Historical Pesticide Exposure Using PUR and Land-Use Surveys: An Assessment of Misclassification Error and Bias
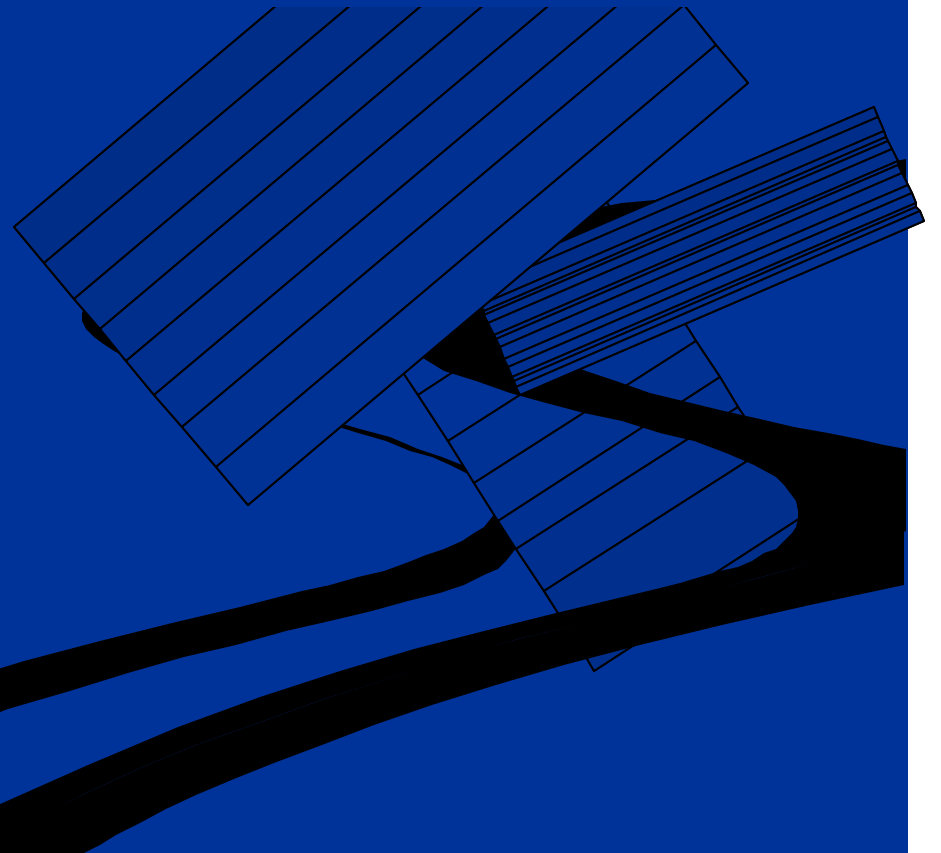
Rudy Rull, Beate Ritz

Department of Epidemiology

UCLA School of Public Health

UCLA

School of Public Health

- Published paper available:
  - Environmental Health Perspectives 111:1582-1589 (October 2003).

PUR Applications in Epidemiology

- PUR has been used by various investigators in epidemiologic studies to assess potential exposure to pesticides

- Parkinson's, Environment, and Genes Study
  - PUR used for *historical* exposure assessment of residential proximity to agricultural pesticide applications
  - Pre-1990 data most relevant for long-term exposure

Spatial Resolution of PUR Data

- Validity of exposure metrics limited by reporting of PUR to 1 TRS (1 sq. mile)
- Without additional spatial information, estimates of true exposure effects occurring at smaller distances could be attenuated

- To increase resolution:
  - Use land-use (LU) surveys (CA Department of Water Resources) to identify fields/orchards of likely pesticide application sites

