ROCKY RIVER WATERSHED INTERAGENCY MEETINGS

Intersection of Rocky River Water Quality and Needs of its Rare Species

Rocky River hosts a diverse assemblage of rare mussels (including several State-listed t/e species) and the Cape Fear Shiner

Photo: Conservation Fisheries, Inc.

Conservation considerations

- In addition to other limiting factors, most endangered aquatic animals are also vulnerable because of small population sizes
  - Small stretches of stream critically important
  - Few individuals to sustain populations
  - Natural re-colonization after impacts slow
  - Mussels are sedentary

Rocky River's fishes and mussels…

- Feed, respire, and reproduce in the water
- Exposed to pollutants in water, sediment, food
- Have persisted despite problems and improvements
- Have been more prevalent well downstream (?)
- Short-term response to dam removal

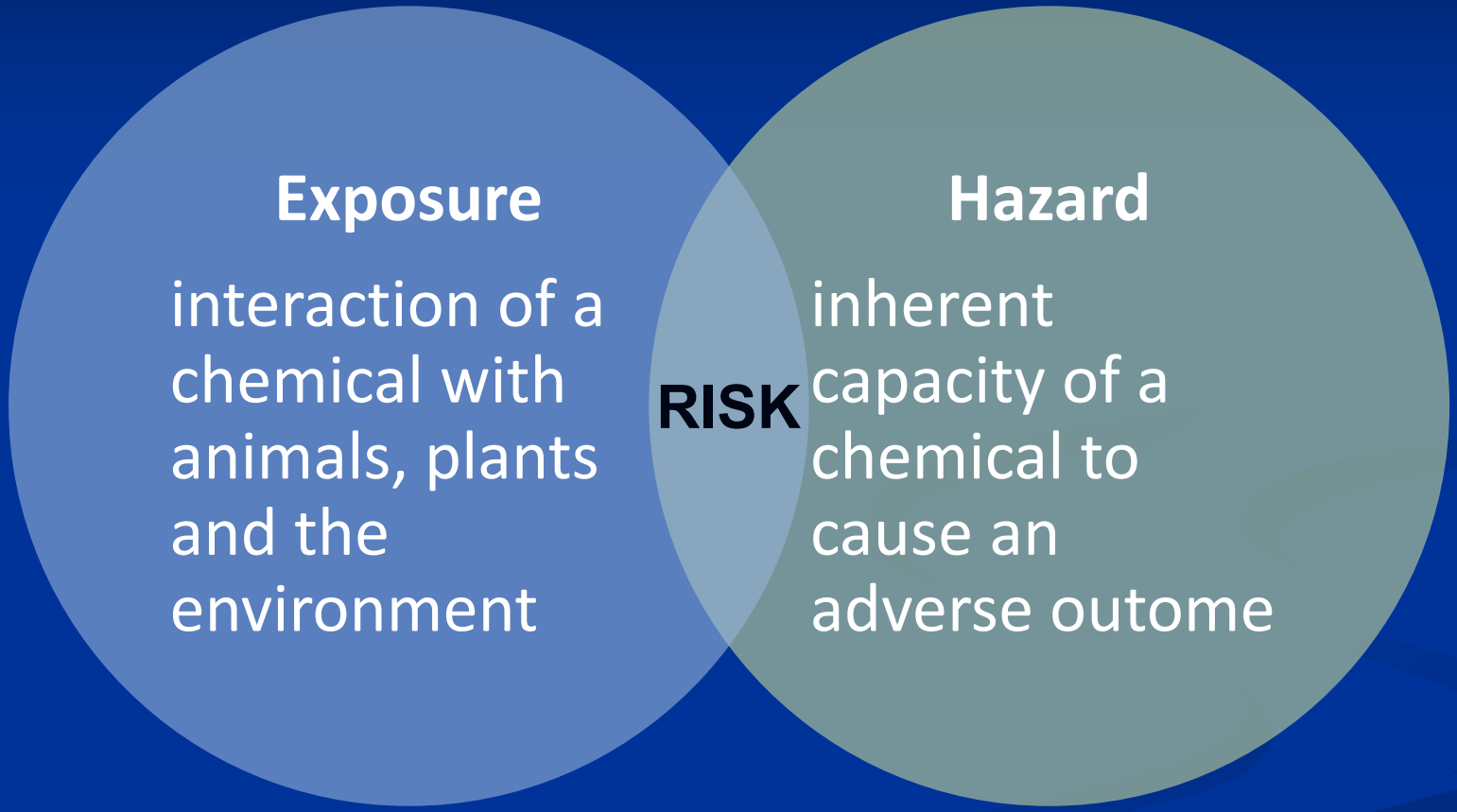
Water quality and aquatic life

- We can measure exposure in water, sediment, tissues …

Exposure

interaction of a chemical with animals, plants and the environment

… but exposure is only part of risk



… also need data on hazard (toxicity)

Cape Fear Shiner in-lab testing…

Arch. Environ. Contam. Toxicol. 48, 143–154 (2005)
DOI: 10.1007/s00244-003-3038-1

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Assessing Contaminant Sensitivity of Endangered and Threatened Aquatic Species: Part I. Acute Toxicity of Five Chemicals

F. J. Dwyer,[1] F. L. Mayer,[2] L. C. Sappington,[3] D. R. Buckler,[3] C. M. Bridges,[3] I. E. Greer,[3] D. K. Hardesty,[3] C. E. Henke,[3] C. G. Ingersoll,[3] J. L. Kunz,[3] D. W. Whites,[3] T. Augspurger,[4] D. R. Mount,[5] K. Hattala,[6] G. N. Neuderfer[7]

