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Pesticides in Surface Waters of the Pacific Northwest—Overview of USGS Regional Findings

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U.S. Department of the Interior
U.S. Geological Survey

Outline

- Background
- Observed Pesticide Concentrations
  - General magnitude and range
  - Compliance with Standards or Criteria, Toxicity
  - Mixtures
- Patterns in what we detect
  - Pesticides commonly detected & general frequency
- Perceived causes of observed patterns
  - Role of hydrology
  - Associations with land use
  - Pesticide Use
- Some Remaining Issues

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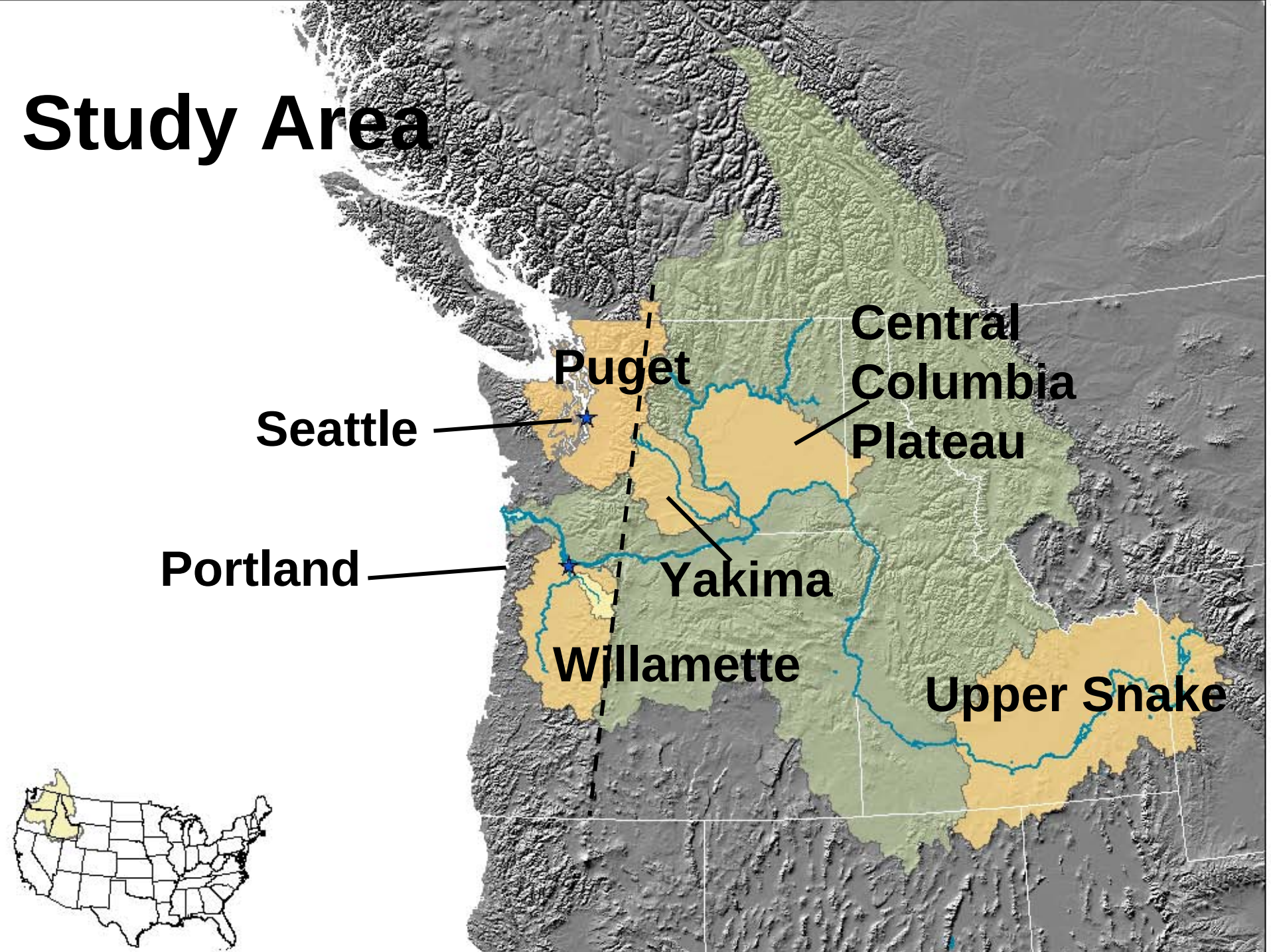
Study Area


Puget
Central
Columbia
Plateau
Seattle
Portland
Yakima
Willamette
Upper Snake

Concentrations and Compliance with Water Quality Criteria

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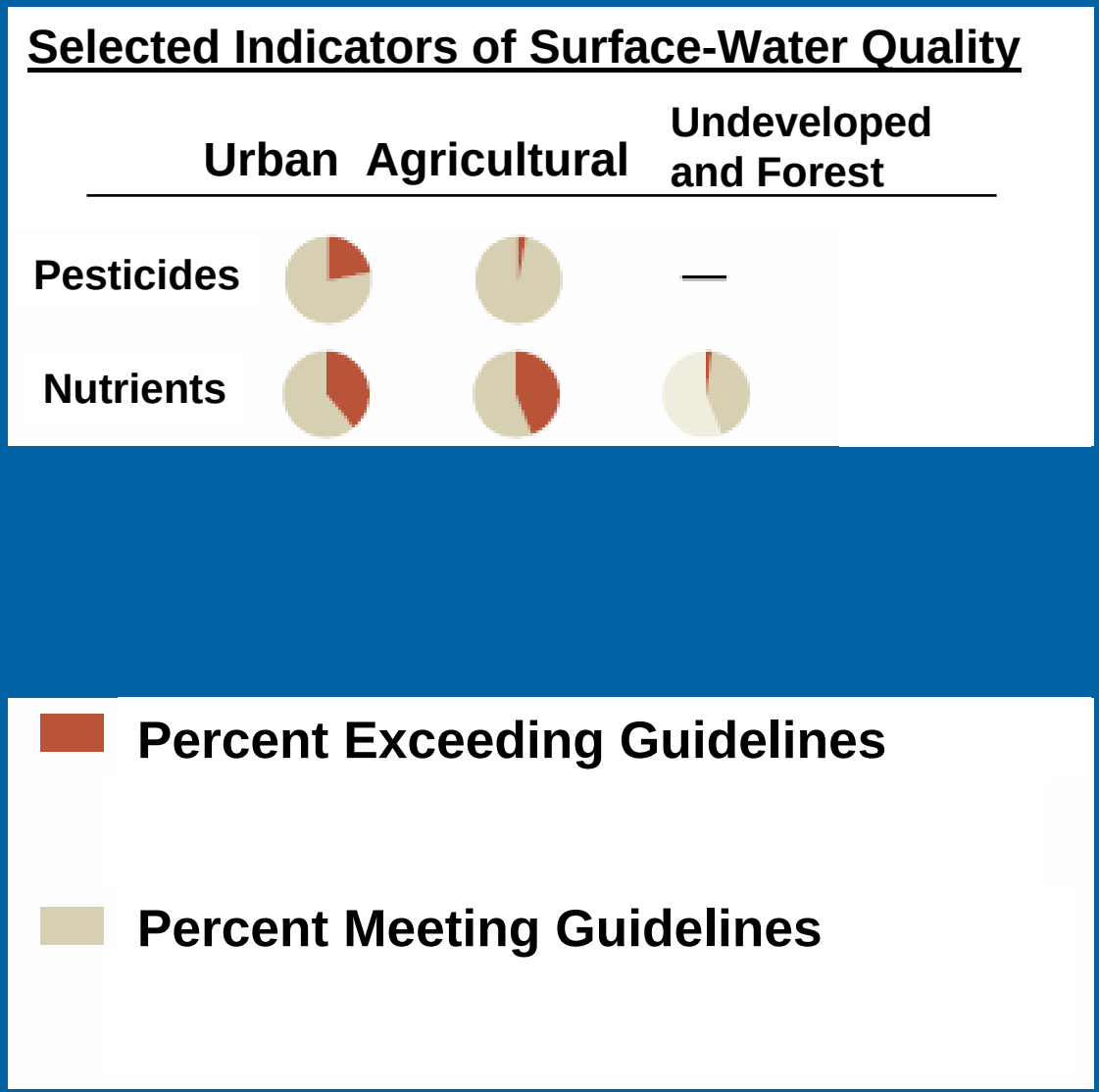
Compliance With Water Quality Criteria

Puget Sound Basins – Urban and Ag. effects



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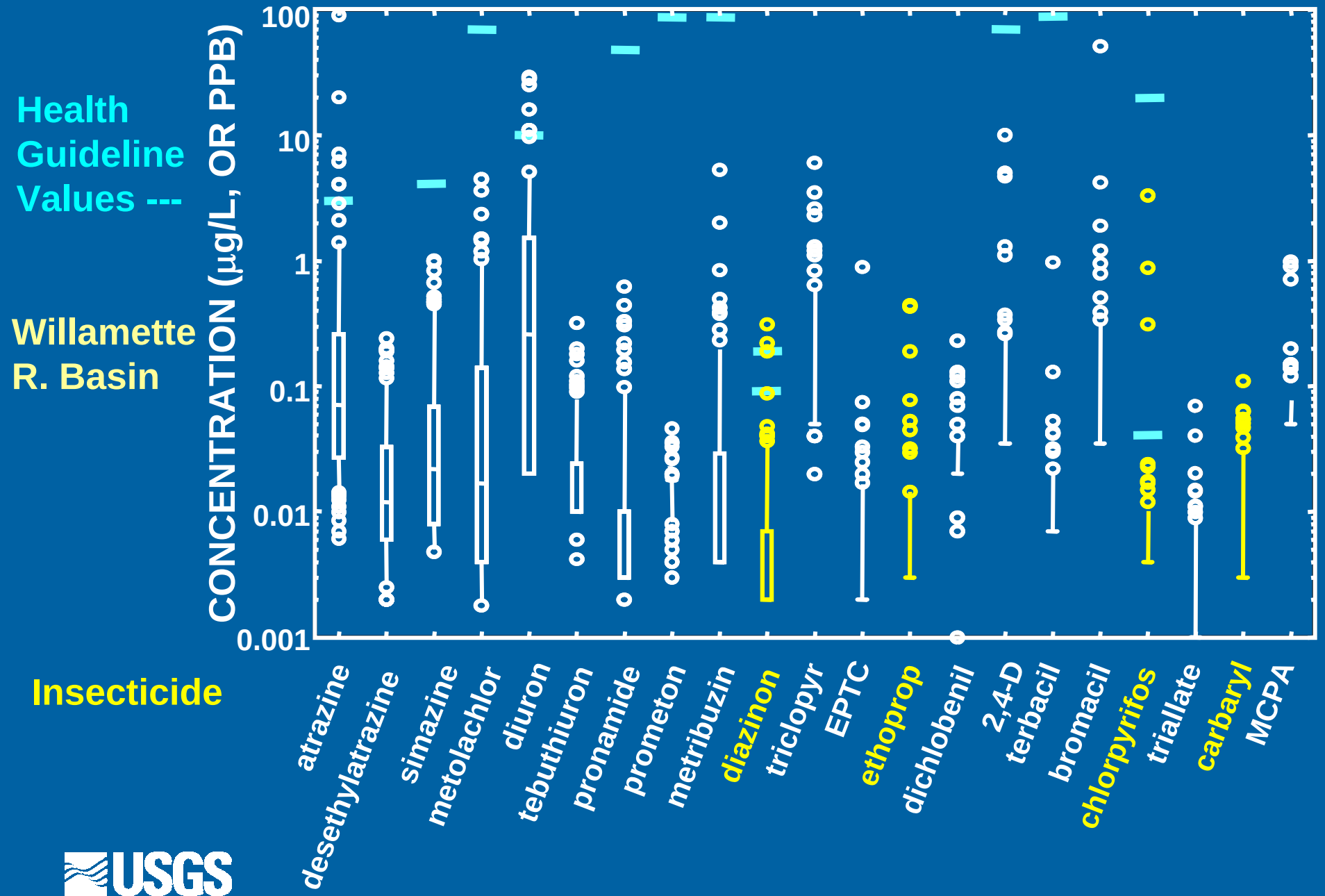
Ebbert and others, 2000 (Puget Sound)

