

Mitigation of
biological-active
contaminants of
emerging concern in
urban stormwater
utilizing Iron-enhanced
sand filtration

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Storm Drain

Sewer System



www.gchd.org/public-health-services/environmental-health-services-/air-water-pollution-services/storm-water-management





Known

Urban stormwater is contaminated with a complex mixture of CECs known to cause adverse biological effects.

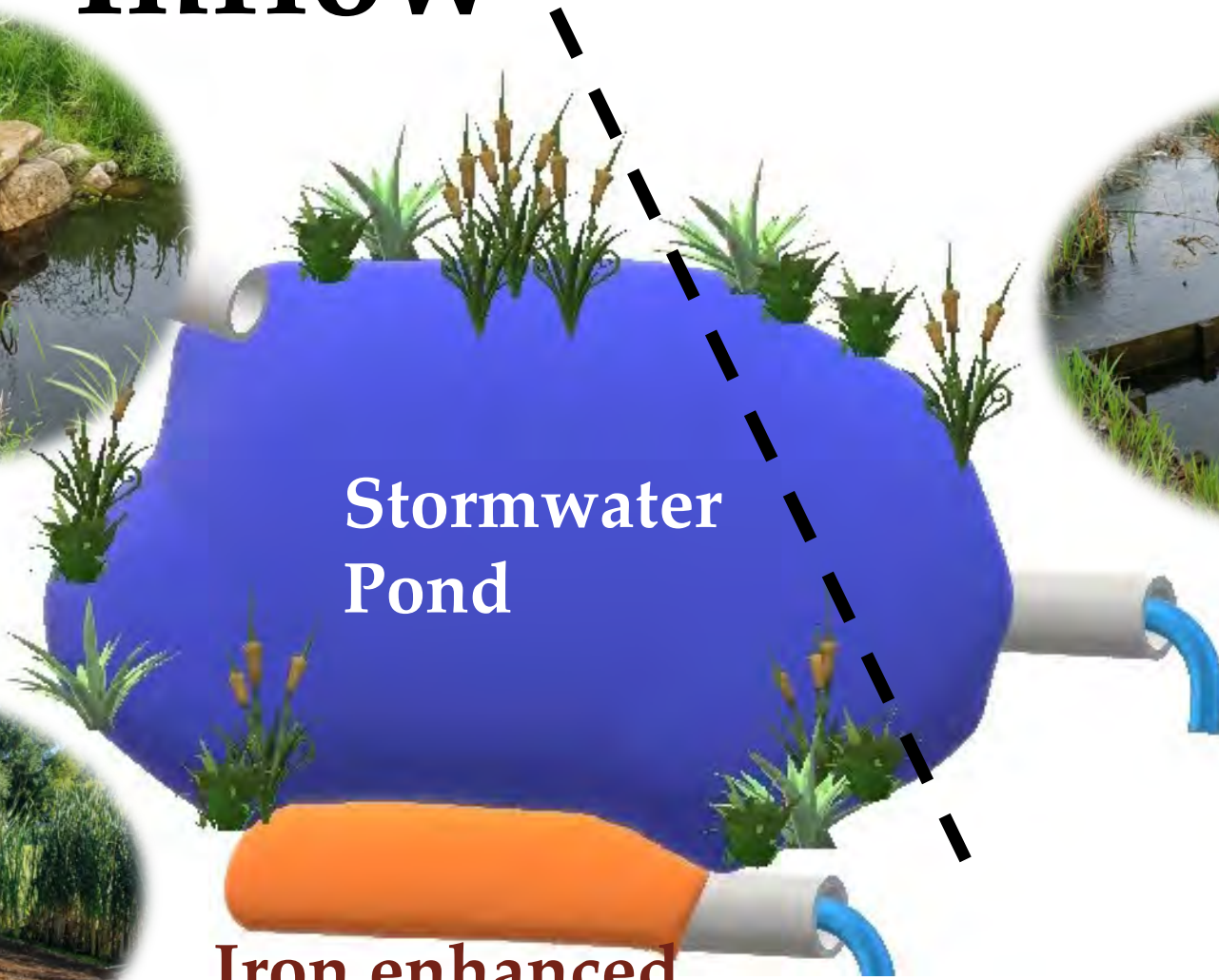


Unknown

Ability of current best management practices to mitigate adverse biological effects, and seasonality of contamination.



