SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Greater Everglades Ecosystem Restoration

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Spatial and Temporal Variation of Total Mercury in Mosquitofish From the Everglades

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Objectives

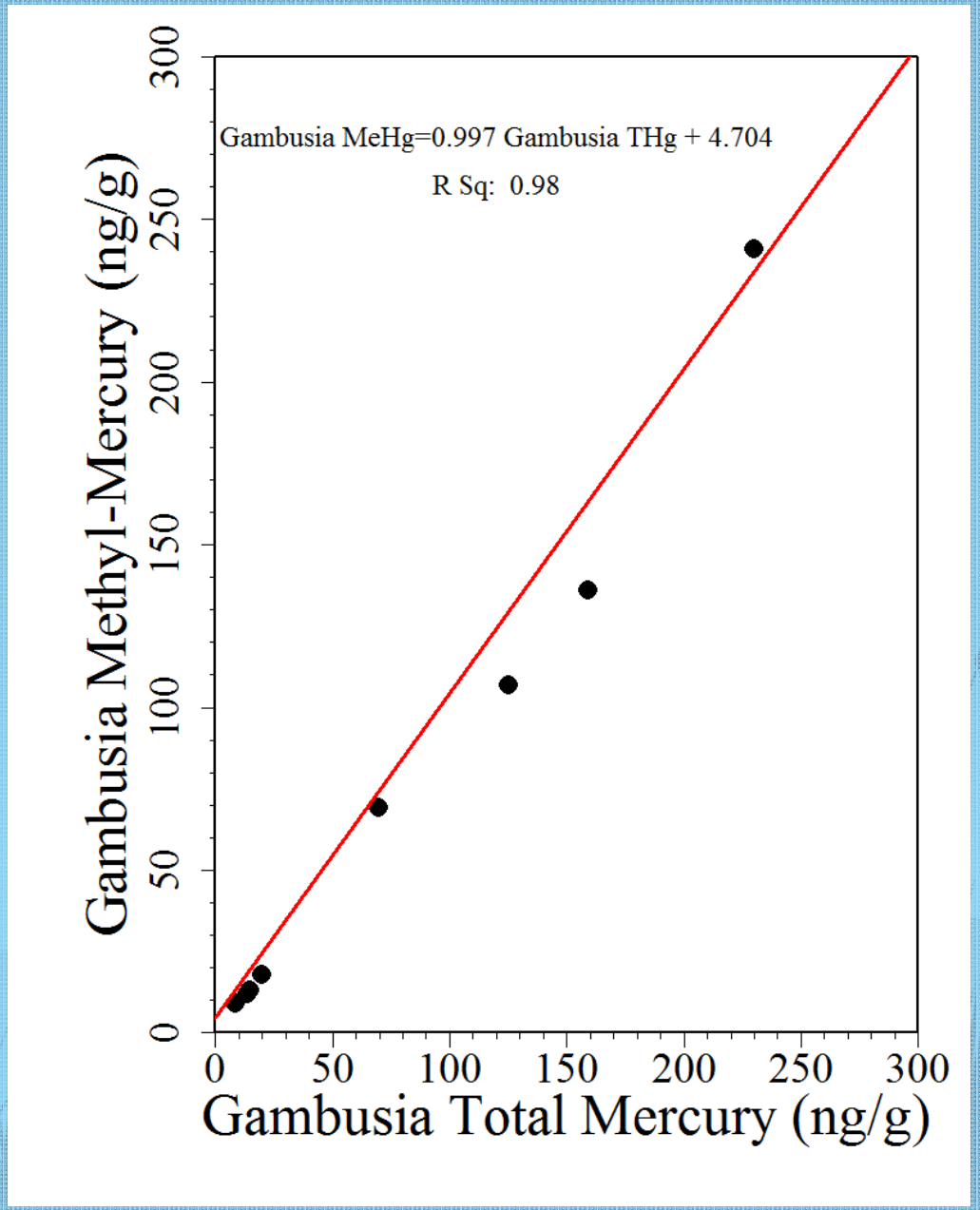
- **Evaluate spatial and temporal trends for mosquitofish mercury in the Everglades**
- **Relate the variations in mosquitofish mercury levels to key environmental factors**

Why We Monitor Mercury in Fish for the Everglades?

- **Elevated Hg concentrations in fish and biota have been a concern for the Everglades regions since the 1970s**
- **Accumulation of Hg in aquatic biota is of concern for both human health and wildlife**
- **Harmful health effects associated with high Hg concentrations have been observed in Everglades biota that have a semi-aquatic diet, including wading birds, alligators and Florida panthers**

Why Mosquitofish?

- **Mosquitofish (*Gambusia* spp.) reflect short-term, localized changes in water quality due to small size, short life span, small home range and widespread occurrence in the Everglades**
- **Composite samples of between 100 and 250 mosquitofish have been collected from 12 sites across Everglades Protection Area (EPA) since 1997**
- **Composite samples were homogenized and analyzed for total mercury (THg)**
- **Data are summarized in the South Florida Environmental Report**



