

Modeling Longer-term Longitudinal Pesticide Exposures to Workers: Seasonal and Lifetime Exposures

Paul S Price M.S. Christine F. Chaisson Ph.D.

The LifeLine Group Inc.

Kristin Macey B.Sc.

PMRA

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Topics

- Findings of the recent ILSI RSI workshop on Probabilistic Methods to Assess Worker Exposure to Agricultural Pesticides.
- Recommendations for the collection of data
- Example of longitudinal analysis using payroll data

What is Longitudinal Exposure?

- Exposure that occurs to the same worker over multiple consecutive days
- Also called intra individual variability
- Tracking of doses received on each individual day and averaging the daily doses to determine subchronic and chronic doses
- Must rely on exposure modeling

Findings of the ILSI Workshop

- General conclusion
 - Current data collection (CAL PUR and BEAD) do not support longitudinal
 - We need to do more to quantify inter- and intra-individual variability in general
 - Need to bring time dependencies into the models for proper understanding of
 - Toxicity data
 - Absorption, metabolism, and elimination
- Additional efforts will be required to achieve trustworthy modeling results

Longitudinal Exposures and Toxicity

- Typically a subchronic health benchmark is applied to a one day exposure
- No evaluation of variation in chronic exposure and the implication for longer term endpoints
- Failure to go beyond one day will prevent the proper consideration of the the role of duration in characterizing risks

Understanding Temporal Processes Requires Longitudinal Modeling

- Dermal absorption may extend beyond one day
- Accumulation of pesticide and pesticide metabolites in workers
- Duration of processes associated with a health endpoint
 - Time interval to cellular damage
 - Time interval to observed effect
 - Time to recovery

Tailoring an Exposure Assessment to a Health Endpoint Duration

- It is relatively easy to tailor the duration of a longitudinal exposure assessment to the duration of the animal study
- Modeling each day as a separate event and using techniques such as rolling averages allows:
 - Matching the duration of the animal study
 - Demonstrating the sensitivity of the risk characterization to a range of durations

Two Sources of Data on Longitudinal Exposures

- Biomonitoring data on workers
 - Can provide a direct measure of longitudinal exposure for pesticides with persistent metabolites
 - Can be used to calibrate models and independently evaluate model predications
- Data collected for other purposes such as financial or insurance

Ongoing and Future Data Collection Efforts

- Existing data collection efforts could support longitudinal exposure assessments
 - It's critical to collect data at the individual level rather than at the farm or county level
 - Collection of data on the characteristics of the worker and the event
- Determination of the events that trigger the exposure event
- Specialized studies:
 - Investigate the stability of exposure related behaviors in workers (the dirty worker hypothesis)
 - Studies of specific populations (German worker study)

Illustration of Longitudinal Modeling of Pesticide Exposures in Workers

- Data collected for 47 workers at a pesticide application company (soil fumigation)
- Soil fumigation performed year round
- Data consists of:
 - Acres treated in a given month for each of 47 workers over a 12-month period
 - Variation in air concentrations associated with the tasks that make up the standard workday, and
 - Typical duration for the tasks during a work day.

Acres Treated

Driver code number	May		June		July		August		September		October		November		December	
	Tarped	Non-Tarped	Tarped	Non-Tarped	Tarped	Non-Tarped	Tarped	Non-Tarped	Tarped	Non-Tarped	Tarped	Non-Tarped	Tarped	Non-Tarped	Tarped	Non-Tarped
1				1		11				24		54		206		65
2			6	6	12		148		102		197		9			
3	3		105		67		94		129		203		47		3	
4	6		0		27		48	13	174	28	88	222		74		
5	25				24		177		123		262		19		4	57
6				292		114		135		229		272		236	81	
7	10		7		22		47		122	28	105	190	9	30	5	
8	49		20		151		207		331		241		50	36	17	50
9	12	14	9		41		68		98		271	11	59	1		
10	4		1		12		12		62		75		33		9	
11			10		70		16	143	36	1	43	118	21	52	6	53
12				10			96		64		104	255	20	10		
13						13		5								
14	40		36	6	41		44		271		197	34	30			3
15	71		21		41		49	6	305		201		21	152		174
16					36		102		90		221	15	5			
17	37		13		35		156		167		227		43			
18					49		55		135		175		17			20
19	12		117		99		98		203		24		18		3	
20					39		160		107		226		10	12		
21					79		123		107		100		5		47	
22		24					155		80		181		32			
23		26			15		161		149		223		24			
24			11		34		84		241		196		15			
25											0			7		
26	48		29		3		71		165	76	236		44		2	
27	40		36		58		51		235		266		18		10	
28						1		20			0					
29		35			16		102		164		152	2	13	97		29
30							1									
31	7		3		72		164		106		205	38	12		23	
32							0			107		169		40		
33	1		13		13		127		129		174		25			120
34							175		216		166	0	110			
35	33				128		95	29	229		295	6	83	32		149
36	3		134		116		162		112		217	23	67	6	22	
37	22						0									
38							0									
39	43		119		86		212		224		141		40			
40				54	118	13	149	2	244		316	21	43	184		49
41			9		46	43	102	13	240		244	6	62		65	
42				292	0			202		214	1	371		121		187
43					0	21							4			
44							65		77		166					
45							28	71	51	114	117	208	26	95	1	107
46										67		219	22	23		
47	21		3	42	104		74		181		121				24	
Total	487	99	703	702	1653	215	3678	638	5469	887	6376	2234	1055	1414	321	1061

