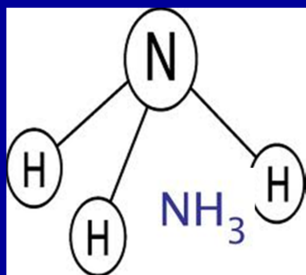
An Evaluation of Liquid Ammonia As a New Candidate Piscicide



David Ward

Southwest Biological Science Center

USGS
science for a changing world

Newspaper Headlines

Ammonia Spill wipes out fish near Clarion Iowa – 1997

Ammonia Spill Kills 700,000 Fish, Algona Iowa 2001

Massive Fish Kill From Toxic Ammonia Spill Closes Winooski River , VT - 2005

Ammonia leak kills fish in Issaquah Creek, WA - 2009

Ammonia leak at Lacona, Iowa leads to fish kill - 2010

Fish Kill At Port Of Catoosa, TN Caused By Ammonia Leak - 2011

Not a new idea

Klussman et al. 1969. **Utilization of anhydrous ammonia in fisheries management**. *Proceedings of the Southeastern Association of Game and Fish Commissioners* 23:512-519.

Champp et al. 1973. **Effects of Anhydrous Ammonia on a Central Texas Pond, and a Review of Previous Research with Ammonia in Fisheries Management**. *Transactions of the American Fisheries Society* (1) 73-82.

Prentice et al. 1976. **Evaluation of anhydrous ammonia for fishery management uses**. *Proceedings of the Annual Conference of the Southeastern Association Game and Fish Commission* 30:88-98.

Rotenone – more accessible and better formulations

Tanner C. et al. June 2011. Rotenone, Paraquat, and Parkinson's Disease. Environmental Health Perspectives 119 (6) 866 – 872.

Results: In 110 Parkinsons disease cases and 358 controls, PD was associated with use of a group of pesticides that inhibit mitochondrial complex including rotenone.

Conclusions: Parkinsons disease was positively associated with pesticides that impair mitochondrial function and increase oxidative stress supporting a role for these mechanisms in PD pathophysiology.

ARIZONA GAME AND FISH DEPARTMENT
INTER-OFFICE MEMO

TO: Regional Supervisors
Wildlife Management Division Branch Chiefs
WMD and FOD Fisheries Program Managers

FROM: Bob Broscheid, Deputy Director, WMD/SSD
Gary Hovatter, Deputy Director, FOD/IED
23 Feb 2011

SUBJECT: Suspension of Fish Renovation Activities Using Rotenone and Antimycin

DATE: February 23, 2011

We are suspending the use or application of antimycin or rotenone for any fisheries management or renovation activities by all Department employees. Use of piscicides in proximity to drinking water supplies has raised public concerns. While the science on the safe use of these chemicals is compelling, Department policies and requirements for the review and approval of projects involving piscicides are currently undergoing re-assessment. This suspension will remain in effect until we have the ability to review our internal processes and procedures regarding the use of piscicides and work with interested parties.

You may be contacted in the near future to assist with the evaluation of our policies and procedures pertaining to the use of aquatic piscicides. It is important that you provide your full cooperation and assistance with this effort. Thank you in advance for your assistance and cooperation with this effort. Please contact Kirk Young, Fisheries Branch Chief, if you have any questions regarding this direction.

MJS:ms

cc: Executive Staff

"It is unlikely that the present arsenal of approved piscicides would be effective for controlling nonnative fishes in the southwestern United States"

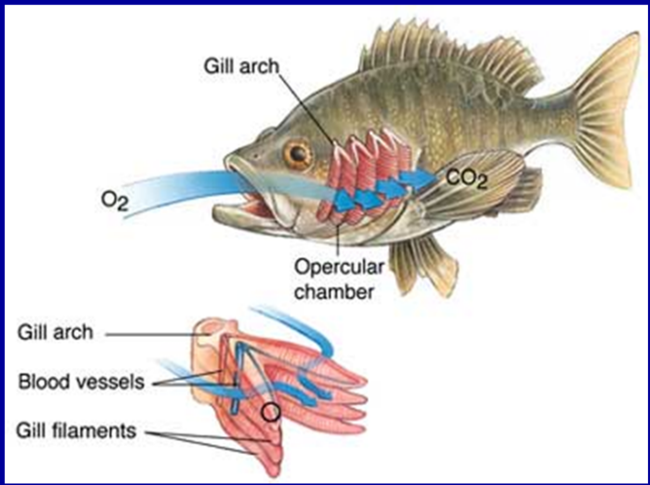
Dawson and Kolar 2003

New Piscicides?

