

IPM trends and data: two decades of pesticide use and risk

Michael Guzy, Peter Ellsworth, Al Fournier, Wayne Dixon,
Paul Jepson, John Palumbo, Wade Pronchinske



ENTOMOLOGY 2014. PDX.

New Perspectives on Changing Landscapes Offered by Big Data Approaches

Homage to worthy adversaries that play a minor role in this talk

- Too big to fit on my hard drive or in memory
- Too much time to compute: $O(2^n)$ or $O(n^2)$ or $O(\log(n))$
- Too many dimensions: e.g. ANN in place of NN; eigen methods
- Noise/Signal $\rightarrow \infty$: machine intelligence/statistical extraction
- Compression/decompression



BIG DATA



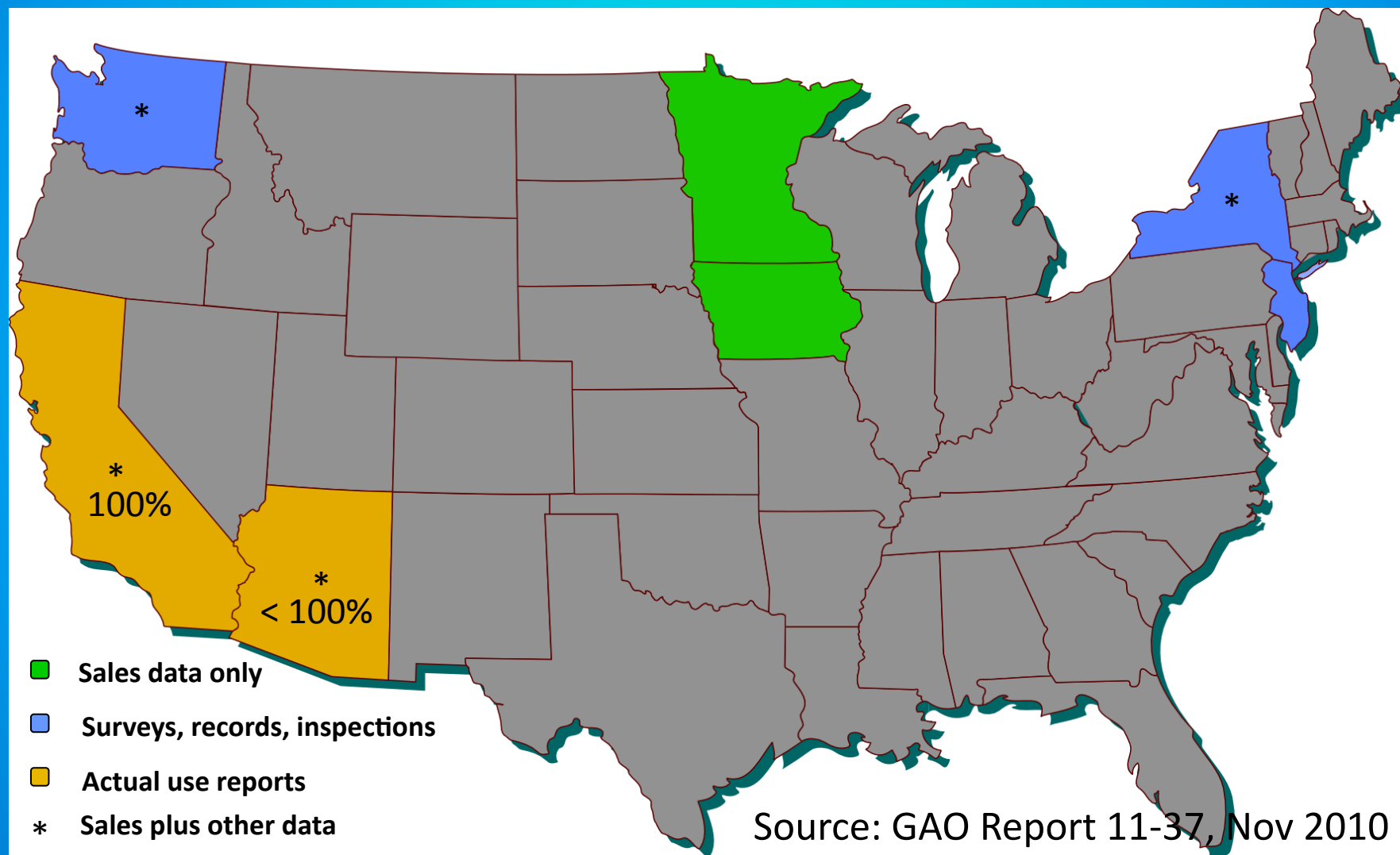
Big Data Stuff related to this talk

- Summary statistics: unbiased, minimum variance; more than one moment, densities (conditional)
- Wrangle, MUNG, auto-ingest (non-lossy casting)
- Lineage and Provenance for Scientific Data Management: quality, defensibility, reproducibility
- HITs: MTurk, crowd-sourcing, low-paid but high-skilled data-hounds
- Visualization



BIG DATA

Timely Pesticide Use Reporting





APMC Pesticide Use Database

Arizona Department of Agriculture
Environmental Services Division
1601 N. 1st Ave., Phoenix, AZ 85007
Phone 602-968-2466 Web-site www.azda.gov

Office Use Only

Form 1080

Seller _____ PSP # _____ Date _____
Grower _____ PGP # _____ County _____
Pest Conditions _____ PMA Area ☐ Yes ☐ No
Harvest Date _____ Worker Safety Reentry Interval _____ Days _____
Pesticide Application Date _____

Crop	Section	Township	Crop	Section	Township	Range	Acres

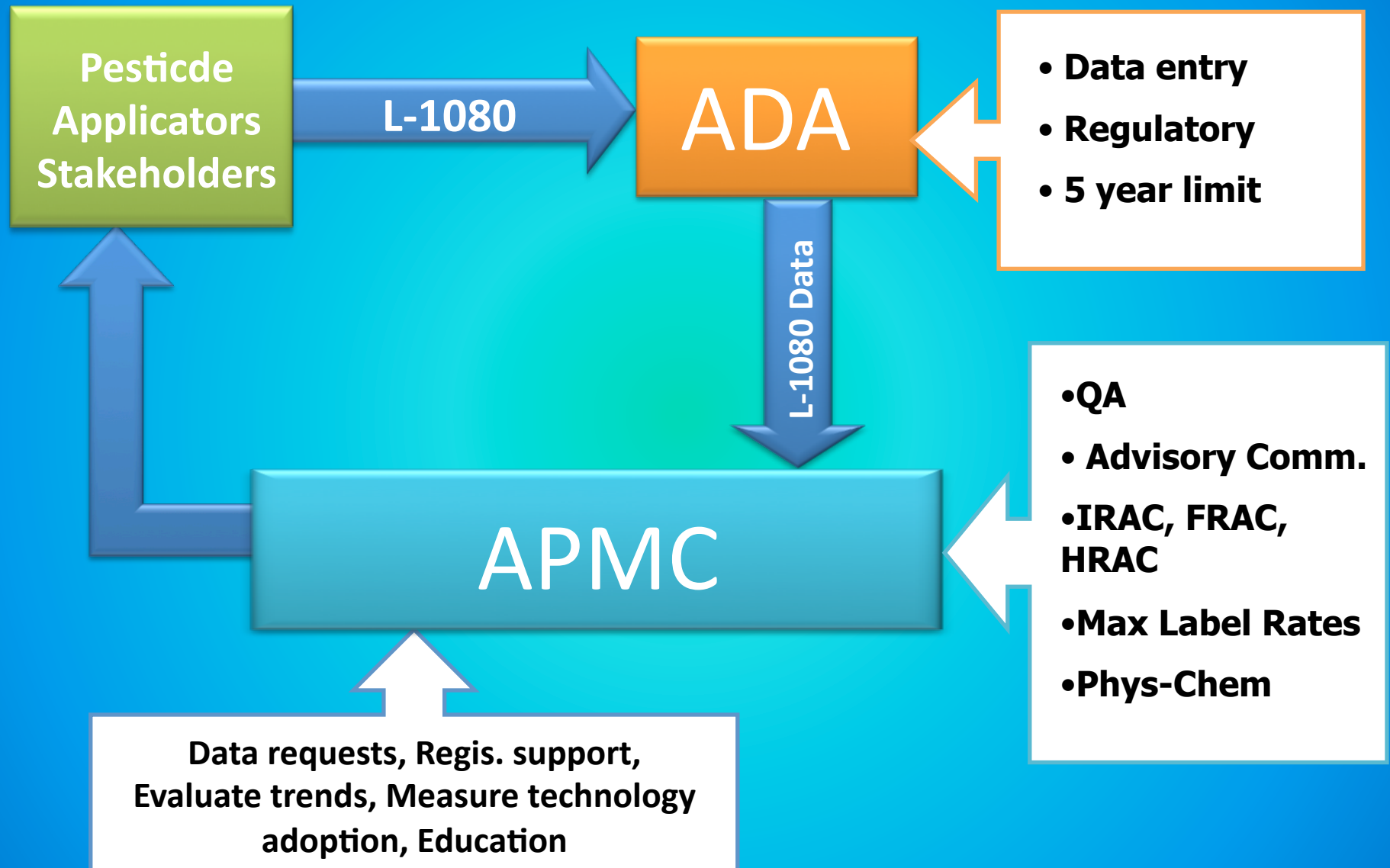
Additional Field Descriptions _____

Product/Brand Name	EPA Reg. No.	Active Ingredient	Rate & Unit of Measure/Acre	Dilution/100 GAL	Total Chemical

