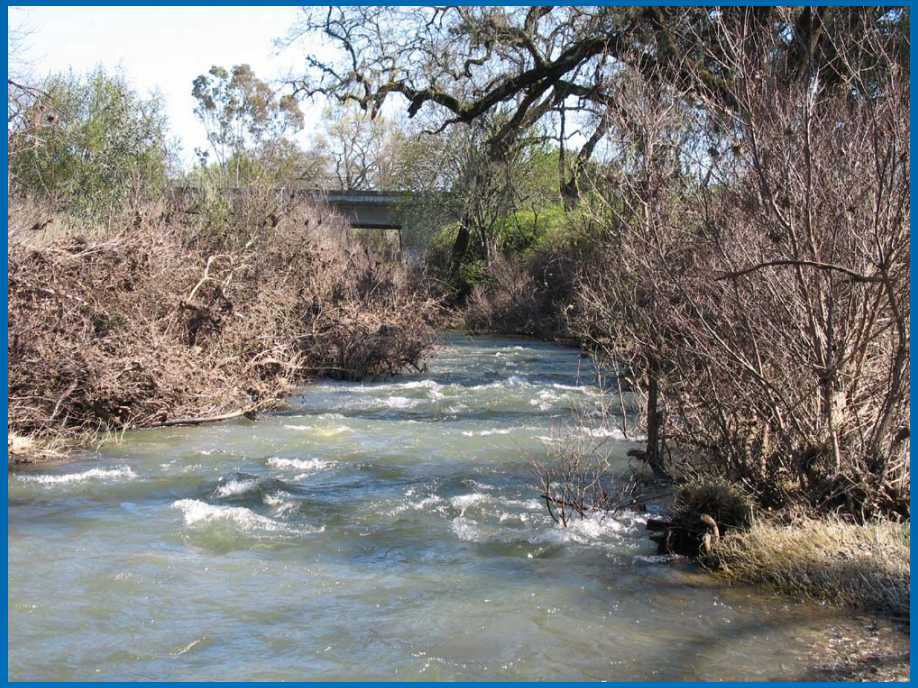
Introduction

- Part I. Herbicides in California - Use and Trends
  - DPR PUR database (http://www.cdpr.ca.gov/docs/pur/purmain.htm)
    - # 1 in world
    - Production Agricultural use
    - Non-production Ag use, commercial applicators
    - No home owner use

Photo: Kean Goh, DPR

Introduction

- Part II. What ends up in the environment?



Purpose, Part II

- Monitoring
- Herbicides in surface waters (Detections)
- Toxicity
- Surface Water Regulations

- DPR Surface Water Database (http://www.cdpr.ca.gov/docs/emon/surfwtr/surfdata.htm)

Herbicide Use in California

Herbicide Use in California

- Greater 15 million pounds a.i. herbicides applied in CA each year
  - ~ 75% - production agriculture use
- Glyphosate highest herbicide use
    - 283 products registered
    - ~40% of all herbicide use
- 10 herbicides > 500,000 lb a.i.
  - 14 herbicides > 100,000 lb a.i.

Herbicide Use in California – Top 10

Herbicide	2006 Use (Pounds a.i.)	Percent of State Total
Glyphosate	7,777,941	40.3%
Propanil	1,493,978	7.7%
Paraquat	1,144,220	5.9%
Diuron	1,051,245	5.4%
Trifluralin	1,041,805	5.4%
Oryzalin	912,715	4.7%
Oxyfluorfen	712,370	3.7%
Pendimethalin	714,755	3.7%
Simazine	635,486	3.3%
2,4-D	491,148	2.5%

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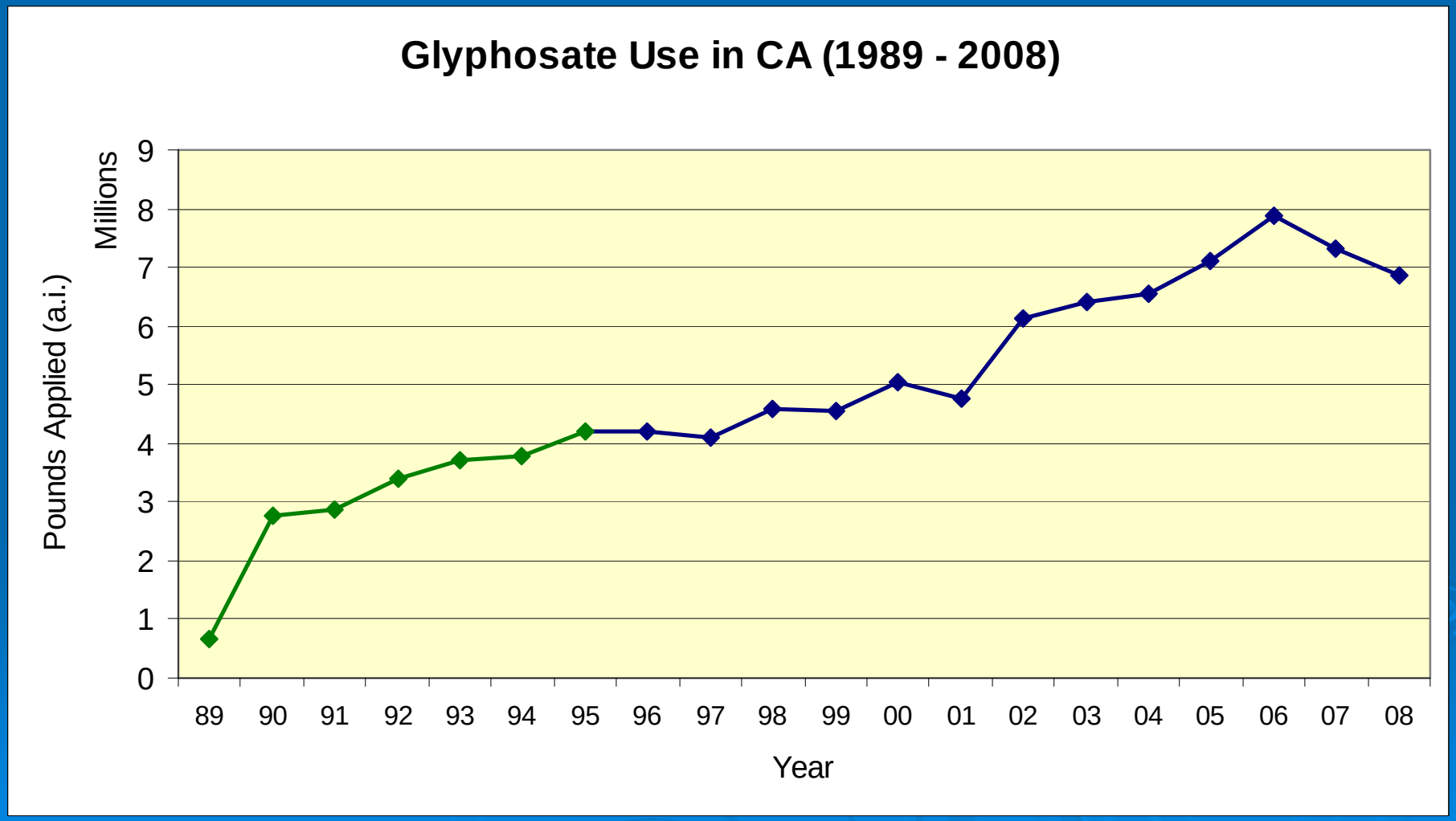
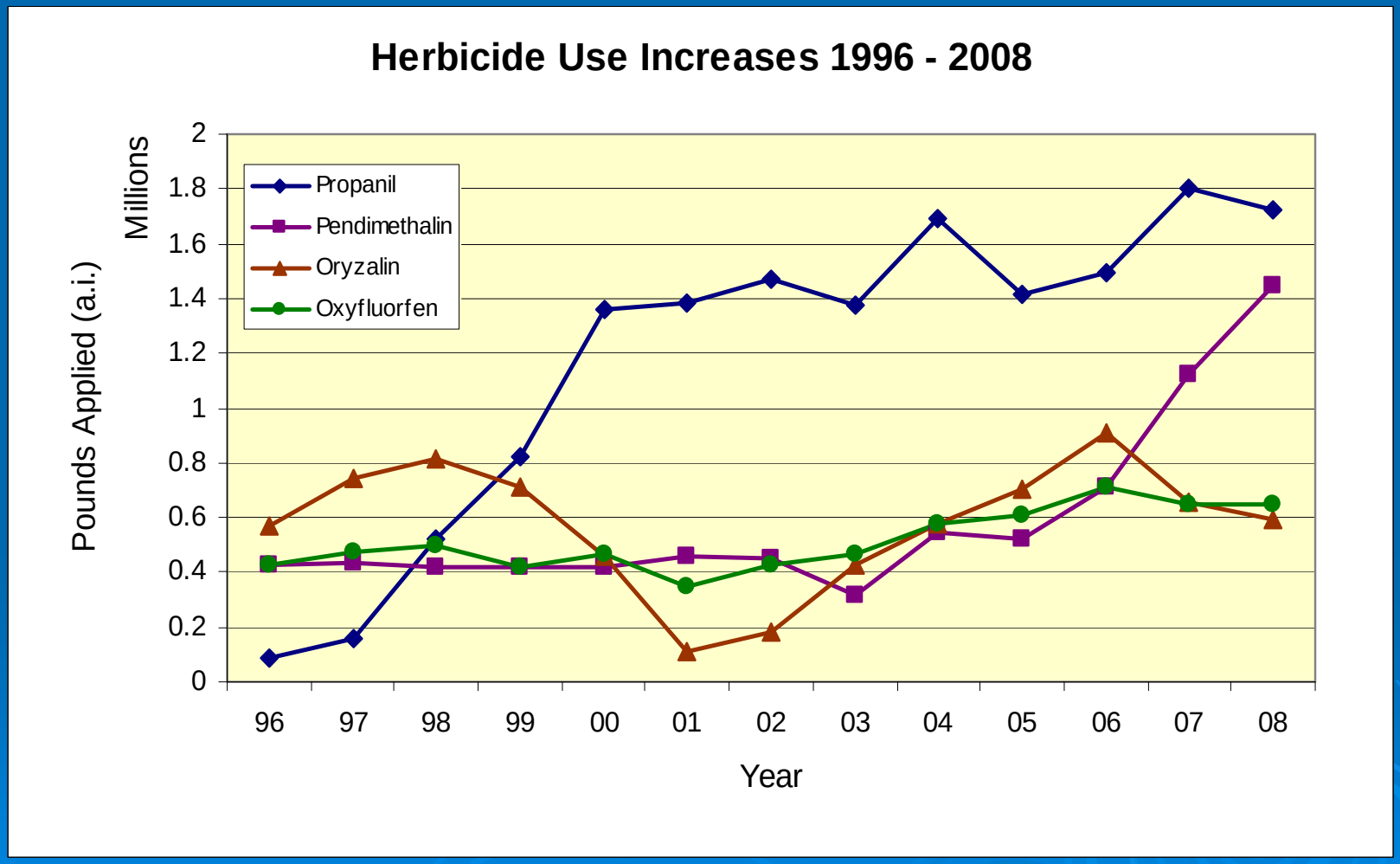
What are the trends in herbicide use?

