

Water quality and chemical pollution: Effect-based monitoring is critical

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Watershed Moments: Nature's Value, NAPA, May 24, 2017

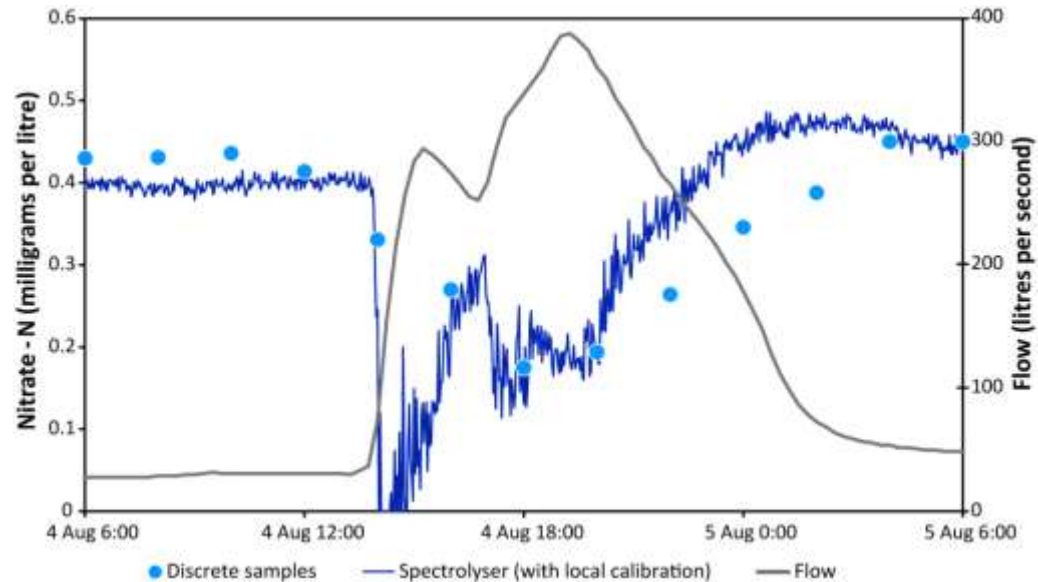
Connon Lab

<https://connonlab.wordpress.com/>

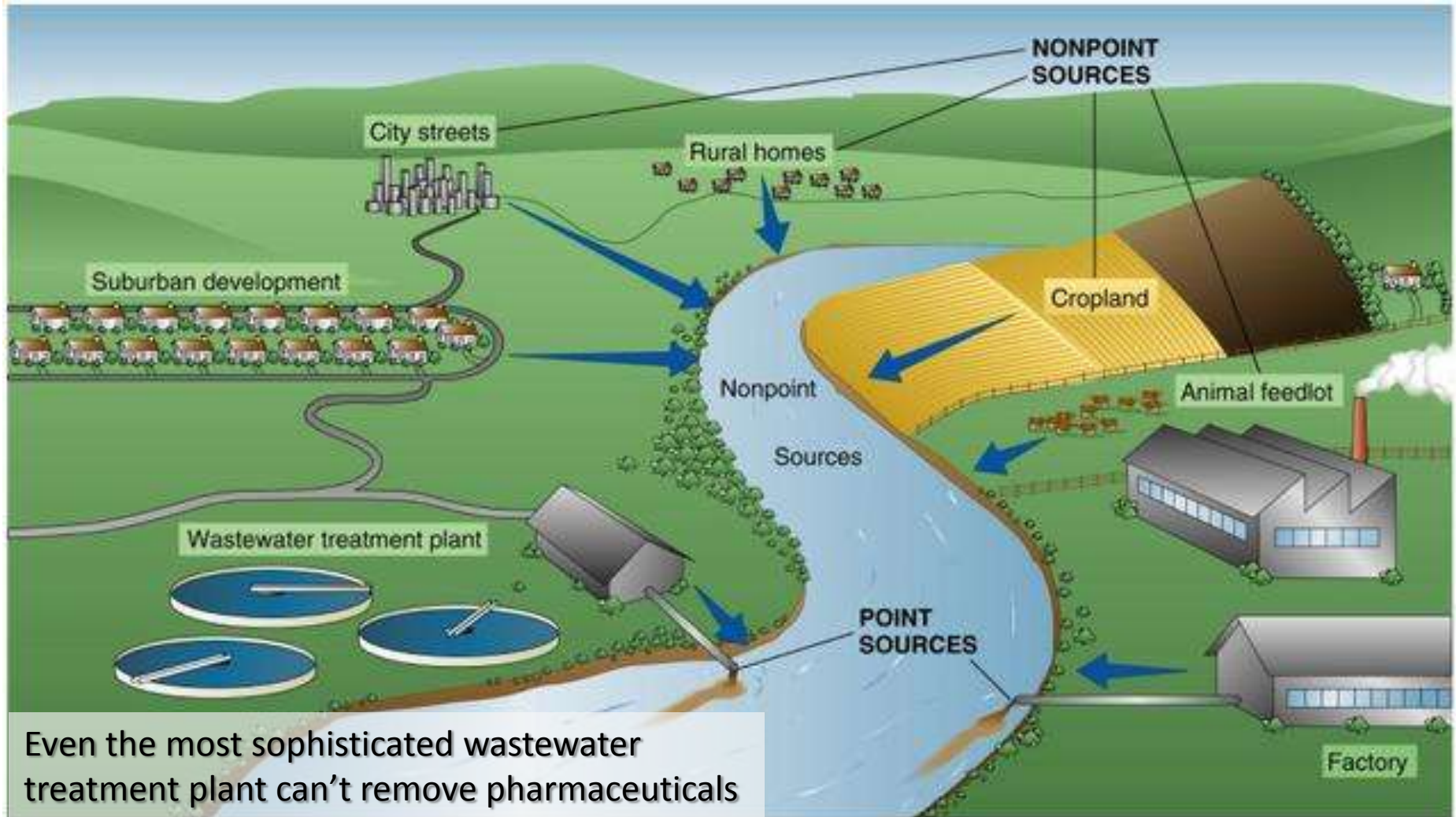
Physicochemical parameters



e.g., Sacramento River a Hood, DWR Continuous Monitoring Field Station



Sources of pollution



Pesticide Action Network (PAN)

www.pesticideinfo.org/DCo.jsp?cok=28

Suggested Sites: Web Slice Gallery, SFCWA mail, Richard's SFCWA Site, SVM-IT Helpdesk, YPER, CORE, My UC Davis, GeoMail, Office 365, VetMed OWR, DevMail, Gmail, Delta Plan Administrator, Common Lab | Trellis, Grad Student Advice, Grad Student Handbook

PAN Pesticides Database - California Pesticide Use

Home > Pesticide Use Help | Feedback

Top 50 Pesticides Used on All Sites in Napa in 2012

Totals for 2003 and later may be under-reported due to omission of adjuvants in DPR's data since that time.

Chemical Name (CA Chem Code)	Chemical Class	PAN Bad Actor	Gross Pounds	Application Rate Pounds per acre treated	Acres Planted where all or part has been sprayed	Acres Treated
All Chemicals (NA, 80) Uses:		Not Listed	1,301,570	1.24	52,160	1,000,350
Sulfur (560) Uses: Fungicide, Insecticide	Inorganic	Not Listed	872,176	8.10	44,037	142,869
Mineral oil, unrefined (401, 2046, 705, 763, 2687, 473) Uses: Insecticide, Adjuvant, Herbicide, Fungicide	Petroleum derivative-Aromatic	Yes	102,509	4.08	16,689	24,873
Note! Data for Mineral oil, unrefined summarizes data from 2 or more chem codes and may not agree with DPR summaries which total data for each chem code.						