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Assessing Contaminant Sensitivity of Endangered and Threatened Aquatic Species: Part III. Effluent Toxicity Tests

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…individual chemicals, mixtures, effluents,

Summary ranks among endangered fishes

- USGS Evaluated toxicity of 5-chemicals to 15 fish species (including 12 t/e fishes)…

…Cape Fear Shiner ranked 8 of 15

Photo: Ken Taylor

What's it mean?

- Cape Fear Shiners are sensitive fish to pollutants, but not the most sensitive among fishes already tested

What's it mean?

- Cape Fear Shiners are sensitive fish to pollutants, but not the most sensitive
- Meeting water quality standards (derived based on sensitivity of other fishes and aquatic organisms) is likely sufficient

What's it mean?

- Excess sedimentation would be a concern for Cape Fear Shiner spawning habitat
- Remember, with some rare species, a single adverse impact can have lasting population level effects

What's it mean?

- "Dam construction in the Cape Fear River system has probably had the most serious impact on the species by inundating the species' rocky riverine habitat and altering stream flows."
- Fish's presence and range expansion will be telling

Explaining mussel declines, from 45 studies

Cause	Percentage
Pollution, water quality degradation	47
Habitat destruction and alteration	47
Damming and impoundment	33
Introduction of exotic species	29
Hydrologic change	20
Exploitation and harvesting	18
Recruitment failure, lack of fish hosts	13
Watershed alterations	13
Riparian alterations	7
Predation	7

Strayer et al. 2004. Changing perspectives on pearly mussels, North America's most imperiled animals. BioScience 54: 429-439.