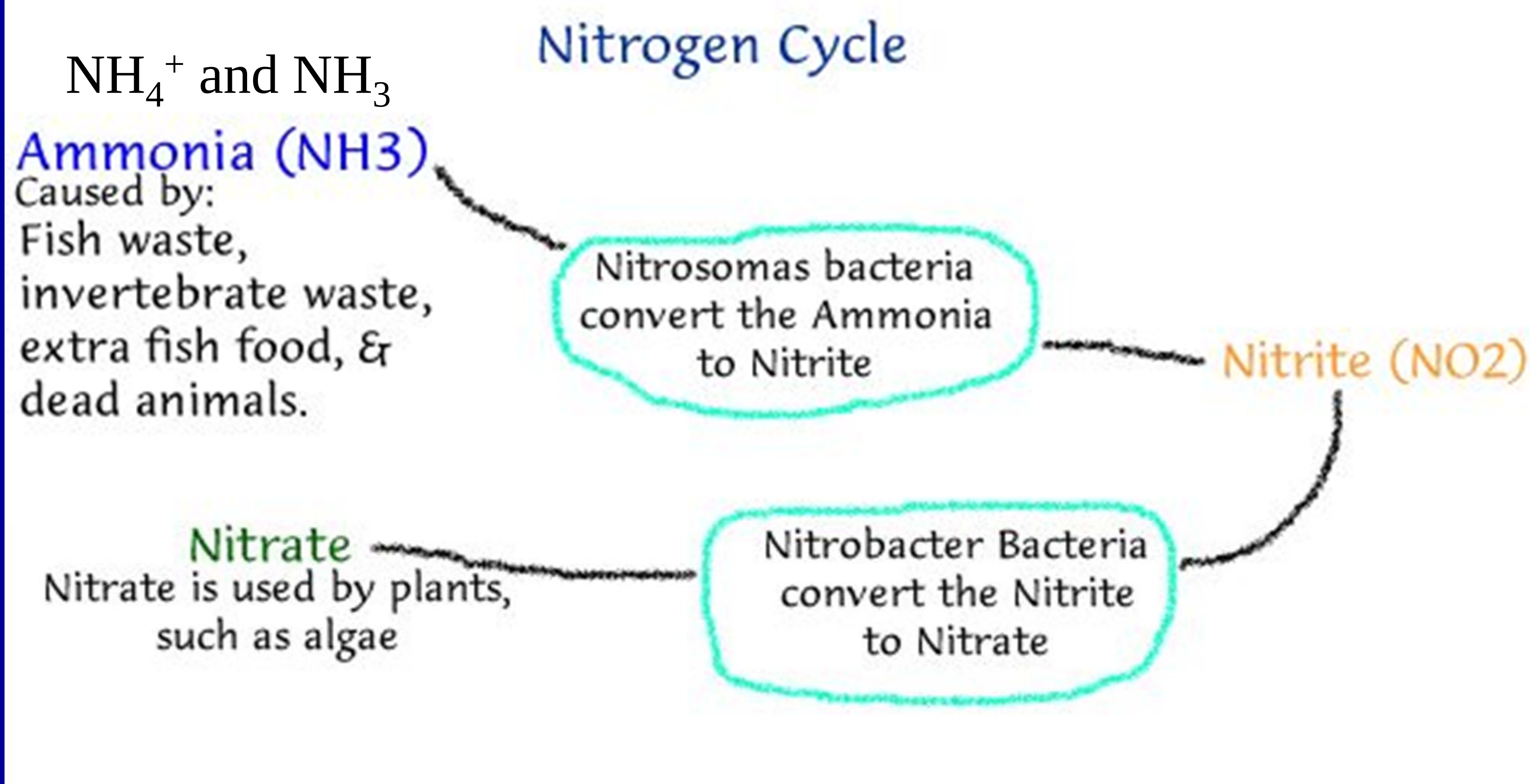
Introduced Aquatic Species

Ammonia

- Waste product of aquatic organisms
- Naturally present in the environment
- Natural bacteria in the environment break it down



NH_4^+ and NH_3



Nitrogen Cycle
Ammonia (NH3)
Caused by:
Fish waste,
invertebrate waste,
extra fish food, &
dead animals.
Nitrosomas bacteria
convert the Ammonia
to Nitrite
Nitrite (NO2)
Nitrobacter Bacteria
convert the Nitrite
to Nitrate
Nitrate
Nitrate is used by plants,
such as algae

