HURDLES IN TOXICITY TESTING

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TOPICS FOR DISCUSSION

- **Toxicity Testing Basics**
- **Specific Challenges with *Ceriodaphnia* and Toxicity in General**

HISTORY

16th century - scientists began testing the lethality of chemical compounds on animals prior to their use on humans for therapeutic purposes

1930's - some of the first uses of aquatic organisms for testing to determine the causes of observed fish kills

1945 - some of the first methods for conducting toxicity tests were published

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PURPOSE OF WHOLE EFFLUENT TOXICITY

DEFINITION

Whole effluent toxicity (WET) is the aggregate toxic effect of an effluent sample measured directly by an aquatic toxicity test.

PURPOSE OF WHOLE EFFLUENT TOXICITY

EXPANDED DEFINITION

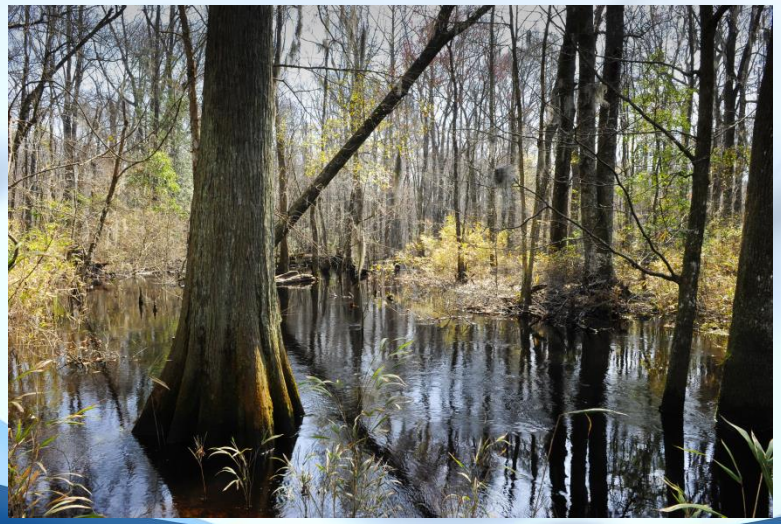
WET tests utilize live organisms to measure actual biological responses to an effluent and, therefore, integrates the effects of all chemicals present in the effluent.

PURPOSE OF WHOLE EFFLUENT TOXICITY

Why Perform Toxicity Testing?

Measuring all potentially toxic chemicals individually in a sample would not be feasible (>50 million in CAS registry)

WET tests are a more feasible way to indirectly measure all potentially toxic chemicals collectively present



WET predicts the potential of an effluent to have an adverse effect on the in-stream aquatic population

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STATISTICS IN SC

1) Nowadays, most toxic POTW effluents are caused by Industrial User activities

2) In SC, about 1 in 2 POTW's can consistently pass toxicity- (Criteria for "consistently" passing is to have had 2 or fewer failures in 5 years)

3) Of the 50% passing facilities, many of them have little or no categorical industrial users

4) Historically, almost all POTW's in SC with more than 20% industrial loading have had toxicity problems at some time

5) Historically, almost all POTW's in SC with CTC > 80% have had toxicity problems.

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FROM EPA-821-R-02-013

Factors which can affect test success and precision

(1) the experience and skill of the laboratory analyst;
(2) test organism age, condition, and sensitivity;
(3) dilution water quality;
(4) temperature control; and
(5) the quality and quantity of food provided.

Basically, grey areas in procedure!

CERIODAPHNIA SPECIFIC HURDLES

- **Issues With the Species**
- **Problems With Statistics**
- **Toxicity Complexity Issues**


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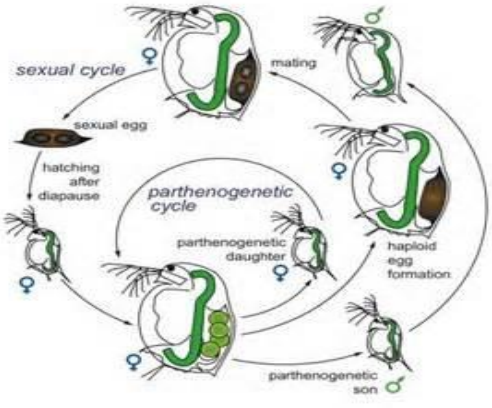
A WORD ABOUT CERIODAPHNIA DUBIA

Why use this species?