Inflow



Stormwater Pond



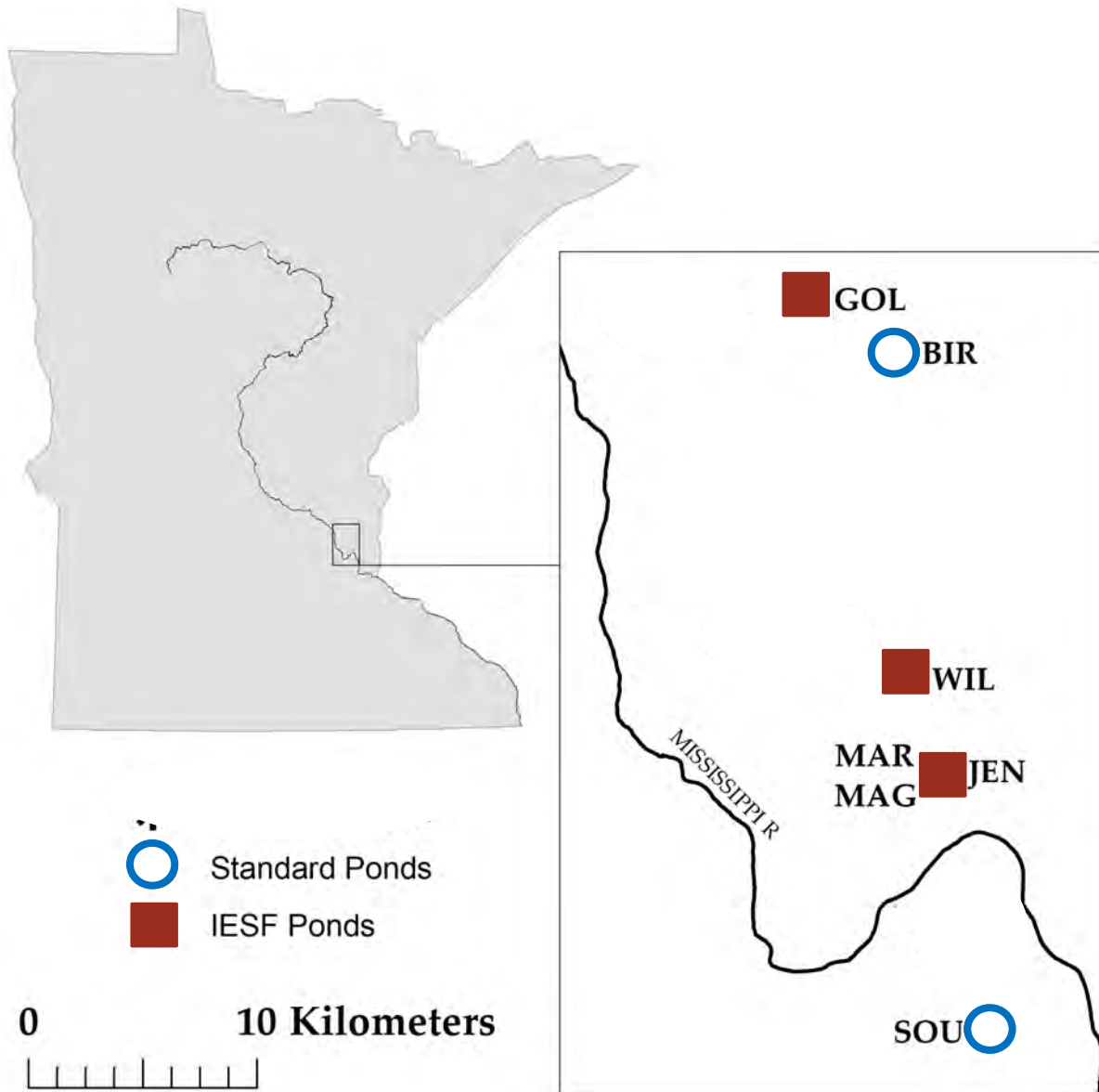
Outflow



Iron enhanced sand filter

IESF





Sampling Sites:

- Golden Lake
- Birchwood Acres
- William Street
- Maryland
- Magnolia
- Jenks
- Southview Blvd