Concentrations usually low, but peaks can be high



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Anderson and others, 1997 (Willamette River Basin)

Patterns in Pesticide Detections

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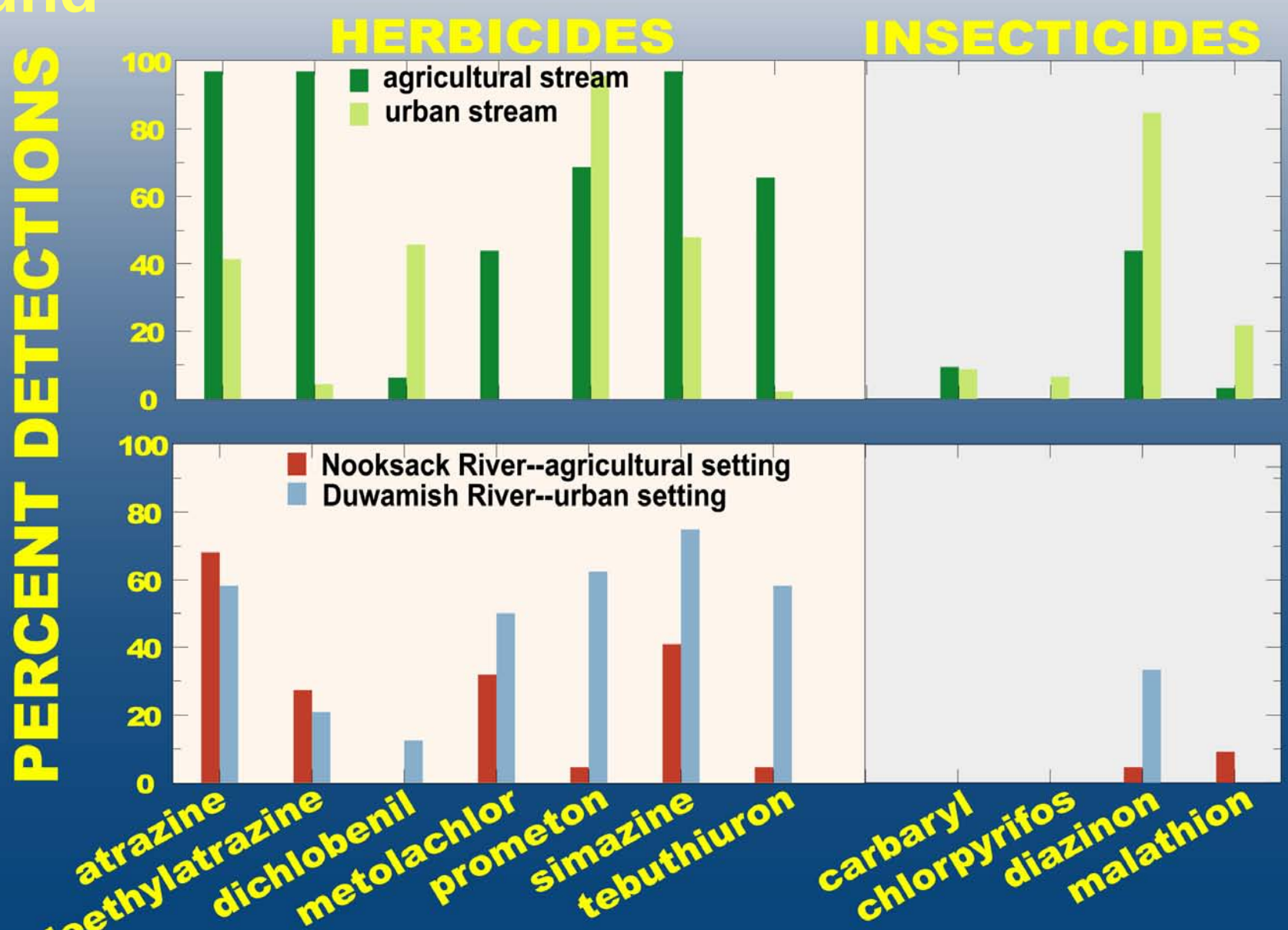
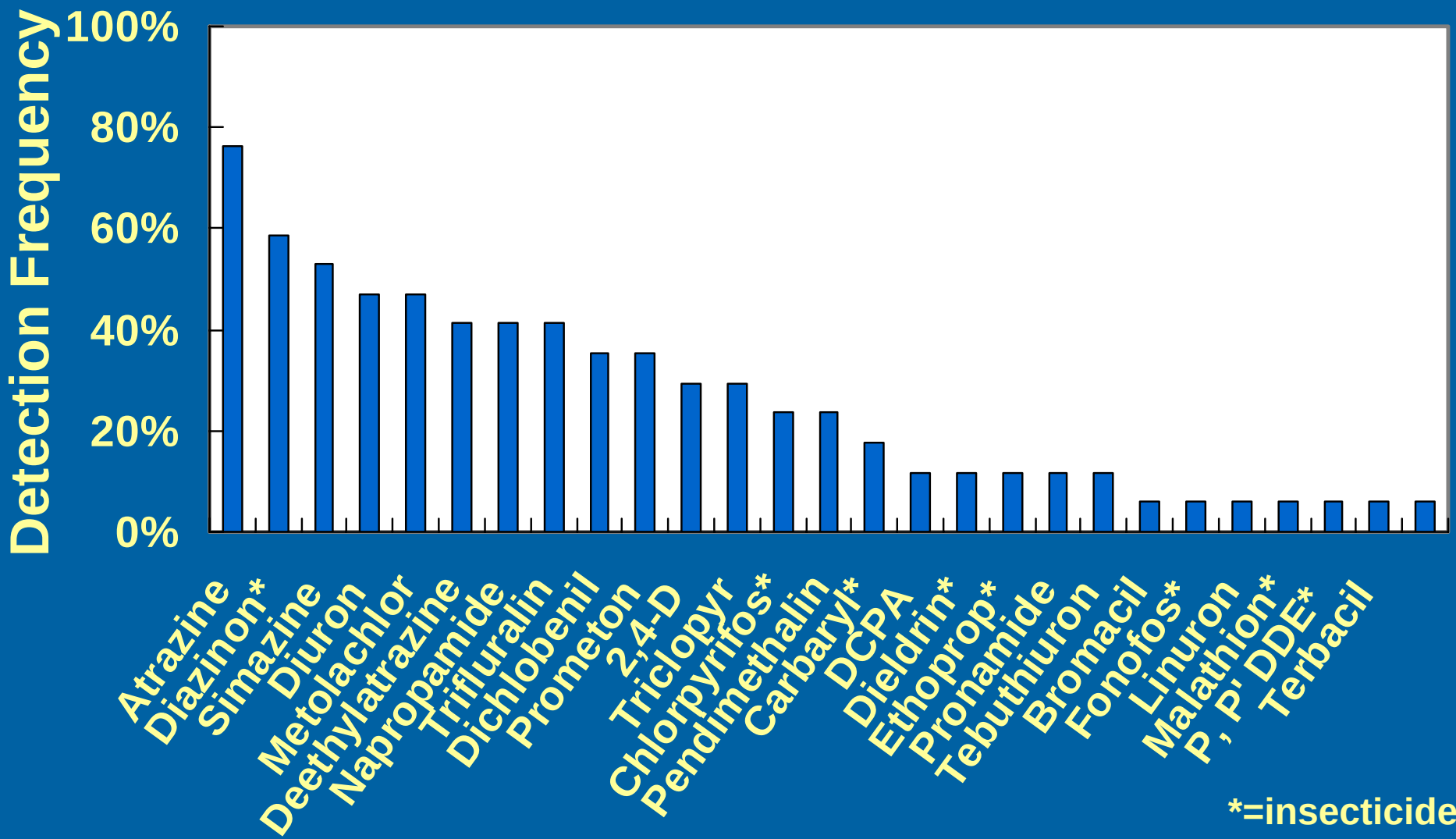
Puget Sound

PESTICIDES IN SURFACE WATER



Ebbert and others, 2004 (Puget Sound)

Detection Frequency – Clackamas River Basin



*=insecticide

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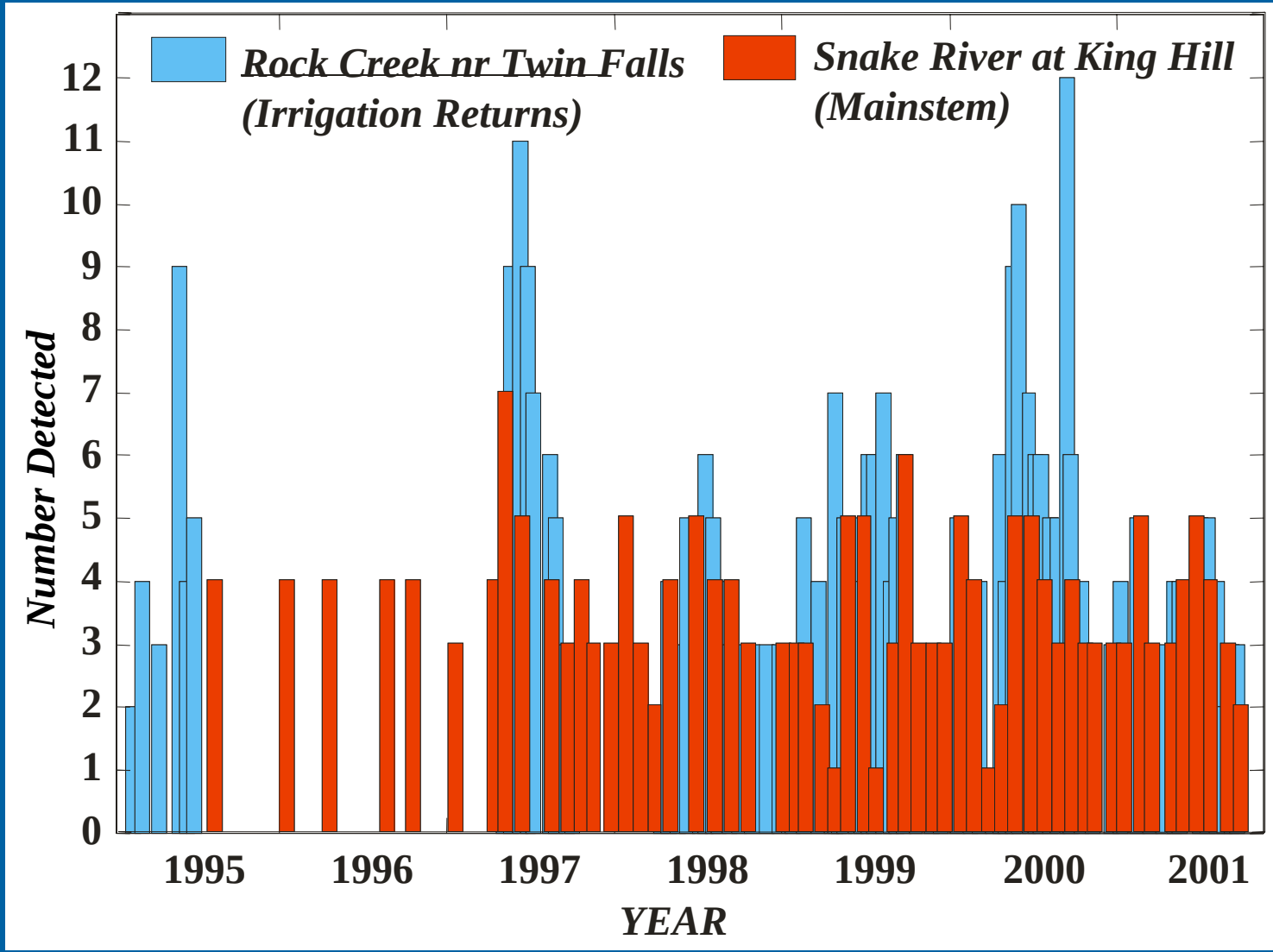
Carpenter, 2003

