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Species-specific refined endangered species risk assessment for static aquatic habitats: Part 1, exposure modeling

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Summary

Following NAS recommendations, the US EPA, FWS, NMFS, and USDA adopted an interim approach for conducting endangered species assessments for pesticides.

The exposure component of the screening level assessment is purposefully conservative. As such, a significant number of species are expected to require refined exposure modeling to obtain a realistic estimate of potential effects.

The EPA's current aquatic exposure modeling approach is not sufficiently representative of the variety of environmental and agronomic conditions found in specific species habitat ranges.

This presentation introduces a refined aquatic exposure modeling approach for malathion applied to species inhabiting medium and high volume static water habitats (bin 6 & 7) in the Ohio River basin (HUC2 05).

The approach is designed to fit within a tiered risk assessment framework to determine the potential effects of pesticide use to endangered species.

EPA aquatic exposure modeling approach with limited spatial resolution

1 or 2 simulations associated with HUC2 watersheds for each crop and habitat size using PRZM5/VVWM. Apply to all species in HUC2.

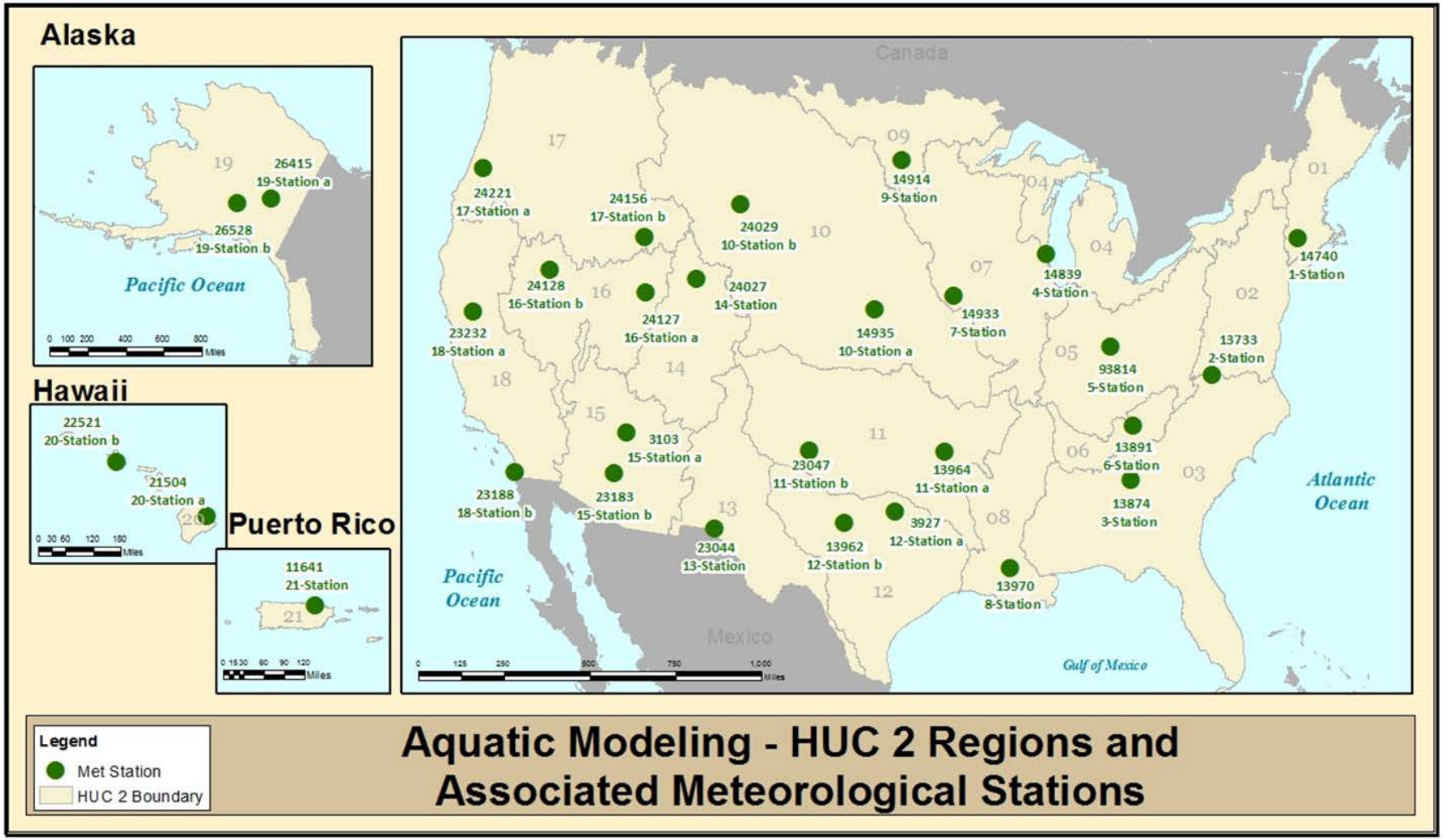
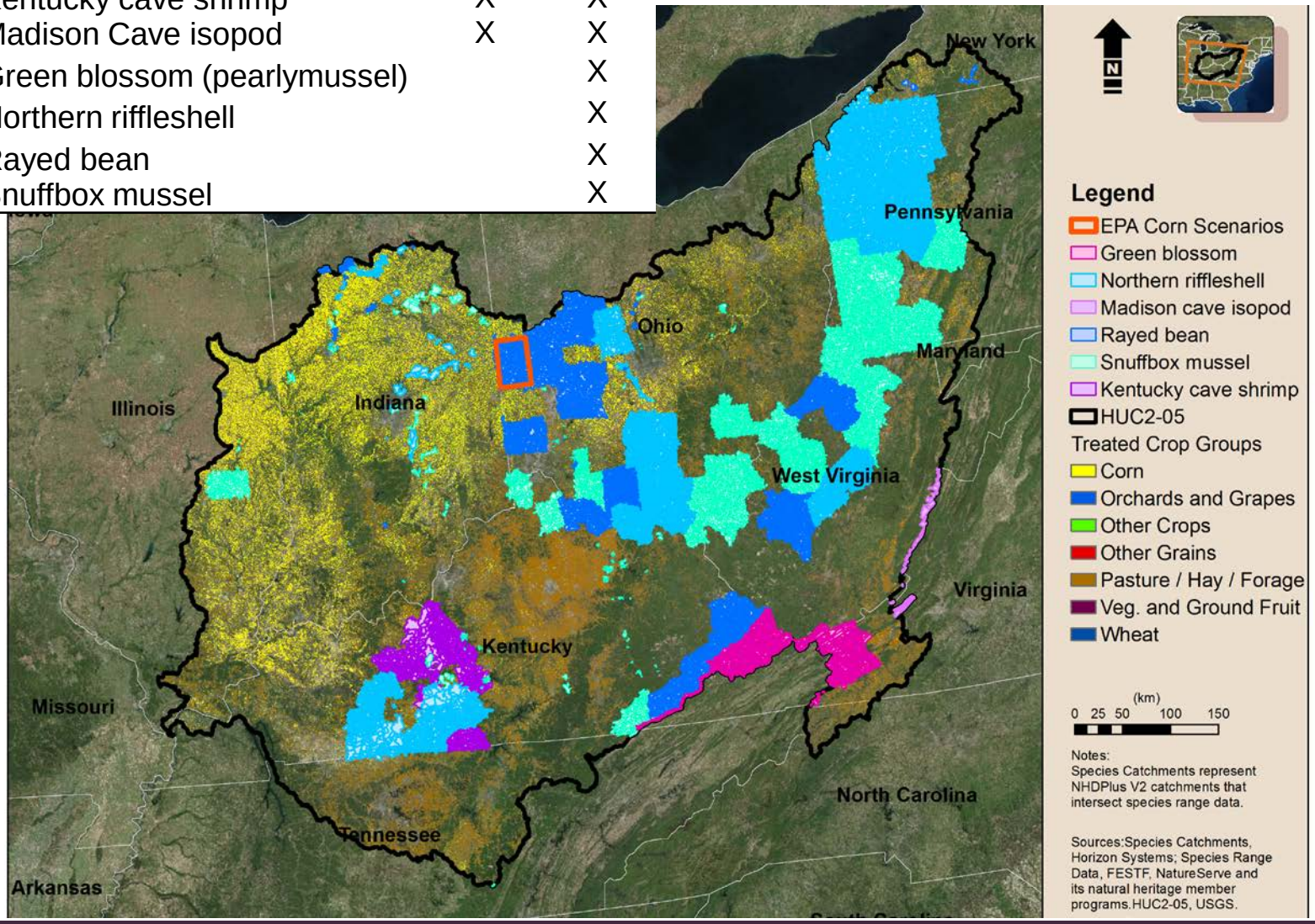


