

Pharmaceuticals in the Environment: Overview of USGS Research

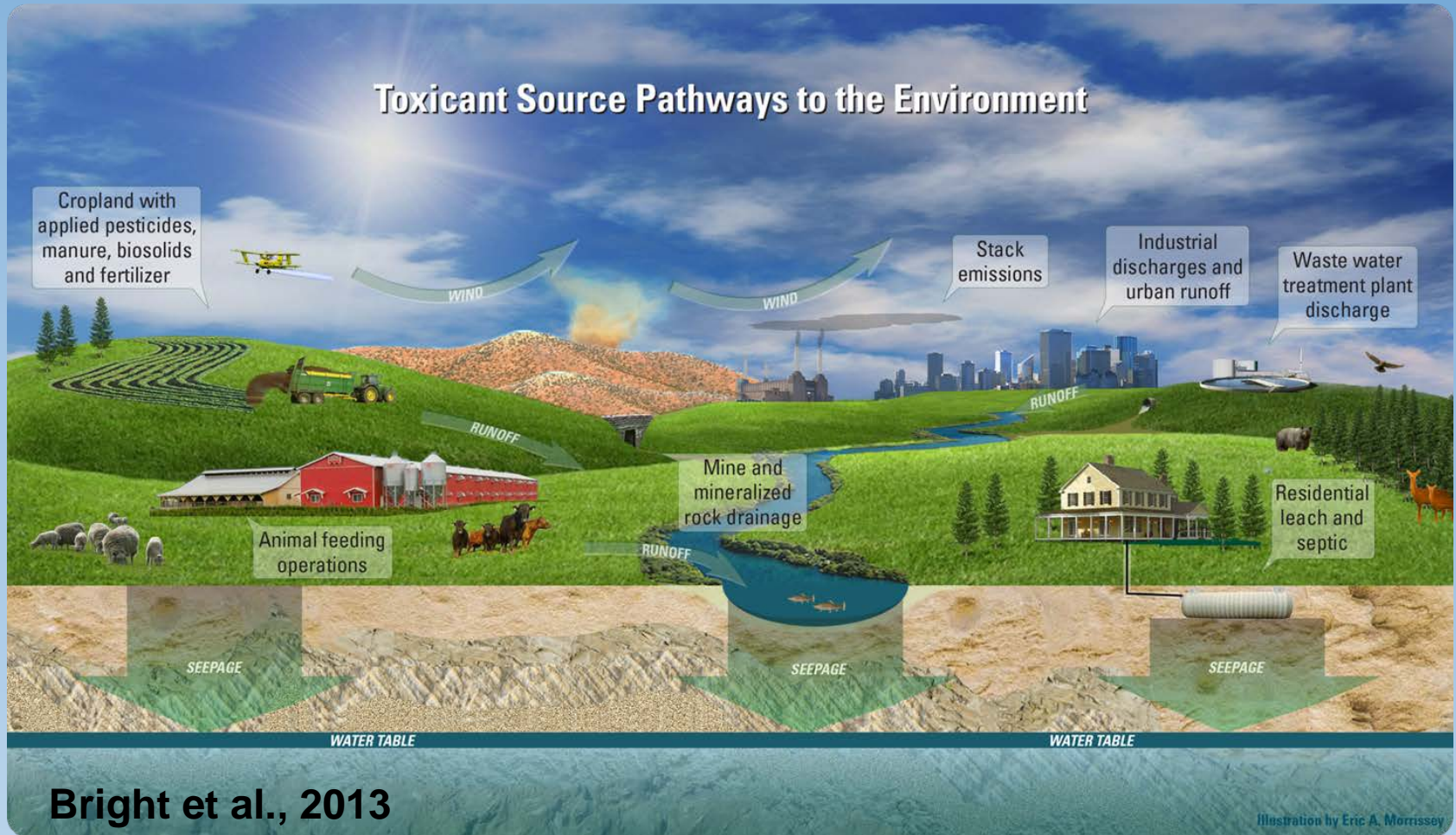
CalRecycle Conference
November 3, 2016

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USGS Toxic Substances Hydrology Program
<http://toxics.usgs.gov/emc/>

Numerous Pharm Pathways

Urban: landfills, WWTPs, PMFs, septic, etc.