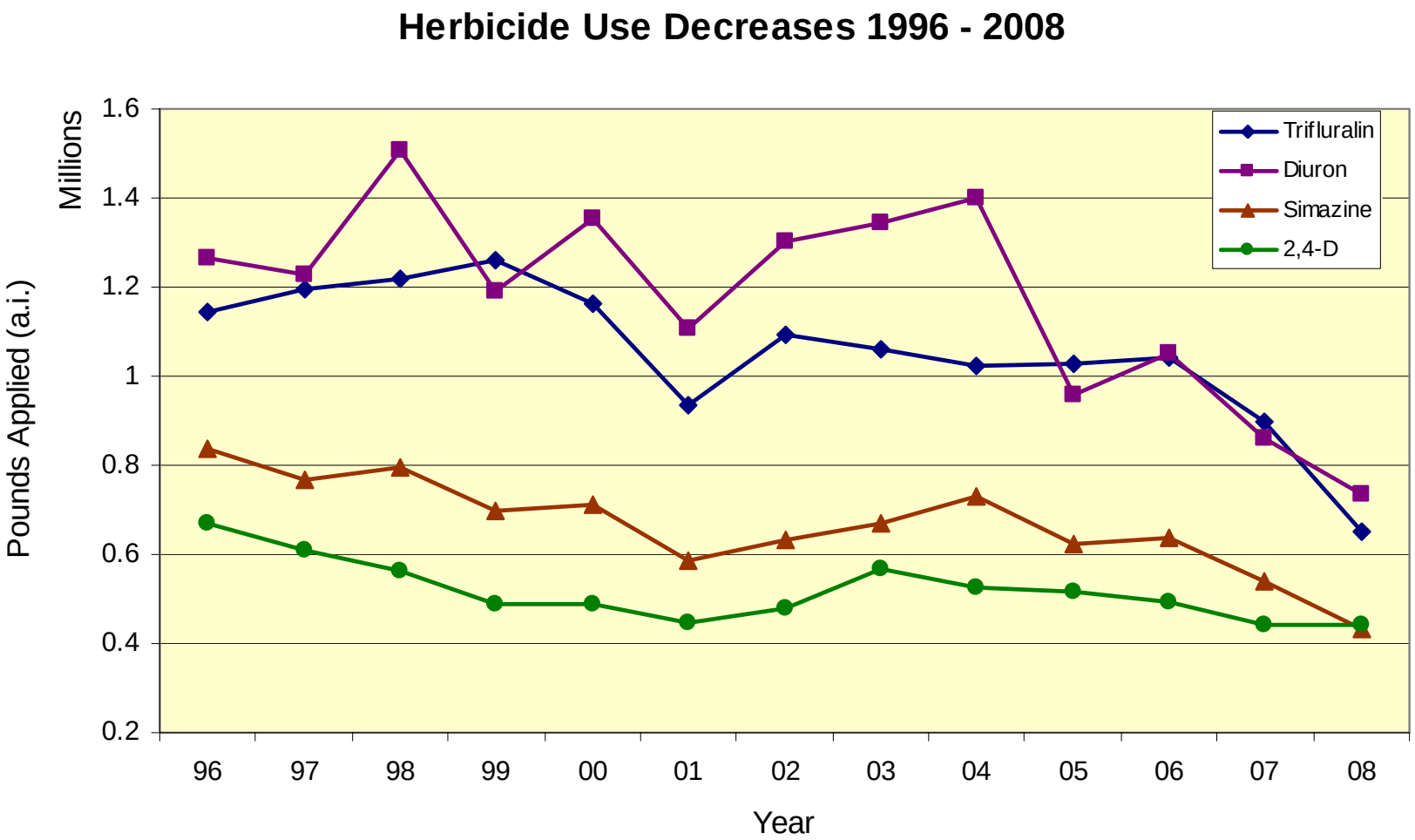
Herbicide Use in California



Herbicide Use - Increases



Herbicide Use - Decreases

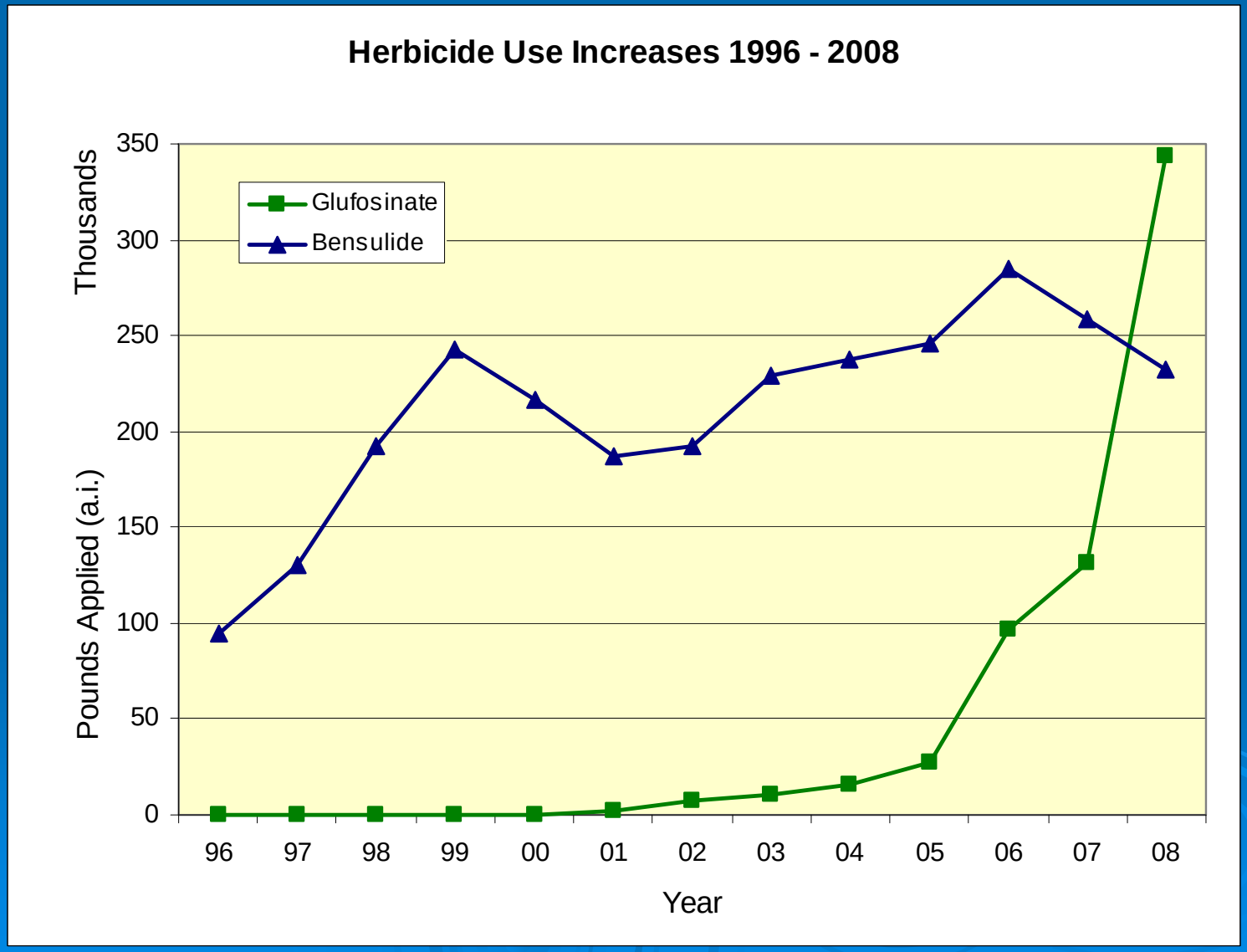


Paraquat use has remained fairly constant (2008 ↓)

Herbicide Use > 100,000 lb. a.i.

Herbicide	2006 Use (Pounds a.i.)
Metolachlor	360,180
Thiobencarb	308,497
Bensulide	284,533
Acrolein	246,659
DCPA	241,294
MCPA	193,659
Triclopyr	147,485
Molinate	141,421
Pronamide	120,804
Hexazinone	115,624
EPTC	108,209
Norflurazon	107,763
Prometryn	103,139
Glufosinate	96,830

Herbicide Use - Increases



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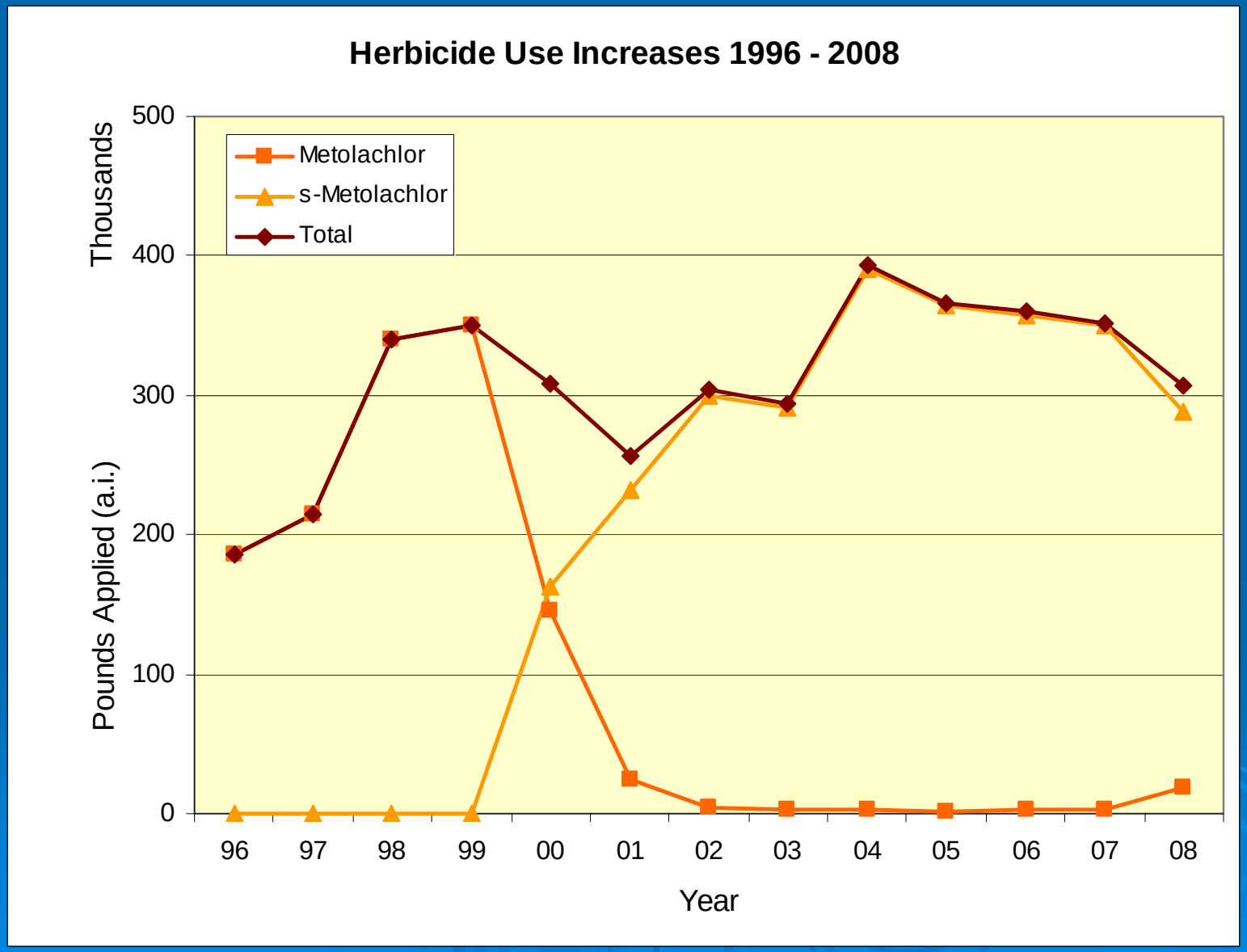