Pesticides in the Upper Snake River Basin



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Clark and others, 1998

Perceived Causes of Observed Patterns

- Hydrology
- Land Use
- Pesticide Use

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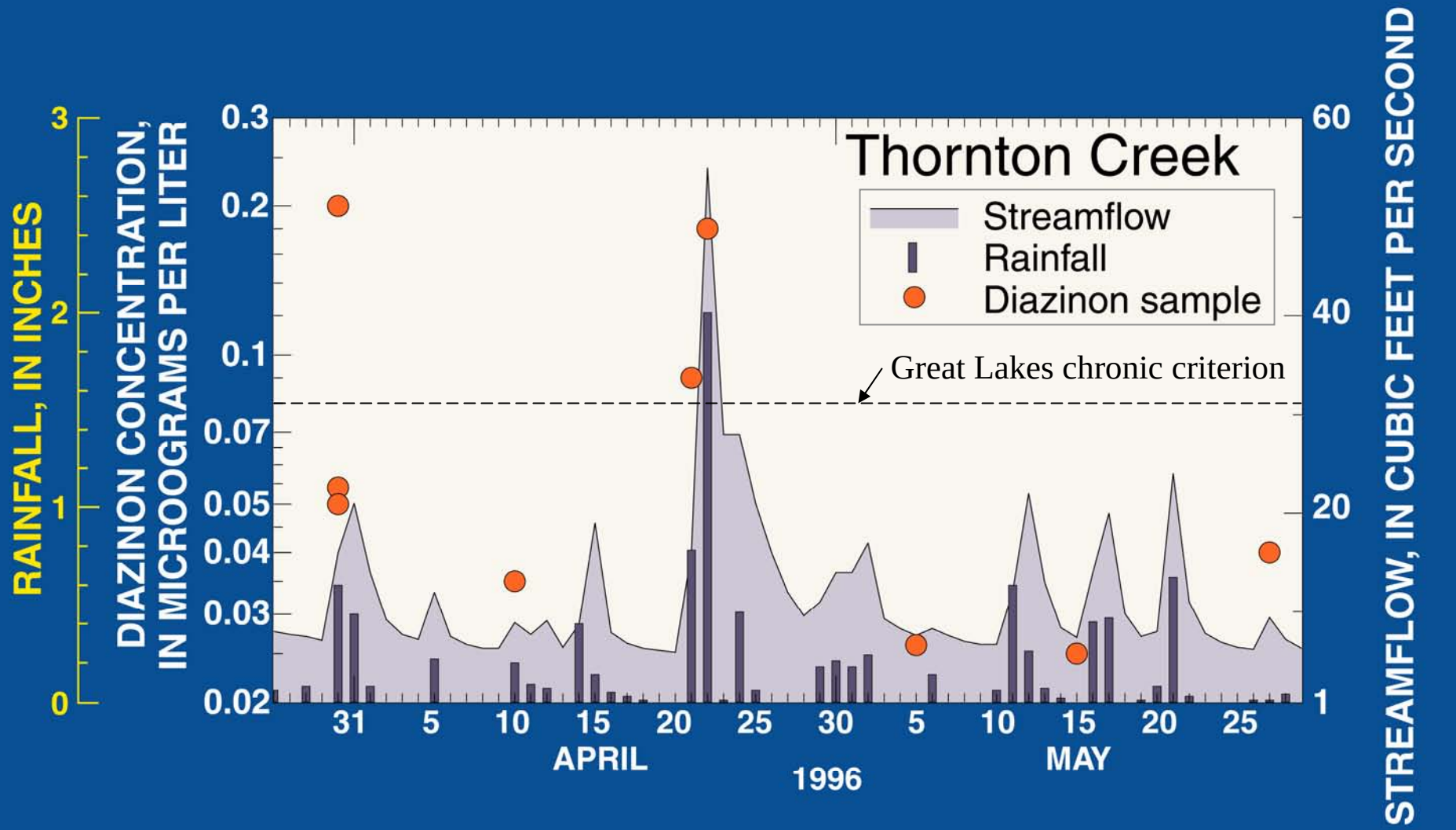
Influence of Hydrology- Rainfall Runoff in an Urban Stream



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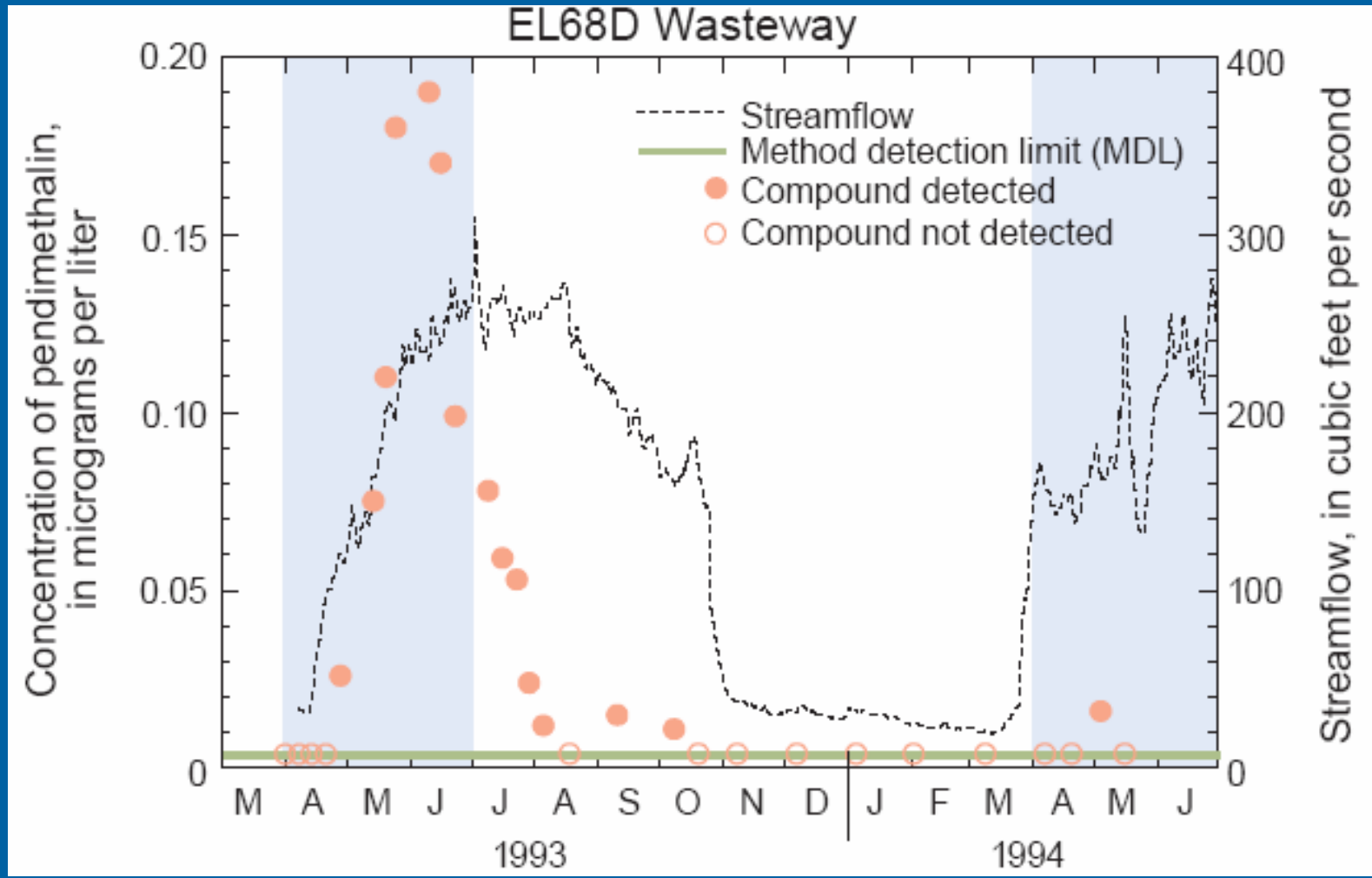
Frans, 2004 (Puget Sound)

Influence of Hydrology – Irrigation and Pendimethalin



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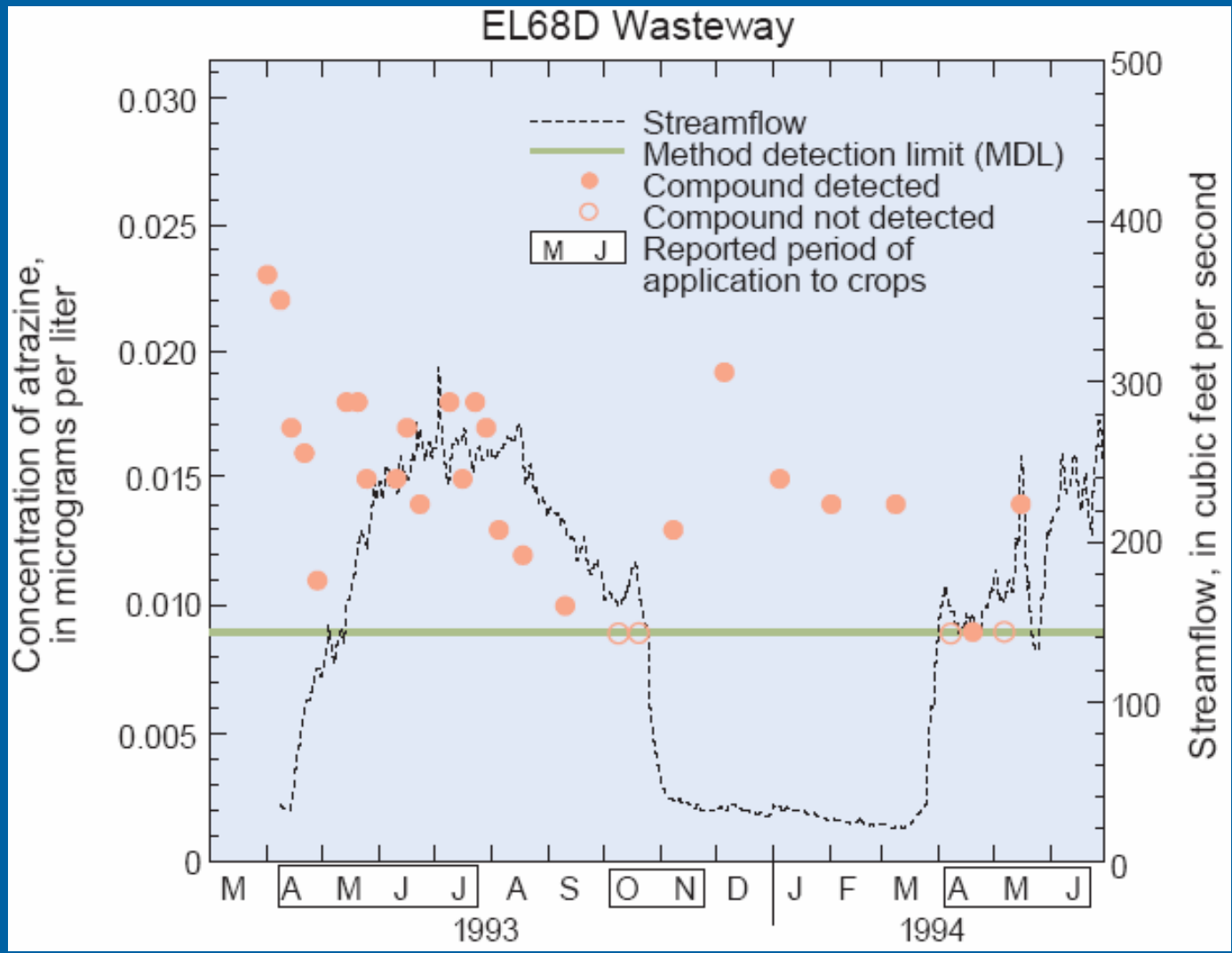
Williamson and others, 1998 (Central Columbia Plateau)

