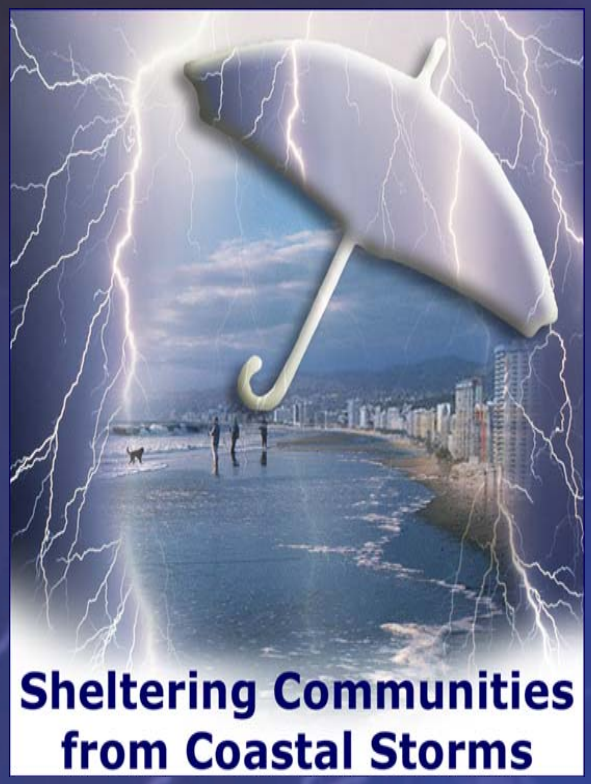
Coastal Storms Project:
Ecological Assessment of Storm Impacts to the Lower Columbia River Watershed by Risk Assessment, Modeling, and Toxicological Testing



Erica Chiovarou
Thomas Siewicki
Karl Phillips
Peter Key

NOAA National Ocean Service
Center for Coastal
Environmental Health and
Biomolecular Research

Acknowledgements

The authors wish to thank the following for their invaluable contributions to this research