Prescription, OTC, illicit drugs and their degradates

Providing Science to Inform Stewardship

“Source-to-Receptor” Approach

Physical Environment

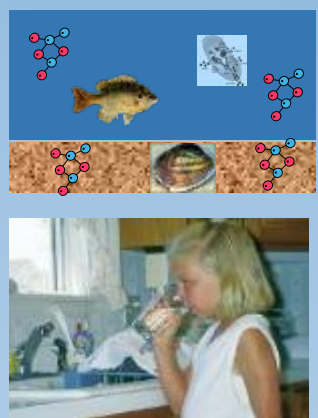
Environmental Health

Sources

Fate / Transport

Exposure

Effects



Reduce Sources

Reduce Transport

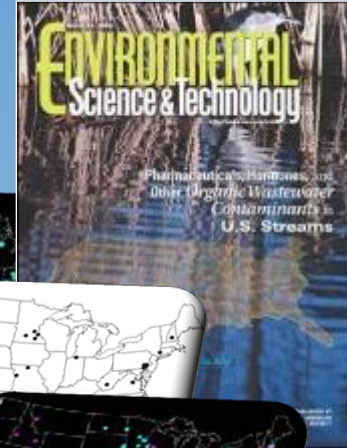
Reduce Exposure

Intervention Points

Are Pharms entering our environment? **Yes!**

