Northwest Center for Alternatives to Pesticides

Best Management Practices to Protect Water and Fish

CHLORPYRIFOS

Broad-spectrum insecticide/acaricide, mostly restricted use

Selected Products Include: Lorsban, Dursban, Andersons Golf Products Insecticide III, Bolton, Durashield, Hatchet, Nufos, Pyrofos, Vulcan, Warhawk, Whirlwind, Warrior

Chlorpyrifos is a Problem in Oregon's Willamette Valley Streams

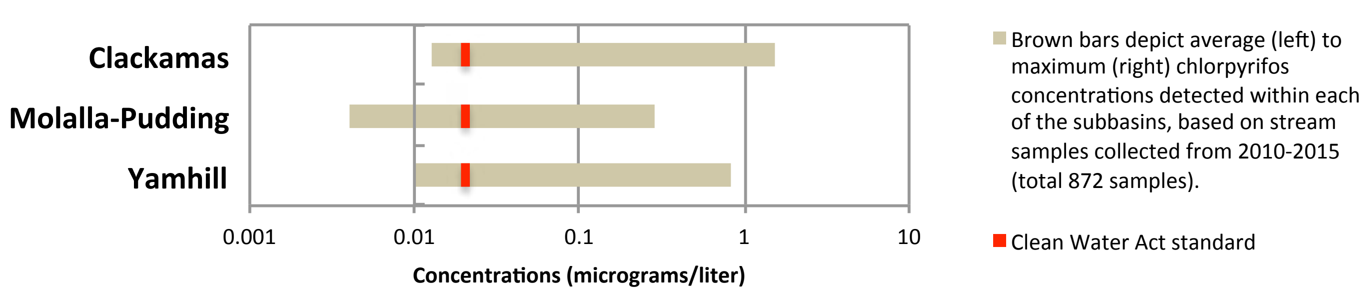
- Chlorpyrifos is likely to adversely affect five threatened species of Chinook salmon, coho salmon and winter steelhead found in the Willamette Basin, as well as their designated critical habitat, based on the toxic effects of chlorpyrifos at predicted aquatic concentrations and exposure potential.[1]
- Chlorpyrifos moves into streams with eroded soil or through drift or volatilization and may be persistent in flooded loam or clay soils.[2]

The Chemical Properties of Chlorpyrifos Predispose It to Be a Water Pollutant

Chemical Property	Chlorpyrifos Rank[3]	Why it Matters for Pollution
Soil Persistence (half-life)	Moderate	More persistent pesticides stick around, with increased opportunities to get carried to streams.
Bioconcentration	Moderate	Pesticides that concentrate in fish or wildlife above aquatic concentrations may cause harm to the animal or create a hazard when eaten. Such pesticides are typically lipophilic (fat-loving) and may also accumulate (magnify) in the food chain.

Rank: red – yellow – green shading above indicates relative risk of pollution (red high).

Concentrations in Willamette Streams Sometimes Exceed Clean Water Act Standards



Harmful Effects of Chlorpyrifos to Salmon, Steelhead or their Habitat

Concentrations similar to those found in the Willamette subbasins have been found to:

- Kill salmon prey, such as caddisflies, mayflies, stoneflies, and daphnids.[4]
- Affect fish ability to smell and swim, both critical salmonid behaviors.[5,6]
- Become more toxic as water warms. At 66°F, chlorpyrifos is seven times more toxic to trout than at 55°F.[7]
- Synergize with other organophosphates (such as malathion and diazinon), resulting in toxic effects at lower concentrations than if found alone.[8]

Many studies have documented chlorpyrifos concentrating in fish and some aquatic invertebrates, with concentration rates of >2000 measured in rainbow trout.[9]

Pay Attention to the Label

Chlorpyrifos product labels warn:

> **This pesticide is toxic to fish, aquatic invertebrates, small mammals and birds. Drift and runoff from treated areas may be hazardous to aquatic organisms in water adjacent to treated areas**.

Labels for flowable products require no-spray setbacks (buffers) from aquatic areas ranging from 25-150 feet, depending on the application method.