Laboratory experiments

Laboratory versus natural environments

Rocky Mountain Research Station, Flagstaff

Upper pond

Length	48' 6''		
Width	27'	Volume	59,023 gal
Average depth	6' 4''		223,426 L
max depth	7' 1''		

Lower pond

Length	44' 5''		
Width	37' 2''	Volume	37,342 gal
Average depth	3' 2''		141,355 L
max depth	3' 6''		

	Lower Pond		Upper Pond	
		TL (mm)		TL (mm)
Species	**Number**	**Mean (Range)**	**Number**	**Mean (Range)**
Black bullhead	20	233 (150 - 340)	20	230 (165 - 320)
Bullfrog tadpoles	35	85 (20 - 176)	39	81 (20 - 157)
Carp	11	329 (260 - 400)	13	339 (140 - 400)
Channel Catfish	1	275	1	292
Crayfish	110	55 (30 - 80)	110	54 (20 - 75)
Fathead Minnow	72	65 (50 - 80)	92	65 (50 - 80)
Flathead Catfish	1	371	1	290
Green Sunfish	97	90 (60 - 193)	80	96 (50 - 190)
largemouth Bass	4	261 (240 - 295)	5	264 (210 - 330)
mosquitofish	30	50 (26 - 65)	30	50 (25 - 65)
Red Shiner	55	65 (45 - 85)	55	64 (50 - 84)
smallmouth Bass	37	72 (50 - 110)	36	70 (50 - 95)