Lime-sulfur (348) Uses: Insecticide, Fungicide	Inorganic	Not Listed	44,382	23.2	2,857	1,912
Glyphosate, potassium salt (5420) Uses: Herbicide	Phosphonoglycine	Not Listed	36,086	1.58	24,851	22,084
Mineral oil, refined (3046, 2091, 2196, 2768, 1941) Uses: Herbicide, Plant Growth Regulator, Insecticide, Adjuvant, Solvent	Petroleum derivative-Saturated	Not Listed	25,703	5.12	4,313	4,745
Note! Data for Mineral oil, refined summarizes data from 2 or more chem codes and may not agree with DPR summaries which total data for each chem code.						
Sulfur dioxide (551) Uses: Deseccant, Preservative	Inorganic	Yes	18,597	83.0	61.3	1.00
Sodium carbonate peroxyhydrate (3765) Uses:	Inorganic	Not Listed	14,450	175.7	-	16.5
1,3-Dichloropropene (573) Uses: Fungicide, Nematocide	Halogenated organic	Yes	13,378	333.3	45.5	40.1
Nonyl phenoxy poly (ethylene oxy) ethanol (1743, 1397, 3939, 5755) Uses: Adjuvant, Plant Growth Regulator, Soap/Surfactant	Polyalkyloxy Compound	Not Listed	12,171	0.18	25,530	65,742
Note! Data for Nonyl phenoxy poly (ethylene oxy) ethanol summarizes data from 2 or more chem codes and may not agree with DPR summaries which total data for each chem code.						
Glyphosate, isopropylamine salt (1855) Uses: Herbicide	Phosphonoglycine	Not Listed	11,111	1.32	11,991	6,483
Bacillus thuringiensis, subsp. spore-forming, strain 4269, 315, formulation in solids and solubles (5429) Uses: Insecticide	Microbial	Not Listed	7,143	0.01	5,938	11,758
Cyprodinil (4700) Uses:	Pyrimidine	Not Listed	6,460	0.35	20,430	18,655