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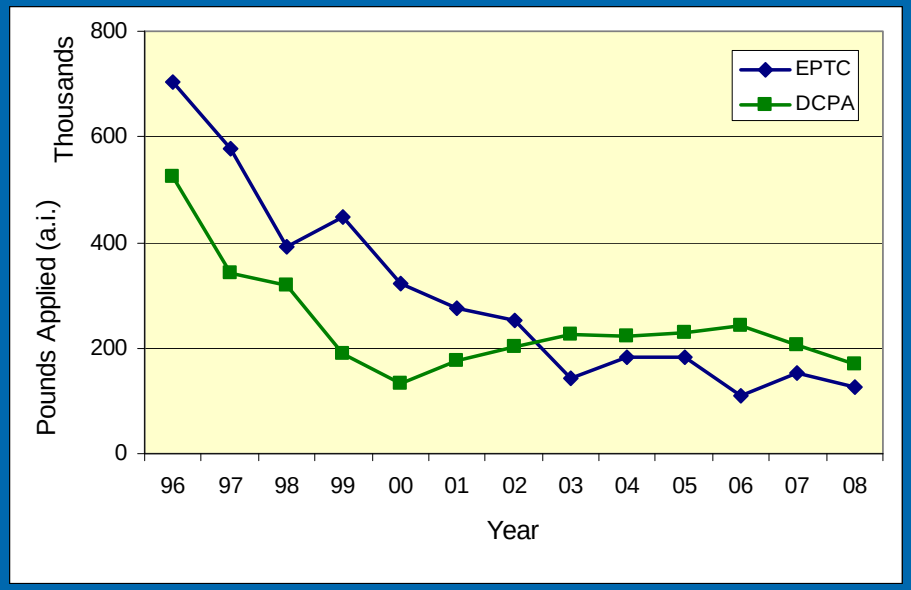
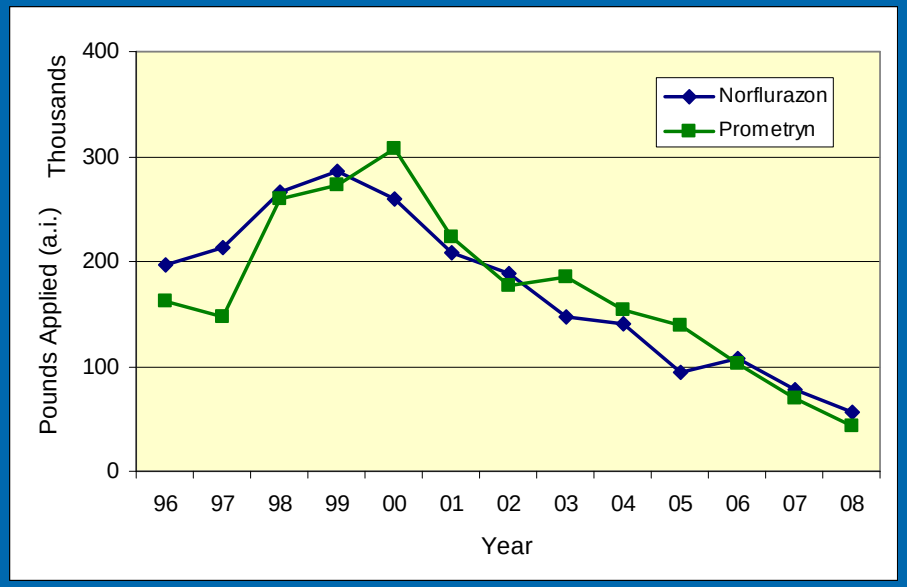
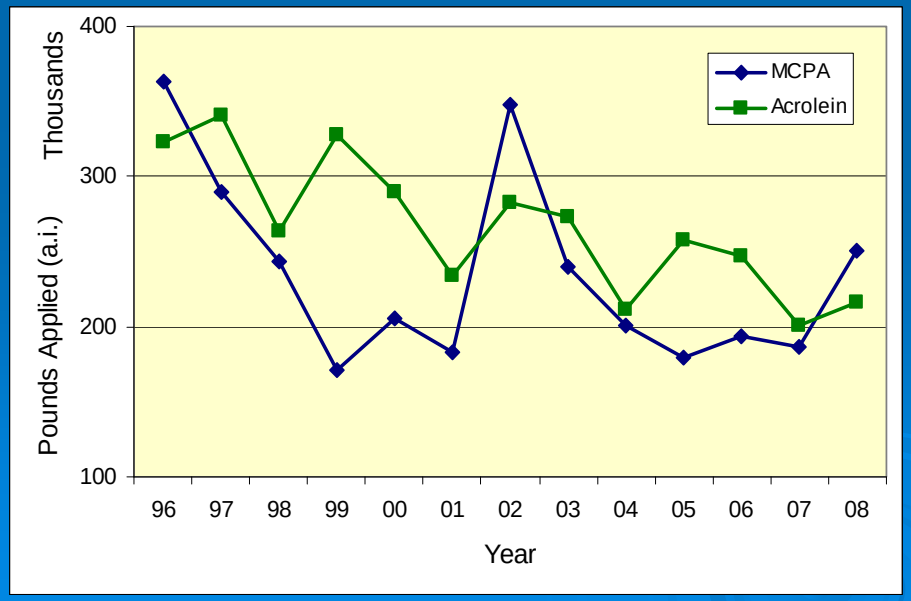
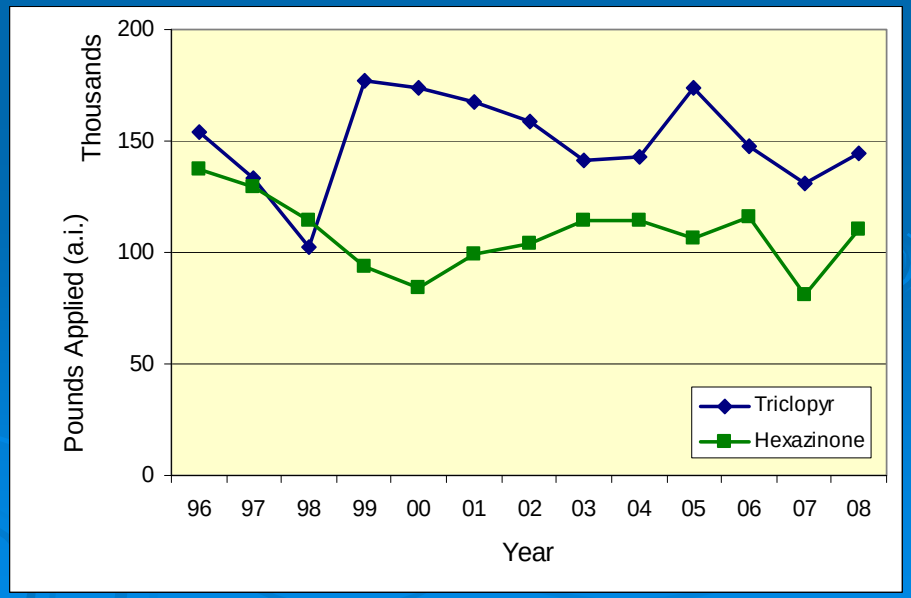
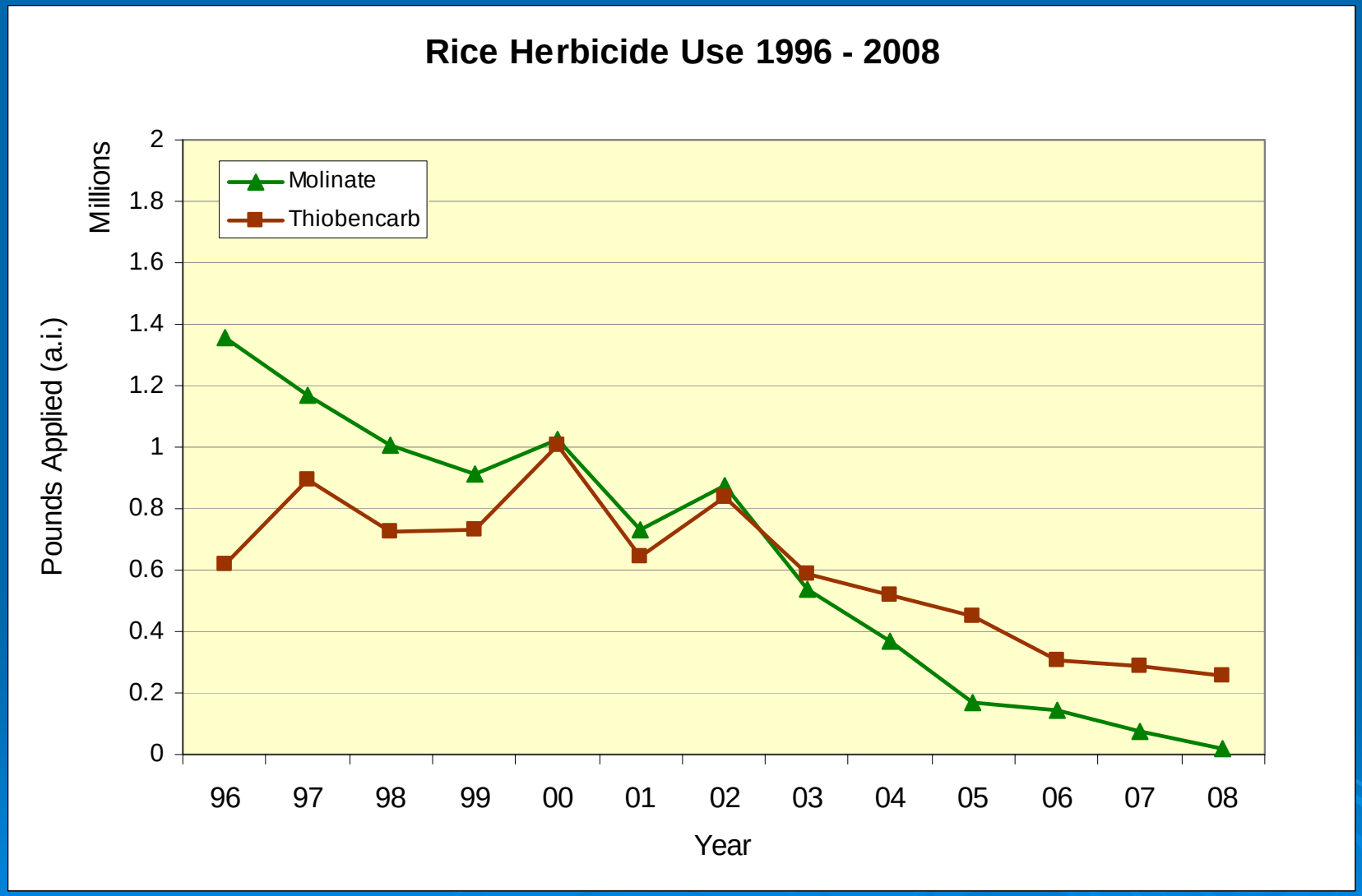