Karl Lee

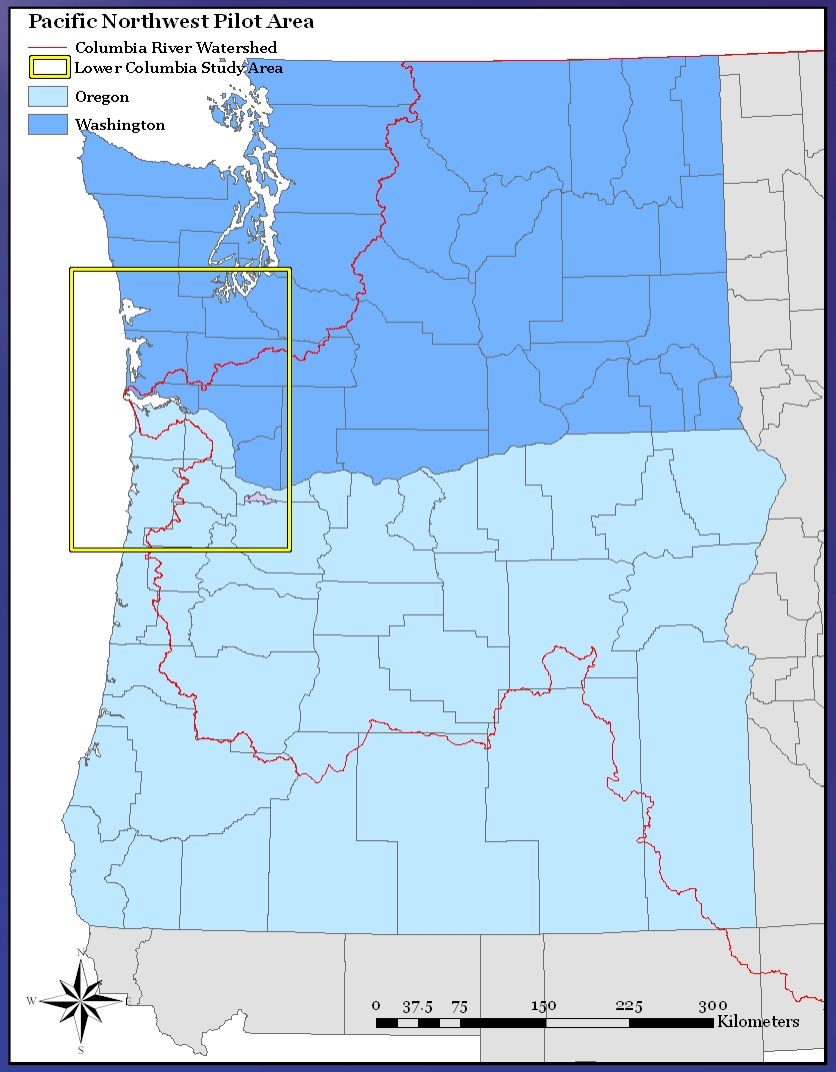
U.S. Geological Survey

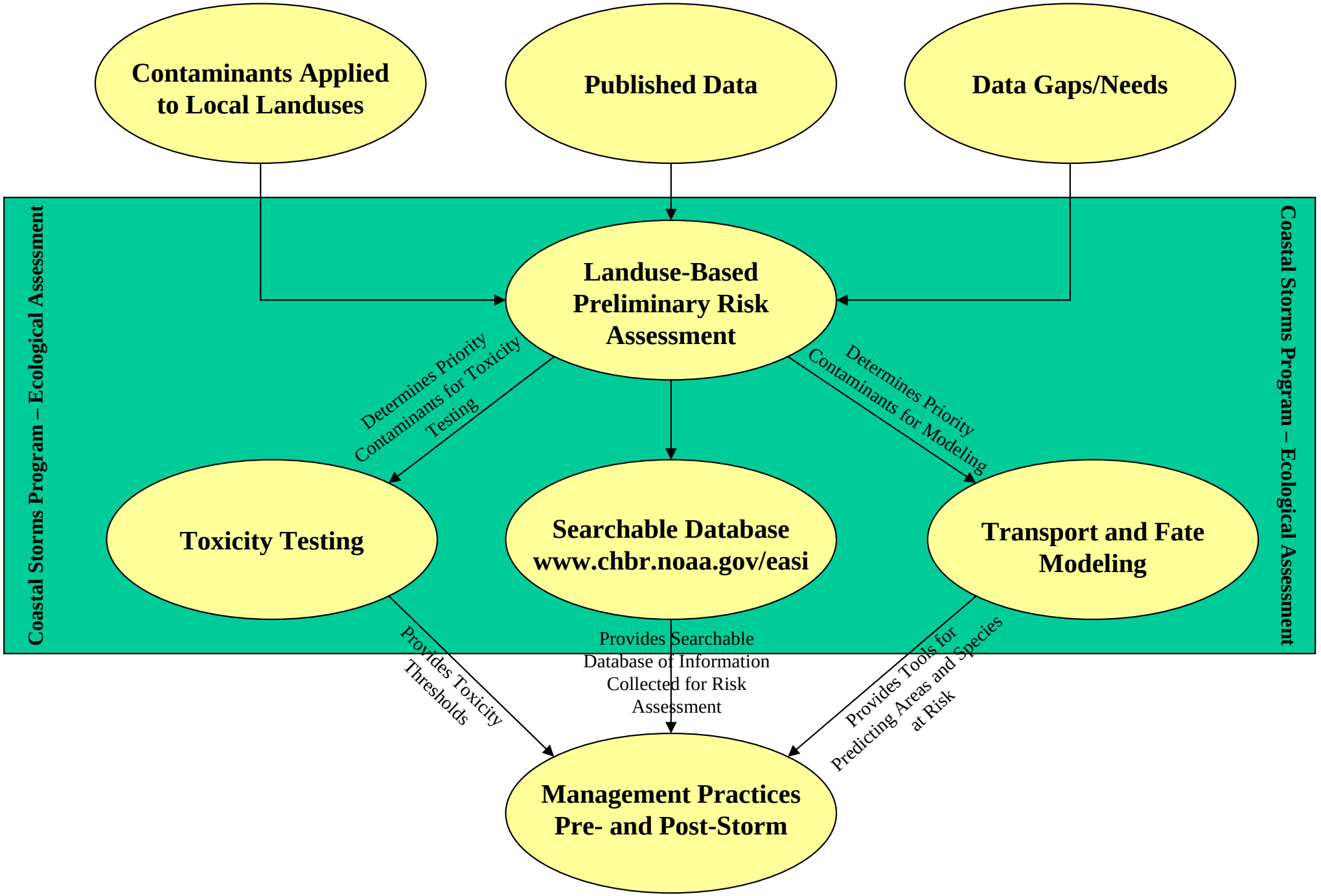
Johnson Creek Watershed Council

Johnson Creek Interjurisdictional Committee

Coastal Storms Program

- NOAA-wide Program
- Addressing storm-related coastal issues
- Second pilot region – Lower Columbia River
- http://csc.noaa.gov/csp
- Coastal Storms Booth




Contaminants Applied to Local Landuses
Published Data
Data Gaps/Needs
Coastal Storms Program – Ecological Assessment
Landuse-Based Preliminary Risk Assessment
Determines Priority Contaminants for Toxicity Testing
Determines Priority Contaminants for Modeling
Toxicity Testing
Searchable Database www.chbr.noaa.gov/easi
Transport and Fate Modeling
Coastal Storms Program – Ecological Assessment
Provides Toxicity Thresholds
Provides Searchable Database of Information Collected for Risk Assessment
Provides Tools for Predicting Areas and Species at Risk
Management Practices Pre- and Post-Storm

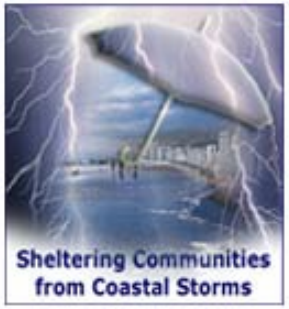
The Ecological Assessment of Storm Impacts on Marine Resources

. . . a part of NOAA's Coastal Storms Initiative

- Home
- The Project
- Glossary
- Products
- Search
- Site Tools
- Contact Us

Ecological Assessment Project: Home Page

Welcome to the website of the Ecological Assessment of Storm Impacts on Marine Resources. This project is a part of the Coastal Storms Initiative (CSI) and is designed to assess potential effects on fish and shellfish from non-point source pollution.



For more about this project, please click here.

