Technical Issues and Workgroup Recommendations Regarding Criteria Derivation for Contaminants of Emerging Concern (“CECs”)

Russell Erickson, Ph.D
ORD (NHEERL-MED) - Duluth, MN

SAB Advisory, June 30, 2008

1a. Relevance of Acute Toxicity Effect Concentrations in Setting ALC for CECs:

Many chemicals of emerging concern are physiologically active at concentrations orders of magnitude lower than those causing acute lethality, and the high concentrations sufficient to cause lethality may never occur in the environment ……the workgroup recommends that aquatic life criteria consist of only a CCC and that no CMC be derived, when sufficient information demonstrates risks of acute lethality are negligible.

1a. Relevance of Acute Toxicity Effect Concentrations in Setting ALC for CECs:

"Except possibly where a very sensitive species is important at a site, aquatic life should be protected if:

The four-day average concentration does not exceed the Criterion Continuous Concentration (CCC) more than once every three years on the average,

And the one-hour average concentration does not exceed the Criterion Maximum Concentration (CMC) more than once every three years on the average."

1a. Relevance of Acute Toxicity Effect Concentrations in Setting ALC for CECs:

(1) Are CVs for sensitive taxa 100X or more below AVs for sensitive taxa? If so, when exposures are managed to satisfy the CCC, then exposures can never be high enough to reach the CMC.

(2) Does available exposure information demonstrate that maximum concentrations will be far below those eliciting acute effects?

(3) Can acute toxicity information for other chemicals inform this evaluation?

(Note – the elimination of the CMC precludes deriving the CCC based on acute-chronic ratios.)

1a. Relevance of Acute Toxicity Effect Concentrations in Setting ALC for CECs:

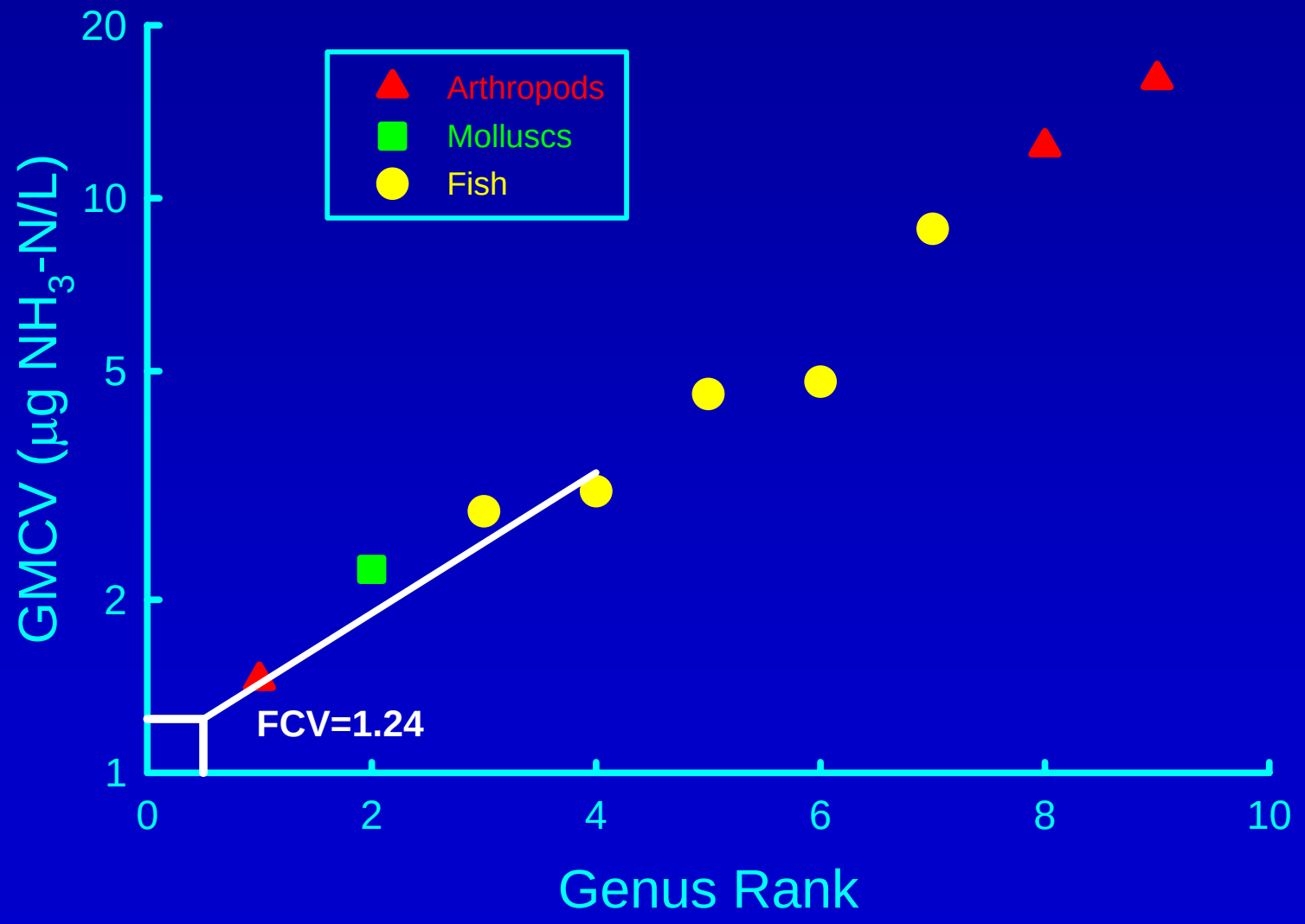
Acute Toxicity of Ethynylestradiol

Genus	GMAV (ng/L)	Comments
Gammarus	>840,000	10-d test
Rana	>850,000	14-d test
Medaka	>1,000,000	
Danio	1,700,000	
Ceriodaphnia	1,800,000	
Hydra	3,800,000	
Sida	>4,100,000	24-h test
Daphnia	>5,000,000	24-h test
Chironomus	9,100,000	24-h test

1b. Defining Minimum Data Requirements Regarding Taxonomic Coverage:

In the case of many CECs, toxicological research tends to focus on organisms for which the MOA is most relevant (e.g., vertebrates for estrogen mimics) and may have limited data coverage for other taxonomic groups that will likely be less sensitive …… rather than requiring an acceptable chronic toxicity test, the data requirement for certain taxonomic group expected to be insensitive might be met by a body of information demonstrating insensitivity of the taxon.

1b. Defining Minimum Data Requirements Regarding Taxonomic Coverage:



1b. Defining Minimum Data Requirements Regarding Taxonomic Coverage:

Chronic Toxicity of Ethynylestradiol

Genus	Chronic Value(s) (ng/L)	Notes
Danio	0.6, 1.5, <1.1	Life-cycle tests
Pimephales	<0.32, 1.5	Life-cycle tests
Oryzias	3.2	F0 from 1 d through spawning
Oncorhynchus	<16	Adult exposure, fertilization success
Potamopyrgus	50	Adult exposure; embryo production
Gammarus	>7600	100 d test, population size
Daphnia	45,000	Life-cycle test
Tisbe	>100,000	Saltwater copepod
Chironomus	320,000	Larval growth and molting schedule
Brachionus	800,000	72 h test, intrinsic rate of increase

1c. Use of Non-Resident Species in Criteria Development:

Excluding species simply because they are not resident may be unnecessarily restrictive for the purposes of deriving national criteria, and may actually increase rather than decrease uncertainty. The workgroup recommends that non-resident species be considered for use in criteria derivation calculations, focusing on those species with widely used and standardized test methods and [if] there is no reason to believe [that these species] would misrepresent the sensitivity of resident species.

