

Organophosphate Pesticides as Pollutants of Urban Lakes and Streams

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Presented at North American Lake Management Society
National Meeting, Reno, NV December 1999

The organophosphate pesticides, diazinon and chlorpyrifos, are used on urban residential properties for structural (termite and ant) and lawn and garden pest control. In Orange County, CA, which includes the cities of Newport Beach, Santa Ana, Orange, Anaheim, etc., over 100,000 pounds (ai) per year of these pesticides are used principally for residential structural pest control. In areas where urban stormwater runoff discharges to urban lakes and streams, there is potential for significant toxicity to selected zooplankton due to these OP pesticides. This toxicity has the potential to be adverse to the waterbodies' fisheries resources. Studies of stormwater runoff in Orange County, CA, San Francisco Bay and Los Angeles areas, Sacramento, Stockton and San Diego have found this runoff to be acutely toxic to *Ceriodaphnia dubia* and *Mysidopsis bahia*, with some samples having over 20 acute toxic units (TUa). This toxicity is due to the organophosphate pesticides, diazinon and chlorpyrifos, as well as some yet unidentified chemicals. The USGS national monitoring program has found sufficient concentrations of diazinon and chlorpyrifos in urban streams and several areas of the US to be toxic to some forms of aquatic life.

Urban stormwater runoff in many parts of the US results in pulses of toxicity for certain zooplankton, and therefore represents a threat to upper trophic level organisms. However, because of the highly selective nature of this toxicity associated with being non-toxic to fish larvae, algae and many forms of zooplankton and the short-term pulses of the toxicity, there is controversy over the water quality significance of the OP pesticide-caused aquatic life toxicity. Further, there is considerable confusion about the approach that should be used to regulate this toxicity. Under the Clean Water Act, this toxicity would be eliminated from the streams if it were due to heavy metals or other non-pesticide chemicals. However, the US EPA Office of Pesticides Programs regulatory requirements allow toxicity so long as it is not significantly adverse to the beneficial uses of the waterbody. This paper reviews the current information on urban stormwater runoff aquatic life toxicity and presents information on issues that need to be addressed to assess the water quality significance of this toxicity to the beneficial uses of urban waterbodies.

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Topic Covered

- Occurrence of Aquatic Life Toxicity in Urban Stormwater Runoff Due to Residential Use of Orthophosphate (OP) Pesticides
- Water Quality/Ecological Significance of Toxicity to Beneficial Uses of Waterbodies
- Regulatory Issues for Toxicity Control

The Situation

Monitoring of Urban Stormwater Runoff in California and Texas Has Revealed Toxicity to *Ceriodaphnia dubia* - Potentially Toxic Concentrations Found throughout US

Originally Thought Cause of Toxicity Was Heavy Metals (Cu, Zn, Pb, and Cd) Present in Runoff at Concentrations above Worst-Case-Based Water Quality Criteria for Protection from Aquatic Life Toxicity

Criteria Exceedance Indicates **Potential** Heavy Metal Toxicity - Need Confirmation

Toxicity Identification Evaluation (TIE) Identified Organophosphate (OP) Pesticides Diazinon & Chlorpyrifos as Cause of Runoff Toxicity

Urban Stormwater Runoff in San Francisco Bay Area, Orange County CA Cities, Stockton, Sacramento, Los Angeles, San Diego Toxic to *Ceriodaphnia dubia* and *Mysidopsis bahia* - 1 to 10 TUa

National Problem Based on Diazinon & Chlorpyrifos Concentrations Found in USGS (1999) Urban Stormwater Runoff Monitoring

Issues That Need to Be Addressed

Diazinon and Chlorpyrifos Used for Control of Termites, Ants, Lawn and Garden Pests

Over 100,000 lbs (AI) of OP Pesticides Used in Orange County Each Year - 95% for Residential Structural Purposes

Toxic to Some Zooplankton at a Few ng/L

What Does This Toxicity Mean to Water Quality-Beneficial Uses of Urban Streams and Lakes?

Does Toxicity Mean That Another Pesticide Will Have to Be Used for Termite Control? Will Replacement Pesticides Be Safe for Public Health and Environment?

