

Western Ecological Research Center

Publication Brief for Resource Managers

Release:
May 2007

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Comparative Toxicity of Chlorpyrifos, Diazinon, Malathion and Their Oxons to Amphibians

Organophosphorus pesticides are known to be highly toxic to amphibians, which can absorb these chemicals in both aquatic and terrestrial systems. Results from laboratory experiments conducted by scientists of Southern Illinois University, Carbondale, and U.S. Geological Survey suggest the oxon breakdown products of the three most commonly used pesticides in California's agricultural Central Valley — chlorpyrifos, malathion, and diazinon — are 10–100 times more toxic than the parent compounds. The study was published recently in the journal *Environmental Pollution*.

The researchers conducted laboratory experiments to determine the acute toxicity — the lethal dosage causing death in 96 hours or less — of chlorpyrifos, malathion, and diazinon, and their oxon derivatives for tadpoles of the foothill yellow-legged frog (*Rana boylei*). Organophosphorus pesticides have been implicated in the declines of several species of amphibians in the California Central Valley and in downwind montane areas. One of these species is the foothill yellow-legged frog, which inhabits the transition zone between the valley and the Sierra Nevada.

Organophosphorus pesticides suppress an enzyme called acetylcholinesterase, which is essential for the proper functioning of the nervous system. Most pesticides of this group reach their greatest potencies when metabolized internally and converted to an oxon form in the liver. However, oxon forms of pesticides can also be found in the environment, formed by bacterial decay of parent pesticides.

For the laboratory experiments, tadpoles were raised from foothill yellow-legged frog eggs collected from a stream in the California Coast Range, upwind of agri-

Management Implications:

- The dynamics of pesticide application and conversion in the Central Valley of California and environs suggest that agricultural run-off may be toxic to amphibians.
- Amphibians inhabiting ponds in the Central Valley of California could be simultaneously exposed to two or all three of these pesticides (chlorpyrifos, malathion, and diazinon) and their oxons. The potential for interactive effects of these chemicals needs to be explored.
- Although environmental concentrations of oxon derivatives are often lower than their parental forms, they may under some conditions equal or exceed parental forms.
- The combination of field and laboratory studies is revealing that organophosphorus pesticides pose hazards to native populations of amphibians in California. Since some of the parent pesticide compounds are already at concentrations sufficient to cause amphibian mortality in the Sierra Nevada, the higher toxicity of the oxons poses a serious problem.

cultural activities in the Central Valley away from areas where significant quantities of pesticides are used. Experiment results indicated that chloroxon killed all tadpoles and was at least 100 times more toxic than the lowest concentration of the parent compound chlorpyrifos, which resulted in no mortality. Maloxon was nearly 100 times more toxic than malathion, and diazoxon was approximately 10 times more toxic than diazinon.

Sparling, D.W., and G. Fellers. 2007. Comparative toxicity of chlorpyrifos, diazinon, malathion and their oxon derivatives to larval Rana boylei. Environmental Pollution 147:535–539.