

An Ecological Risk Assessment of the Acute and Chronic Effects of the Herbicide Clopyralid to Rainbow Trout (*Oncorhynchus mykiss*)

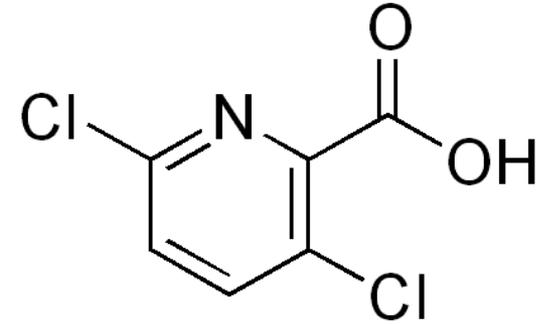
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A decorative graphic consisting of several horizontal lines of varying lengths and colors (teal, white, and light blue) extending from the right side of the slide towards the center.

Background

- ~325 million kg of pesticides used per year
 - 60% are herbicides
- Non-native, Invasive plants
 - Primary ecological threat
 - \$120 billion per year
 - Loss of ecosystem services
- 2004
 - ~50,000kg of herbicides to 85,000 ha of land

Clopyralid



- 3,6-dichloro-2-pyridinecarboxylic acid
- Health Effects
 - Eye irritation—irreversible impairment
 - Reproductive issues
 - Vomiting, diarrhea, dizziness
- Persistent in soil
- Potatoes extremely sensitive
- No carcinogenic studies

Clopyralid

- Used to control:
 - Perennial & Annual Broadleaf plants
- Mode of Action:
 - Similar structure to auxins
 - Binds to receptors for natural growth hormones
- Acute Effects – watery eyes, dizzy, lethargic
- Subchronic – increase in liver size
- Chronic – stomach, blood, liver, body weight changes

Materials and Methods



- Dow Agrosiences—primary manufacturer
 - Donated commercial formulation
- Rainbow trout obtained as eyed eggs
 - Shipped and chilled in 5°C, oxygenated water
 - Acclimated to ambient well water conditions
 - Fed twice daily

Chronic Toxicity Testing

- Proportional flow-through diluters
- 12 replicate tanks divided into 2 replicate test chambers
 - 10 juvenile trout per chamber
- 0.48 L of test solution every 20 min
 - 35ml per day total
- Used 6 concentrations
 - 0, 16, 32, 64, 128, 256 mg/L

Herbicide Analysis

- Four samples collected weekly from control, low, medium, and high concentrations
 - Triplicate samples taken once—precision and accuracy
- Ion chromatography
- Method quantitation limit was 0.366 mg/L

Statistics

- Tested for normality – Shapiro-Wilks
- ANOVA – analyzed growth
- Duncan's mean separation – analyzed treatments

- Maximum Acceptable Toxicant Concentration
 - Geometric mean of NOEC and LOEC
- Acute:Chronic ratio
 - Previous ALC_{50} / MATC

Results

- Acute Toxicity
 - Toxic at 104 mg/L – USEPA
- Chronic Toxicity
 - No significant mortality in juvenile trout
 - 30-day toxicity study @ 256mg/L clopyralid
 - No significant effects on growth at 15 days
 - At 256 mg/L
 - Decrease in weight of 9% of fish at 30 days

Table 2 - Avg. lengths and weights

Measured concentration (mg/L)	Day 15		Day 30	
	Length (mm)	Weight (g)	Length (mm)	Weight (g)
0	49.5 (0.8) ^a	1.18 (0.06) ^a	57.6 (0.99) ^a	1.80 (0.99) ^a
17	48.8 (0.9) ^a	1.15 (0.08) ^a	56.1 (0.22) ^a	1.67 (0.04) ^{abc}
34	48.6 (1.0) ^a	1.12 (0.08) ^a	56.8 (1.54) ^{ab}	1.76 (0.16) ^{ab}
68	48.7 (0.8) ^a	1.16 (0.05) ^a	56.5 (0.61) ^{ab}	1.74 (0.07) ^{ab}
136	48.3 (0.8) ^a	1.11 (0.07) ^a	55.1 (0.90) ^{bc}	1.63 (0.06) ^{bc}
273	47.7 (1.1) ^a	1.11 (0.09) ^a	53.9 (1.02) ^c	1.56 (0.06) ^c

Results

- Acute:chronic ratio
 - Used to calculate margin of safety between acute and chronic effects for fish exposed to chemicals
 - $ACR = 7.3$
 - 96-h ALC₅₀/MATC for growth
 - = (700mg/L) / (96mg/L)

Expect Environmental Exposures

- Tier 1 – Worst case scenario—direct overspray of 1-ha pond of 2m depth at upper limit of clopyralid
 - 0.054 mg/L
- Tier 2 – rain event 2 days after application

Model end point	Exposure concentration (mg/L)
Peak	0.058
Max. 4-day average	0.058
Max. 21-day average	0.057
Max. 60-day average	0.054
Max. 90-day average	0.052