Summer
2018

Fall
2018

Winter
2018

Spring
2019

Summer
2019



Snow Melt

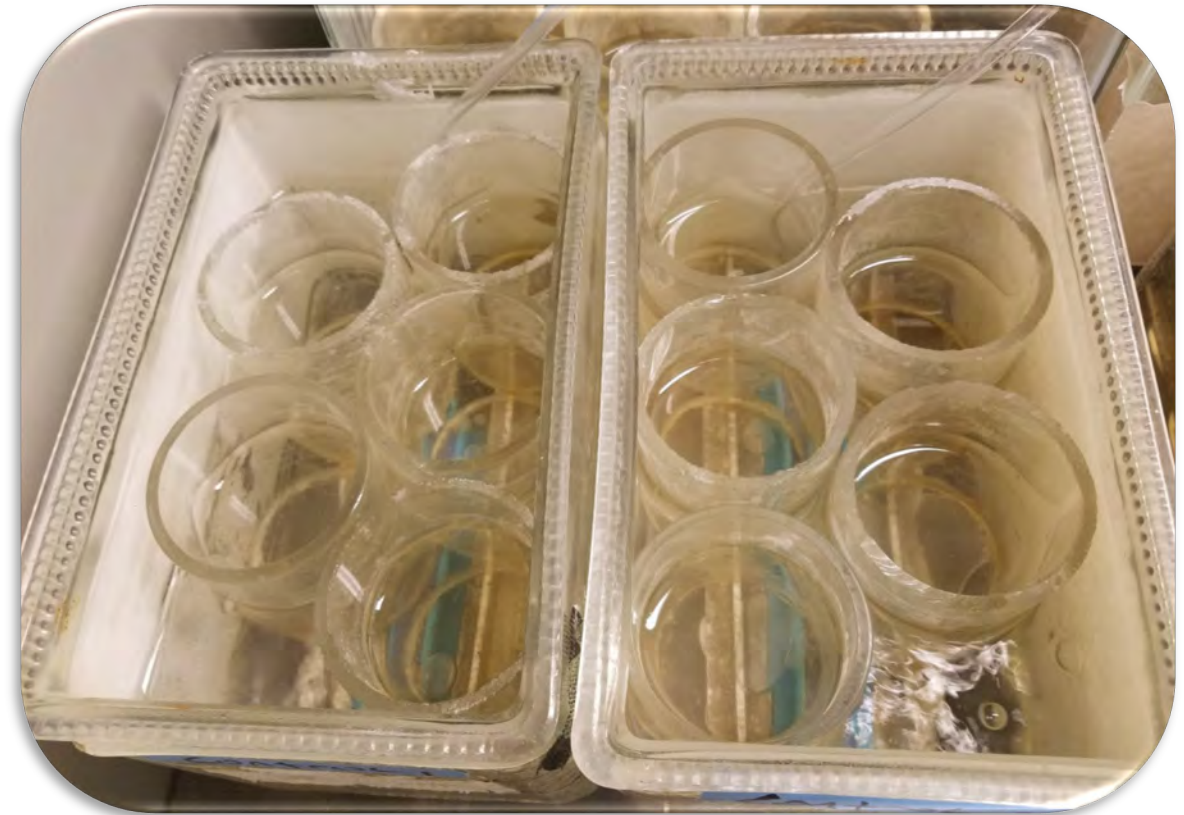
Spring Rain

Summer Rain

Fall Rain



21-Day Larval Fathead Minnow Exposures



Inflow

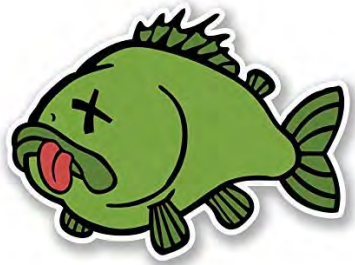
Outflow

- **5 replicates**
- **15 larvae per replicate**
- **Static renewal**

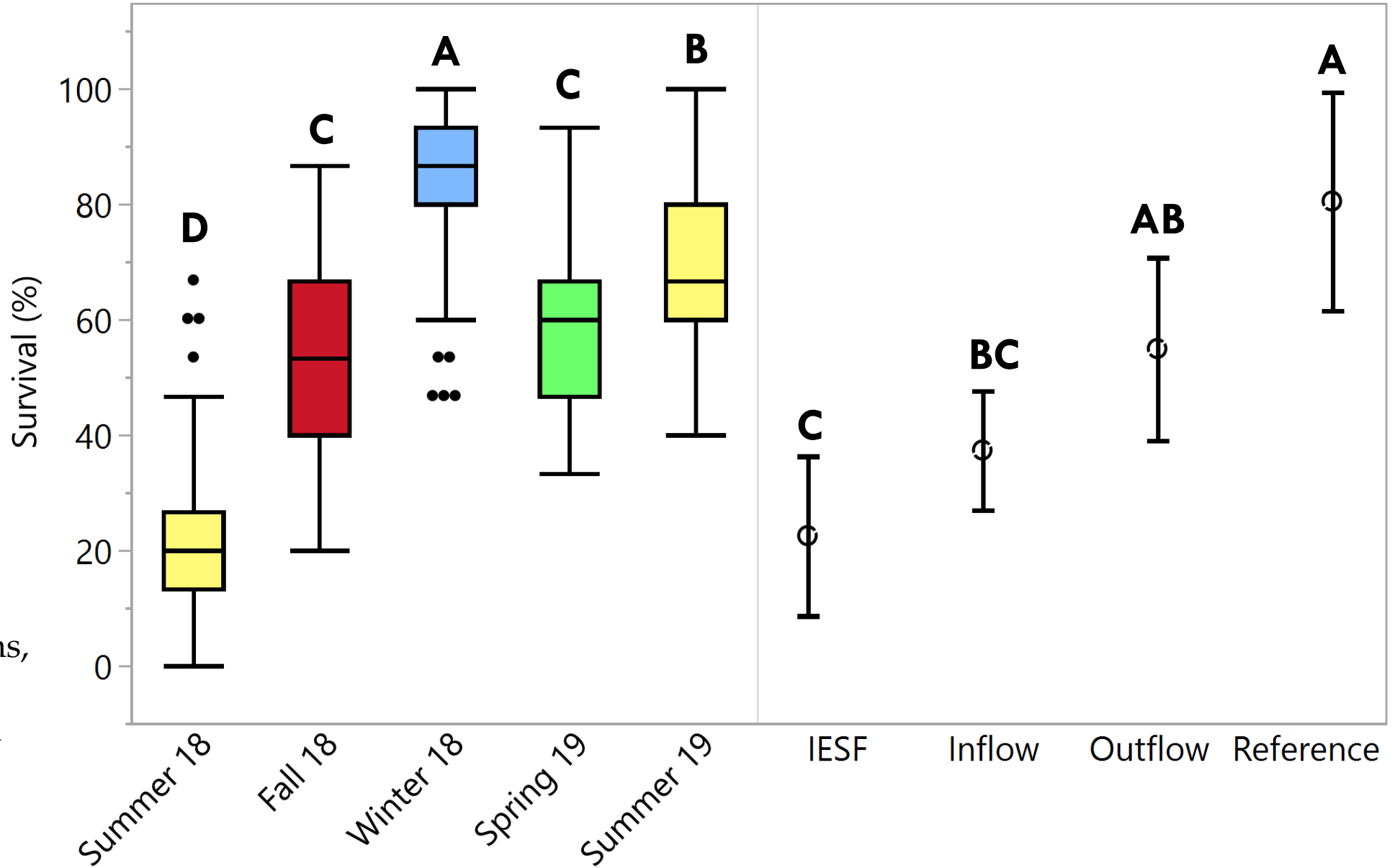
Season

Treatment

Survival



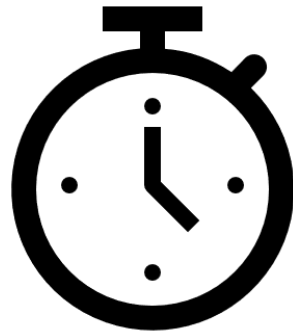
Least squares means,
Season $P = <0.01$
Treatment $P = <0.01$



