Aquatic Life Toxicity in Stormwater Runoff to Upper Newport Bay, Orange County, California: Initial Results[1]

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Executive Summary

An Evaluation Monitoring based water quality evaluation and management Demonstration Project has found that stormwater runoff during the fall of 1996 that entered Upper Newport Bay in Orange County, California via San Diego Creek was highly toxic to *Ceriodaphnia*. Approximately half of this toxicity is apparently due to diazinon, chlorpyrifos and methomyl. The remainder is due to unidentified constituents present in the runoff waters. The dry weather flow in San Diego Creek during early November 1996 was non-toxic to *Ceriodaphnia*.

The water quality significance of this toxicity in terms of adversely impacting the designated beneficial uses of San Diego Creek and Upper Newport Bay is poorly understood. There is sufficient toxicity to be potentially adverse to aquatic life within the Creek and Bay. Beginning July 1, 1997, a US EPA 205(j) grant will provide funds to enable studies to be conducted of the fate/persistence of diazinon, chlorpyrifos and methomyl toxicity in Upper Newport Bay waters. The results of these studies will provide the database upon which to make a decision on whether the toxic pulses of stormwater that enter Upper Newport Bay are likely significantly adverse to the aquatic life resources of the Bay.

Approximately 63,000 pounds of diazinon and chlorpyrifos are used each year in Orange County by commercial pesticide applicators. Most of this use is for urban structural and landscape purposes. In addition, another 60,000 pounds of diazinon and chlorpyrifos purchased over the counter are estimated to be used by homeowners for around the home and

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[1] Reference as: Lee, G.F. and Taylor, S. "Aquatic Life Toxicity in Stormwater Runoff to Upper Newport Bay, Orange County, California: Initial Results," Report to Silverado, Irvine, CA Submitted by G. Fred Lee & Associates, El Macero, CA, June (1997).

US EPA Standard Three Species Aquatic Life Toxicity Tests

Ceriodaphnia - Zooplankton - fish food

Pimephales - Fish Larva

Selenastrum - Algae

Toxicity Test Results for San Diego Creek: Standard Three Species Test Sample Collected on 10/30/96

7-day *Ceriodaphnia* Test

Treatment	Reproduction (neonates/adult)		% Mortality
	mean	standard error	
Lab Control	24.6	0.93	0.0
San Diego Creek	0.0	0.00	100 (24 hr)

7-day *Pimephales* Test

Treatment	Growth (mg)		Mortality (%)	
	mean	standard error	mean	standard error
Lab Control	0.470	0.01	0.0	0
San Diego Creek	0.473	0.02	0.0	0

96-hour *Selenastrum* Test

Treatment	Cell Count (x 10^4)	
	mean	standard error
Lab Control	138.2	10.6
San Diego Creek	450.3	7.3

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Toxicity Test Results for San Diego Creek: Additional *Ceriodaphnia* Testing Sample Collected on 11/21/96

96-Hour *Ceriodaphnia* Dilution Series

Treatment	% Mortality for each day of the test			
	1	2	3	4
Lab Control	0	0	0	0
Lab Control + 100 µg/L PBO	0	0	0	0
San Diego Creek 100%	100	100	100	100
San Diego Creek 65%	100	100	100	100
San Diego Creek 65%+ 100 µg/L PBO	100	100	100	100

96-Hour *Ceriodaphnia* Dilution Series

Treatment	% Mortality for each day of the test			
	1	2	3	4
San Diego Creek 50%	100	100	100	100
San Diego Creek 25%	100	100	100	100
San Diego Creek 25% + 100 µg/L PBO	0	45	100	100
San Diego Creek 12.5%	0	100	100	100

Toxicity Test Results for San Diego Creek: *Pimephales* Testing Sample Collected on 11/21/96

7-day *Pimephales* Test

Treatment	Growth (mg)		Mortality (%)	
	mean	standard error	mean	standard error
Lab Control	0.498	0.006	0.0	0.0
San Diego Creek	0.477	0.014	2.5	2.5

San Diego Creek Base Flow Studies

Monitoring San Diego Creek between the Two Monitored Storms Showed That Creek Waters

- Were Non-Toxic
- Had Low, Non-Toxic Concentrations of OP Pesticides during Dry Weather/Base Flow Conditions

Toxicity Associated with Stormwater Runoff

Composition of San Diego Creek Stormwater Runoff Sample Obtained on 11/21/96

Pesticide	Appl (GC)	UCD (ELISA)
Diazinon	540	359
Chlorpyrifos	130	133
Pendimethalin (Prowl)	450	
Simazine	3200	
Carbaryl	900	
Methomyl	2000	
Malathion	90	

Estimated Toxicities of Selected Pesticides (Concentrations in ng/L)

Pesticide	Bailey *et al.* 96-hr LC50	Foe 96-hr LC50
Chlorpyrifos	60	100
Diazinon	450	500
Malathion		1400
Methomyl		5560
Carbaryl		3500 - 5200
Simazine		
Pendimethalin (Prowl)	--	--

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Cause of Toxicity

Based on ELISA, PBO Testing, and Chemical Analysis, Determined Some of the Toxicity Is Due to