Resources available on this website

This site includes a database of chemical and toxicological information on pesticides permitted for use in the St. Johns River Watershed, Florida. It will include other classes of chemical contaminants and other study areas in the future. You can search the database by contaminant name, Chemical Abstract Service registry number or molecular formula. It will provide estimates of application rates and locations derived from actual reported agricultural applications and USEPA-permitted non-agricultural applications. Locations were cross-referenced to available GIS data layers.

Queries will also provide available information on chemical structure, molecular weight, octanol-water partition coefficients, organic carbon partition coefficients, water solubility, persistence in soil, general toxicity information and specific toxicity levels, to five groups of organisms (algae, mollusks, finfish, crustaceans, and select terrestrial animals).

Toxicity to terrestrial animals is provided as a general comparison to a large body of

EASIMR Web Site - www.chbr.noaa.gov/easi/

To begin querying the project's database, click here. To learn more about this

The Ecological Assessment of Storm Impacts on Marine Resources

. . . a part of NOAA's Coastal Storms Initiative

- Home
- The Project
- Glossary
- Products
- Search
- Site Tools
- Contact Us

Basic Search

This Basic Search will allow you to generate information about a contaminant within a specific study area. The Detailed Search will allow you to aggregate information based on specific categories.

Begin your search by choosing a category below (CAS Number, Molecular Formula, or Name of contaminant), and enter text to search for. If you are not sure of the full name, number, or formula, the search utility supports the query of partial characters (e.g. Enter '2' to find '2,4-D', '2-Undecanone', or '3,6-dichloro-2-methoxy-benzoic acid').

Search for Contaminants

Study Area: St. Johns River Water Management District, Florida

Search By: Choose a category *

Search For: *

- Choose a category
- CAS Number
- Molecular Formula
- Name of Contaminant

Detailed Search Search Help

Submit Search Clear Search

EASIMR Web Site - www.chbr.noaa.gov/easi/

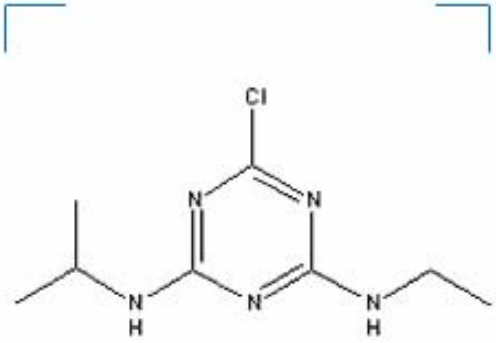
Home
The Project
Glossary
Products
Search
Site Tools
Contact Us

Contaminant Details

Atrazine

CAS Number: 1912-24-9

Synonym(s): Atrazine; Atrazine 4L; Atrazine 80W; Atrazine (Primatol); Atred; Atrex; Attrex; ATZ; Azinotox 500; Candex; Cekuzina-t; Chromozin; Crisamina; Crisatrina; Crisazine.



Formula: $C_8H_{14}ClN_5$

Molecular Weight: 215.6851

Boiling Point (°C): 200

Melting Point (°C): 175

Pronounciation: Ah-trah-zeen

Contaminant Type: Atrazine is an herbicide.

Additional Information: Atrazine is moderately to highly mobile in soils, especially where soils have low clay or organic matter content. Because it does not absorb strongly to soil particles and it has a lengthy soil half-life, it is expected to have a high potential for groundwater contamination, even though it is only moderately soluble in water. [m]

Solubility (in water)

EASIMR Web Site - www.chbr.noaa.gov/easi/

- **Solubility**: 28 mg/l [k]

Solubility (in water)

- **Solubility**: 33 mg/l [g]
  Temperature (°C): 25

- **Solubility**: 28 mg/l [k]
  Temperature (°C): 20

- **Solubility**: 33 mg/l [k]
  Temperature (°C): 27

Half-Life

- **$t_{1/2}$**: 30 days [dd]
  Environment: Estuarine conditions

- **$t_{1/2}$**: 60 days [l]

- **$t_{1/2}$**: 60-100+ days [m]

Toxicity Effects

- **Type**: Algae [e]
  Scientific Name: *Microcystis aeruginosa*
  Toxicity: 0.003 mg/l
  Test: 8d EC0

- **Type**: Algae [e]
  Scientific Name: *Chlorococcum spp.*

Formulation (°C): Technical acid

Environmental Partition Coefficients

- K_{oc}: 45 - 63 [b]
- K_{oc}: Log 1.95 - 2.71 [k]
- K_{oc}: 100 ml/g [m]
- K_{oc}: 100 ml/g [l]
- K_{oc}: 45 - 63 [e]
- Log K_{ow}: 2.33 - 2.8 [k]

Resource Map: Click below to open in a new window to view or print.
Potential applications of this contaminant in the St. Johns Water River Management District