Total Acres _____ Total Volume Per Acre _____
Ground Water BMP ☐ Yes ☐ No DEQ Soil Applied ☐ Yes ☐ No Supplemental Label Required ☐ Yes ☐ No
☐ Air ☐ Ground ☐ Chemigation Other _____
Label Restrictions/Special Instructions _____

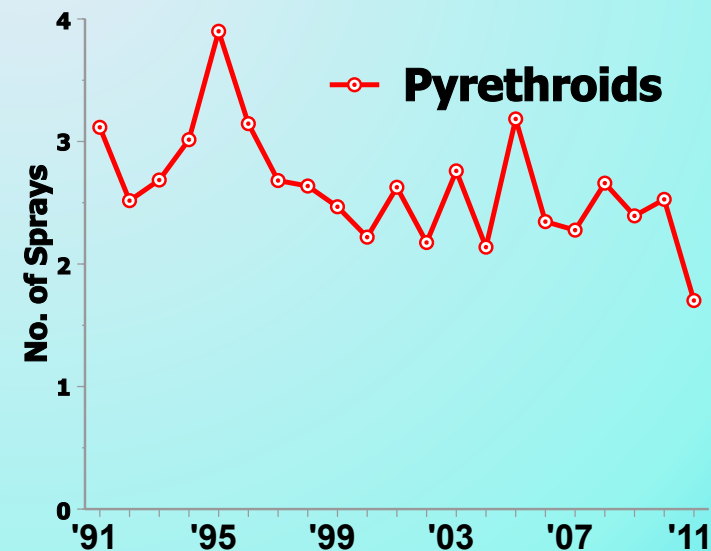
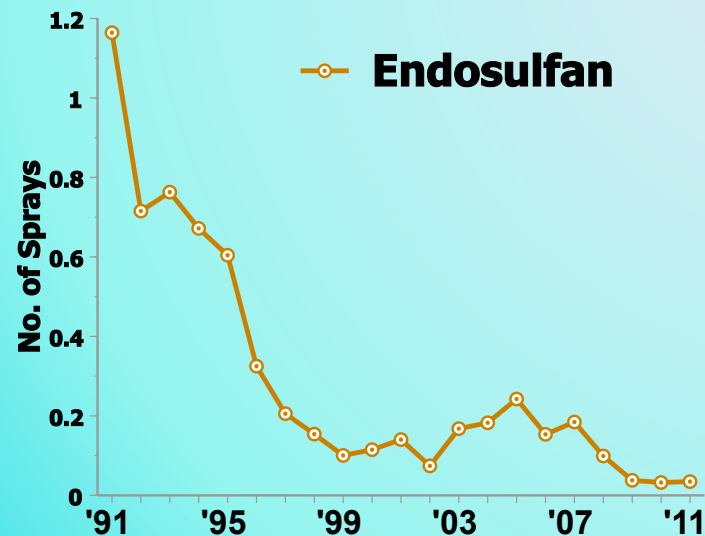
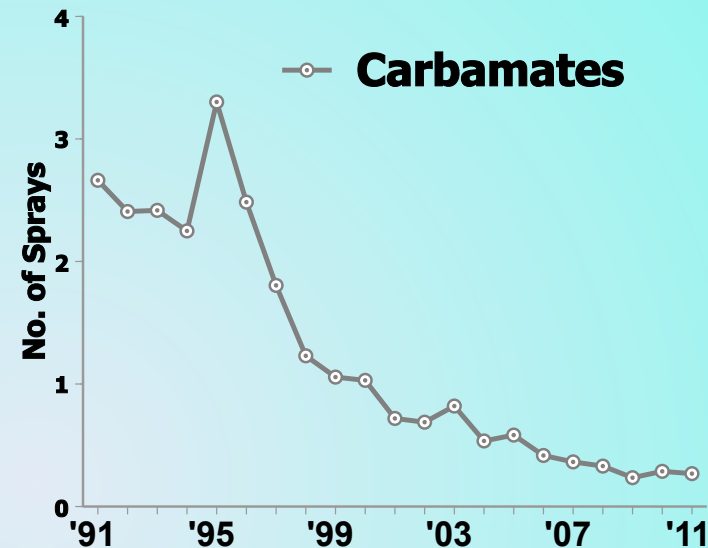
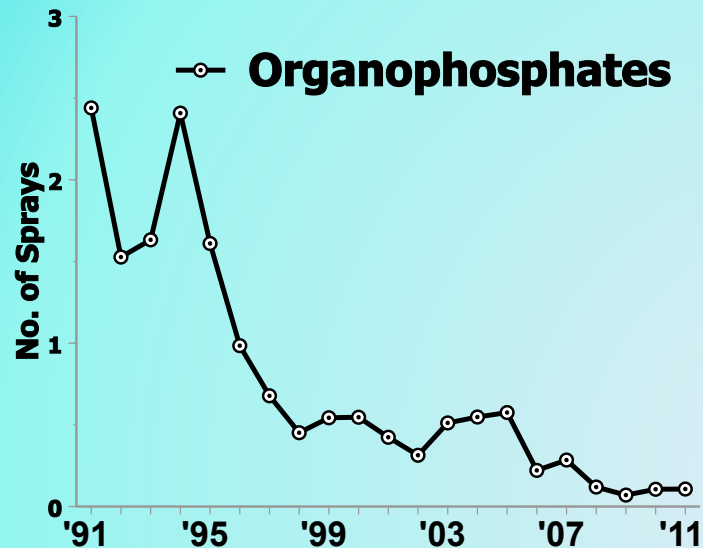
- Form 1080
- AZ Pesticide use 1991 – present
- $N \approx 10^6$
- Supports research, education, registration
- Verified, corrected data
- Integrated with ancillary information

Az L-1080 Information Flow



Data available upon request, pending approval from our advisory board

Broad Spectrum Insecticide Sprays





https://ipmprime.org/pesticides/



ipmPRiME Pesticide Risk Mi... x



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Pesticide Risk Assessment for Integrated Pest Management

IPM PRiME at Oregon State University



...provides improved security and usability, and will continue to deliver new tools and enhancements on a regular basis. ipmPRiME serves US and international agriculture with applications in research,

