An Assessment of the Hazard of the Herbicide Rodeo® and the Non-ionic Surfactant R-11® to Non-target Aquatic Invertebrates and Larval Amphibians

"Killing only the bad things"

"Using our powers for good and not for evil"

Joel Trumbo

Staff Environmental Scientist

Pesticide Investigations Unit

CA Dept of Fish & Game

There's nothing quite so disconcerting to the general public as the statement "According to government scientists...."

What's so important about killing the weeds and not other things?

- Amphibian decline
- Concerns about toxics (their role in amphibian decline?)
- Controlling invasives vs protecting natives
- Biodiversity

Glyphosate Herbicide

An Effective Tool for Exotic Invasive Weed Control

- TERRESTRIALS

1. Giant cane
2. Salt cedar
3. Ailanthus

- AQUATICS

1. Water primrose
2. Parrotfeather
3. Purple loosestrife

Two Important Issues

1. Many of these weeds are found in or near water where other native species are present.

2. “Aquatic” glyphosate works better when you add a surfactant to the tank.

Some Other Stuff to Wring Our Hands Over...

- Some surfactants pose a higher toxicity risk than herbicides. (i.e. Rodeo & R-11)
- Lingering concerns about glyphosate toxicity to non-targets.


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So, what's the question?

- If you use a glyphosate herbicide with a surfactant, can you kill the weeds without killing the frogs?

- HAZARD = TOXICITY X EXPOSURE

Elements of the Experiment

- STEP 1: apply the herbicide/surfactant to water
- STEP 2: determine herbicide & surfactant concs. in the treated water (exposure)
- STEP 3: find out what tankmix conc. is toxic to tadpoles (toxicity)
- STEP 4: Look at the results of Step 3 in relation to the results of Step 2.

One More Thing...
The Worst-Case Scenario Approach

- Herbicide/surfactant applied directly to water
- High use rates (5pts/ac...max is 7.5)
- and something else...


WHAT'S MISSING
IN THIS PICTURE?

Does this help?