A series of national recon studies provided a picture that **Pharms occur as complex mixtures** in the environment (e.g. streams, groundwater, drinking water).

(Kolpin, et al., 2002, Barnes et al., 2008; Focazio et al., 2008)



What pharmaceuticals are entering our environment?

National Landfill Leachate Study

129 CECs detected

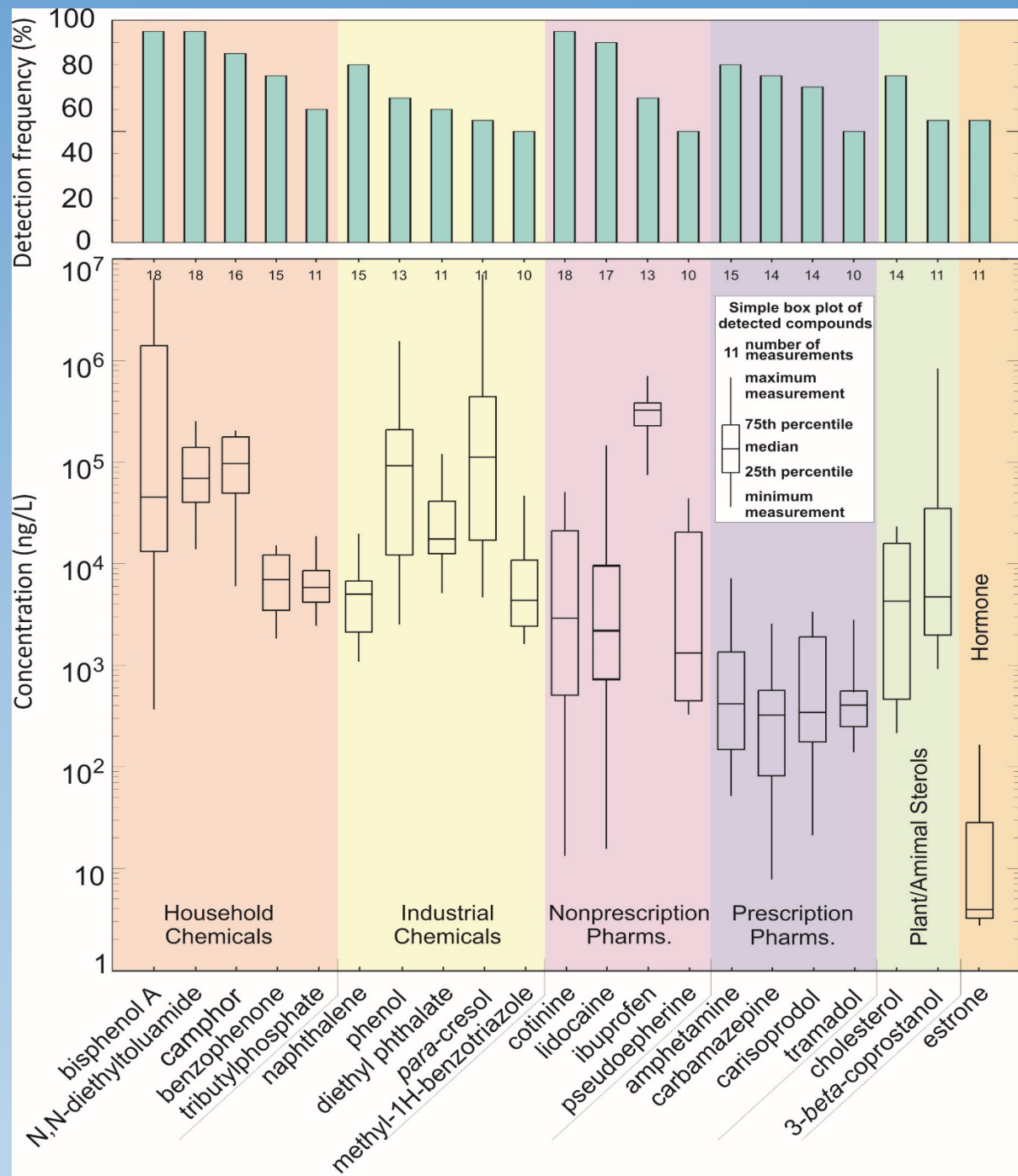
- BPA (95%)
- cotinine (95%)
- DEET (95%)
- lidocaine (89%)
- camphor (84%)