Bibliography

a Beyond Pesticides Fact Sheets. Washington, DC: Beyond Pesticides. (n.d). Retrieved November 2003, from http://www.beyondpesticides.org

b AQUIRE (AQUatic toxicity Information REtrieval) Database (As part of the ECOTOX Database) [Internet]. Washington, DC:United States Environmental Protection Agency. [date unknown] - [updated February 2003, cited June 2002]. Available from http://www.epa.gov/ecotox/

c EPR Professional 2002 CD

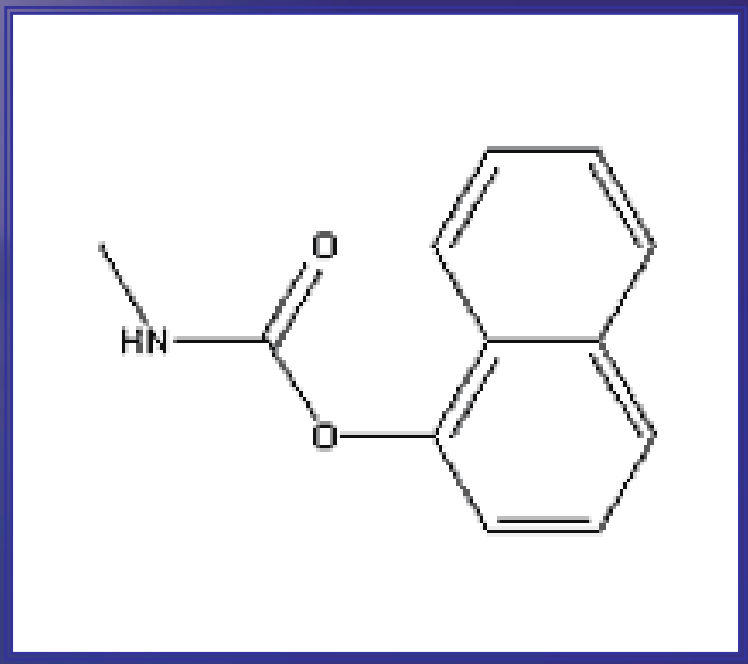
d ChemFinder. Cambridge MA: CambridgeSoft Corporation. Retrieved November, 2003, from http://chemfinder.cambridgesoft.com

e Verschueren, K. (1996). Handbook of Environmental Data on Organic Chemicals (3rd ed.). New York: John Wiley & Sons, Inc.

f Howard, P.H., Boethling, R.S., Jarvis W.F., Meylan, W.M., & Michalenko, E.M. (1991). Handbook of Environmental Degradation Rates. Chelsea, MI: Lewis Publishers

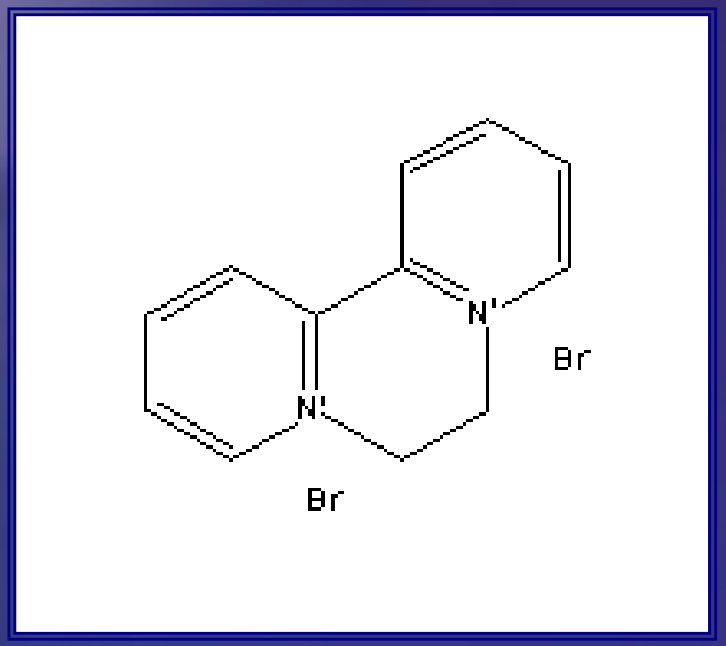
h Extension Toxicology Network. Corvallis, OR: Oregon State University. (n.d). Retrieved November, 2003, from http://ace.orst.edu/info/extoxnet/

Carbaryl



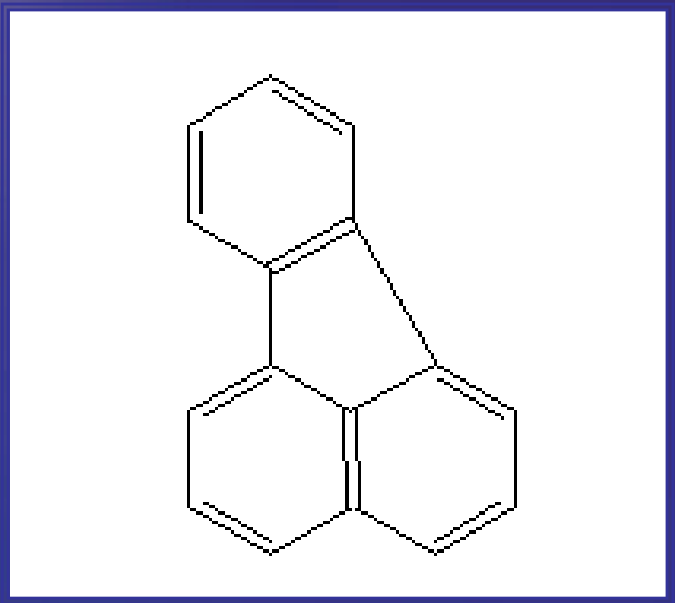
- Insecticide
- Active ingredient in over 300 registered products (NPIC, 2007)
- 3.9 million pounds sold annually (EPA, 2004)
- Used for insect control on fruit, cotton, forests, lawns, nuts, ornamentals, shade trees, and other crops, as well as on poultry, livestock and pets