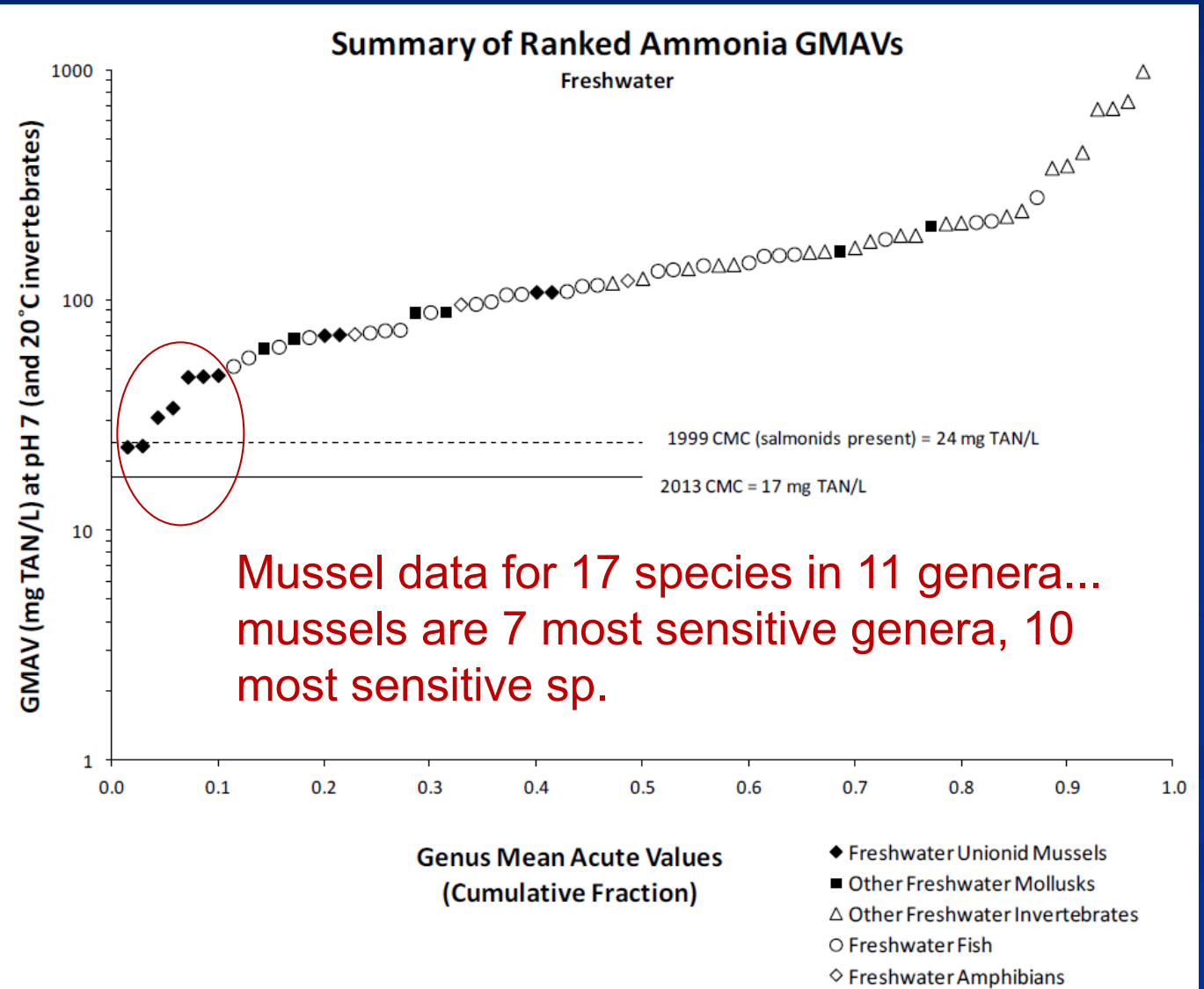
Ammonia and mussels

"We suggest that excessive concentrations of interstitial un-ionized ammonia may be responsible for widespread declines of freshwater mussel populations, especially in agricultural areas."

Strayer and Malcom 2012

Strayer DL, Malcom HM. 2012. Causes of recruitment failure in freshwater mussel populations in southeastern New York. *Ecological Applications* 22: 1780-1790.