Levels from ng/L to mg/L

- cresol (7 mg/L)
- BPA (6 mg/L)
- phenol (1.5 mg/L)



Masoner et al., 2014



Fourmile Creek: Field Laboratory

WWTP Characterization: October 2012

- 52 pharmaceuticals detected
- $\Sigma_{\text{con}} = 16,131 \text{ ng/L}$

1. Fexofenadine	3400 ng/L
2. Metformin	3310
3. Desvenlafaxine	1760
4. Acyclovir	1360
5. Atenolol	721
6. Sulfamethoxazole	654
.	
10. Carbamazepine	354



Change to WWTP Operation

October, 2013
(pre-closure)



November, 2013
(post-closure)



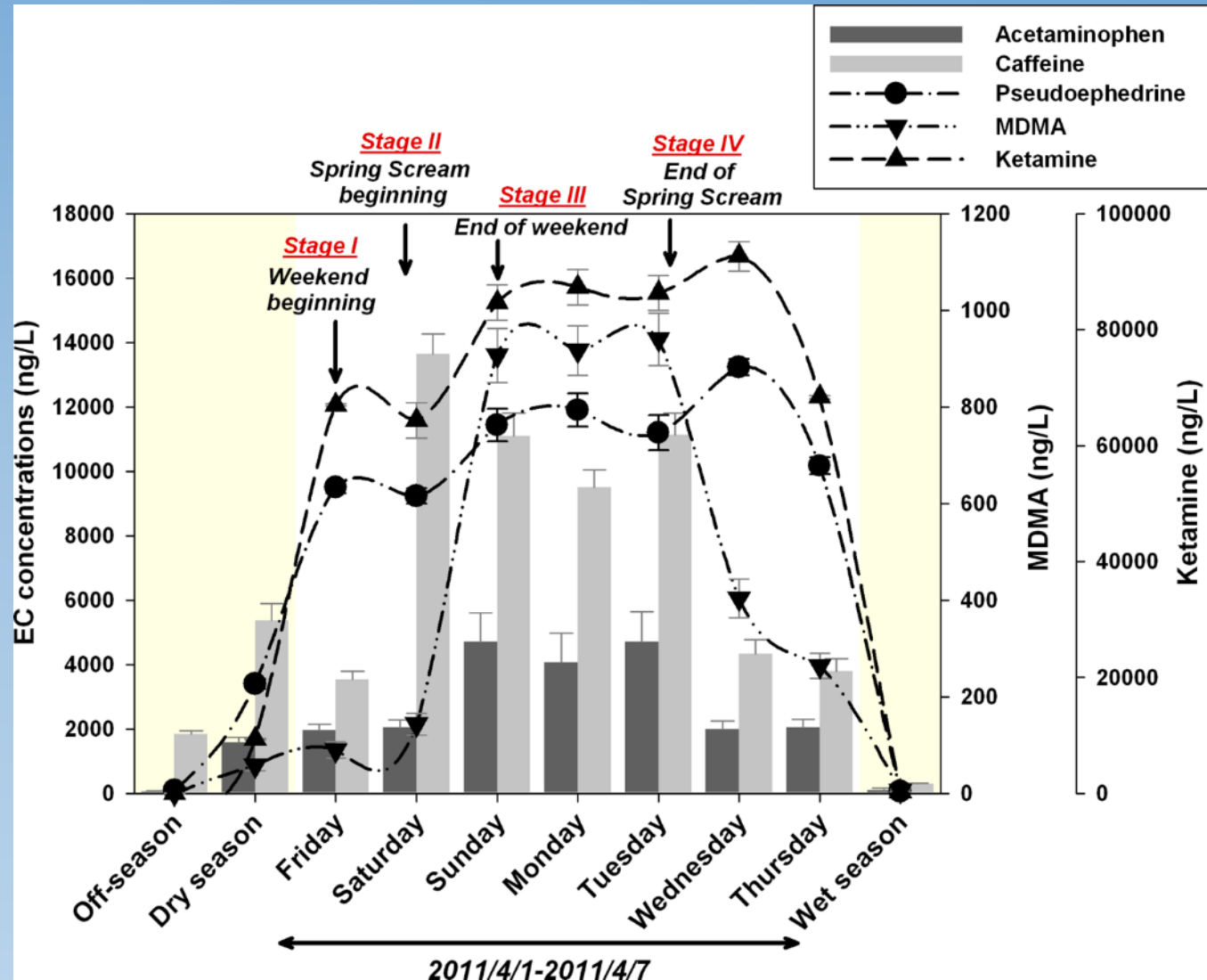
Pre/post-closure Pharmaceutical Results

- Rapid decrease in stream detections
 - 69 pharms detected pre-closure
 - 8 pharms detected post-closure
- Reverse in Σ_{con} trends
 - pre-closure: stream >> GW
 - post-closure: GW >> stream (5X higher)
- For the 21 pharms detected in GW transect just prior to WWTP closure:
 - 8 exhibited rapid attenuation
 - 13 exhibited limited attenuation over 1 year
- Results document that effluent-impacted shallow GW accumulate pharms and can serve as a long-term source of pharms.

