Toxicity Testing In Ambient Water Quality Assessment

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Ambient Water Toxicity Tests

- Expose test species to water
  - 100%, 75%, 50%, 25%, and 12.5% ambient water or other dilution series
- Compare treatment to control(s)
- Standard test duration (species specific)
  - 48 to 96 h (acute tests)
  - 4 to 10 days (short-term chronic tests)
  - 21 days, month (chronic tests)
- Standard chronic test endpoints are survival and growth or reproduction

Advantages of Ambient Water Toxicity Testing

- Integrates point sources and non-point sources
- Aggregates effects of mixtures
- Measures toxicants with no chemical specific water quality standards and/or are not being monitored by chemical analysis
- Sites exhibiting toxicity can be targeted for additional evaluation



Objectives:

- To assess if toxicity, as measured in laboratory controlled experiments, is present in the river water samples collected.
- To develop appropriate toxicity tests with sensitive species and endpoints.

Standard Freshwater Test Species

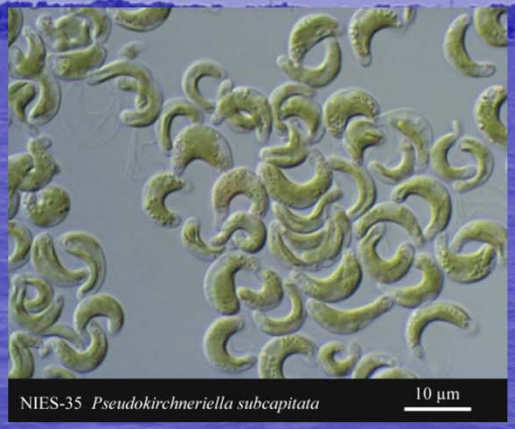
< 1 ppt salinity

Pimephales promelas

fathead minnow

Ceriodaphnia dubia

water flea



Pseudokirchneriella subcapitata

green algae

Salinity Tolerant Test Species

Menidia beryllina

inland silverside (5 to 32 ppt)

Americamysis bahia (acclimated)

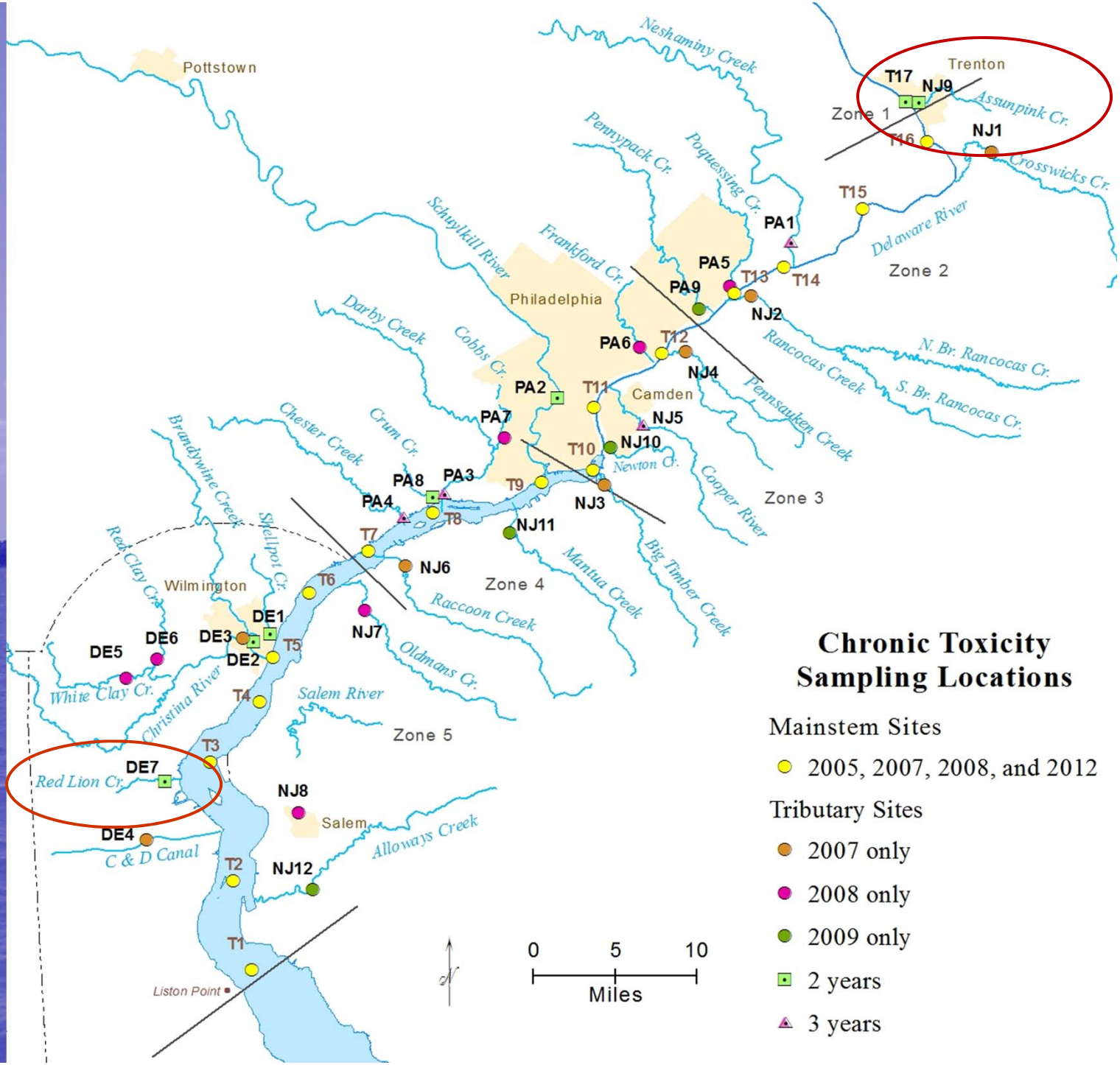
mysid shrimp (10 to 30 ppt)

