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science for a changing world

Understanding Pesticides in California's Delta

The Sacramento-San Joaquin River Delta (Delta) is the hub of California's water system and also an important habitat for imperiled fish and wildlife. Aquatic organisms are exposed to mixtures of pesticides that flow through the maze of Delta water channels from sources including agricultural, landscape, and urban pest-control applications. While we do not know all of the effects pesticides have on the ecosystem, there is evidence that they cause some damage to organisms in the Delta.

Decades of USGS research have provided a good understanding of when, where, and how pesticides enter the Delta. However, pesticide use is continually changing. New field studies and methods are needed so that scientists can analyze which pesticides are present in the Delta, and at what concentrations, enabling them to estimate exposure and ultimate effects on organisms. Continuing research will provide resource managers and stakeholders with crucial information to manage the Delta wisely.

Pesticide Sources

- Pesticides are applied in agricultural and urban areas to control unwanted insects, plants, and fungi.
- The amount and type of pesticides used changes as pesticides are withdrawn from the market, cropping patterns and pest pressures change, and new chemicals are developed.
- Pesticide application, followed by runoff from rain or irrigation, creates well-defined seasonal patterns of pesticide concentrations in Delta water channels.
- Waters carrying pesticides enter the Delta from the Sacramento and San Joaquin Rivers, Yolo Bypass, surrounding creeks, and within-Delta lands.
- Changing water use and climate affect pesticide input and transport through the Delta.

Delta Watershed:

- 6 million people (2009 estimate).
- 4 million acres agricultural land.
- 400 pesticides applied for total of 10 million pounds each year.

U.S. Department of the Interior
U.S. Geological Survey

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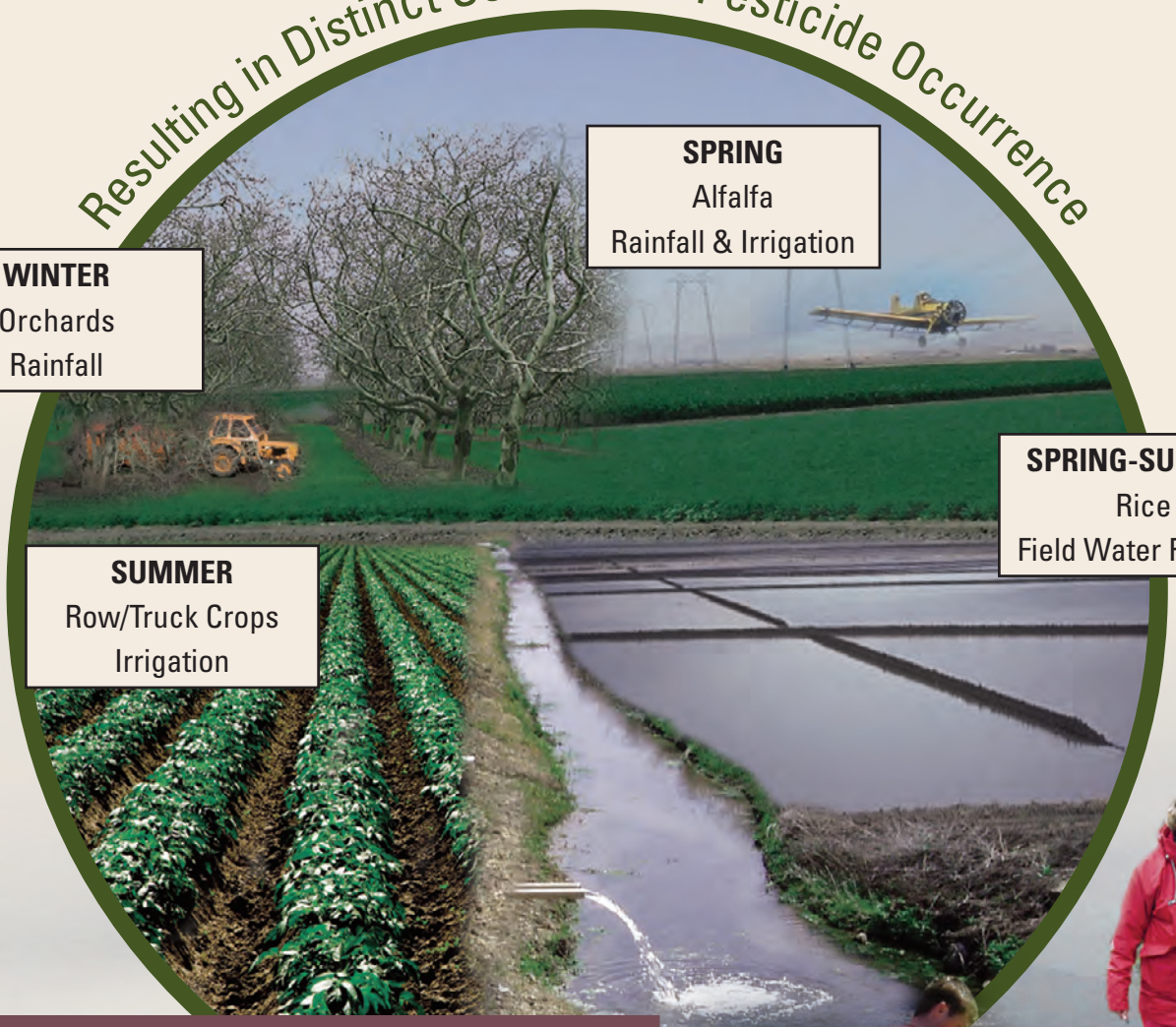
How do Pesticides Move into the Water?