Bradley et al., 2016

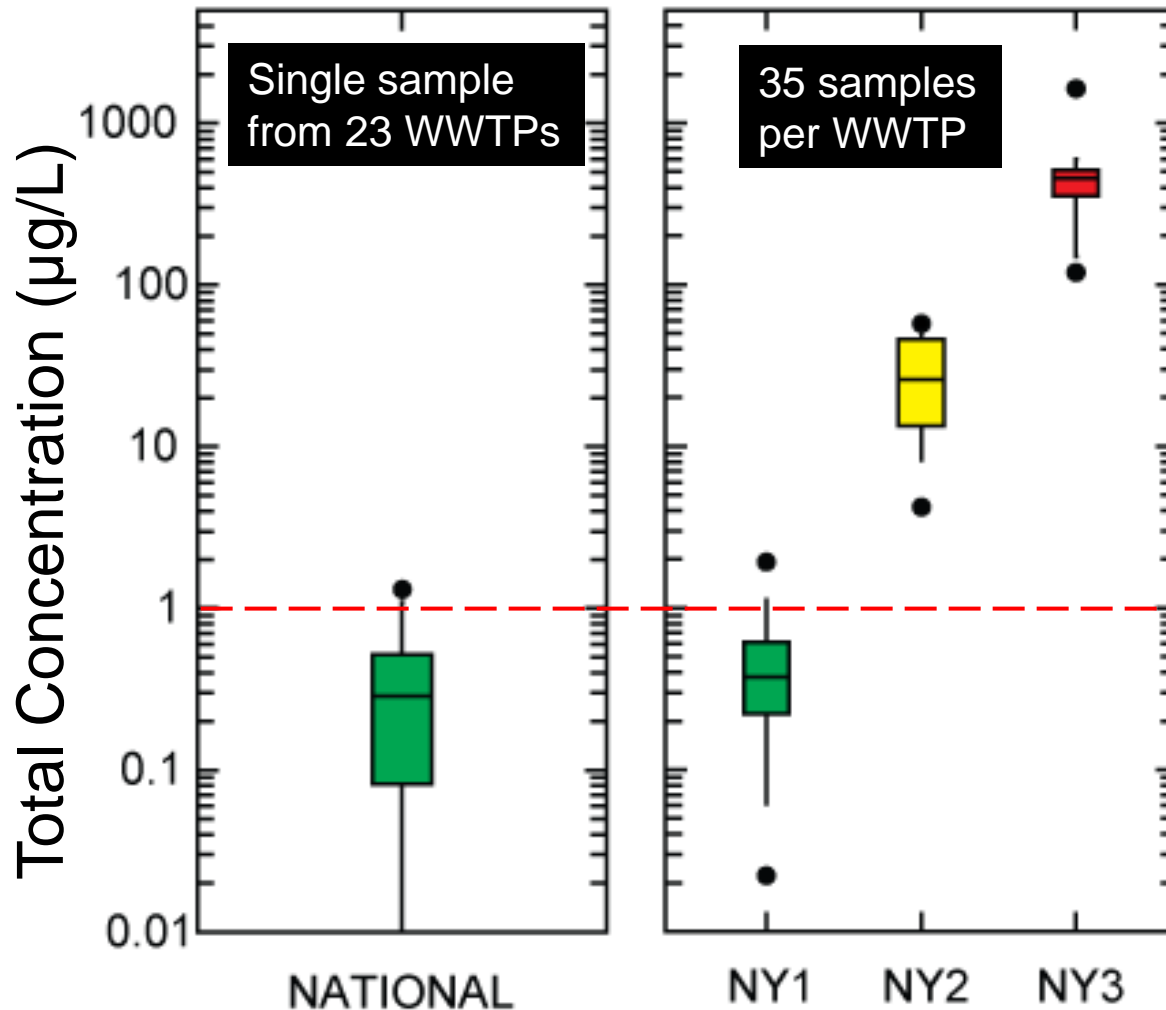
Temporal pattern in illicit drugs/control substances in WWTP influent during music festival (~600,000 people)

Spring Scream (Taiwan)