Influence of Hydrology– Groundwater Source for Atrazine



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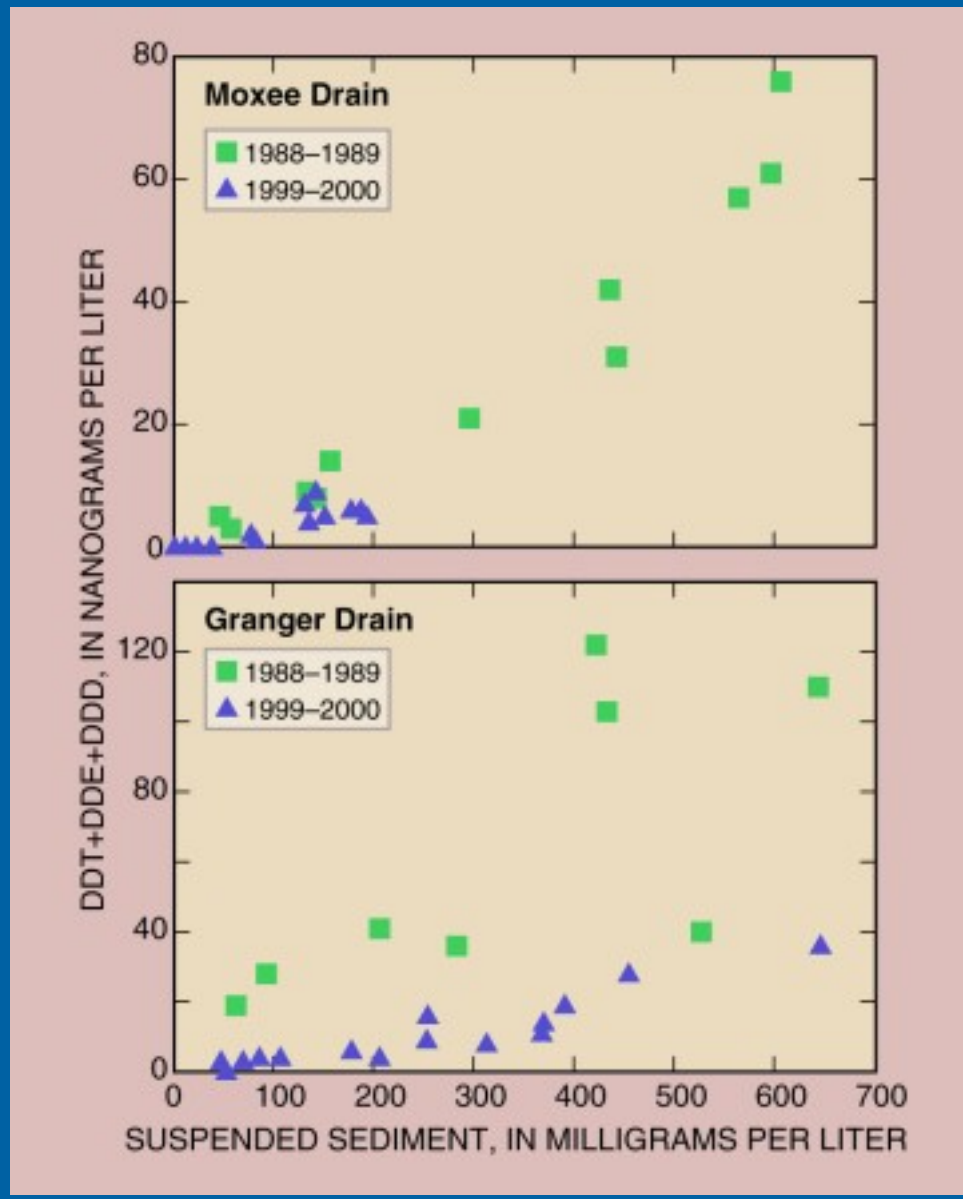
Williamson and others, 1998 (Central Columbia Plateau)

Reductions in DDT

- Changing relation between total DDT and suspended sediment since 1980's
- Importance of erosion control measures
  - Reduced sediment concentrations
  - Reduced transport of DDT



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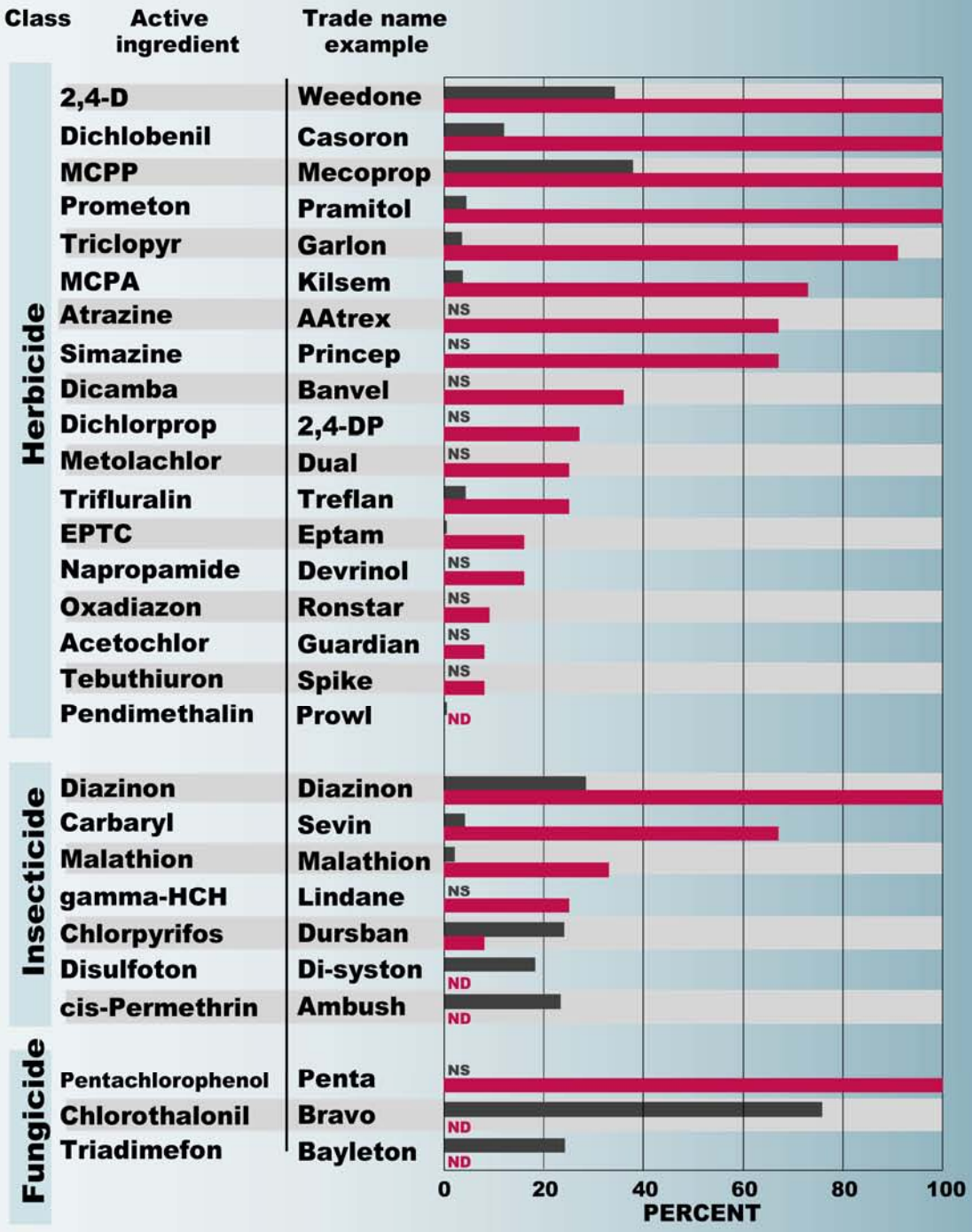
Fuhrer and others, 2004 (Yakima River Basin)

PERCENTAGE OF RETAIL SALES AND RELATION TO FREQUENCY OF DETECTIONS IN URBAN STREAMS DURING SPRING STORM RUNOFF



Percentage of unit sales within a class contributed by the pesticide

Percentage of sites with pesticide detection

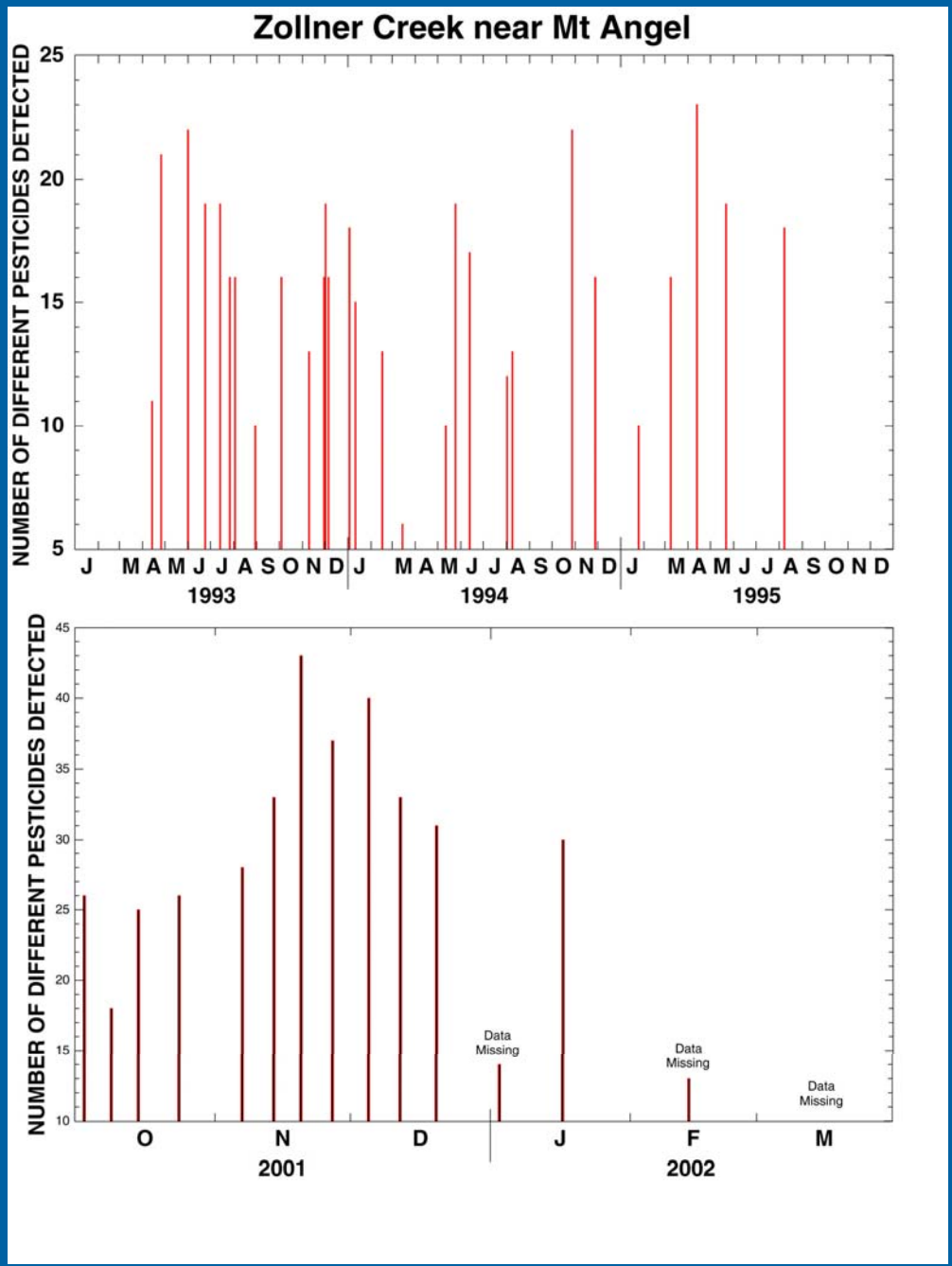
NS No sales reported

ND Not detected

Ebbert and others, 2004 (Puget Sound)

Mixtures are Common

At this Agricultural site in the Willamette Valley, ~10-40 different pesticides detected in any one sample