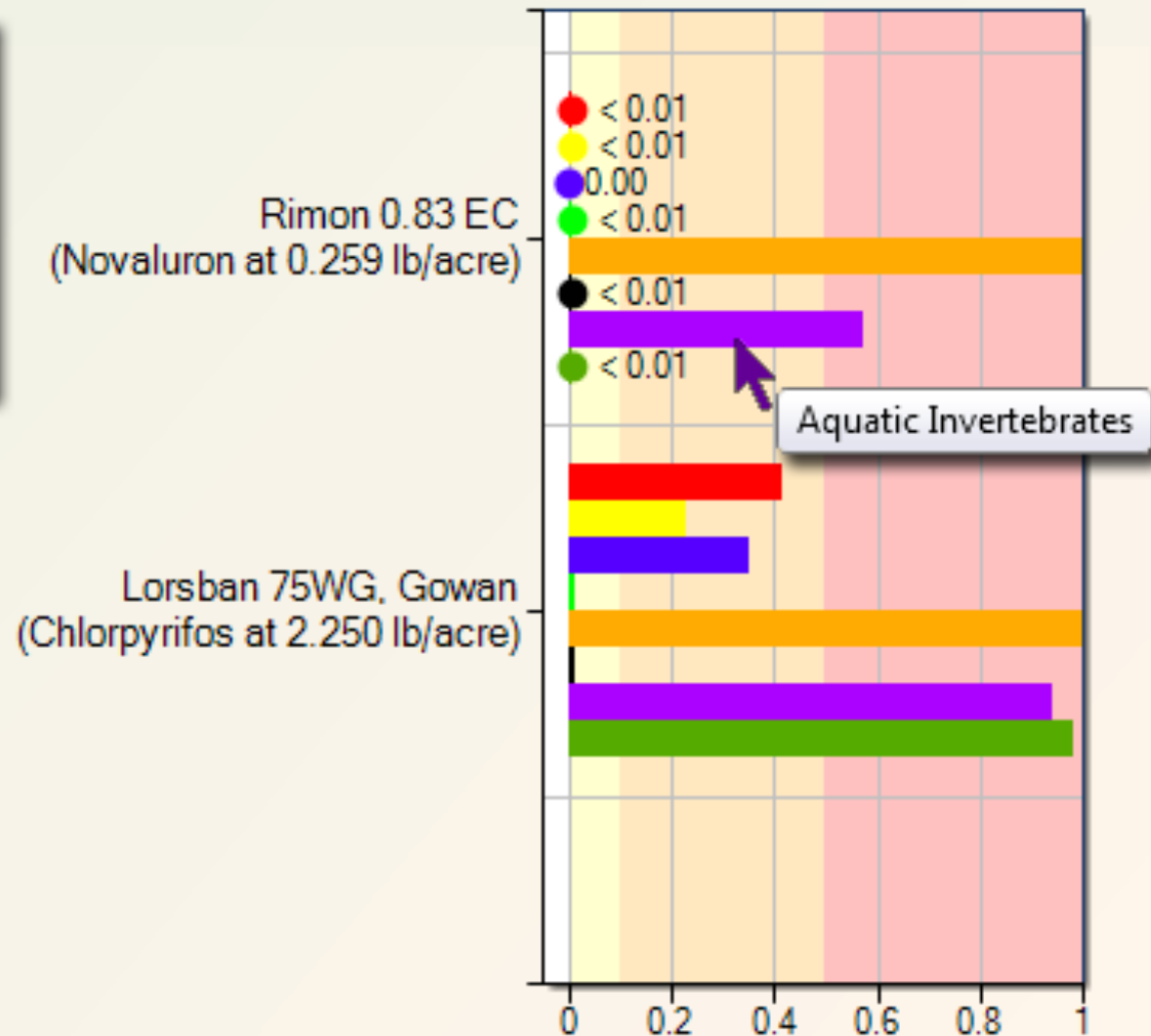
Farm: Evaluate pest management options using science-based tools.

System: Analyze patterns of many growers and sites.



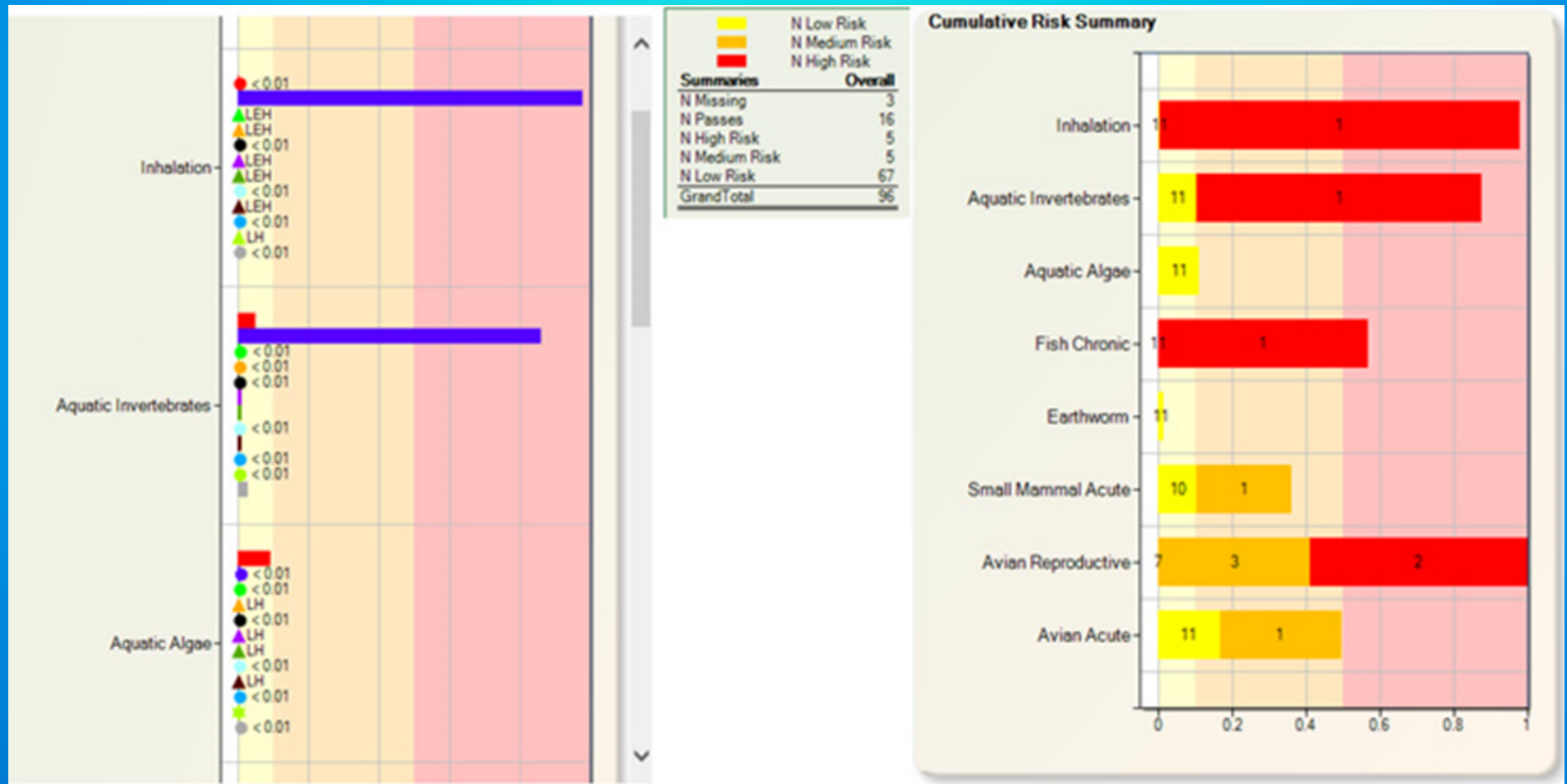
Index	Adverse Effect			
Aquatic Invert.				
Algal Acute				
Fish Chronic				
Small Mammal				
Avian Acute				
Avian Chronic				
Earth-worm				
Bystander inhalation				