Diquat Dibromide



- Herbicide
- Less than 500,000 millions pounds applied annually (EPA, 2002)
- Used for residential, non-crop, industrial, and aquatic weed control

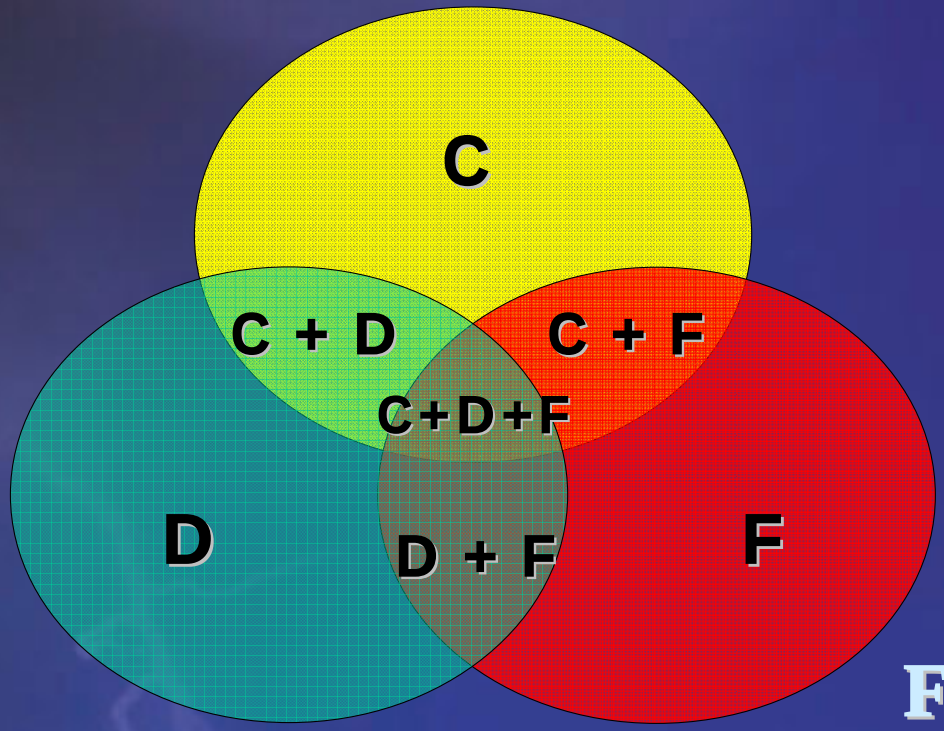
Fluoranthene



- Polycyclic aromatic hydrocarbon (PAH)
- Commonly reported component of roadway runoff
- Potentially toxic to fish and crustaceans

Toxicity Testing
Palaemonetes pugio

Carbaryl



Diquat Dibromide

Fluoranthene

Toxicity Conclusions

- Fluoranthene most toxic to grass shrimp larvae with 96h LC50 = 32.45 ug/L
- Carbaryl 96h LC50 = 43.1 ug/L
- Diquat Dibromide 96h LC50 = 1624 ug/L
- All mixtures were additive

Transport and Fate Modeling

- **Goal: To Identify Events and Locations of Concern**

- **PRZM-3 (Pesticide Root Zone Model)**
  - **Groundwater chemical transport**

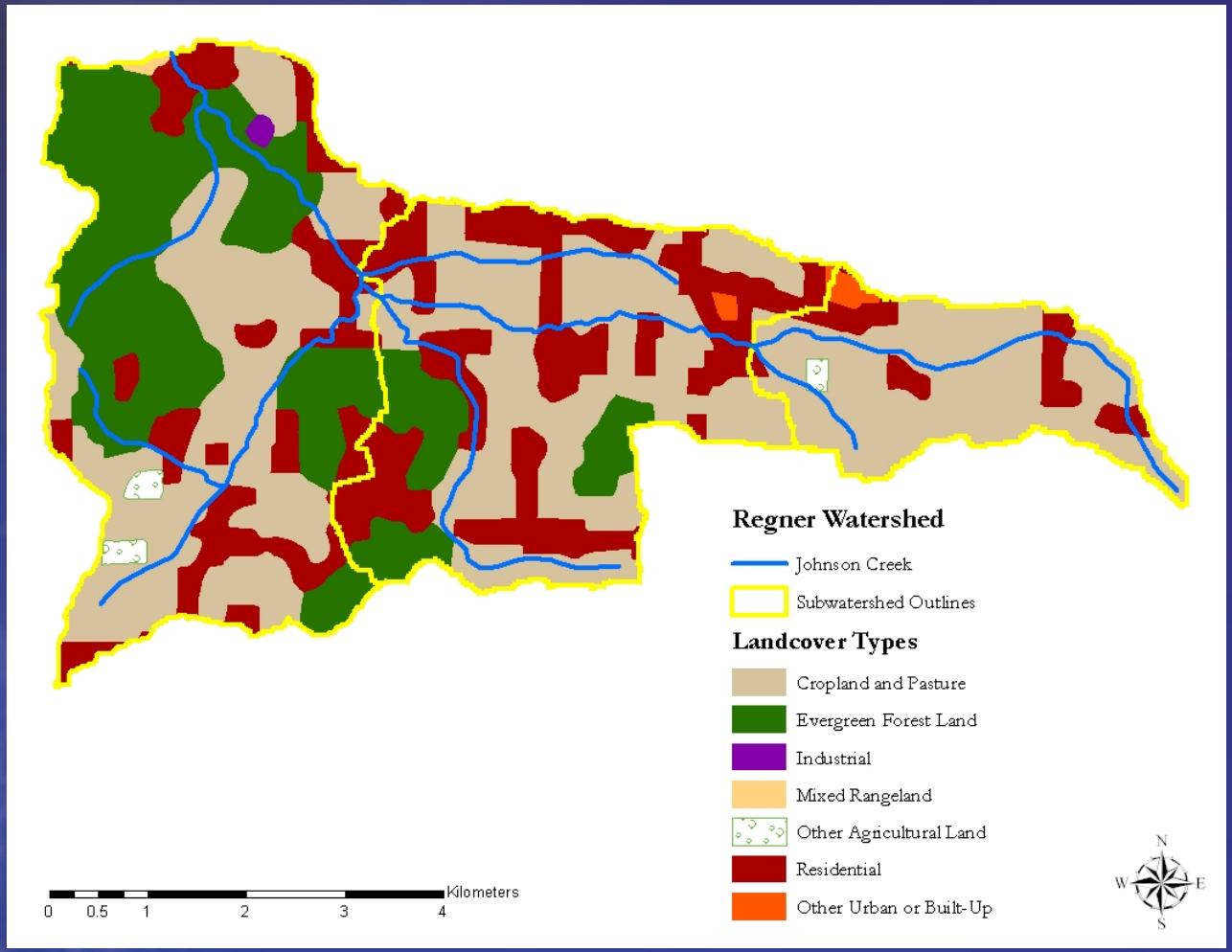
- **EXAMS-II (Exposure Analysis Modeling System)**
  - **Surface water chemical transport and fate**
  - **Uses output of PRZM**
  - **Predicted concentrations compared to aquatic animal and human health Levels of Concern.**