<http://www.pesticideinfo.org/DCo.jsp?cok=28>

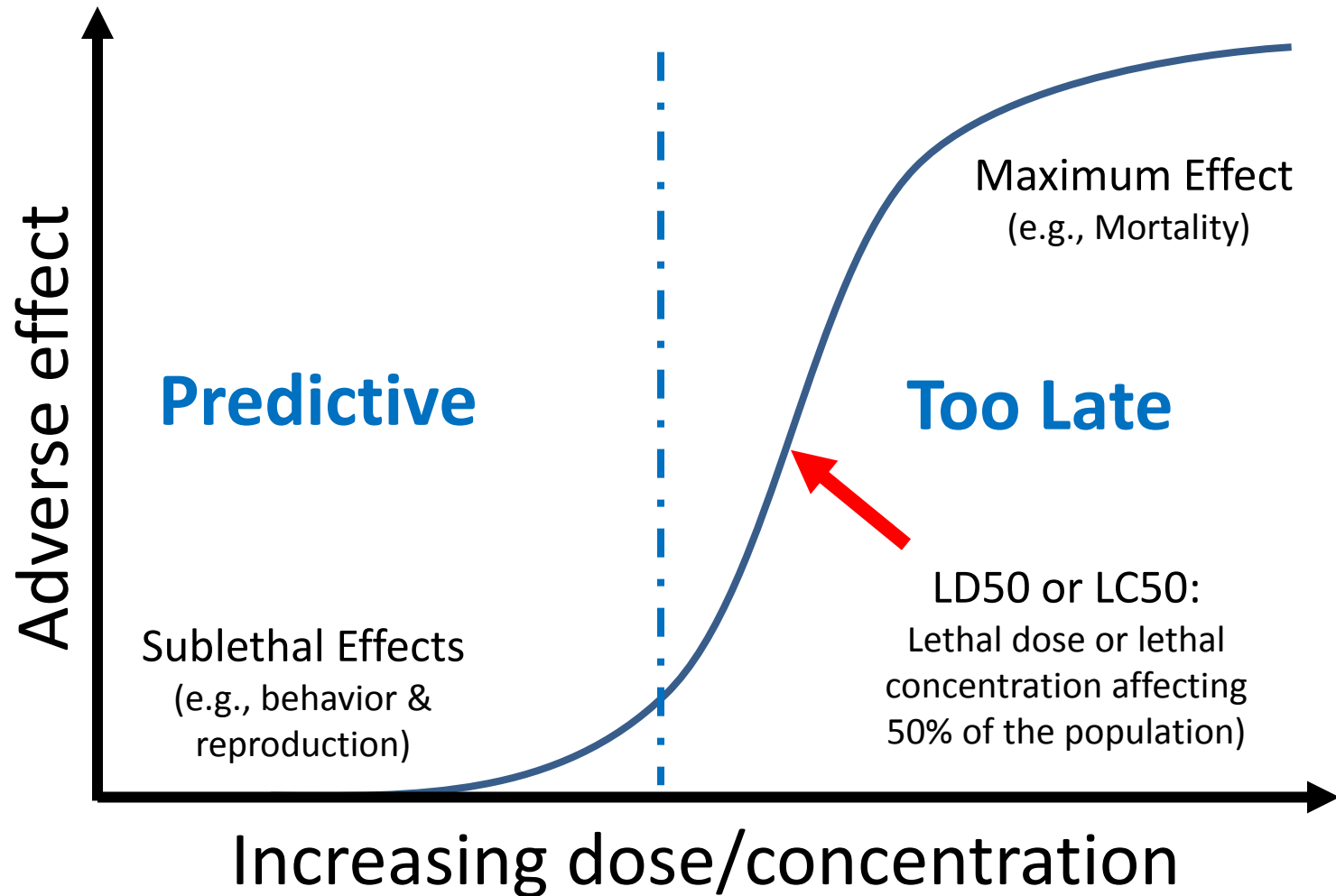
6:28 PM 5/17/2012

Effects of contaminants

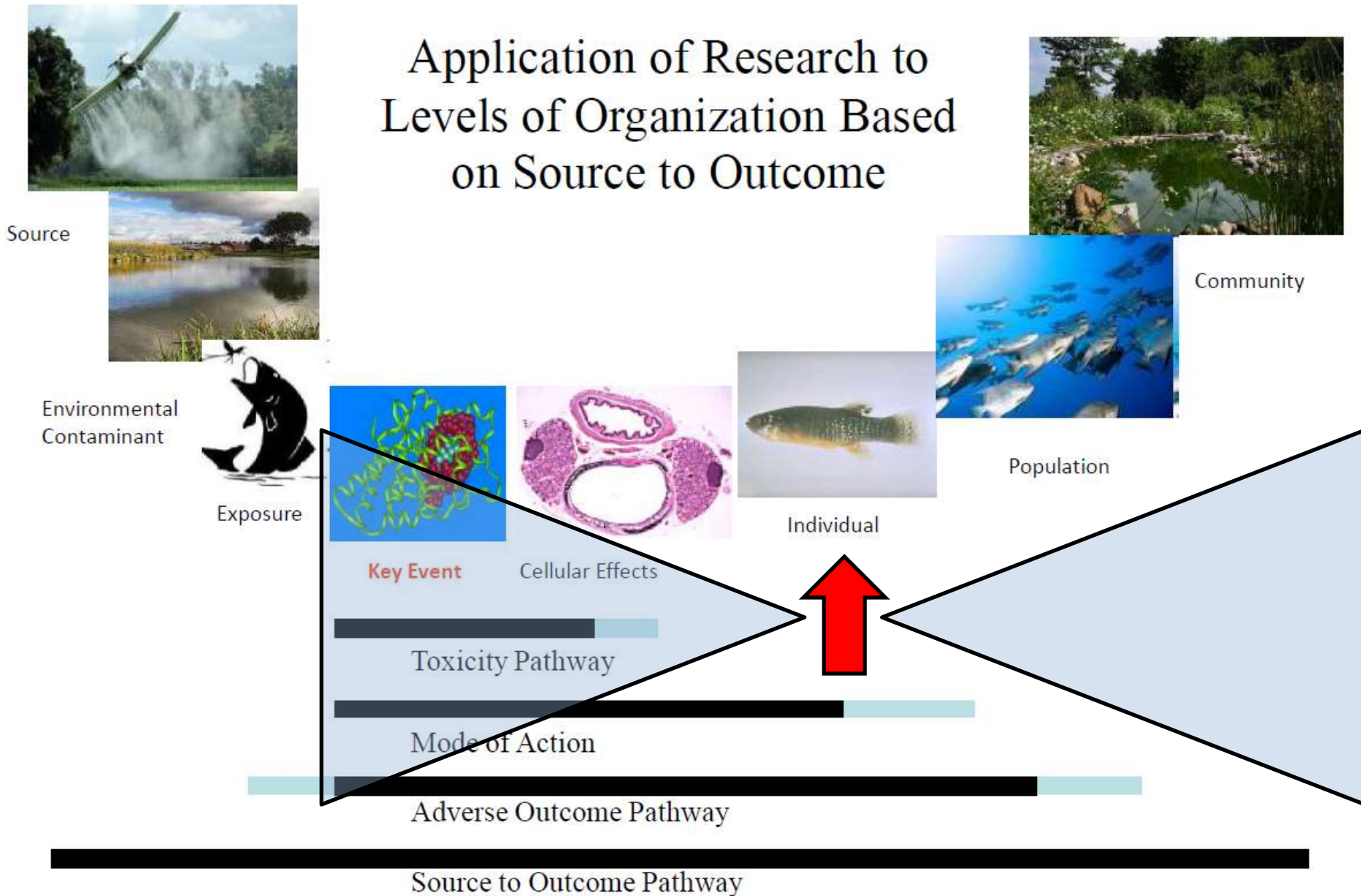


**“This means something,
but I can’t remember what!”**

Effect-Based Toxicity Testing



Application of Research to Levels of Organization Based on Source to Outcome



Sensitivity Differences & Indicator Species

Group 1