Kern County, 1990 Survey
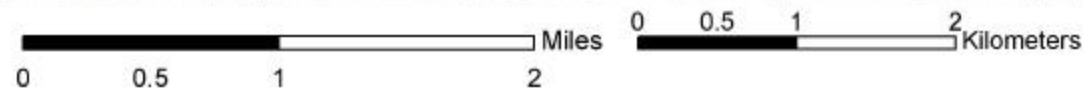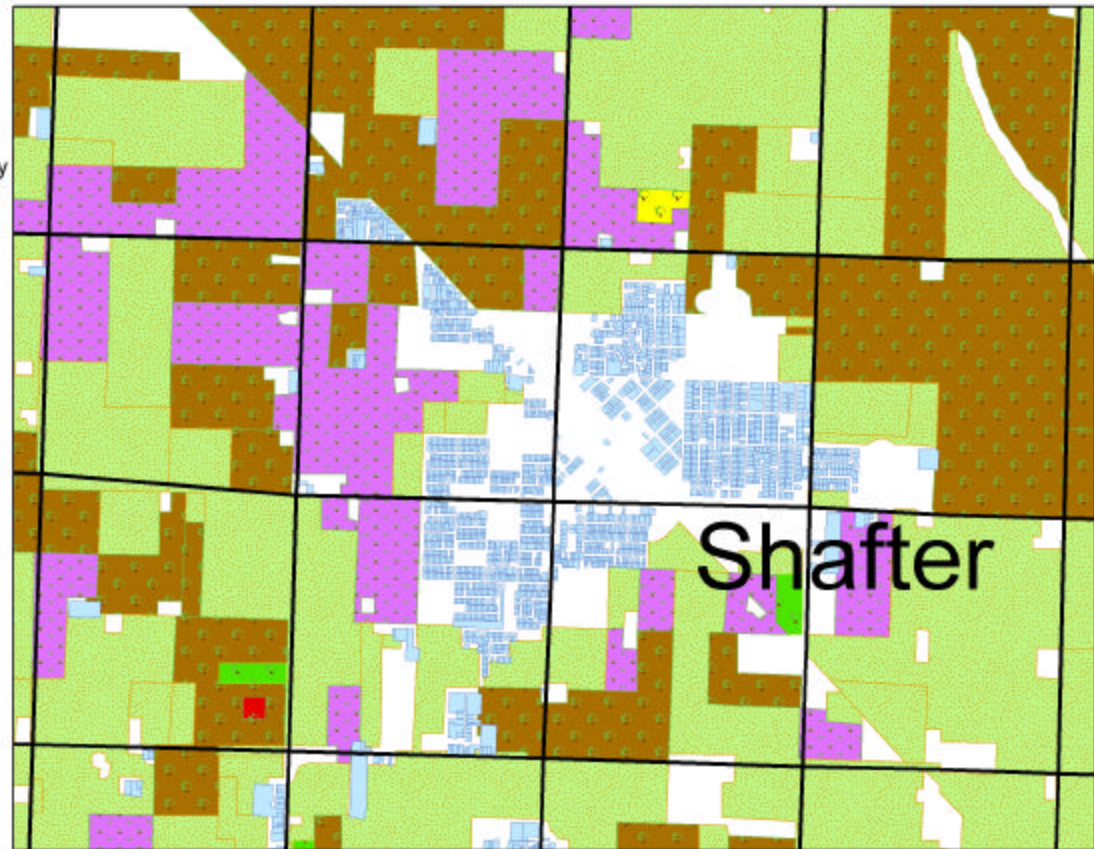
Other Sources of Misclassification

- Lack of detailed residential histories
  - Using only birth, death, or most recent address to assess long-term exposure
  - 20-25% women change residences during pregnancy

- Using annual exposure measures as a proxy for seasonal exposure status
  - E.g., gestational months in a birth-defect study

Study Methods

- Study population: 1,000 randomly selected sets of 200 rural residential parcels
  - Simulated selection of controls in a case-control study
  - 1998 Parcel data from Kern County Assessor