- **Very sensitive**

  Toxicity of copper to C. dubia is 0.006 ppm
- **Low trophic level**

  Important to determine effect on species lower on the food chain
- **Very prolific**

  (15-40 young/female in 7 days)
- **Parthenogenetic**

  Asexual reproduction= mostly female in lab

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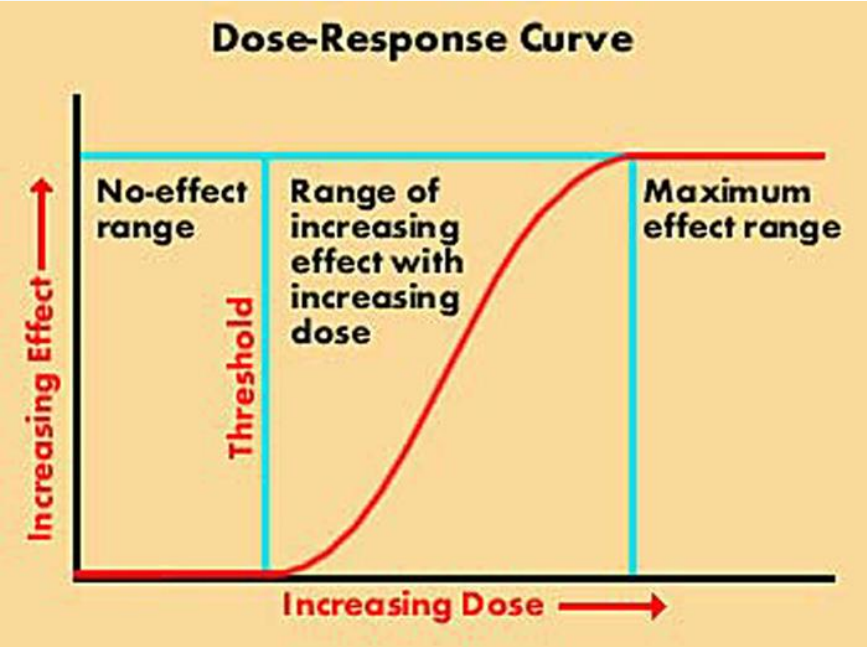
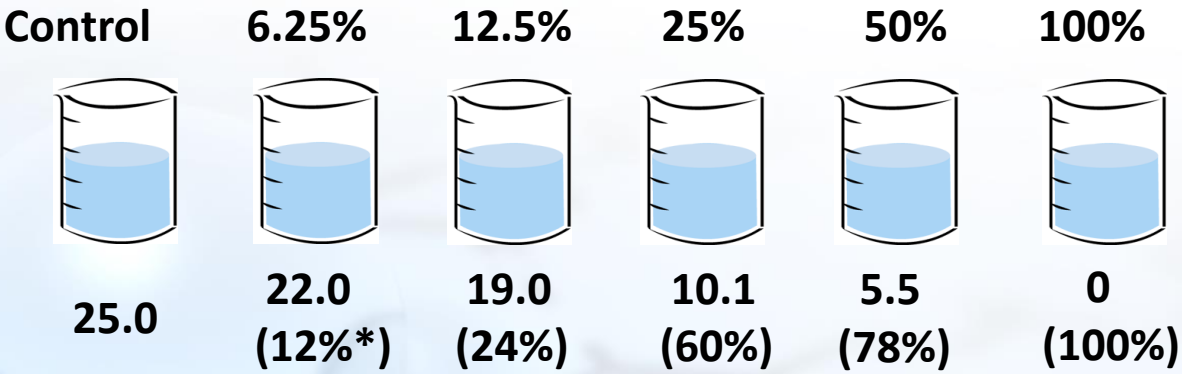
TYPICAL DOSE RESPONSE

Percent effect increases as the concentration of effluent in the mixture increases.



CHRONIC TEST #1 – "TYPICAL RESPONSE"

Typical dose response where percent effect increases as the concentration of effluent in the mixture increases.

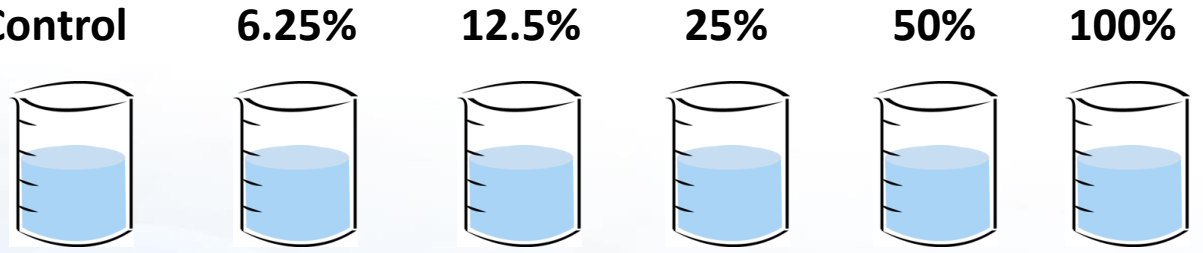


IC25 would be somewhere between 12.5% effluent and 25.0% effluent.