$$\text{Risk} = \text{Pr}(\text{adverse event})$$

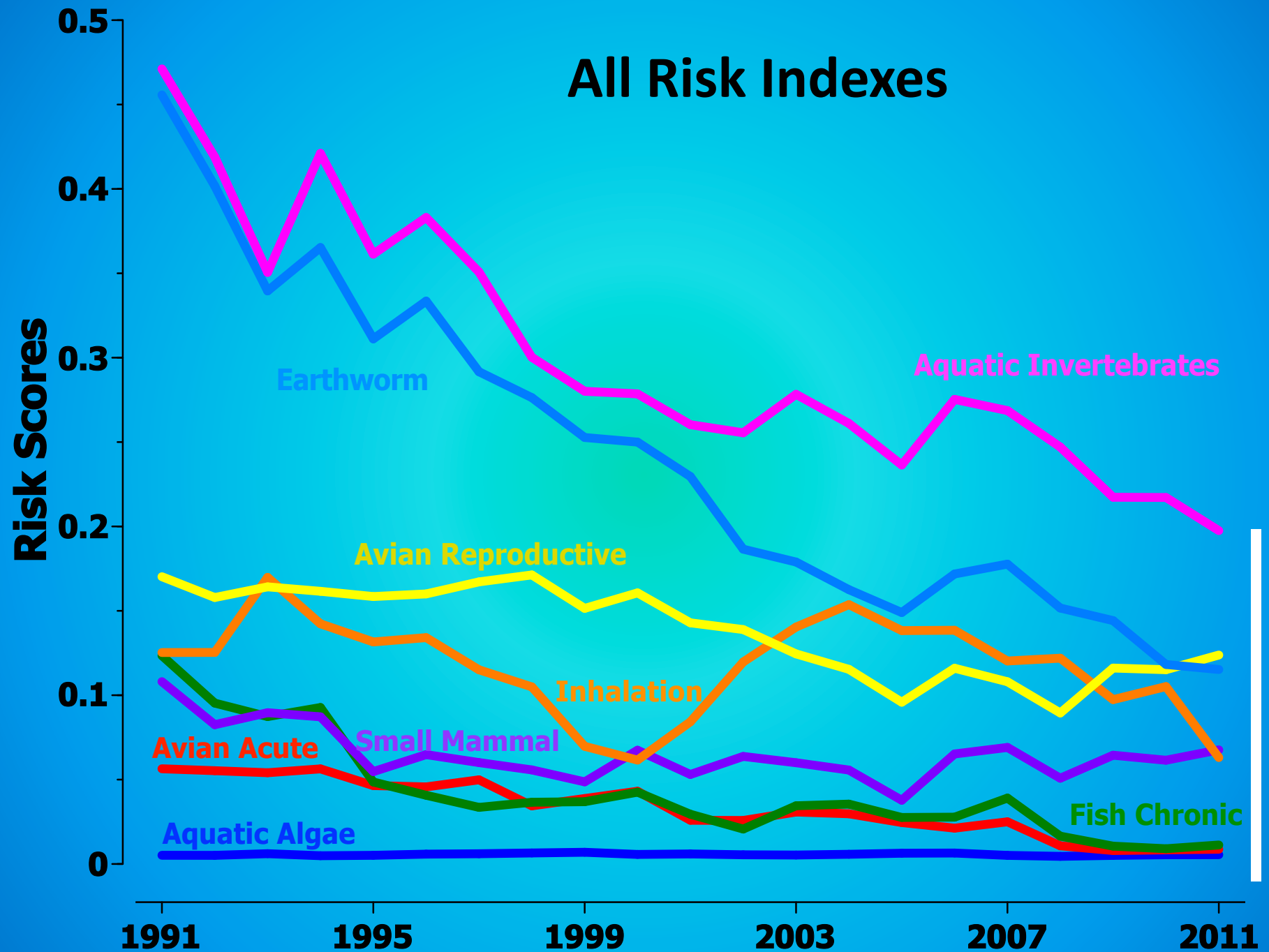


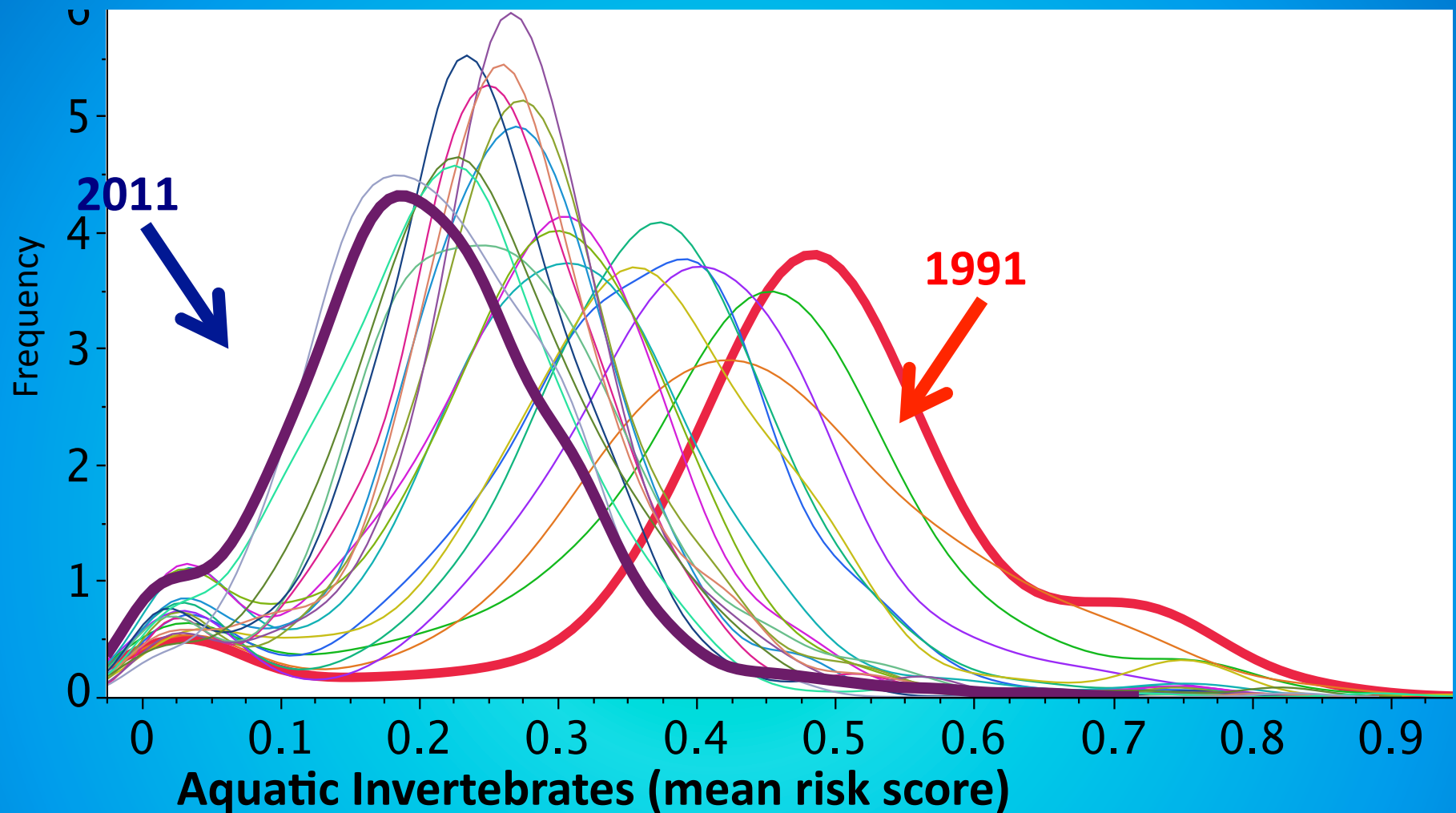
Independent Spray Events One-at-a-time & Cumulative