Figure 3-1 from EPA malathion BE Chapter 3 exposure characterization

Pilot of approach for HUC2 05 Ohio River Basin

Evaluated 6 species from the most sensitive taxa (crustaceans and mollusks)

Taxa	Species Common Name	Bin 6	Bin 7
Crustacean	Kentucky cave shrimp	X	X
Crustacean	Madison Cave isopod	X	X
Mollusks	Green blossom (pearlymussel)		X
Mollusks	Northern riffleshell		X
Mollusks	Rayed bean		X
Mollusks	Snuffbox mussel		X



Refined modeling approach

Parameterize PRZM5/VVWM inputs to environmental conditions observed in individual species ranges

Incorporate more realistic landscape characteristics

- Drainage area/normal capacity
- Application date range
- Soil & slope distribution
- Regional weather distribution
- Range of drift fractions based on crop proximity
- Distribution of local crops and corresponding percent cropped area
- Percent treated area

Make many simulations to sample the range of conditions

- 1000 30-year *realizations* per species and habitat bin

Evaluate the probability of exposures across the species range

Water body and watershed characteristics

	Habitat Bin 6	Habitat Bin 7
Volume Range (m^3)	100 - 20,000	> 20,000
Modeled Volume (m^3)	100	20,000
Depth (m)	1	2
Width (m)	10	100
Length (m)	10	100
Watershed Area (m^2)	500	100,000
Drainage area/Normal capacity	5	5