PRZM Methods

- 3 pesticides identified by preliminary risk assessment (EASIMR)
- Published chemical parameters
- Local meteorological data
  - 2-Yr, 25-Yr and 100-Yr storms
- Pesticides applied at maximum allowed rate
- Pesticides applied 1, 6 or 16 days before storms
- Estuarine headwaters

PRZM Methods

- Johnson Creek – urbanized, freshwater stream and historical salmon spawning ground
- Segmented watershed based upon dominant landuse
  - Agriculture
  - Urban
  - Forested



Groundwater Runoff

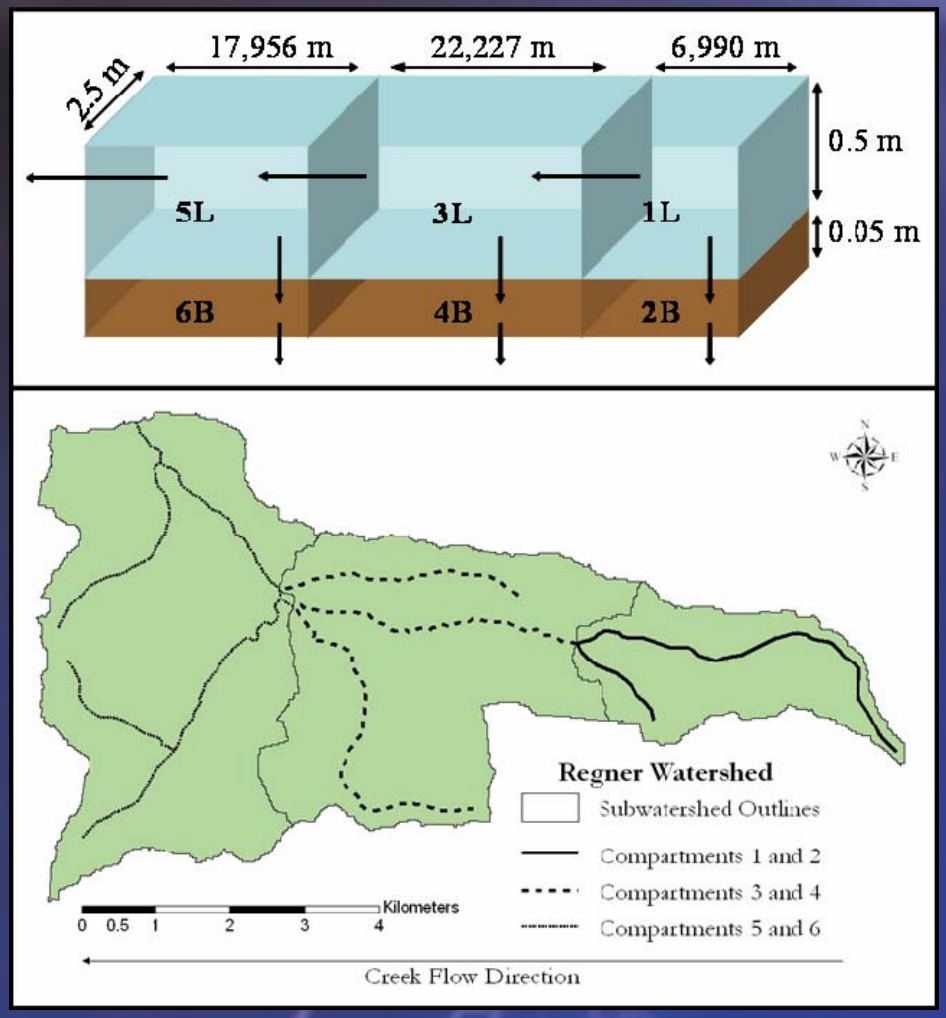
- Carbaryl > Diquat Dibromide
- Both pesticides
  - 100 Yr > 25 Yr > 2 Yr
- Storm type and application date dependent
- Provides input to EXAMS