USEPA 2013 Ammonia Criteria



>600 tests

99 species

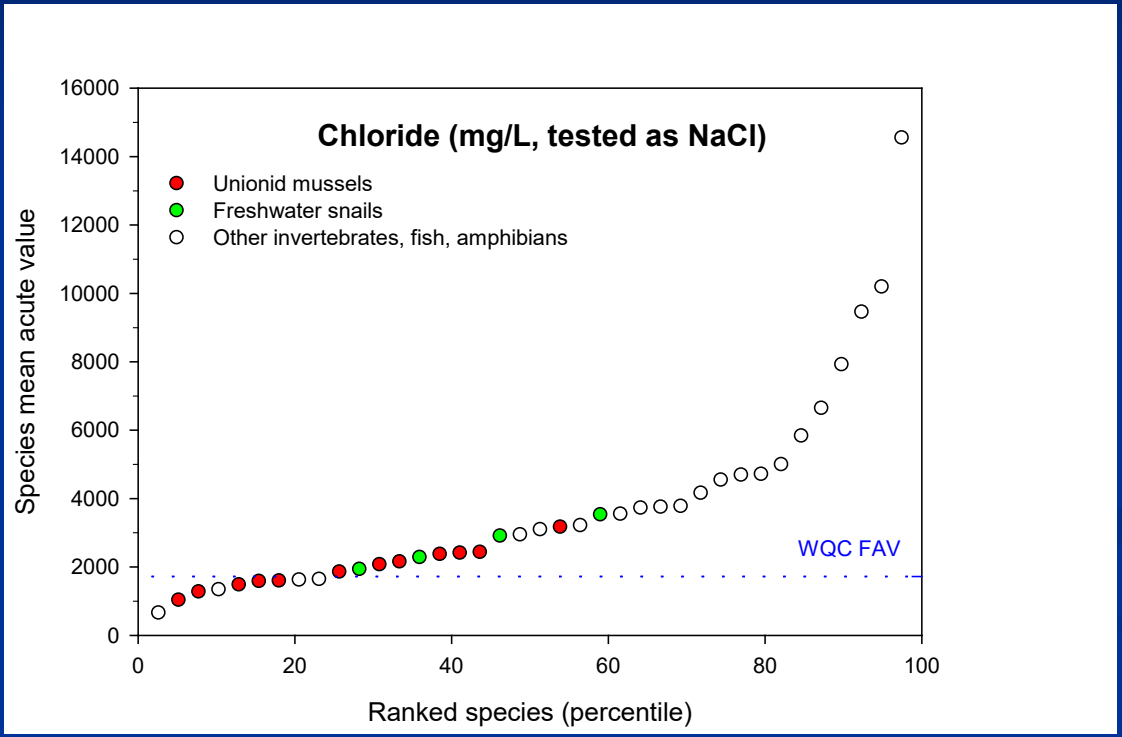
69 genera

51 invert. sp.

44 fish sp.

4 amphib. sp.

Chloride – mussels sensitive



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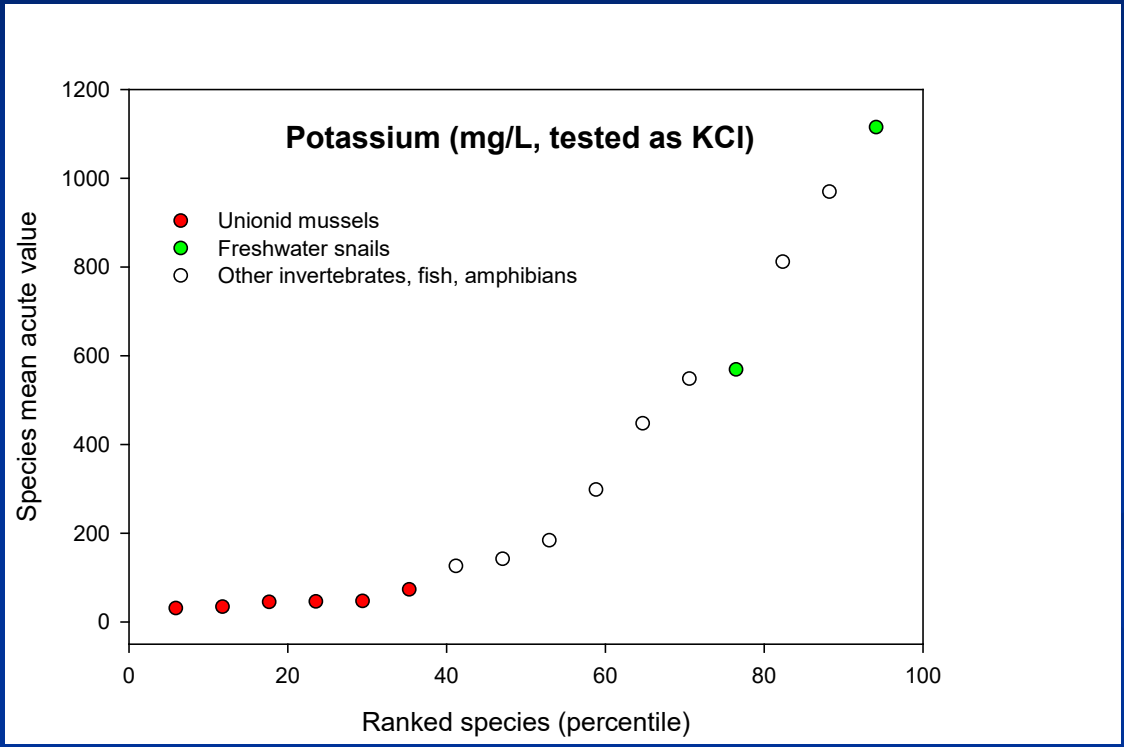
ACUTE SENSITIVITY OF A BROAD RANGE OF FRESHWATER MUSSELS TO CHEMICALS WITH DIFFERENT MODES OF TOXIC ACTION