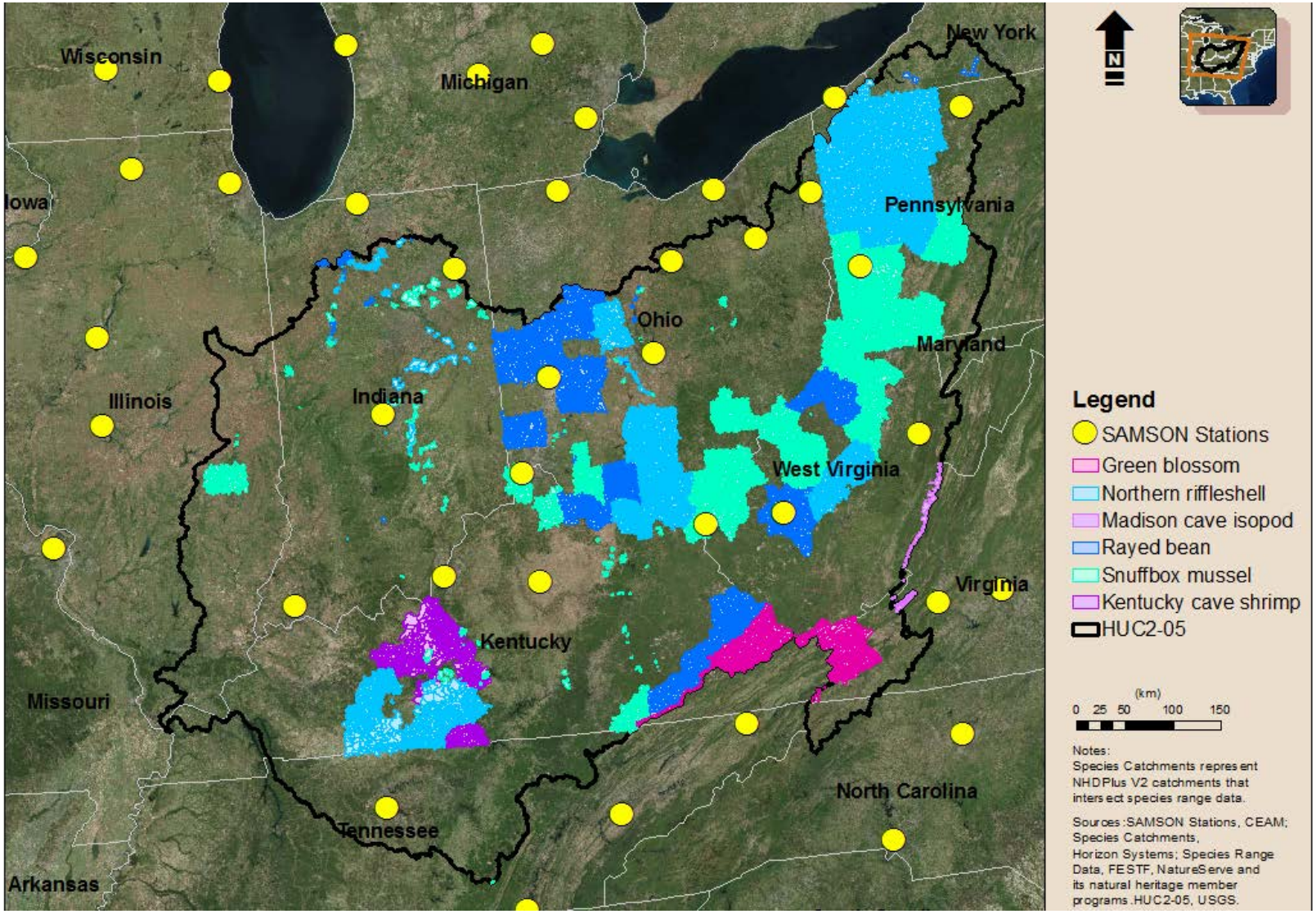
Water body dimensions at low end of range provided by EPA/Services for each habitat bin

Drainage area/normal capacity determined following a water balance approach, constrained to 5 to 15 m^2/m^3

Values outside of this range not consistent with conceptual model of static water body without significant overflow/flow-through