4 Hatchling Three striped mud turtles
Kinosteron baurii

4 adult Red ear sliders
Trachemys scripta

Dosage of ½ ml ammonia (29%) per gallon of water

7.8 gallons
29.5 L

4.93 gallons
18.66 L

Fish dying within 20 minutes

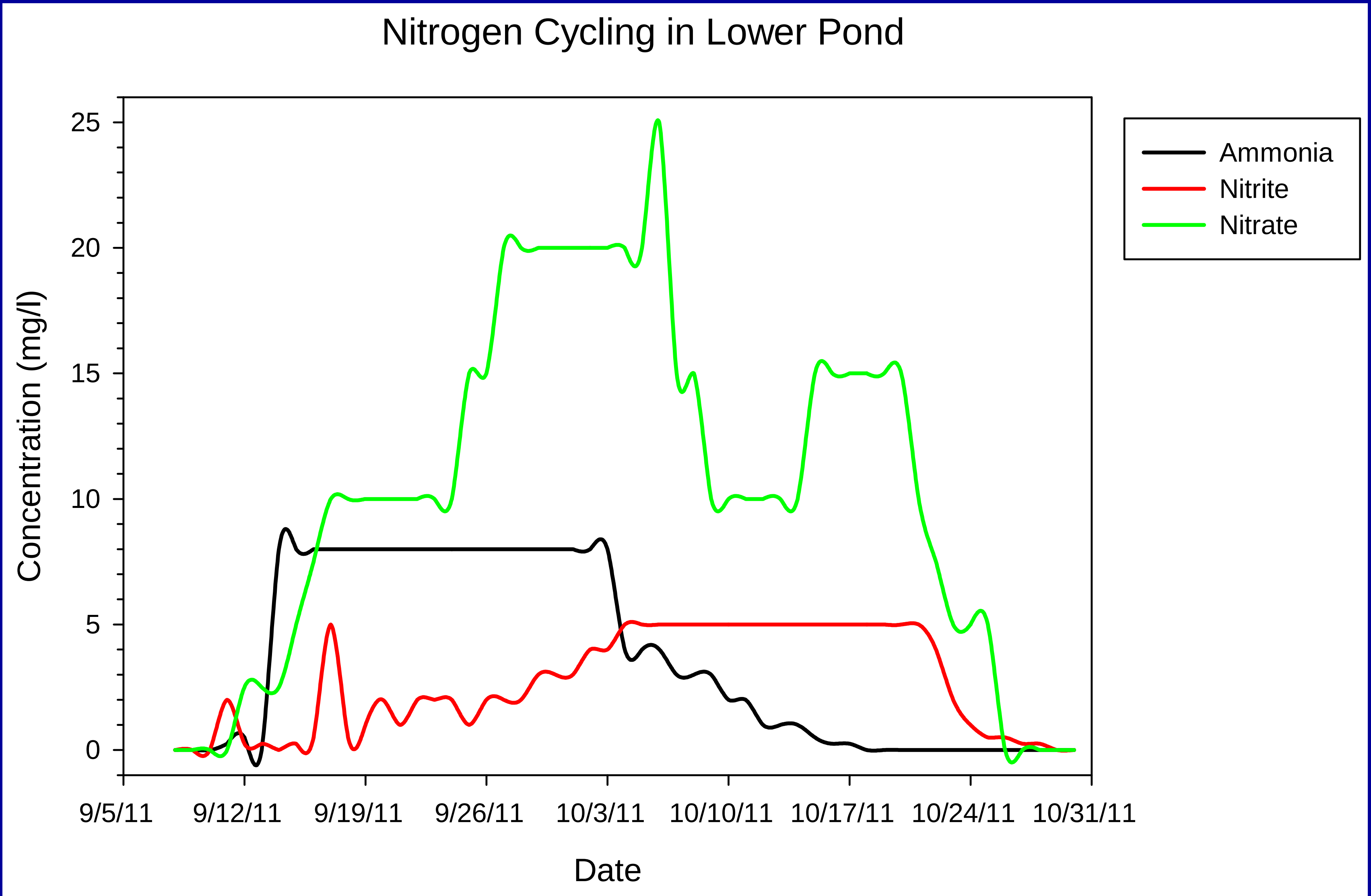
Methods

Ammonia
Nitrite
Nitrate
PH
Temp
DO

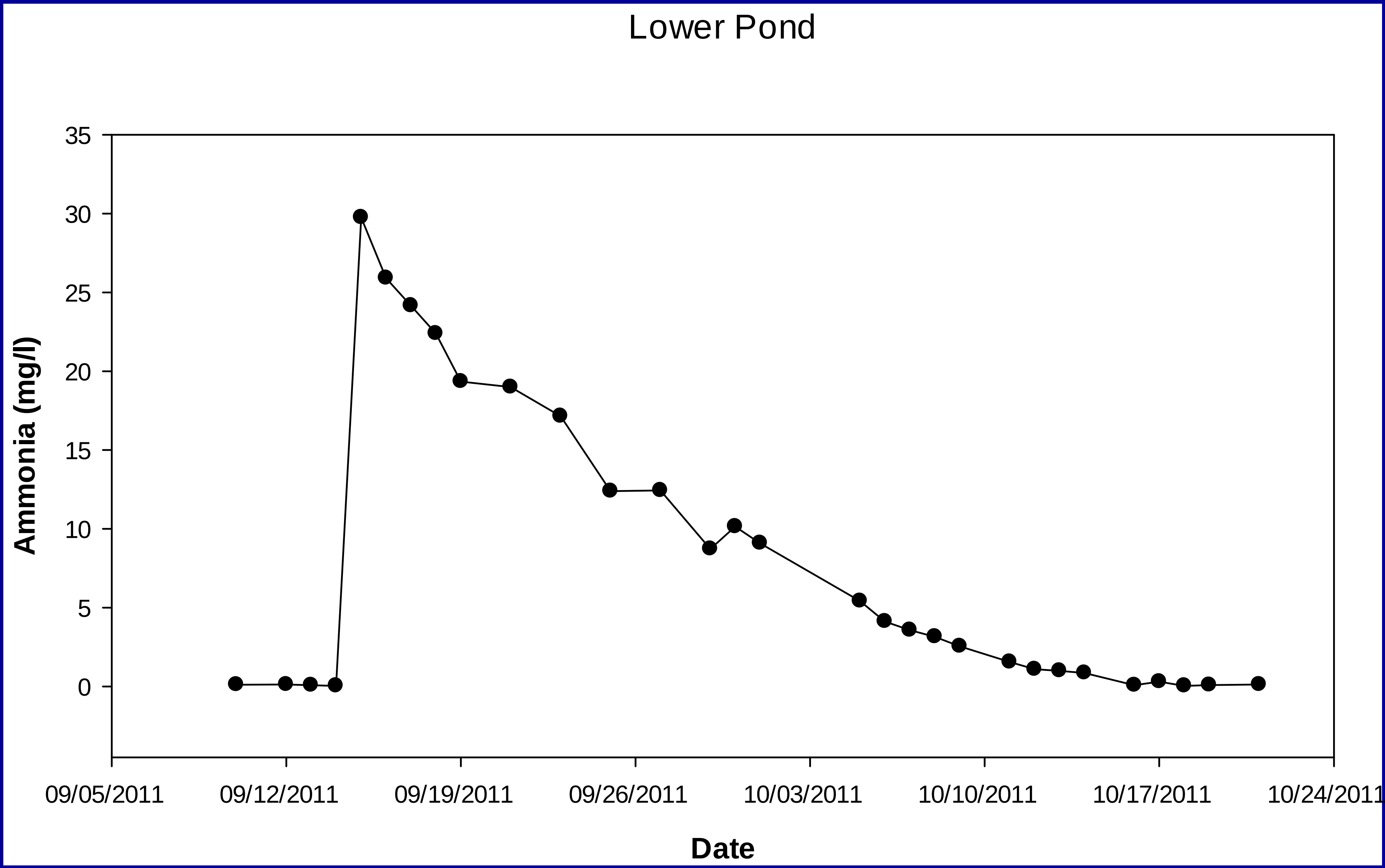
NORTHERN ARIZONA UNIVERSITY

Colorado Plateau Analytical Laboratory

Field Readings – Lower Pond