- Assess exposure to 5 pesticides using PUR linked (by crop) to LU
  - Exposure: specific pesticide applied within distance or zone of residence
- Use PUR-LU exposure model with 500 or 1,000 meter buffer radii as "alloyed" gold standard
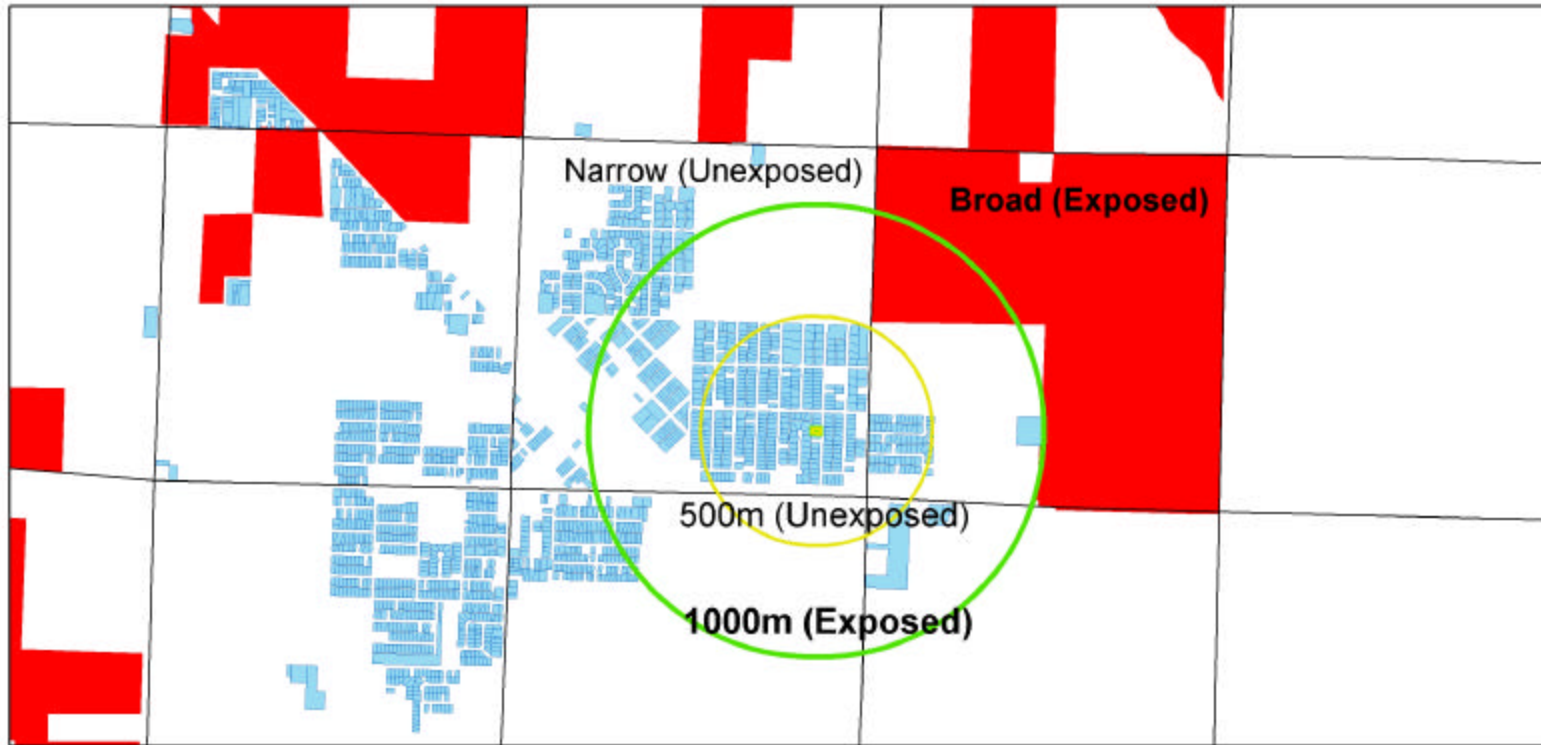
Legend

◻ (yellow outline) 500m Radius Buffer
◻ (green outline) 1,000m Radius Buffer
◻ PLSS Sections
◼ (light blue) Residential Parcels
◼ (red) Potential Parathion Application Sites

Map labels: Narrow (Unexposed), Broad (Exposed), 500m (Unexposed), 1000m (Exposed)

Scale: Meters 0 250 500 1,000 1,500
Miles 0 0.5 1

Study Methods

- Comparison models:
  - 1) PUR without LU (broad/narrow (Bell))
  - 2) use LU data only (as in other states)
  - 3) assuming long-term residential stability in a mobile population (i.e., no residential mobility)
  - 4) use annual exposure measures as a proxy for seasonal exposure status