Do not Tolerate
pollution



e.g., Mayfly nymph

Group 2
Tolerate moderate
pollution



e.g., Dragonfly nymph

Group 3
Tolerate
pollution



e.g., Blackfly larvae



e.g., Caddisfly larvae

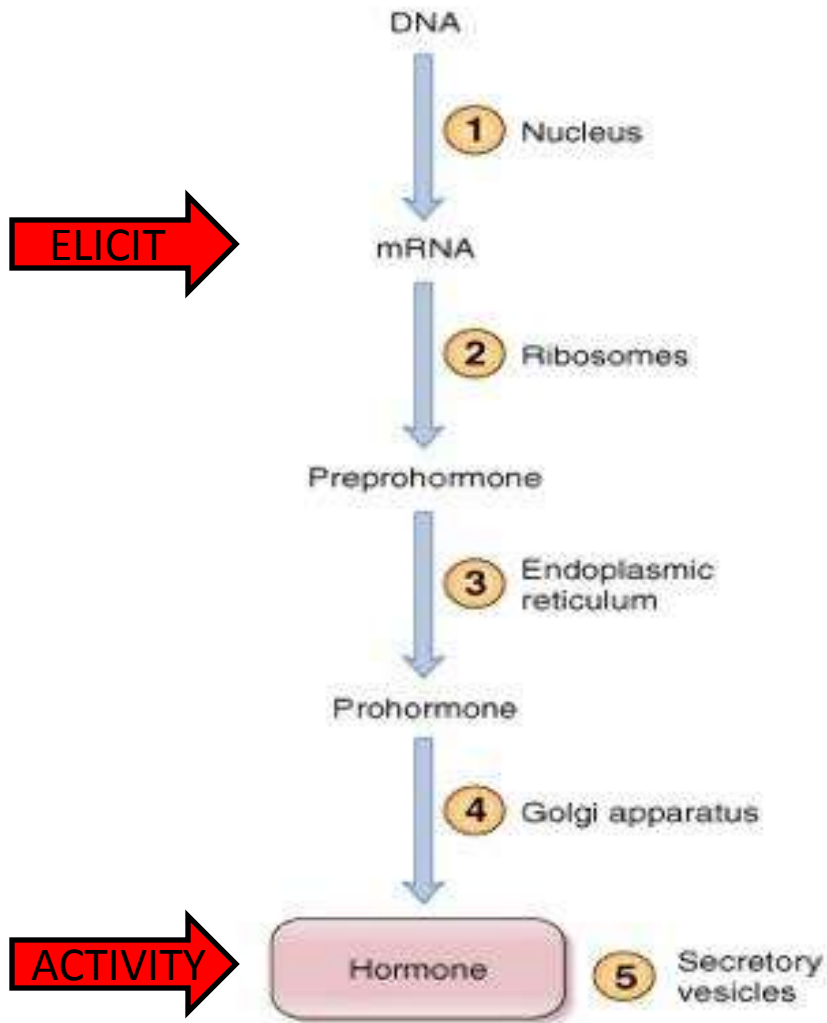


e.g., Crayfish



e.g., Flatworms

PEPTIDE HORMONE SYNTHESIS

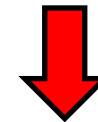


JOSEPH TOMELLERI

EXPOSED AS ADULTS



Reproductive output?