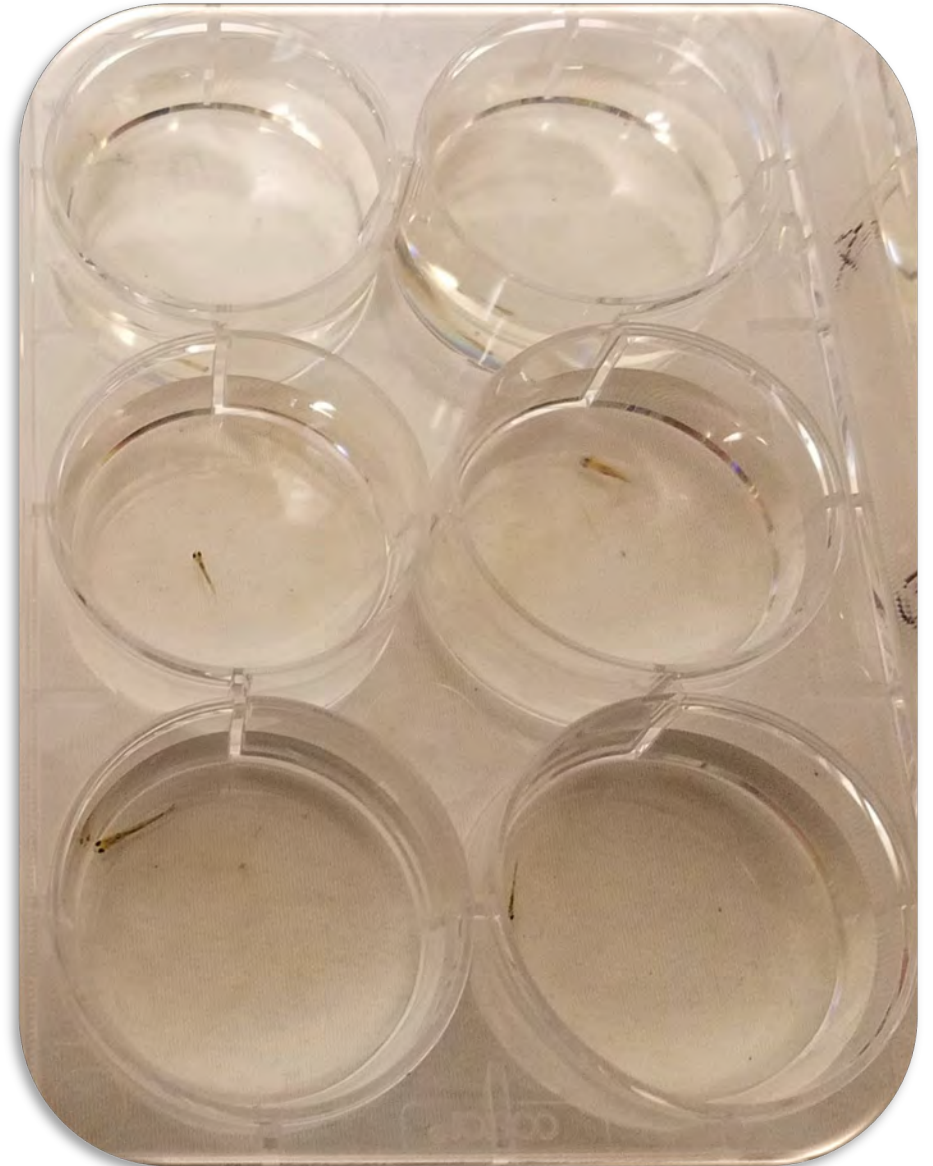
Foraging Efficiency



x 15 shrimp



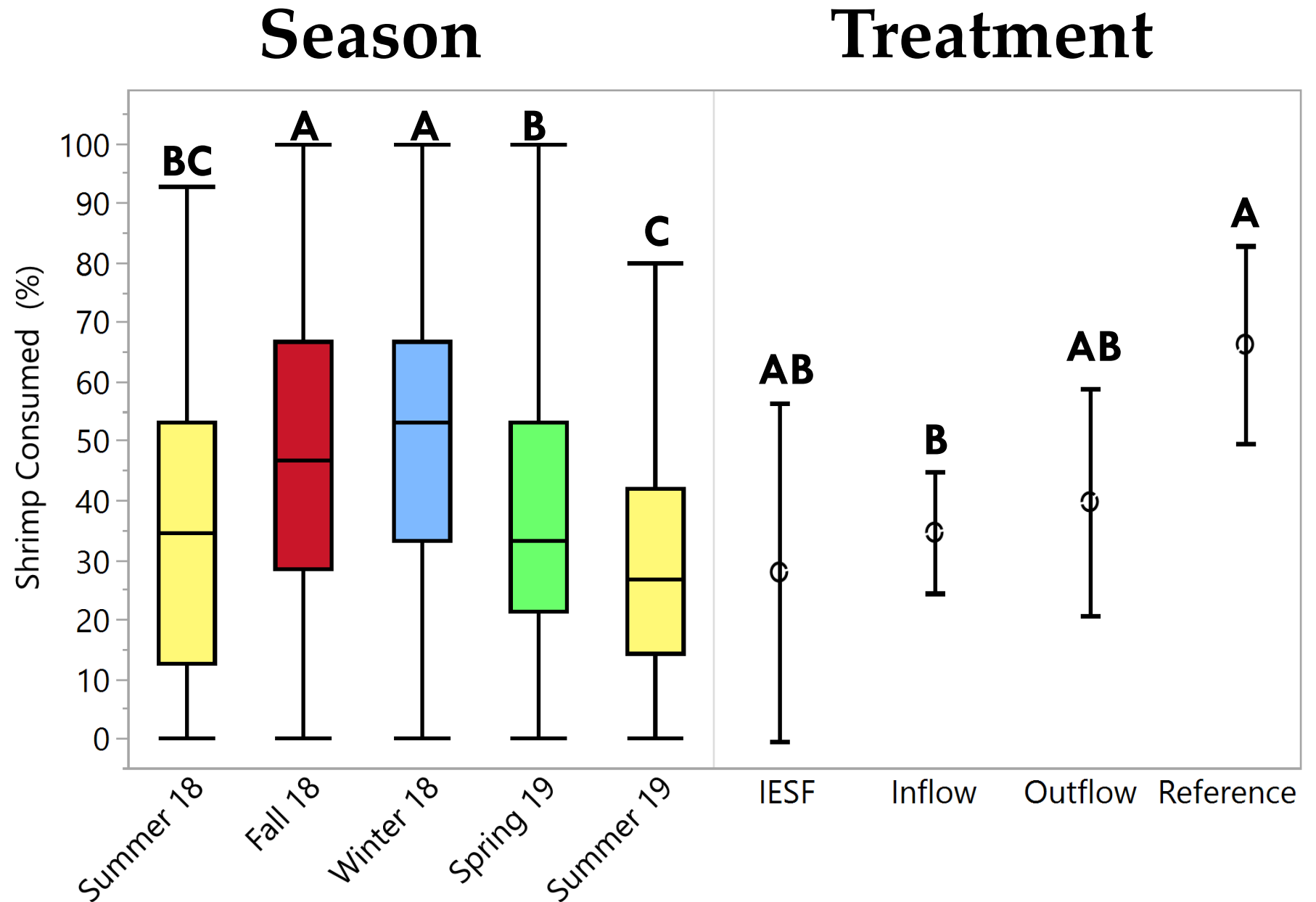
1 Minute



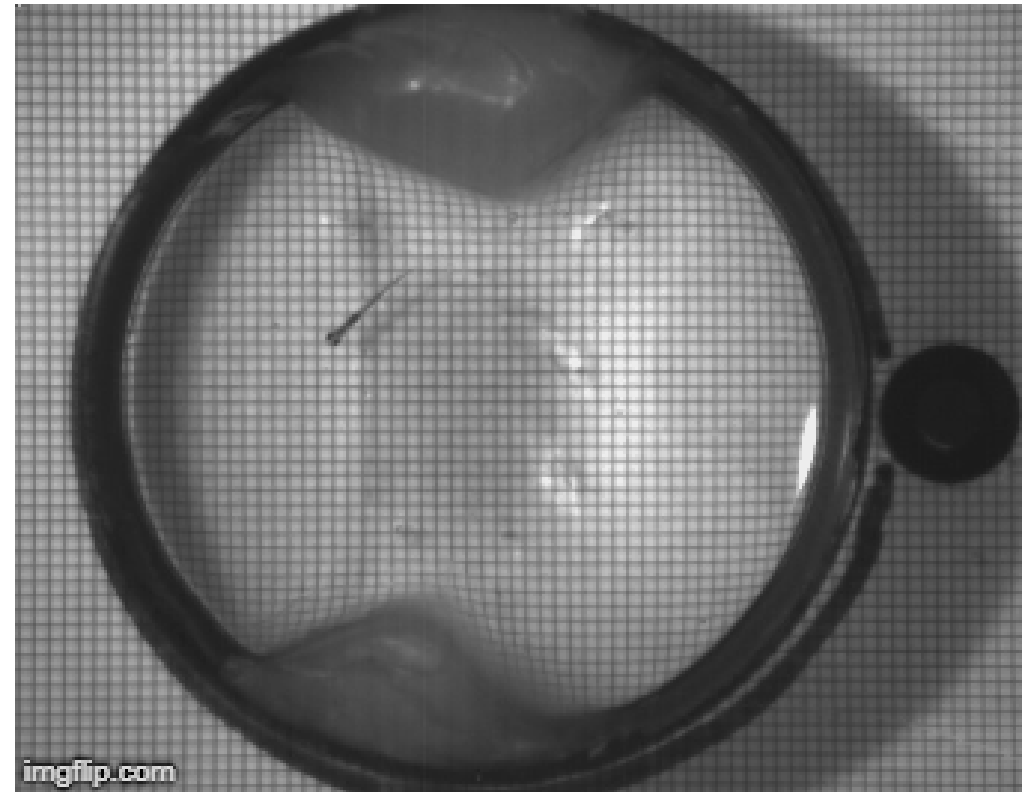