Previously, Chlordane Used for Termite Control

Banned Because Bioaccumulates in Fish to Levels That Could Cause Cancer in People Who Eat the Fish

Widespread Chlordane Contamination of Fish to Levels above Hazardous Concentrations

Regulatory Issues

Clean Water Act (CWA) - No Toxics in Toxic Amounts - No Toxicity in Ambient Waters

- If Runoff Toxicity Were Due to Heavy Metals, They Would Have to Be Controlled
- OP Pesticide Toxicity in POTW Effluent Must Be Controlled
- No Explicit Requirements for Control in Urban Stormwater Runoff

Stormwater Runoff Currently Regulated Based on Implementation of BMPs; BMPs Not Defined

US EPA Office of Pesticide Programs (US EPA OPP) - No Significant Toxicity

No Toxicity That Significantly Impairs Beneficial Uses

Conflict between CWA and US EPA OPP Regulatory Approaches for Pesticides

TMDL Development Aquatic Life Toxicity from OP Pesticides Causes Waterbodies to Be Listed as 303(d) "Impaired" Waterbodies

Requires Development of Total Maximum Daily Loads (TMDLs) to Control Impairment

Diazinon and Chlorpyrifos Toxicities Are Additive and Should Be Regulated Together Based on LC50-Normalized Sum of Concentrations --Usually Water Quality Standard Is TMDL Goal

Water Quality Standards for Diazinon and Chlorpyrifos

In early 1980s US EPA Developed Water Quality Criterion for Chlorpyrifos

Not Adopted by States as Water Quality Standard

- Not a Priority Pollutant - No Requirement to Adopt Criterion as Standard
- Diazinon & Chlorpyrifos Not Yet Regulated Based on Water Quality Standards

US EPA Has Been Developing Water Quality Criterion for Diazinon for Years

Draft Acute Criterion Released in 1998

Final Acute and Chronic Criteria May Be Released in a Year

Will Diazinon and Chlorpyrifos Criteria Be Used as TMDL Goals?

Typically, Concentrations of Diazinon and Chlorpyrifos in Urban Stormwater Runoff Are above Proposed and Adopted Water Quality Criteria/Standards

Only about 5 lbs/yr in Urban Stormwater Runoff of the 100,000 lbs/yr OP Pesticides Applied to Residential Properties in Orange County Is Responsible for Aquatic Life Toxicity Found in Stormwater Runoff

Probabilistic Ecological Risk Assessment

Examine Aquatic Life Genus Sensitivity vs Aquatic Life LC₅₀

Ceriodaphnia (Freshwater) and *Mysidopsis* (Marine) Zooplankton among the Most Sensitive Organisms Known to Diazinon and Chlorpyrifos Toxicity

Amphipod *Gammarus fasciatus* More Sensitive Than *Ceriodaphnia*

Not Toxic to Fish Larvae and Many Other Forms of Zooplankton & Benthic Organisms

Toxicity of Short Duration (few hours to a day or so) and of Limited Areal Extent

- Restricted to Urban Streams and Lakes
- Usually Rapidly Diluted in Ambient Waters Outside of Urban Areas
- Rapid Repopulation of Waters with Zooplankton Killed by OP Pesticides
- Mesocosm Studies Show No Impact on Fish Populations

From the Information Available, Amount of Stormwater Runoff Aquatic Life Toxicity Is within the “Allowable” Kill of Organisms without Loss of Ecosystem Function

- “Can Kill 10% of the Organism Species 10% of the Time and Not Harm Ecosystems”
- Validity of This Approach Questionable unless Ecological/Water Quality Significance of Killed Organisms Known

Endangered Species Act Issues in Some Areas Where OP Pesticide Toxicity Found

What Is the Ecological and Water Quality Significance of OP Pesticide-Caused Toxicity to *Ceriodaphnia*-like Organisms?