***Percent = % reduction in the #young/female COMPARED TO CONTROL as calculated by statistical model**

CHRONIC TEST #2 HORMESIS OBSERVED

Hormesis is the term for generally favorable biological responses to low exposures to toxins



IC25 would be somewhere between 6.25% effluent and 12.5% effluent

***Percent = % reduction in the #young/female COMPARED TO CONTROL as calculated by statistical model**

FROM EPA-821-R-02-013

A dilution factor of 0.5 is commonly used. Improvements in precision decline rapidly if the dilution factor is increased beyond 0.5, and precision declines rapidly if a smaller dilution factor is used. ***Therefore, USEPA recommends the use of the 0.5 dilution factor.***

Examples of test concentration used on 2 SC permits

Control, 60%, 70%, 80, 94% and 100%
Control, 1.6%, 3.1%, 15.9% and 51.6%

WHAT HAPPENS WHEN A FACILITY FAILS TOXICITY TESTING REQUIREMENTS

State Specific

- In SC

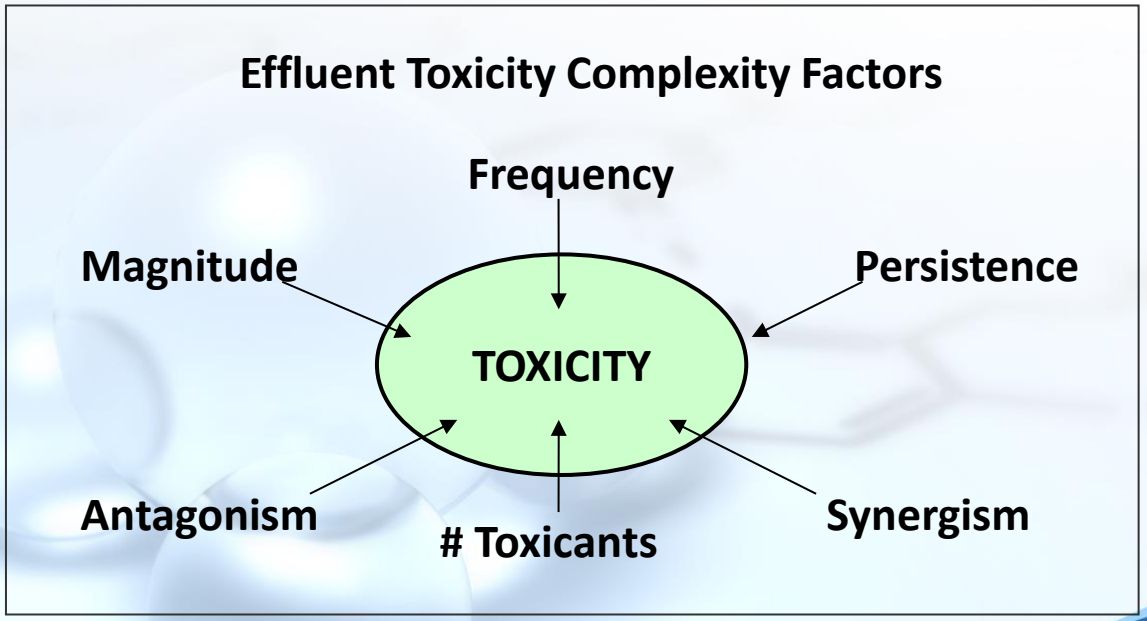
If a facility fails two tests in 12 month period - Enforcement Action

Enforcement Action usually includes a consent order and a civil penalty

Facility is Required to Eliminate Toxicity

TOXICITY COMPLEXITY FACTORS

Several factors effect the complexity of toxicity and make it more difficult to control



EXAMPLE OF SYNERGISM

Chlorinating some organics can make them more toxic

From AQUIRE database

Compound	LC 50 (mg/l) Water Flea *D. magna*	# Tests
Benzene	305 mg/l	9
Chlorobenzene	17 mg/l	10
1,3-Dichlorobenzene	2 mg/l	7
1,2-Dichlorobenzene	0.042 mg/l	2

THE TOXICITY PROBLEM IN SUMMARY

Controlling toxicity can be more difficult than expected.

A TIE may only identify one component of a toxicity problem

SHEALY

QUALITY AND TRACEABILITY IN TOXICITY TESTING IS OF PARAMOUNT IMPORTANCE!

Questions?
More Information?

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