- Estimated exposure prevalence, sensitivity, and specificity of comparison models
- Measure impact of non-differential exposure misclassification on the observed effect estimates of hypothetical true odds ratios

Study Parameters

- Western Kern County
- 1988 PUR data (restricted-use only)
    - PUR checked for errors (e.g., extremely high application rates)
    - Pesticides: methomyl, parathion, paraquat, endosulfan, maneb
- 1990 LU survey
    - Collapsed non-permanent field, truck, grain, pasture crops into one category to uncertainty of location

PUR-LU (radius) vs. Narrow (1 TRS) & Broad (9 TRS) PUR-only models
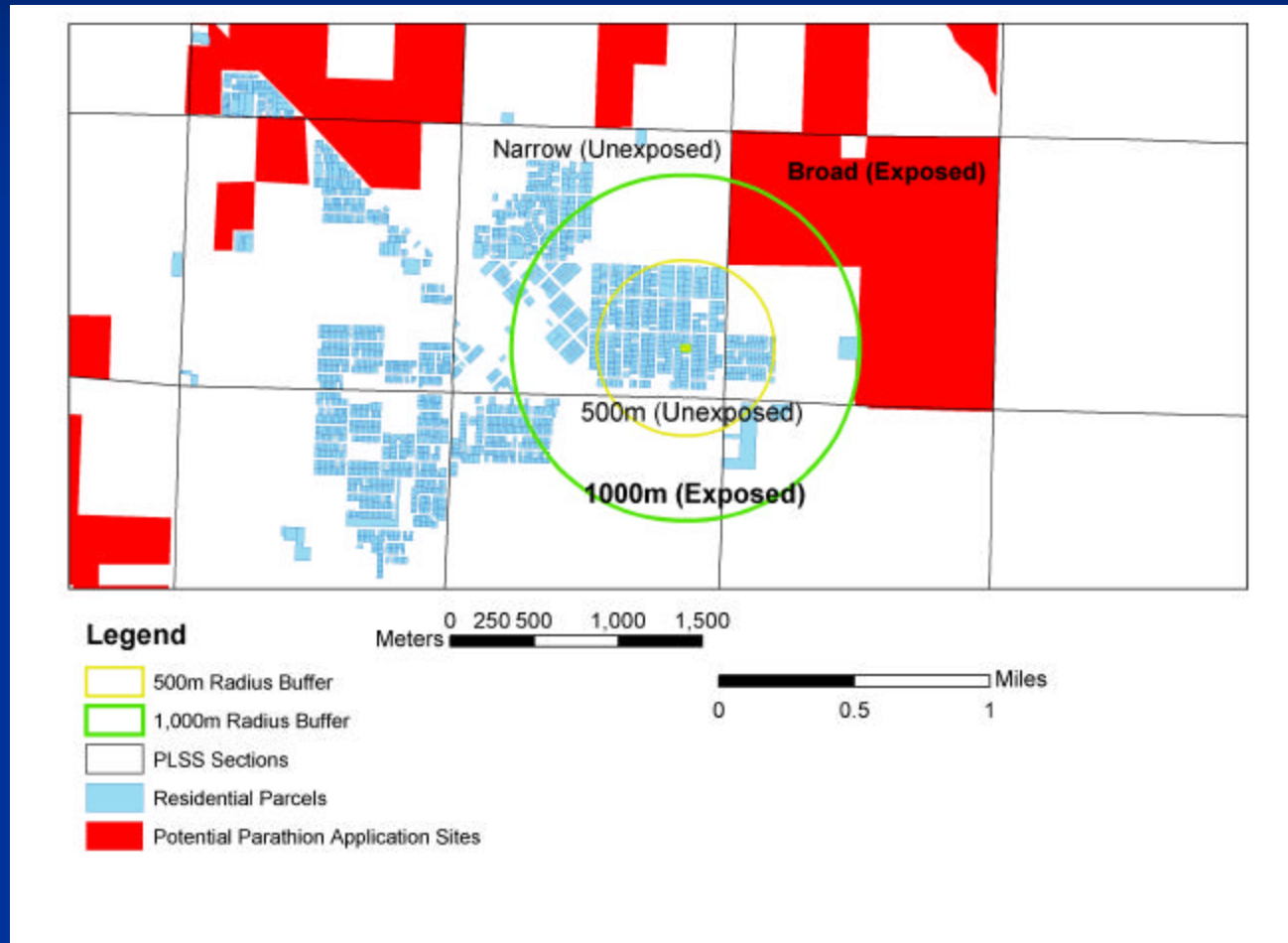
Simulated Mean Exposure Prevalence (%)
1,000 replicates of 200 randomly sampled parcels