EXPOSED AT EARLY LIFE STAGE



EDC



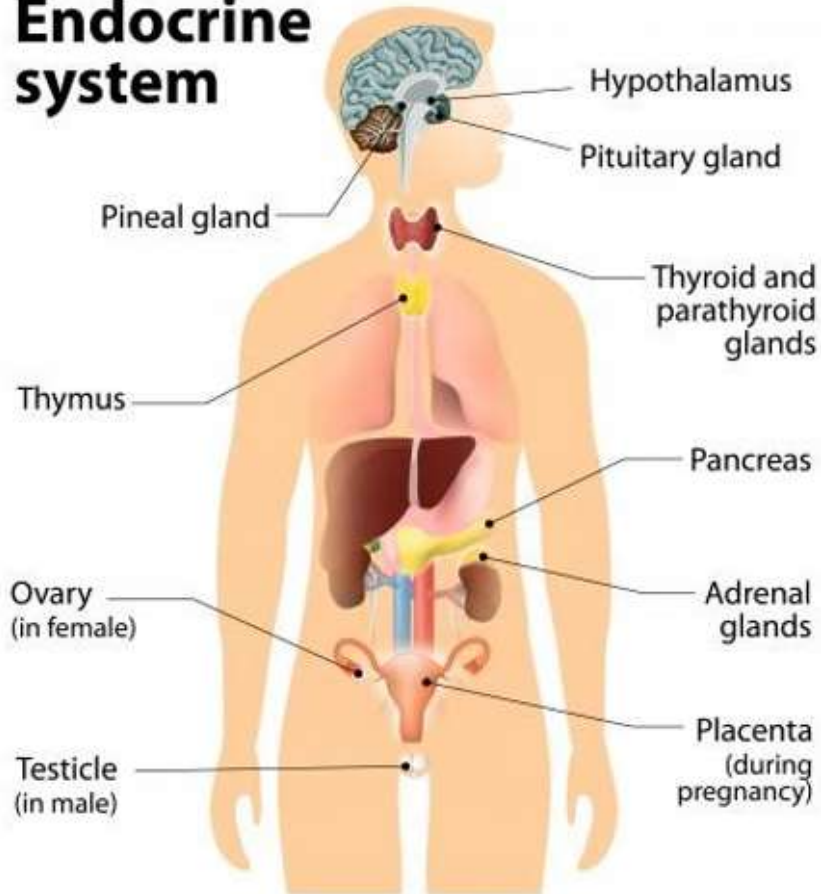
?



Vertebrate Systems:

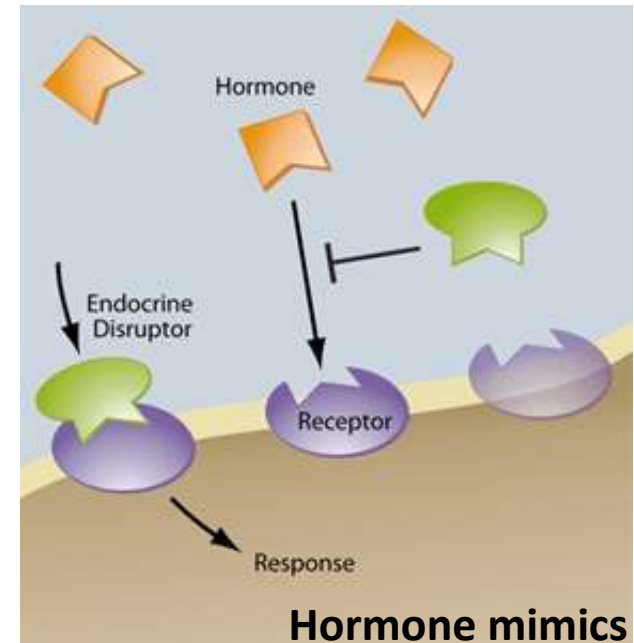
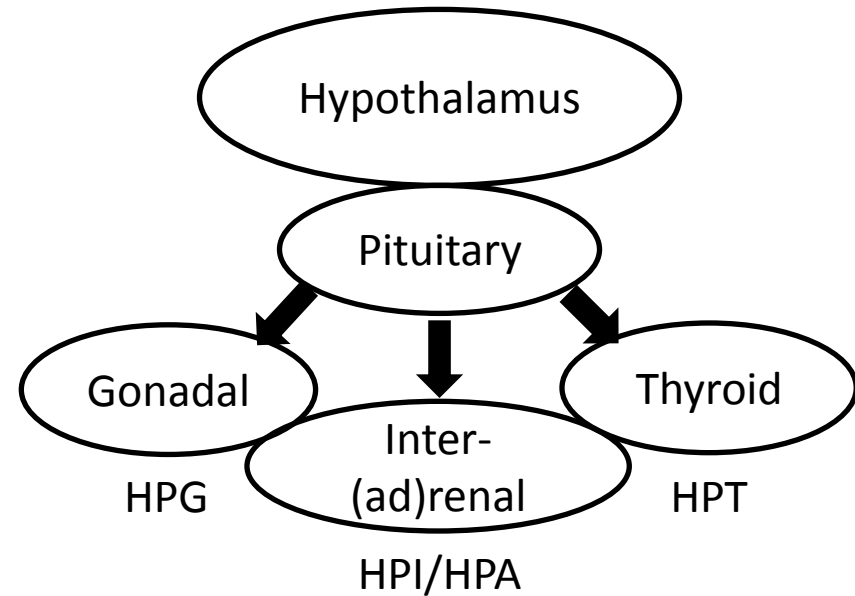
REPRODUCTIVE VS. NON-REPRODUCTIVE

