Passive Integrative Water Samplers for Pesticides: Methodology, Quantification and Water Quality Assessment.

Wednesday March 13

Alan Kolok
Director
Aquatic Toxicology Laboratory

UNIVERSITY OF Nebraska Omaha

Who I am **not:**

- *analytical chemist*
- *POCIS/SPMD producer/inventor*

Who I am:

- *University Professor*
- *Aquatic Toxicologist*
- *POCIS/SPMD user*

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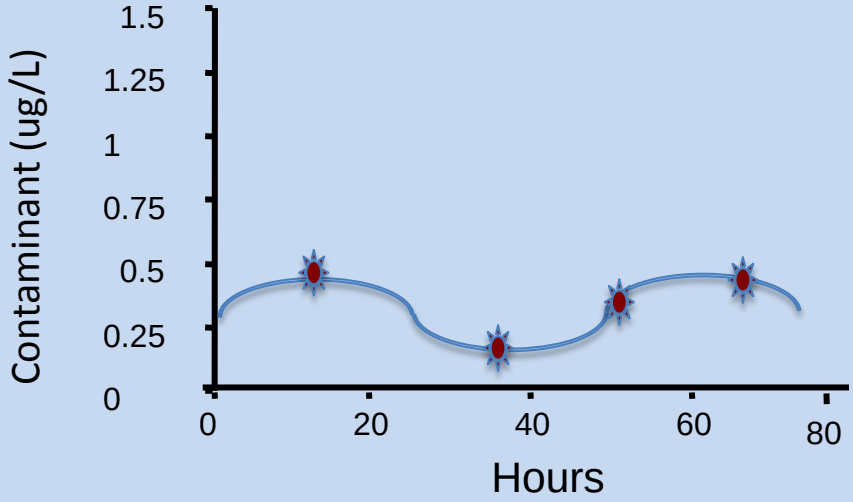
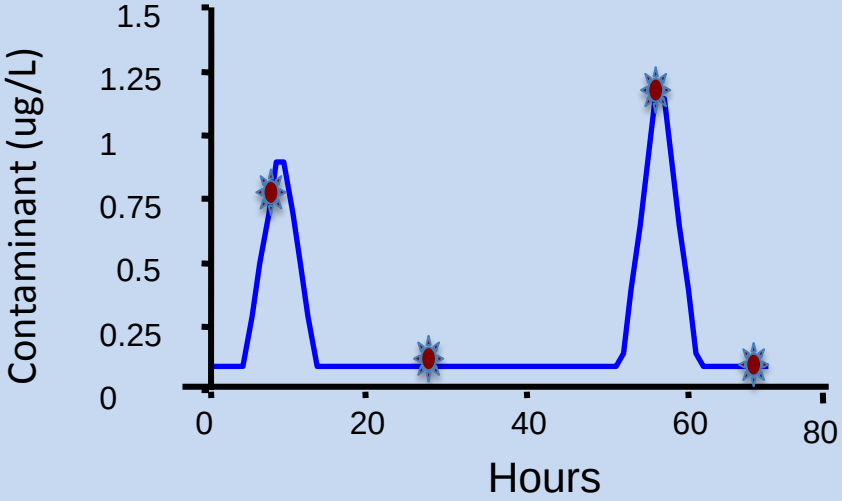
How do BACs enter the water?

Point source pollutant
Wastewater Treatment Plant



Non-point source pollutant
Agrichemicals



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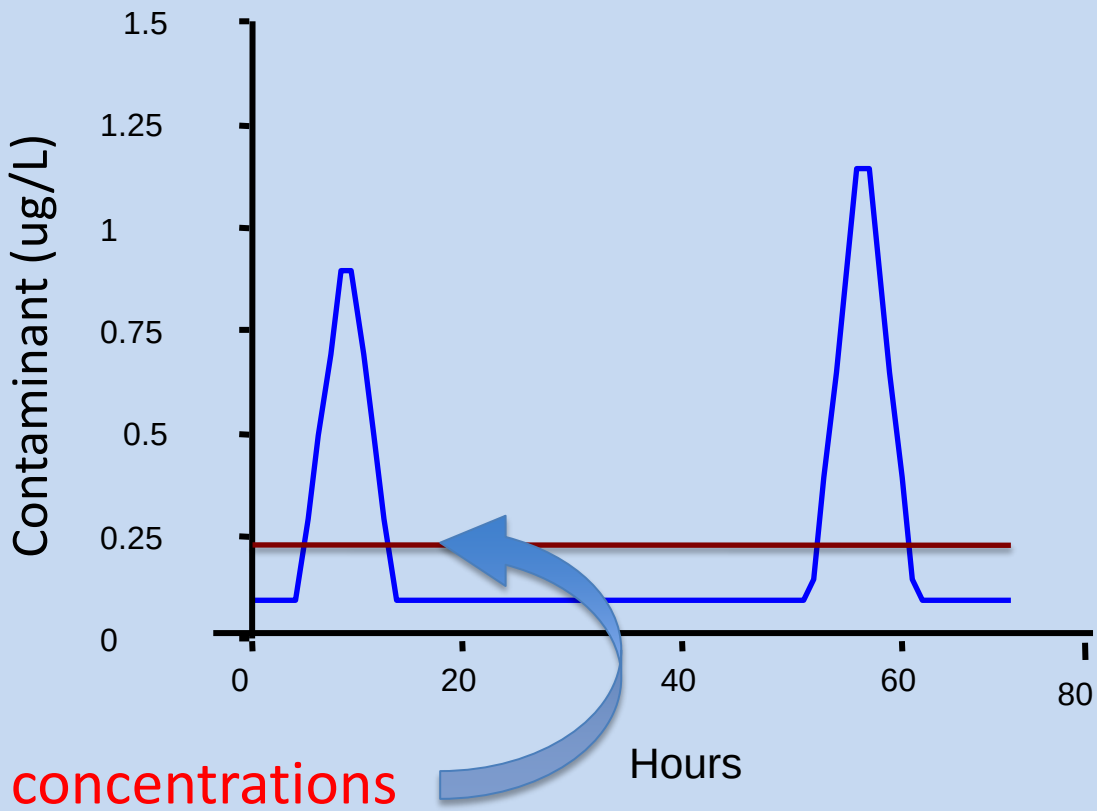
Non-point source pollutant
Agrichemicals

How can the compounds be quantified ?



Time Weighted Average concentrations from passive samplers.

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Interpretation

The first passive sampler was a sessile organisms (bivalves).

First used with:
Persistent Organic Pollutants

- low concentration
- lipophilic, log K_{ow} > 3.0
- resists biotransformation

For these compounds it has been suggested that the biological concentration factor (BCF) and the device concentration factor (DCF) are similar.

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Nonprescription drugs

Insect repellents pesticides

Plasticizers, disinfectants

Detergents, Personal care products

Biologically active compounds have been released into the environment and are active at very low concentrations.

Biologically Active Compounds
- very low concentrations
- hydrophilic log $K_{ow} < 3.0$
- readily biotransformed

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Passive sampler theory

A passive sampler allows the compounds of interest to diffuse into a sorbent from which they do not desorb.

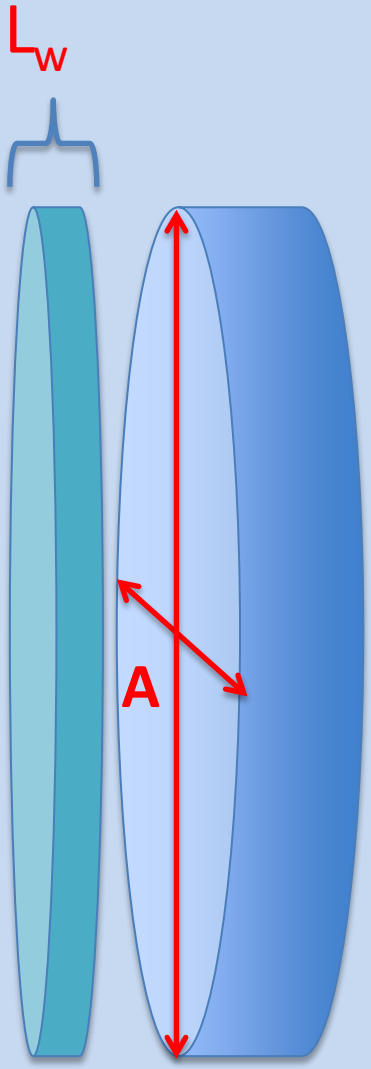
$$R_s = (D_w/L_w)\ A$$

R_s = uptake rate of compound into the sampler

D_w = diffusion coefficient for specific compound into the specific sampling matrix.

A = surface area of sampler.

L_w = water boundary thickness.



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Workshop Outline

1. Before you hit the field
2. Field work
3. Quantification
4. Interpretation

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Before you hit the field

Know the question that you are asking.

Presence/absence

Is the compound found in the environment (exploratory investigations) Is there a potential problem, do you know the compounds of interest you are looking for?)

Comparison between sites

Are there statistically significant differences among sites in the amount of compound (useful when comparing biological effects from one site to another).

Quantification

What was the time weighted concentration of compounds in the water?

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Before you hit the field

Know the question that you are asking.

Which sampler best suits my needs?

POCIS
(polar organic
Chemical integrative
sampler)

SPMD
(semipermeable
membrane device)

Environmental Sampling Technologies www.est-lab.com

USGS Columbia Environmental Res. Cen. www.cerc.usgs.gov

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Before you hit the field

Know the question that you are asking.

Which sampler best suits my needs?

POCIS

Relatively hydrophilic compounds

Log K_{ow} < 3.0

Relatively lipophilic compounds

Log K_{ow} > 3.0

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Before you hit the field

Know the question that you are asking.

Which sampler best suits my needs?

POCIS - water sampling only

solid sorbent

Pesticide POCIS – more aggressive sorption, non-pesticide compounds do not readily desorb

Pharmaceutical POCIS

the solid sorbent is more 'universal', but possibly less efficient for some specific compounds.

SPMD – sediment, water , air

Liquid sorbent (triolein)

high purity
(residual methyl oleate and oleic acid)
ultra high quality

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Before you hit the field

Know the question that you are asking.

Which sampler best suits my needs?

2,4D	2.8
Atrazine	2.8
Cyanazine	2.1
DEET	2.0
Dimethenamid	2.2
Diuron	2.8
Glyphosate	0.002
Isoproturon	2.5
Metribuzin	1.7
Norflurazon	2.3
Propachlor	2.3
Propazine	2.9
Terbufos	2.8

Arochlor cogeners	4.7 - 6.8
Butylate	4.2
Chlorpyrifos	4.7
DDT	6.9
EPTC	3.2
fluoranthene	5.5
Lindane	3.5
Metolachlor	3.1
Pendimethalin	5.2
Prometryn	3.1
Tefluthrin	6.5
Trifluralin	5.3

POCIS

Log $K_{ow} < 3.0$

SPMD

Log $K_{ow} > 3.0$

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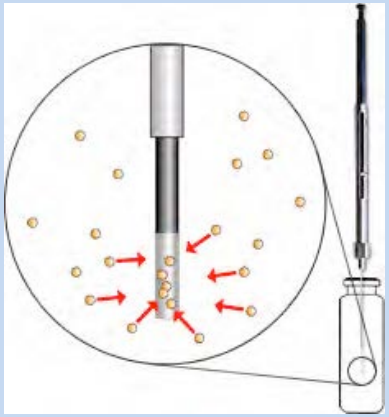
Before you hit the field

What other kinds of long-term sampling devices are available ?



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Other passive samplers

- Chemcatcher

- Empore disks
- polar or nonpolar organics or metals
- water
- Commercially available

/www.port.ac.uk/research/chemcatcher/research/

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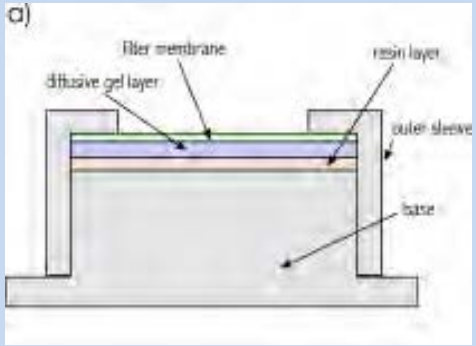
Other passive samplers

- Diffusive gradients in thin-film (DGT)

- Resin-impregnated hydrogel layer
- Hydrogel diffusion-layer
- Filter membrane
- ***Metals***
- Water, soil, sediment
- Commercially available
- http://www.dgtresearch.com/



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Other passive samplers

- Membrane-enclosed sorptive coating (MESCO)

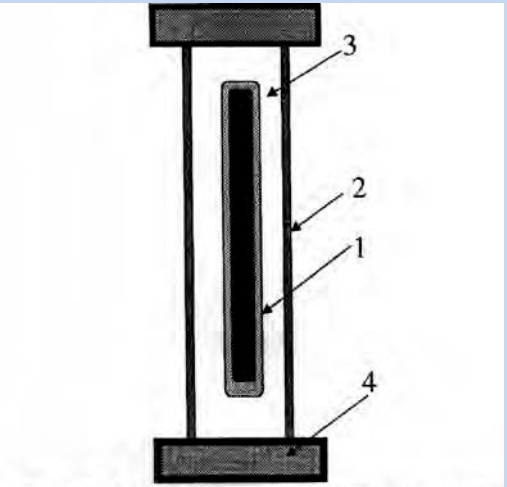

Figure 1. Schematic diagram of the MESCO passive sampling device. A Gerstel-Twister bar used for SBSE (component 1) is enclosed in a dialysis membrane bag made from regenerated cellulose (component 2). The dialysis membrane bag is filled with 3 mL of bidistilled water (component 3) and sealed at each end with Spectra Por enclosures (component 4).

- Adaption of stir bar sorptive extraction (SBSE)
- Hydrophobic solid receiving phase enclosed in a water-filled hydrophobic semipermeable membrane
- polar or nonpolar organics
- water
- Not commercially available

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Other passive samplers

The C.L.A.M.