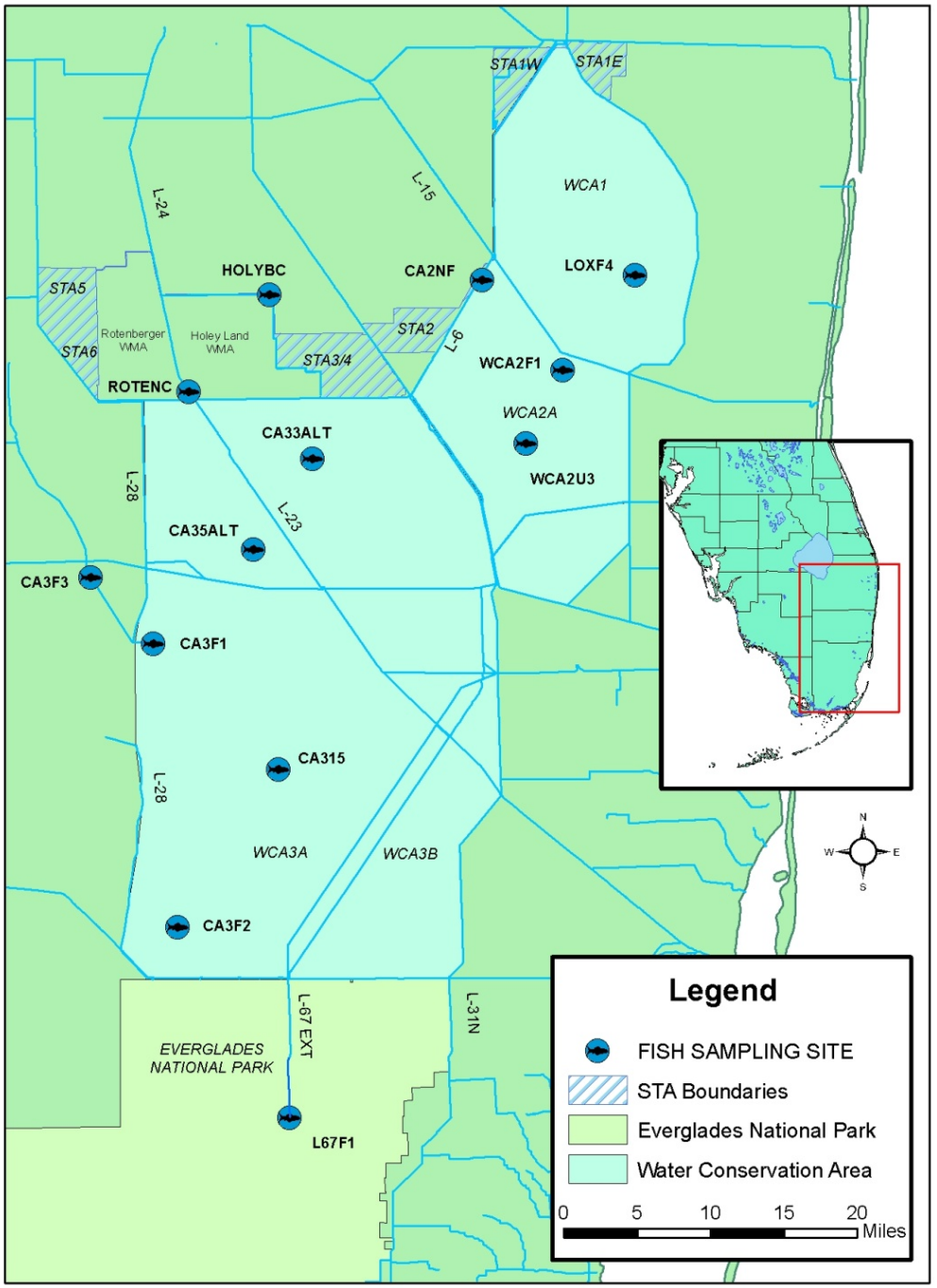
- **The most toxic form of mercury is methylmercury (MeHg)**
- **The majority of the mercury in mosquitofish is methylmercury (MeHg) (~99%).**
- **Therefore total Hg is used to assess MeHg concentrations in mosquitofish.**
- **However MeHg concentrations can vary with studies.**

Largemouth bass (*Micropterus salmoides*)