PESTICIDES ARE APPLIED

THEN TRANSPORTED BY WATER AND SEDIMENTS INTO WATERWAYS

Resulting in Distinct Seasons of Pesticide Occurrence



SPRING
Alfalfa
Rainfall & Irrigation

WINTER
Orchards
Rainfall

SPRING-SUMMER
Rice
Field Water Release

SUMMER
Row/Truck Crops
Irrigation

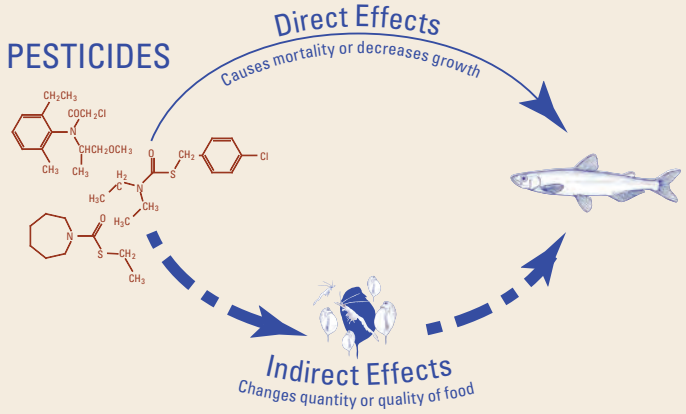
ALL YEAR
Urban Use
Rainfall & Irrigation

How Are Living Organisms Affected?

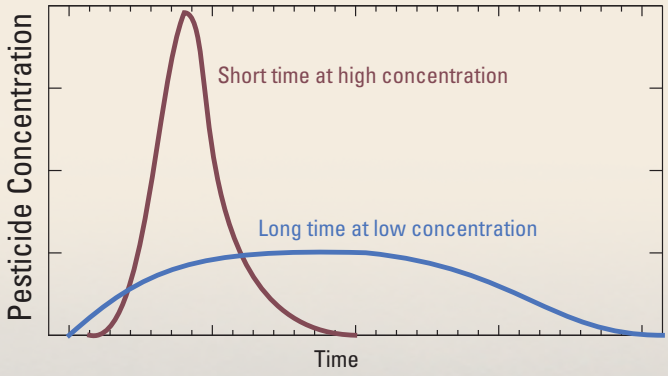
ORGANISMS LIVING IN THE DELTA ARE EXPOSED TO PESTICIDES

EFFECTS CAN BE DIRECT OR INDIRECT

Both pesticide concentration and the length of time that an organism is exposed to a pesticide determine the eventual effect it has on the organism. Some pesticides move through the Delta quickly (hours to days), but are present at high concentrations. Other pesticides are present for longer periods (weeks to months), but at much lower concentrations. Both types of exposure can affect an organism, so it is important to know specific environmental pesticide concentrations and durations.



EXPOSURE = CONCENTRATION * TIME



The most obvious effect of pesticide exposure on organisms is death, usually, as a result of direct exposure to high concentrations of pesticides over a short time. But, exposure to lower concentrations over a longer time can be just as deadly. Decreased growth, impaired reproduction, and inhibition of swimming performance can all diminish population size. Pesticides in the environment can also have indirect effects, which result in problems such as reduction in availability or quality of food.

USGS Pesticide Fate Research Group

Effective pesticide analysis requires persistent method development and research. The USGS Pesticide Fate Research Group is a leader in current-use pesticide science. Researchers frequently add new compounds to USGS methods to keep up with changing pesticide use and new environmental concerns. Laboratory methods are sensitive enough to precisely and accurately measure pesticide concentration levels that are very low but that still may affect living organisms.

Water is analyzed because this is where most animals live. Sediments are important for organisms that live in, or at the bottom of, streams. Pesticides can also “move up the food chain” as organisms eat animals or plants that have already accumulated pesticides. To gain a more complete view of environmental effects of pesticides on organisms, we analyze water, sediments, and animal tissue.

Science to Help Resource Managers

Summarizing Our Current Understanding of Pesticides in the Delta

Four major seasonal patterns of riverine inputs of pesticides to the estuary were identified on the basis of application timing and transport mechanism. In contrast, urban inputs took place throughout much of the year. Identified data gaps included the lack of analysis of many pesticides (or degradates), changing pesticide use, limited information on pesticide transport within the Delta, and an incomplete understanding of the transport and persistence of sediment-associated pesticides (Kuivila and Hladik, 2008).

Using Our Expertise to Address Data Gaps

Continuing to Conduct Focused Research on Pesticides

ADAPTING TO CHANGING USE

As pesticide use changes and new chemicals come on the market, the timing and concentrations of pesticides entering the Delta will change. Routine monitoring and advanced methods to analyze new pesticides provide current information on the complex mixture of pesticides present in the ecosystem.

EVALUATING PESTICIDE FATE

Pesticides entering the Delta can be dissolved in the water or attached to sediments, and can also degrade to new compounds of potential concern. Focused field and laboratory studies provide information on the factors controlling these processes, which in turn influence the transport and persistence of pesticides.

ASSESSING FISH EXPOSURE

In the complex Delta, it is difficult and expensive to adequately characterize fish exposure by measuring pesticide concentrations in water and sediments. A different approach is to "ask the fish" by directly analyzing levels of pesticides and their metabolites in fish tissue with sensitive analytical methods.

Through ongoing collaborations with toxicologists, ecologists, and fisheries biologists, we can address questions of concern such as "how do pesticides affect native fish populations in the Delta and the ecosystem as a whole?"

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For More Information: http://ca.water.usgs.gov/projects/toxics/

Designed by Yvonne Roque

Reference: Kuivila, K.M. and Hladik, M.L., 2008. Understanding the occurrence and transport of current-use pesticide in the San Francisco Estuary Watershed, San Francisco Estuary and Watershed Science, v. 6 (3), article 2.