Feeding Efficiency



Least squares means,
Season $P = <0.01$
Treatment $P = 0.01$

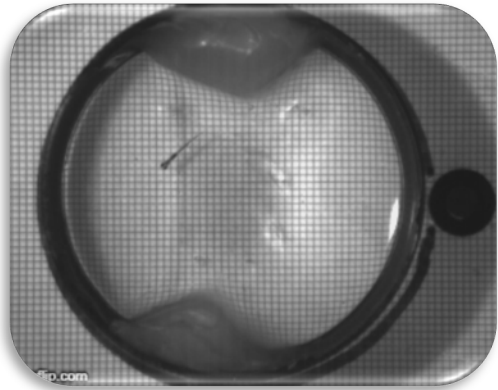


Predator Avoidance

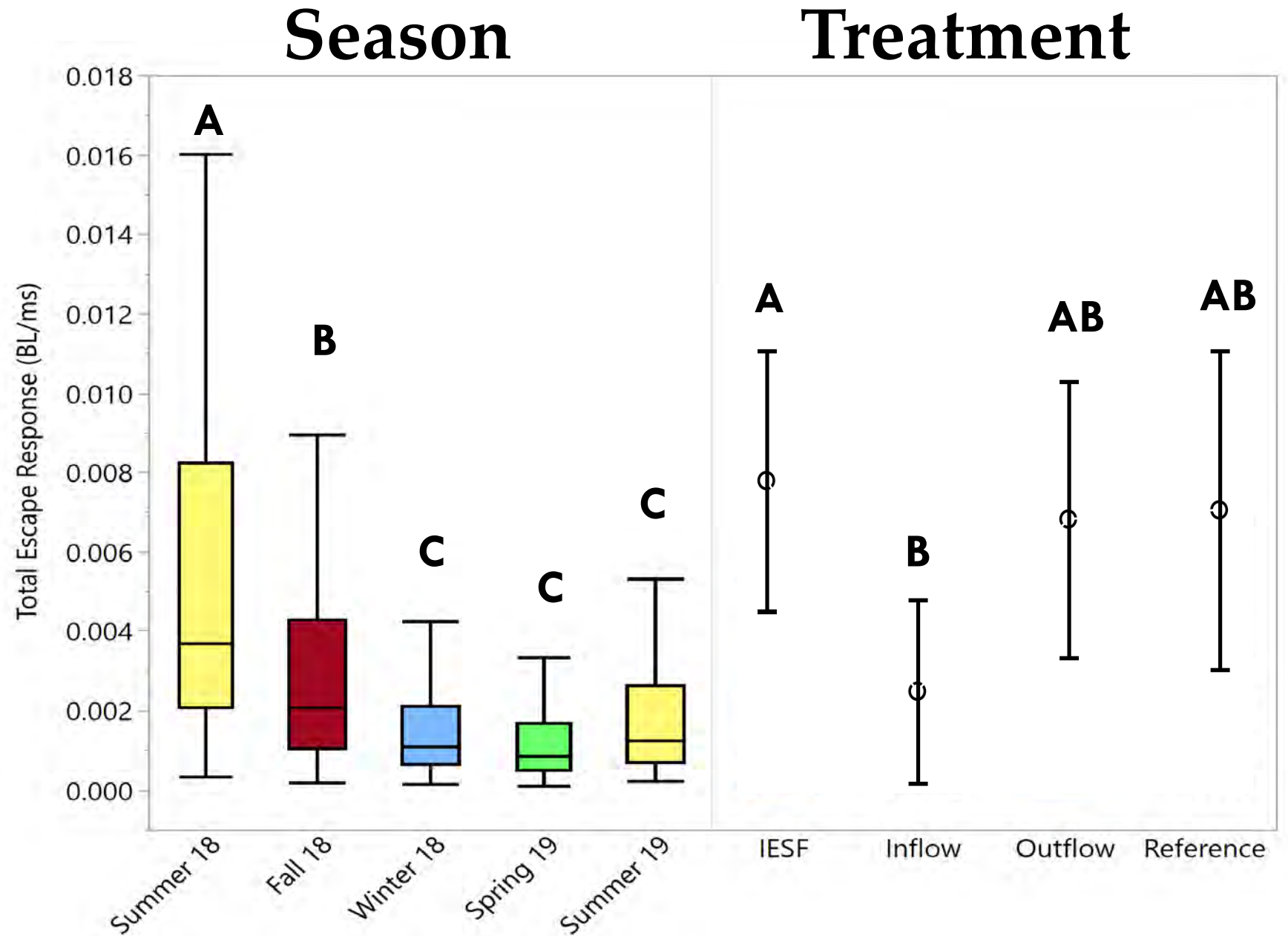


 = Stimulus

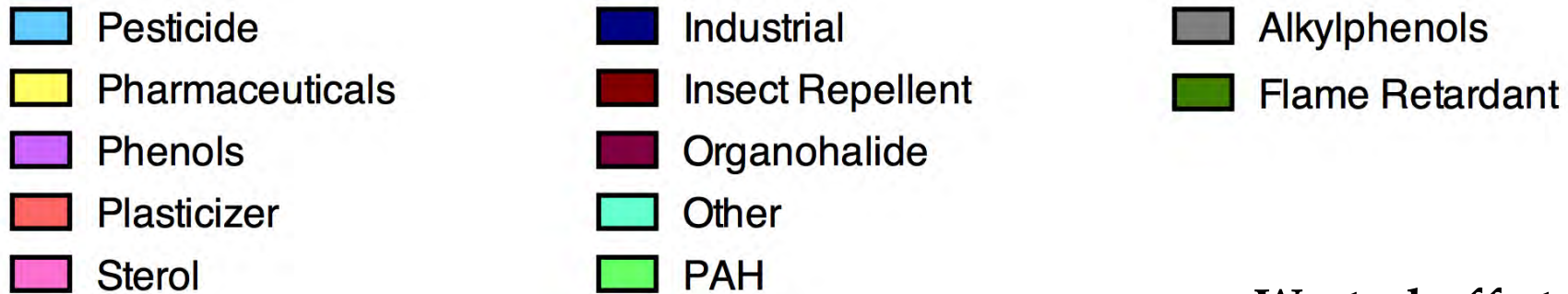
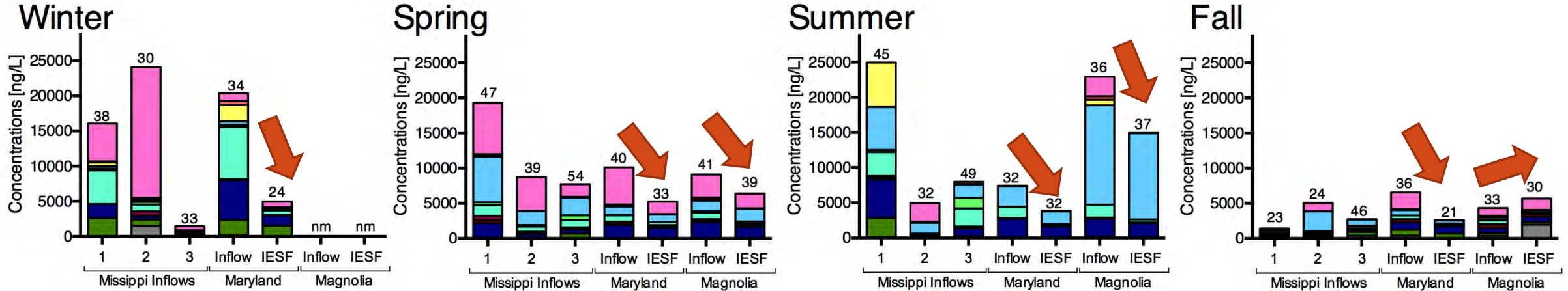
Predator Avoidance