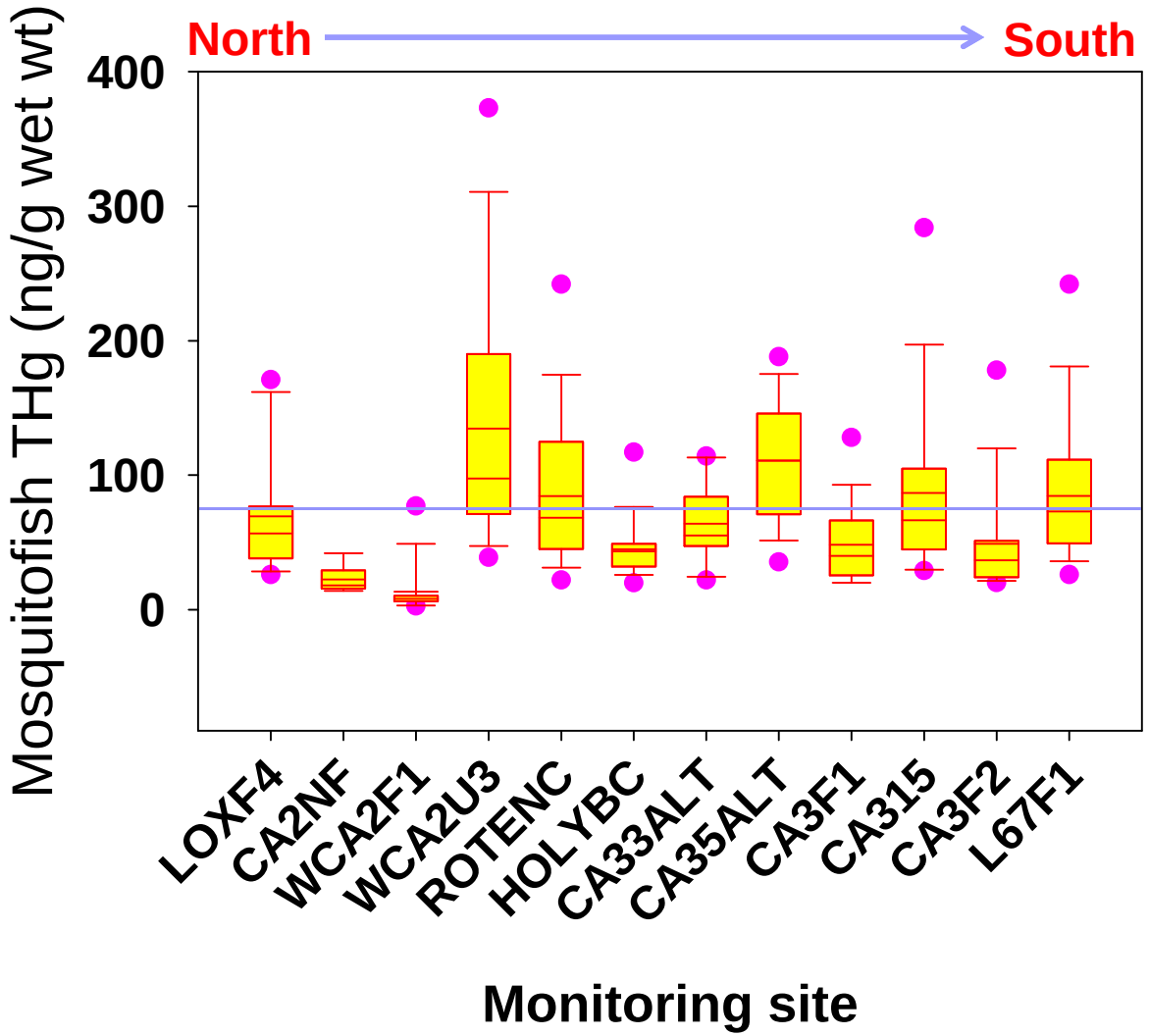
Sunfish (*Lepomis* spp.)

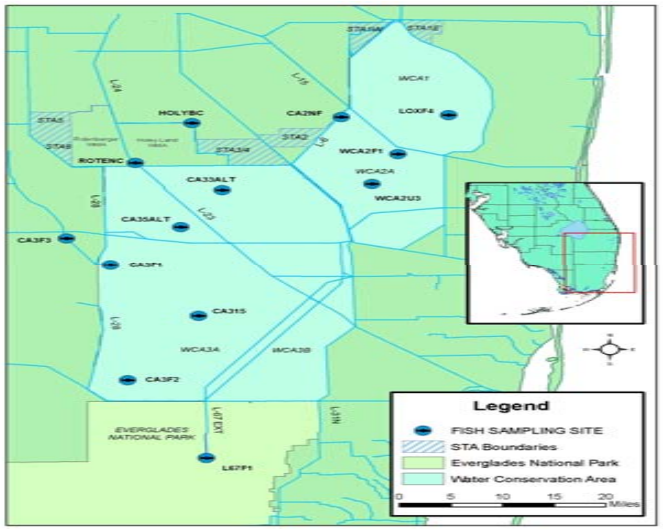
Mosquitofish (*Gambusia* spp.)

- **The fish monitoring network initiated during 1997**
- **Fishes from three trophic levels collected annually**
- **12 monitoring stations represent both canal and marsh habitat types and cover all WCAs and the ENP**