Endocrine system

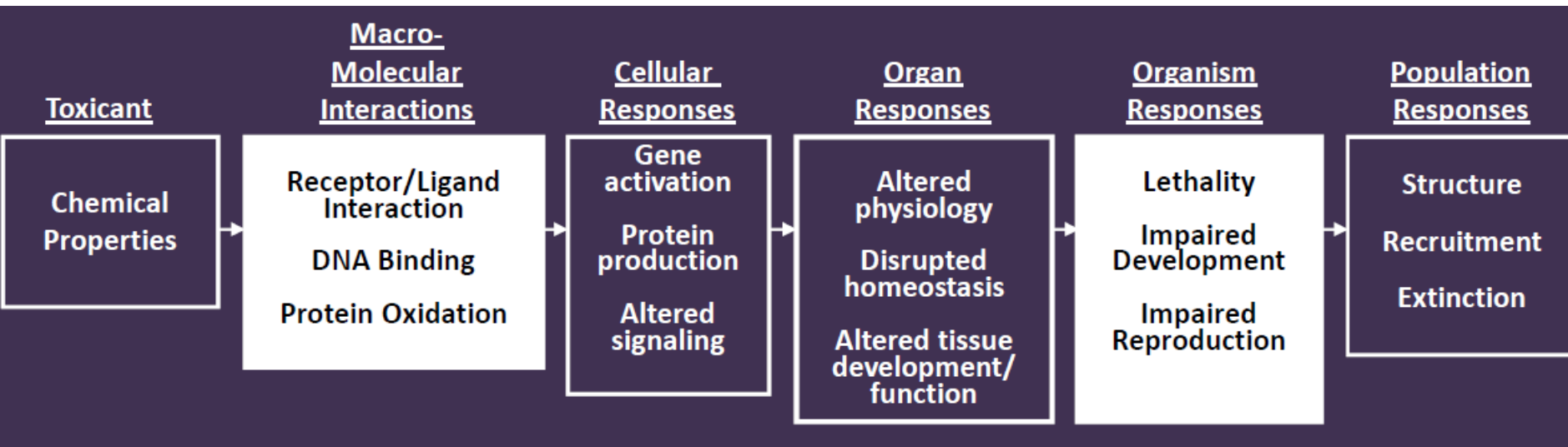


Source: Environmental Protection Agency

www.epa.gov/endocrine-disruption/what-endocrine-system



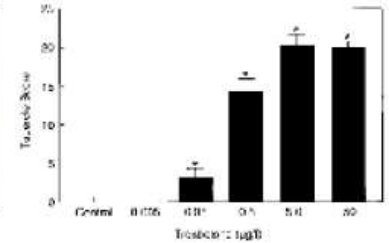
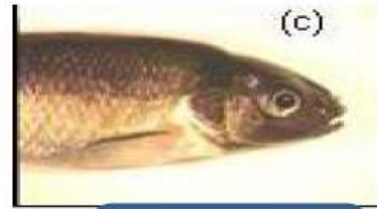
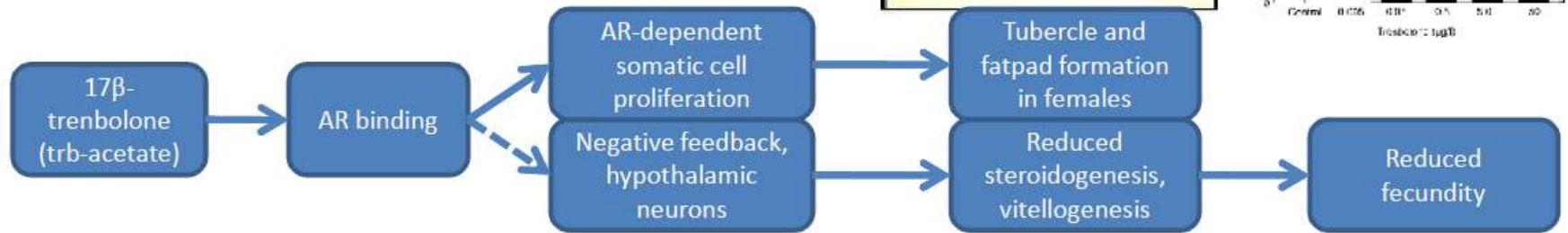
ADVERSE OUTCOME PATHWAY FRAMEWORK