Spectrophotometry data - Ammonia

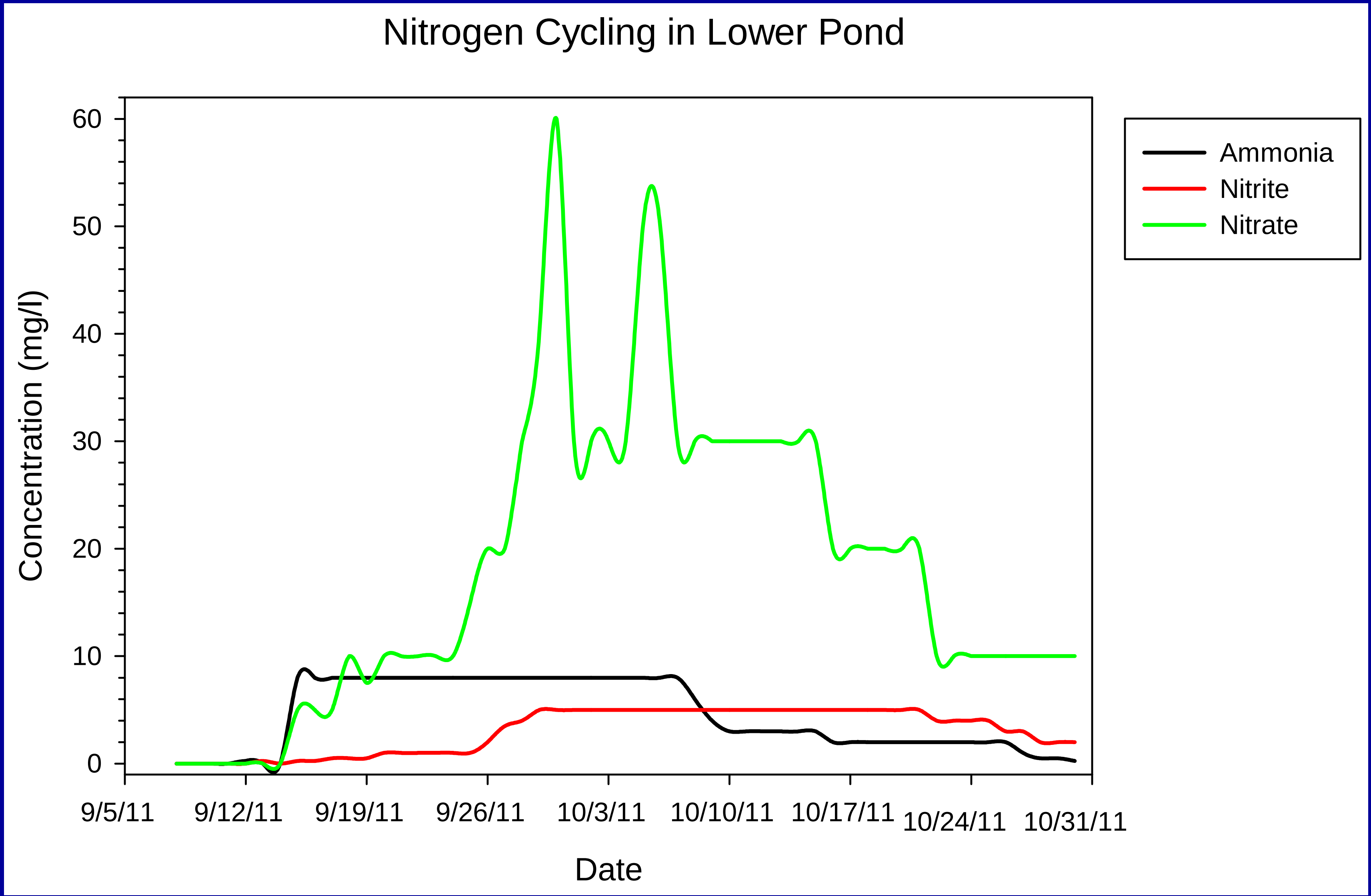


EPA toxicity values for selected aquatic organisms

Species	Ammonia (mg/L)	* Nitrite mg/L
Rainbow trout	1.09	2.5
Brown trout	0.701	
Brook trout	1.05	
Northern whitefish	0.473	
Red shiner	3.16	
Fathead minnow	3.44	2.61
White sucker	2.22	
Channel catfish	3.8	1.39
Mosquitofish	3.2	
Green sunfish	2.11	
Bluegill	2.97	
Smallmouth bass	1.78	
Largemouth bass	1.7	1.14
Walleye	1.1	