Spatial Variations in Mosquitofish Mercury

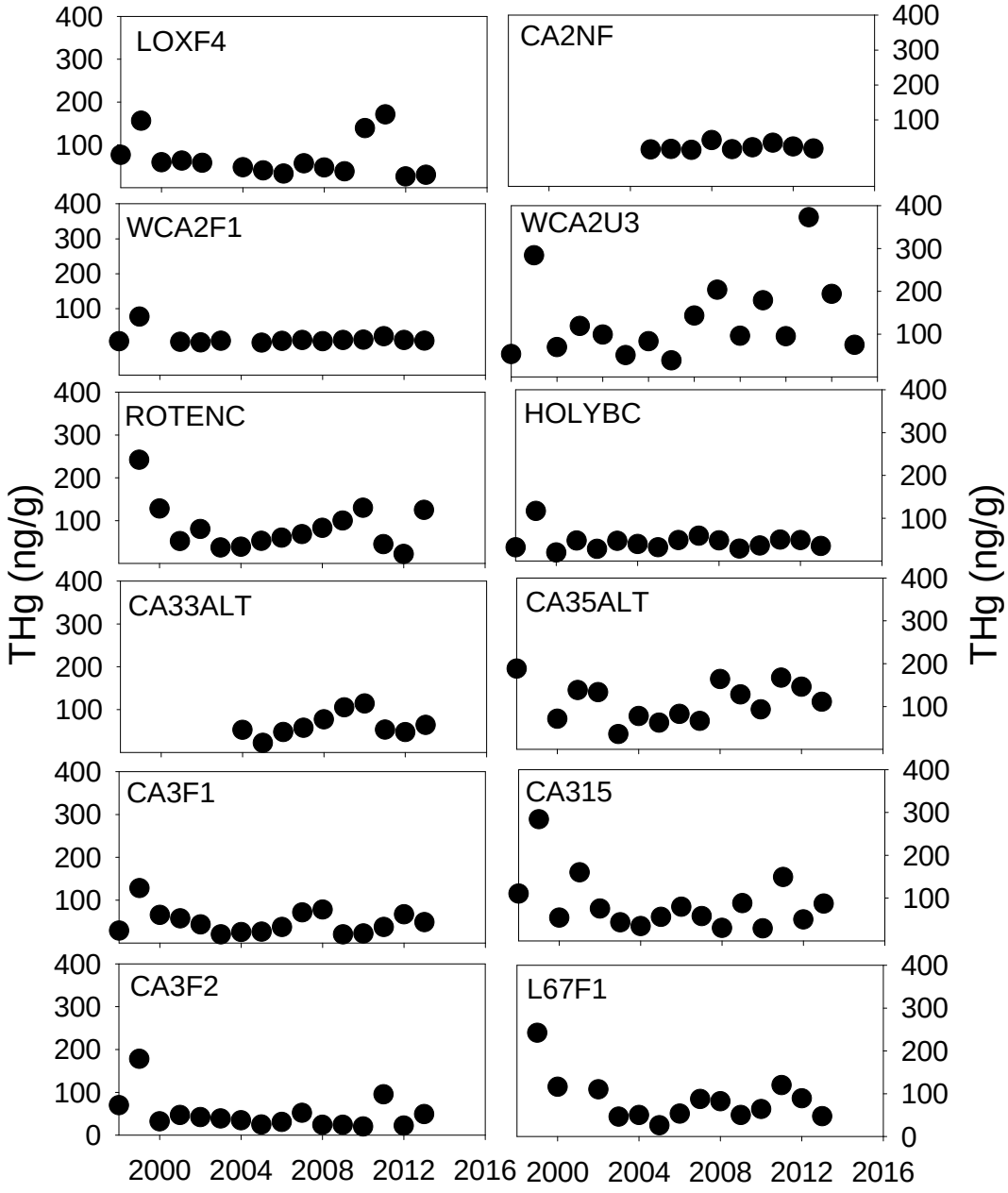




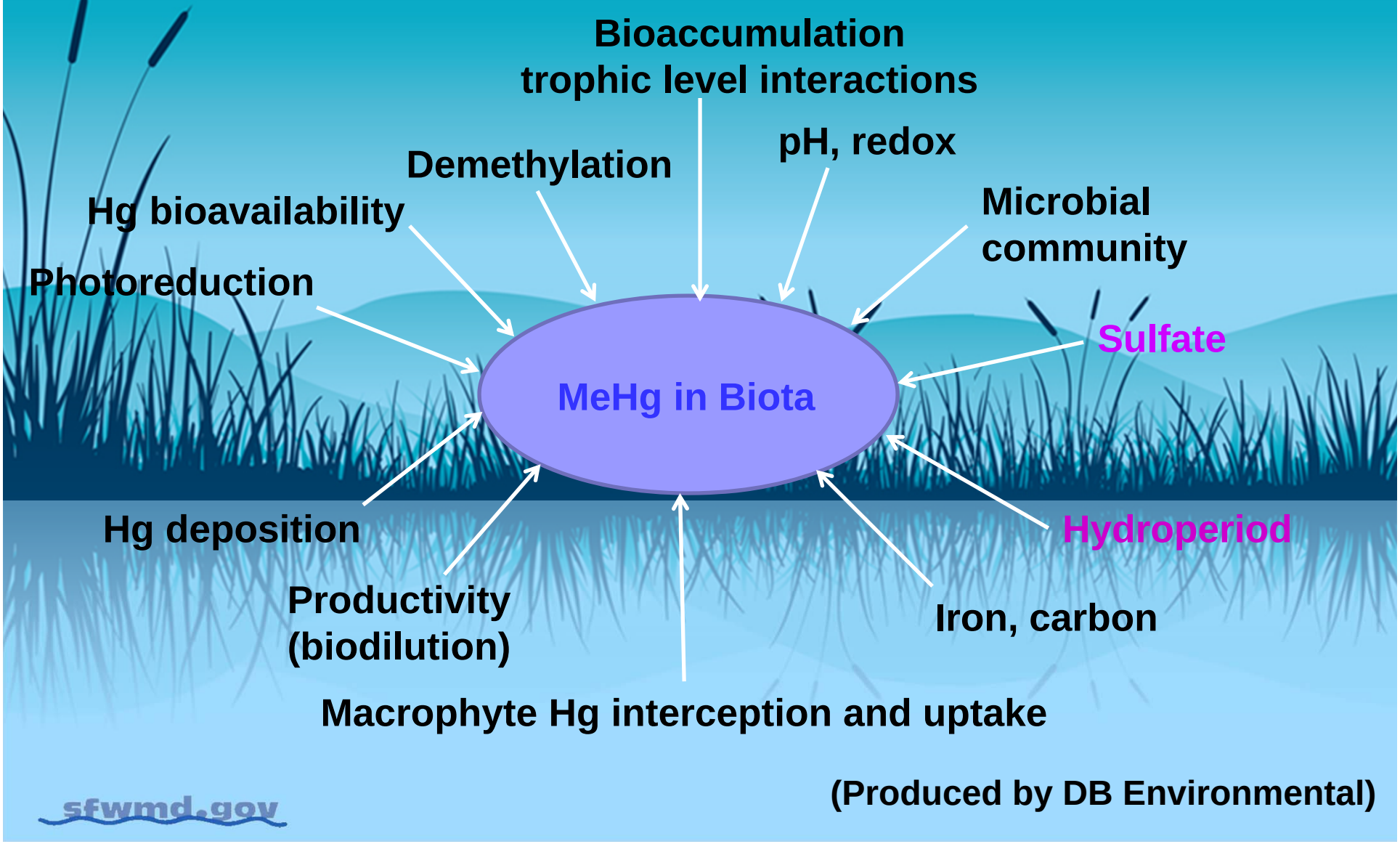
- High within/among site variability
- No north-south trend
- About 30% of the data exceeded USEPA trophic level III fish limit (77ng/g)