PMFs – Environmental Sources of pharms

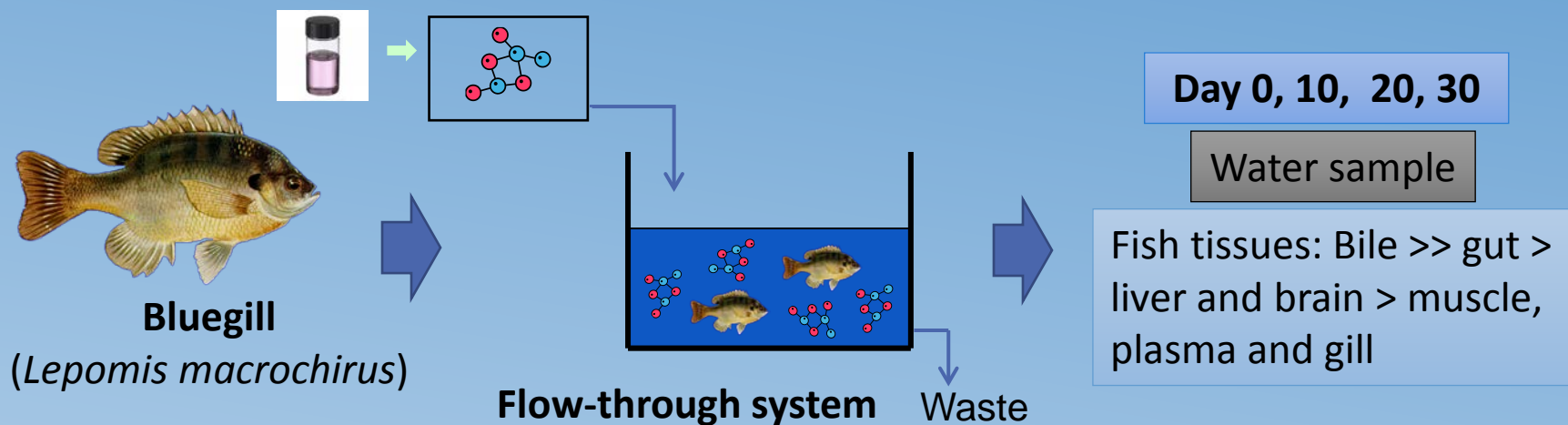
Phillips et al., 2010



Max Conc. (ug/L)
3800 metaxalone
1700 oxycodone
>400 methadone
160 butalbital
>40 phendimet.
>40 carisoprodol
4 diazepam

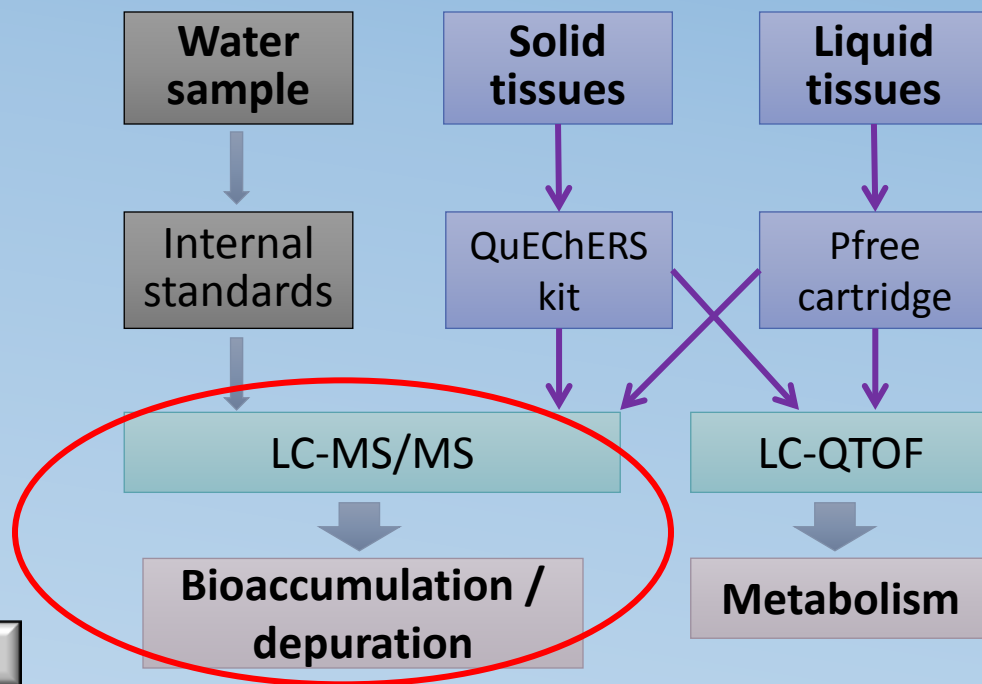
<http://toxics.usgs.gov/highlights/PMFs.html>