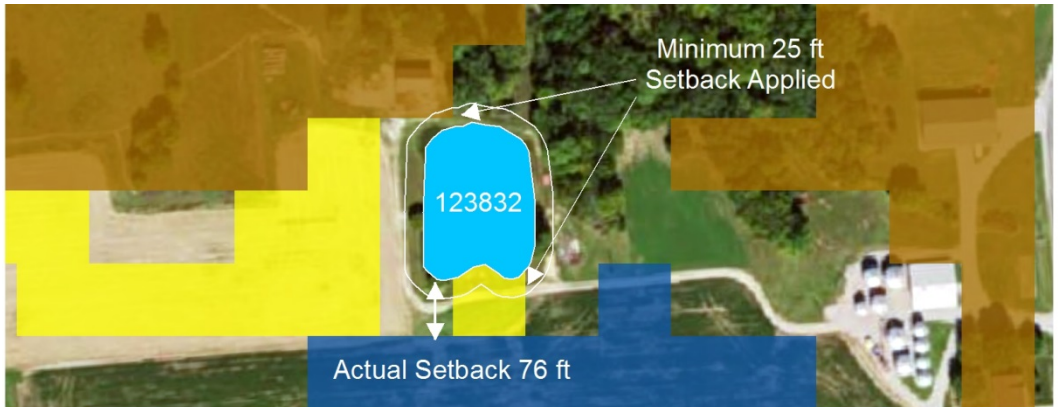
Weather stations

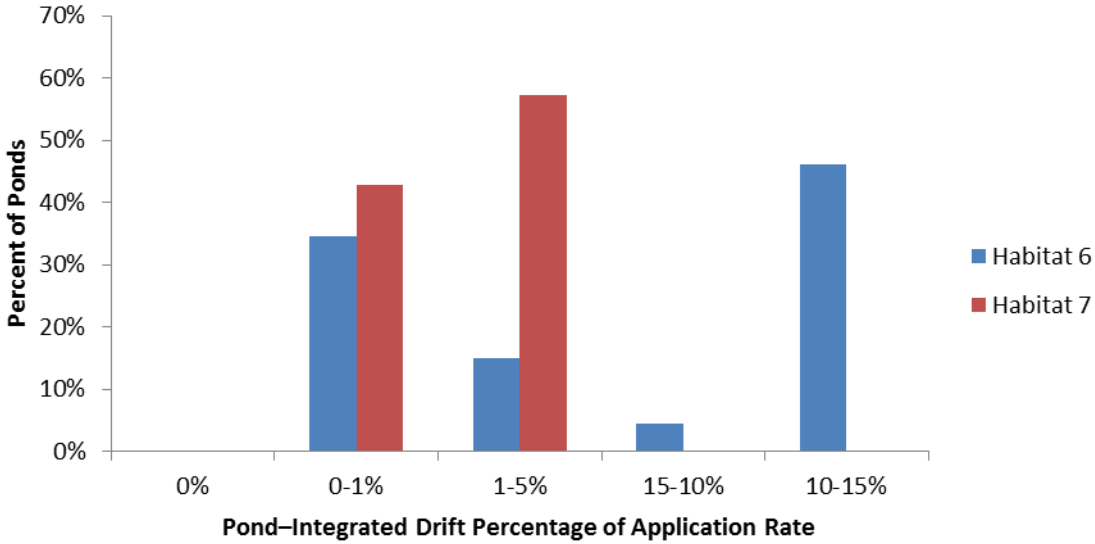
Distribution of SAMSON weather stations in each species range, sampled randomly in the 1000 realizations per species and habitat bin, proportional to the area around each station that overlapped with species range

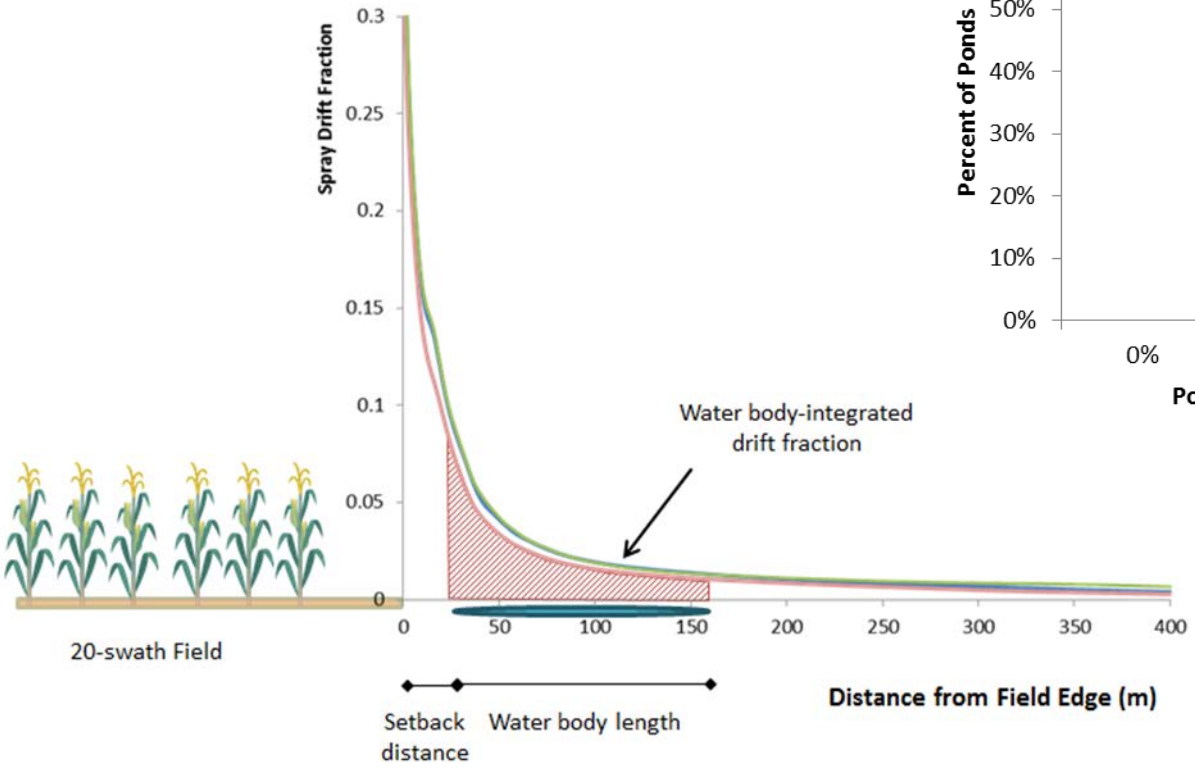


Spray drift calculated based on proximity and label restrictions

- Aerial applications
- 25 ft spray buffer
- AgDISP version 8.26
- Higher drift fractions possible for smaller water body