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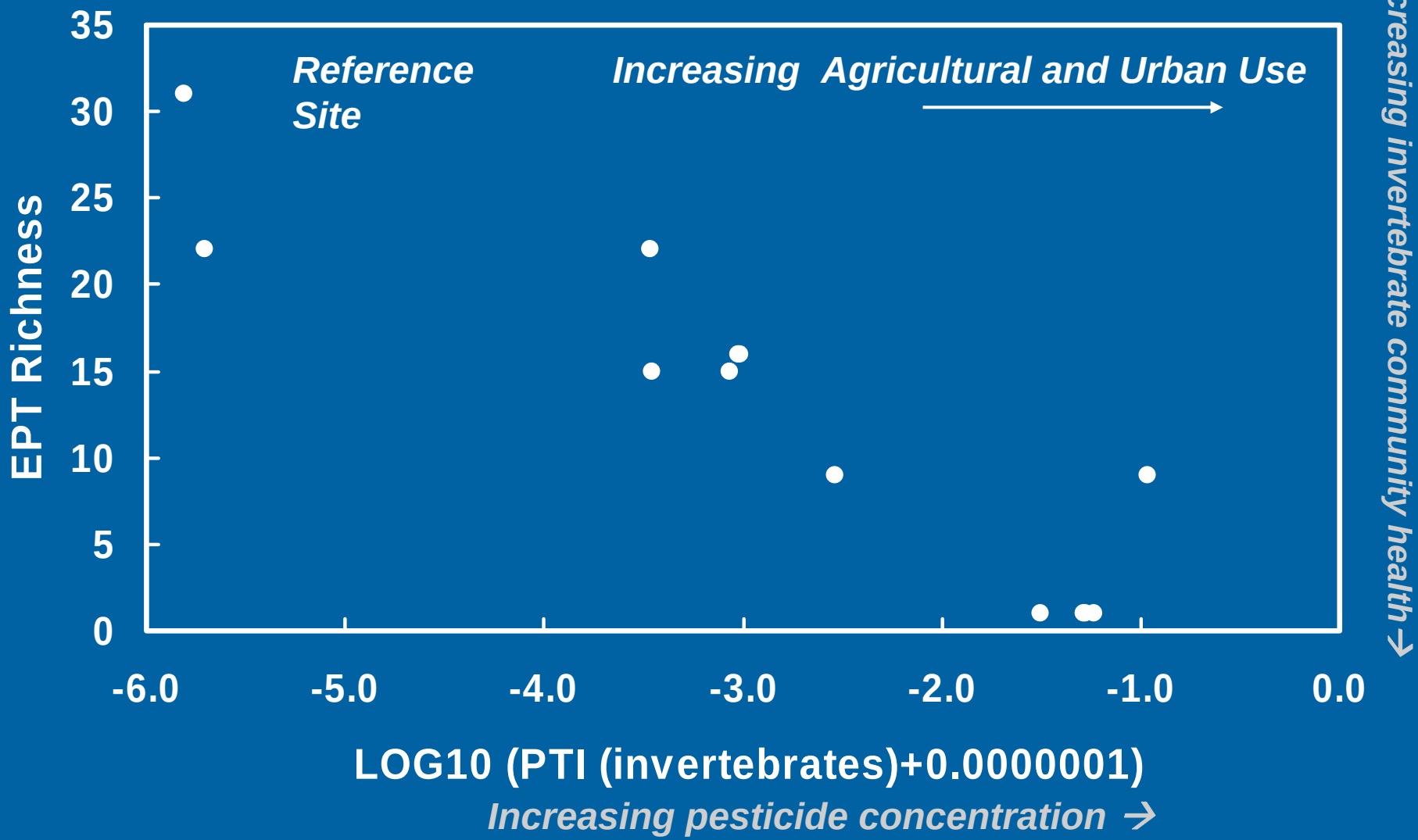
Pesticide Toxicity— Clackamas River Basin



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Carpenter, 2003

Conclusions – Concentrations, Compliance, and Toxicity

- Concentrations are typically low but variable
  - Average concentrations usually < 0.1 ppb
  - Range over 3-5 orders of magnitude, depending on seasonality, pesticide use, land use, hydrology
- Water Quality Criteria and Standards are occasionally exceeded
  - Mostly for insecticides
  - Few compounds have criteria/standards established
  - Mixtures are largely unaddressed

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Conclusions– Patterns in detections

- **Common Herbicides**
  - **Urban: Atrazine, 2,4-D, simazine, prometon, tebuthiuron, dichlobenil**
  - **Agricultural: atrazine, metolachlor, diuron, EPTC**
- **Common Insecticides**
  - **Urban: Diazinon**
  - **Agricultural: Diazinon, chlorpyrifos**
  - **Legacy: DDT + metabolites, dieldrin**
- **Usually a mixture of many pesticides**

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Conclusions: Effects of hydrology and climate

- Type of runoff is a major controlling factor
  - Western and Urban areas dominated by rainfall runoff
  - Eastside dominated by irrigation
    - Irrigation and erosion control methods make a difference

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Conclusions– Effects of Land Use

- Pesticide detections reflect land use
- Changes in pesticide use should result in changes in detection patterns in streams
  - Rate of change is partly dependent on physical properties of pesticides, and local soils and hydrology

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Remaining issues

- Lack of clear toxicity guidelines
  - Individual compounds (or metabolites)
  - Mixtures
  - Sublethal effects
- Many more compounds being used than we can analyze
  - e.g. glyphosate, metaldehyde
- Poor data on pesticide use
- Can’t yet rank urban vs agricultural impacts
- Model availability

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The End

Questions?

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All data from:
http://water.usgs.gov/nawqa/data

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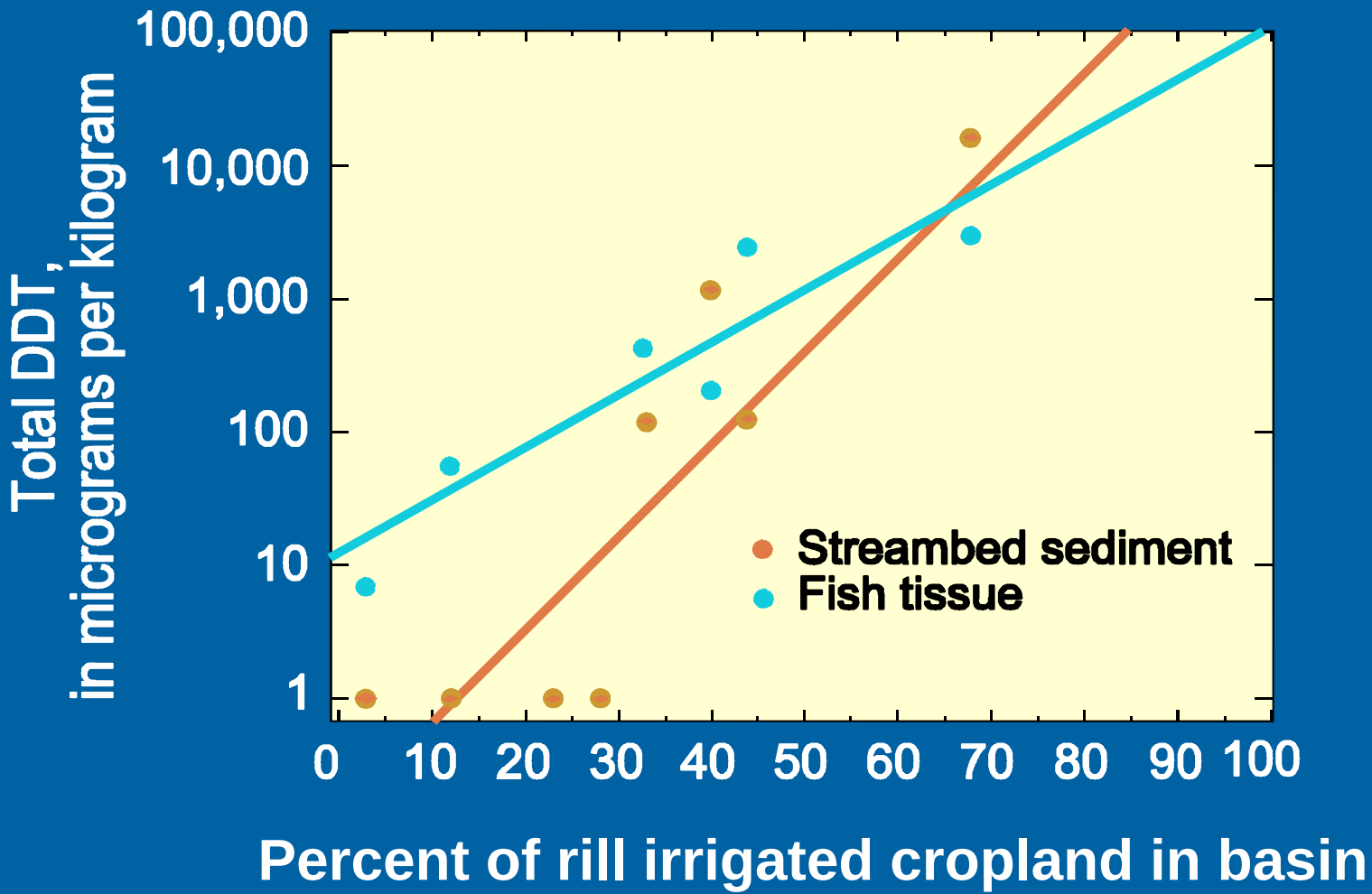
Influence of hydrology – Irrigation and DDT



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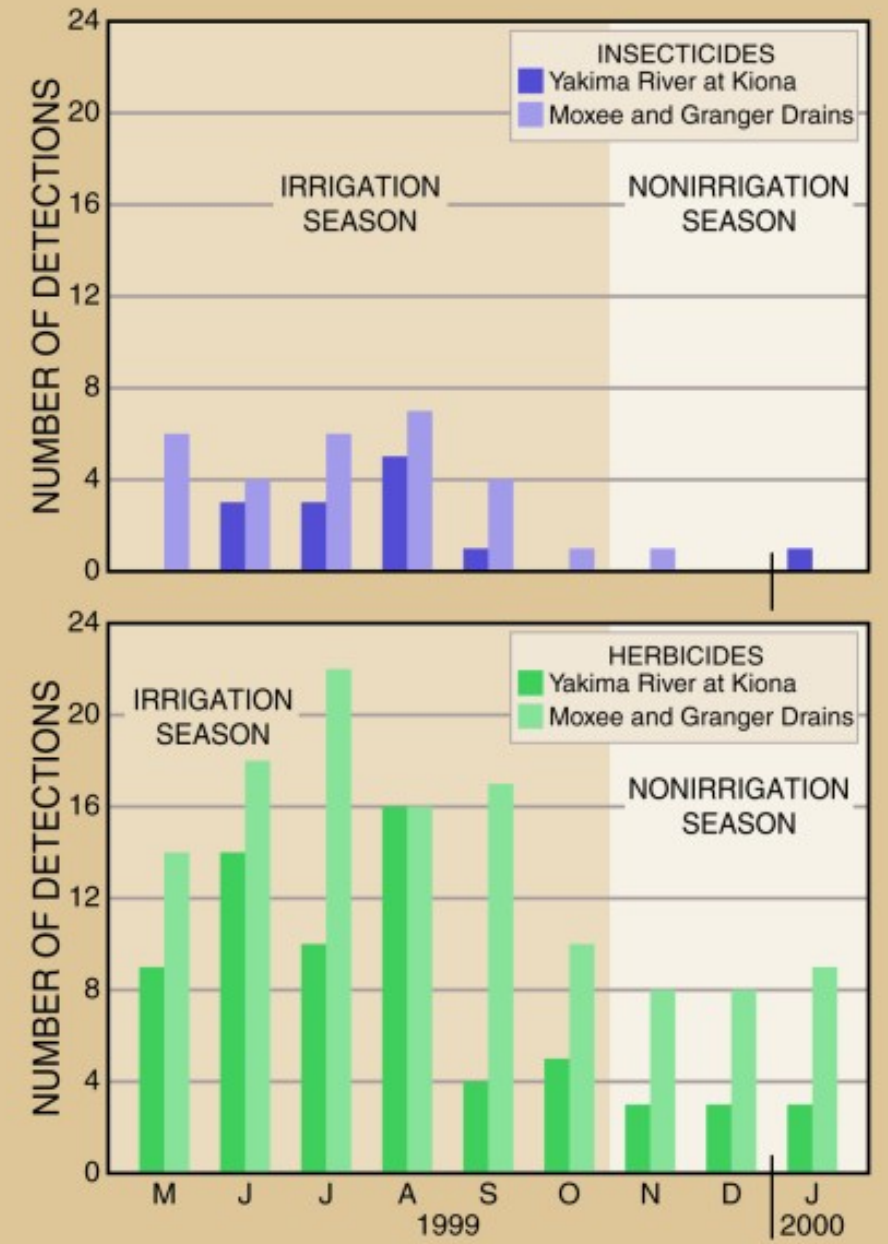
Williamson and others, 1998 (Central Columbia Plateau)