Hyalella azteca (water only tests)

amphipod (0 to 15 ppt)

Estuary Water Column

<1 to 15 ppt salinity

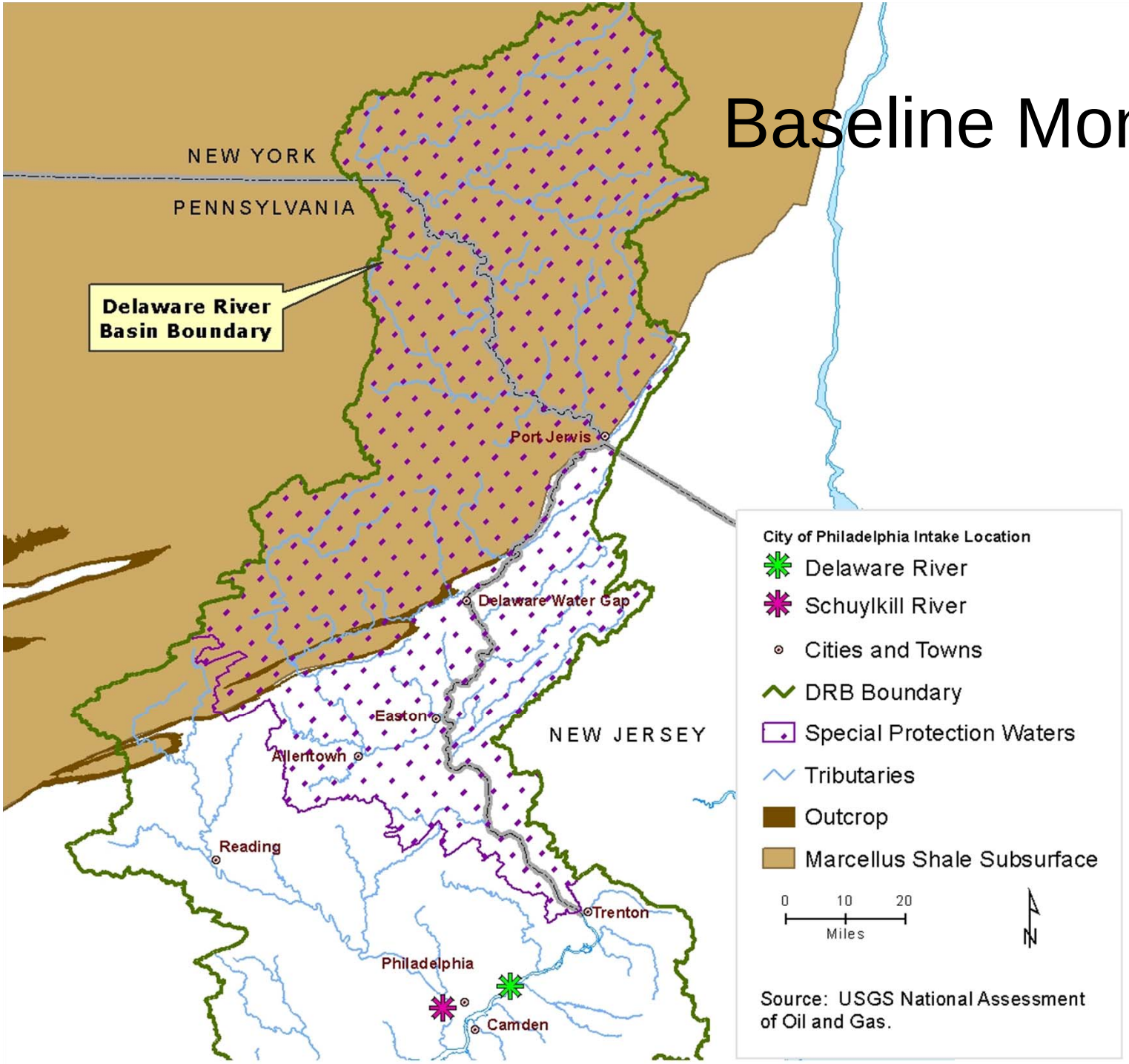


Summary

- Identified a set of test species and modified toxicity testing methods appropriate for routine monitoring of the estuary
- Periodic monitoring of main stem tidal Delaware River with coordination through DRBC Ambient Toxicity Workgroup and DRBC Toxics Advisory Committee on annual test plans and data review
- Promoting collaboration with states in tributaries that warrant further assessment for potential impairment from toxicity

Integr Environ Assess Manag. 2011 Jul;7(3):466-77

Baseline Monitoring



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Baseline Monitoring: Toxicity Tests

- Delaware River Basin headwaters
  - typically soft water (hardness - 20 mg/l)
  - low ionic strength (spec. cond. – 70 µS/cm)
- Water quality characteristics may influence effects of pollutants
- Different waters types may impact test species response
- Evaluate alternative test species - mayflies - *C. triangulifer, Procloeon rivulare, Procloeon frondale*

Centroptilum triangulifer
Photo from: www.discoverlife.org

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Sample Collection and Analysis

- Collected pre-drilling alteration surface water samples
- Collected a sample of natural gas drilling flowback/production water
- Analysis of surface water and produced water for physical-chemical parameters including
  - dissolved solids
  - ions
  - metals
  - organics
  - radiochemistry

Short-term Chronic Toxicity Tests of Ambient Stream Water In Different Water Types (hardness, mg $CaCO_3$/L)