EXAMS Methods

- Used PRZM loadings and other inputs
- Fluoranthene loading was estimated from reported roadway runoff concentrations (Hewitt and Rashed, 1992) – entered the modeled system on days of rain
- Published chemical parameters
- Local meteorological data

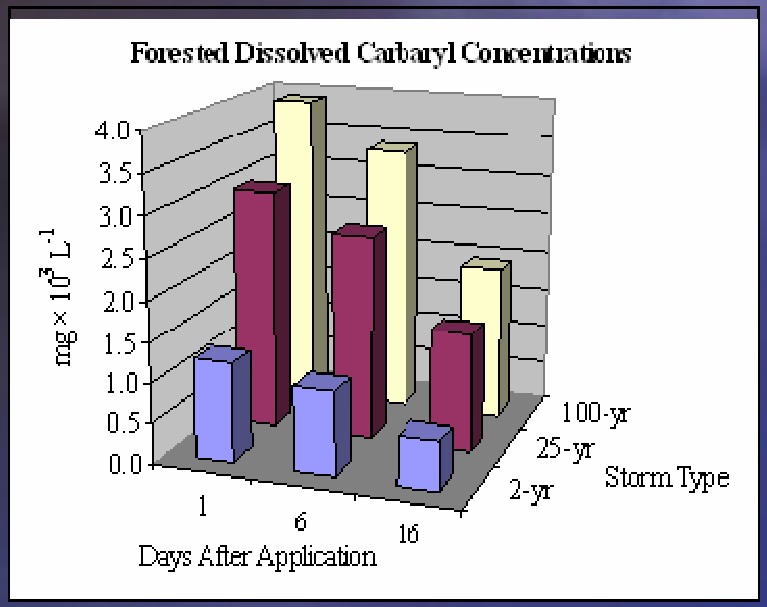
http://web.pdx.edu/

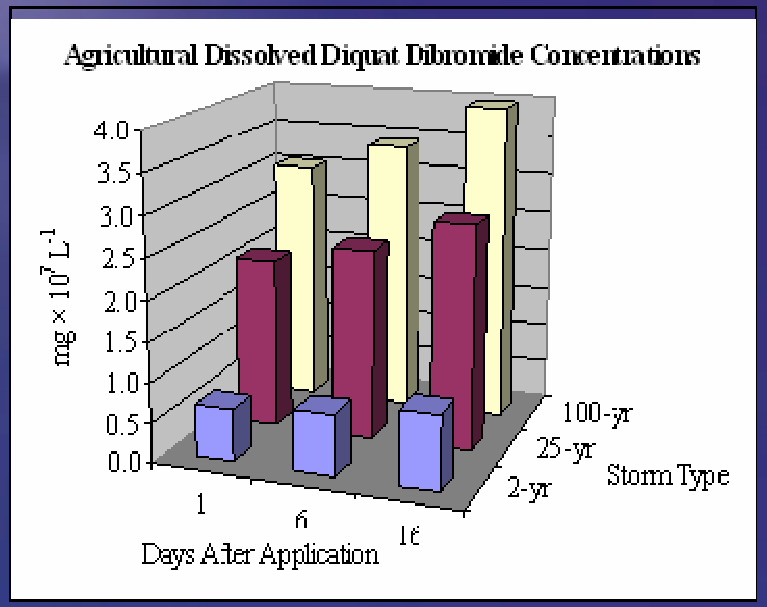
Johnson Creek EXAMS Compartments *(Conceptual)*

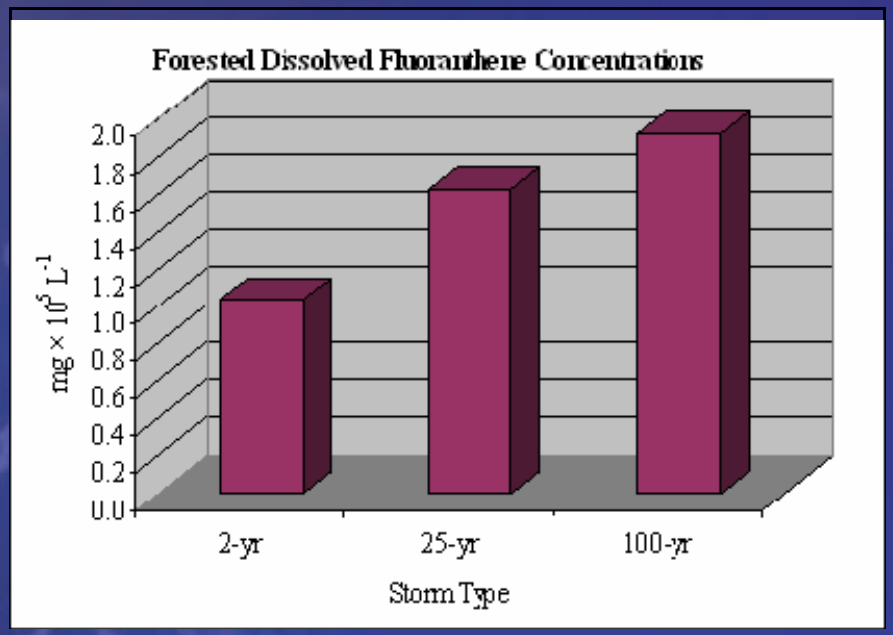


- Odd numbers are littoral
- Even numbers are benthic
- 1 and 2 are headwaters
- 5 and 6 flow into the rest of the creek