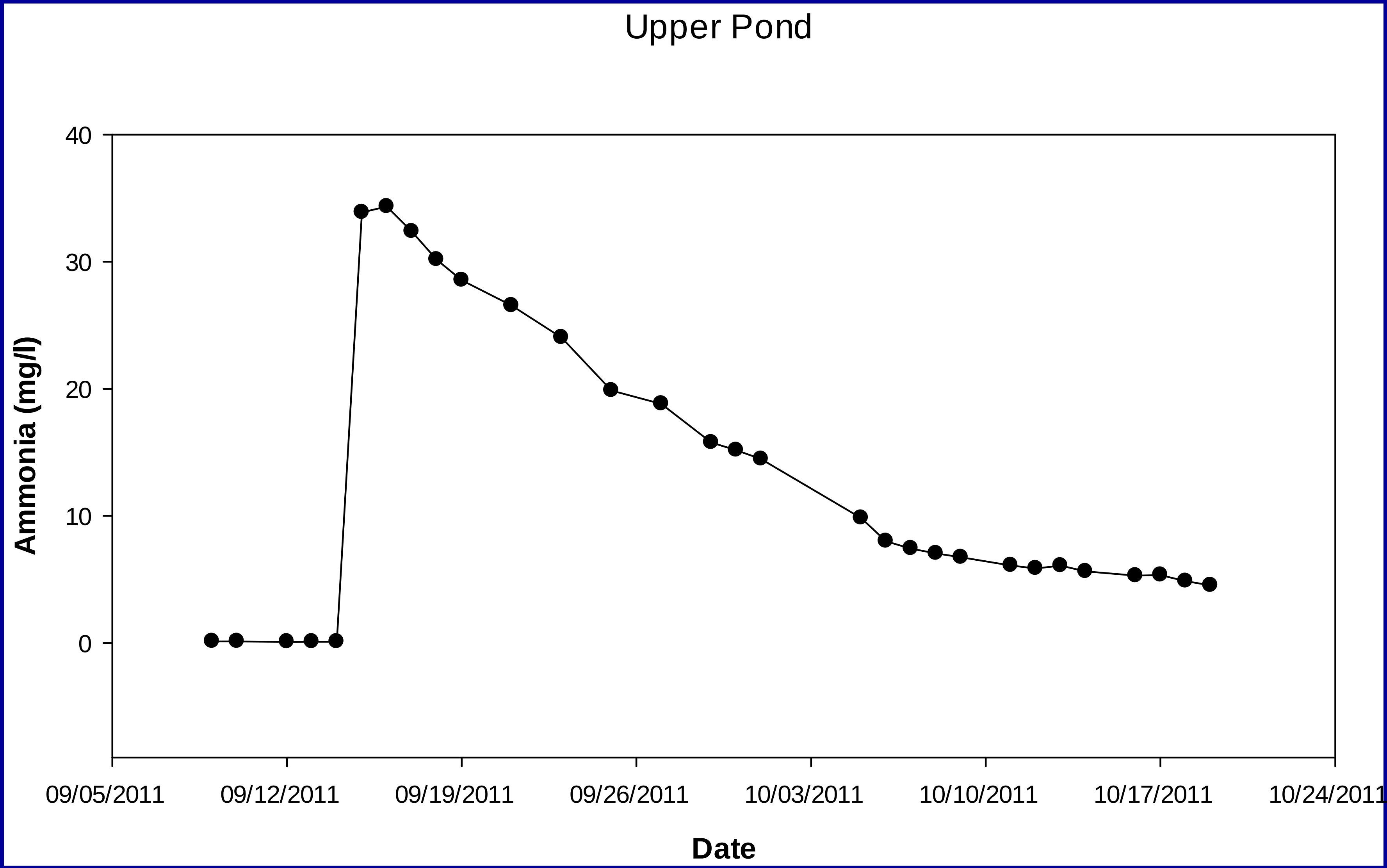
*Lewis and Morris 1986. Toxicity of nitrite to fish: A review. *Transactions of the American Fisheries Society* 115: 183-195.