Herbicide Use – Rice Herbicide



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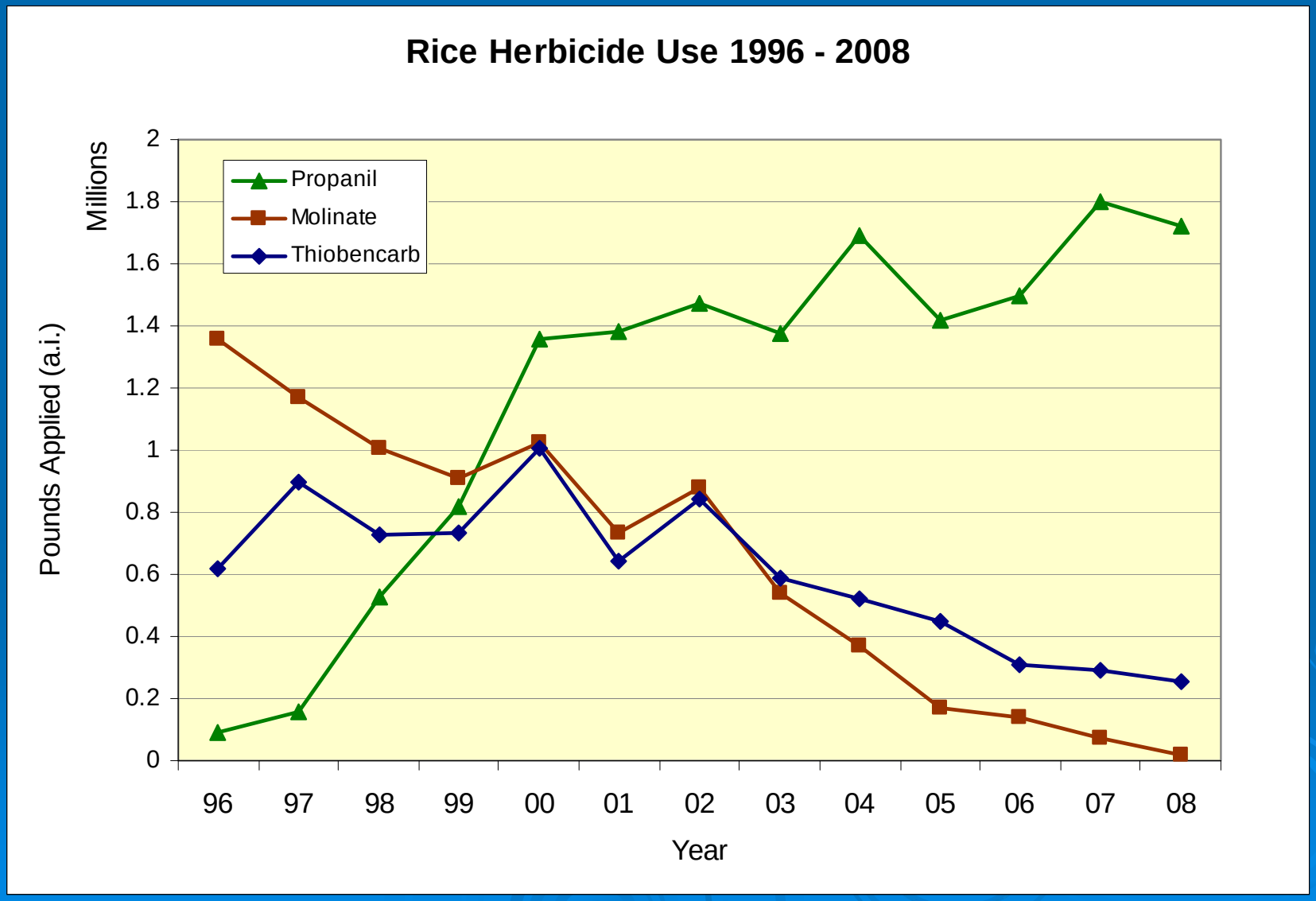


Part II. Herbicide Monitoring and Detections

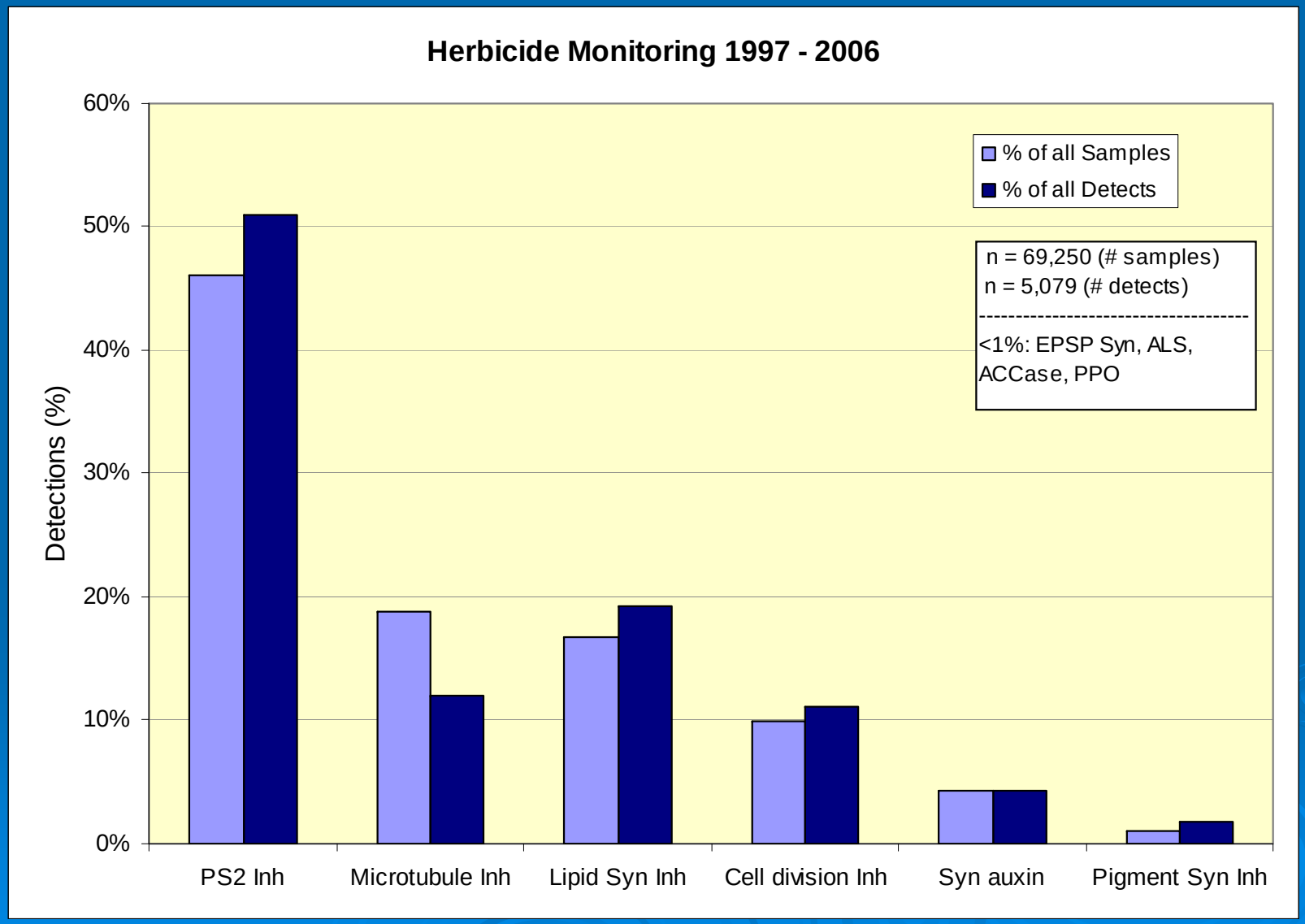
- Environmental Monitoring
  - DPR – EM Branch
    - "monitors the environment to determine the fate of pesticides"
    - "protects the public/environment from pesticide contamination"
  - Many others
    - U.S Geological Survey (USGS)
    - California State Water Quality Board
    - Central Valley Regional Water Quality Board
    - *et al.*

Part II. Herbicide Monitoring and Detections

- Maintained by EM branch DPR
- 1990 - 2006
- 54 different studies
  - 1997 – 2006
  - 83 herbicides monitored, 46 detected