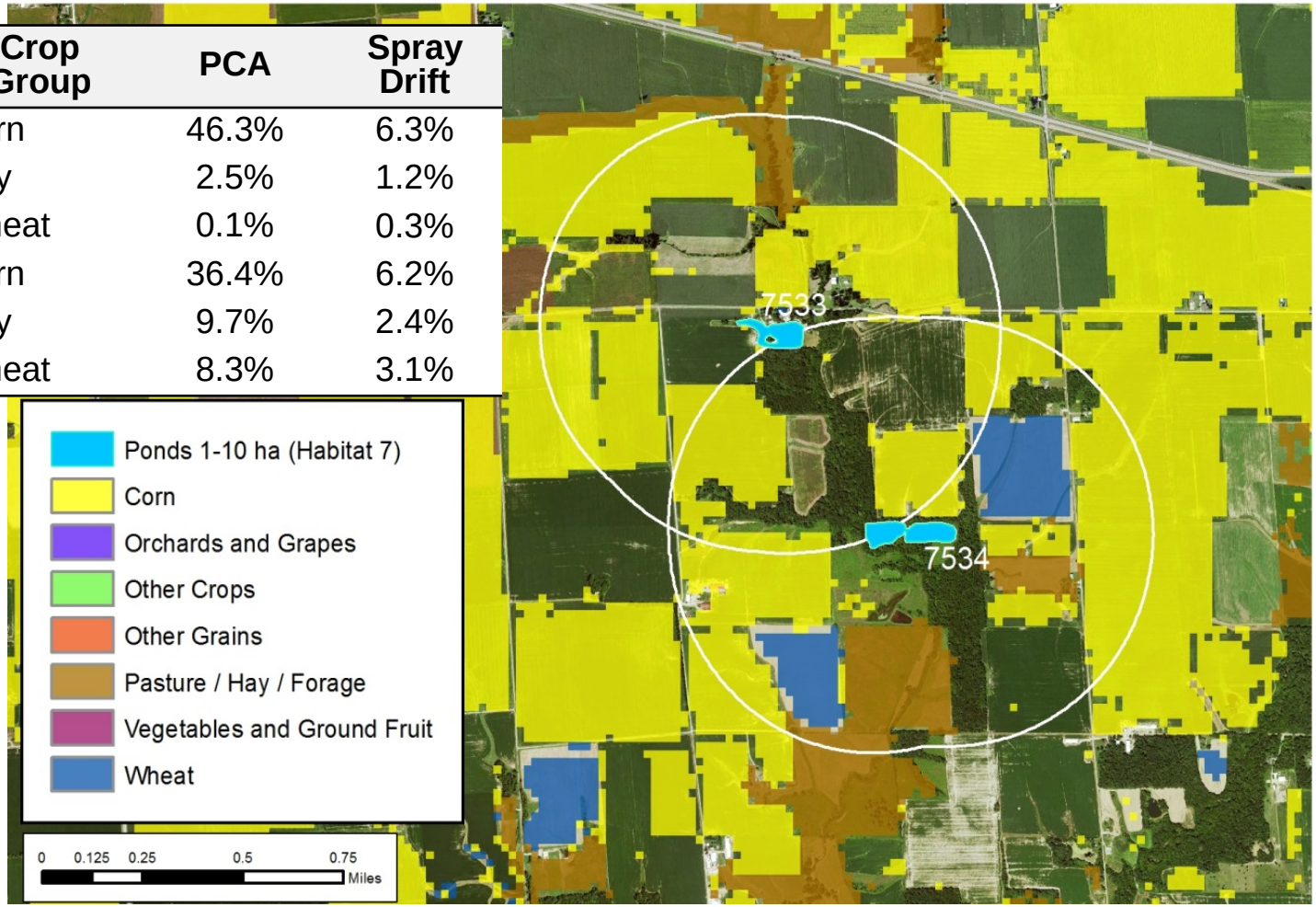
Crop configurations based on actual crops occurring in approximate watershed around ponds

Spatial analysis to determine multi-crop PCAs in approximate pond watershed

Up to 5 crops (each a unique PRZM simulation) per configuration, PCA and spray drift correlated for each crop

