

Assessing Herbicide Risks to Endangered Wildlife

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Hazards & exposure & toxicity

- ▶ Are they the same?
- ▶ Are they related?
- ▶ How are they related?



Some terminology...

- ▶ Hazard – the risk the chemical poses
- ▶ Exposure – the amount of contact and the type of contact a subject has to a toxicant
- ▶ Toxicity – a measurement of the “poisonousness” of the toxicant

$$\text{HAZARD} = \text{TOXICITY} \times \text{EXPOSURE}$$

Me on the Summit





Hazard Quotients (HQ)

- ▶ $HQ = \text{exposure}/\text{toxicity}$
- ▶ Exposure is determined by...
 - Computer modeling
 - Field monitoring
- ▶ Toxicity is determined by laboratory tests
 - Standardized methods are used
 - “Representative” test species are used
 - Tests involve replication (statistical strength)
 - Reproducibility is important

Hazard Quotients (HQ)

- ▶ Exposure is typically expressed as
 - mg (pesticide) / L (water)
 - mg (pesticide) / kg (food weight)
- ▶ Toxicity is typically expressed as...
 - LD⁵⁰ values for terrestrial organisms (mg/kg)
 - LC⁵⁰ values for aquatic organisms (mg/L)
 - EC⁵⁰ values for invertebrates (mg/L or mg/kg)
 - NOEL (no observable effect levels)
 - NOAEL (no observable adverse effect level)

HQ – Exposure Routes

- ▶ Direct contact
- ▶ Water consumption or exposure
 - Spills (up to 200 gals)
 - [Expected peak]
- ▶ Contaminated vegetation
 - Direct application
 - Drift or other off-target movement
- ▶ Contaminated prey
- ▶ Aggregate exposures



HQ – Exposure Scenarios

- ▶ Direct spray to honeybees 100% absorption
- ▶ Small bird (10 g)/contaminated seed
- ▶ Large bird (4 kg)/contaminated grass
- ▶ Large grazing mammal (70 kg)
- ▶ Small carnivorous mammal (5 kg)
- ▶ Large piscivorous bird (5 kg)
- ▶ Sensitive fish species (salmonids)
- ▶ Tolerant fish species (warm-water fish)
- ▶ Sensitive plant species
- ▶ Tolerant plant species

HQ – Toxicity

- ▶ Derived from laboratory tests
 - Both acute (i.e. 24 or 96-h) and chronic (i.e. 4 mo)
 - Endpoints may be lethality or sub-lethal effects
- ▶ Typical test organisms include...
 - Rats for mammals
 - Japanese quail & mallard ducks for birds
 - Fathead minnow for warm-water fish
 - Rainbow trout for cold-water fish
 - Honeybees for terrestrial invertebrates
 - Ceriodaphnia for aquatic invertebrates

HQ – Toxicity



- ▶ Surrogate species may be used
 - Larval fish for frogs
 - Birds for reptiles
- ▶ Data are derived from...
 - The USEPA registration process
 - Open literature (USFS)

Hazard Quotients (HQ)

- ▶ Assume that the 96-h LC⁵⁰ value for rainbow trout exposed to the herbicide active ingredient “triclosulfonate” is

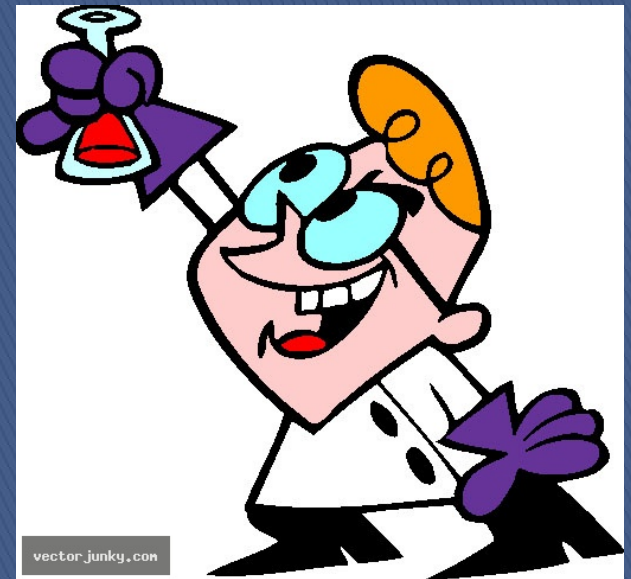
10 mg/L

- ▶ and... field monitoring has determined that the peak triclosulfonate concentration after direct application of the herbicide to water is

11 mg/L

Hazard Quotients (HQ)

- ▶ Concentration that is lethal = 10 mg/L
- ▶ Concentration expected in water = 11 mg/L
- ▶ $HQ = EXPOSURE / TOXICITY$
- ▶ $HQ = 11 \text{ mg/L} / 10 \text{ mg/L}$
- ▶ $HQ = 1.1$



Level of Concern (LOC)

- ▶ HQ > LOC means adverse effects are plausible.
- ▶ The question is... is the LOC conservative enough to protect the non-target organism?
- ▶ How representative is this assessment of the real world?
- ▶ So, what's the LOC? How is it determined?