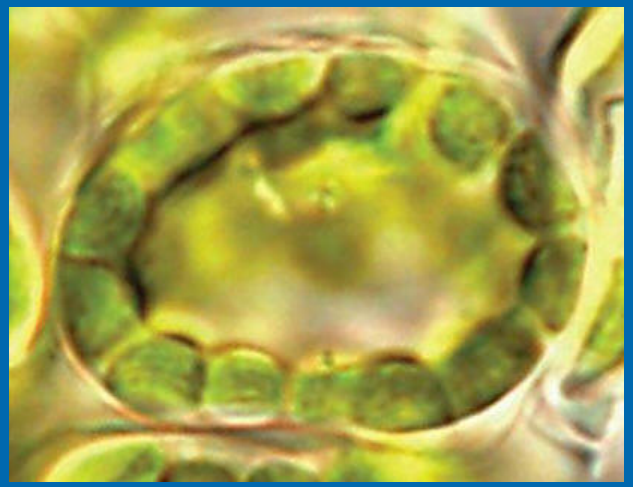
Surface water database: http://www.cdpr.ca.gov/docs/emon/surfwtr/surfdata.htm

Herbicide Monitoring Results



HRAC, http://www.hracglobal.com/

Photosynthetic Inhibitor Herbicides



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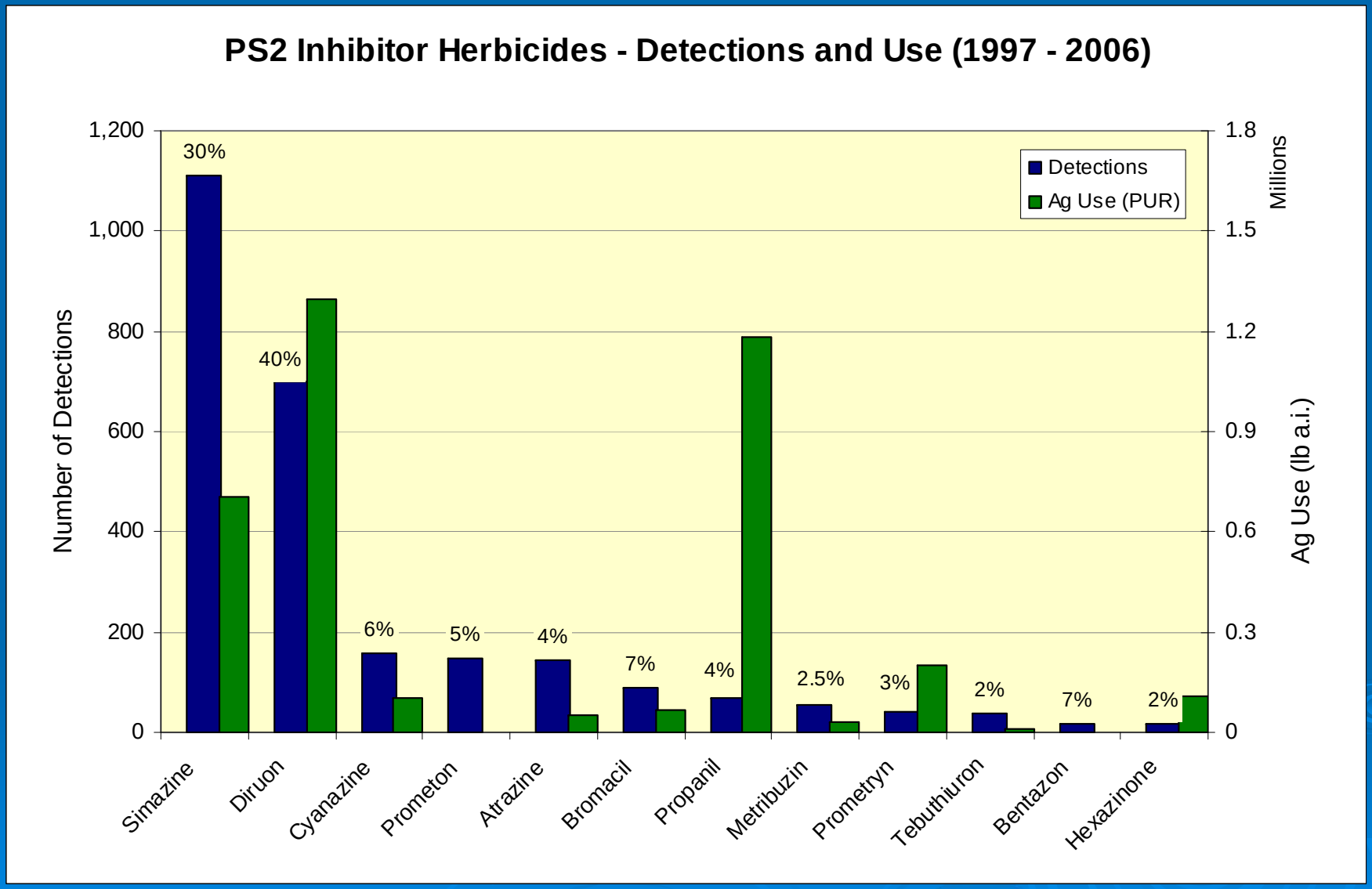
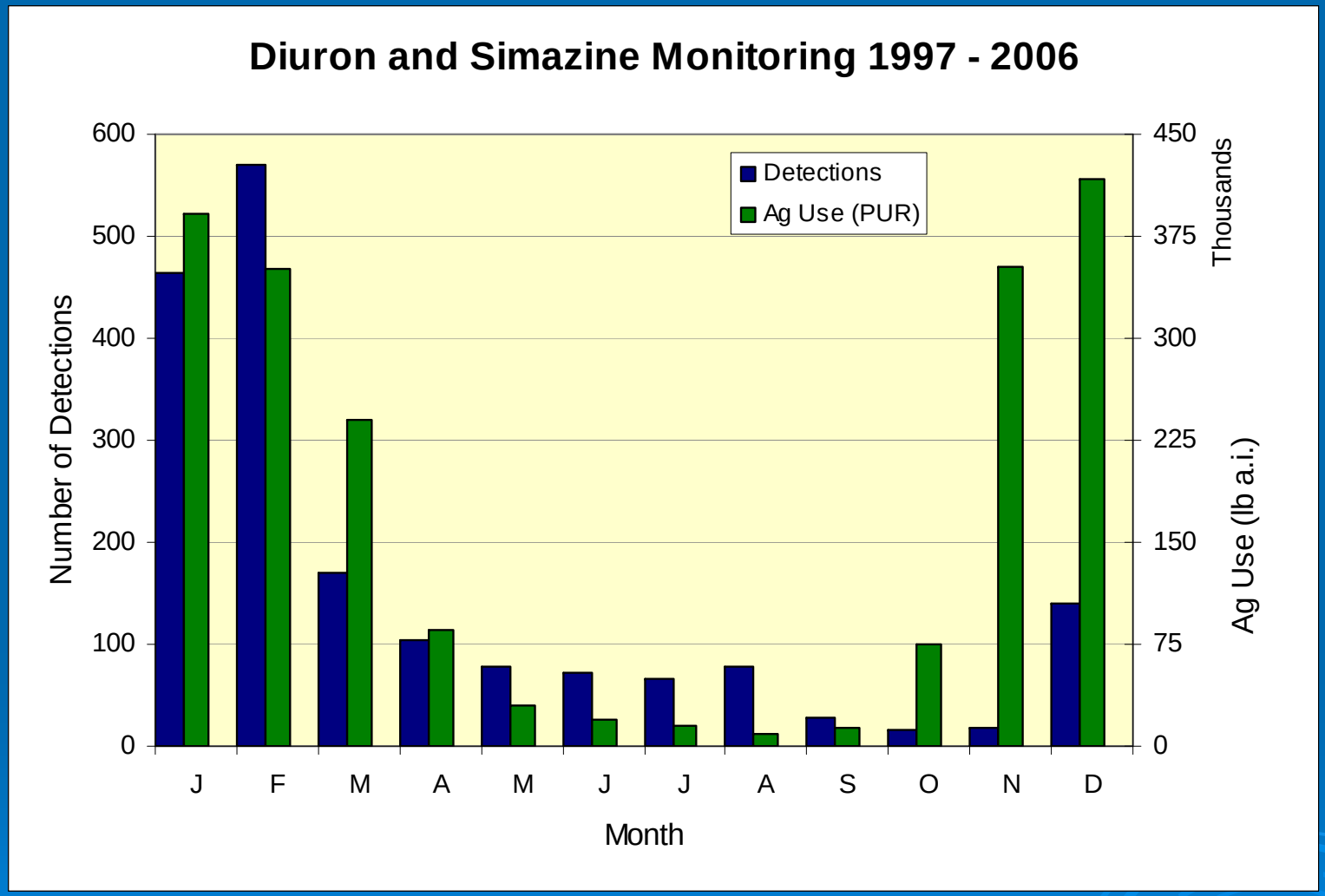


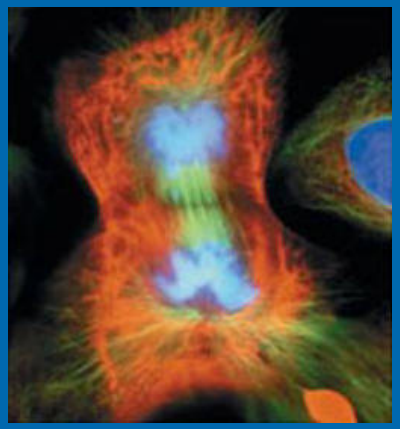
- Simazine, diuron have most detections in California surface waters.

Photosynthetic Inhibitor Herbicides



- Most detections in the winter months (rainy season) …and follow Ag use patterns

Microtubule Inhibitor Herbicides



N.A. Campbell, J.B. Reese, M.R. Taylor, E.J. Simon, J.L. Dickey. Biology, Concepts and Connections, 6th ed. San Francisco: Pearson, 2009.