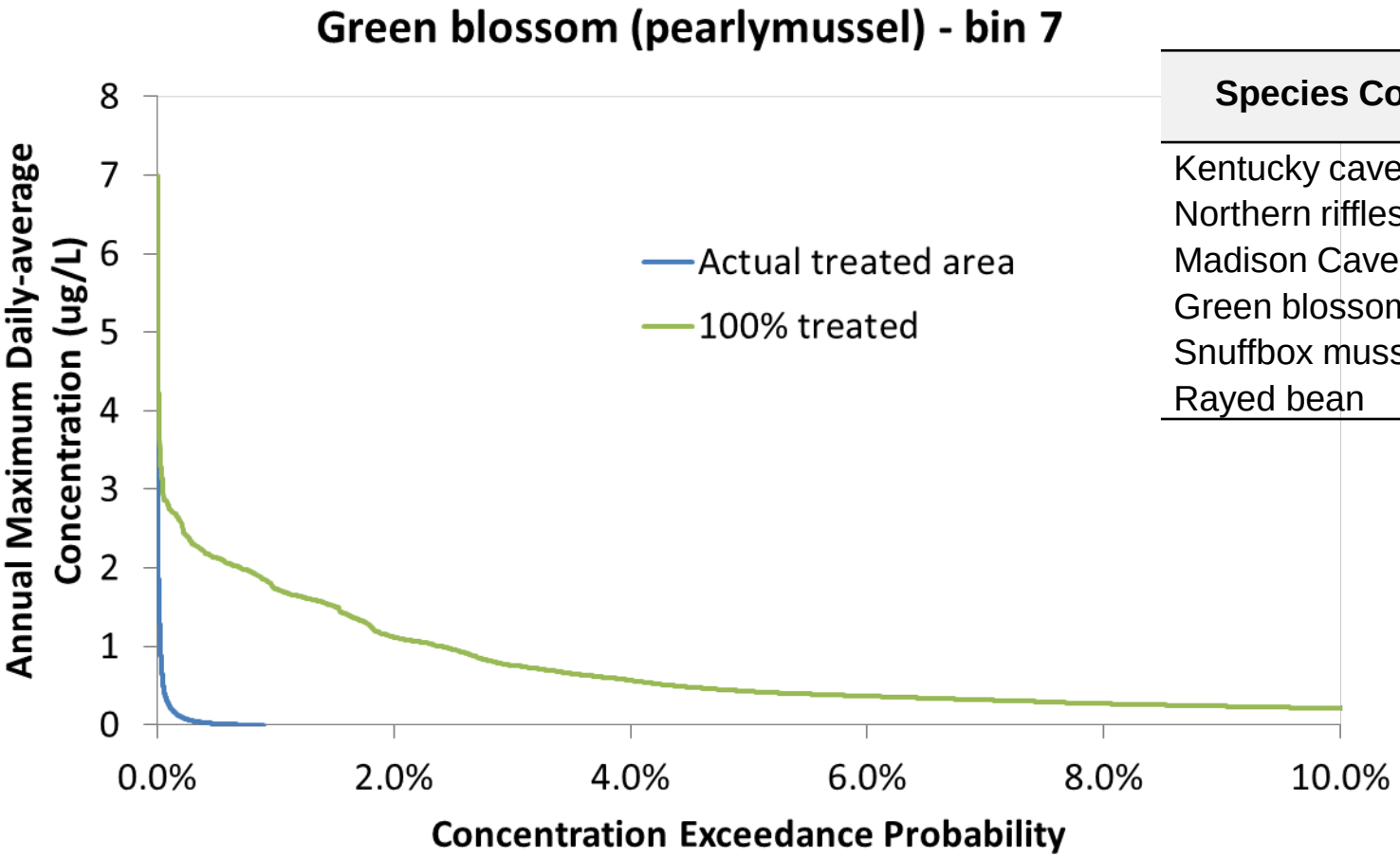
Crop Config.	Pond	Habitat	Crop Group	PCA	Spray Drift
1	7533	7	Corn	46.3%	6.3%
1	7533	7	Hay	2.5%	1.2%
1	7533	7	Wheat	0.1%	0.3%
2	7534	7	Corn	36.4%	6.2%
2	7534	7	Hay	9.7%	2.4%
2	7534	7	Wheat	8.3%	3.1%

Distribution of crop configurations sampled randomly to create 1000 realizations



Comparison of percent treated area assumptions

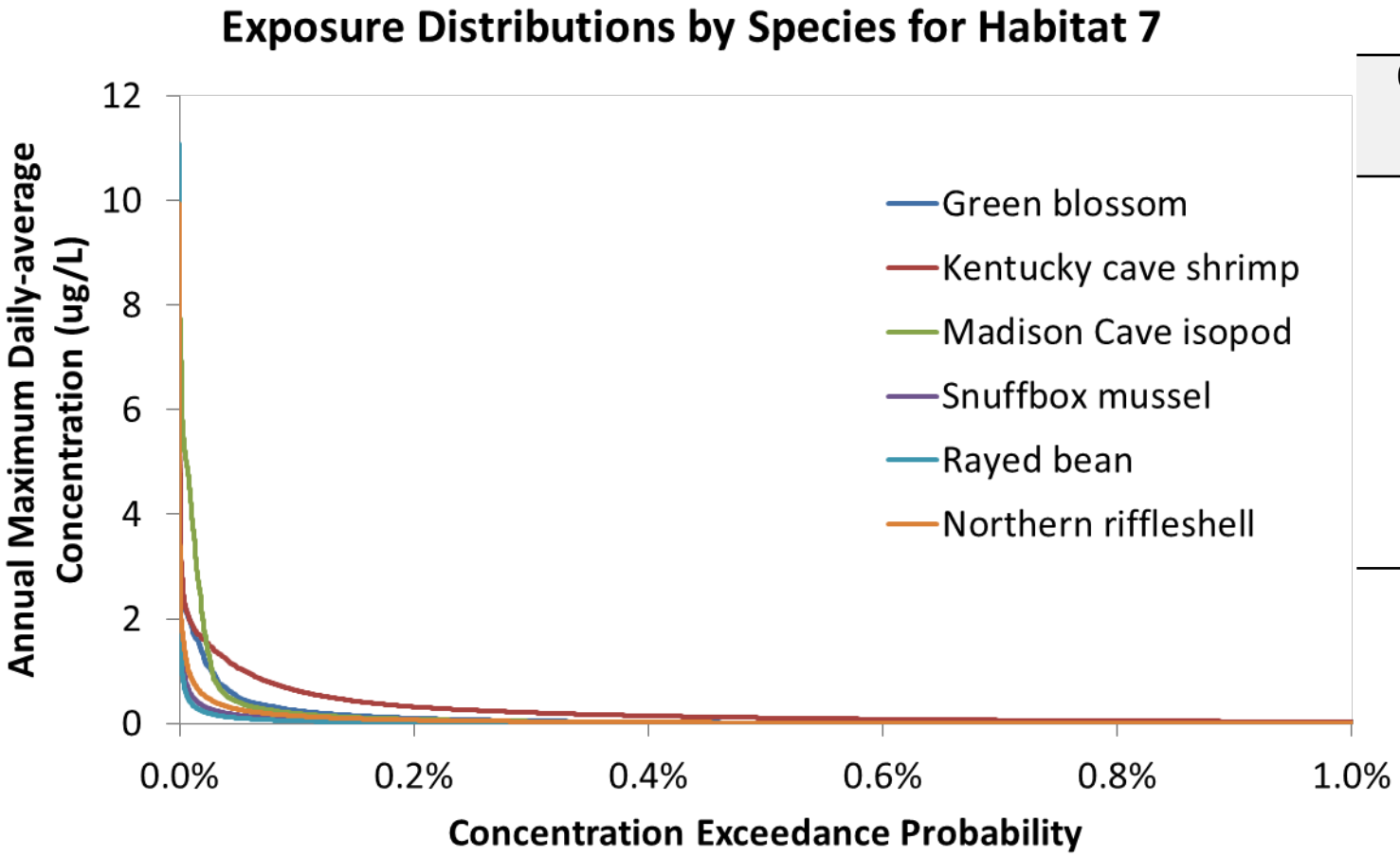
Only 0.91% of potential use sites in green blossom habitat treated with malathion in HUC2 05 – reduces probability of exceeding a given exposure at each concentration, does not reduce concentrations