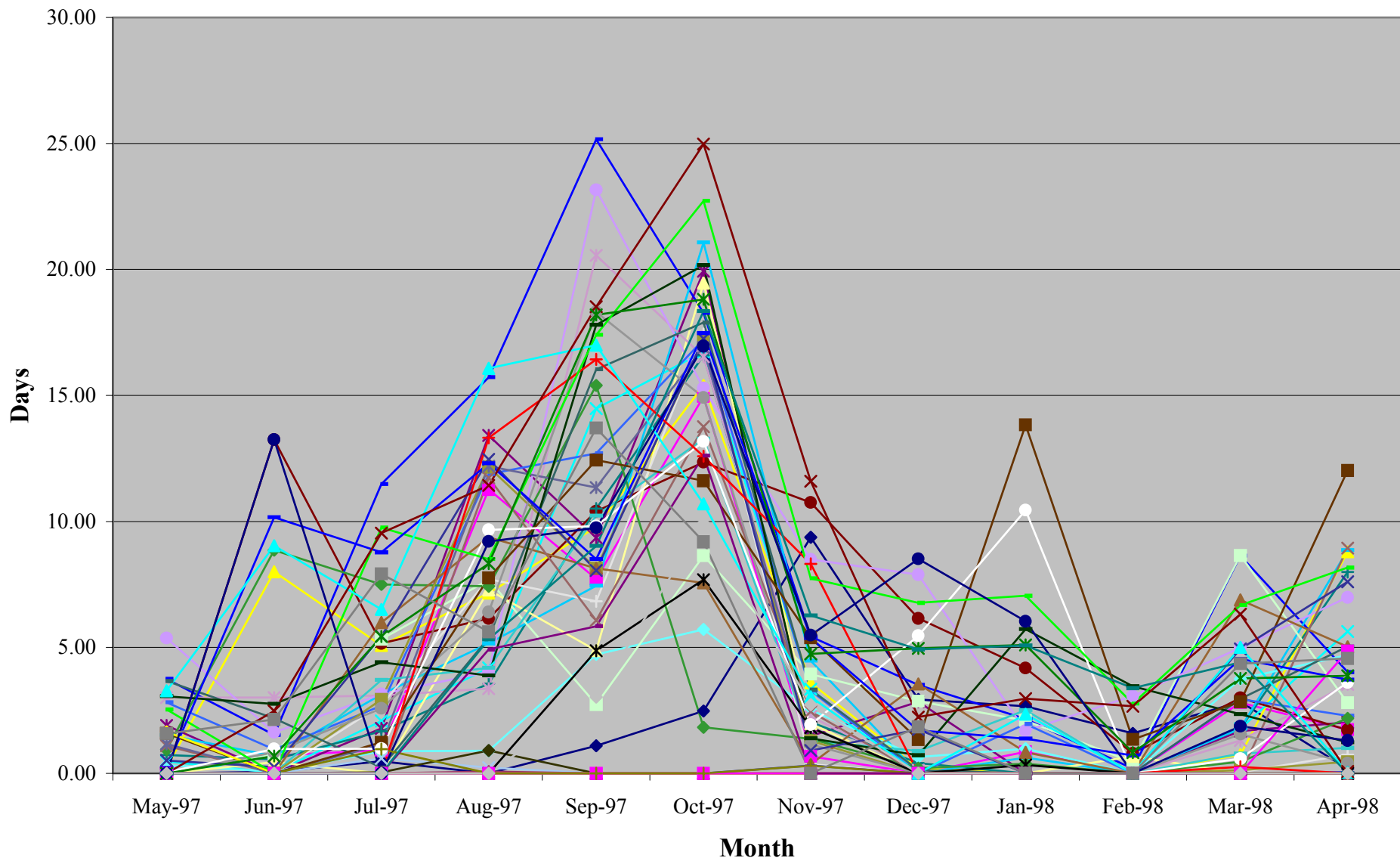
Reported Air Monitoring Data (ppm)

Sample	Set-up	Drivers Air conc.	Lunch and Takedown
1	0	0.903	0.459
2		ND	0.337
3		0.423	0.184
4		0.052	0.366
5		0.251	1.536
6		0.245	0.146
7		0.087	0.252
8		0.397	0.201
9			0.122
ND: Non detect			

Longitudinal Exposure in Soil Fumigators

- Using these data, the number of days worked per month per worker can be estimated