- Are There Aquatic Organisms Killed by OP Pesticide Toxicity That Are Important to Ecosystem Functioning and/or Beneficial Uses of Urban Waterbodies?
- Not a New Problem - Ecosystem and Water Quality Damage (If Any) Due to OP Pesticide Toxicity Began Many Years Ago and Still Occurs Today

Would the Beneficial Uses of Waterbodies Be Significantly Changed If the Urban Use of Diazinon and Chlorpyrifos That Leads to Stormwater Runoff Aquatic Life Toxicity Were Eliminated?

Many Questions about the Water Quality and Ecological Significance of OP Pesticide Caused Aquatic Life Toxicity

Regulation Will Likely Be Decided by Litigation in the Courts

Restricting Use of Diazinon & Chlorpyrifos Will Result in Use of Other Pesticides

- Will Replacement Pesticides for Control of Termites, Ants, Lawn and Garden Pests Be Less Damaging to the Environment and Public Health Than Diazinon and Chlorpyrifos?
- Current Pesticide Regulation Allows Substitution of One Registered Pesticide for Another without Adequate Evaluation of Potential Aquatic Life Toxicity of the Type Caused by Diazinon and Chlorpyrifos
- Current US EPA OPP Pesticide Registration Does Not Include Adequate Screening for Potential Aquatic Life Toxicity Problems

About Half of the Diazinon and Chlorpyrifos Used in Urban Areas Is Purchased at Garden Supply Stores - Other Half of Urban Use Is by Registered Pesticide Applicators

Use in Accord with Current Registration Label Does Not Prevent Stormwater Runoff from Residential Properties from Being Toxic

Use in Excess of Label Requirements Likely Large

Diazinon and Chlorpyrifos Also Cause Aquatic Life Toxicity Associated with Agricultural Use - Aquatic Life Toxicity Problems in Some Areas

- Use of Diazinon as a Dormant Spray in Central Valley California Orchards Causes *Ceriodaphnia* Toxicity at Considerable Distances in the Sacramento and San Joaquin Rivers That Lasts for Several Weeks Each Winter
- Airborne Transport Is Significant Problem

Agricultural Interests Oppose Restricting Use of Pesticides beyond That Required by Registration

- Diazinon and Chlorpyrifos Registration under Review by US EPA OPP
 - Chlorpyrifos Use May Be Restricted Based on Human Health Toxicity
 - Food Quality Protection Act (FQPA) May Limit OP Pesticide Use Based on Cumulative Use and Cumulative Potential Toxicity to Humans

Future Regulation of Use Evolving - Will Likely Have Restricted Use

Conclusion and Recommendations

- Urban Stormwater Runoff in California and Some Other Parts of the Country Toxic to Some Forms of Zooplankton (*Ceriodaphnia* and *Mysidopsis*) and Benthic Organisms (Amphipod *Gammarus*)
- Toxicity Due to OP Pesticide Diazinon and Chlorpyrifos Used on Residential Properties
- The Water Quality and Ecological Significance of OP Pesticide Toxicity in Urban Streams and Lakes Unknown - May Be Insignificant
 - Need Detailed, Comprehensive Field Studies of Organism Assemblages and Toxicity
- It Is Unclear How This Toxicity Will Be Regulated

May Be Regulated Based on Cumulative Potential Human Health Toxicity

- Need Substantial Research Directed toward Evaluating Water Quality/Beneficial Use Impairment Caused by OP Pesticide Aquatic Life Toxicity Associated with Urban Stormwater Runoff to Appropriately Regulate Use of Diazinon and Chlorpyrifos
- Research Should Be Funded by Pesticide Manufacturers and Users
- Need to Change Pesticide Registration so That Registration Includes Proper Evaluation of Aquatic Life Toxicity Problems and the Potential Impacts of Substituting One Pesticide for Another under Conditions Where Substitution Is Due to Potential Aquatic Life Impacts

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Copies of these papers and reports are available from Dr. Lee's website, www.gfred.com.

USGS Recent Publication with Information on Urban Pesticides:

Larson, S., Gilliam, R., and Capel, P., "Pesticides in Streams of the United States - Initial Results from the National Water-Quality Assessment Program," USGS Water-Resources Investigation Report 98-4222, 92pp., Sacramento, CA (1999).