Species Common Name	Weighted PTA
Kentucky cave shrimp	2.29%
Northern riffleshell	1.11%
Madison Cave isopod	0.93%
Green blossom (pearlymussel)	0.91%
Snuffbox mussel	0.67%
Rayed bean	0.49%

Comparison of exposure distributions

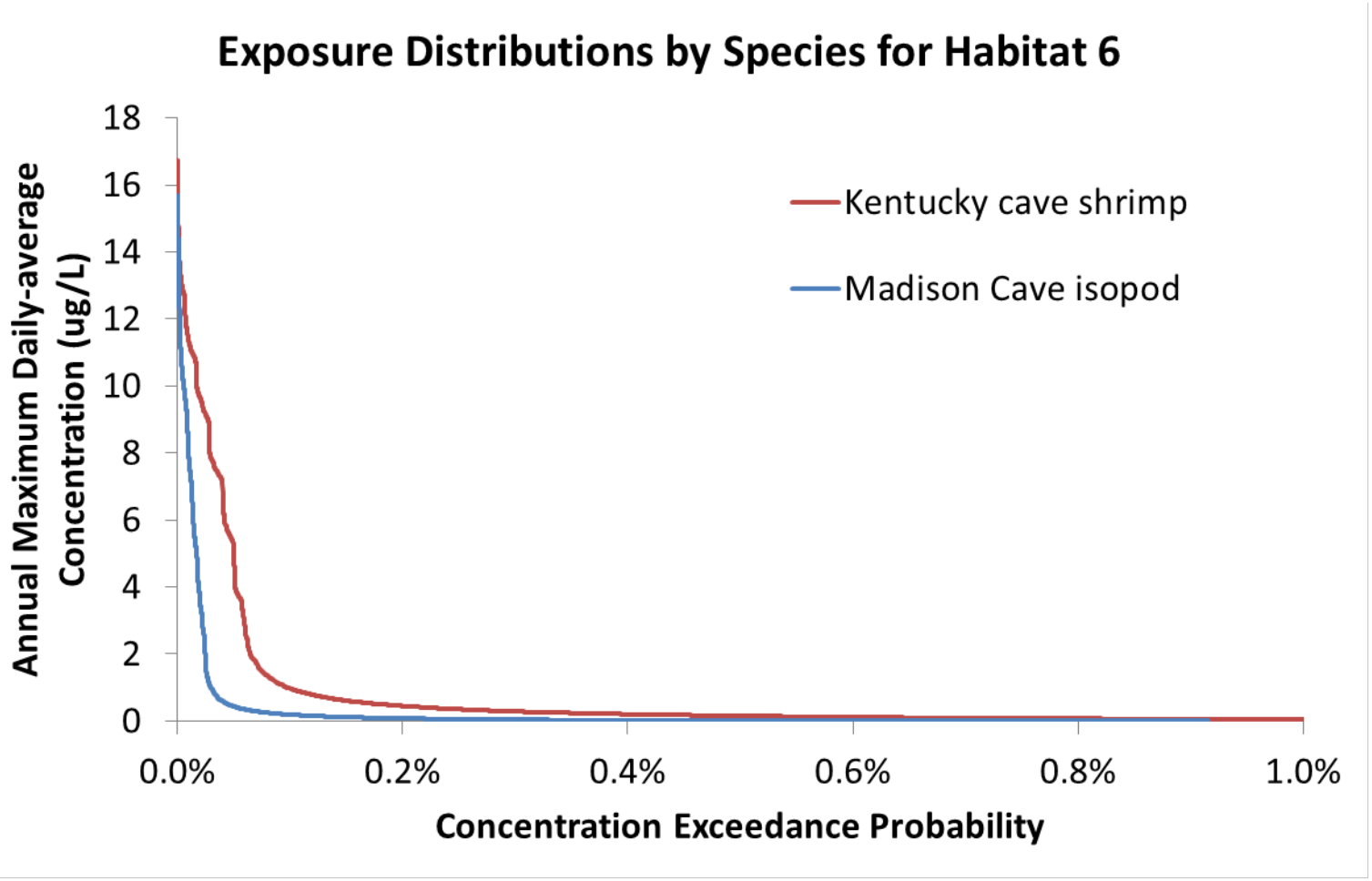
Assuming realistic treated area, probability of annual maximum daily-average concentration exceeding 0.01 ug/L (a typical detection limit) is less than 1.5% for all species.