Least squares means,
Season $P = <0.01$
Treatment $P = 0.03$

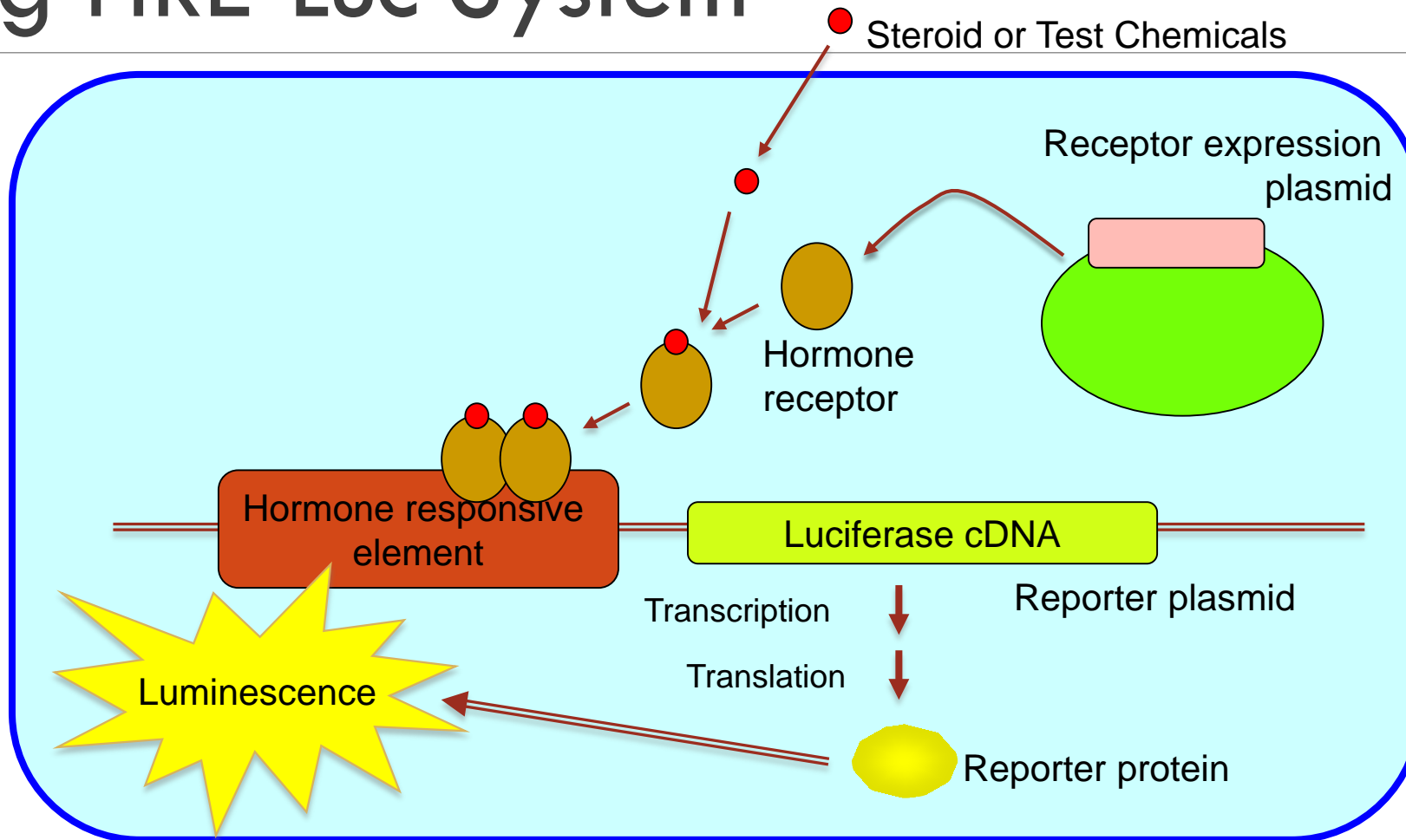


Water Chemistry -2016

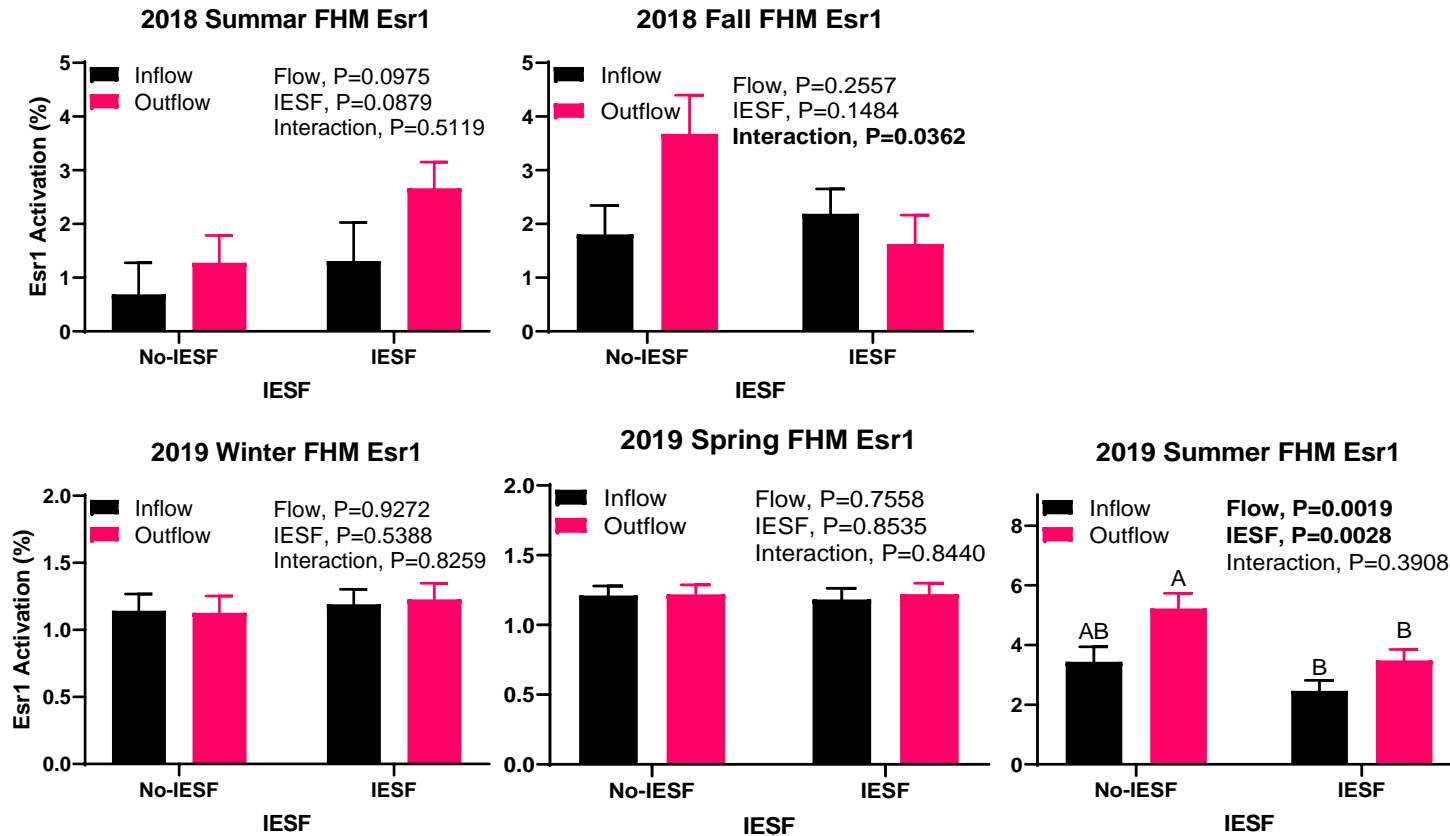


Westerhoff et al. ET&C 2018

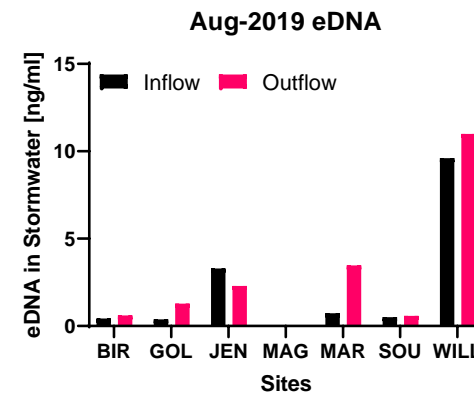
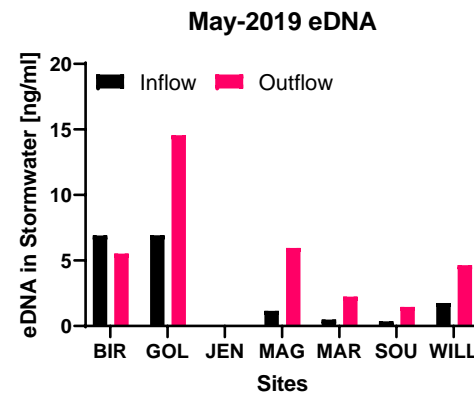
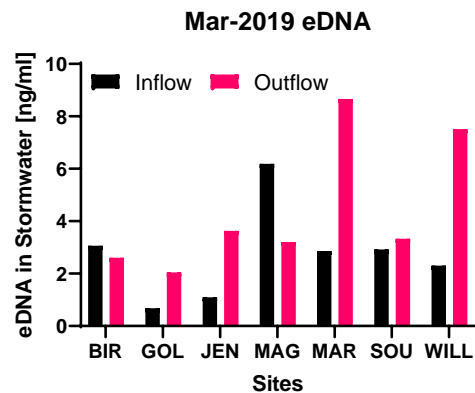
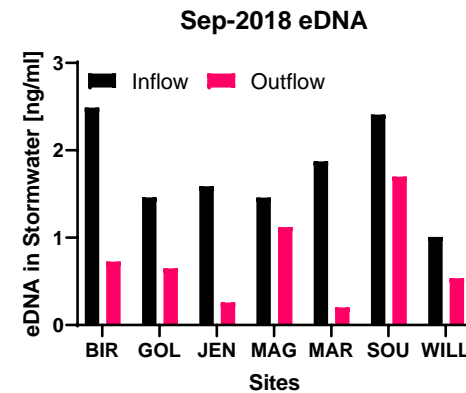
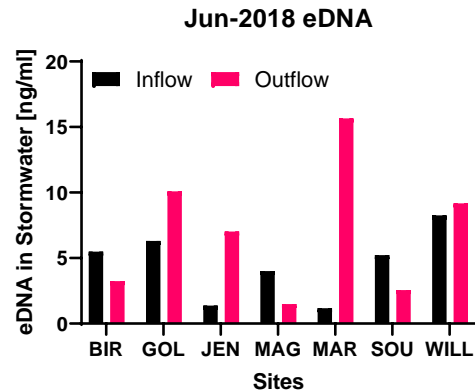
In Vitro Reporter Gene Assay Using HRE-Luc System



Estrogenicity of stormwater *in vitro*



Environmental DNA concentration in urban stormwater

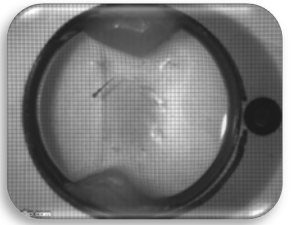


Species specific fecal bacteria in urban stormwater

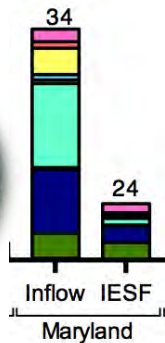
		Apr-2018	Jun-2018	Sep-2018	Mar-2019	May-2019	Aug-2019
BIR	IN			Duck			
	OUT			Duck			
GOL	IN					Human	
	OUT			Duck			
JEN	IN			Duck	Dog		
	OUT						Dog
MAG	IN		Human/Dog			Human/Dog	
	OUT		Human			Human/Dog	
MAR	IN			Duck			
	OUT	Human					Dog
SOU	IN				Dog		
	OUT			Duck		Human	
WIL	IN			Human/Duck		Dog	Dog
	OUT			Human			
BIR	IN						
	OUT						



Discussion- Effectiveness of Treatment



- Biological effects greater for inflow than outflow



- IESF removes select contaminants. However, may negatively affect bio-outcomes

Acknowledgments

Researchers

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Maxim Kroll



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