One More Thing...
The Worst-Case Scenario Approach

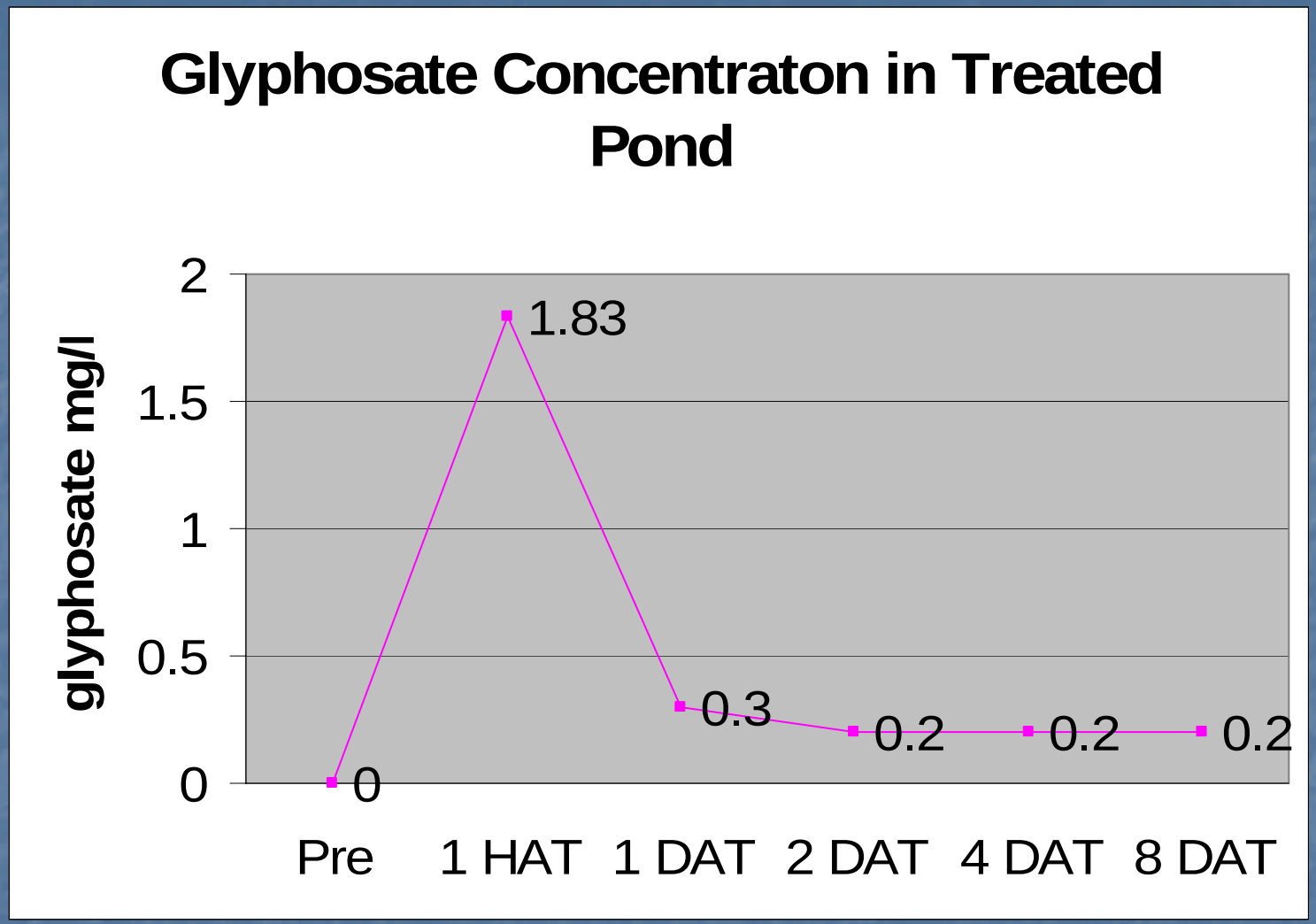
- Herbicide/surfactant applied to water
- High use rates
- No aquatic vegetation present
- No pond outlet