	0.01 ug/L Exceedance Probability	
	Bin 6	Bin 7
Green blossom	-	0.53%
Kentucky cave shrimp	0.89%	1.45%
Madison Cave isopod	0.25%	0.51%
Snuffbox mussel	-	0.34%
Rayed bean	-	0.25%
Northern riffleshell	-	0.56%

Comparison of exposure distributions

Potential for slightly higher exposure concentrations in habitat 6 expected due to smaller water body volume. Detection probability still low.



Comparison of refined concentrations to EPA Draft Biological Evaluation estimates

EPA exposure estimates were several orders of magnitude higher than refined approach

	EPA Draft BE[1] (ug/L)		Refined, 90th %-ile, 100% PTA (ug/L)		Refined, Realistic PTA[2] (ug/L)		
Species Common Name	**Bin 6**	**Bin 7**	**Bin 6**	**Bin 7**	**90th %-ile**	**99th %-ile**	**99.9th %-ile**
Green blossom (pearlymussel)	-	28	-	0.280	0.0	0	0.25
Kentucky cave shrimp	163	28	0.396	0.283	0.0	0.044	0.98
Madison Cave isopod	163	28	0.209	0.209	0.0	0	0.19
Northern riffleshell	-	28	-	0.130	0.0	8.2E-05	0.14
Rayed bean	-	28	-	0.107	0.0	0	0.05
Snuffbox mussel	-	28	-	0.120	0.0	0	0.08

1. EPA's EECs were annual maximum peak (not 1-day) 1-in-15 year EECs within HUC2 05.
2. Based on the habitat bin with the highest EECs for the species.

Malathion monitoring data by year for HUC2 05 watershed from NAWQA database

Maximum detection of 0.21 ug/L in 2004 is two to three orders of magnitude lower than EPA estimate

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	
Samples	10	10	7	12	24	131	109	165	196	118	125	
Detections	0	0	4	2	2	3	3	1	11	4	13	
%-Detections			57%	17%	8%	2%	3%	1%	6%	3%	10%	
Maximum (ug/L)			0.05	0.01	0.02	0.13	0.02	0.03	0.12	0.02	0.1	
Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	All years
Samples	150	164	118	67	68	60	65	57	71	67	336	2,130
Detections	5	3	1	0	0	0	0	0	0	0	2	54
%-Detections	3%	2%	1%								1%	3%
Maximum (ug/L)	0.01	0.21	0.01								0.03	0.21

Species-specific, refined probabilistic approach compared to EPA's Draft Biological Evaluation

Refinement	*Stone/Intrinsik Assessment*	*EPA Malathion BE*
Species relevance	EEC *distributions* for each species and aquatic habitat bin occupied	Same EECs applied to all species within a given HUC2
Species exposure	Spatial resolution of individual species ranges	Spatial resolution at HUC2 scale
Best available spatial data	Crop, soils, and hydrography spatial datasets used to characterize landscape conditions for each species range	One soil and landscape profile per crop group to represent all species habitat in each HUC2
Agronomic practices	Sampled application dates based on regional practices	One application date per crop group and HUC2
Pesticide use	Observed treated area based on 8+ years of malathion use data	Assumed 100% treated area for all crops
Probabilistic analyses	1000, 30-year pond realizations per species, each realization composed of 1 to 5 PRZM simulations	1 or 2 PRZM/VVWM simulations per crop group within each HUC2

Conclusions

The conservative assumption of 100% treated area for labeled malathion crops resulted in EECs that were 2 to 3 orders of magnitude lower than the EPA's analysis.

Analysis of historical malathion use data showed malathion use on less than 1% of the dominant crops in the HUC2 05 region.

Accounting for actual treated area resulted in more realistic EECs. The probabilities of maximum 1-day malathion exposure concentrations exceeding a reference concentration (0.01 ug/L) ranged from 0.25% and 1.5% depending upon species and habitat bin size.

This species-specific methodology is readily reproducible and extendable to assess aquatic species in the remaining HUC2 watersheds across the US.

The approach can be applied within a tiered endangered species effects determination process.

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See Part 2 – Effects Assessment and Risk Characterization

Monday, November 7th
Exhibit Hall
Poster MP090

Session: Assessing Risks of Pesticides to Federally Listed (Threatened and Endangered) Species at a National Level - Part 1

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