1c. Use of Non-Resident Species in Criteria Development:

Chronic Toxicity of Ethynylestradiol

Genus	Chronic Value(s) (ng/L)	Notes
*Danio***	0.6, 1.5, <1.1	Life-cycle tests
Pimephales	<0.32, 1.5	Life-cycle tests
*Oryzias***	3.2	F0 from 1 d through spawning
Oncorhynchus	<16	Adult exposure, fertilization success
Potamopyrgus	50	Adult exposure; embryo production
Gammarus	>7600	100 d test, population size
Daphnia	45,000	Life-cycle test
Tisbe	>100,000	Saltwater copepod
Chironomus	320,000	Larval growth and molting schedule
Brachionus	800,000	72 h test, intrinsic rate of increase

1c. Use of Non-Resident Species in Criteria Development:

Sex Reversal, Intersex for EE2

Genus	LOECs (ng/L)
*Danio***	0.10 - >25
Pimephales	1.0 - 12
*Oryzias***	2.9 - 100
Margariscus	3.5
*Gobiocypris***	5.0
Gasterosteus	50
Poecilia	110

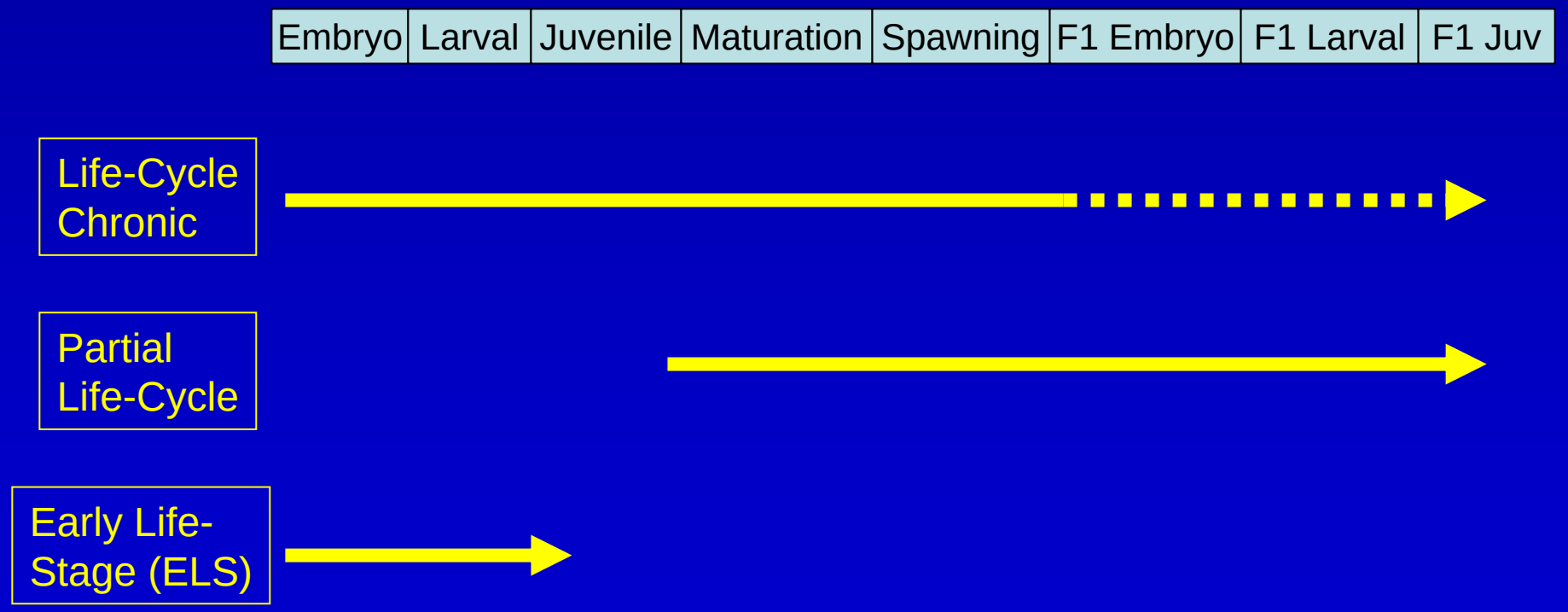
1d. Defining Appropriate Chronic Toxicity Data:

……important effects of these chemicals may not occur, or at least not be expressed, until after the ELS exposure window; in fact, PLC exposures may also miss important effects, such as those on sexual development …… the workgroup recommends that the Office of Water …… require at least one full life-cycle test for a fish unless there is a compelling body of information indicating that life processes outside the ELS or PLC exposure/observation window are not critical to capturing the biologically important effects of chronic exposure to the chemical.

1d. Defining Appropriate Chronic Toxicity Data

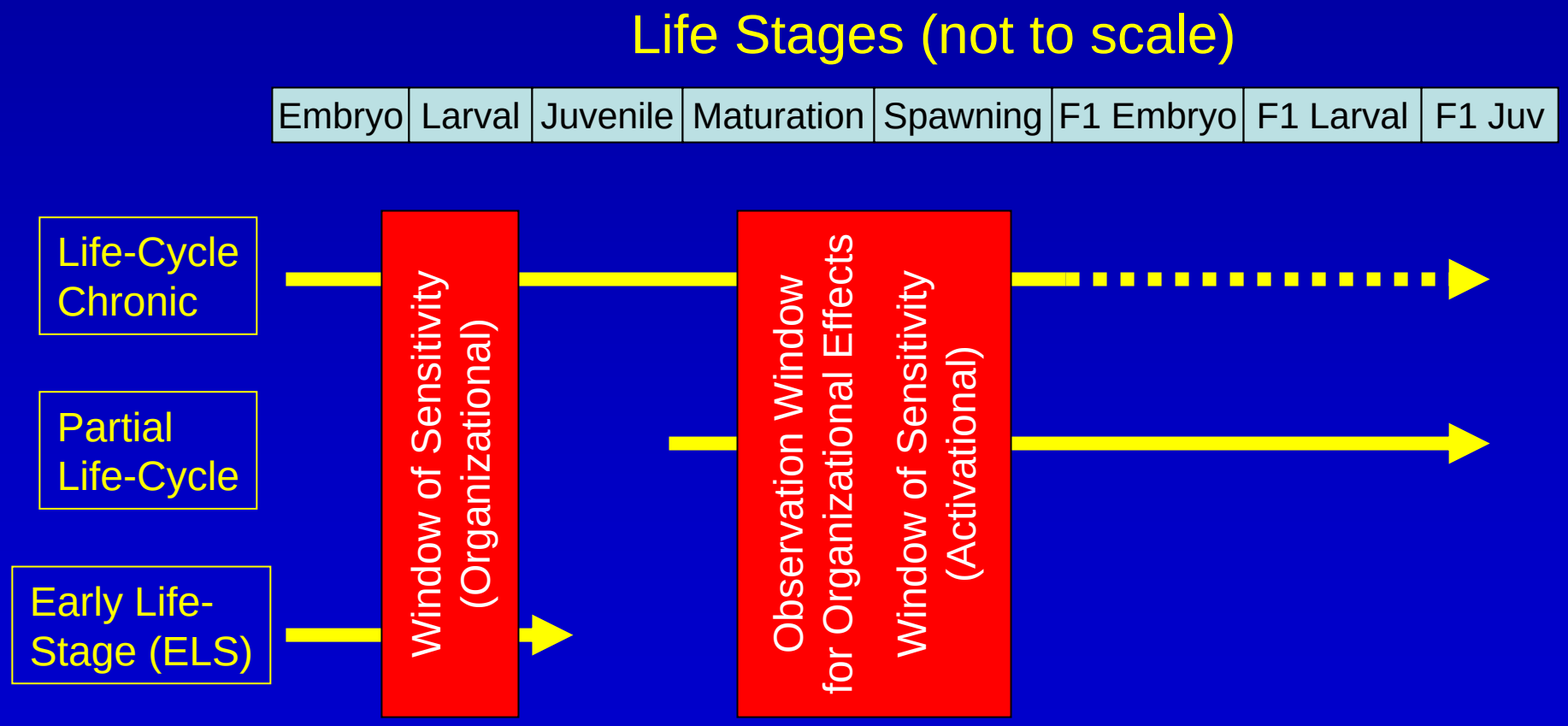
Sources of Chronic Data for Fish

Life Stages (not to scale)