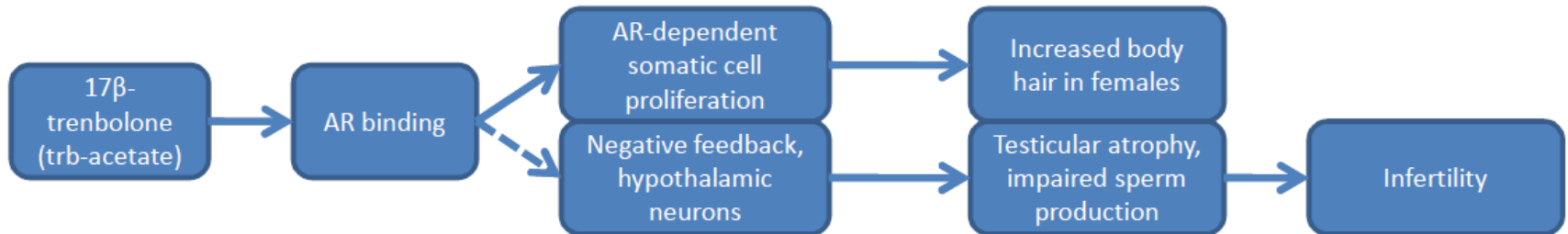
Source: An Adverse Outcome Pathway (AOP) is a conceptual framework that portrays existing knowledge concerning the linkage between a direct molecular initiating event and an adverse outcome, at a level of biological organization relevant to risk assessment. (Ankley et al. 2010, Environ. Toxicol. Chem., 29(3): 730-741.)

Example: Potent AR Agonists

Adverse Outcome Pathway: Fathead Minnow



Adverse Outcome Pathway: Human

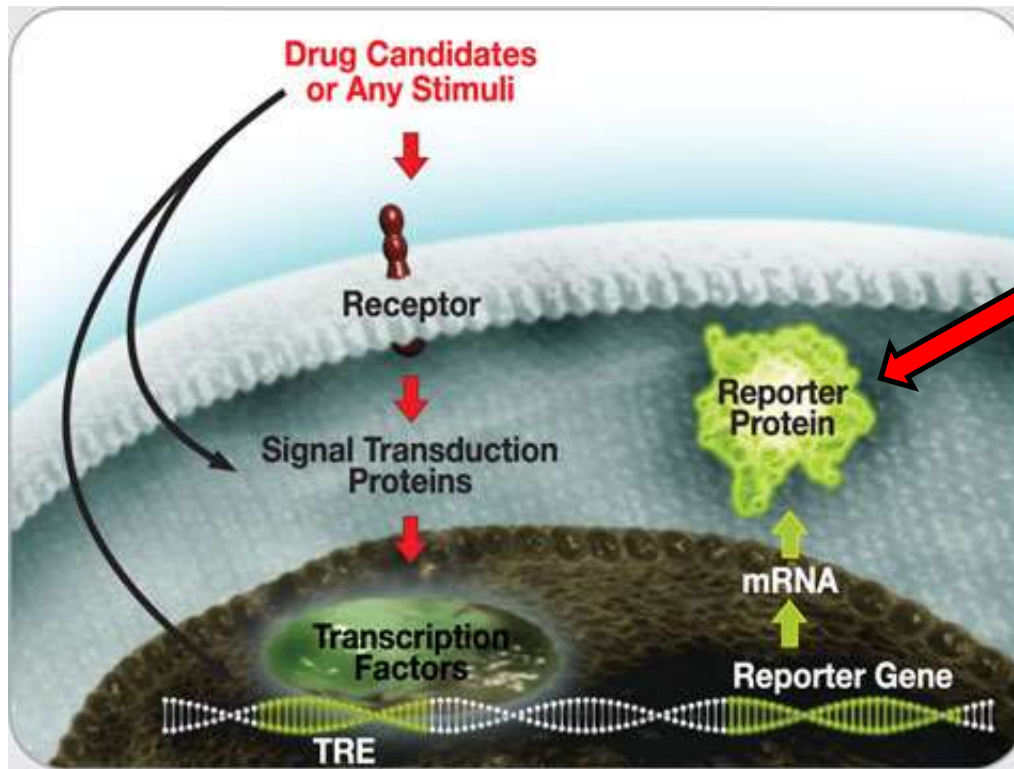


In vivo Approaches

- **Gene Expression:** CEC (or metabolite) activates mRNA production to generate Hormones, i.e. Initiation of hormone synthesis mimic.
 - Targeted Quantitative PCR: receptor and/or HPX axis.
- **Hormone quantitation/activity:** mRNA has led to hormone production
 - Enzyme linked immunosorbent assay (ELISA)/Binding assays: e.g., vitellogenin, choriogenin, testosterone, T3, T4...

Zebrafish model transgenic ER reporter

Live determination of EDC activity



FLUORESCENCE REPORTER: glows if receptor is activated

NO ENDOGENOUS HORMONE:

Only external “mimics” activate reporter

Transgenic line:
cyp19a1a (-/-);Tg(5xERE:egfp)