Figure 1. Days Worked Each Month by Each Worker



Longitudinal Exposure in Soil Fumigators

- Using these data an estimate of the number of days worked per month per worker
- Using the “day per month” data a Monte Carlo model of each workers’ longitudinal exposures over a one year period is prepared.
 - Probability of working on a given day is based on worker’s days worked per month
 - Each day modeled independently
 - Air concentrations sampled independently

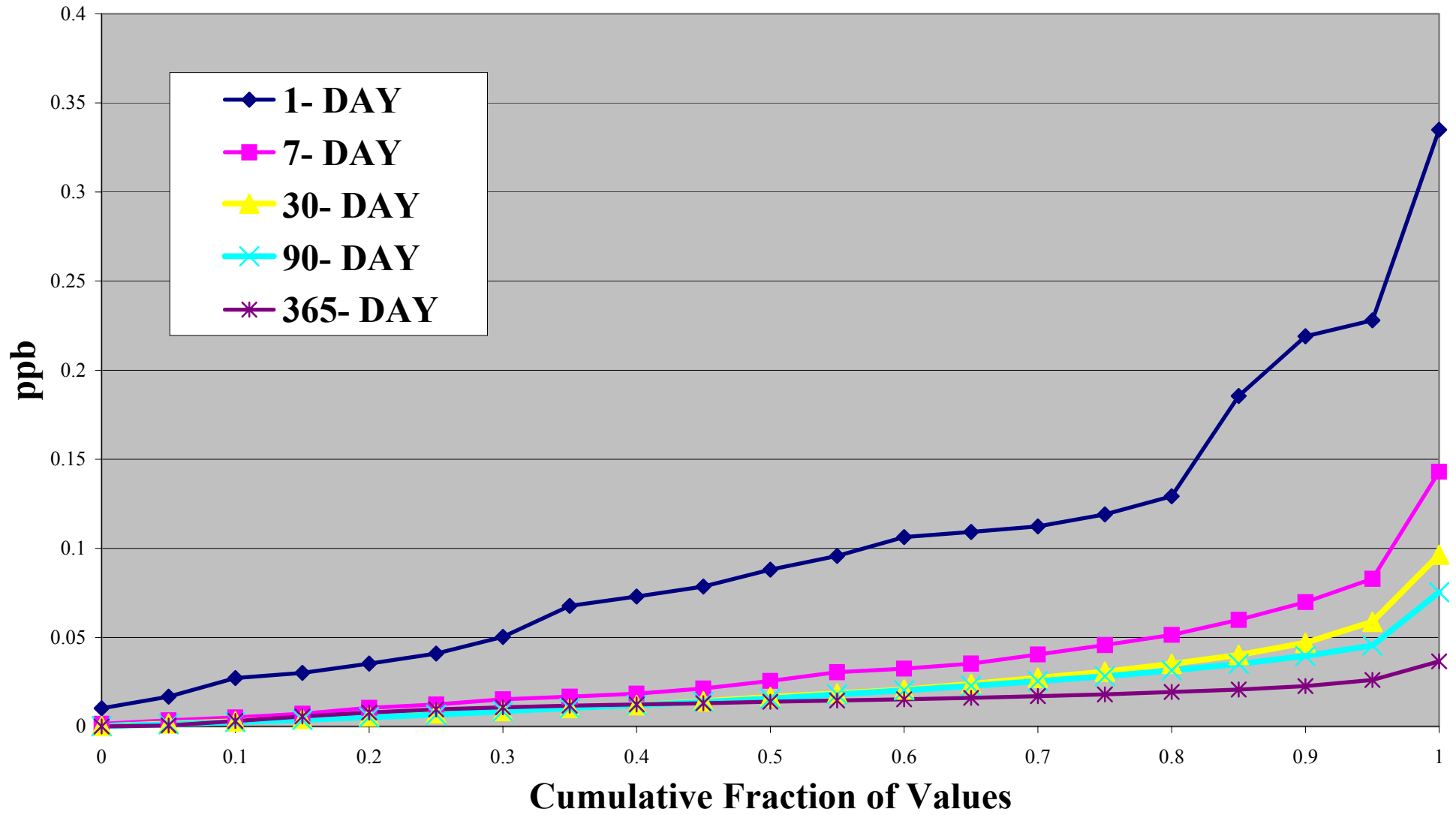
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- Exposure is expressed as average air concentration over 24 hours
- Data on individual days averaged using a rolling average approach

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- Exposure is expressed as average air concentration over 24 hours
- Data on individual days averaged using a rolling average approach
- Distributions of 24-hour TWA air concentrations were prepared for 1-, 7-, 30-, 90- and 365-day averaging periods

Figure 2. Cumulative Distribution of Average Daily Exposure



Results

- The dose for the median exposed individual ranged from
 - 0.9 ppb for 1-day measurements to
 - 0.01 ppb for 365-day averages.
- The dose at the 95th percentile ranged from
 - 0.2 ppb for 1-day measurements to
 - 0.03 ppb for 365-day averages

Summary

- Modeling longitudinal exposure will improve the risk assessment process
- The collection of different types of data will be required to support such assessments
- Modeling will play a large role in the process