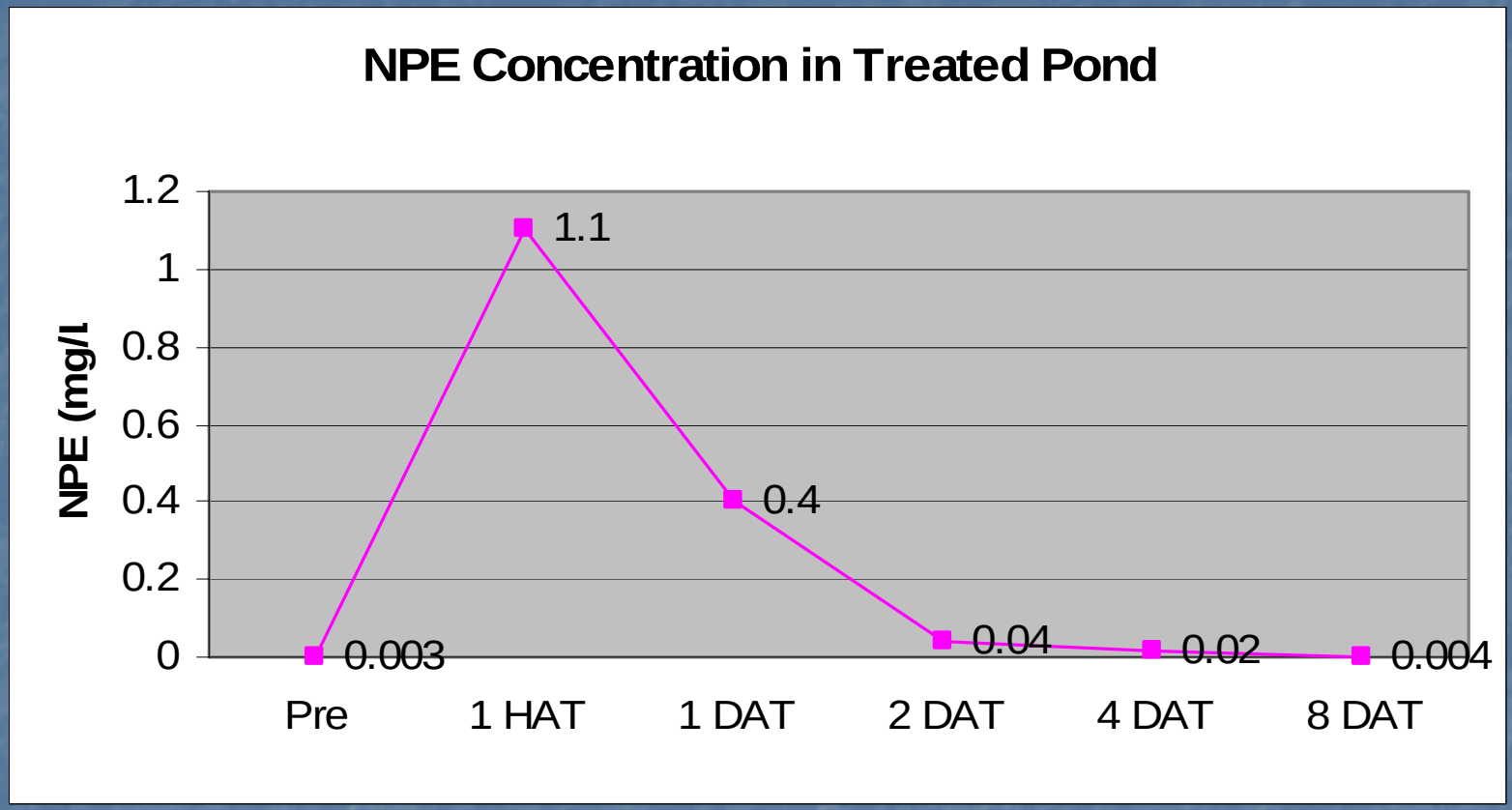
The Application

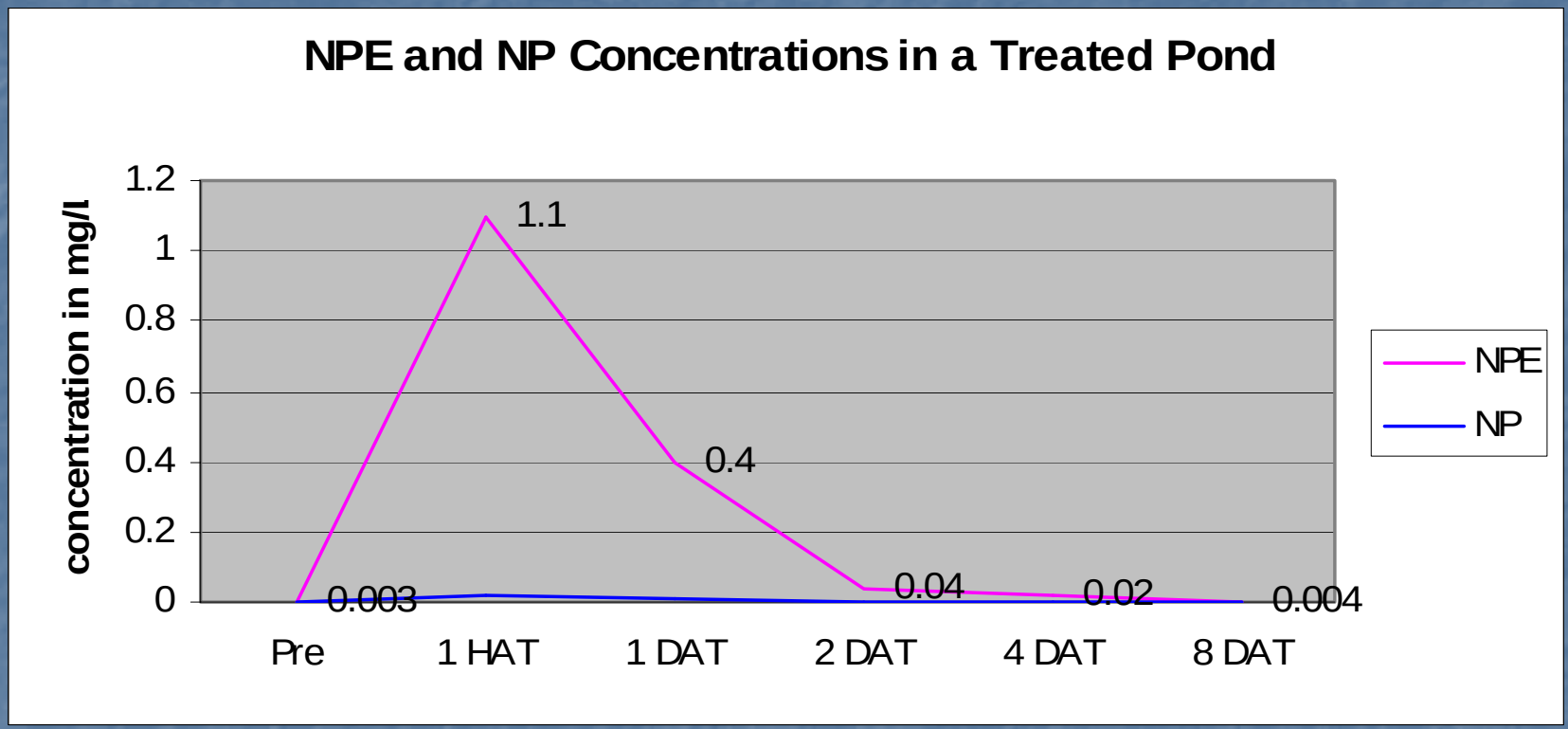
- Rodeo® 1% tankmix (5pts/surface acre)
- R-11® : 0.5% tankmix
- Hose gun application

Herbicide & Surfactant Residue Analyses

- 3 sampling locations in the treated pond
- 1 untreated control pond
- Pretreatment samples were collected
- One hour post-treatment (1 HAT)
- One day after treatment (1 DAT)
- 2, 4 and 8 DAT
- Glyphosate, AMPA, NPE and NP


Glyphosate Concentraton in Treated Pond
glyphosate mg/l
2
1.5
1
0.5
0
1.83
0
0.3
0.2
0.2
0.2
Pre
1 HAT
1 DAT
2 DAT
4 DAT
8 DAT


NPE Concentration in Treated Pond
NPE (mg/l
1.2
1
0.8
0.6
0.4
0.2
0
1.1
0.4
0.04
0.02
0.004
0.003
Pre
1 HAT
1 DAT
2 DAT
4 DAT
8 DAT


NPE and NP Concentrations in a Treated Pond
concentration in mg/l
1.2
1
0.8
0.6
0.4
0.2
0
1.1
0.4
0.04
0.02
0.003
0.004
Pre
1 HAT
1 DAT
2 DAT
4 DAT
8 DAT
NPE
NP

Tadpole Toxicity Test

- 96-h toxicity tests
- Mortality endpoint
- Larval leopard frogs *Rana pipiens* (7-d)
- 5 test solutions of herbicide/surfactant

Toxicity Test Results

Dilution No.	Glyphosate (mg/L)	NPE (mg/L)	NP (mg/L)	Survival (%)
1	17.6	4.5	<MDL	0*
2	8.7	2.5	<MDL	0*
3	4.5	1.0	<MDL	92.5
4	2.4	0.6	<MDL	100
5	1.3	0.3	<MDL	100
96-h LC_{50}	6.5	1.7	NA	NA