Johnson Creek EXAMS Results







EXAMS Estimation of Risk

- Carbaryl
  - Max runoff with rainfall 1 or 6 days after application
  - Peak concentration higher than several crustacean thresholds and near salmonid thresholds (Verschueren, 2001; Macek and McAllister, 1970; Buchanan et al., 1969; Sanders and Cope, 1966)
  - Toxic but short lived
- Diquat Dibromide
  - Max runoff with rainfall 16 days after application
  - Peak concentration was much less than trout and salmon thresholds (Pimental, 1971; Bond et al. 1960)
  - Very toxic but high enough levels are unlikely

http://techalive.mtu.edu/meec/module07/exotics_2.htm

EXAMS Estimation of Risk

- **Fluoranthene**
  - **Peak concentration near mysid shrimp and sea urchin thresholds (Verschueren, 2001; EPA, 1991) and near salmonid thresholds when UV activated (EPA, 1991)**
  - **Toxic levels possible with intense runoff and little mixing**

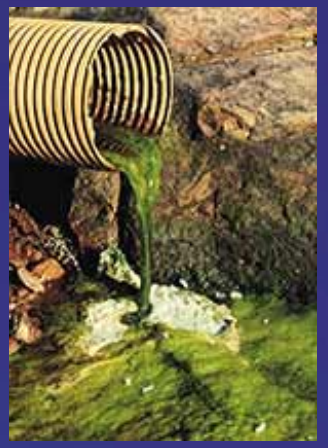
Overall Summary

- EASIMR
  - Web-accessible risk assessment database
  - Risk based upon land uses
  - Useful for preliminary risk estimation

- Toxicity testing
  - Provides toxicity thresholds
  - Heavily used pesticides in Pacific Northwest
  - Fluoranthene > Carbaryl > Diquat Dibromide
  - Mixtures were additive
    - Mixtures rarely studied

Overall Summary

- PRZM Model
  - Estimates shallow groundwater and runoff contamination
  - Identifies effects on runoff
  - Provides inputs to exposure model
- EXAMS Model
  - Estimates surface water and sediment concentrations
  - Used to identify sensitive areas/habitats
  - Effects of storms types, application date
  - Compares pesticides, other contaminants
    - Risk to salmon: Fluoranthene > Carbaryl >>> Diquat Dibromide
    - Risk to crustaceans: Carbaryl > Fluoranthene >>> Diquat Dibromide



Uses

- Easy preliminary risk assessments based upon land use data
- Identify species at risk
- Identify geographic locations at risk
- Focus post-storm ecological assessments
- Assist mitigation planning
- Provide access to available risk information
- Promote responsible pesticide use

Works Cited

Bond, C.E., Lewis, R.H. and Fryer, J.L. 1960. Toxicity of various herbicidal materials to fish, Second Seminar on Biological Problems in Water Pollution, R.A. Taft San Eng. Cen. Tech. Rept. W603, 96-101 .

Buchanan, D.V., Millemann, R.E., and Stewart, N.E. 1970. Effects of the insecticide Sevin on various stages of Dungeness crab, *Cancer magister*. J. Fish. Res. Bd. Canada 27:93-104.

Hewitt, C.N. and Rashed, M.B., 1992. Removal rates of selected pollutants in the runoff waters of a major rural highway. Wat. Res. 26(3): 311-319.

Macek, K.J. and McAllister, W.A. 1970. Insecticide susceptibility of some common fish family representatives. Trans. Amer. Fish. Soc., 99(1), 20-27.

National Pesticide Information Center (NPIC). 2007. Carbaryl: General Fact Sheet. Oregon State University and U.S. Environmental Protection Agency. Corvallis, Oregon. (http://npic.orst.edu/factsheets/carbgen.pdf).

Pimentel, D. 1971. Ecological Effects of Pesticides on Nontarget Species. Executive Office of the President's Office of Science and Technology, U.S. Government Printing Office, Washington, DC.

Sanders, H.O., and Cope, O.B. 1966. Toxicities of several pesticides to two species of cladocerans," Trans. Amer. Fish Soc., 95(2), 165-169.

United States Environmental Protection Agency. 2004. Carbaryl IRED Facts. Washington, DC. (http://www.epa.gov/oppsrrd1/REDs/factsheets/carbaryl_factsheet.pdf).

United States Environmental Protection Agency. 2002. Diquat Dibromide TRED Facts. Washington, DC (http://www.epa.gov/pesticides/reregistration/REDs/factsheets/diquat_tred_fs.htm).

United States Environmental Protection Agency. 1991. Proposed sediment quality criteria for protection of benthic organisms: Fluoranthene. US Environmental Protection Agency, Office of Water and Office of Research and Development, EPA 440/5-91-007, Washington, DC.

Verschueren, K. 2001. Handbook of Environmental Data on Organic Chemicals, 4th edition. John Wiley & Sons, Inc., New York .