Experimental Design: Chemistry

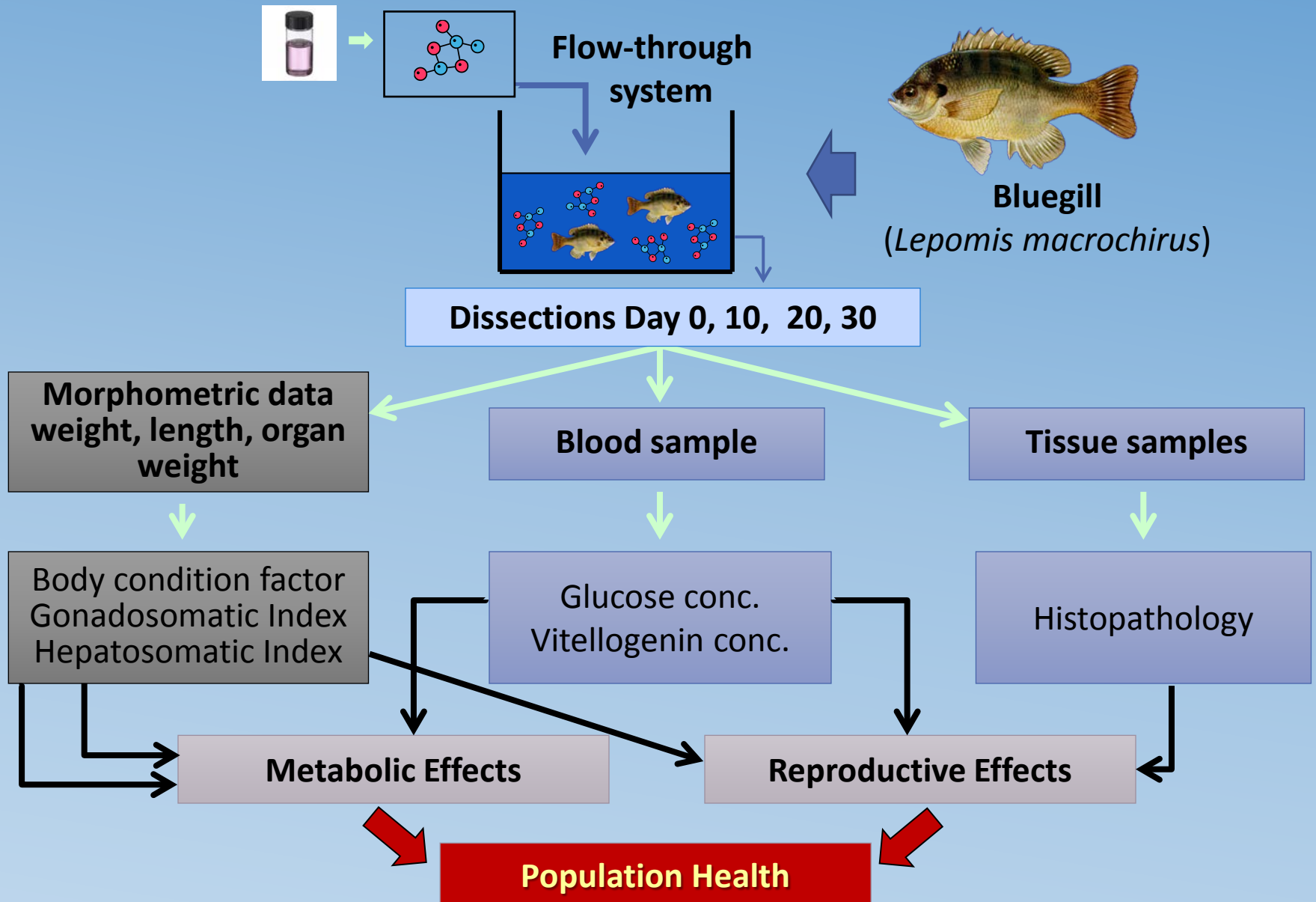


Chemicals:

Temazepam (TEM)
Methocarbamol (MET)
Sulfamethoxazole (SMX)
Diclofenac (DCF)
Rosuvastatin (ROS)
EtOH (vehicle and control)



Experimental Design: Biology



Targeted-chemical-analysis lamppost: We can only see what we look for

Future directions

- Enhanced methods
- Non-target analysis
- Bioassays for biologic activity