Ning Wang,*† Christopher D. Ivey,† Christopher G. Ingersoll,† William G. Brumbaugh,† David Alvarez,† Edward J. Hammer,‡ Candice R. Bauer,‡ Tom Augspurger,§ Sandy Raimondo,‖ and M. Christopher Barnhart#

Potassium – mussels sensitive, and no AWQC



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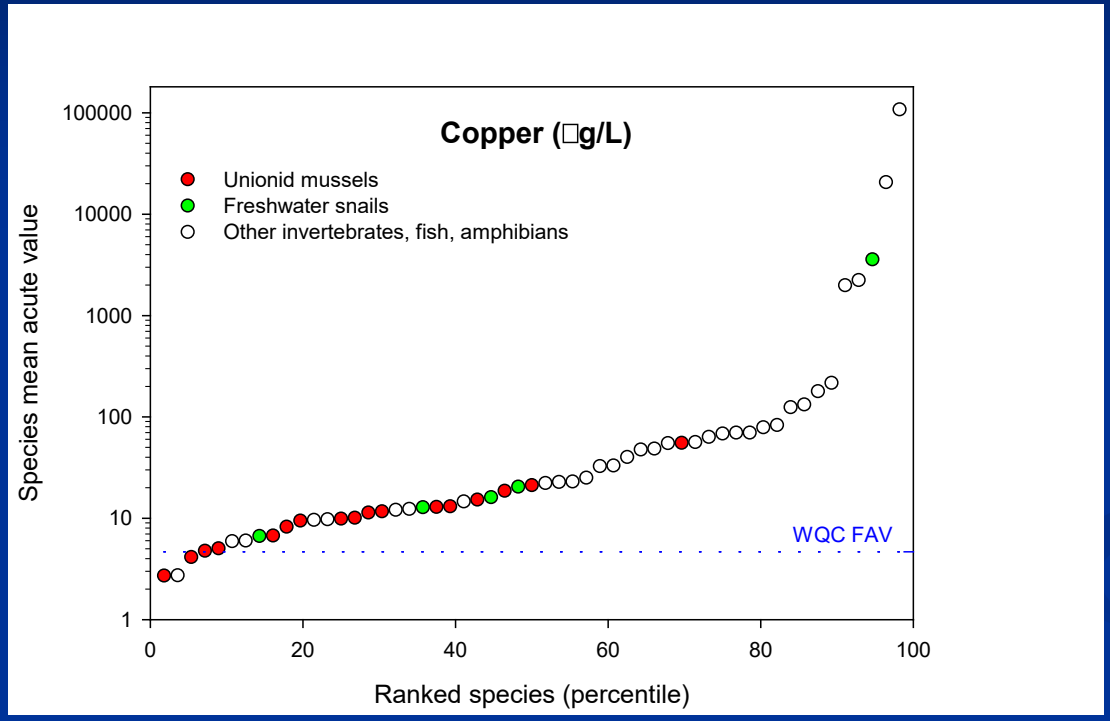
Copper – mussels sensitive, and AWQC appear protective