Applications of chlorpyrifos are subject to a 2014 court order for interim salmon protection that requires no-spray buffers adjacent to salmon-supporting waters (60 feet for all ground or granular applications and 300 feet for all aerial applications). Restriction does not apply to cattle ear tags. See maps and information online at Salmon Mapper.[10]

Some labels also contain drift reduction measures for aerial, airblast and ground boom applications.

Registered Uses in Oregon

Foods: A variety of cereal grains, vegetables, tree nuts, tree fruit, sugar beets
Grasses and Forage/Fodder: Perennial grass seed, alfalfa, field corn, clover, rangeland, grass forage, hay
Nursery/Greenhouse and Landscape: Nursery stock, ornamental trees, flowers
Landscape: Turfgrass, golf courses, recreation areas
Non-Crop: Rights-of-way (roadsides), wood protection, farm premises, commercial buildings, industrial sites, food processing plants, fencerows
Tree Crops: Christmas trees, tree plantations
Vector or Wide Area: Mosquitos, cattle ear tags

Alternative Strategies to Reduce Insect Pressure

- Promote plant vigor by maintaining healthy soil,[11] and plant pest-resistant cultivars if available.
- Prevent or suppress pests with cultural strategies, where possible and recommended, to make the area less hospitable to the pest. For example, delaying planting dates can inhibit pests such as flea beetles and cabbage maggots. Certain crop rotations interrupt the life cycle for corn rootworm, wireworms, Colorado potato beetle, and symphylans.[12] Removing known alternate hosts reduces pest resources.
- Pheromones (chemicals produced by an insect to communicate) can be used in many crops for monitoring – or for mass trapping or mating disruption, suppressing insect populations.[13] Mating disruption for codling moth is currently used on 90% of the apple and pears grown in Washington State.
- Use exclusion or barrier techniques where feasible.
- Support biological pest control by natural enemies (predators or parasites on the pest). Many biocontrols can be purchased from commercial providers. Conserving or creating on-farm or garden habitats (such as beetle banks, cover crops, alley cover crops or hedgerows) also supports native natural enemies (conservation biocontrol).[14] Such habitats also provide habitat for native pollinators, important to many Oregon crops. Research appropriate plants to ensure the biocontrol habitats don't increase host plants for pests of concern.
- Mass-trap pests using trap crops, pheromone technology or baits. Mass-trapping with the aid of a pheromone was found to signifi cantly reduce western flower thrip in strawberries.[15] In Washington and Idaho, trap crop designs including mustard, rape, and pak choi were found to reduce populations of flea beetles on broccoli more effectively than trap crops with only one species.[16]
- Check with Oregon State, Washington State or University of California extension for advice on specific pests.


Pheromone dispenser for mating disruption. Photo: E. Beers

National Marine Fisheries Service Recommendations to Protect Salmon

National Marine Fisheries Service is assessing the risk of chlorpyrifos to threatened and endangered salmon. By December 2017, NMFS recommendations to protect salmon will be posted at http://www.nmfs.noaa.gov/pr/consultation/pesticides.htm.

Photo: United States Fish and Wildlife Service

Additional Suggested Best Management Practices

Especially adjacent to permanent water bodies, sloped sites or on bare or erodible soils

Reduce Drift and Volatilization:

1. Use untreated setbacks (no-spray buffers) next to streams, especially for aerial applications or if no windbreak or drift barrier is present. Setbacks of 100 feet for ground applications can reduce drift by 95%. For aerial applications, 300-foot setbacks can reduce the drift fraction by 90%.[17]
2. Use precision sprayers, spot spray, or conduct banded applications.
3. Use shields and other drift reduction technology. Adjust nozzles to coarse droplet sizes.
4. Apply only when wind speeds are between 2-8 mph, only when winds are blowing away from streams and when temperatures are lower than 70°F. Vapors may evaporate for 5-10 hours after application and can drift.[18]

Soil Erosion | Photo: East Multnomah Soil and Water Conservation District

Reduce Erosion and Runoff:

1. Avoid application when soils are close to saturation or when a significant precipitation event is expected.
2. Trap erosion and slow runoff from treated sites. Eroded soil particles may carry chlorpyrifos. Other techniques include:
   - -Strip cropping (strips of perennial vegetation alternated with cultivated strips on contours),
   - -"Perms" (grass strips) or cover crops between rows of conifer plantations, berries, orchard crops,[19]
   - -Reduced-tillage, which maintains organic material on site, holding soil in place,
   - -Straw ropes laid across the contour on sloped sites slow runoff and erosion.[20]
3. Infiltrate concentrated, channeled runoff leaving the treated sites using grassed waterways.[21] Grass-filter strips or sediment-retention ponds can be helpful. Such techniques trap sediment and promote infiltration, reducing pesticide loading to adjacent ditches and streams. While large variability exists, a review found, on average: [22]
   - -a 17 ft. wide vegetative strip reduces pesticide loading by 50%,
   - -a 33 ft. wide vegetative strip reduces pesticide loading by 90%,
   - -a 67 ft. wide vegetative strip reduces pesticide loading by 97%.

Pesticide Selection:

1. Use a product that is less toxic (check SDS sheets or talk to your crop consultant or extension specialist). Botanical extracts and microbials are effective against many pests and widely available, and these products can be less toxic to non-targets.
2. Avoid tank mixes and formulations containing multiple active ingredients, which may cause additive or synergistic effects.

1 U.S. Environmental Protection Agency (EPA). 2017. Biological Evaluation Chapters for Chlorpyrifos ESA Assessment. https://www.epa.gov/endangered-species/biological-evaluation-chapters-chlorpyrifos-esa-assessment, Appendix 4-3.
2 Ibid, Appendix 3-1.
3 Reported values in U.S. EPA, 2017 (Endnote 1). Persistence ranking in accord with classification at National Pesticide Information Center (NPIC). Bioconcentration ranking follows McBrien, S. [and others]. 1987. Hazard Ranking System Issue Analysis: Classification of Hazardous Substances for Potential to Accumulate in the Food Chain.
4 U.S. EPA. 2003. Chlorpyrifos Analysis of Risks to Endangered and Threatened Salmon and Steelhead. Office of Pesticide Programs. Cited in National Marine Fisheries Service. 2008. pp. 269-271 (Endnote 7).
5 Sandahl J., Baldwin D. [and others]. 2004. Odor-evoked field potentials as indicators of sublethal neurotoxicity in juvenile coho salmon (Oncorhynchus kisutch) exposed to copper, chlorpyrifos, or esfenvalerate. Canadian Journal of Fisheries Aquatic Sciences 64:404-413.
6 Sandahl J., Baldwin D. [and others].2005. Comparative thresholds for acetylcholinesterase inhibition and behavioral impairment in coho salmon exposed to chlorpyrifos. Environmental Toxicology and Chemistry 24:136-145.
7 National Marine Fisheries Service. 2008. Endangered Species Act Section 7 Consultation Biological Opinion. U.S. EPA Registration of Pesticides Containing Chlorpyrifos, Diazinon, and Malathion. See pages 269-270.
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16 Parker, J., D. Crowder [and others]. 2016. Trap crop diversity enhances crop yield. Agriculture, Ecosystems and Environment 232:254-262. http://entomology.wsu.edu/david-crowder/files/2016/09/2016_parker-et-al_ag-ecosyst-environ.pdf.
17 AgDrift model, results presented on pp. 394-395 of National Marine Fisheries Service. 2008 (Endnote 7).
18 U.S. EPA. 2013. Chlorpyrifos Preliminary Evaluation of the Potential Risks from Volatilization.
19 Pacific Northwest Extension Publication PNW 625. Weed and Vegetation Management in Christmas Trees.
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21 USDA Natural Resources Conservation Service. 2000. Conservation Buffers to Reduce Pesticide Losses. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_023819.pdf.
22 European Crop Protection Association, 2009. Vegetative Buffer Strips, http://abe.ufl.edu/Carpena/files/pdf/software/vfsmod/VFS_Flyer_07_09_09__FINAL.pdf.

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