Pesticide	PUR-LU Model		PUR-only Model	
	500m	1000m	Narrow (1 TRS)	Broad (9 TRS)
Methomyl	17.1	30.9	7.0	48.6
Paraquat	10.8	21.7	4.5	36.2
Parathion	8.4	15.8	5.0	27.1
Endosulfan	5.3	10.7	3.2	24.5
Maneb	0.9	2.4	1.0	6.9

Validity of PUR-only models vs. PUR-LU (500m) model

	Narrow		Broad	
	Sensitivity	Specificity	Sensitivity	Specificity
Methomyl	36.9	99.1	100.0	62.0
Paraquat	35.3	99.3	100.0	71.5
Parathion	45.4	98.7	100.0	79.6
Endosulfan	42.8	99.0	100.0	79.7
Maneb	54.8	99.4	100.0	93.9

- Sensitivity: % of exposed in PUR-LU model classified as exposed in PUR-only model
- Specificity: % of unexposed in PUR-LU model classified as unexposed in PUR-only model

Attenuation of the true OR
(based on previously presented estimates)

	True OR=2.0 (PUR-LU @ 500m)	
Pesticide	Narrow	Broad
Methomyl	1.70 (30)	1.35 (65)
Paraquat	1.73 (27)	1.30 (70)
Parathion	1.69 (31)	1.31 (69)
Endosulfan	1.66 (34)	1.22 (78)
Maneb	1.45 (55)	1.12 (88)