Zebrafish model transgenic ER reporter

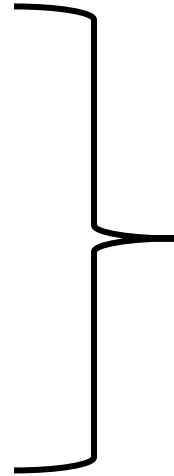
Live determination of EDC activity



In vivo Approaches

Males expressing of:
female hormones

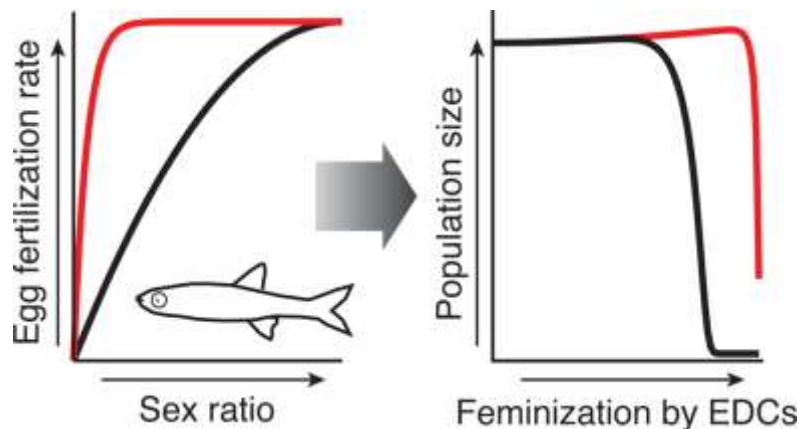
Females expressing
male hormones



Impacts contribution
of the individual to
the population

Population effects

- **Fecundity:** emergence/number of offspring
- **Sex ratios:** male:female skewness
- **Epigenetics:** parental transfer.
 - MethylSeq – DNA methylation



White J.W., Cole B., Cherr G., Connon R.E. and Brander S. (2017). Scaling up the individual-level effects of endocrine disruptors: how many males does a population need? *Environmental Science and Technology*, 51(3): 1802–1810.

Chemical analyses on their own will not inform on risk: *In vivo* methods are crucial in identifying the connection between exposure and biological effects.

Pros:

- cross-talk between biological pathways,
- environmental influence,
- integration of action through different mechanisms at different tissues
- metabolic transformations, bioaccumulation, and homeostatic controls

However (Cons):

- inter-individual, seasonal, and temporal variability
- Expensive and difficult to accommodate high throughput screening (but possible).

Watershed Moments: Nature's Value

- What typical water quality parameters are measured in streams/rivers?
 - Standard physicochemical parameters: Temperature, Dissolved Oxygen, pH, Salinity, Alkalinity, Ammonium, Turbidity
- What do these parameters tell us about the health of our watershed?
 - Physicochemical parameters will give an indication of niche suitability, and alert to potential changes to that niche
- What are emerging/new water quality challenges we will face in the future?
 - Multiple contaminants (synergism/additivity) & multiple stressors
- What can we do to protect or improve water quality – the health of our watershed?
 - Instigate an effect-based monitoring system

Watershed Moments: Nature's Value

Identify your questions needs

- Current monitoring?
- Continuous monitoring?
- Monitoring Station(s)?
- Seasonal impacts?
- Species protection?
- Watershed protection?
- Environmental or Political concern?

Screening with *in-vitro*

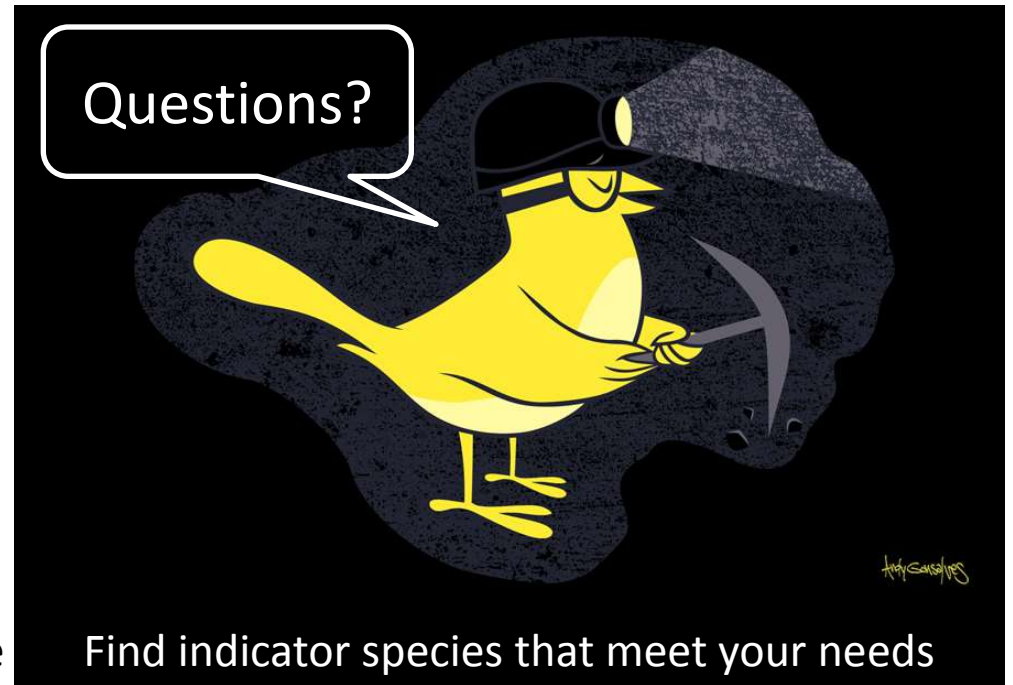


Verification with *in-vivo*

Analytical Chemistry



Over 100 compounds in a single sample



Find indicator species that meet your needs