$$CR = 1 - \prod (1 - R_i)$$

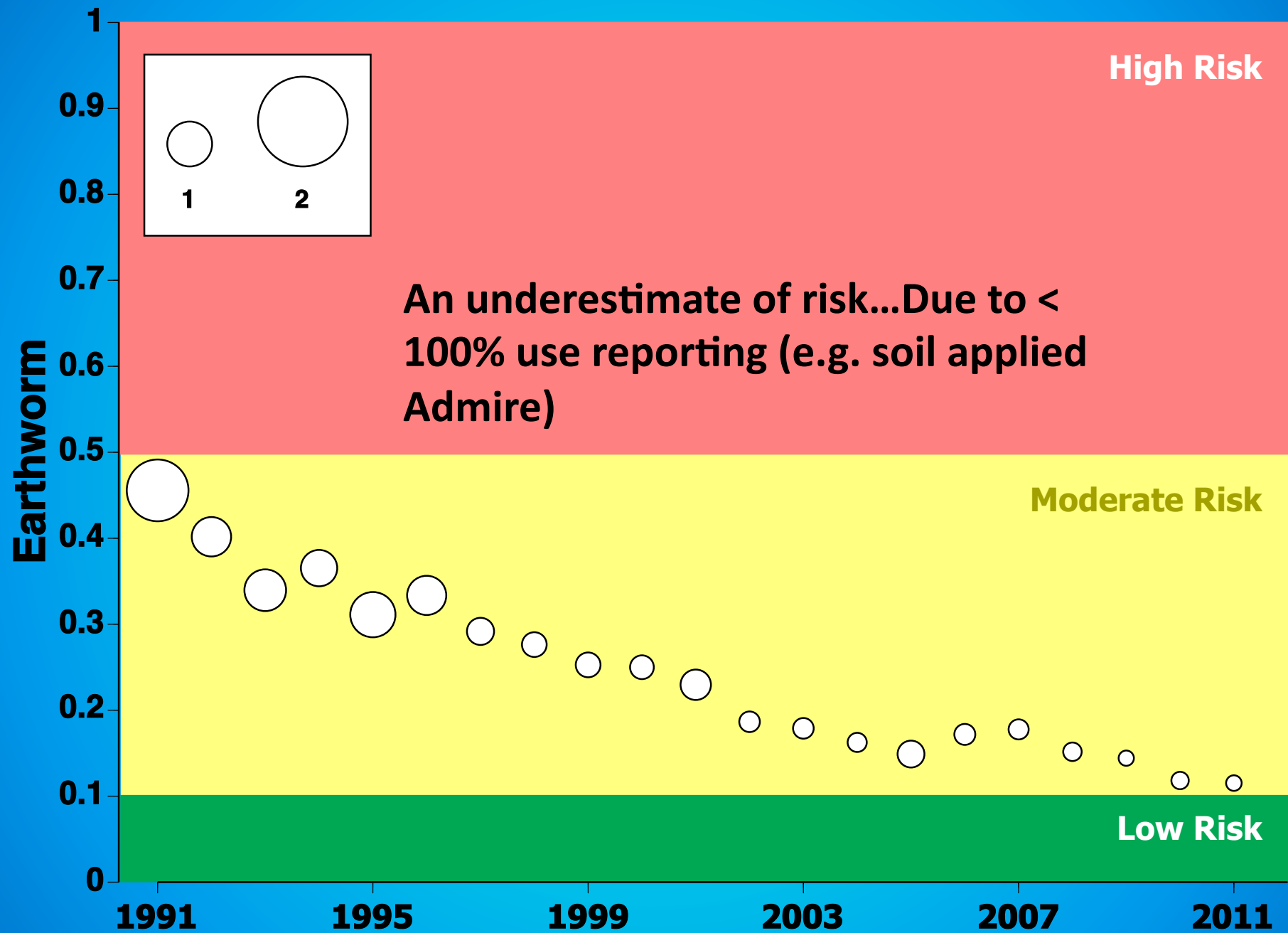


All Risk Indexes

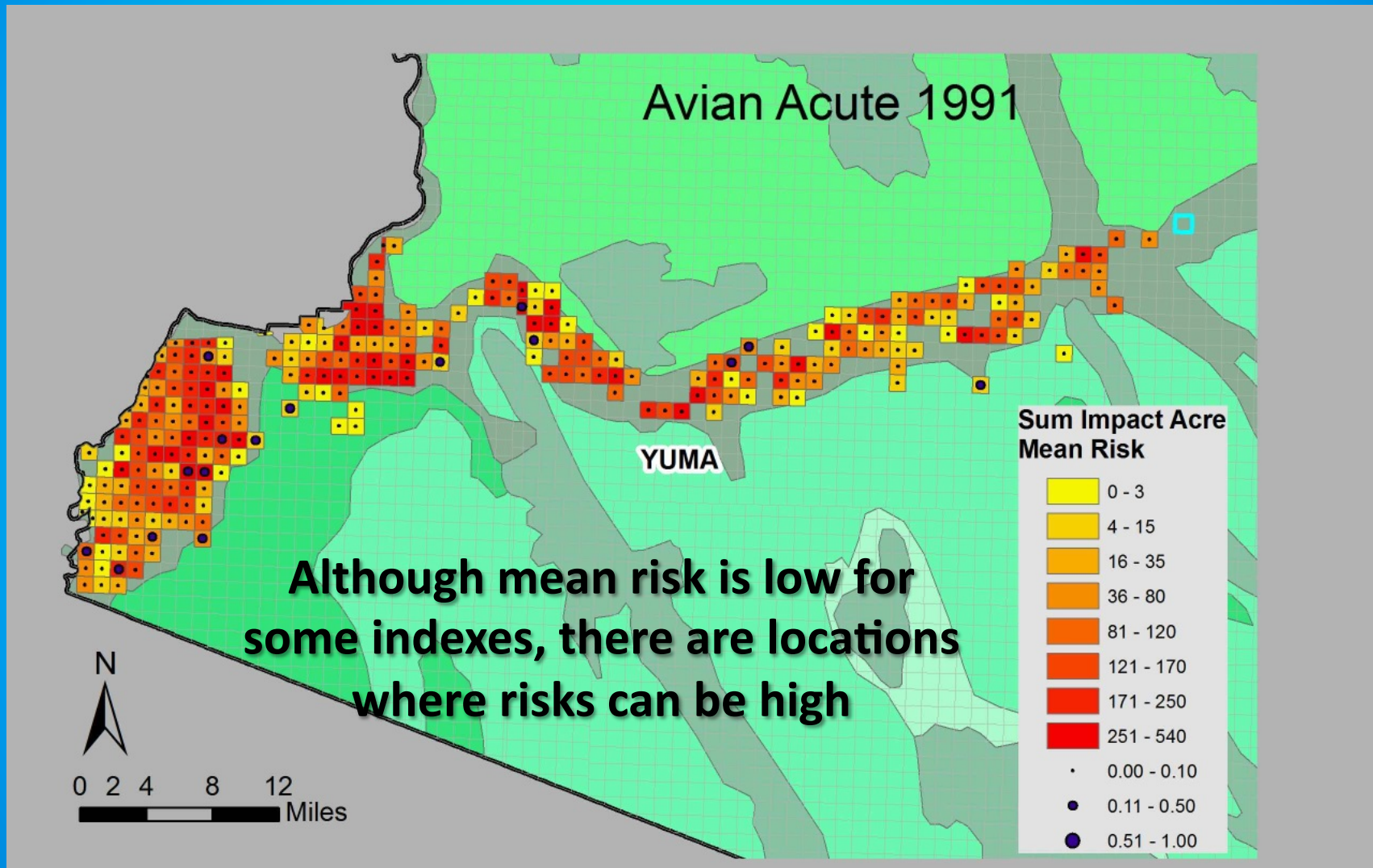




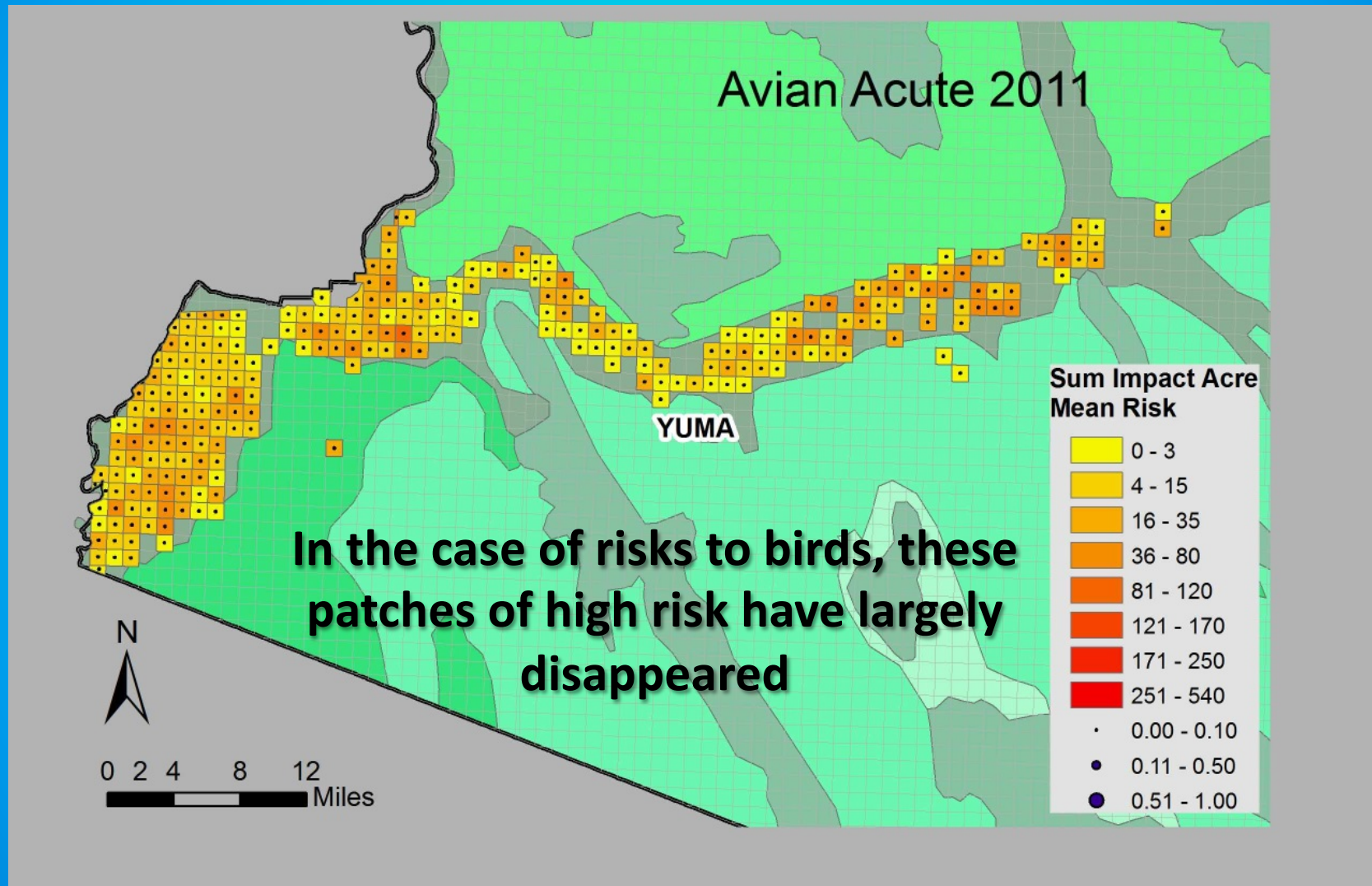
**The range of risk is still wide, although
the mean level of risk has declined over
time**