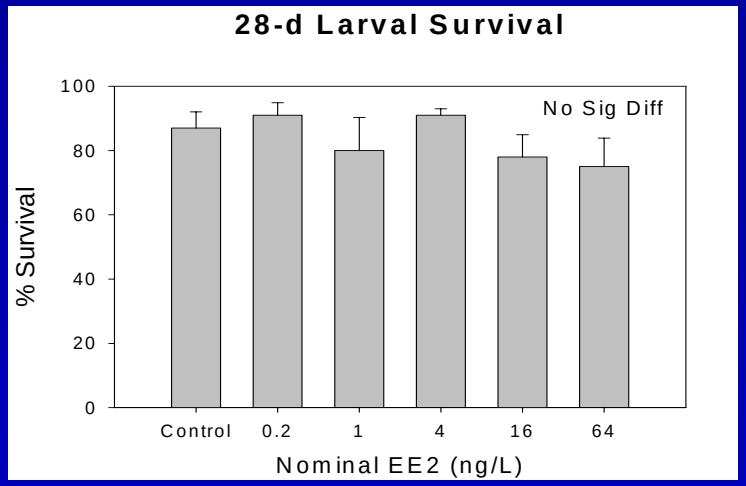
1d. Defining Appropriate Chronic Toxicity Data