Temporal Variations in Mosquitofish Mercury

- **No systematic temporal trend found**
- **More variation with lower nutrient levels**



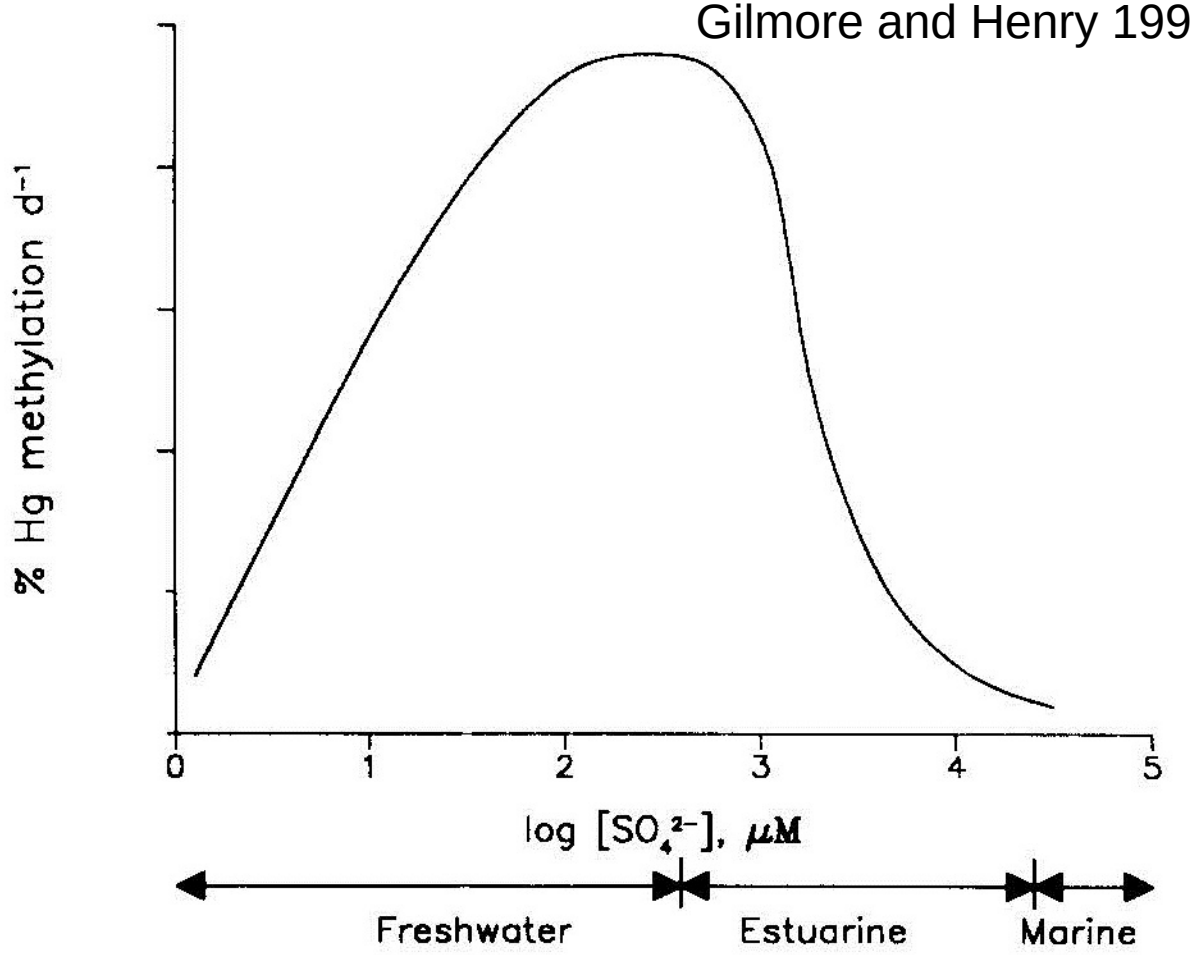
Factors Affecting MeHg Concentrations in Biota