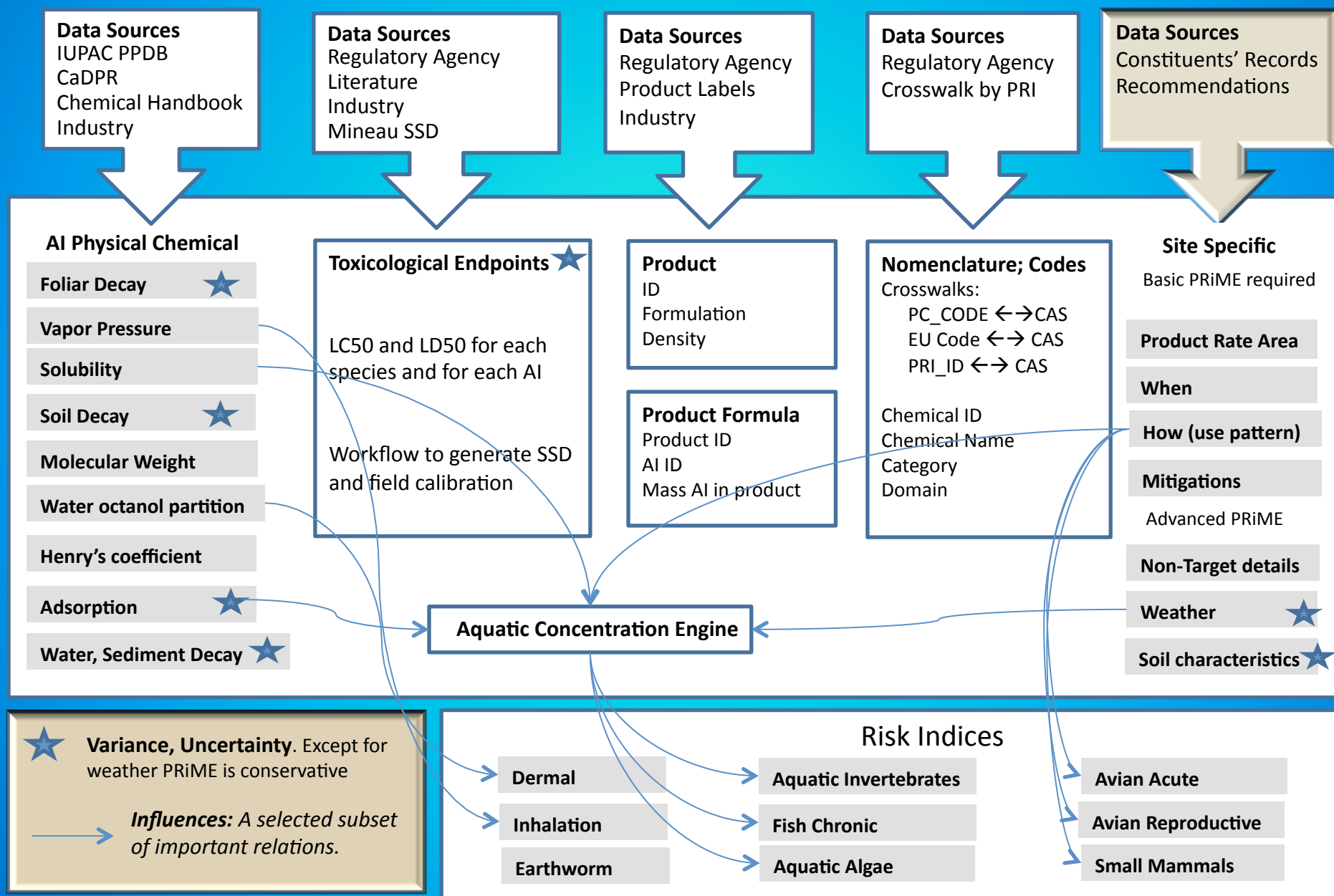
Arizona Lettuce



Arizona Lettuce

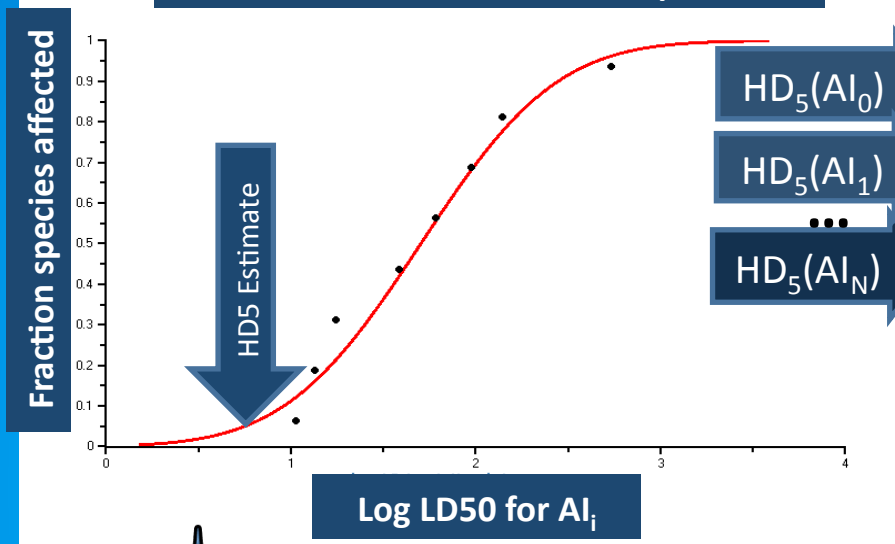


BIG DATA: ipmPRiME.org Pesticide Risk Assessment Data, Sources, Variances



SSD based, Field Fit ipmPRiME Risk

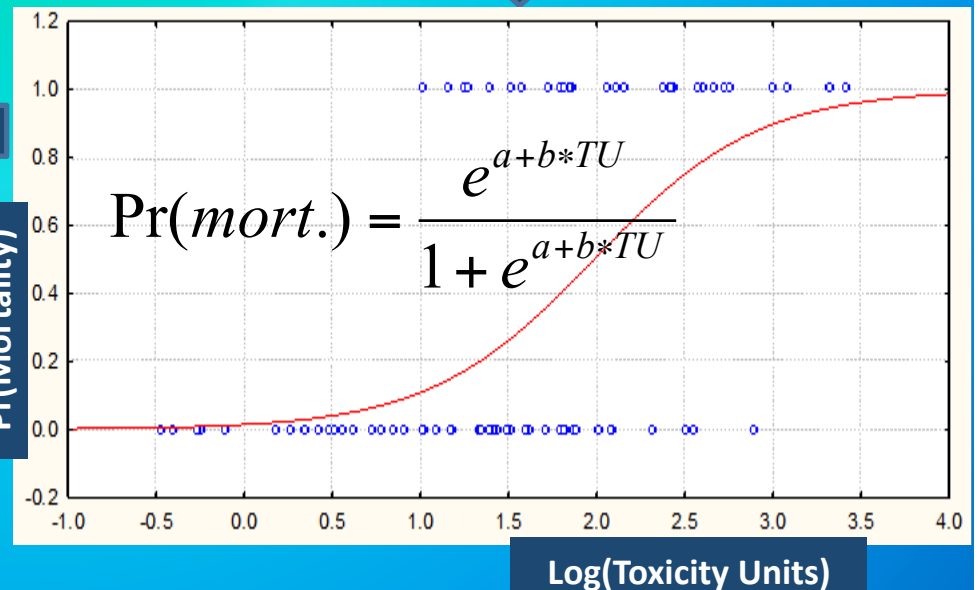
SSD for Each AI: $\Phi(\log(LD_{50}))$
Data for all available avian species