What's the LOC?

US FOREST SERVICE

Acute = 1

Acute T/E = 1

Acute aquatic = 1

Acute aquatic T/E = 1

Chronic = 1

Uses the more conservative NOEL rather than the LD50 or LC50, or an uncertainty factor

US EPA

Acute = 0.5

Acute T/E = 0.1

Acute aquatic = 0.5

Acute aquatic T/E = 0.05

Chronic risk = 1

Uses the less conservative LD50 or LC50 rather than the NOEL and does not factor in uncertainty.

T/E Species & Pesticides

- ▶ The USEPA uses a more conservative LOCs for threatened/endangered species...
 - Terrestrial T/E... LOC = 0.1
 - Aquatic T/E... LOC = 0.05
- ▶ T/E species are not more sensitive to pesticides than non-protected species
- ▶ But, the lower LOC provides a higher level of protection due to their low population status

What if the HQ > LOC?



- ▶ HQ > LOC ≠ Deaths
- ▶ HQ < LOC... no cause for concern
- ▶ HQ > LOC... a suggestion that effects might be plausible

GRASS OR LEAVES ?

WHICH HERBICIDE ?

HOW MUCH
EATEN PER DAY ?

WHAT USE RATE ?

ACUTE OR CHRONIC ?

TANK DILUTION ?

HOW LARGE IS
THE DEER ?

DIRECT SPRAY
OR DRIFT ?

LD50 OR NOEL ?

WHAT % OF DIET IS
CONTAMINATED ?

A.I. OR
A.E. ?

HOW LONG IS
THE EXPOSURE ?