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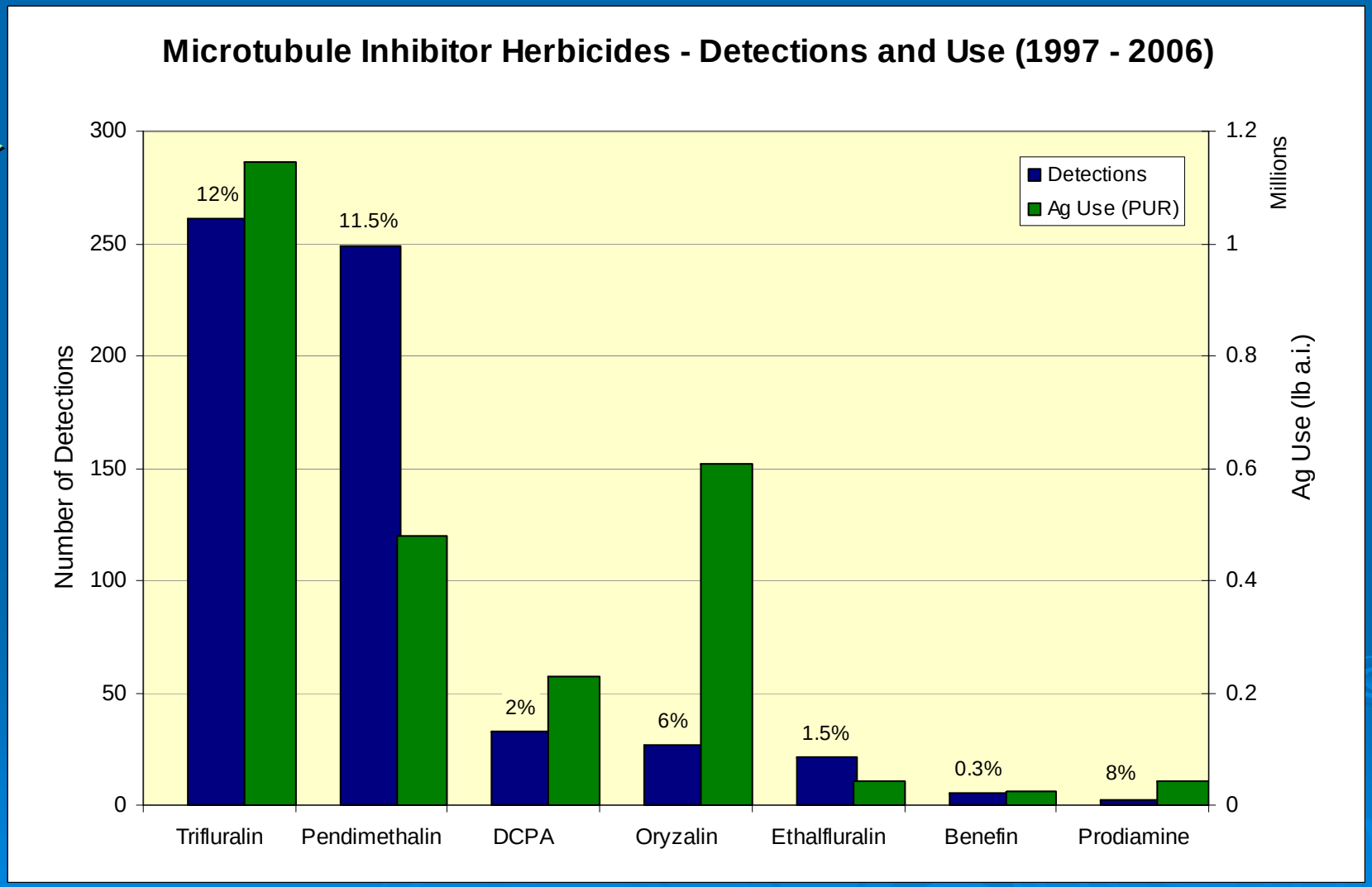

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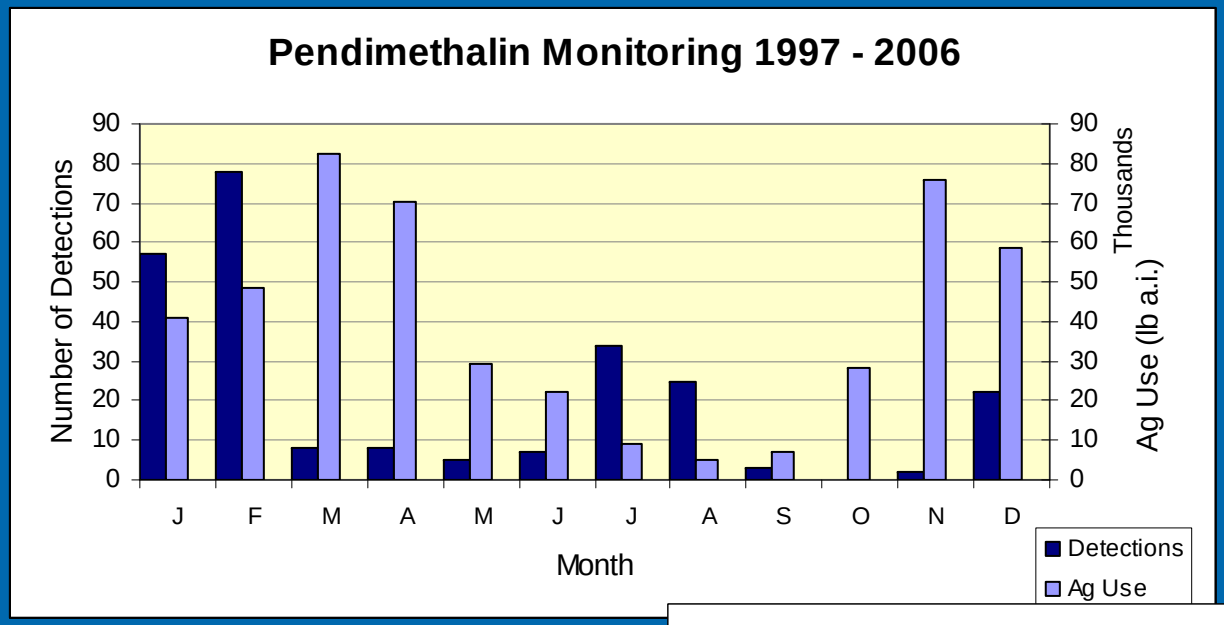
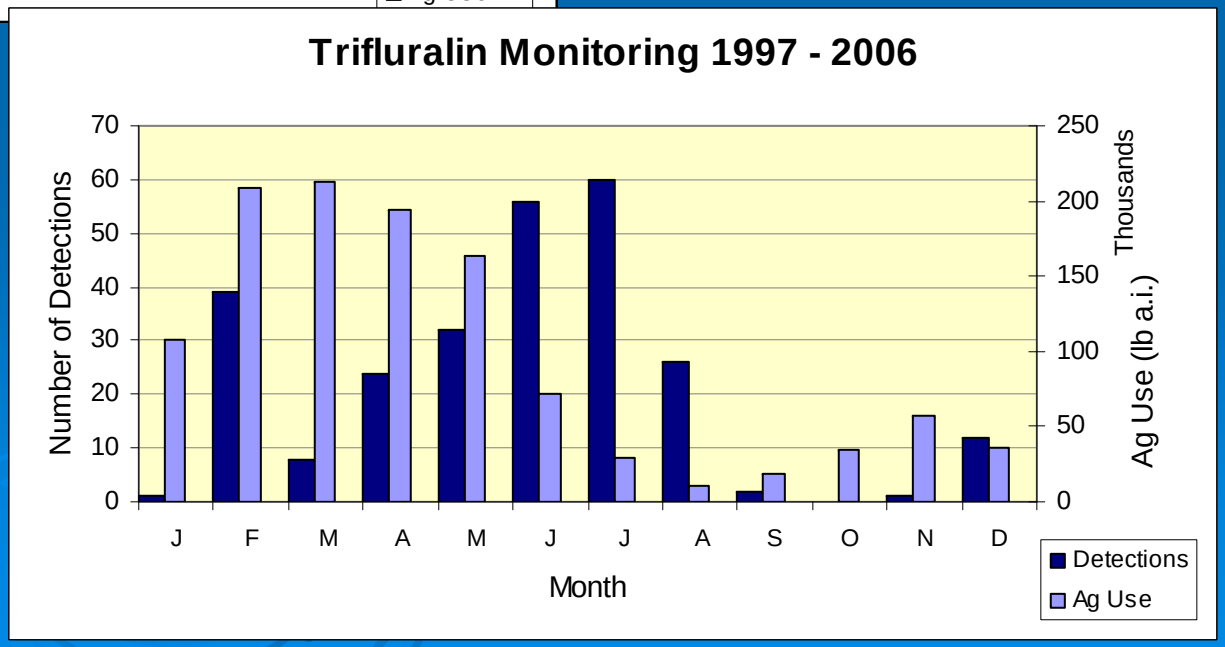
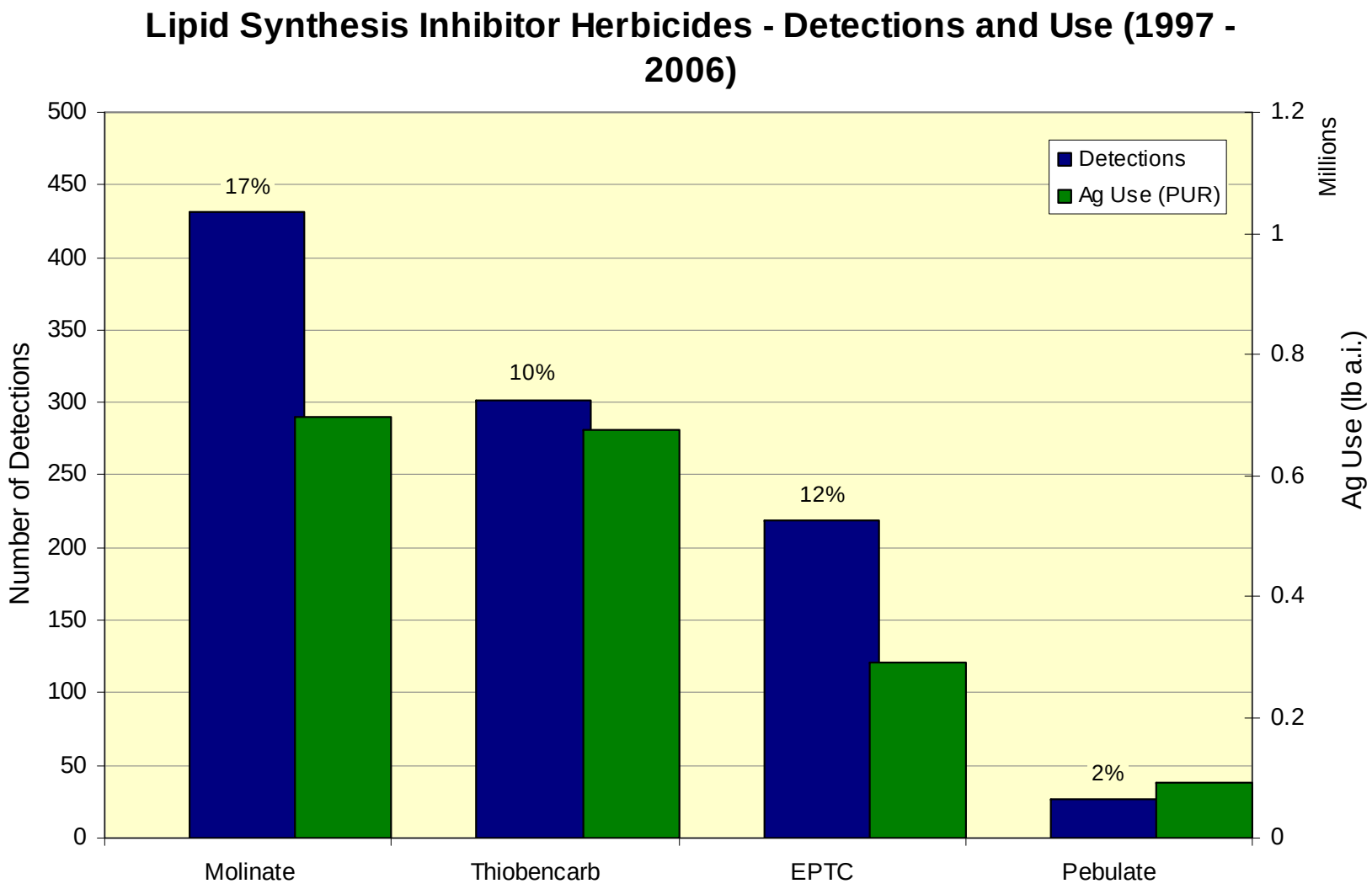


- Pendimethalin and trifluarlin have different detecion patterns.