Acquire Avian Acute **Field Data**
Apply rules to accept/reject

Transform Observed Application Rates
Toxicity Units = $f(HD_5, \text{rate})$

Fit Field Data to **Logistic**
Ordinate = 1 if mortality observed; else 0



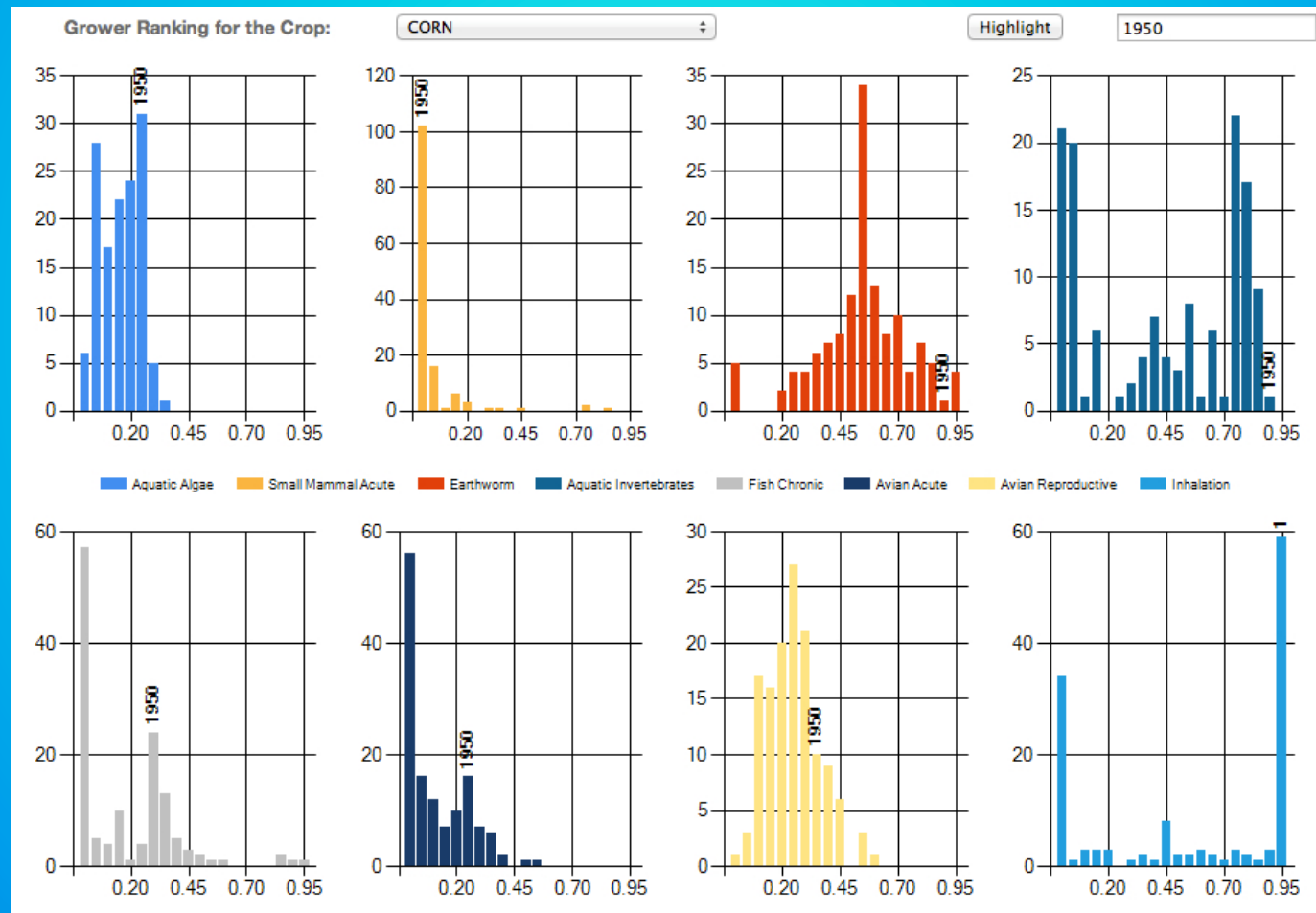
**Avian Acute
Risk Calc.**

**Grower Scenario
Tox. Units = f
(HD_5 , rate, ...)**

Avian Tox.:
 $LD_{50}(AI_0)$
Apply rules to
accept/reject

WORKFLOW

Some growers can determine where they lie in the risk spectrum relative to neighbors