TRICLOPYR ESTER

GRASS

18 % of body weight consumed per day

7 OZ/ACRE

ACUTE

25 GALS/ACRE

70 kg DEER

DIRECT SPRAY

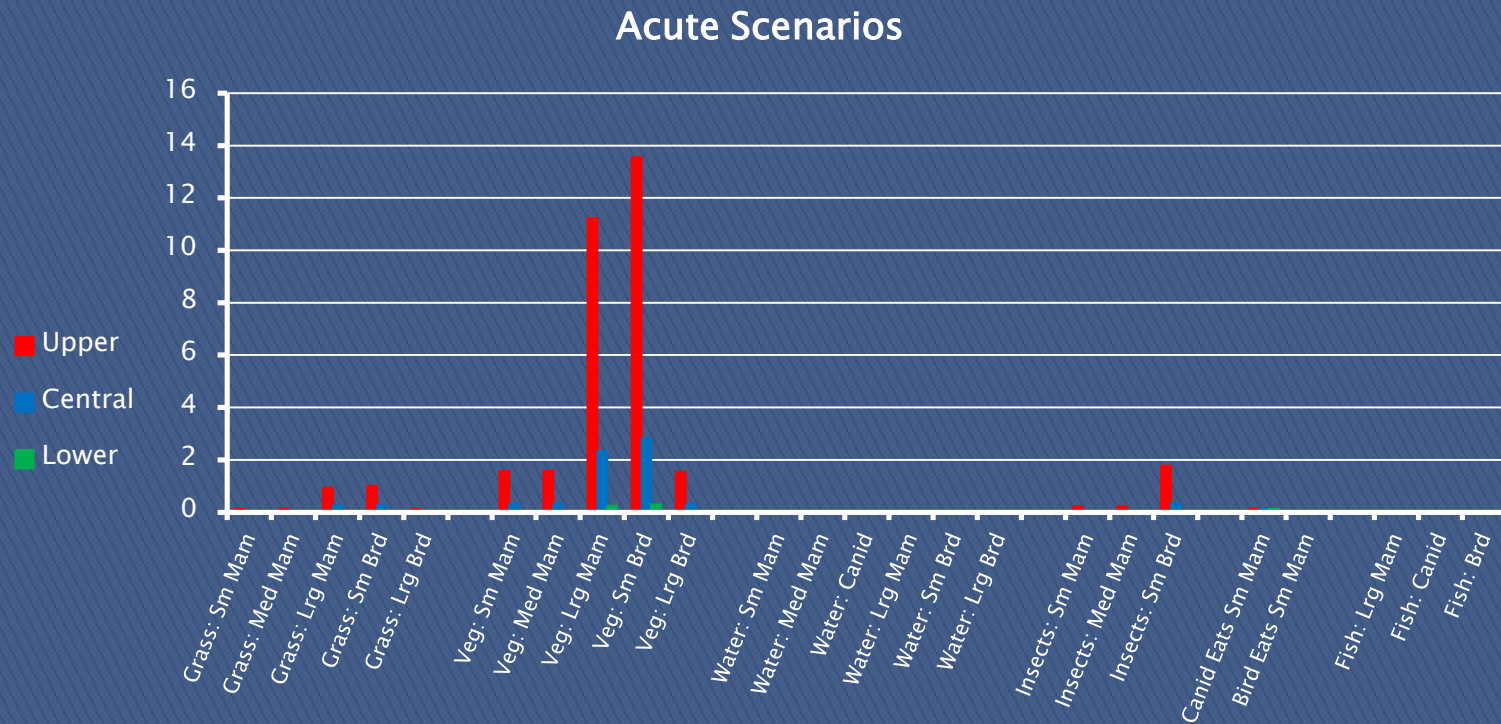
100 % OF DIET IS CONTAMINATED

NOEL

ACID EQUIVALENT



HQs for Triclopyr BEE



Things to keep in mind...

- ▶ These HQs are based on NOEL values
- ▶ Most HQs are $< \text{LOC (1)}$
- ▶ The majority of these involve UPPER exposure scenarios (high volume/acre).
- ▶ The only CENTRAL exposure scenarios (typical) involve large mammals consuming short grass (deer) and small birds consuming short grass.

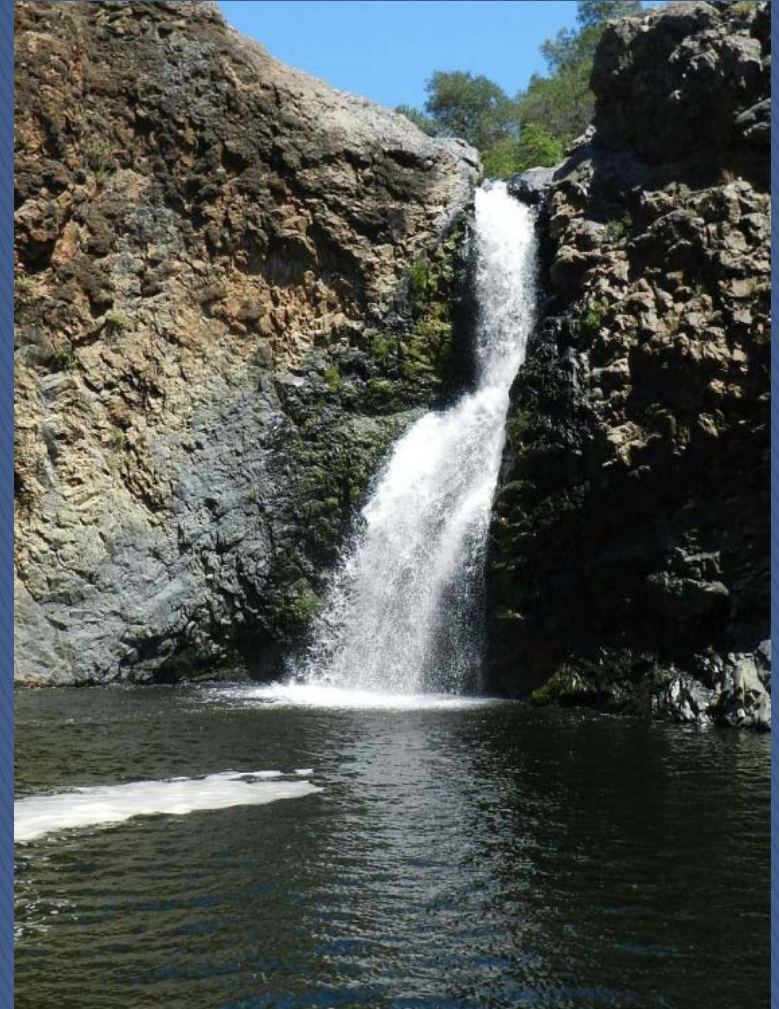
If the HQ > LOC...

- ▶ Use a different application method
- ▶ Time the application to lessen exposure potential
- ▶ Use spray buffers
- ▶ Use a different formulation
- ▶ Switch herbicides



Last point...

- ▶ The HQ Method is quantitative
- ▶ Should eliminate “philosophical” decision-making...
- ▶ Herbicides as “a last resort” mindset



If you say something long enough...

If you are younger than 40 you may not know who this is...

Its Colonel Klink from the 1970s t.v. show Hogan's Heroes...

WTF? Looking back on it now... a "funny" show about Nazi's seems very messed up...



Resources

- ▶ ExToxNet website
- ▶ USFS Herbicide Hazard Assessments
- ▶ Coming soon... Cal IPC Wildlands BMP Manual