(continuous low level aquatic monitoring)

-Elution to a solid phase extraction
(3-D filtration)
- up to 200 L (open ocean)
- 25-30 L (turbid water)
- need to replace the filter every 40 hr.
- Max. rate 80 ml/ min min. 20 ml/min
- water
- commercially available
- http://www.ciagentstormwater.com/the-c-l-a-m/

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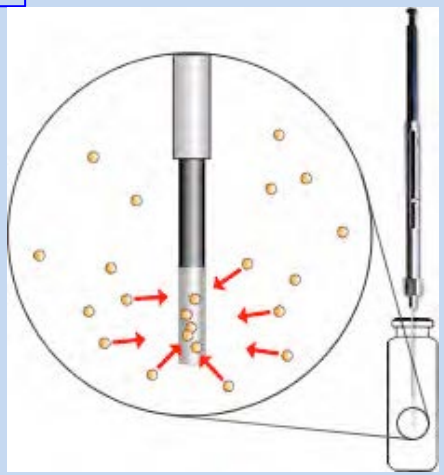
Before you hit the field

What about SPME? Solid Phase MicroExtraction



- solvent - free
- can be used In the field without having to collect a water sample
- sampling is based upon transport to a thin film coated on the SPME fiber
- driving force (similar to POCIS and SPMDs) is diffusion
-rapid equilibrium times (s to min to h)

- results are more comparable to grab samples.

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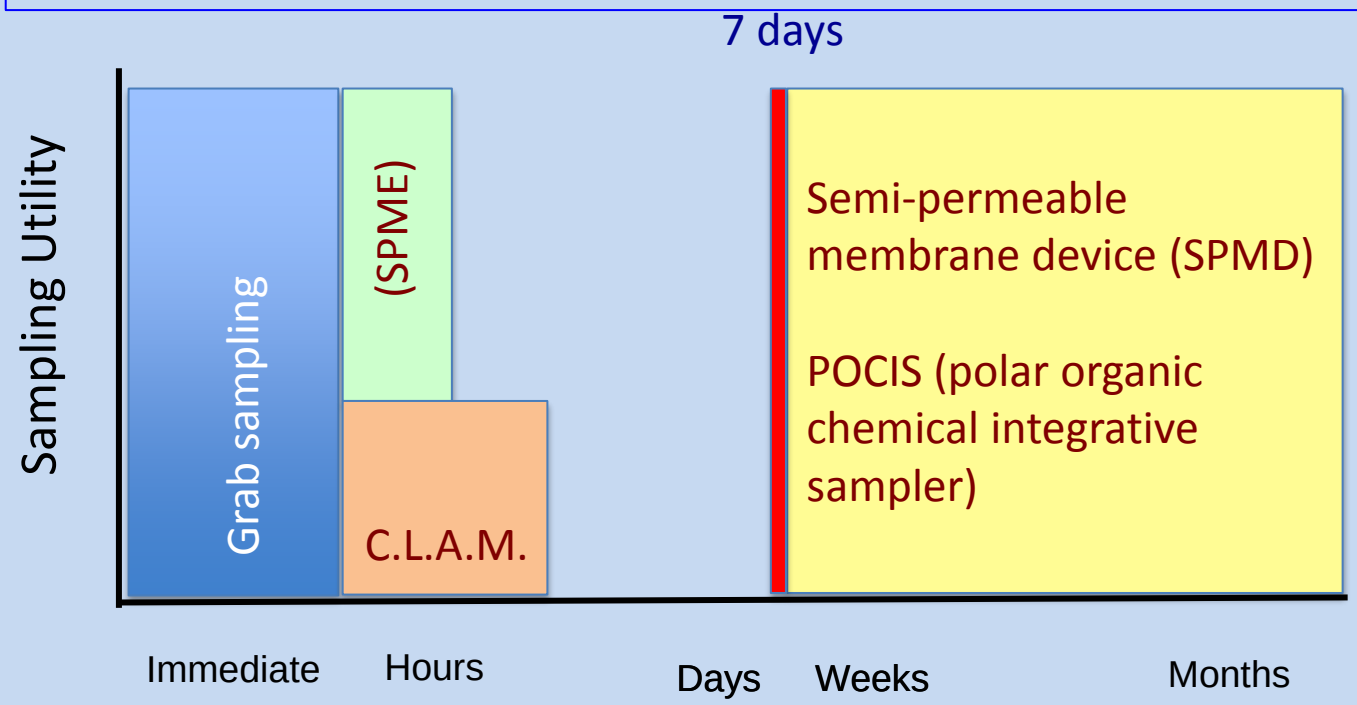
Before you hit the field

Know the question that you are asking.

Is the exposure time for the device too long or too short?



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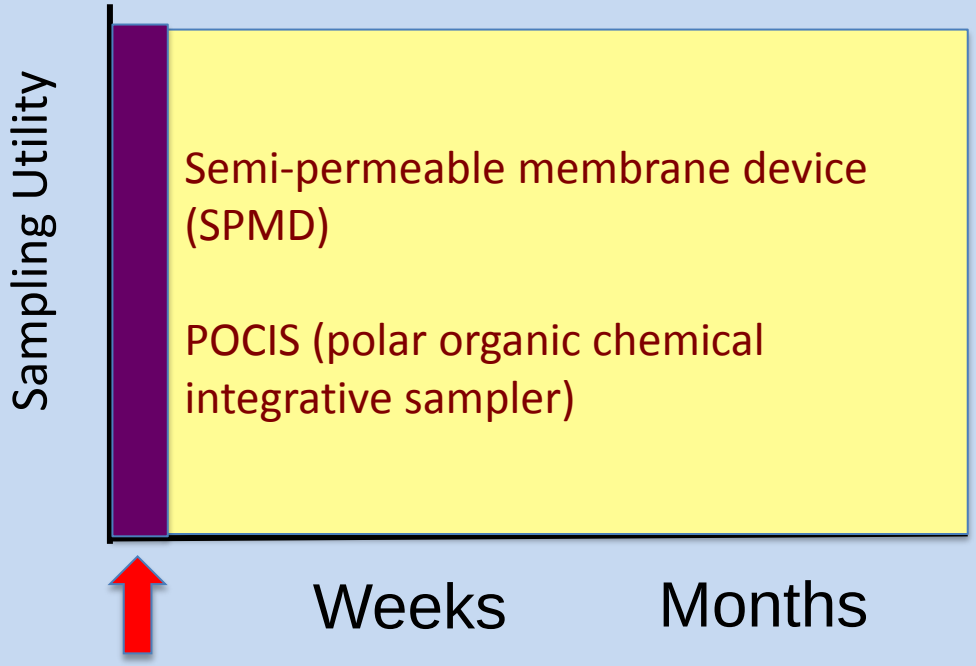
Before you hit the field

How long should the sampler remain in the field?



SPMDs and POCIS should be deployed in the field for at least one week !

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Workshop Outline

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2. Field work
3. Quantification
4. Interpretation

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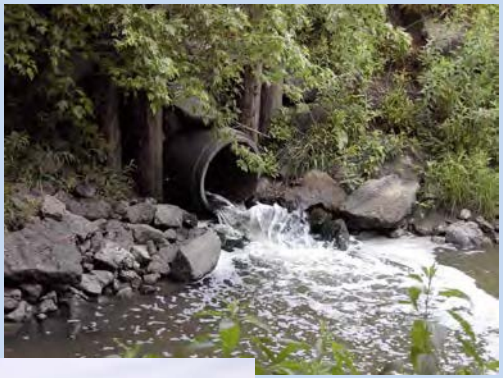
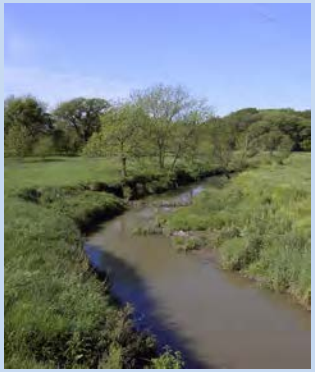
Field work





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Field work

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Extraction and QA/QC

Contamination
From lab to field

- POCIS and SPMDs come in clean paint cans. Keep on ice or blue ice into the field.

- Bring paint can to the field and open there.

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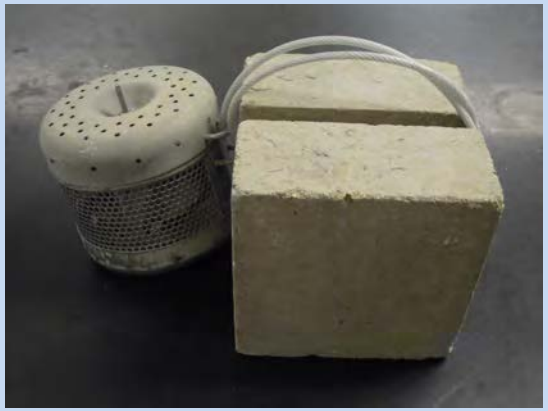
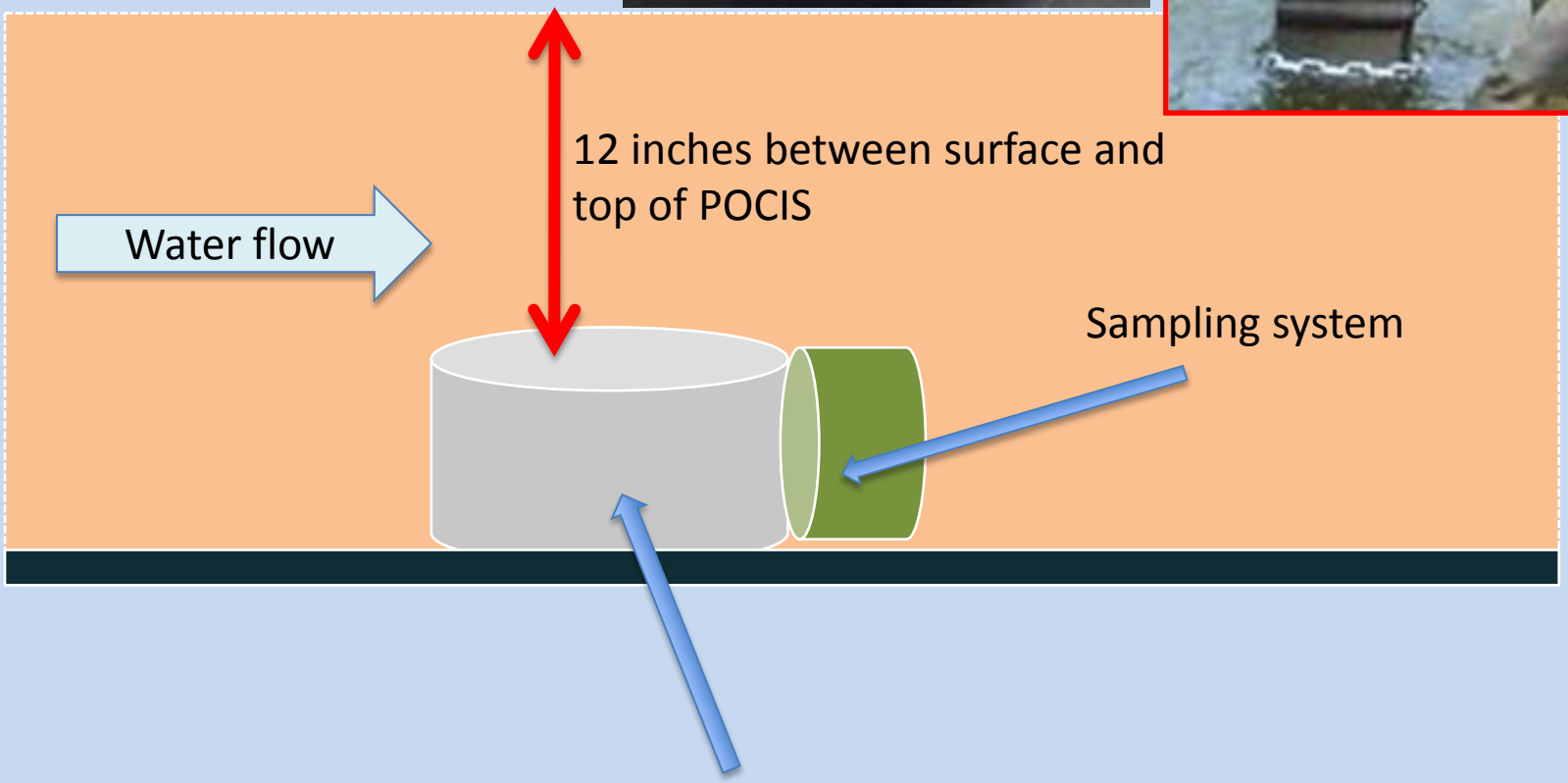
Field work