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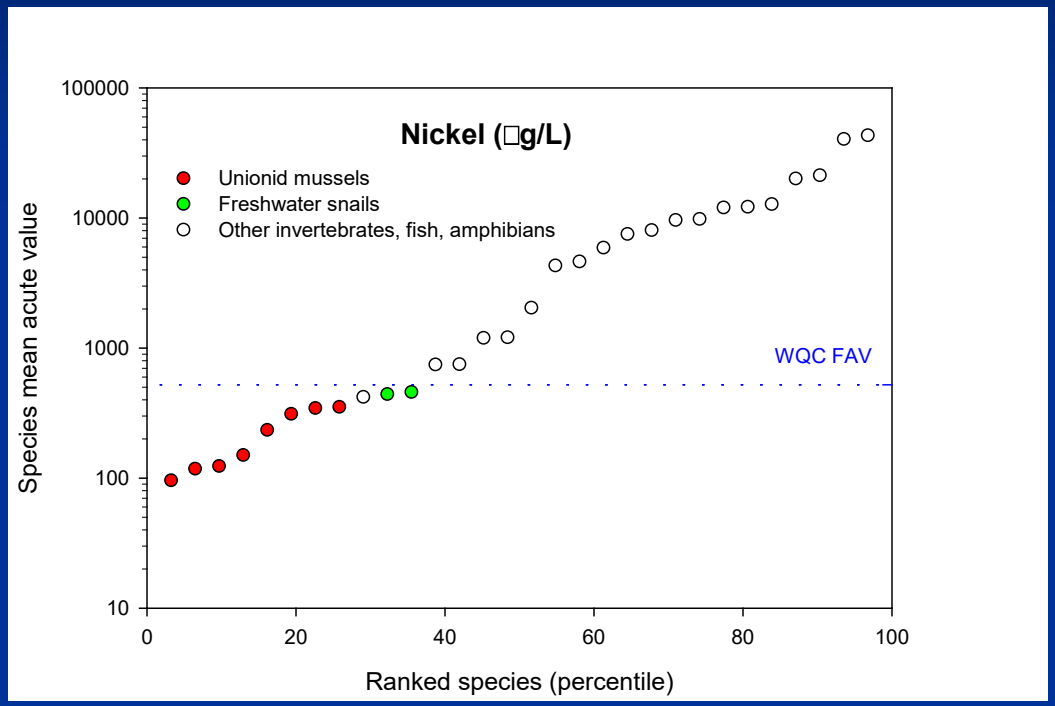
Nickel – mussel data could drive a reassessment of the 1995 AWQC



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Summary: Mussel sensitivity

Toxicant	Acute sensitivity	Chronic sensitivity
Alachlor	Yes	ND
Metolachlor	Yes	ND
4-Nonylphenol	Yes	No
Azoxystrobin	No	No
Ammonia	Yes	Yes
Potassium	Yes	Yes
Chloride	Yes	Yes
Nitrate	No	Yes
Sulfate	Yes	Yes
Aluminum	No	Yes
Cadmium	No	No
Chromium (VI)	No	No
Copper	Yes	Yes
Lead	No	No
Nickel	Yes	Yes
Zinc	Yes	Yes

Mussel vulnerabilities to excessive sedimentation

Upon settling, excessive sediment can:

- smother adult and juvenile life stages
- reduce feeding
- reduce respiration from clogged gills
- reduce growth rates
- limit burrowing activity
- impair interaction with host fish

Also tests from the lab have been short and do not typically include mussel reproduction

- Mussel are long-lived so estimates of protective concentrations will likely decrease with longer test durations and as additional endpoints are evaluated
- Recall Brena's point about nitrate…