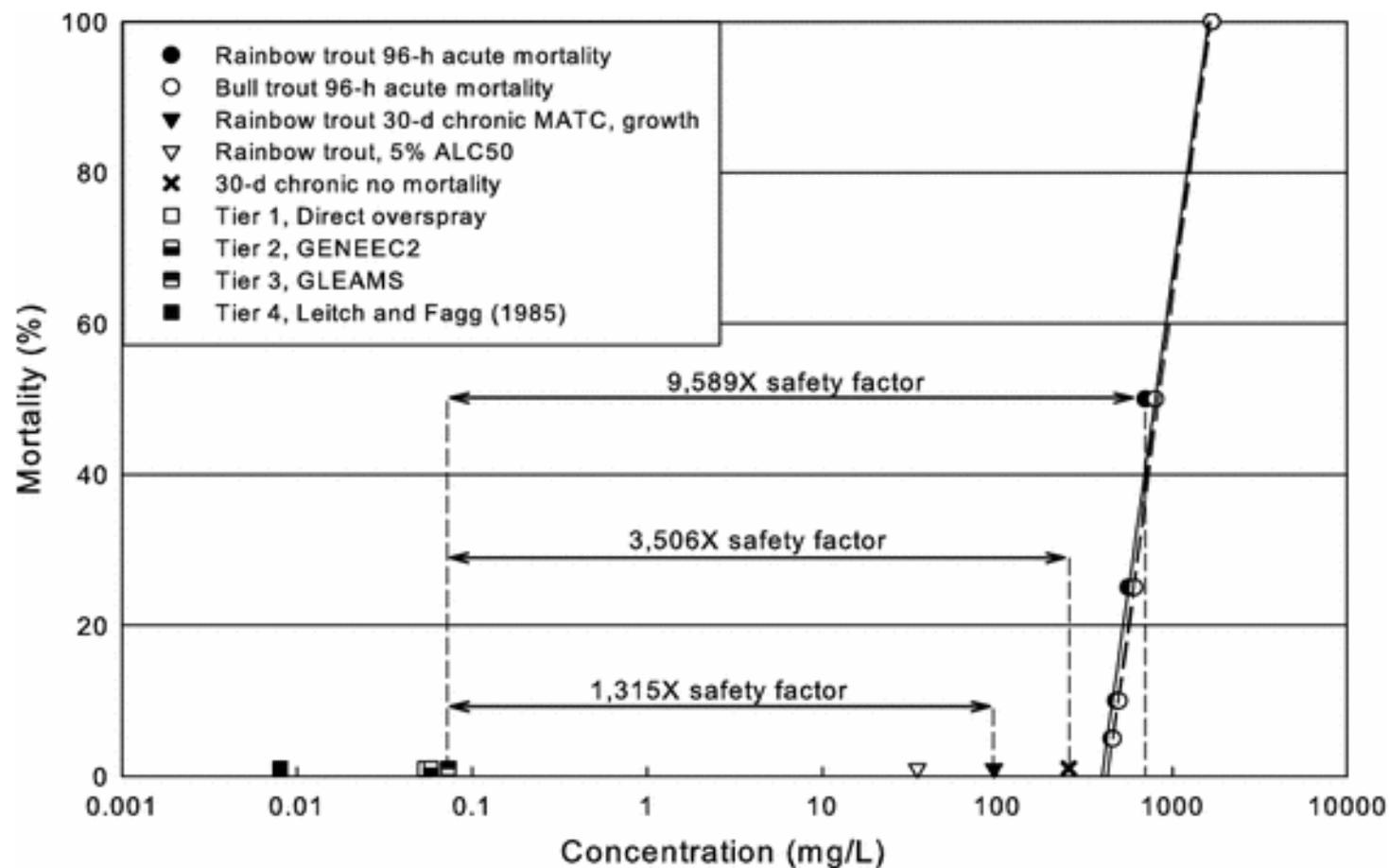
Expect Environmental Exposures

- Tier 3 – half-lives in environmental compartments
 - Highest stream water concentration was 0.062 mg/L in soil under annual rainfall of 635 cm/yr
- Tier 4 – Edge-of-field concentrations
 - 0.008 mg/L

Risk Assessment for Rainbow Trout

- Comparisons of lab toxicity data to modeled and observed concentrations in the environment
- Safety factors
 - 1315 for growth effects
 - 3507 for mortality
 - 10,000 for acute effects
- Indicate extremely low probability for adverse effects of clopyralid to rainbow trout

Figure 1



Works Cited

- Cox, Caroline. "Herbicide Factsheet - Clopyralid." Journal of Pesticide Reform (1998): 15-19.
- Fairchild JF, Allert AL, Feltz KP, Nelson KJ, Valle JA. "An ecological risk assessment of the acute and chronic effects of the herbicide clopyralid to rainbow trout (*Oncorhynchus mykiss*)."
Arch Environ Contam Toxicol. (2009): 725-731.