Rivers and streams





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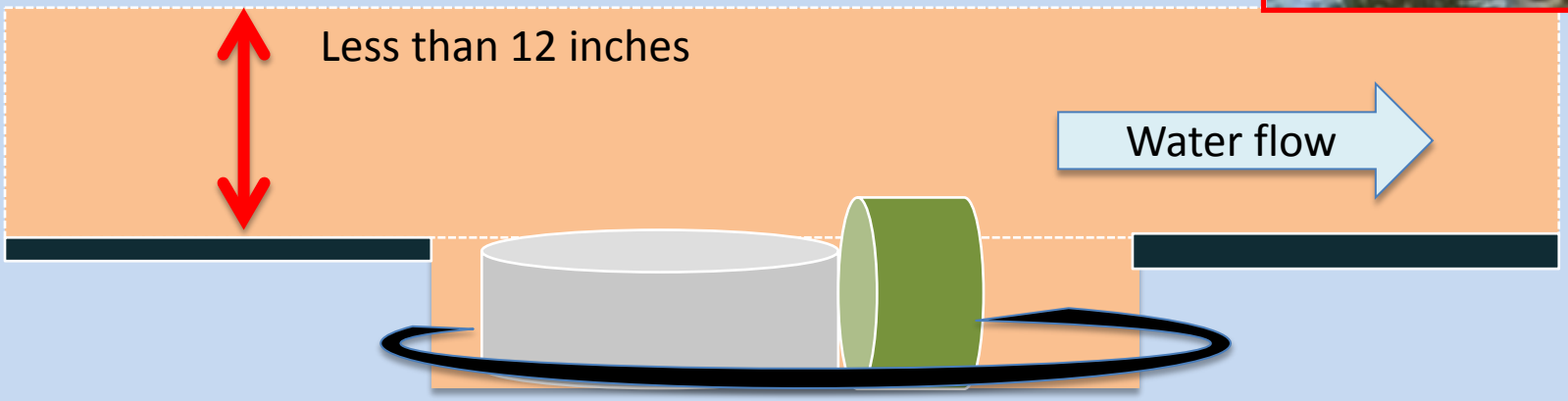
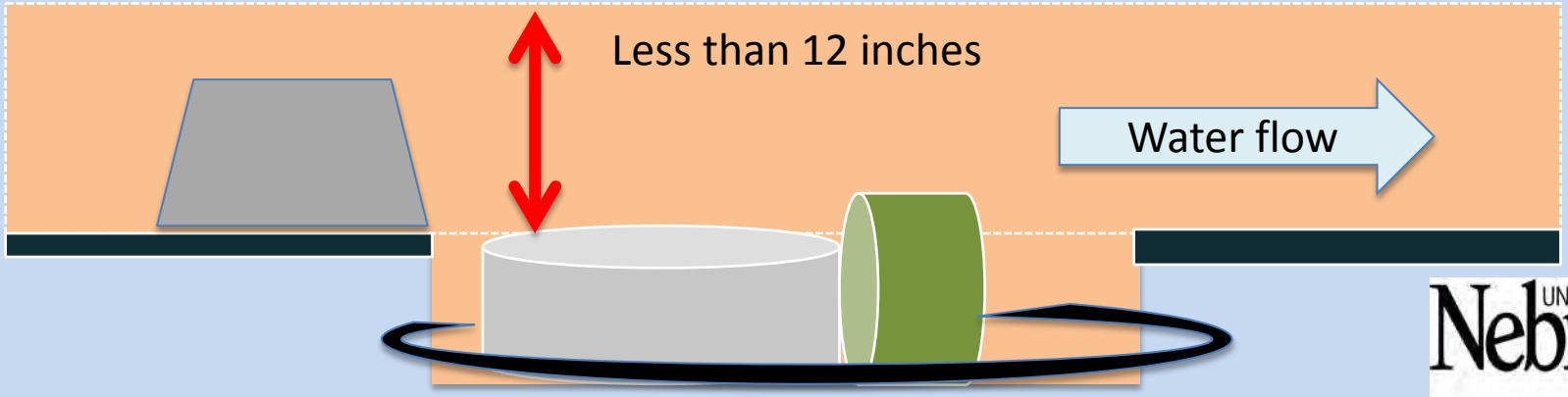
Field work

Rivers and streams





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Field work

Rivers and streams

How do you know if the sampler has been out of the water?

Use a temperature data logger.

- Inexpensive ~$50.00
- Easy to operate
- Periodic sampling of water temperature
- Energy efficient

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Field work

Sediment

Rivers and streams

Rock
Boulder
Cobble
Easy

Sand
Silt
Clay
Difficult

Clogging
Burial
Biofilm

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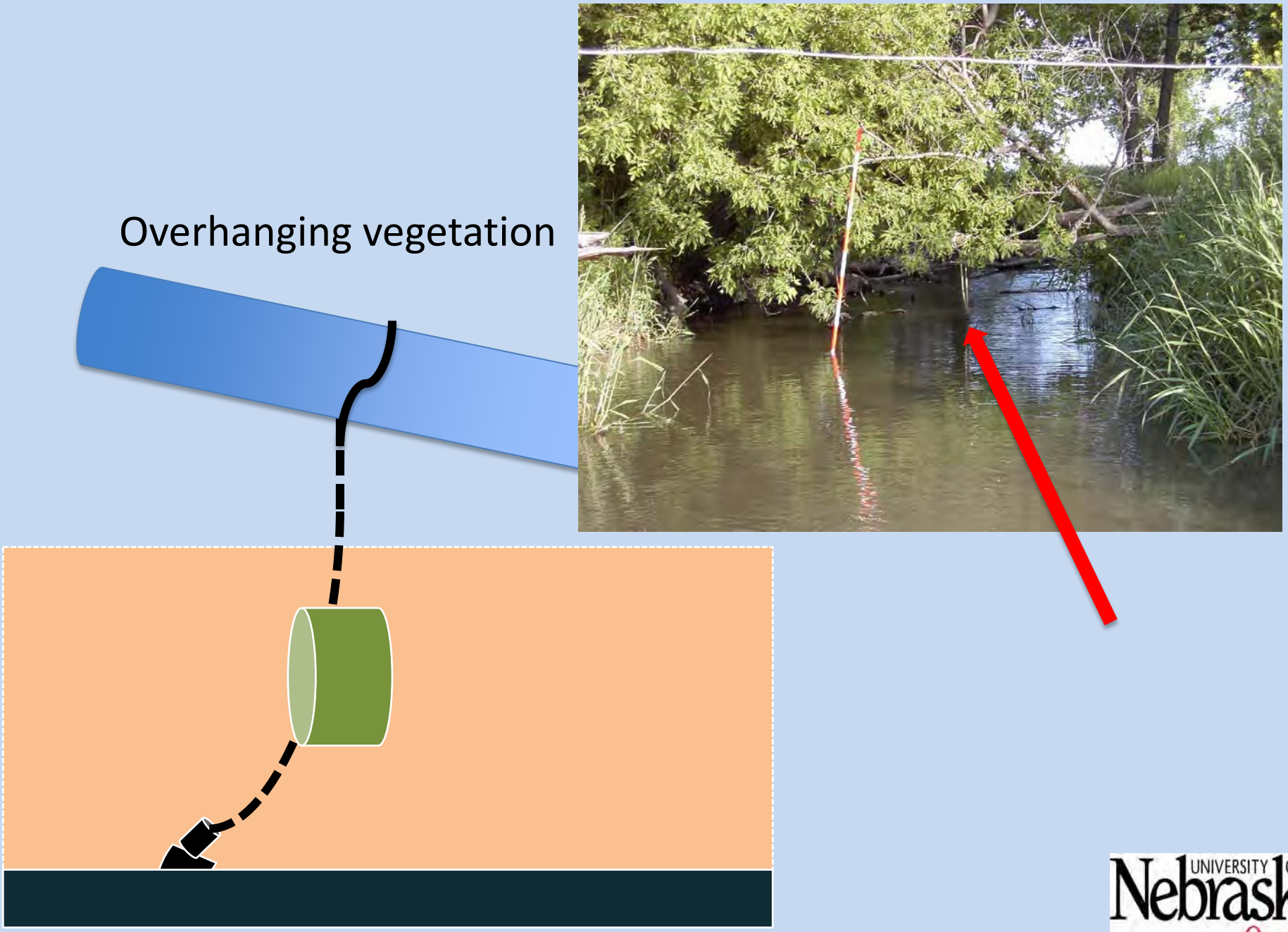
Overhanging vegetation



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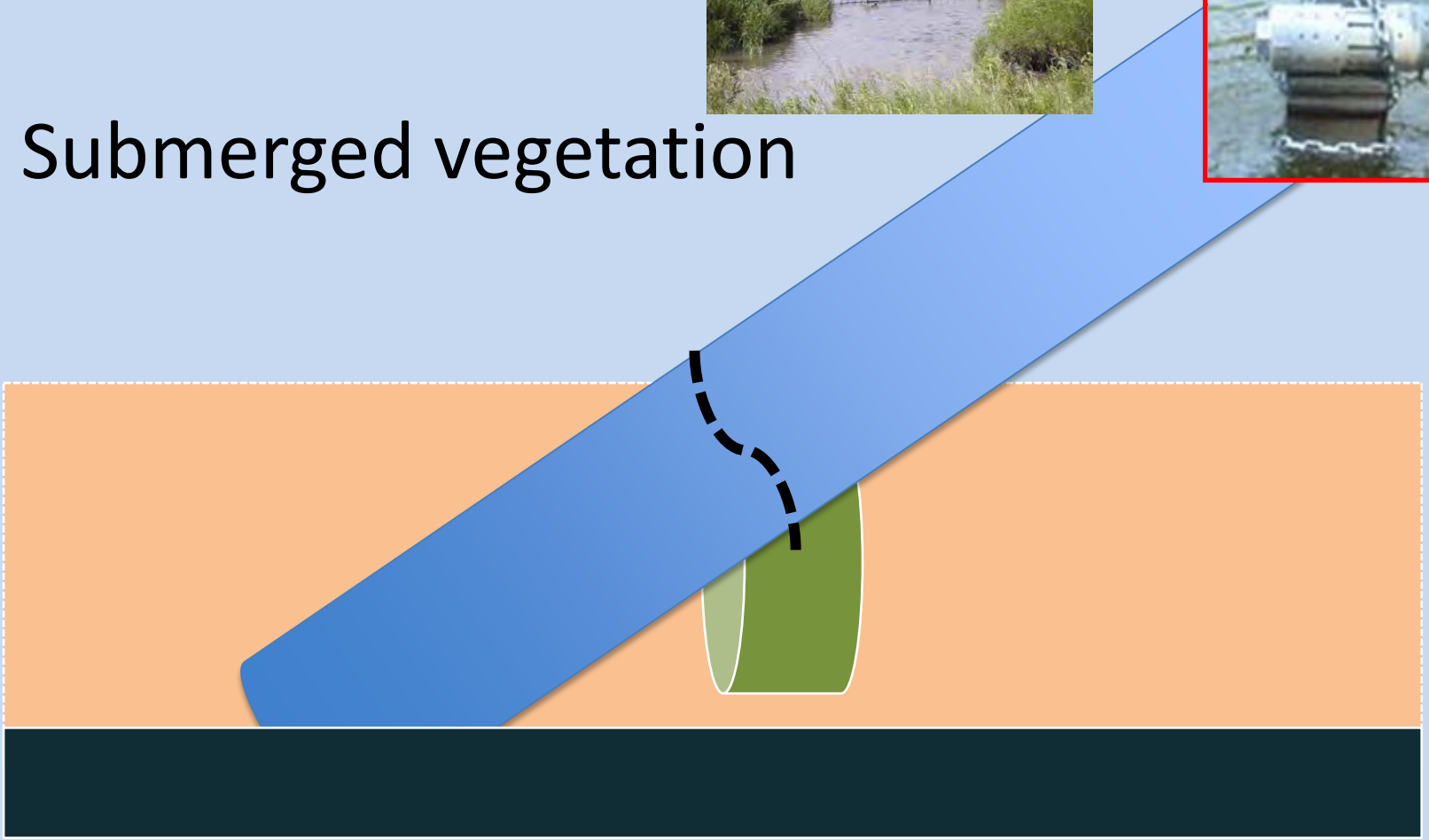
Field work

Rivers and streams

Submerged vegetation



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Field work

Fence posts

Fence posts driven into the stream bed make ideal attachment points for deployment devices.

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Field work

Rivers and streams

Water flow and velocity

R_s = sampling rate (L/day) by the passive sampler

As water flow past the sampler increases,
sampling rate increases.

Higher flows create problems with securing the POCIS and run the risk of snagging with floating debris.

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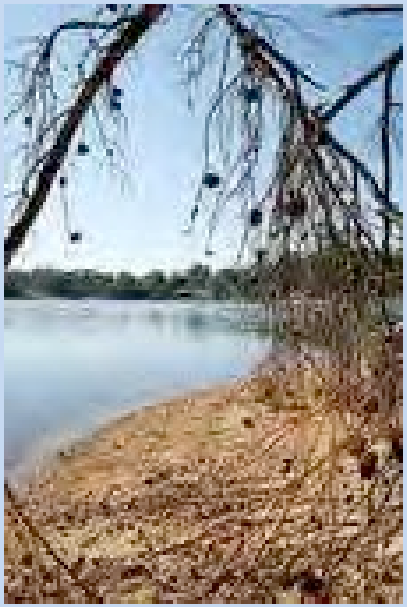
Field work

Lakes and Ponds



Near shore deployment

-Similar to stream/river deployment

- Docks (good deployment option, but beware of dock sealants being collected by the sampling device.

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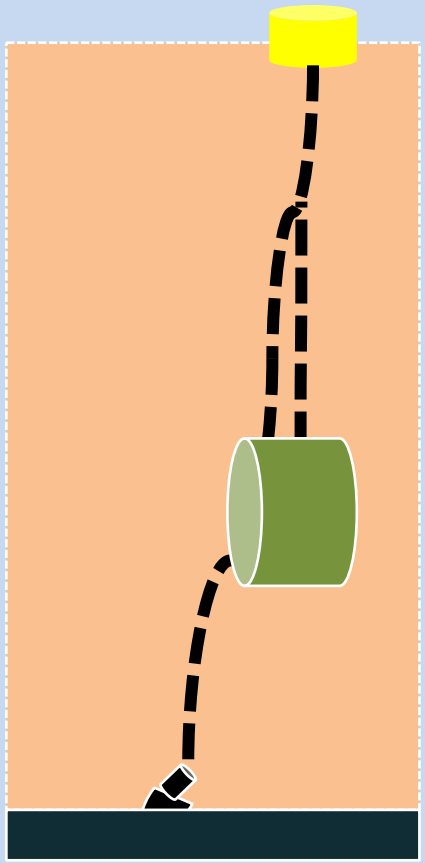
Field work

Lakes and Ponds

Deepwater deployment



There may not be any substrate to tie off to.