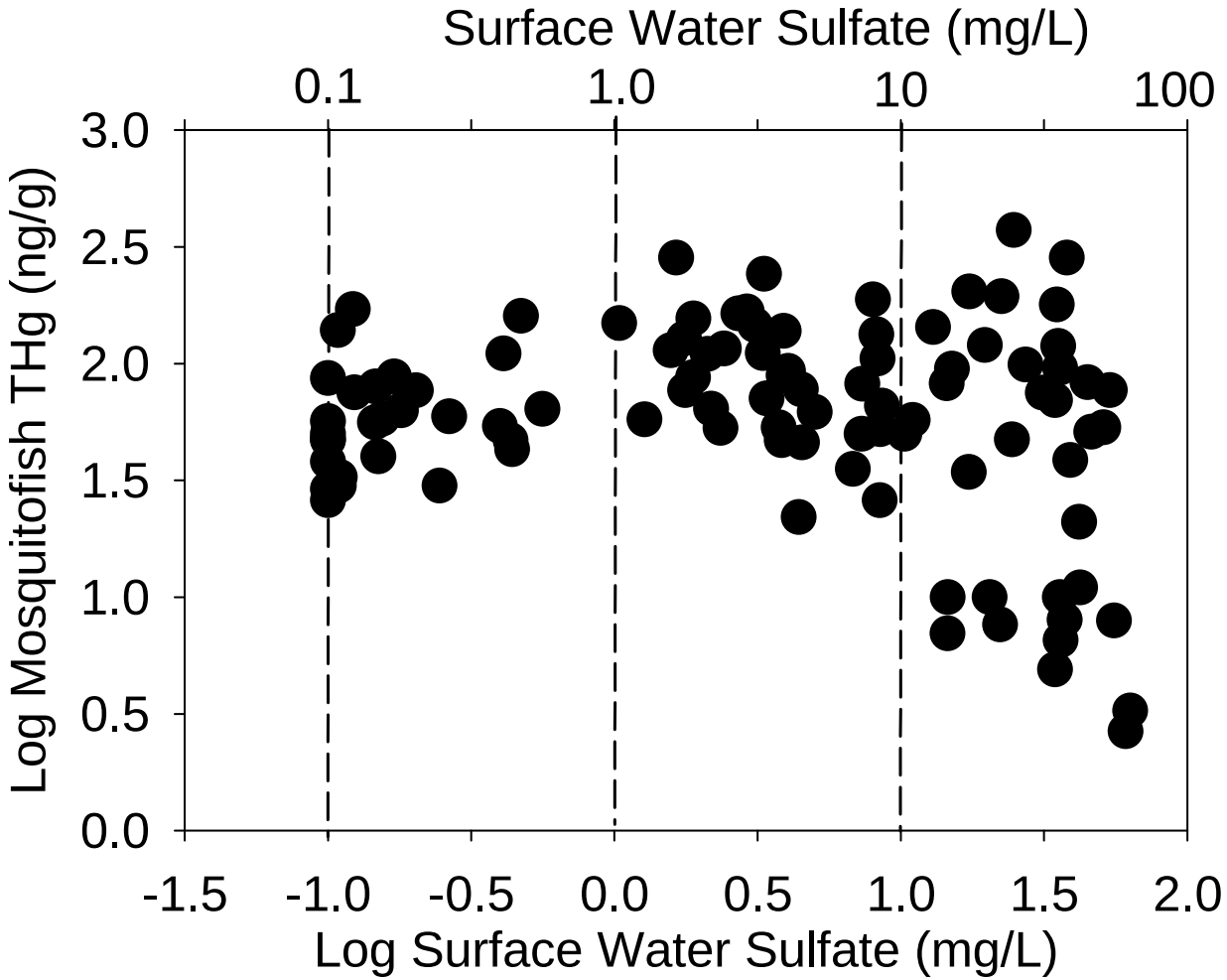
(Produced by DB Environmental)