Lipid Synthesis Inhibitor Herbicides



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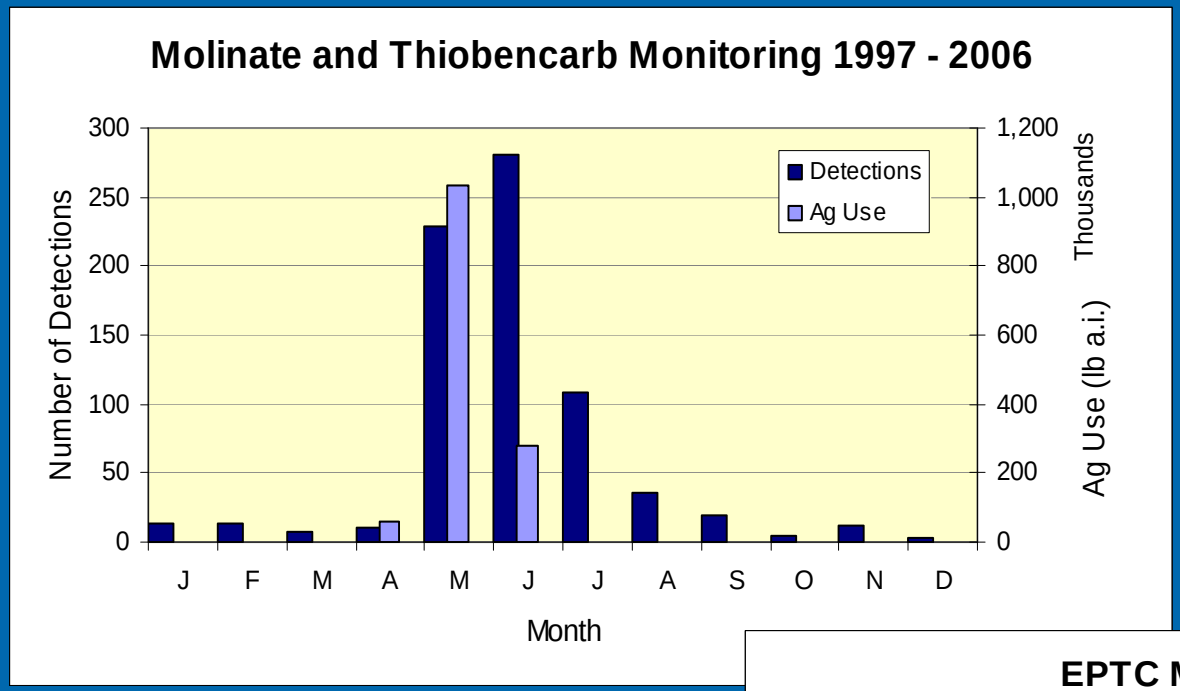
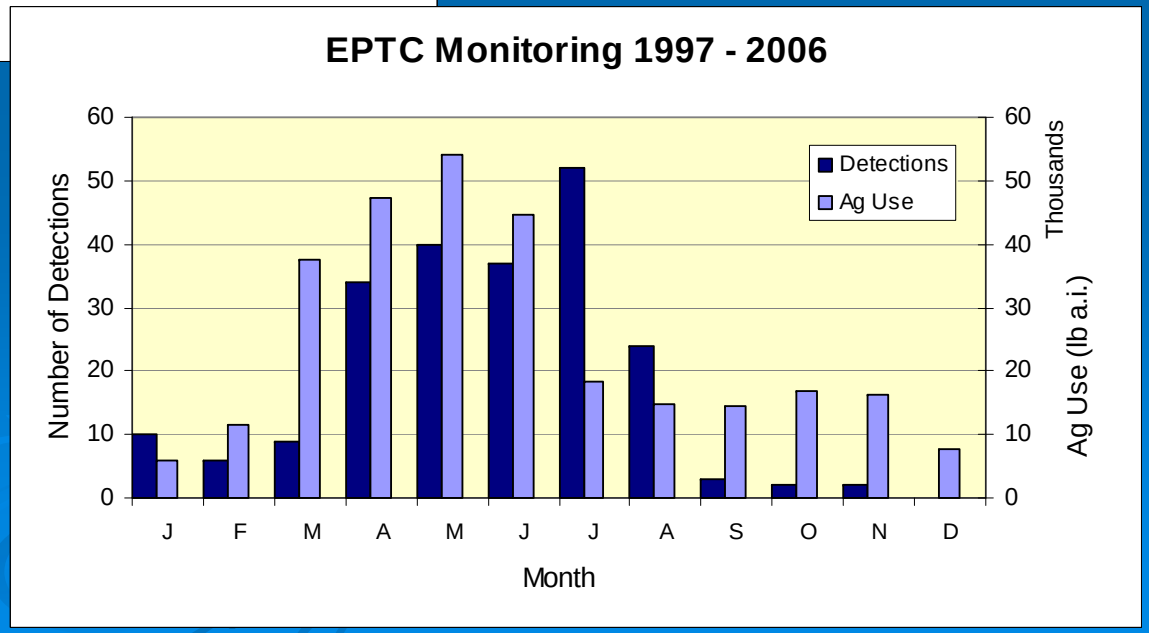
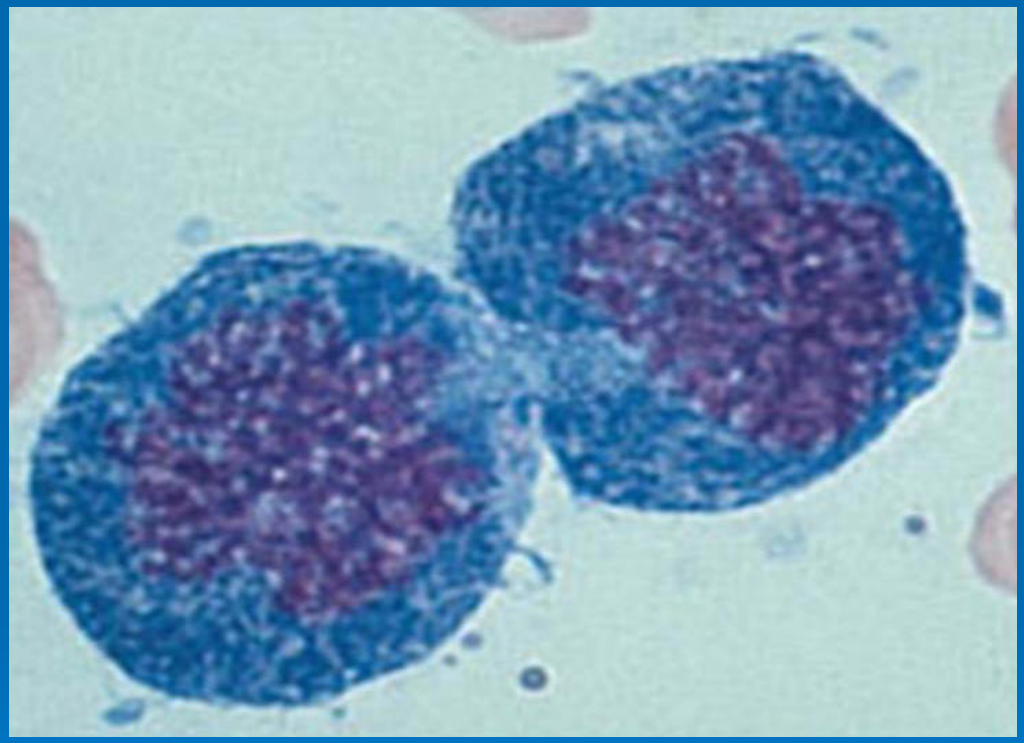


- Detections follow use patterns



Cell Division Inhibitor Herbicides



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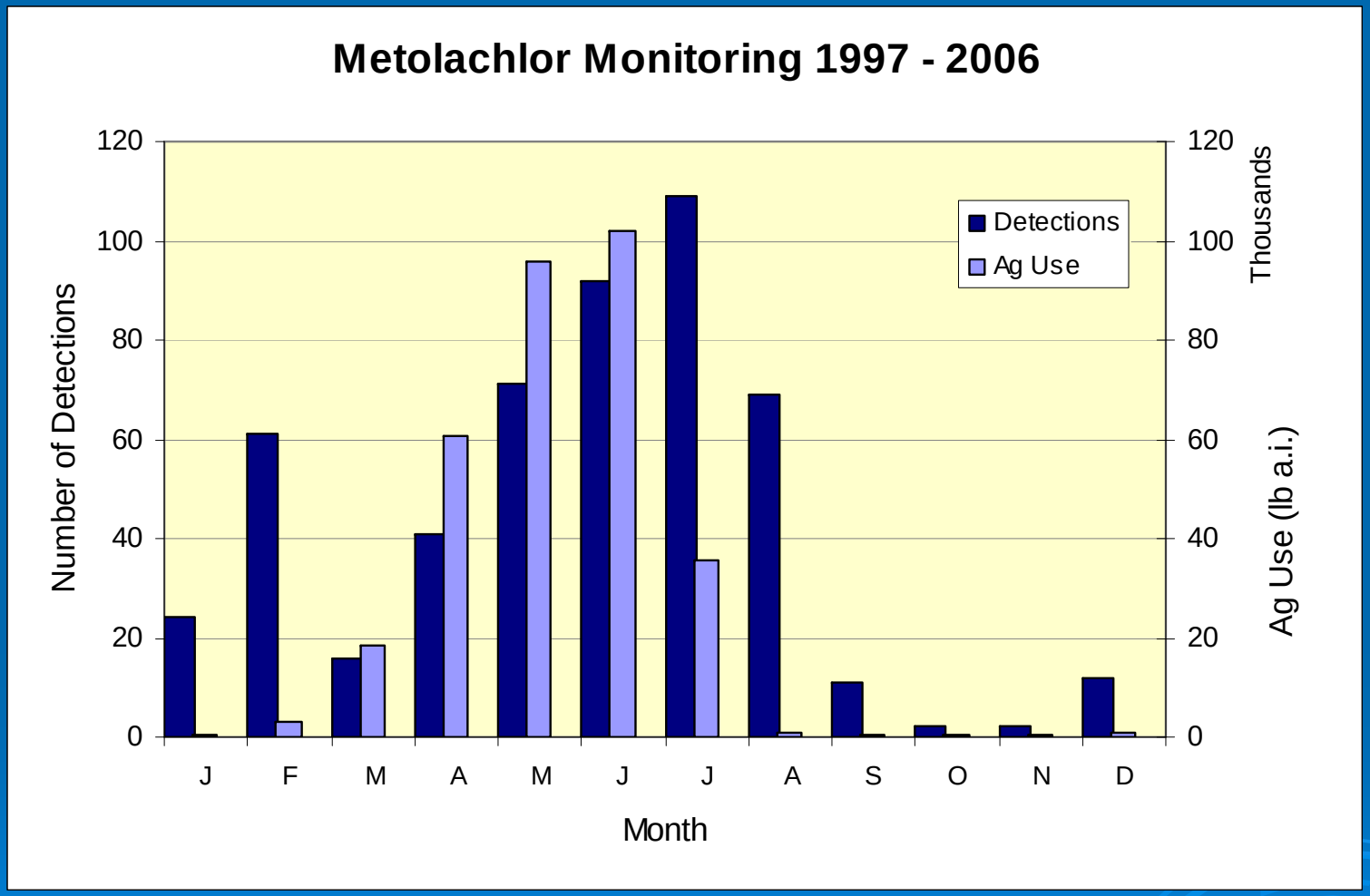