Standard Test Species in undiluted surface water	No Observed Effect Conc. (NOEC)	Dyberry Creek 22mg/l hardness soft	Del R @Callicoon 19 mg/l hardness soft	West Branch Lackawaxen River 25 mg/l hardness soft	Lackawaxen River @ Honesdale 28 mg/l hardness soft	White Clay Creek 105 mg/l hardness mod. hard
P. promelas	NOEC	<100% [1]	<100% [2]	100%	100%	100%
C. dubia	NOEC	100%	100%	100%	100%	100%
P. subcapitata	NOEC	<100% [3]	<100% [3]	100%	<100% [3]	<100% [3]

1 – Not a biologically significant effect. Survival is 100%.
Growth exceeds acceptable amount at 0.25 mg.

2 – Fungal infection observed

3 - Not a biologically significant effect.
Mean cell density exceeded acceptable criteria of 1x106 cells/ml.

Toxicity of a Natural Gas Drilling Produced Water Sample

Standard Test Species	Lethal Conc. 50% mortality (LC50) acute test endpoint	Produced water in Dyberry Creek Water (soft water) ACUTE TEST	Produced water in White Clay Creek Water (mod hard water) ACUTE TEST	Inhibit conc. 25% org. (IC25)	Produced water in Dyberry Creek Water (soft water) Short-term CHRONIC TEST	Produced water in White Clay Creek Water (mod hard) Short-term CHRONIC TEST
P. promelas	LC50	0.63%	0.97%	IC25	0.04% growth	0.08% growth
C. dubia	LC50	0.59%	1.0%	IC25	0.5% reproduction	0.55% reproduction
P. subcapitata	NA	NA	NA	IC25	0.08% growth	0.06% growth
P. promelas	PREDICTED LC50	GRI FW STR MODEL	4%		NA	NA
C. dubia	PREDICTED LC50	GRI FW STR MODEL	2%		NA	NA

Summary

Evaluating test species and toxicity testing methods for baseline monitoring in the upper basin

Measuring toxicity of produced water from natural gas drilling using standard test species and non-standard native mayfly species