Attenuation %: $1 - ((OR_{obs} - 1)/(OR_{true} - 1))$

Attenuation of the true OR=2.0 (paraquat), incorporating residential mobility

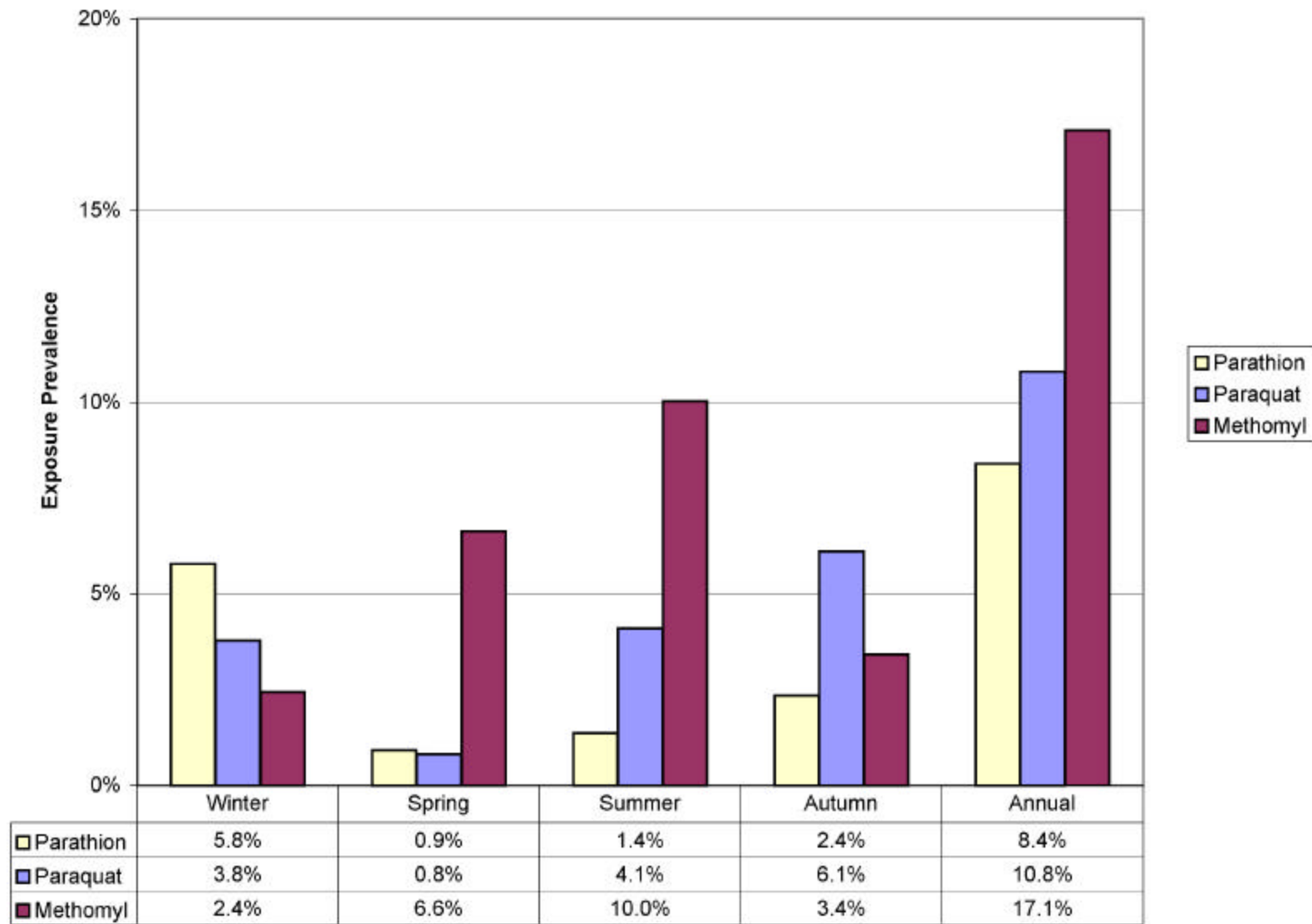| Mobility Rate	PUR/LU @ 500m	Narrow	Broad
0%	2.00 (0)	1.73 (27)	1.30 (70)
10%	1.89 (11)	1.65 (35)	1.26 (74)
25%	1.75 (25)	1.57 (43)	1.23 (77)
40%	1.62 (38)	1.50 (50)	1.20 (80)

Results Summary

- True ORs attenuated:
  - When exposure is based on large geographic area yielding higher SE but low SP (vs. smaller area with high SP)
  - For less frequently applied pesticides
  - With increasing mobility of residents among the study population

LU-Only vs. PUR-LU

Parathion	PUR/LU	LU-Only		
Radius	Prevalence	Prevalence	Sensitivity	Specificity
500m	8.4	10.5	60.1	94.0
1000m	15.8	22.3	72.2	87.0

- LU-only based on proximity to likely parathion-treated orchard crops.
- Attenuation of true OR=2.0: 1.43 (57%).

Differences in Seasonal Exposure Prevalence

	Winter	Spring	Summer	Autumn	Annual
Parathion	5.8%	0.9%	1.4%	2.4%	8.4%
Paraquat	3.8%	0.8%	4.1%	6.1%	10.8%
Methomyl	2.4%	6.6%	10.0%	3.4%	17.1%