Sulfate Effect on Mercury Methylation

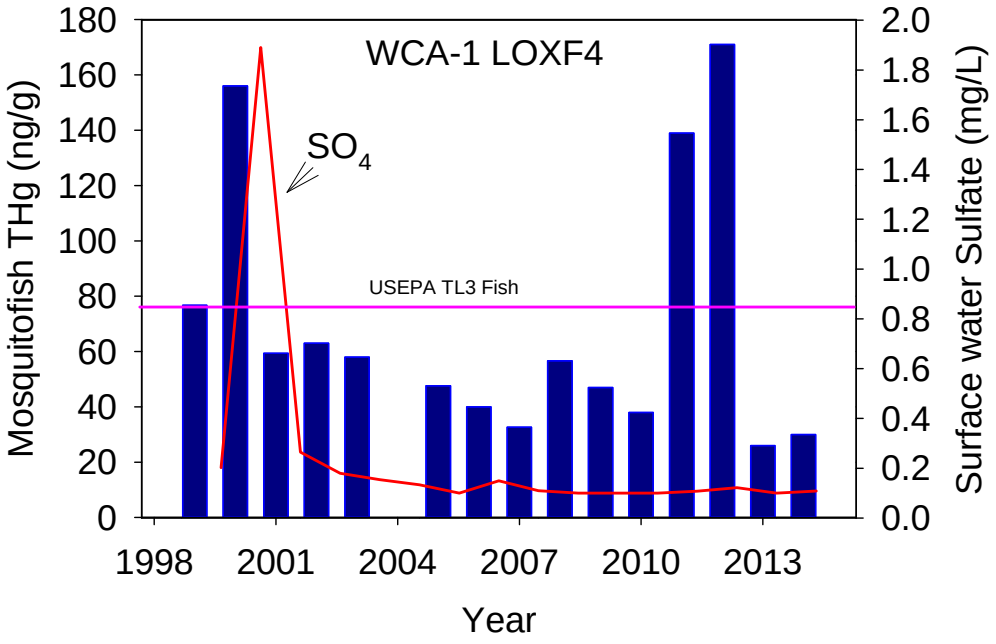
Gilmore and Henry 1991



Relationship between Sulfate and Mosquitofish Mercury



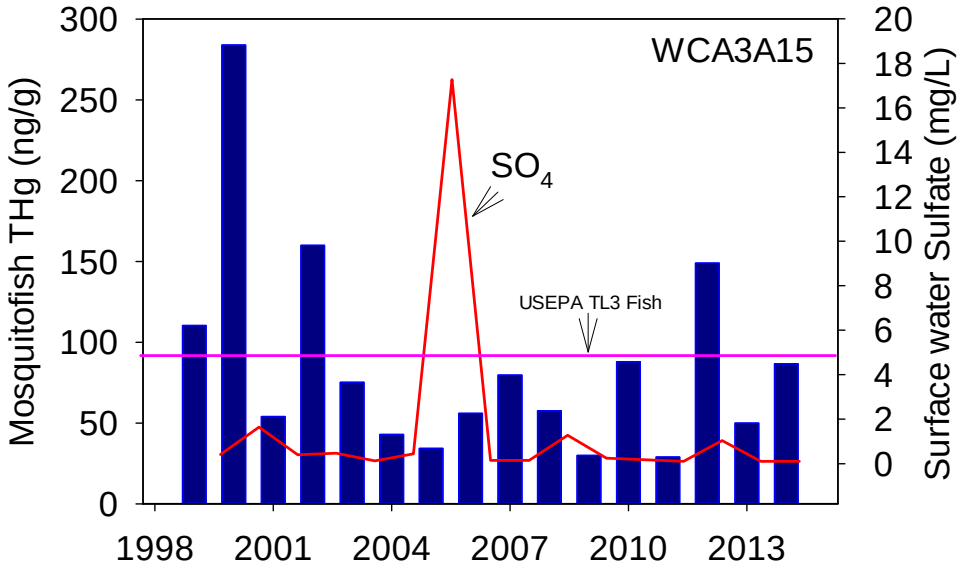
- **Consistent from 0.1 to 10 mg/L**
- **Some low values when SO_4>10 mg/L**