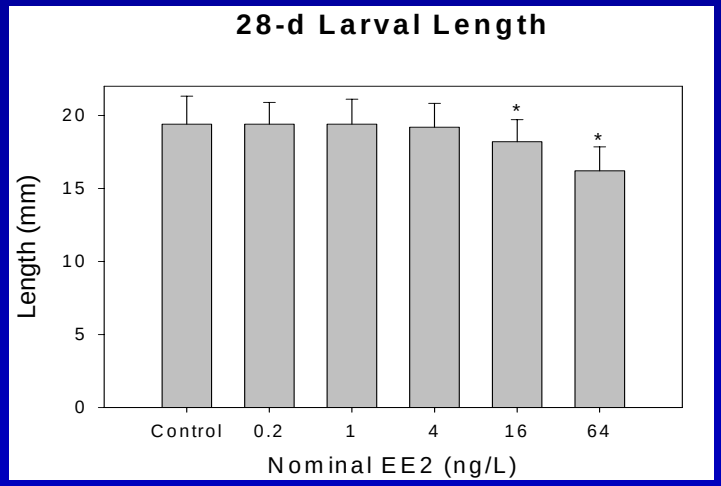
Windows of Sensitivity for EE2

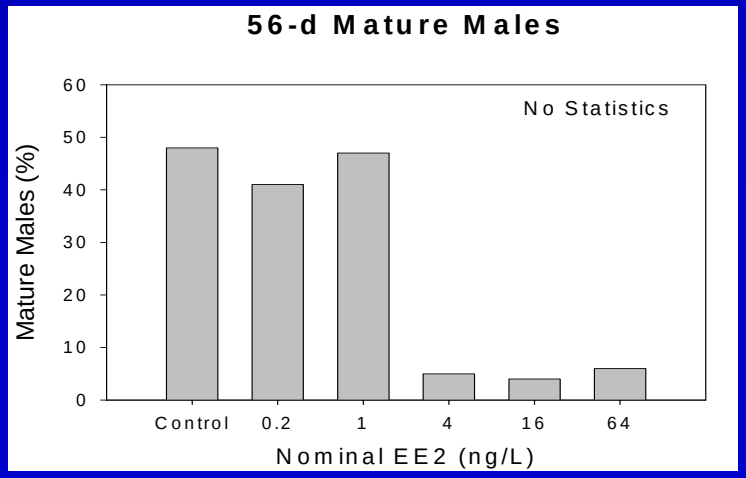


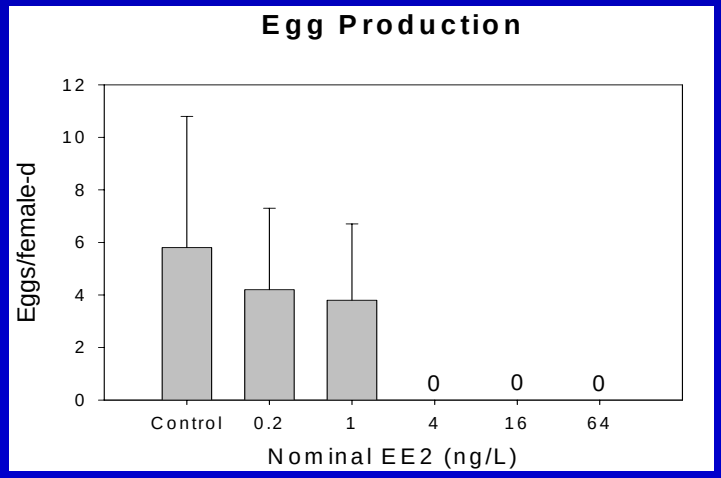
1d. Defining Appropriate Chronic Toxicity Data

FHM Chronic by Länge et al. (2001)