Using Annual Exposure Status as a Proxy for Seasonal Exposure Status

	Winter	Spring	Summer	Autumn	True OR
Parathion	1.70	1.11	1.17	1.29	2
Paraquat	1.35	1.08	1.38	1.57	2
Methomyl	1.15	1.40	1.60	1.20	2
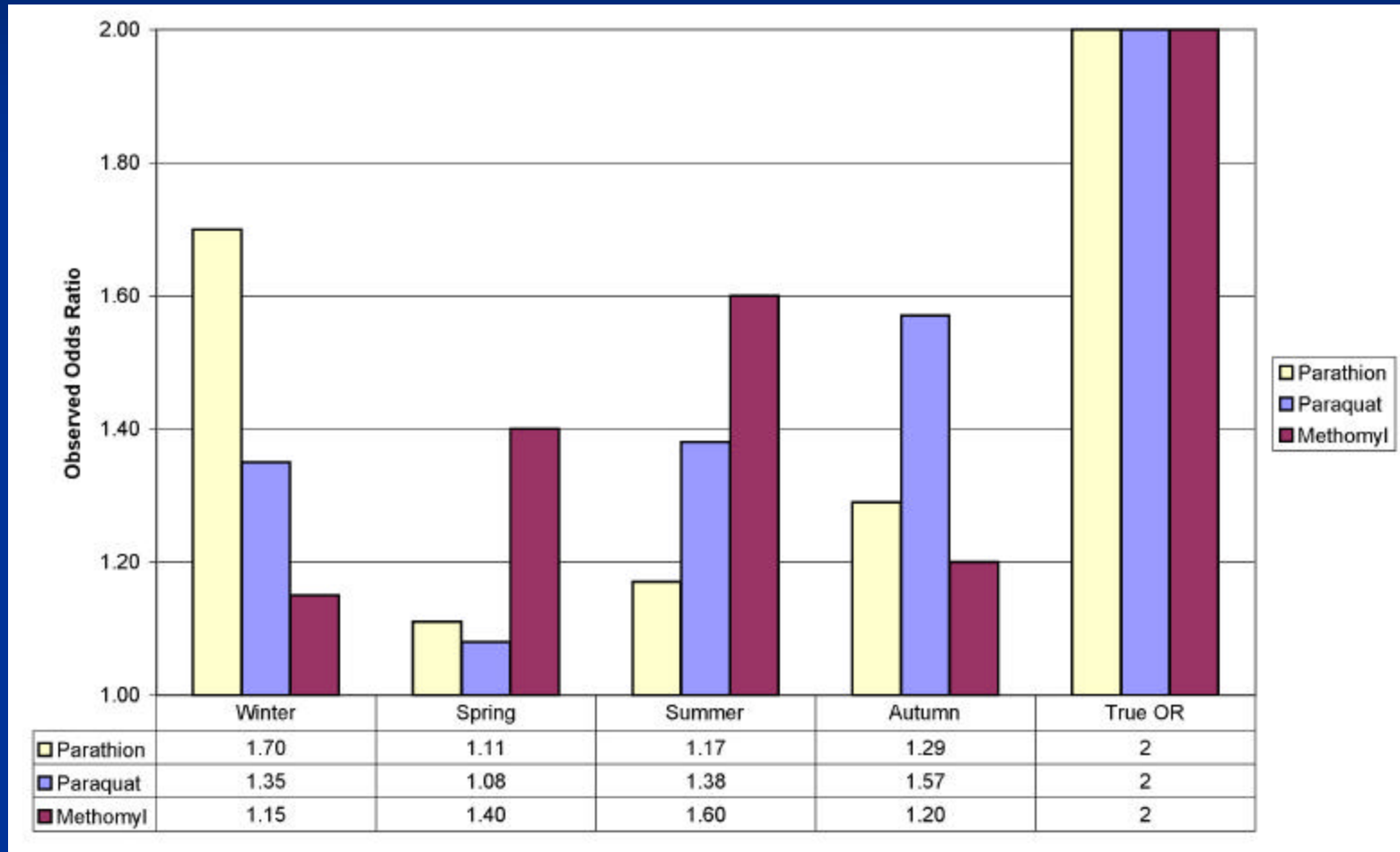
Study Limitations

- Potential changes in land-use during 2-year lag between 1988 year and 1990 LU survey
    - Changes in urban/rural gradient
    - Fields/orchards may enlarge, shrink, or change location
- Collapsing of field crops into 1 category
    - PUR-LU linkage less specific and accurate than for orchard crops

Study Limitations

- 500 or 1000m buffer radii may be a good indicator of exposure for some pesticides, but not others

- Dichotomous exposure categorization reflects no vs. any pesticide applied in proximity
  - How would results change with different definitions?