Metolochlor: overall detection rate: 29%

Irrigation season use matches detections, but not rainy season detections.

Synthetic Auxins

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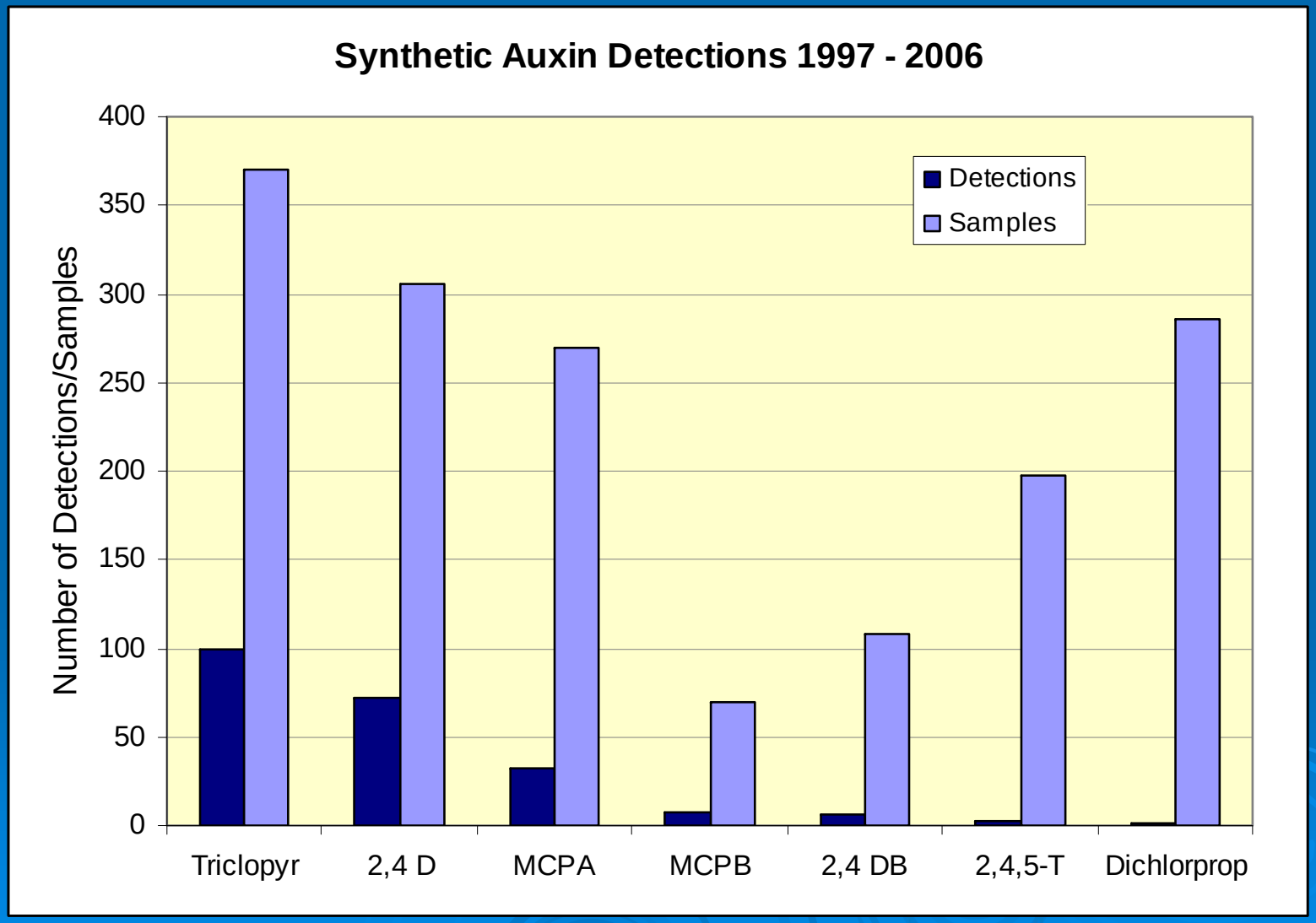
Synthetic Auxins



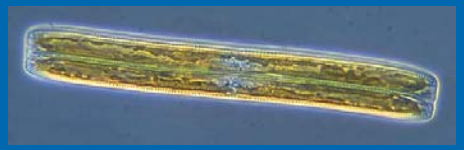
Why the Fuss? - Phytoplankton

- Herbicides in surface waters may affect producers (Sommer *et al*., 2007)

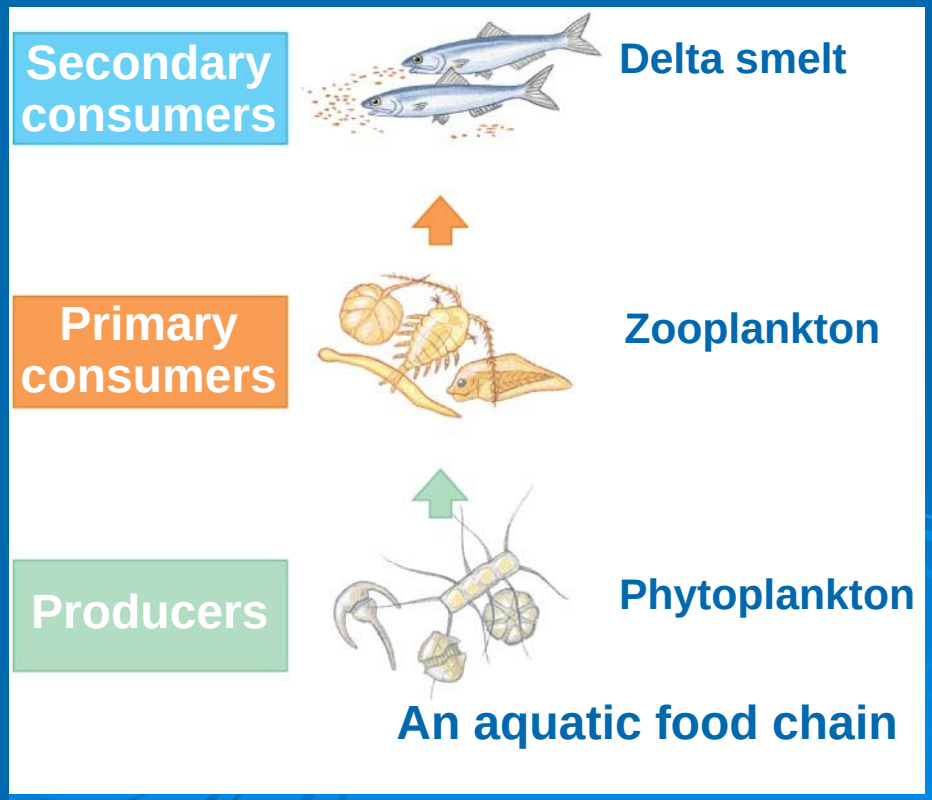
Euglenozoans

Dinoflagellates

Green algae



Diatoms



Why the Fuss?

- Office of Pesticide Programs (OPP), EPA, sets aquatic benchmarks
  - Toxicity values reviewed by EPA
  - OPP uses aquatic toxicity data in ecological risk assessments
  - Establish water quality standards under the Clean Water Act
  - Use to prioritize pesticides that need further investigation

Why the Fuss? – Detections > Benchmark

Herbicide	Benchmark (ppb)	Detections > Benchmark
Thiobencarb	1.0	142
Diuron	2.4	63
Metolachlor	1.0	19
Simazine	36	5
Oryzalin	15.4	4
Oxyfluorfen	0.29	3
Bromacil	6.8	2
Atrazine	1.0	1

Conclusions – Herbicide Use

- > 15 million lb a.i. annually
- Glyphosate has highest use (~40%)
  - Use has increased 1996 – 2007 (4 to 7 MY lb)
  - Use may be leveling off (2008)
- Herbicides > 1 MY lb
  - Propanil, pendimethalin

Conclusions – Herbicide Use

- Herbicides – use increasing

  ↑↑ Propanil, glufosinate, bensulide, pendimethalin

  ↑ Oxyfluorfen

- Herbicides – use decreasing

  ↓↓ DCPA, EPTC, norflurazon, prometryne, trifluralin, diuron, molinate, thiobencarb

  ↓ 2,4-D, acrolein

Conclusions – Herbicide Detections

- Diuron, simazine, metolachlor
  - Most detections in surface waters (30 – 40%)
  - Frequent detections above EPA aquatic benchmarks

Conclusions – Herbicide Detections

- Thiobencarb, EPTC, trifluralin, pendimethalin, molinate
  - Moderate detection rate (10 - 17%)
  - Thiobencarb - detections above EPA aquatic benchmarks
    - Propanil: high use, fewer detections than other rice herbicides (4.3%)

Conclusions – Herbicide Detections

- Synthetic auxins - 2,4-D and triclopyr
  - High detection rate (25%)
  - Detected below aquatic benchmarks
- Few glyphosate detections (3%)
  - All below EPA aquatic benchmarks

Conclusions – Herbicide Detections

- Surface Water Regulations
  - Draft regulatory concept
  - Prevent or reduce surface water contamination
  - Workshops Feb 11, Mar 26, Apr 28, May 11
  - http://www.cdpr.ca.gov/docs/emon/surfwtr/regulatory.htm