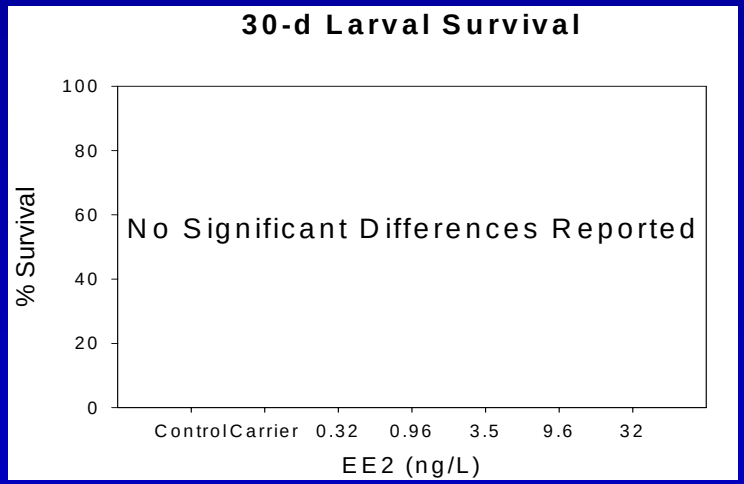


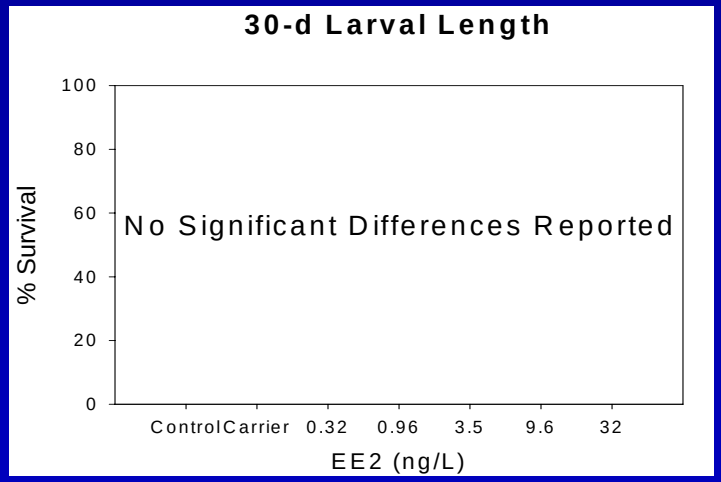


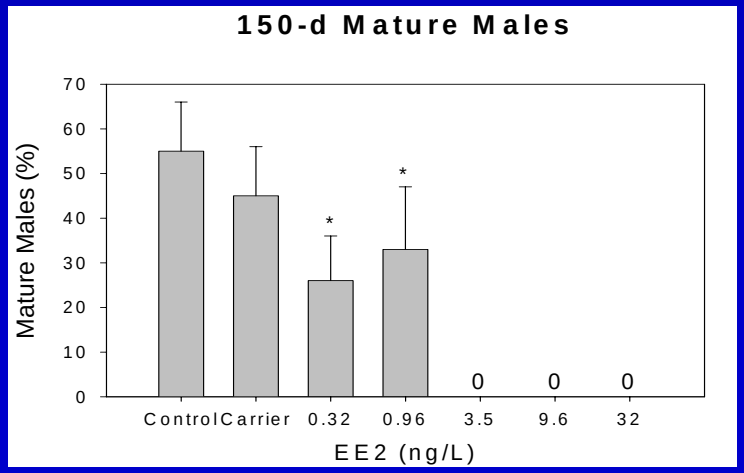


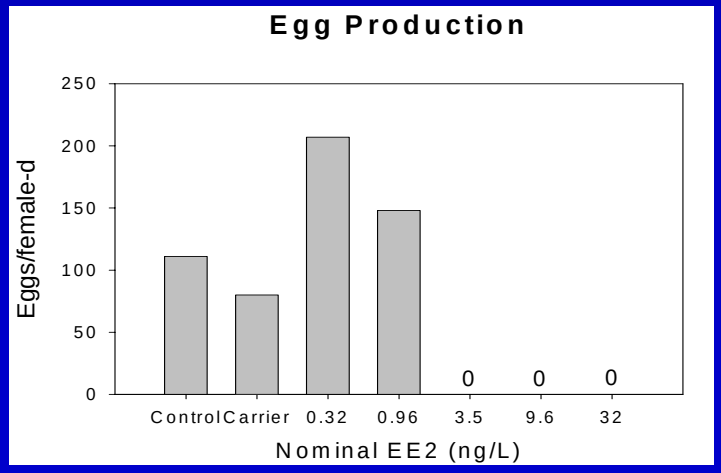
1d. Defining Appropriate Chronic Toxicity Data

FHM Chronic by Parrott and Blunt (2005)









1e. Selection of Effect Endpoints Upon Which to Base Criteria:

……many CECs, particularly those with very specific modes of action like steroid hormone agonists/ antagonists, will have data for a wide variety of histological, biochemical, physiological, or behavioral endpoints …… The degree to which such measures can be used to infer population level effects is likely endpoint-, chemical-, and/or organism-specific, and developing a universal list of recommended endpoints is beyond the scope of the workgroup …... the recommendation here is simply that criteria development more thoroughly explores such possibilities.