A working summary … we can improve on it together

Parameter	Are Mussels particularly sensitive?	Are Cape Fear Shiners particularly sensitive?	Water Quality Criteria?	Monitored in Rocky River?
Sediment	Y	Y	None	Y
Ammonia	Y		EPA 2013	Y
Chloride	Y		EPA 1988	Y
Potassium	Y		None	
Sulfate	Y		None	
Nitrate	Y		None	Y
Copper	Y		EPA 2007	
Nickel	Y		EPA 1995	
Zinc	Y		EPA 1995	

Other approaches to protective concentrations (if no national ambient water quality criteria)

Statewide water quality standards

Stream or site-specific standards

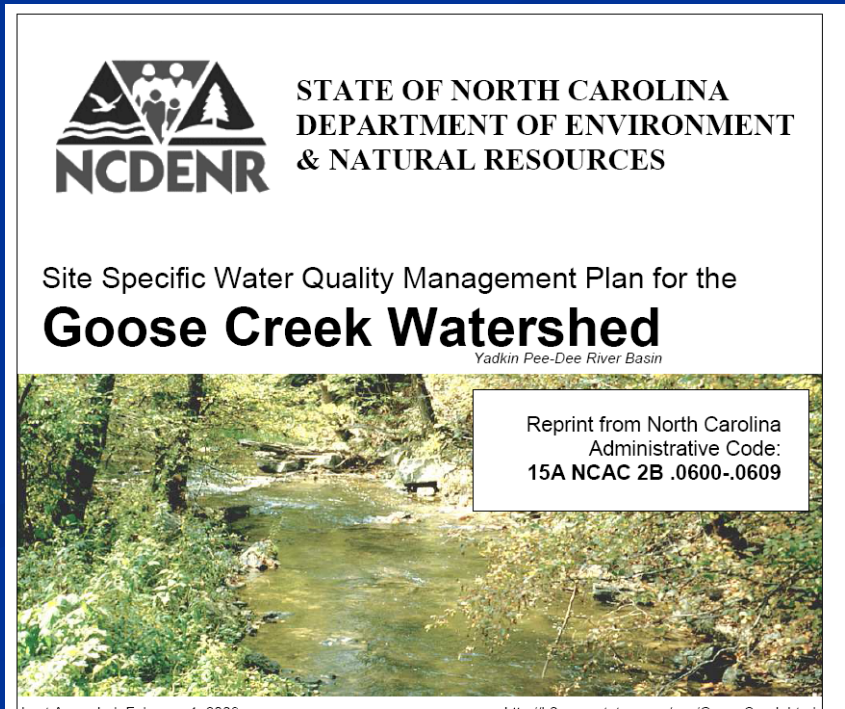
Permit limits

Water quality guidance / recommendations

Site-specific standards example

Habitat for the endangered Carolina heelsplitter

Carolina heelsplitter, NCWRC



STATE OF NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT
& NATURAL RESOURCES