Influence of climate, hydrology, and crop type

- **Insecticides**
  - Typically at lower concentrations
  - Detected primarily during irrigation season
- **Herbicides**
  - More being used & analyzed
  - Year-round detections



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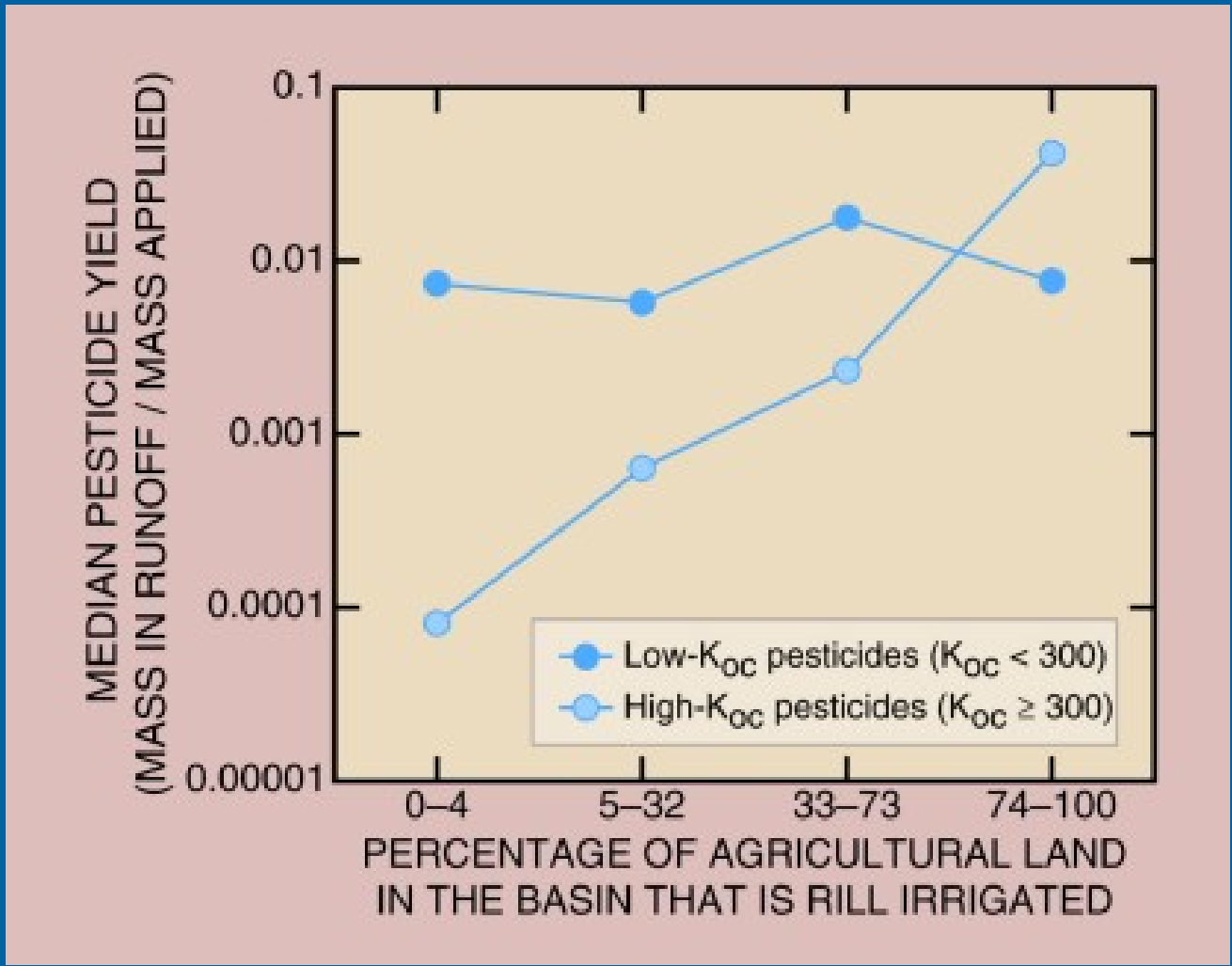
Fuhrer and others, 2004 (Yakima River Basin)

Irrigation Methods, Pesticide Physical Properties, and Stream Yields

- Yield of low-K_{oc} (less sorptive) pesticides was relatively constant
- Yield of high-K_{oc} (more sorptive) pesticides increased in proportion to the amount of rill-irrigated farmland



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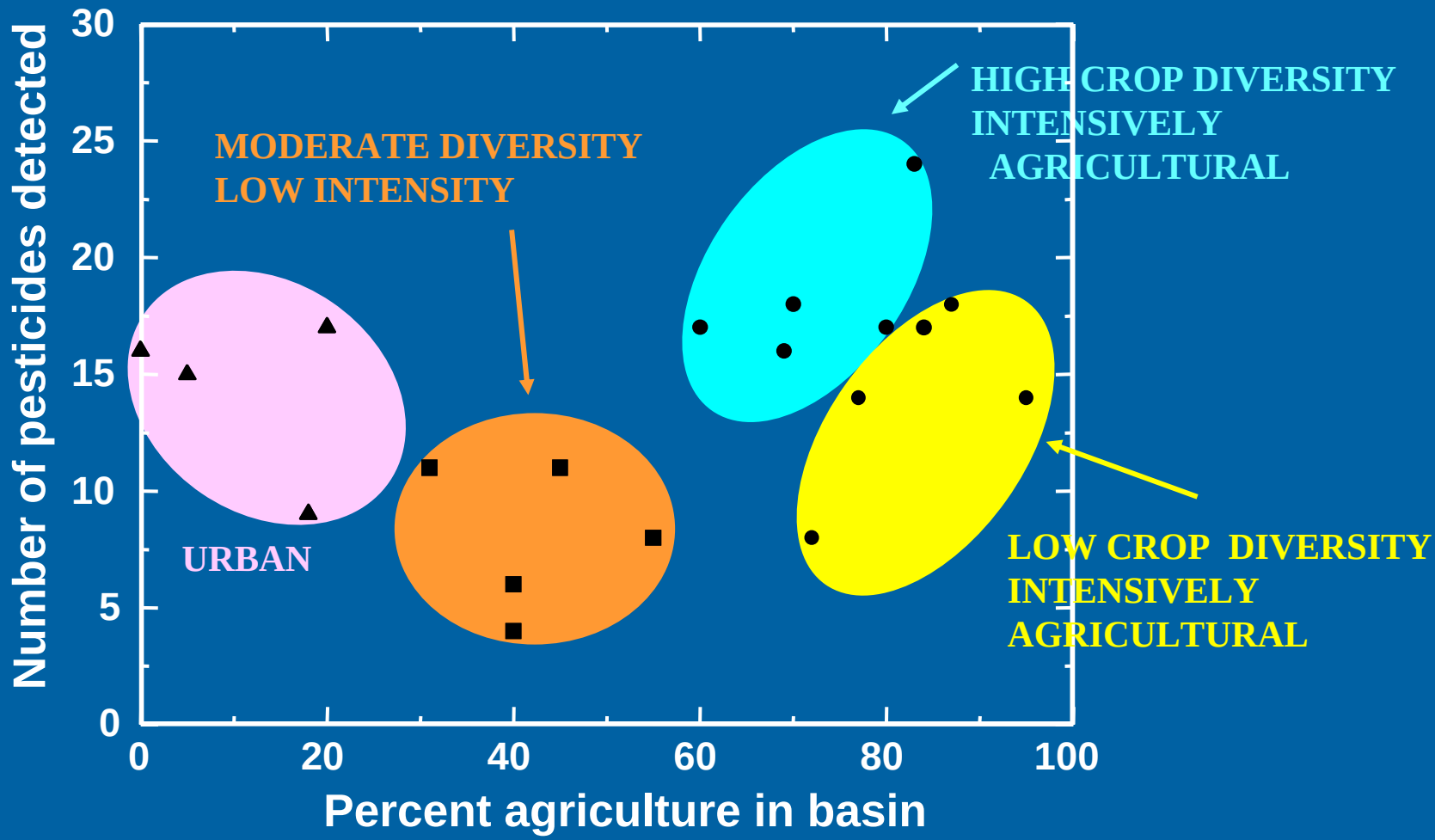
Fuhrer and others, 2004 (Yakima River Basin)

Diversity in crop types is reflected in detections of pesticides in water



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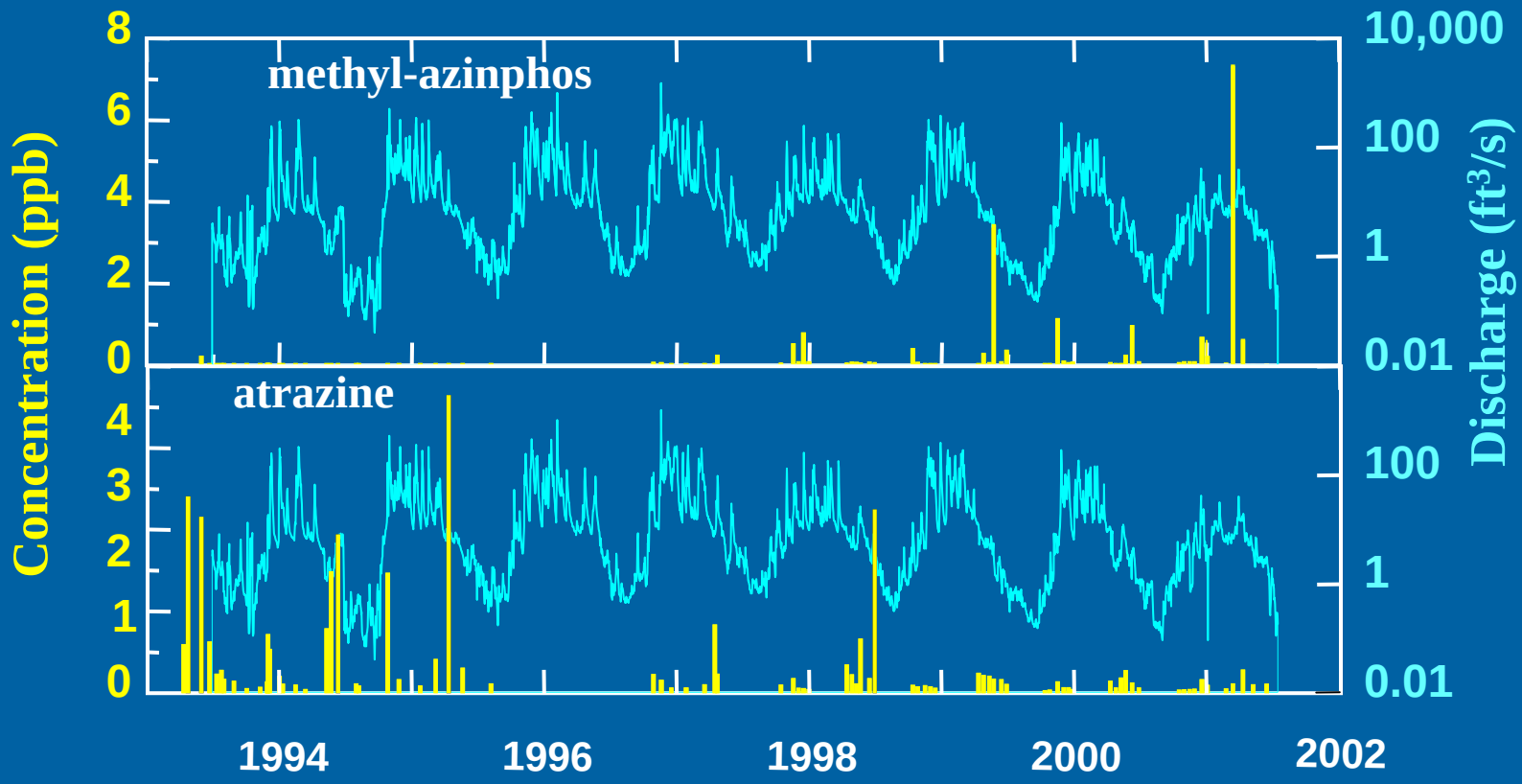
Anderson and others, 1997 (Willamette River Basin)