Anchor/buoy systems can work well.

Easy to find (buoys), susceptible to vandalism.

Make sure to turn boat motor off before sampling, the samplers will detect atmospheric fumes from exhaust.

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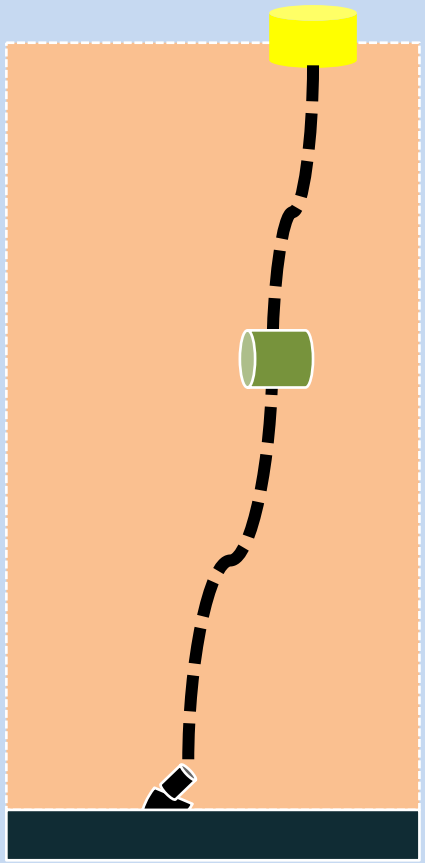
Field work

Lakes and Ponds

Vertical Gradients



Vertical (depth) gradients may lead to differences in: water temperature, flow (from river discharge) or water quality (salinity) particularly in salt or brackish water environments.

All of these will influence sample rate (R_s).

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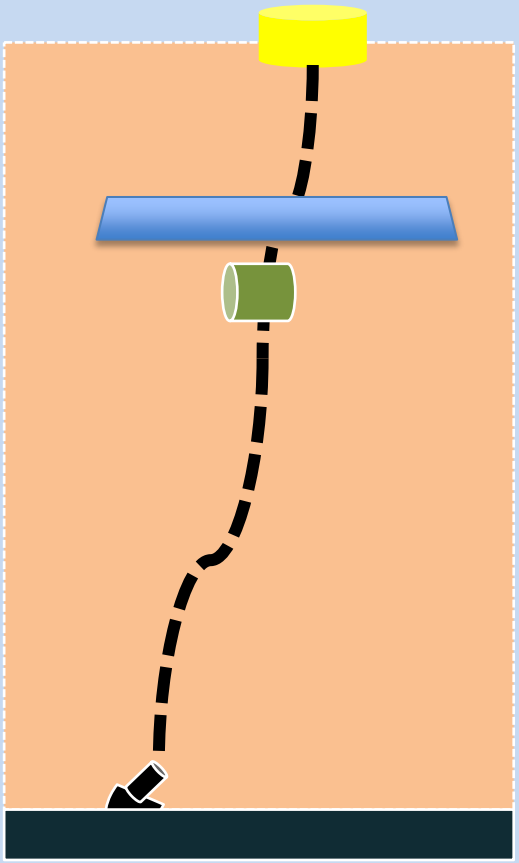
Field work

Lakes and Ponds

Phytodegration



Sunlight can cause the degradation of compounds collected by the SPMD (but not POCIS).

Sun shield (garbage can top) can be used to keep in the shade, but not in flowing waters.

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Contamination
From field to lab

SPMDs

- Return to EST in the same containers that they were shipped in.

- In the field, place the SPMD back in the container, then store on Blue ice or ice,
NOT DRY ICE !, for the return trip to the lab.

- Store in the refrigerator until shipped. Ship back to EST on blue ice.

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Contamination
From field to lab

POCIS

- Return to lab in the same containers that they were shipped in.

-Entire unit can be placed in a cooler with blue ice and travel back to the lab.

- Each individual POCIS can then be wrapped in cleaned aluminum foil and put into plastic bag, then stored in the refrigerator.

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Field work

Security and Vandalism

- The best protection against vandalism is camouflague.

- Use the local environment (overhanging vegetation, aquatic vegetation, In-stream trash to hide the units).

- Design the experiment with the expectation of some vandalism (Replication)

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Field work

Security and Vandalism

Does it help to tag the equipment with a "Reward if Stolen" tag?

Doesn't seem to make any difference.

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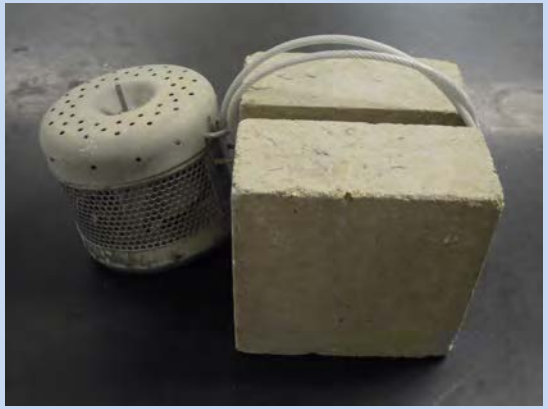
Field work



Security and Vandalism

-Concrete block (hard to find underwater, heavy to lift)

-Steel cable (harder to cut through than rope)

- When using cable make sure it is clean !

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Workshop Outline

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Extraction and QA/QC

Contamination
From lab to field

- POCIS and SPMDs come in clean paint cans. Keep on ice or blue ice into the field.

- Bring paint can to the field and open there.

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Contamination
From field to lab

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Contamination
From field to lab

POCIS

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-Entire unit can be placed in a cooler with blue ice and travel back to the lab.

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Extraction and QA/QC

POCIS extraction

Two common techniques
- Glass gravity flow chromatography columns
- Empty solid phase extraction cartidges

Extraction solvents vary depending upon the compounds sought after.

SPMD Dialysis

- patented process conducted by EST laboratory.

-Sample returned to sender in a flame sealed ampule.

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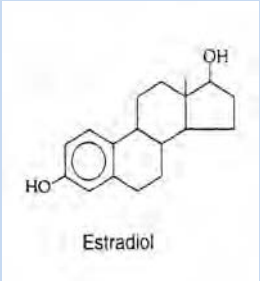
Quality Control



Good laboratory practices
with respect to extraction and experimental quantitation will enhance quality control with respect to the use of passive samplers.

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University of Nebraska Water Center – Water Sciences Laboratory

Group 1
Pesticides, herbicides
'Pesticide' POCIS
Elution: DCM/toluene
(GC/MS)

Group 2
Steroid Hormones
'Pesticide' POCIS
Elution DCM/toluene
(LC/MS/MS)

Group 3
Veterinary Pharmaceuticals
'Pharmaceutical' POCIS
Elution Methanol
(LC/MS/MS)

Group 4
WWTP effluent
'Pharmaceutical' POCIS
Elution Methanol
(LC/MS/MS)

Quality Control

Blanks

Fabrication blanks

Samplers that are made along with the batch of samplers used in the field, but not taken to the field or opened prior to analysis.

Field blanks

Field blanks are taken into the field, opened and exposed to the air for the same time period as the experimental samplers, then returned to the lab and analyzed.

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Quality Control

Matrix spikes

An SPMD or a POCIS prepared with a known quantity of target chemical.

Used to determine percent recovery of target chemical.

If multiple target chemicals are being looked for, multiple matrix spike samplers are generally used.

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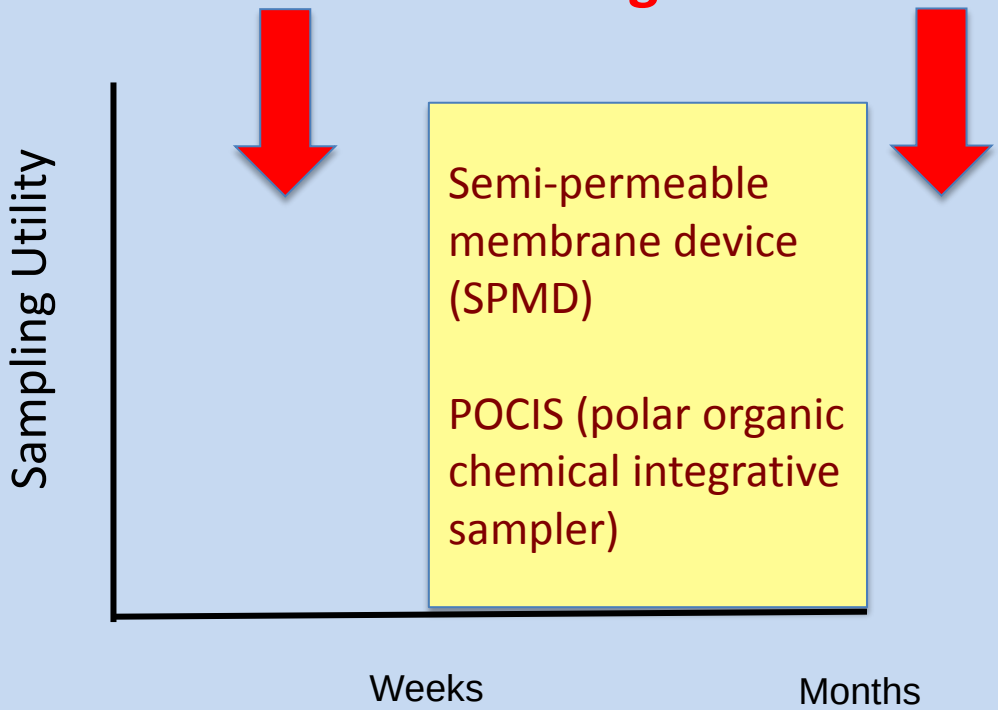
Exposure Time

Sampling time
not long enough

Sampling time
Just right

Sampling time
too long



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Exposure Time
Sample time is too short

With sample times less than 7 d, the user runs the risk on there not being enough time to collect low concentration compounds from the environment (a lot of non-detects).

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Exposure Time
Sample time is too short

Pooling samples

$$C_c\ t\ n\ R_s\ P_r\ E_t > (MQL)\ V_i$$

C_C = expected compound concentration (ng/L)

t = deployment time (days)

n = number of samplers

R_s = sampling rate (L/day) by the passive sampler

P_r = extraction recovery rate (%)

E_t = fraction of total sample extracted (%)

MQL = chemical method quantitation limit (ng/L)

V_i = volume of standard injection

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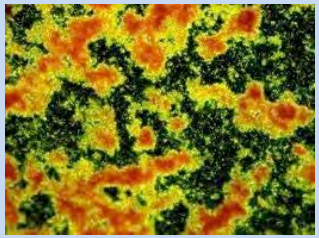
Exposure Time
Sampling period too long.

Can the samplers be deployed for too long of a time period? Yes !

Average field deployment = 1 month.

Longer deployments, can lead to equilibrium rather then continuous sampling.

Also, biofilms !



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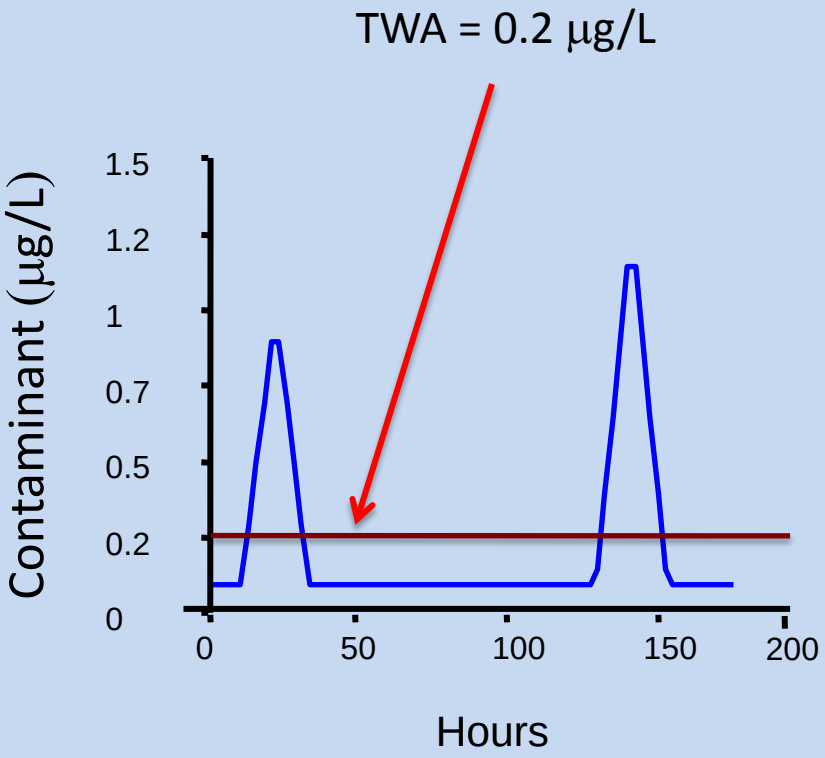
Limitations

Time weighted average (TWA)



A time weighted average allows you to assign
a single concentration to an episodic event.

The response of an organism to a constant concentration (0.2 μg/L) may not be the same as the response to the episodic events.

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Limitations

R_s = sampling rate (L/d)

To determine a TWA concentration, you must know the R_s

Sampling rates (in the lab) can be determined and are constants (coefficients).

R_s values have been determined for over 200 chemicals including a number of pesticides.

Without R_s, the contaminant in the sampler (μg/sampler) cannot be converted into TWA concentration.

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A relationship between R_s variability and K_{ow} for POCIS ?