Field Readings – Upper Pond

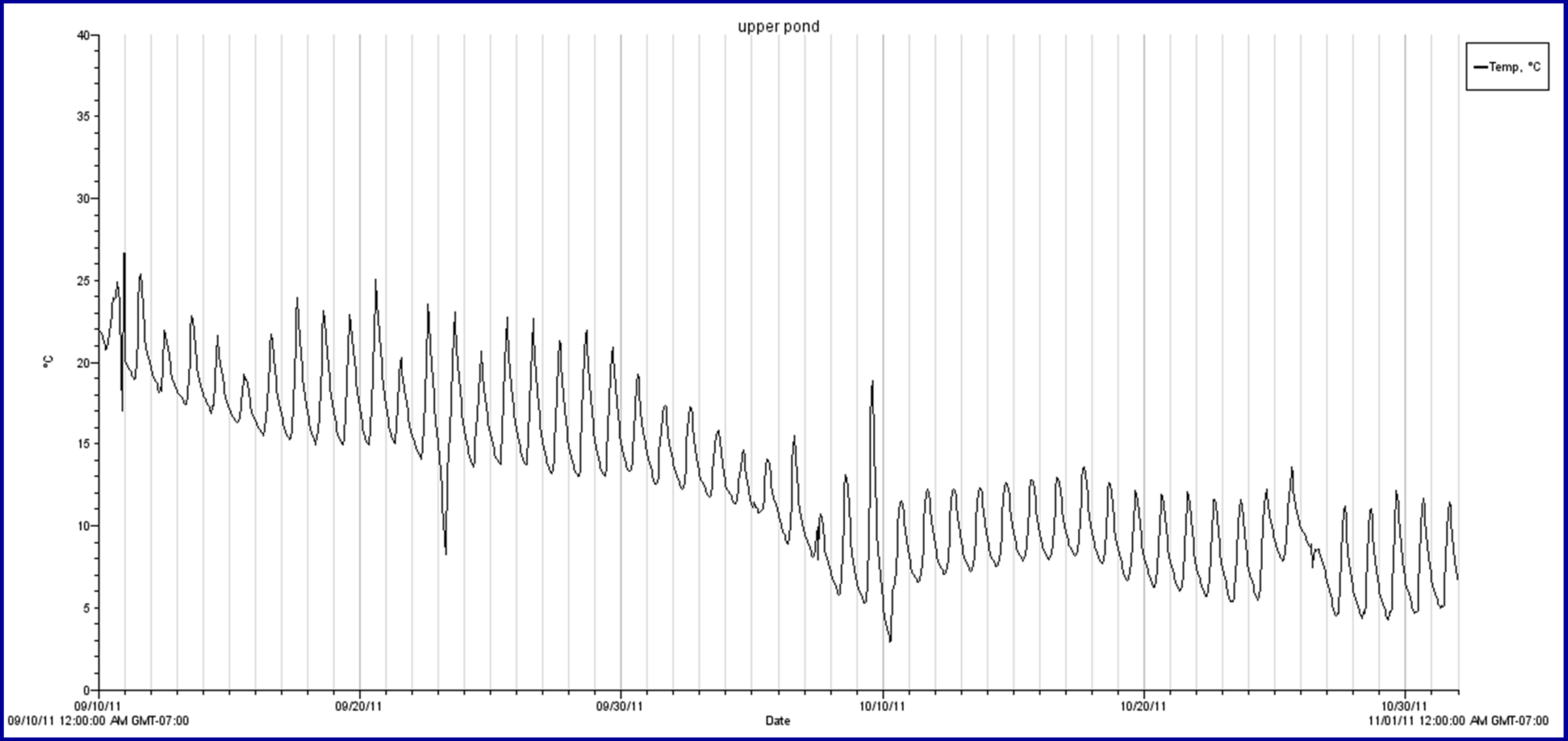


Toxic for at least 35 days!