NCDENR

Site Specific Water Quality Management Plan for the

Goose Creek Watershed

Yadkin Pee-Dee River Basin

Reprint from North Carolina Administrative Code:
15A NCAC 2B .0600-.0609

Goose Creek – ammonia exposure

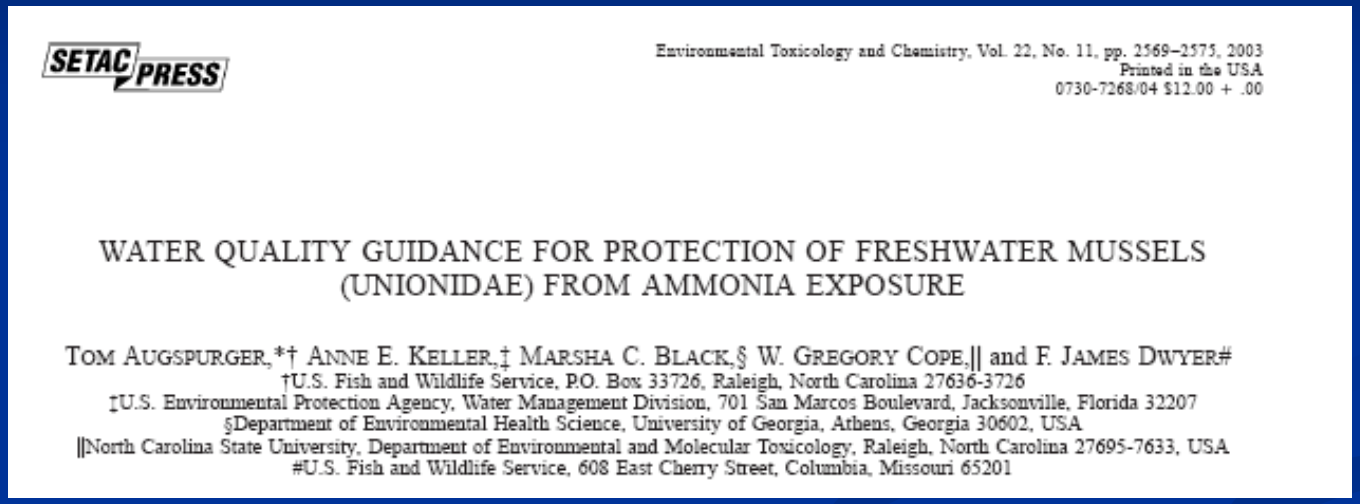
Ambient Monitoring System Station Summaries
NCDENR, Division of Water Quality
Basinwide Assessment Report

Location: GOOSE CRK AT SR 1524 NR MINT HILL
Station #: Q8360000 **Hydrologic Unit Code:** 3040105
Latitude: 35.13090 **Longitude:** -80.63105 **Stream class:** C
Agency: NCAMBNT **NC stream index:** 13-17-18

Time period: 01/07/2002 to 12/12/2006

	# result	# ND	Results not meeting EL				Percentiles						
			EL	#	%	%Conf	Min	10th	25th	50th	75th	90th	Max
Field													
D.O. (mg/L)	60	0	<4	4	6.7		1	5.1	6.8	8.4	10.4	12.3	14.7
	60	0	<5	5	8.3		1	5.1	6.8	8.4	10.4	12.3	14.7
pH (SU)	60	0	<6	1	1.7		5.9	6.3	6.6	6.8	7.4	7.9	8.6
	60	0	>9	0	0		5.9	6.3	6.6	6.8	7.4	7.9	8.6
Spec. conductance (umhos/cm at 25°C)	60	0	N/A				91	101	121	141	212	358	609
Water Temperature (°C)	60	0	>32	0	0		4	7.7	11.3	17.9	22.9	25.2	30.9
Other													
TSS (mg/L)	20	2	N/A				2.5	2.6	4	5	14.5	27.8	48
Turbidity (NTU)	60	0	>50	4	6.7		2.1	4	4.9	10.3	20	48.9	80
Nutrients (mg/L)													
NH3 as N	58	10	N/A				0.02	0.02	0.02	0.07	0.41	1.66	18

Goose Creek – ammonia hazard



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WATER QUALITY GUIDANCE FOR PROTECTION OF FRESHWATER MUSSELS (UNIONIDAE) FROM AMMONIA EXPOSURE

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‖North Carolina State University, Department of Environmental and Molecular Toxicology, Raleigh, North Carolina 27695-7633, USA
#U.S. Fish and Wildlife Service, 608 East Cherry Street, Columbia, Missouri 65201

Safe ammonia level for mussels about 0.5 mg/L for this stream's pH

Site-specific standards outcome

15A NCAC 02B .0604 SITE SPECIFIC WATER QUALITY MANAGEMENT PLAN FOR THE GOOSE CREEK WATERSHED: CONTROL TOXICITY INCLUDING AMMONIA

No activity that results in direct or indirect discharge is allowed if it causes toxicity to the Carolina heelsplitter (*Lasmigona decorata)* endangered mussel. For any direct or indirect discharge that may cause ammonia toxicity to the Carolina heelsplitter freshwater mussel, action shall be taken to reduce ammonia (NH3-N) inputs to achieve 0.5 milligrams per liter or less of total ammonia based on chronic toxicity defined in 15A NCAC 02B .0202. This level of total ammonia is based on ambient water temperature equal to or greater than 25 degrees Celsius.

Eff. February 1, 2009