Compound	R_s (replicate values)				K_{ow}
Cyanazine	0.340[h]	0.711[a]			1.64
Metribuzin	0.168[h]	0.815[a]			1.99
Simazine	0.178[b]	0.210[g]	0.210[d]		2.07
Propachlor	0.240[h]	0.447[a]			2.36
Atrazine	0.210[e]	0.239[d]	0.245[b]	0.290[a]	2.42
Propazine	0.228[h]	0.297[a]			2.77
Prometon	0.453[h]	0.459[a]			2.82
Promethryn	0.182[b]	0.360[c]			3.25
Alachlor	0.230[b]	0.337[h]	0.773[a]		3.27
Chlorpyrifos	0.025[b]	0.761[a]			3.99
Pendimthalin	0.260[h]	0.546[a]			4.78

[a]Bartelt-Hunt, et al., 2011
[b]Thomatou, et al., 2011
[c] Tapie, et al., 2011
[d]Mazella, et al., 2010
[e]Bueno, et al., 2011
[f]Harman, et al., 2008
[g]Mazella, et al., 2007
[h]Alvarez, et al., 2007

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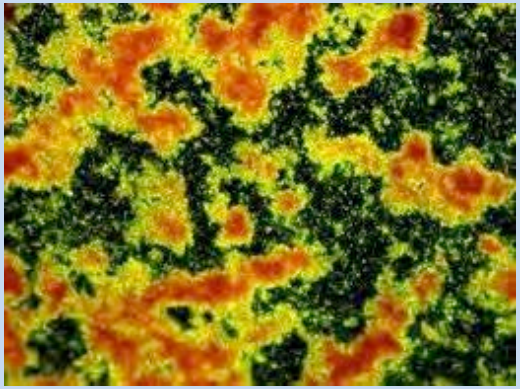
Limitations

R_s = sampling rate (L/d)

Water temperature ~ as Temperature increases, R_s increases.

Flow rate ~ as flow rate increases, R_s increases.

Biofilm ~ as the thickness of the biofilm increases, R_s decreases.



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Limitations

R_s = sampling rate (L/d)

Sampling rate (in the field) is not constant but depends upon:

- water temperature,
- flow rate,
- development of a biofilm,
- burial.

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Limitations

R_s and Performance Reference Compounds (PRCs)

A PRC is a chemical with moderate to high fugacity, added to the sampler during formulation.

- By measuring the loss of of the PRC, adjustments can be made to the R_s.

-The PRC cannot occur naturally, therefore radio-labeled compounds are often used.

- If important, a photolysis surrogate (radio-labeled PAH) can also be added.

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Limitations

R_s and Performance Reference Compounds (PRCs)

PRCs only exist for SPMDs !

Release of the PRC from POCIS may not display first order kinetics, rates of sampling may not be consistent with rates of desorption.

If quantitative data from a POCIS is needed, then POCIS and SPMDs should be deployed simultaneously.

Efforts are underway to develop a PRCs for POCIS.

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Quantification

$$C_w = \frac{N}{R_s\, t}$$

C_w = concentration (ng/L)
N = ng/sampler
R_s = Sampling time (L/d)
t = number of sample days

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Quantification

$$C_w = \frac{N}{R_s\, t}$$

For SPMDs, regression models have been created to estimate R_s and C_w, based upon:

log K_{ow} of the chemical,
PRC release rate constant (k_e)

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Quantification

$$k_e = \frac{\left| \ln \left[\frac{N_{prc}}{N_{o\text{-}prc}} \right] \right|}{t}$$

k_e = PRC release rate constant

N_{prc} = concentration of PRC at the end of the exposure

$N_{o\text{-}prc}$ = concentration of PRC at time zero

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Quantification

Therefore if the user can provide:

- log K_{ow} of chemical collected
- time (days)
- N = concentration of compound in the device
- N_{prc} = concentration of PRC at the end of the exposure
- $N_{o\text{-}prc}$ = concentration of PRC at time zero

- The TWA concentration (μg/L) can be determined.

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Quantification

An Excel spreadsheet calculator is available from the USGS to perform these calculations at:

http://www.cerc.usgs.gov/Branches.aspx?BranchId=8

follow the Environmental Chemistry links.

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Workshop Outline

1. Before you hit the field
2. Field work
3. Quantification
4. Interpretation

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Interpretation

Know the question that you are asking.

Presence/absence

Comparison between sites

Quantification

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Interpretation

The first passive sampler was a sessile organisms (bivalves).

First used with:
- Persistent Organic Pollutants
- low concentration
- lipophilic, $K_{ow} > 3.0$
- resists biotransformation

For these compounds it has been suggested that the biological concentration factor (BCF) and the device concentration factor (DCF) are similar.

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Interpretation

Bivalves and POPs.

Presence/absence

Comparison between sites

Quantification

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Persistent Organic Pollutants

SPMDs vs. Bivalves

Advantages
- Can generate a time weighted average (TWA)

- Deployable in harsh conditions

- No *a priori* preparation

Disadvantages
- Less environmentally relevant

- Cannot account for ingestion.

Advantages
- Environmentally relevant

- Local species easily usable

Disadvantages
- Animals die in extreme environments

- TWA is possible, with many assumptions.

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Interpretation

Biotransformation

Some lipophilic compounds (PAHs) and many hydrophilic compounds (pharmaceuticals, some pesticides) are biotransformed and do not bioaccumulate.

In that case the DCF >> BCF and the device (POCIS) does not mimic the animal.

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PAHs, Hydrophilic compounds

POCIS vs. Bivalve

Advantages

- Can generate a time-weighted average (TWA).

- Deployable in harsh conditions

- No *a priori* preparation

Disadvantages

- Even less environmentally relevant

- Cannot account for sequestration, ingestion, biotransformation.

Advantages

- Environmentally relevant

- Local species easily usable

Disadvantages

- Animals die in extreme environments

-Compounds are sequestered and/or metabolized.

- Cannot generate a TWA.

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Interpretation

Hydrophilic Biologically Active Compounds

Biologically active compounds can influence cell signaling (endocrine disruption) at low concentration.

An aquatic vertebrate model (fish) is more valuable than a bivalve, as
the cell signaling pathways of all vertebrates are very similar.

As such, the sentinel organism for BAC research is generally a fish.

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Biologically Active Compounds

POCIS vs. Fish

Advantages

- Can generate a time-weighted average (TWA).

- Deployable in harsh conditions

- No *a priori* preparation

Disadvantages

- Does not mimic the organism at all.

- No cell signaling pathway.

Advantages

- Environmentally relevant

- Relevant cell signaling pathway

- Responds to mixtures

Disadvantages

- Animals die in extreme environment.

- Cannot generate an TWA.

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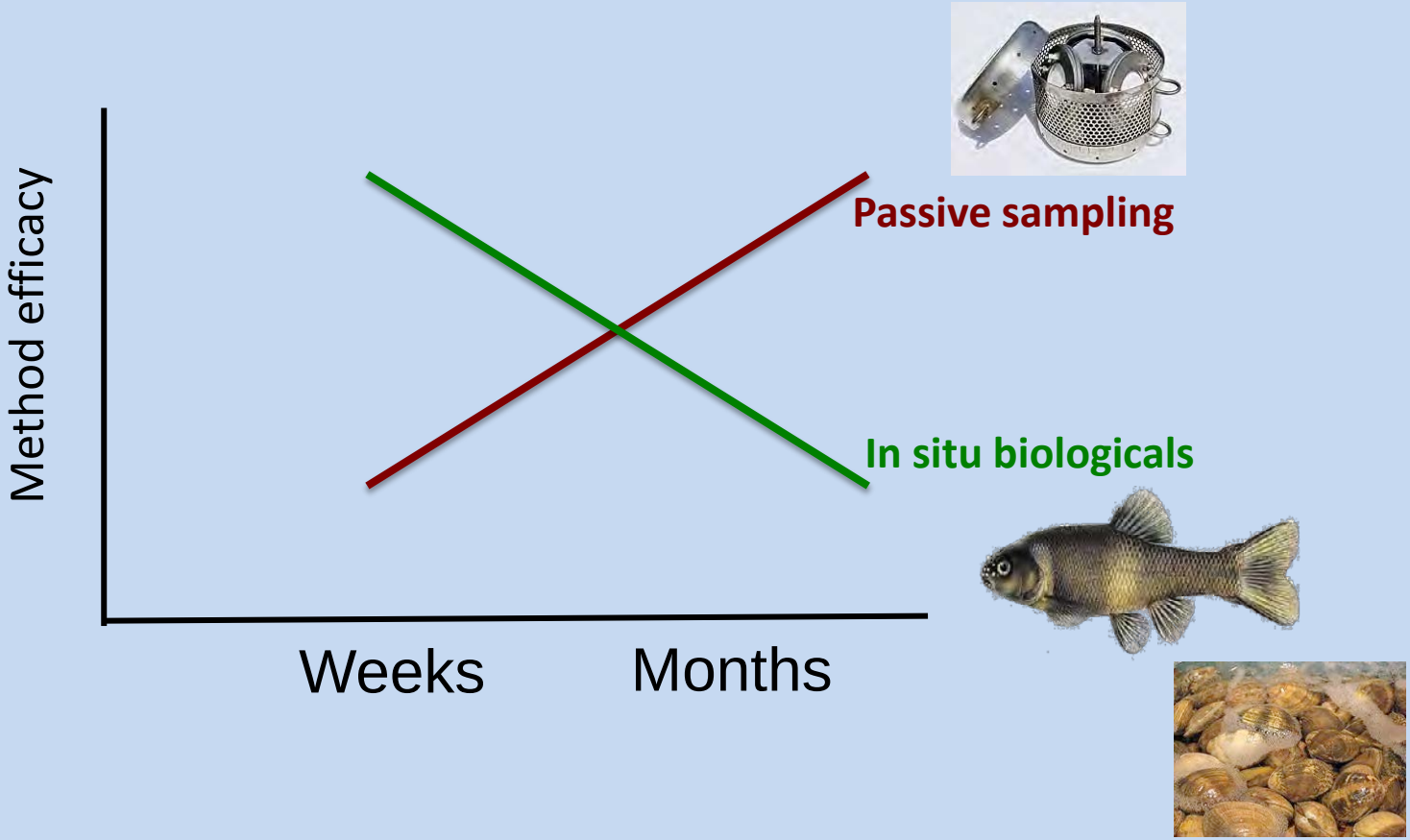
Matching Biology to Chemistry



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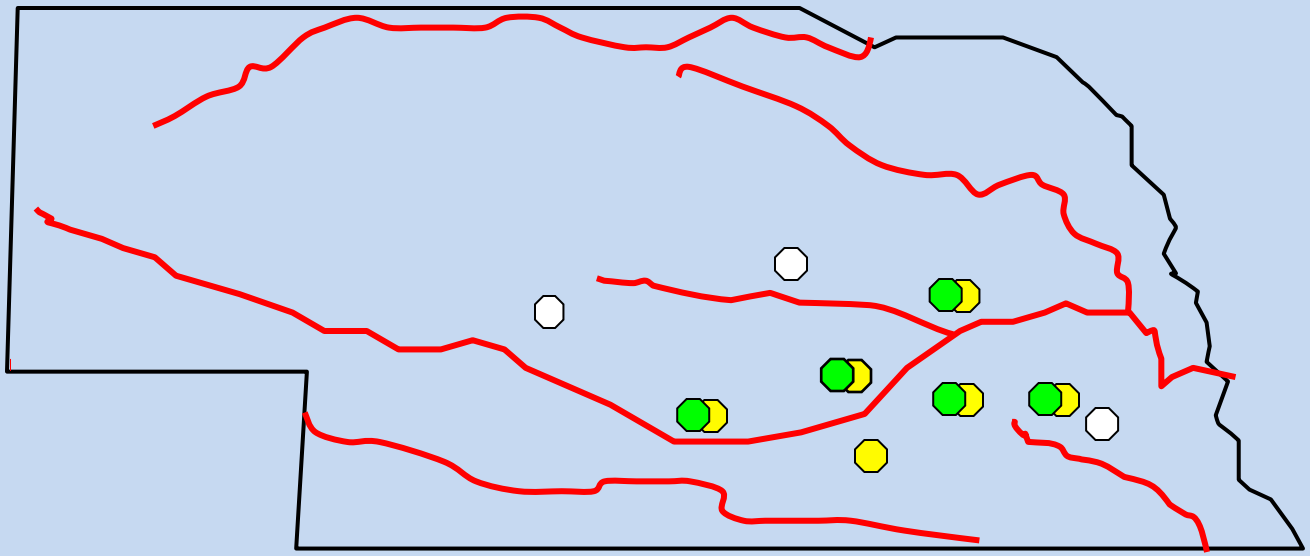
The release of estrogenic contaminants from wastewater treatment plants.

Wastewater Treatment Plants



Columbus,
Grand Island,
Kearney,
Seward,
York and
Hastings.

Pawnee Creek
Middle Fork Loup River
Little Blue River

Polar organic chemical integrative samplers (POCIS)

- POCIS deployed for 7 d at:
- 8 locations during 2006 and 7 locations in 2007.
- Deployment occurred during the last two weeks of August.
- Organic chemicals were extracted from the sorbent in the POCIS, then analyzed using LC/MS/MS.

Compounds extracted from POCIS in 2006 and 2007.

Steroid metabolites

Estrogens
- Ethynyl estradiol
- 17β-Estradiol
- Estrone

Progestogin
- Progesterone

Androgen
- Androsterone

Other compounds

- Caffeine

- α-Zearalonol

Many compounds, some important
Others not so much.