- Diazinon - Urban Pesticide
- Chlorpyrifos - Urban Pesticide
- Methomyl - Ag Pesticide

About Half of Toxicity Due to Unknown Causes

Water Quality Impact of Aquatic Life Toxicity Depends on

Magnitude of Toxicity/Duration of Exposure Relationship Relative to the Sensitivity of the Test and Field Organisms

- Event-Mean Concentrations Not Valid for Characterizing Water Quality Impact of Chemicals & Toxicity
- Must Relate Toxicity/Duration Relationship for the Test Organism(s) & Key Ambient Organisms

Areal Extent of Toxic Concentrations & Rate of Change of Toxic Conditions

- Toxicant Transformations
- Dilution of Toxic Concentrations Due to Mixing

Characteristics of Toxicity

- Rapid- or Slow-Acting (1 or 4-day)
- Species of Aquatic Organisms Impacted
  - Fish, Shellfish, Zooplankton, Algae
  - Importance to Water Quality & Society

Table 11. Combined toxicity database. Acute toxicity (EC50 and LC50 concentrations, in ng/L) of diazinon to aquatic organisms. N=number of LC50 or EC50 values included in geometric mean. Data from EPA (1995), Menconi and Cox (1994), and AQUIRE (1995).

Species	Common Name	EC50 or LC50 (Geometric Mean, ng/L)	N
Gammarus fasciatus	Amphipod	200	1
Ceriodaphnia dubia	Daphnid	493	3
Daphnia pulex	Daphnid	776	3
Daphnia magna	Daphnid	1020	10
Simocephalus serrulatus	Daphnid	1590	2
Gammarus pseudolimnaeus	Amphipod	2000	1
Acartia tonsa	Copepod	2570	1
Neomysis mercedis	Mysid	4150	2
Mysidopsis bahia	Mysid	4500	2
Cloeon dipterum	Mayfly	7800	1
Orconectes propinquus	Crayfish	15000	1
Acroneuria ruralis	Stonefly	16000	1
Asellus communis	Amphipod	21000	1
Hyalella azteca	Amphipod	22000	1
Chasmichthys dolichognathus	Goby	23400	3
Baetis intermedius	Mayfly	24000	1
Pteronarcys californica	Stonefly	25000	1
Palaemonetes pugio	Shrimp	28000	1
Penaeus aztecus	Shrimp	28000	1
Seriola quinqueradiata	Yellowtail	40000	1
Paraleptophlebia pallipes	Mayfly	44000	1
Physa gyrina	Snail	48000	1
Lestes congener	Damselfly	50000	1
Anguilla anguilla	Eel	80000	1
Girella punctata	Green fish	94700	2
Orthetrum albistylum	Dragonfly	140000	1
Leuciscus idus	Golden orf	150000	1
Mugil cephalus	Mullet	150000	1
Gammarus lacustris	Amphipod	184000	2
Lepomis macrochirus	Bluegill sunfish	204000	13
Mugil curema	White mullet	250000	1
Notemigonus crysoleucas	Golden shiner	400000	1

(from Novartis Crop Protection, 1997) 120

Test Conditions

Must Consider Physical, Chemical, Biological Characteristics of Toxicity Test Relative to Those Experienced by Key Ambient-Water Organisms

Should Match Laboratory Exposure to Field Conditions in Follow-Up Testing

Interpretation of Toxicity Test Results Complex - Yes, But:

Far More Reliable Than Estimating Toxicity Based on Chemical Measurements

Chemical Approach Has All the Interpretation Problems of Toxicity Testing in Addition to the Need to Evaluate Whether the Regulated and Unregulated Chemicals in Sample Are Toxic

Urban OP Pesticide Toxicity - Water Quality Issues

- Only Toxic to *Ceriodaphnia, Others ?*
- Importance of *Ceriodaphnia*-Like Toxicity Sensitivity to Upper Newport Bay Waters
- Additive Toxicity
- Stormwater Runoff-Related
  - Short, Pulse Toxicity
- Importance of OP Pesticides to Society
- Political Power of Pesticide Companies & Ag Interests

Suggested Regulatory Approach

WRCB, Regional Boards, Regulated Community, Environmental Groups, & the Public Should Develop an Approach to Acquire the Information Needed to Define the Water Quality Significance of Aquatic Life "Toxicity"

Need to Appropriately Implement WRCB CTR Implementation Approach for Defining Significant Water Quality Impacts Due to Toxicity

Conclusions

Evaluation Monitoring Provides a Technically Valid Basis for Cost-Effective Pollution Control

Evaluation Monitoring Is a Readily Implementable Approach That Can:

Define the Real Water Quality/Use-Impairments in Receiving Waters for Stormwater Runoff

Determine the Water Quality Significance of the Use-Impairments

Determine the Source of the Constituents Responsible for the Use-Impairments

Provide a Technically Valid Basis for Formulating Cost-Effective Pollution Control Programs

Conclusions

Occurrence of Urban Stormwater OP Toxicity to *Ceriodaphnia* Does Not Necessarily Mean That There Will Be Use-Impairment / Adverse Impact on Water Quality

Need Detailed, Site-Specific Investigation to Evaluate Water Quality (Use-Impairment) Significance of the Toxicity

Best Done in Evaluation Monitoring Program Framework