* Indicates survival significantly less than control group ($P<0.05$)

Puttin' it All Together: Glyphosate

- [Glyphosate] ^{max} = 1.83 mg/L (ppm)
- [Glyphosate]$^{1\ DAT}$ = 0.3 mg/L
- [Glyphosate]$^{4\ DAT}$ = 0.3 mg/L
- [Glyphosate]$^{8\ DAT}$ = 0.2 mg/L
- Min. detection = 0.02 mg/L
- 96-h LC_{50} tadpoles: 6.5 mg/L

Puttin' it All Together: NPE

- $[NPE]^{max}$ = 1.1 mg/L (ppm)
- $[NPE]^{1\ DAT}$ = 0.4 mg/L
- $[NPE]^{4\ DAT}$ = 0.02 mg/L
- $[NPE]^{8\ DAT}$ = 0.004 mg/L
- Min. det = 0.0002 mg/L
- 96-h LC_{50} tadpoles: 1.7 mg/L

Puttin' it All Together: NP

- $[NP]^{max}$ = 0.02 mg/L (ppm)
- $[NP]^{1\ DAT}$ = 0.005 mg/L
- $[NP]^{4\ DAT}$ = 0.001 mg/L
- $[NP]^{8\ DAT}$ = 0.001 mg/L
- Min. det = 0.0002 mg/L
- 96-h LC_{50} fish: 0.13 mg/L

Hazard Quotient

- HQ = exposure ÷ toxicity value
- A HQ < 1 is an acceptable risk (USEPA)
- Glyphosate: 1.8/6.5 = 0.2
- NPE: 1.1/1.7 = 0.6
- NP: ??? No NP detected in tox test sol'ns

Summary
Glyphosate

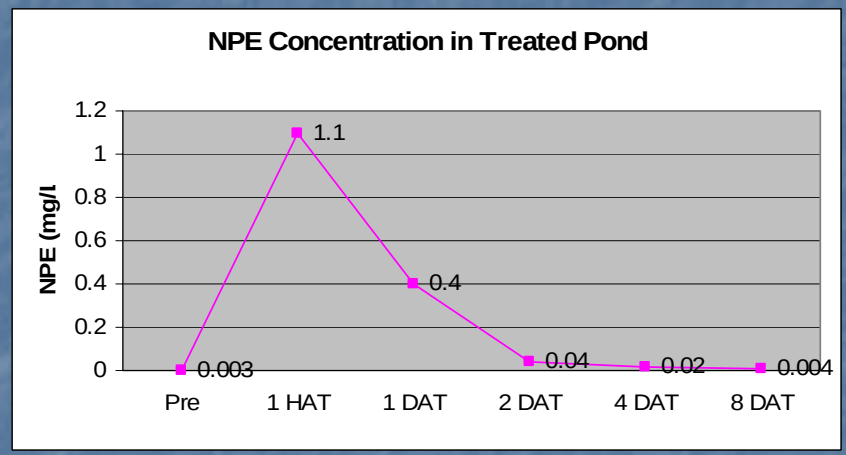
- Both concentration and exposure time appear insufficient to cause acute mortality of tadpoles.

1. [Glyphosate] ^{max} = 1.83 mg/L
2. 29% of LC_{50} value at 1-h peak
3. Hazard Quotient: 0.2 (HQ<1 are safe)

Summary
NPE

- Exposure time appears insufficient to cause acute mortality of tadpoles.

1. [NPE] ^{max} = 1.1 mg/L
2. 100% of LC_{50} value at 1-h peak
3. Hazard Quotient: 0.6 (HQ<1 are safe)



Summary
NP

- Both concentration and exposure time appear insufficient to cause acute mortality of tadpoles.

1. [NP] ^{max} = 0.02 mg/L
2. 15% of LC_{50} value at 1-h peak
3. Hazard Quotient: ???


QUESTIONS?