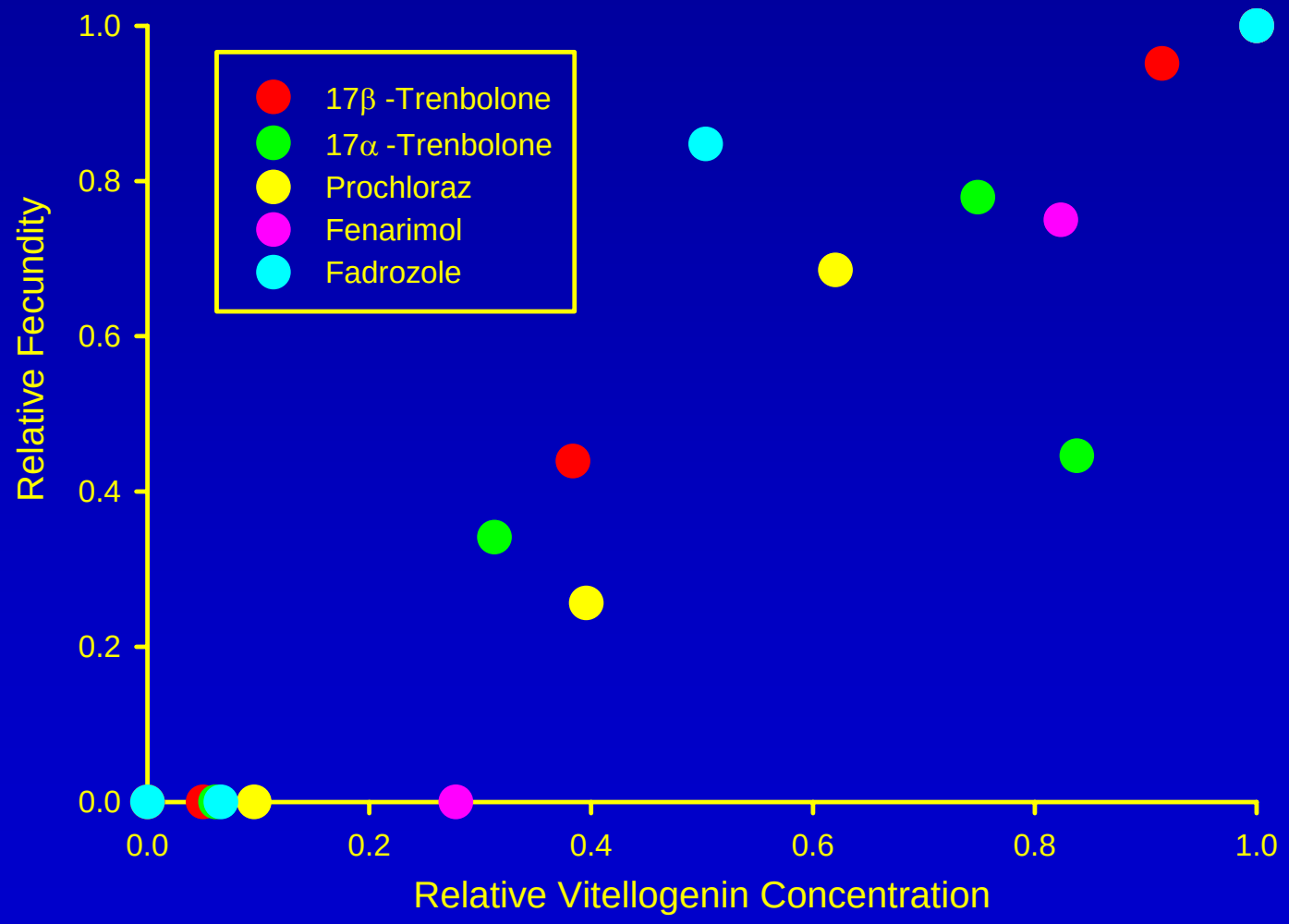
1e. Selection of Effect Endpoints Upon Which to Base Criteria:

(1) Endpoint important in its own right? Or used for interchemical, interspecies extrapolations based on established correlations to important endpoints?

(2) EE2 Effects Discussed in White Paper, Part II:

- Vitellogenin in males
- Sex ratios
- Intersex/testis-ova

1e. Selection of Effect Endpoints Upon Which to Base Criteria:



1f. Involvement of an Expert Panel:

……the complexities involved in the assessment of many CECs, and the reliance on professional judgment in making some of the determinations required under the workgroup's recommendations, make clear the need to bring the best scientific knowledge to bear in the development of criteria ……The workgroup supports the recommendation from a SETAC Pellston workshop (2003) that criteria development involve recruitment of an expert panel early in the process to insure that all relevant issues are considered during initial development of the criterion and to provide scientific perspective on decisions that are made as part of the process.