Caffeine as chemical surrogate

NDEQ WWTP - Project Summer 2007 POCIS Results

Interpretation

Triplicates for Statistics

			17a-Ethynyl Estradiol	Estriol	Estrone	a-Estradiol	17b-Estradiol	4-Androstenedione	Androsterone	a-Zearalonol	17beta-Trenbolone	17alpha-Trenbolone	Melengestrel Acetate	Progesterone	17a-Hydroxyprogesterone	Caffeine
	Detection Limits (ng) =>		*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*
Lab_ID_String	**Sample_ID**	**Collection_Date**														
07-1747	HASTINGS DOWN 1	08/24/07	27.4	41.4			6.2		1.3				1.9			2363.1
07-2176	HASTINGS DOWN 2	08/24/07	13.6	35.9	0.5		5.2		7.7				0.7			1272.0
07-2183	HASTINGS DOWN 3	08/24/07	17.7	6.0		1.3	2.4						0.8			1016.8
	Average		**19.6**	**31.1**	**0.2**	**0.4**	**4.6**		**3.0**				**1.1**			**1550.6**
	Std Dev		**5.8**	**10.9**	**0.2**	**0.6**	**1.6**		**3.4**				**0.5**			**583.9**
07-1745	KEARNEY UP 1	08/24/07	0.6						0.0				0.4			40.4
07-2174	KEARNEY UP 2	08/24/07	3.8										0.6			49.6
07-2181	KEARNEY UP 3	08/24/07											0.0			42.5
	Average		**1.5**						**0.0**				**0.4**			**44.2**
	Std Dev		**1.7**						**0.0**				**0.2**			**3.9**
07-1746	KEARNEY DOWN 1	08/24/07	0.8	3.3			2.0					0.5	10.9			62.1
07-2175	KEARNEY DOWN 2	08/24/07	3.6		0.9		1.5		4.4	0.2			0.1			59.3
07-2182	KEARNEY DOWN 3	08/24/07	51.0			8.3			16.7							138.0
	Average		**18.5**	**1.1**	**0.3**	**2.8**	**1.2**		**7.0**	**0.1**		**0.2**	**3.7**			**86.5**
	Std Dev		**23.0**	**1.5**	**0.4**	**3.9**	**0.9**		**7.1**	**0.1**		**0.3**	**5.1**			**36.5**

Many non-detects

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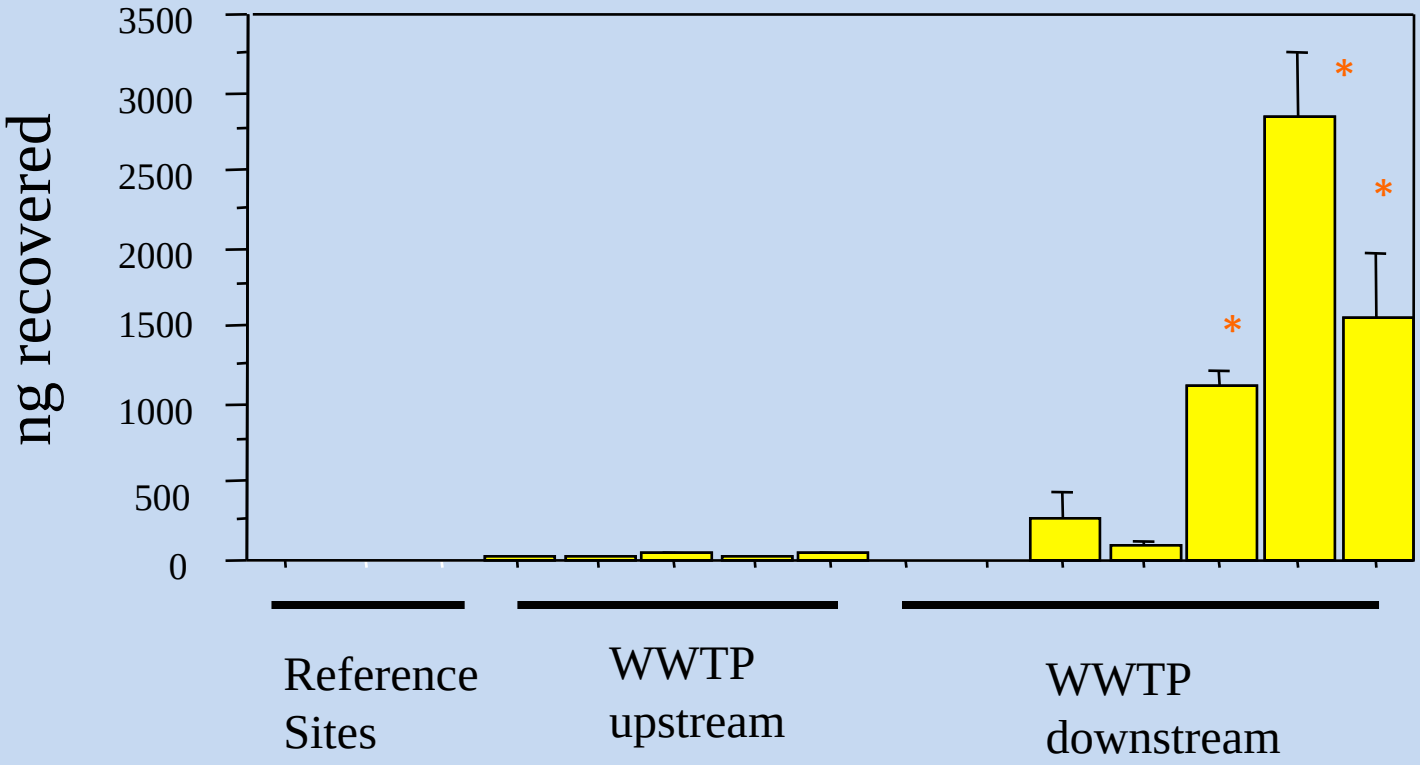
Caffeine



Sellin et al. 2009. JAWRA 45(1):14-21

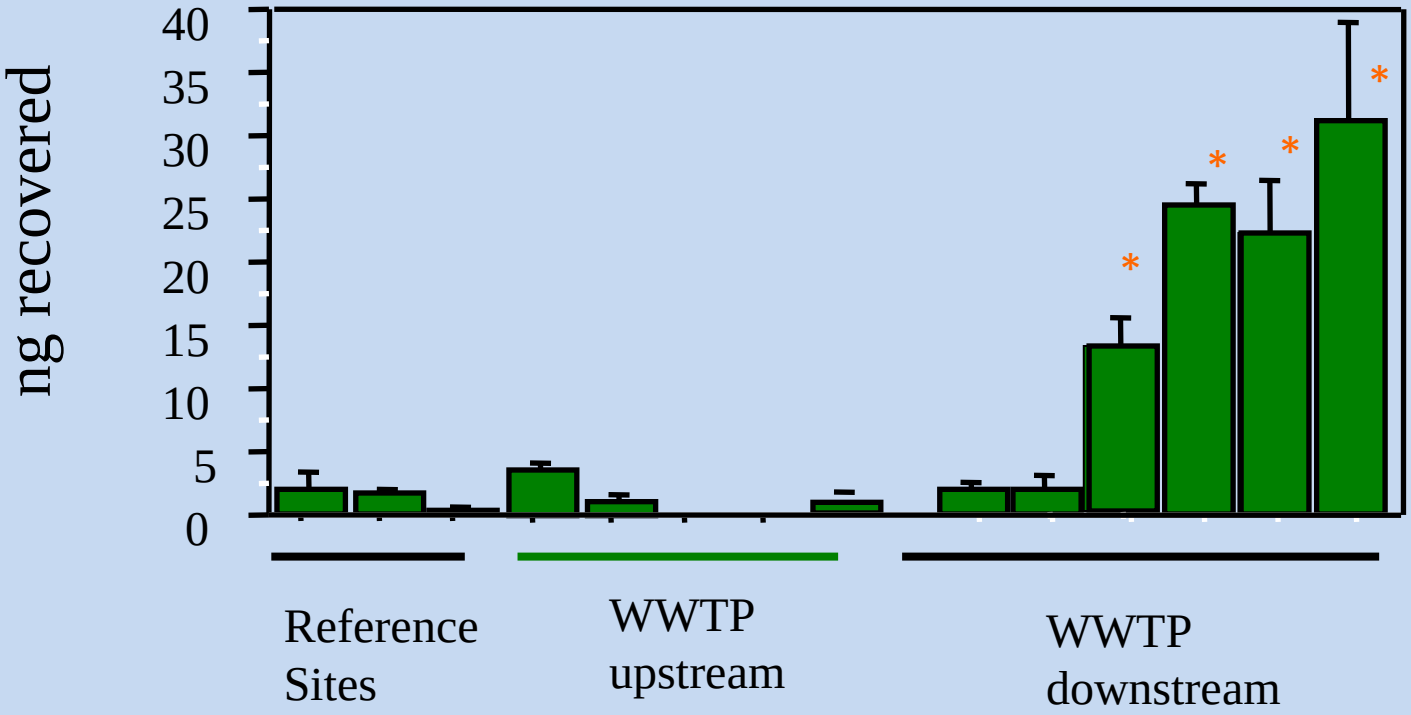
Estrogens

- 17-α Ethynylestradiol
- 17-β Estradiol
- Estrone

Estrogen Equivalents =

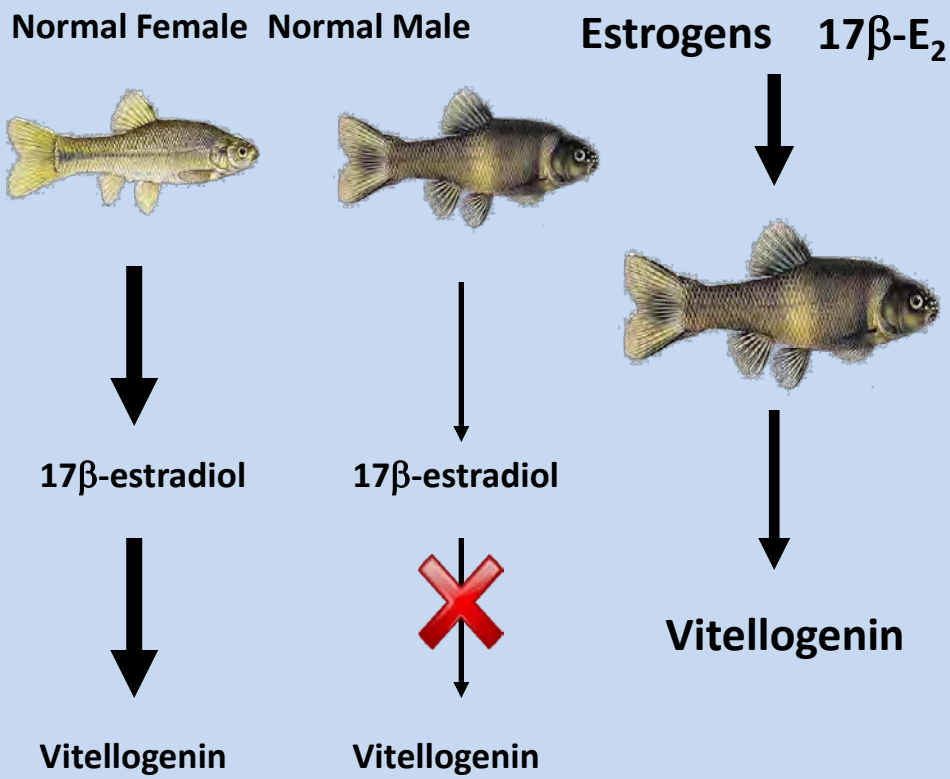
2.2 (17-α ethinylestradiol) + 17-β estradiol + 0.33(estrone)

Estrogen Equivalents

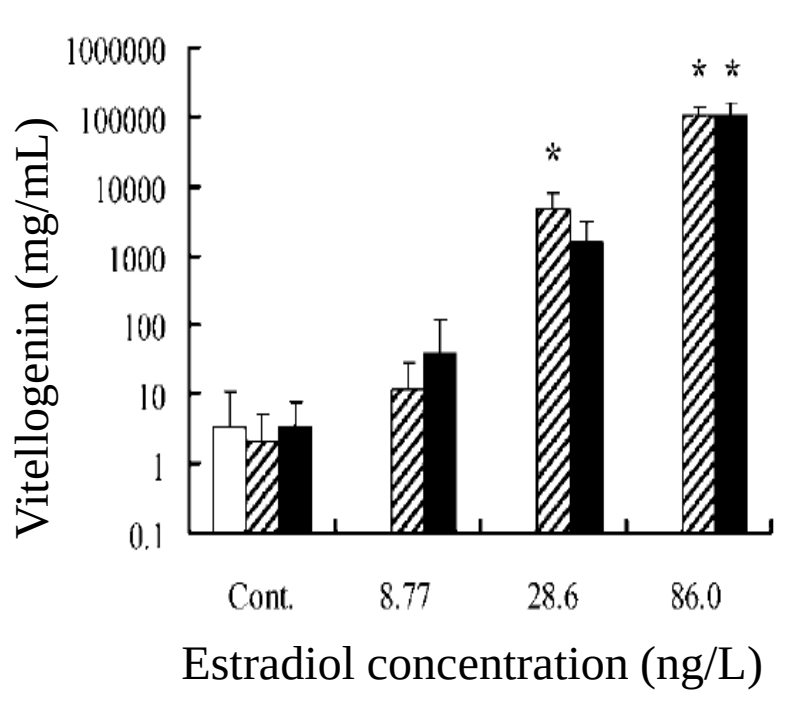


Sellin et al. 2009. JAWRA 45(1):14-21

Exposures to steroids and steroid mimics disrupt the endocrine function of fish.