THE END
thank-you

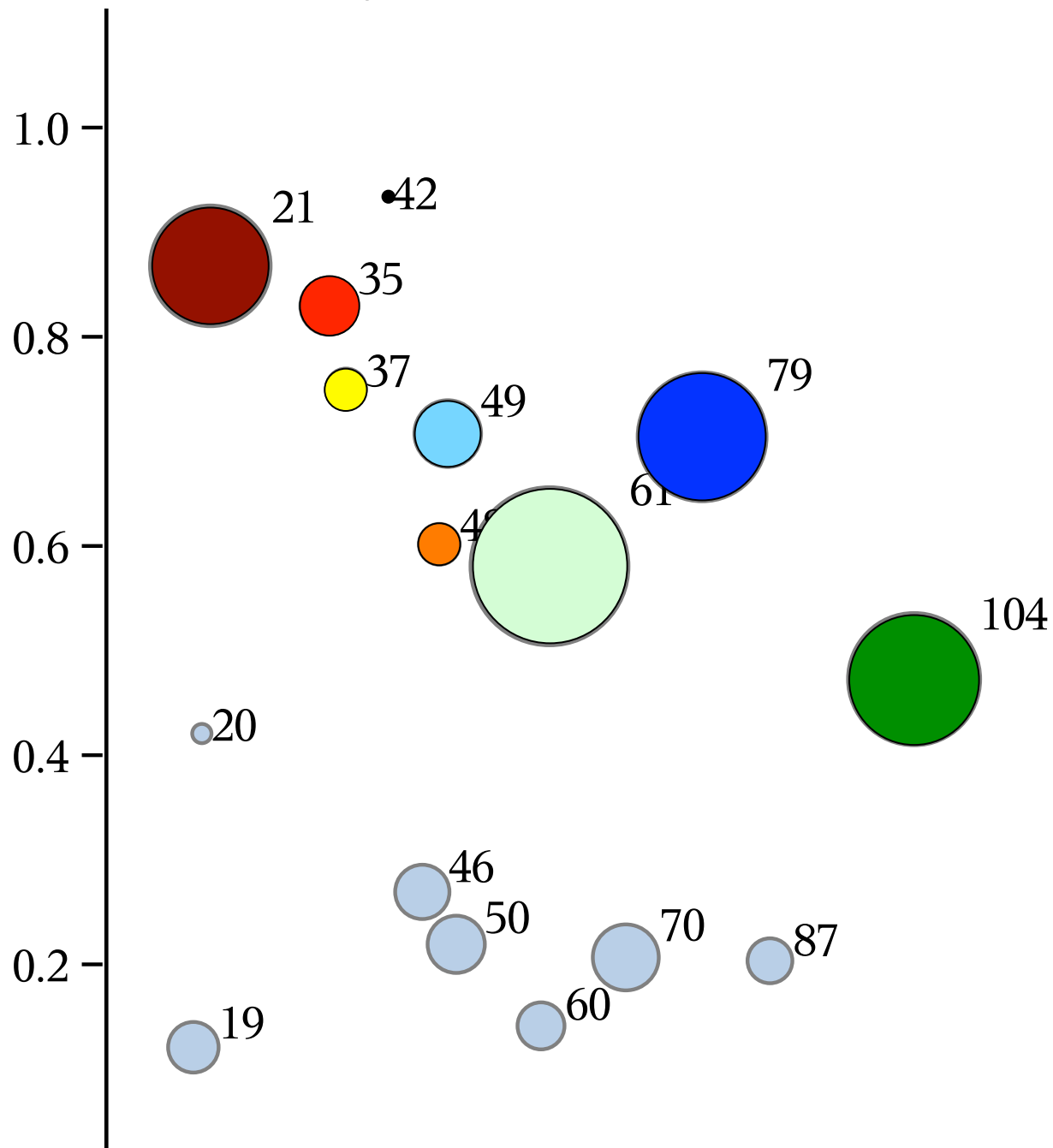


BIG DATA

2010

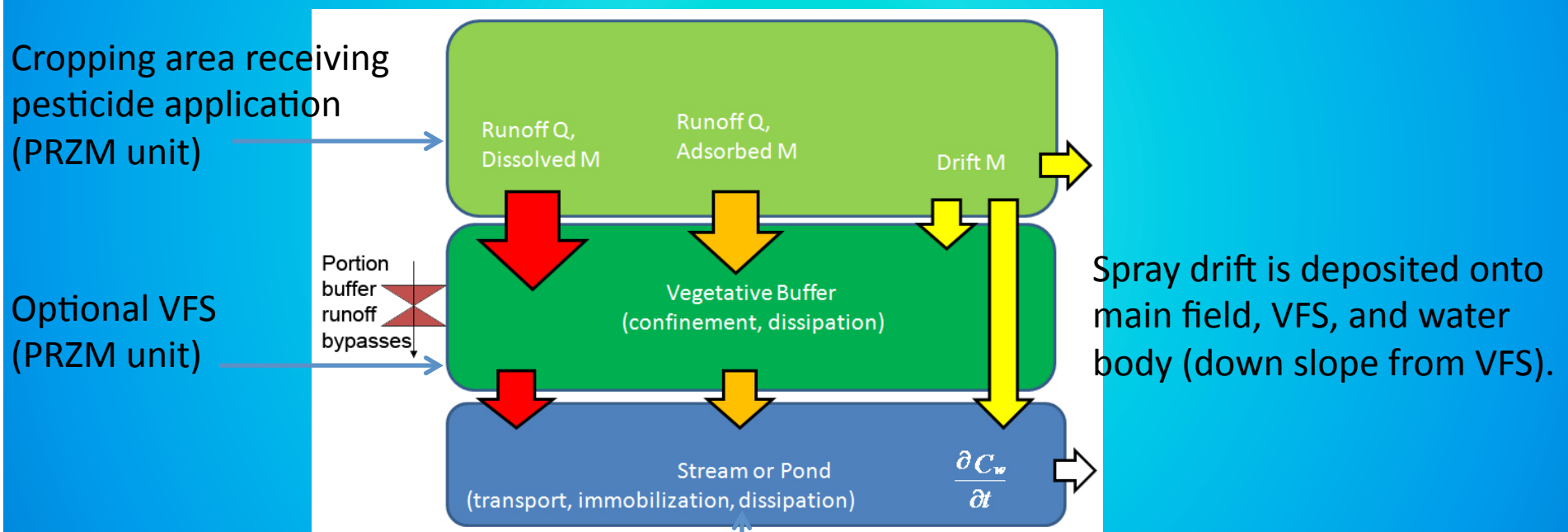
Aquatic Invertebrates

- 21, bifenthrin
- 35, cyfluthrin
- 37, cypermethrin
- 42, dimethoate
- 48, endosulfan
- 49, esfenvalerate
- 61, lambda cyhalothrin
- 79, permethrin
- 104, zeta-cypermethrin



Aquatic Pesticide Concentrations

PRiME uses a combination of the Pesticide Root Zone Model (PRZM) and the Exposure Analysis Modeling System (EXAMS) with an optional PRZM unit representing a vegetative filter strip (VFS).



The EXAMS water body is the ultimate receptor of pesticide loadings from the PRZM units.

Modeling Core = PRZM-PRZM-EXAMS shell (extended EXPRESS)



Arizona Pesticide Users

- >1,100 licensed growers
- >200 licensed PCAs
- >900 private & commercial applicators
- 41 aerial applicators

Uses Reported to ADA

- Custom “for hire”
- Aerial
- Soil applied, on Groundwater Protection List
- Section 18 only if label requires reporting
- Odoriferous pesticides



Form "L-1080"

- PCA initiates
 - Crop, location
 - Product, a.i., rate
 - Target pest(s)
- Applicator completes
 - Date of application
 - Deviations
 - Signature
- Submit to Arizona
Dept. of Agriculture



Arizona Department of Agriculture
Environmental Services Division
 1688 W. Adams, Phoenix, AZ 85007
 Phone 602-542-0901 Fax 602-542-0466 Web-site www.azda.gov

Office Use Only

Form 1080

Seller _____					PSP # _____					Date _____				
Grower _____					PGP # _____					County _____				
Pest Conditions										PMA Area ☐ Yes ☐ No				
Harvest Date _____		Label a.i. _____			Reentry Interval _____			Label Days to Harvest _____			Pesticide Application Date _____			
Crop	Section	Township	Range	Acres	Crop	Section	Township	Range	Acres					

Additional Field Descriptions _____

Product/Brand Name	EPA Registration No.	Active Ingredient	Rate & Unit of Measure/Acre	Dilution/100 GAL	Total Chemical

Total Acres _____	Total Volume Per Acre _____	DEQ Soil Applied ☐ Yes ☐ No	Supplemental Label Required ☐ Yes ☐ No	☐ Air ☐ Ground ☐ Chemigation
Ground Water BMP ☐ Yes ☐ No	Other: _____			

Label Restrictions/Special Instructions _____

Custom Applicator _____ Delivery Location _____

Grower/Pesticide Advisor's Signature _____ PGP/PCA Number _____

I, undersigned certify that the above instructions comply with Arizona Revised Statutes, Title 3, Article 6 and A.A.C. R3-3-302.

A.A.C. R3-3-302 PESTICIDE APPLICATION REPORT

I, the undersigned, certify that an application of pesticides was made by the designated applicator in strict compliance with the above recommendation and instructions on the date and under the conditions specified below.

Equipment Tag #	Time(s) of Application	Wind Direction & Velocity	Date(s) Applied

Deviation From Instructions _____

Company Name _____ PGP/CA # _____

Grower/Applicator Signature _____ PUP/PUC # _____

Print Operator(s)/Pilot Name _____ AAP # _____

THIS DOCUMENT MUST BE SUBMITTED TO THE ARIZONA DEPARTMENT OF AGRICULTURE NO LATER THAN THE THURSDAY FOLLOWING THE CALENDAR WEEK IN WHICH AN APPLICATION WAS COMPLETED.

Copy Distribution: Two Copies to Applicator -- One Copy to Advisor -- One Copy to Seller -- One Copy to Grower -- One Copy to ADA

User Data—web interface

Product	EPA Reg. No.	Product App Rate	Active Ingredient(s) App Rate	Use Pattern	Date/Time
DELIVER BIOLOGICAL INSECTICIDE	70051-69	0.500 lb/ac	[Bacillus thuringiensis (berliner), subsp. Kurstaki, strain SA-11 0.425 lb/acre]	Use Pattern/liquid/air blast/orchards and dormant vineyards/	5/6/2009 12:00:00 AM
EPI-MEK 0.15 EC MITICIDE/INSECTICIDE	100-1154	0.494 floz/ac	[Avermectin 4.634E-003 lb/acre]	Use Pattern/liquid/air blast/orchards and dormant vineyards/	5/24/2009 12:00:00 AM
PROKIL CRYOLITE 96	10163-41	6.000 lb/ac	[Cryolite 5.760 lb/acre]	Use Pattern/liquid/air blast/orchards and dormant vineyards/	5/24/2009 12:00:00 AM
MOVENTO	264-1050	6.748E-002 floz/ac	[Spirotetramat 1.059E-003 lb/acre]	Use Pattern/liquid/air blast/orchards and dormant vineyards/	5/24/2009 12:00:00 AM
WILBUR-ELLIS BT 320 SULFUR 25 DUST	2935-399	20.000 lb/ac	[Bacillus thuringiensis, subsp. Kurstaki, strain ABTS-351, fermentation solids and solubles 0.116 lb/acre][Sulfur 5.000 lb/acre]	Use Pattern/liquid/air blast/orchards and dormant vineyards/	6/3/2009 12:00:00 AM
WILBUR-ELLIS BT 320 SULFUR 25 DUST	2935-399	22.500 lb/ac	[Bacillus thuringiensis, subsp. Kurstaki, strain ABTS-351, fermentation solids and solubles 0.131 lb/acre][Sulfur 5.625 lb/acre]	Use Pattern/liquid/air blast/orchards and dormant vineyards/	6/9/2009 12:00:00 AM
WILBUR-ELLIS BT 320 SULFUR 25 DUST	2935-399	20.000 lb/ac	[Bacillus thuringiensis, subsp. Kurstaki, strain ABTS-351, fermentation solids and solubles 0.116 lb/acre][Sulfur 5.000 lb/acre]	Use Pattern/liquid/air blast/orchards and dormant vineyards/	6/15/2009 12:00:00 AM
DELIVER BIOLOGICAL INSECTICIDE	70051-69	0.500 lb/ac	[Bacillus thuringiensis (berliner), subsp. Kurstaki, strain SA-11 0.425 lb/acre]	Use Pattern/liquid/air blast/orchards and dormant vineyards/	7/10/2009 12:00:00 AM