Changes in Pesticides in Water Over Time

Zollner Creek, Agricultural Stream, 1993-2001



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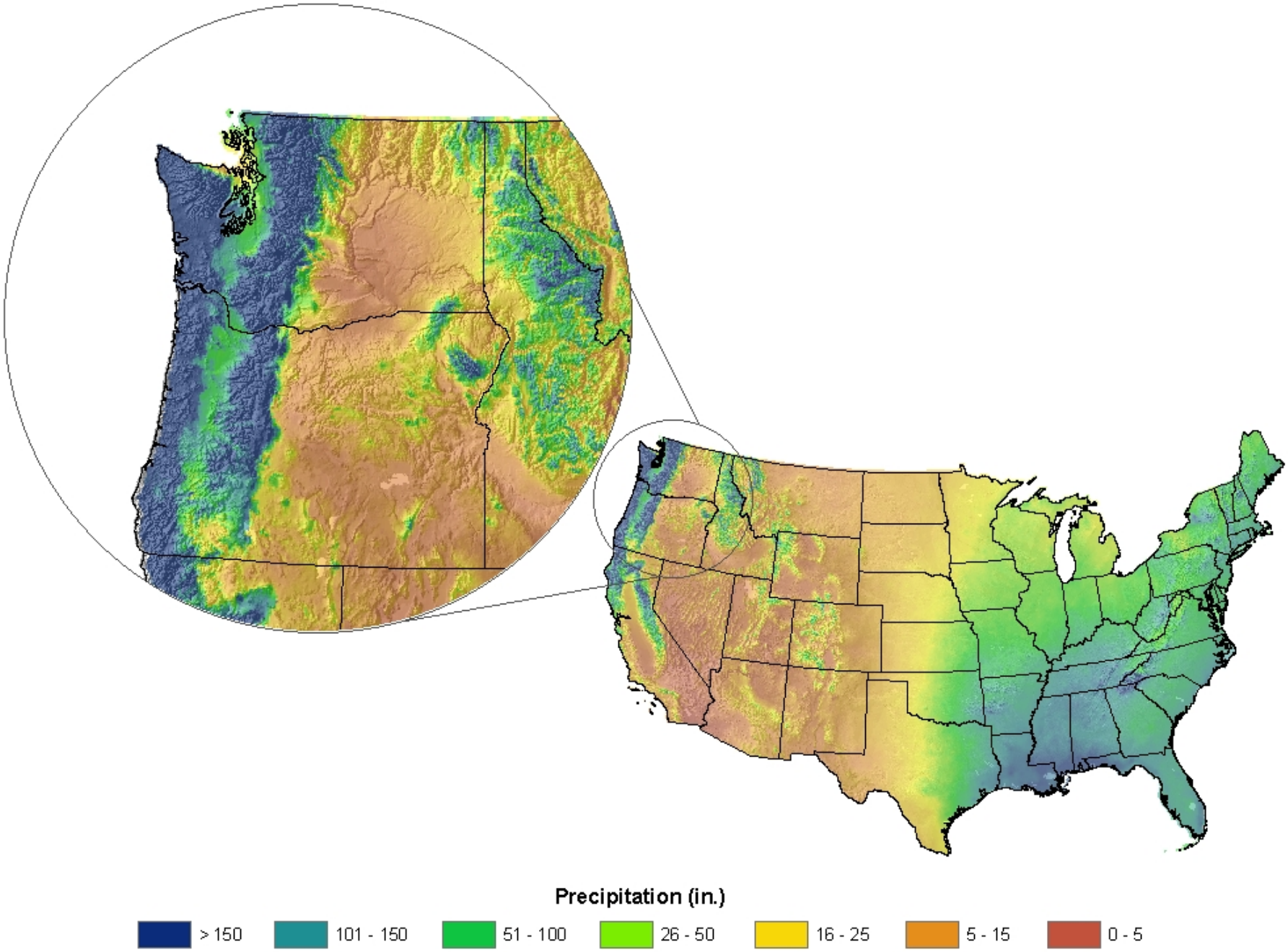

Findings from Multiple Studies over ~15 Years

- National Water Quality Assessment Program (NAWQA)
  - Willamette River Basin (1991-1995, 2001-2004)
  - Puget Sound Basin (1996-1998)
  - Yakima River Basin (1987-1991, 1999-2000)
  - Central Columbia Plateau (1992-1995)
  - Upper Snake River (1992-1995)
- Locally Funded Studies
  - Willamette River Basin (1991-1997)
  - Puget Sound Rainfall Runoff Study (1998)
  - Clackamas River Basin (2000-2001)

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Objectives of Presentation

- Similarities and differences among study results
- Influence of land use
- Importance of local climate and hydrology
- Changes over time
- Identify some major remaining issues

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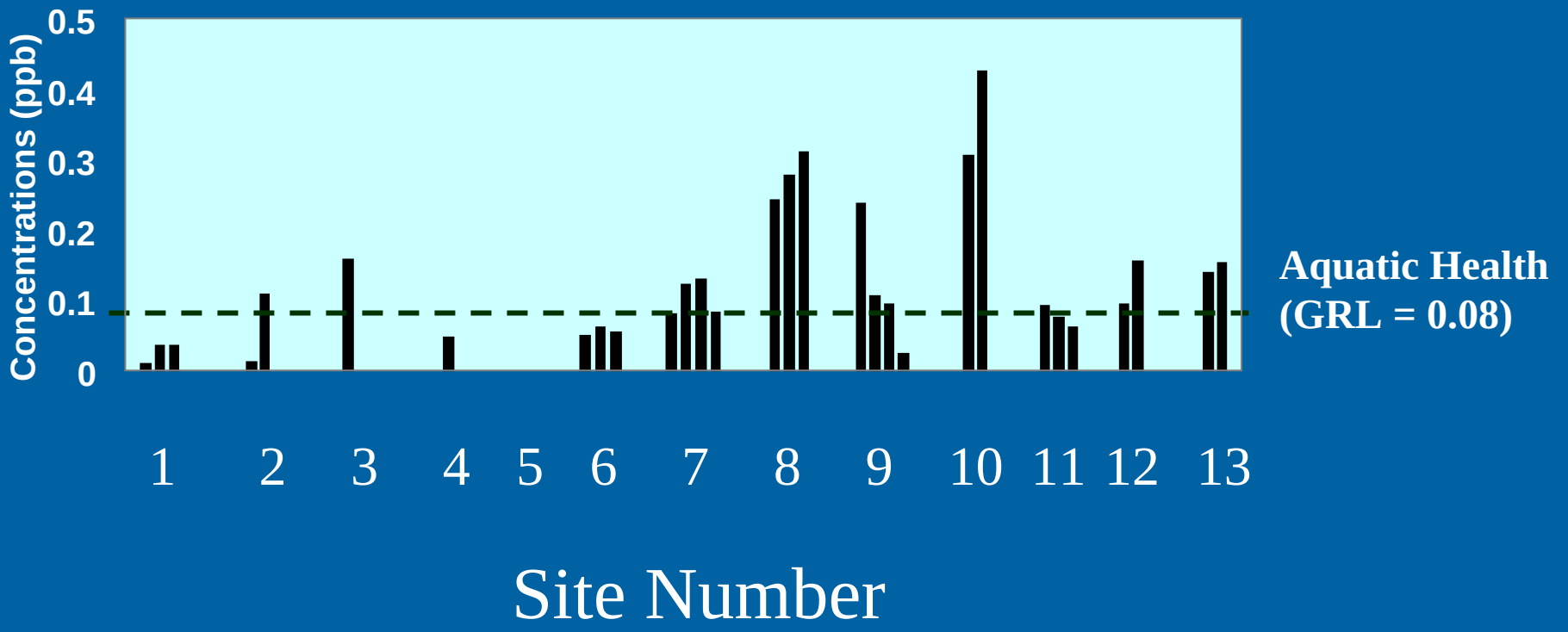
Diazinon in Puget Sound Urban Runoff Study

Concentrations at individual sites



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Frans, 2004

Concentrations and Compliance with Water Quality Criteria

- Typically low (<0.1 ppb) but often highly variable
- High concentrations do occur, usually as short-term pulses
- Water Quality Criteria are violated mostly by insecticides
  - Organophosphates (Diazinon, chlorpyrifos, methyl-azinphos)
  - Legacy organochlorines (DDT & metabolites, dieldrin)
  - Some herbicides exceed drinking water guidelines, but typically the these aren't drinking water sources