Spectrophotometry data - Ammonia



Water Temperature



Day 13

Day 15

Day 25

After 45 days ponds were drained

Results - Fish

- 1/2 ml (29% ammonia) per gallon of water = toxic to fish for over 35 days
- Only turtles survived the treatment in both ponds
- Algae bloom 2 weeks post treatment
- Natural bacteria does clean it up – but it takes 3-4 weeks

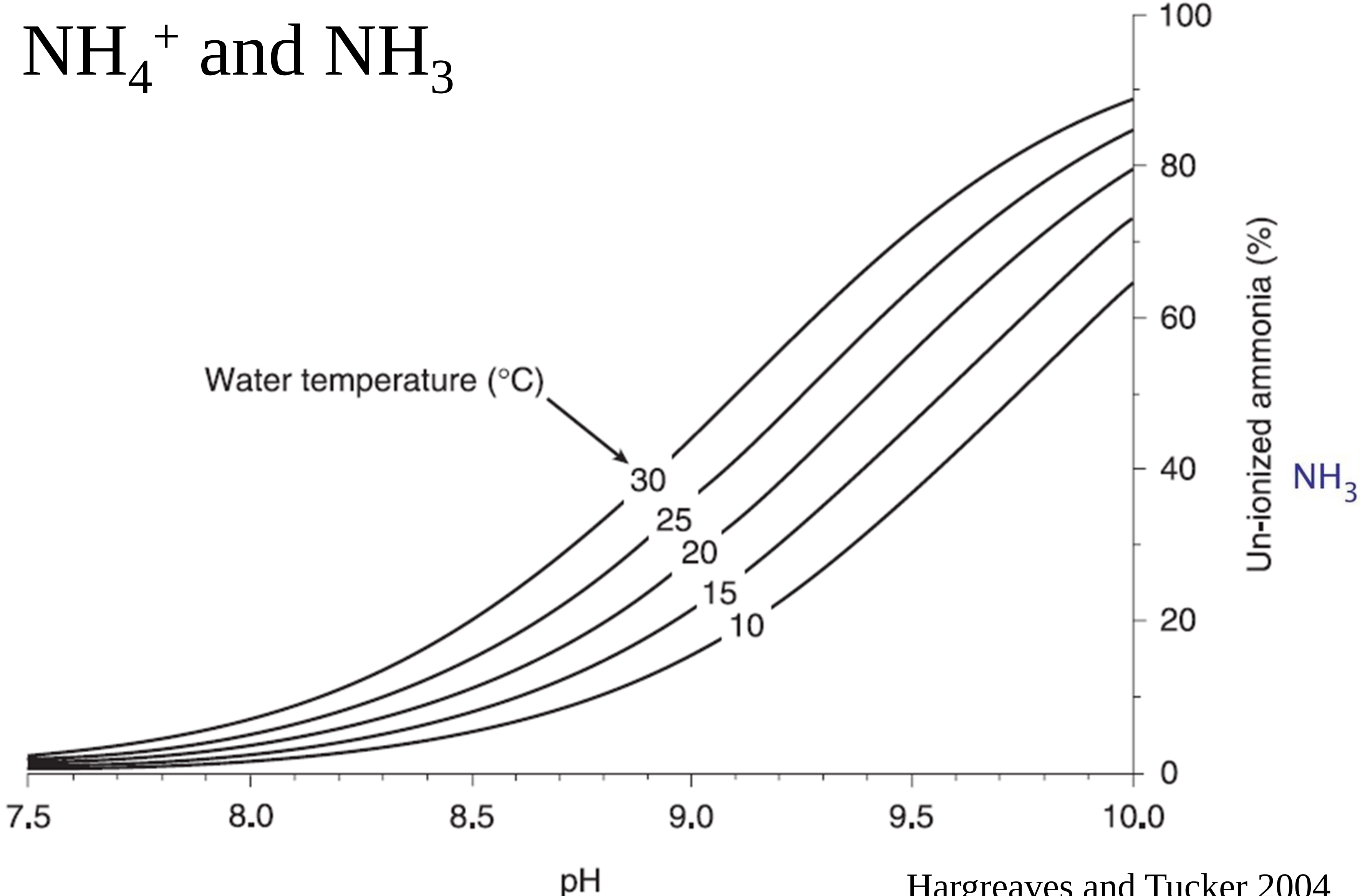
Advantages of Ammonia

- Kills crayfish
- Stayed toxic for 35-40 days
- Highly soluble in water - no mixing needed
- Inexpensive ($213 for a 55 gallon drum)
  - Logistically feasible on a large scale
- Already labeled as a pesticide – just not labeled for aquatic use
- Will not harm terrestrial animals

Disadvantages

- Toxic fumes prior to mixing with water
- Creates an algae bloom
- Not effective at Low pH and low water temperature

NH_4^+ and NH_3



Hargreaves and Tucker 2004

Temperature = minor effect on toxicity

pH = Large effect on toxicity

What's Next

Refine effective minimum dose

Drip applications for streams – detoxification

Acknowledgements

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Southwest Biological Science Center