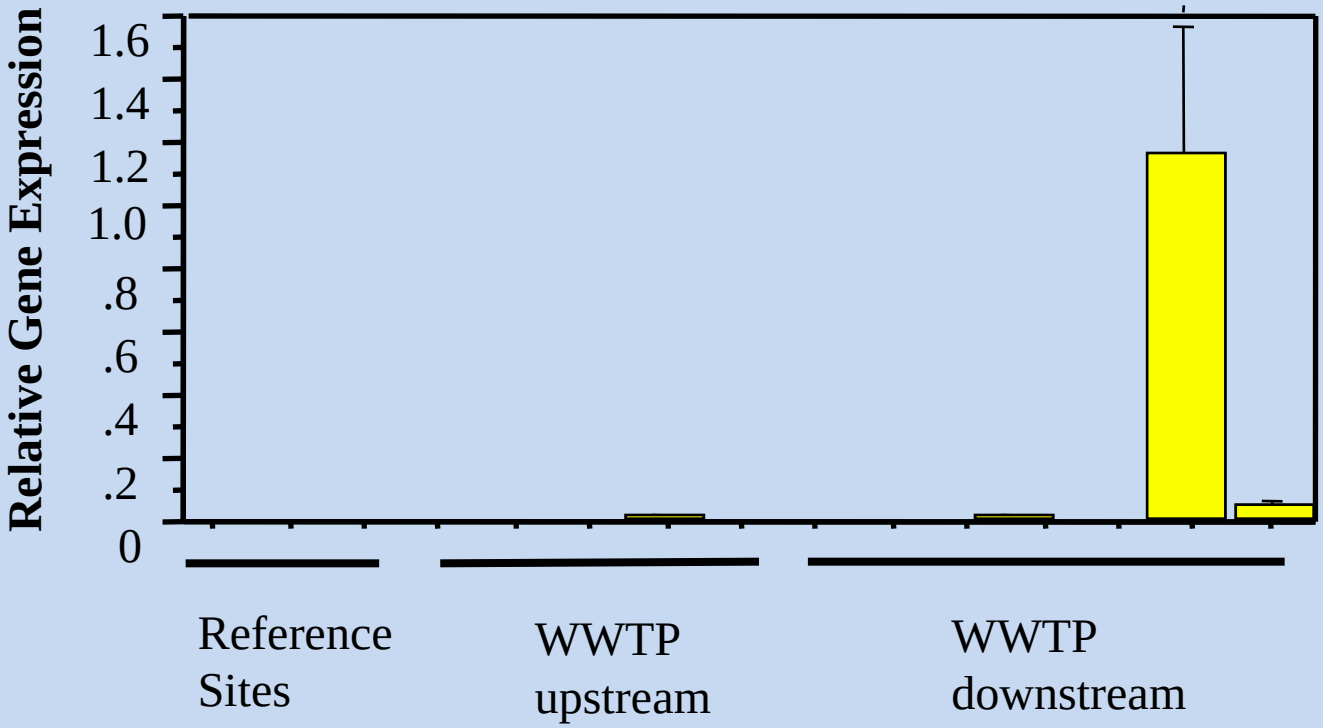


17β-E_2 increases male plasma vitellogenin levels



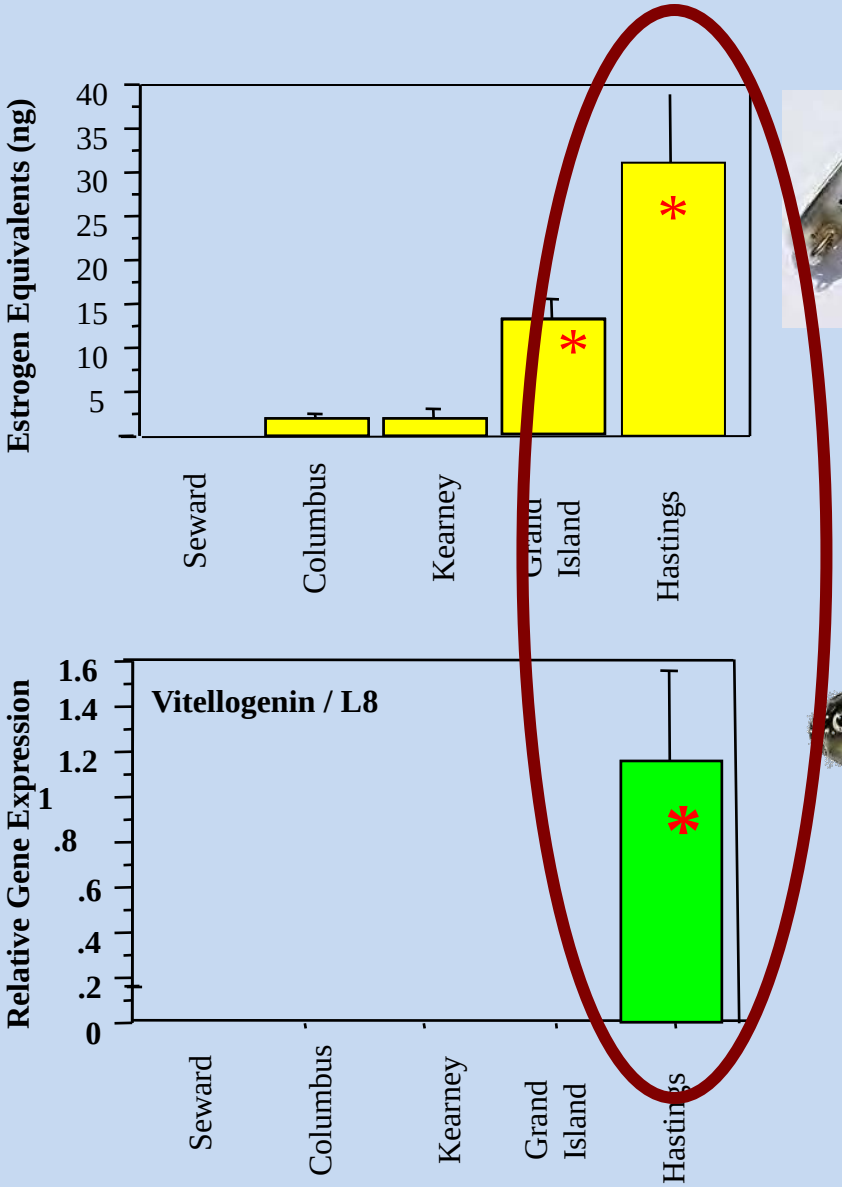
Seki et al. 2006. *Environ Toxicol Chem.* 25:2742-2752.

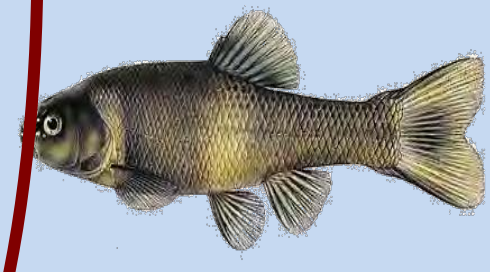
Vitellogenin / L8



Sellin et al. 2009. JAWRA 45(1):14-21

MMUs and Nebraska Wastewater Treatment Plants





Sellin et al. 2009. JAWRA 45(1):14-21

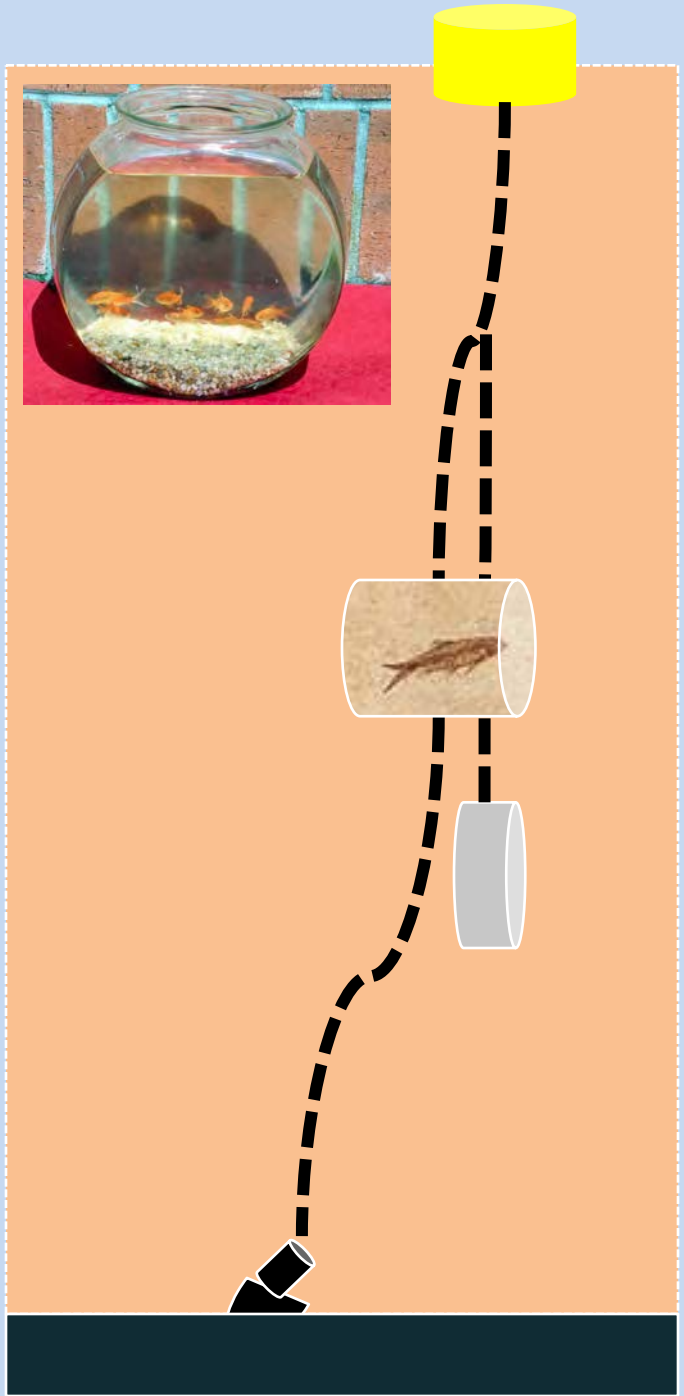
Caged Sentinel organisms

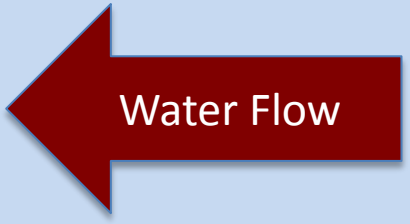
Replicates per unit 🗐🗐

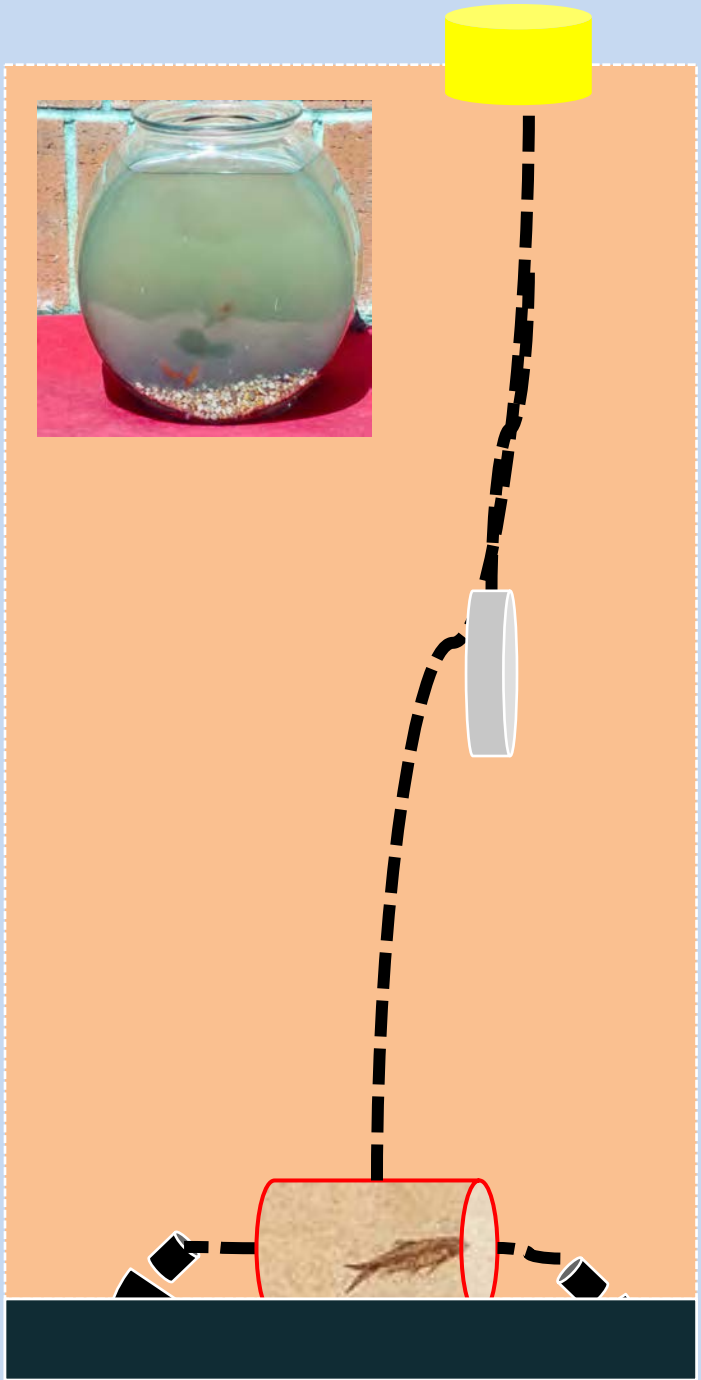
Units per $ 🗐🗐🗐🗐

 # sites per deployment 🗐🗐🗐🗐

Experimental control 🗐




Water Flow



Mobile Laboratory

Replicates per unit

Units per $

 # sites per deployment

Experimental control

Side-by-side comparisons with passive chemical samplers

Mini-mobile unit

Replicates per unit

Units per $

 # sites per deployment

Experimental control

Kolok et al. 2012. J. Environ. Monitor. 14:202-208.

Row Crop Agriculture

Atrazine
deethyl atrazine (DEA)
deisopropyl-atrazine (DIA)
Acetochlor
Metolachlor
Propazine

Polar organic chemical integrative samplers (POCIS)

- POCIS deployed for 7 d at:
- Organic chemicals were extracted from the sorbent in the POCIS, then analyzed using LC/MS/MS.

Interpretation

Many compounds, some important
Others not so much.