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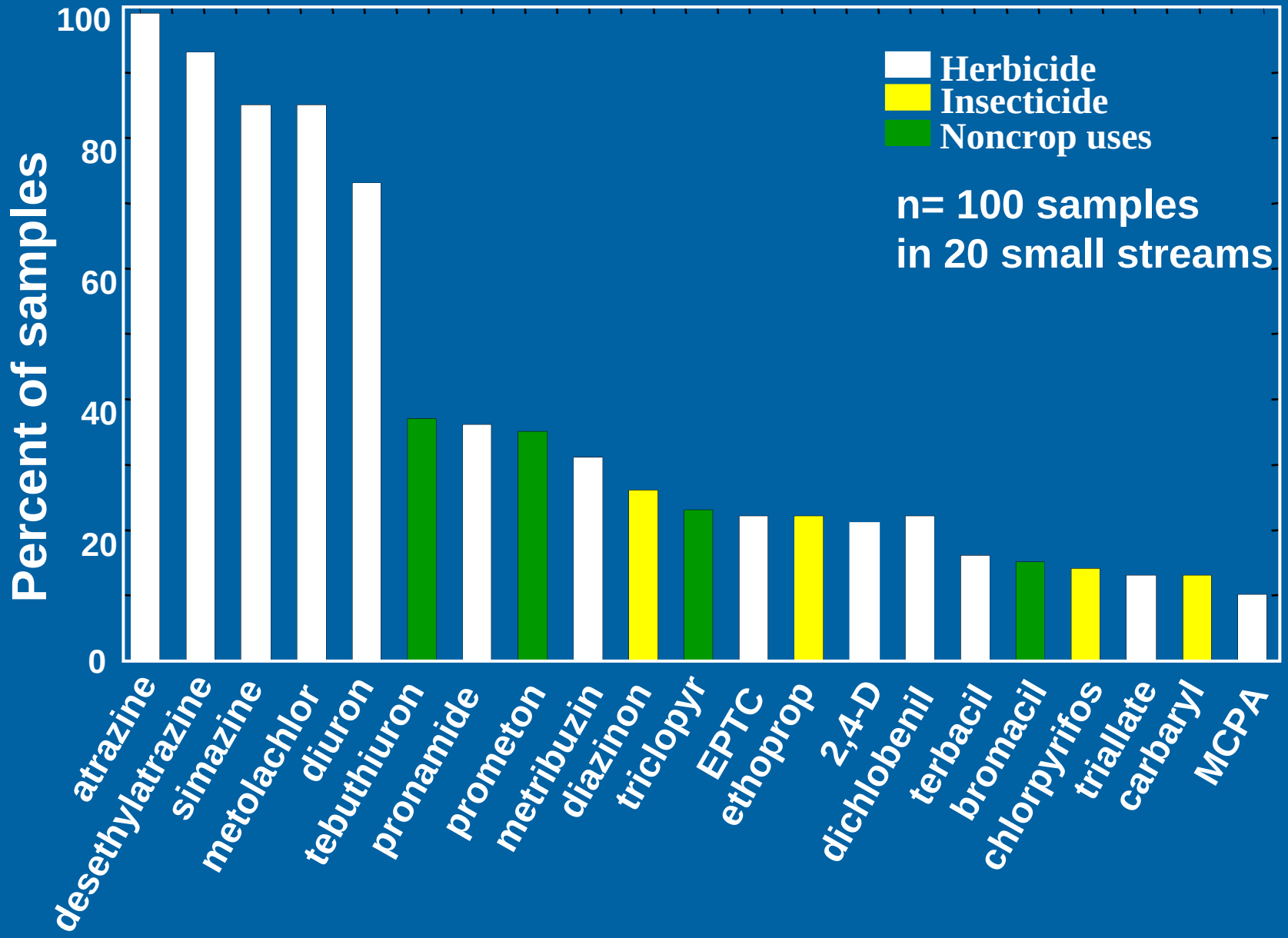
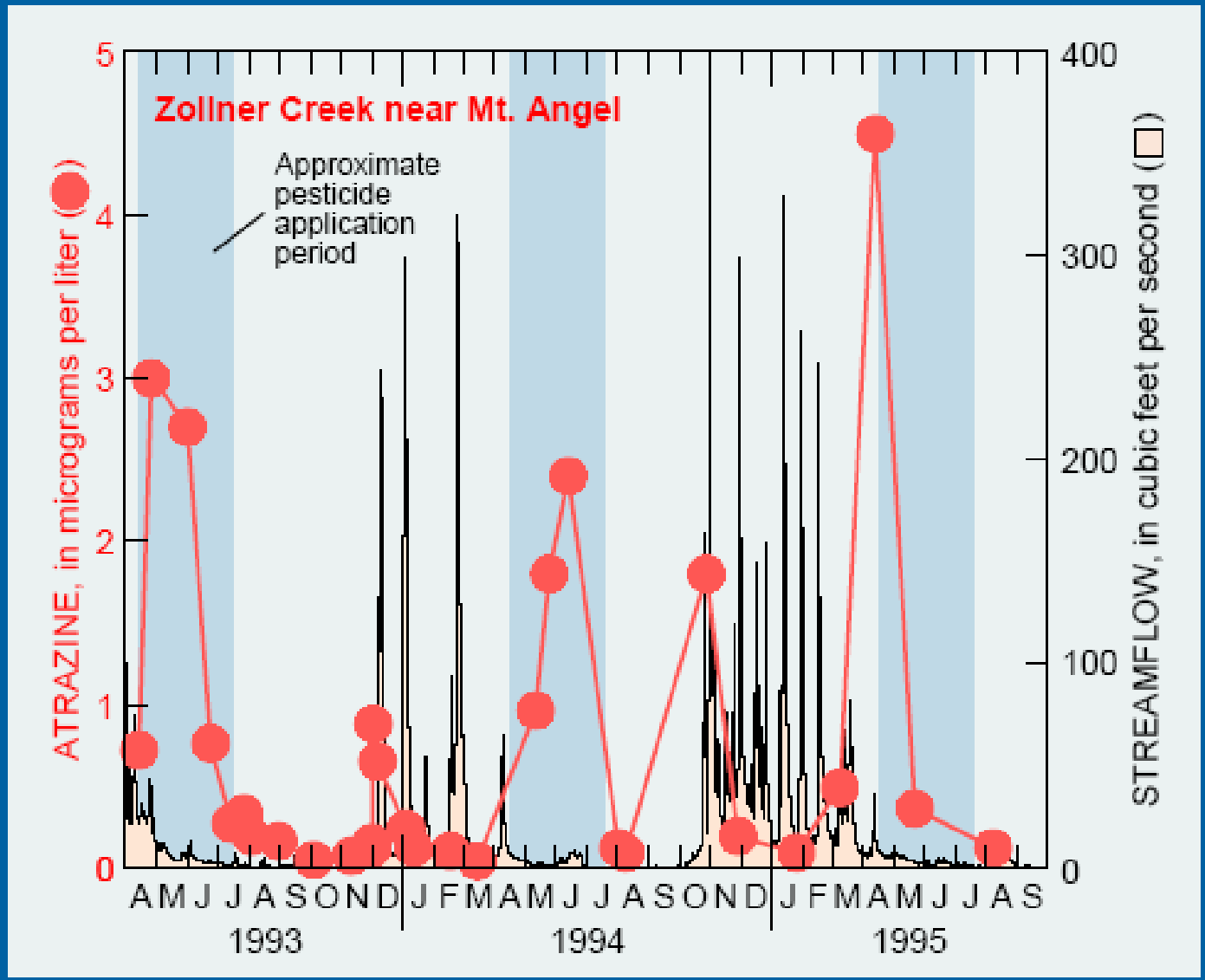
Detection Frequency – Willamette



Anderson and others, 1997

Influence of Hydrology – Rainfall Runoff in an Agricultural Stream



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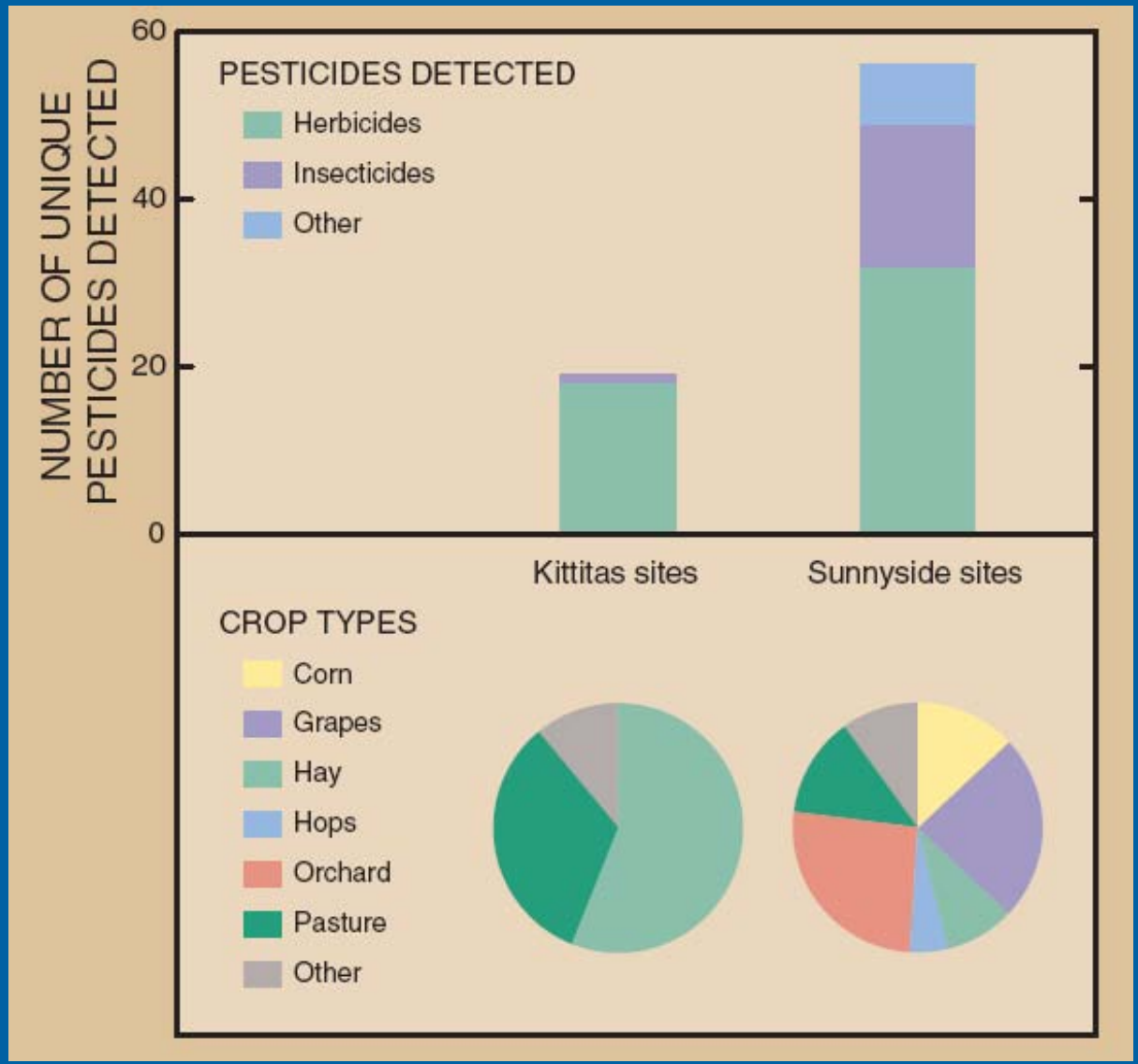
Wentz and others, 1998 (Willamette River Basin)

Diversity in crop types is reflected in detections of pesticides in water



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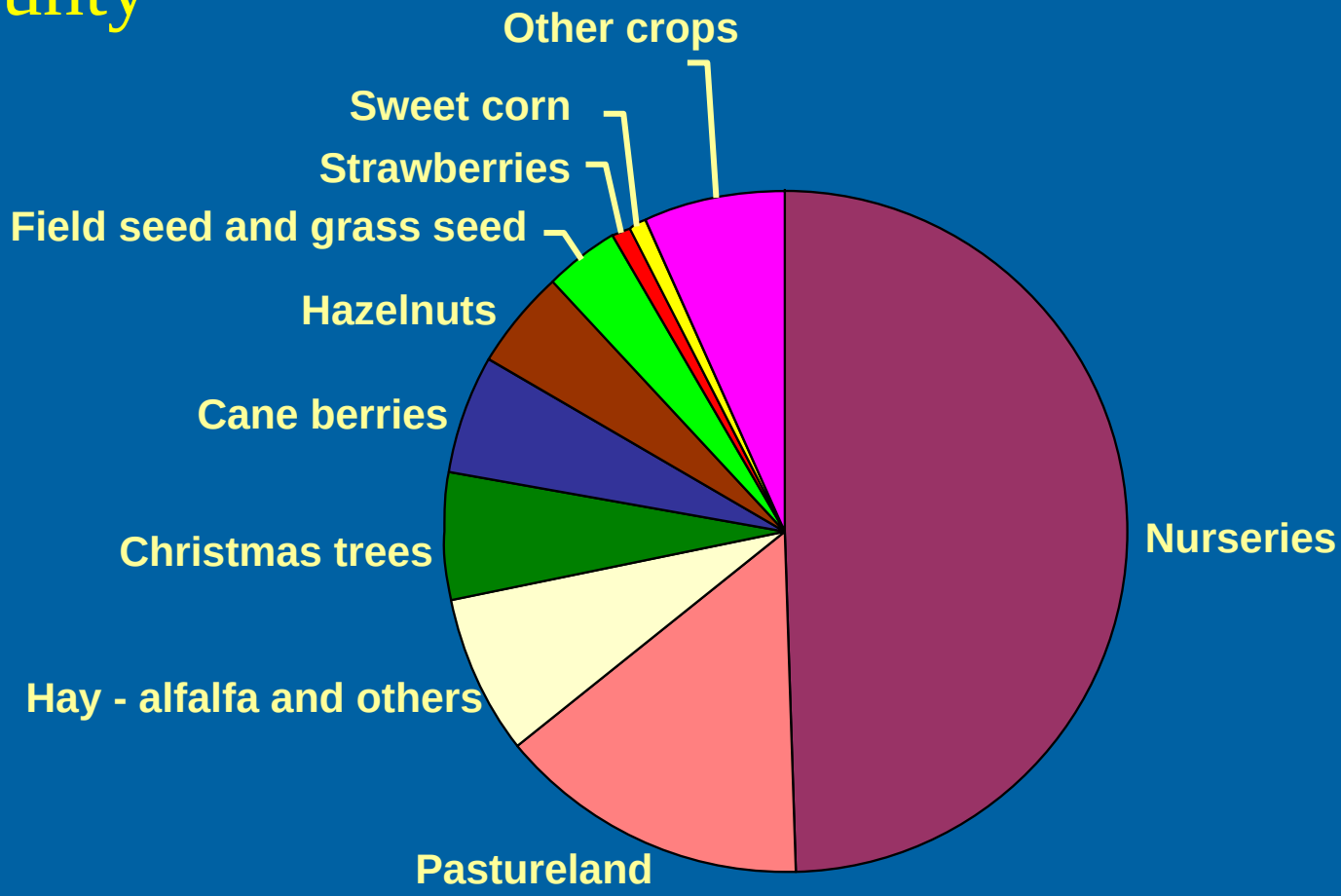
Fuhrer and others, 2004 (Yakima River Basin)

Percentage of Total Estimated Pesticide Applications to Agricultural Crops in Clackamas County



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Carpenter, 2003