Atrazine as chemical surrogate

Replicates for Statistics

Sample_ID	Collection_ Date	Acetochlor	Alachlor	Atrazine	Butylate	Chlorpyriphos	Chlorthalonil	Cyanazine	DEA	DIA	Dimethenamid	EPTC	Metolachlor	Metribuzin	Norflorazon	Pendimethalin	Permethrin	Prometon	Propachlor	Propazine	Simazine	Tebupyrimfos	Telfluthrin	Terbufos	Trifluralin
BOW CREEK SITE 1-1	1/27/09		3.2		77.4				18.9	19.7			10.4							3.9	7.3				
BOW CREEK SITE 2-1	1/27/09		3.7		95.1				21.4	25.8			1.1							4.0	6.0				
BOW CREEK SITE 3-1	1/27/09		40.7		200.7				48.8	44.4			19.9							8.1	6.8				
BOW CREEK SITE 4-1	1/27/09		27.5		443.5				41.7	73.0			31.5							12.0	5.9				
ELKHORN SED-LAB WATER	1/27/09																								
ELKHORN SED-ELK WATER	1/27/09		1258.5		3778.8				300.2	219.2			1351.8							207.4	48.7				
LAB EXPOSURE-UNEXPOSED	1/27/09		19.5		2.1								3.9							12.1					

Many non-detects

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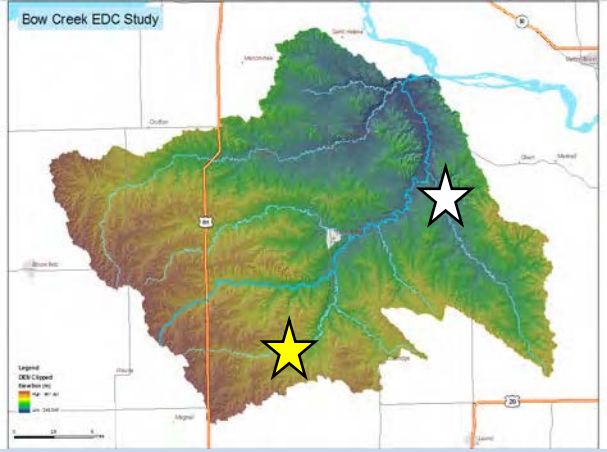
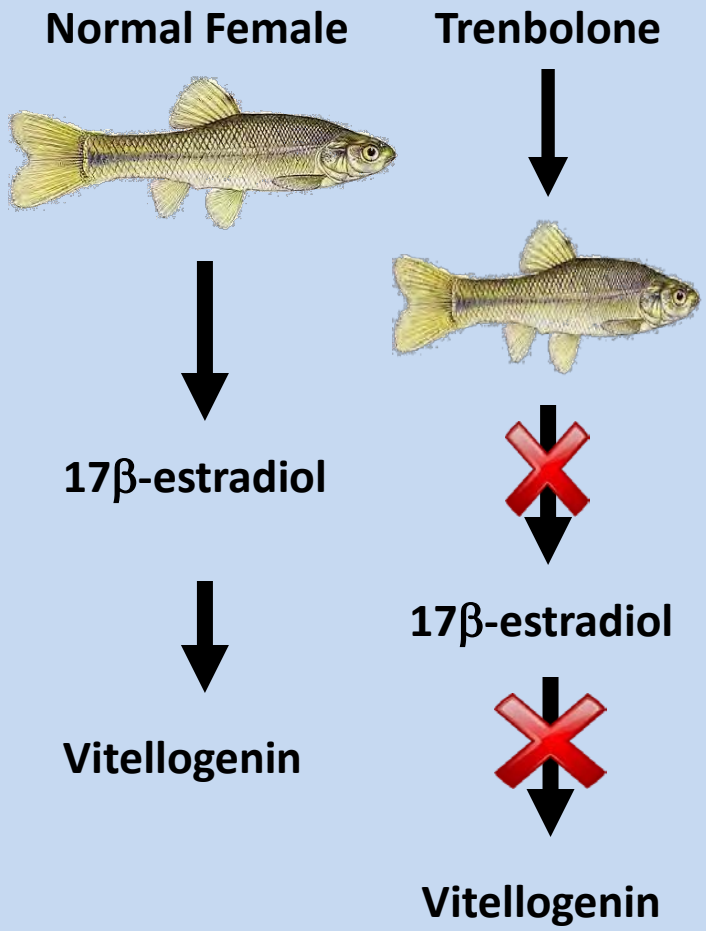


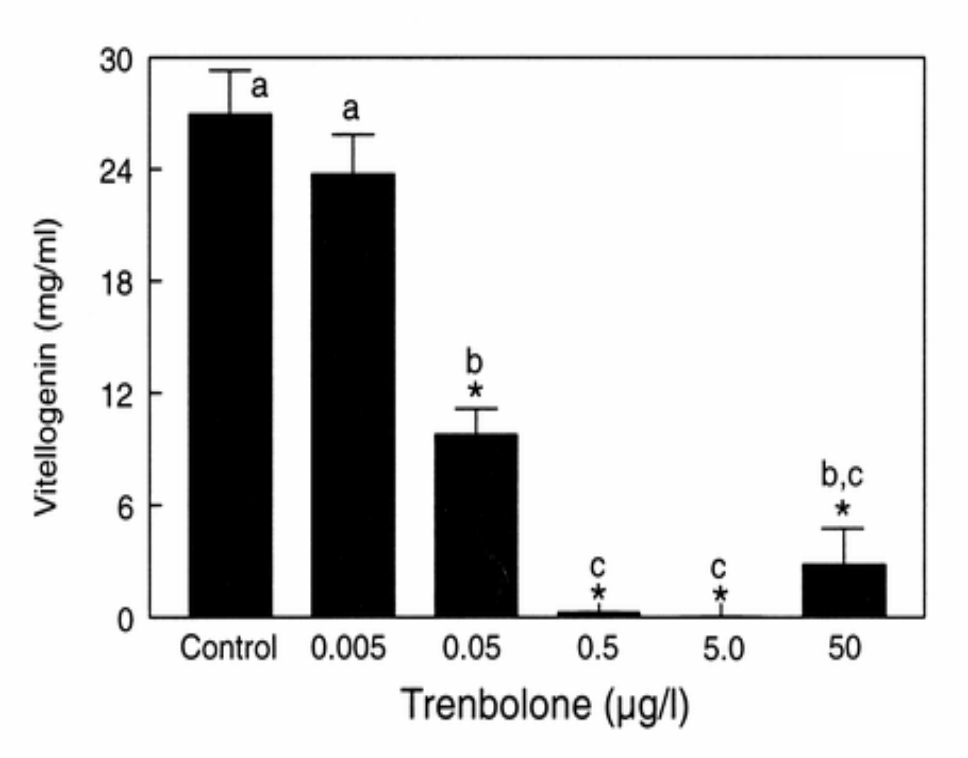
Compound	E. Bow Creek	Pearl Creek
Atrazine	95	201
DEA	21	49
DIA	26	44
Acetochlor		41
Metolachlor		20
Propazine		

Sellin et al. 2011. *ET&C.* 30:2253-2260

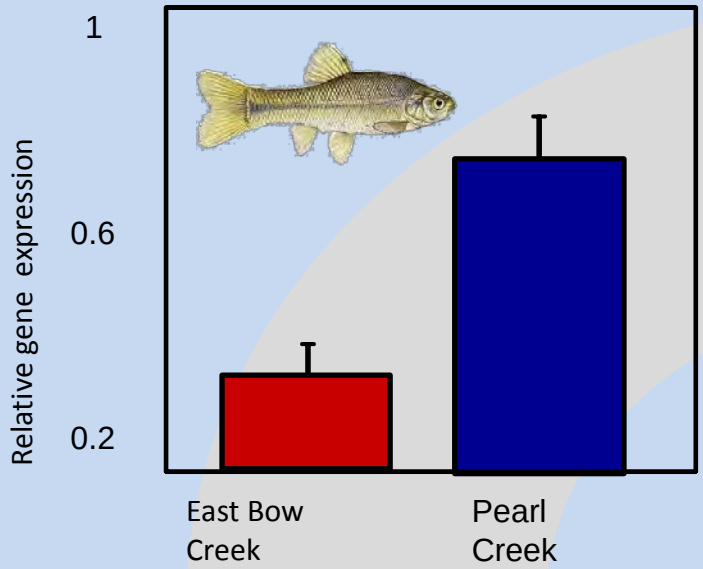
Exposures to exogenous steroids and steroid mimics disrupt the endocrine function of fish.



17β-TB reduces female plasma vitellogenin levels

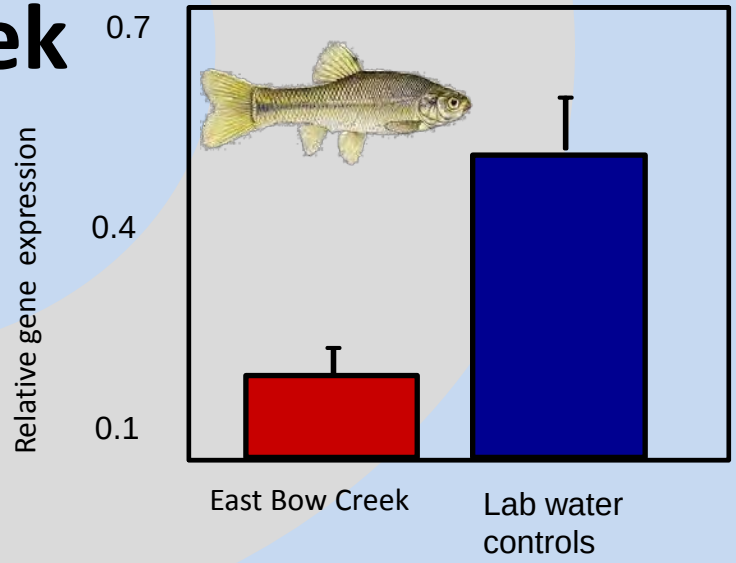


Ankley et al. 2003. *Environ Toxicol Chem* 22:1350-1360.



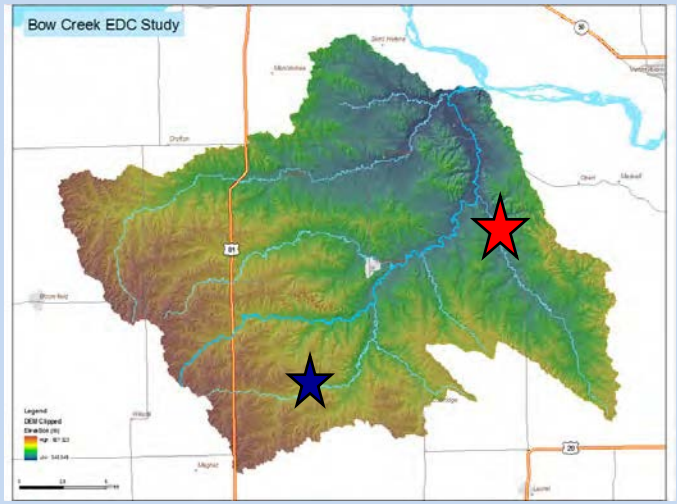
Field

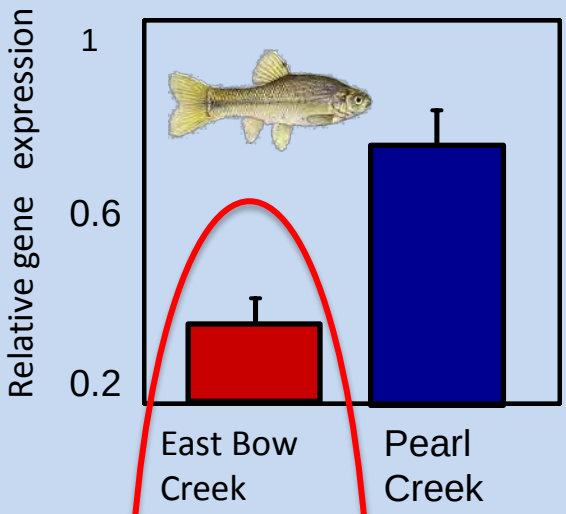
Bow Creek



Laboratory

Sellin et al. 2011. *ET&C.* 30:2253-2260
Sellin et al. 2011. Aq. Tox. 105:189-198





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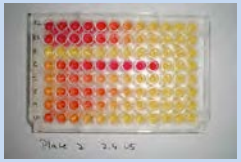
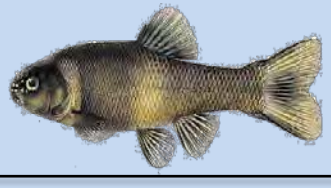
Metolachlor		20
Propazine		

Sellin et al. 2011. *ET&C.* 30:2253-2260.

Biologically Active Compounds

In vitro assays  vs.  Fish

Advantages

- Can determine the cellular mechanism (estrogenicity)
- Responds to a field-appropriate mixture
- Rapid through-put screening (large sample size)
- "Shared" POCIS replicates

Disadvantages

- May not mimic the impact on the organism.
- Exposure is artifactual

Advantages

- Environmentally relevant exposure
- Responsive to field appropriate mixtures
- Impact regardless of specific molecular mechanism

Disadvantages

- Cannot elucidate exact mechanism
- Not a rapid screening tool

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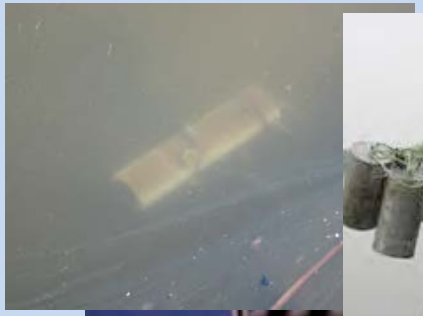

Questions?

email: akolok@unomaha.edu
website: www.unomaha.edu/envirotox

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- Ashley Jessick
- Bethany McAcy
- Racine Rangel
- Josh Krezewski

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