Low Sulfate High Hg

Median SO4 = 0.3 mg/L

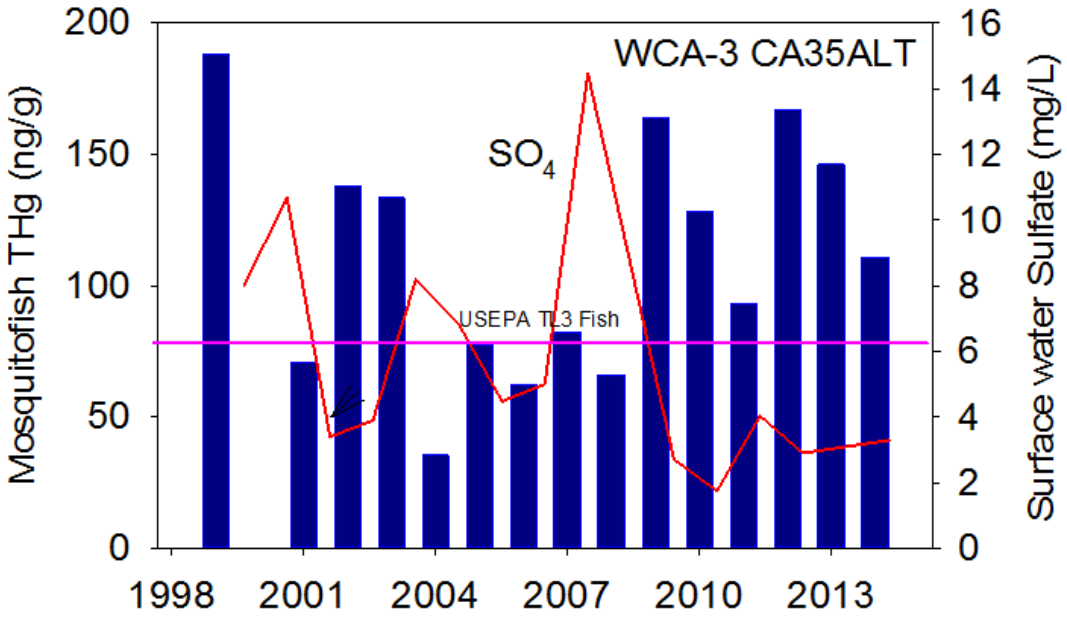
Median THg = 66 ng/g



Low Sulfate High Hg

Median SO4 = 0.1 mg/L

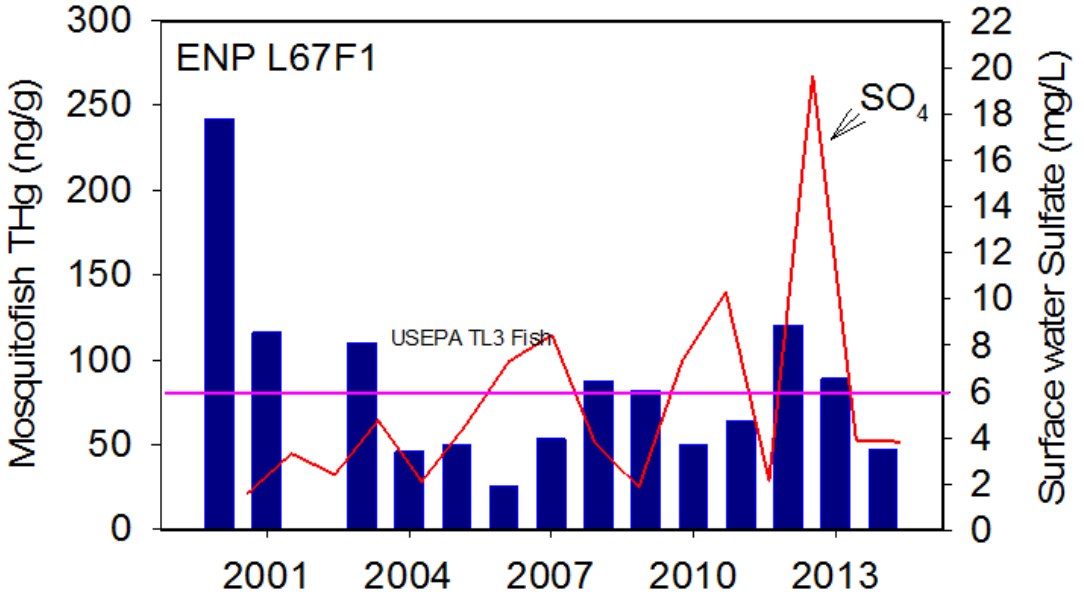
Median THg = 47 ng/g



Moderate SO4, High Hg

Median SO4= 4.3 mg/L

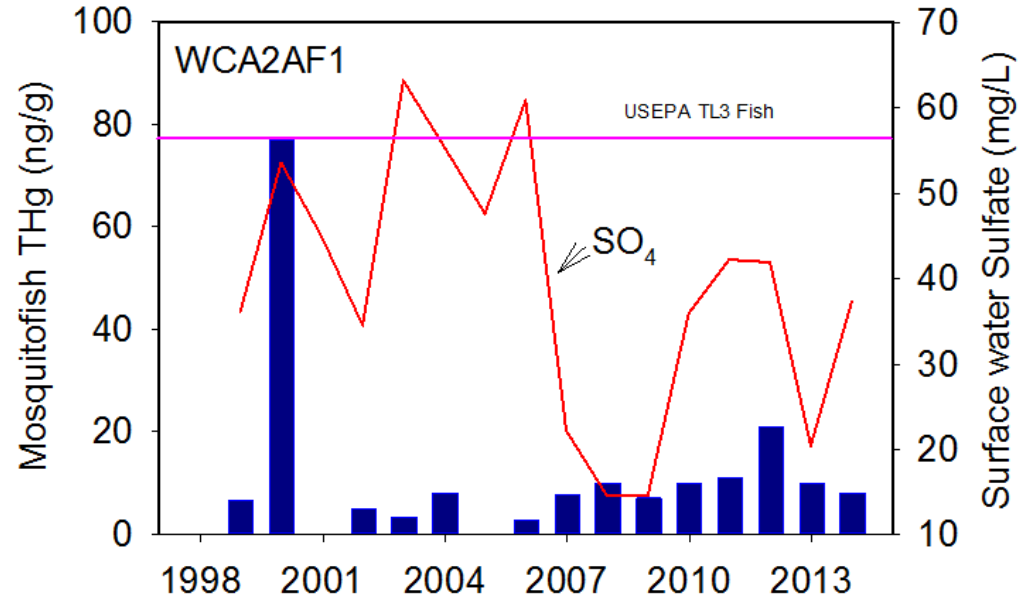
Median THg= 111 ng/g



Moderate SO4, High Hg

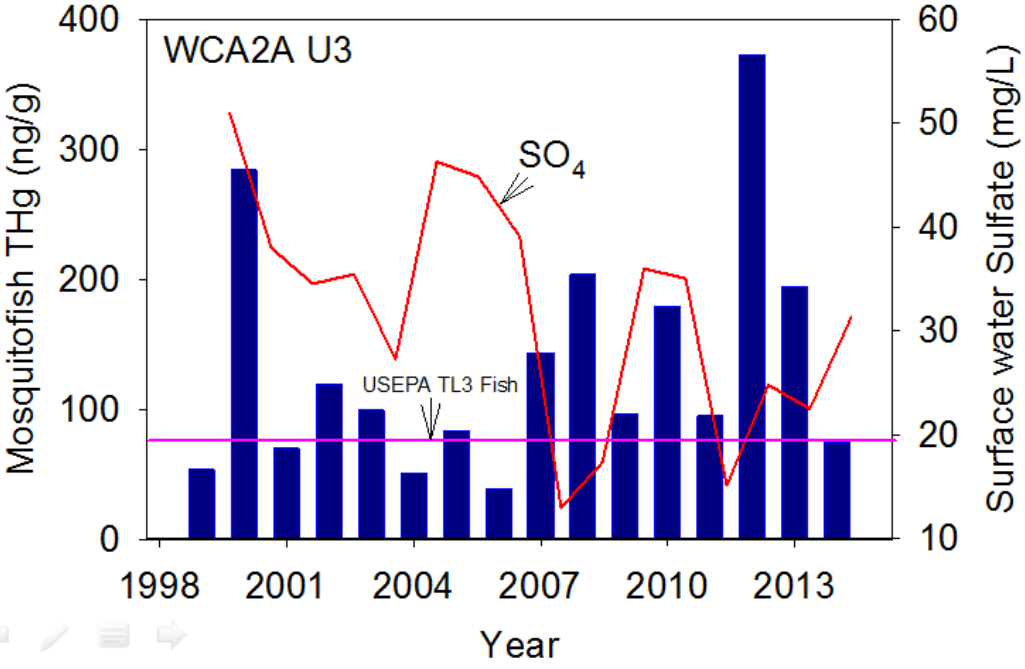
Median SO4= 3.9 mg/L

Median THg= 73 ng/g



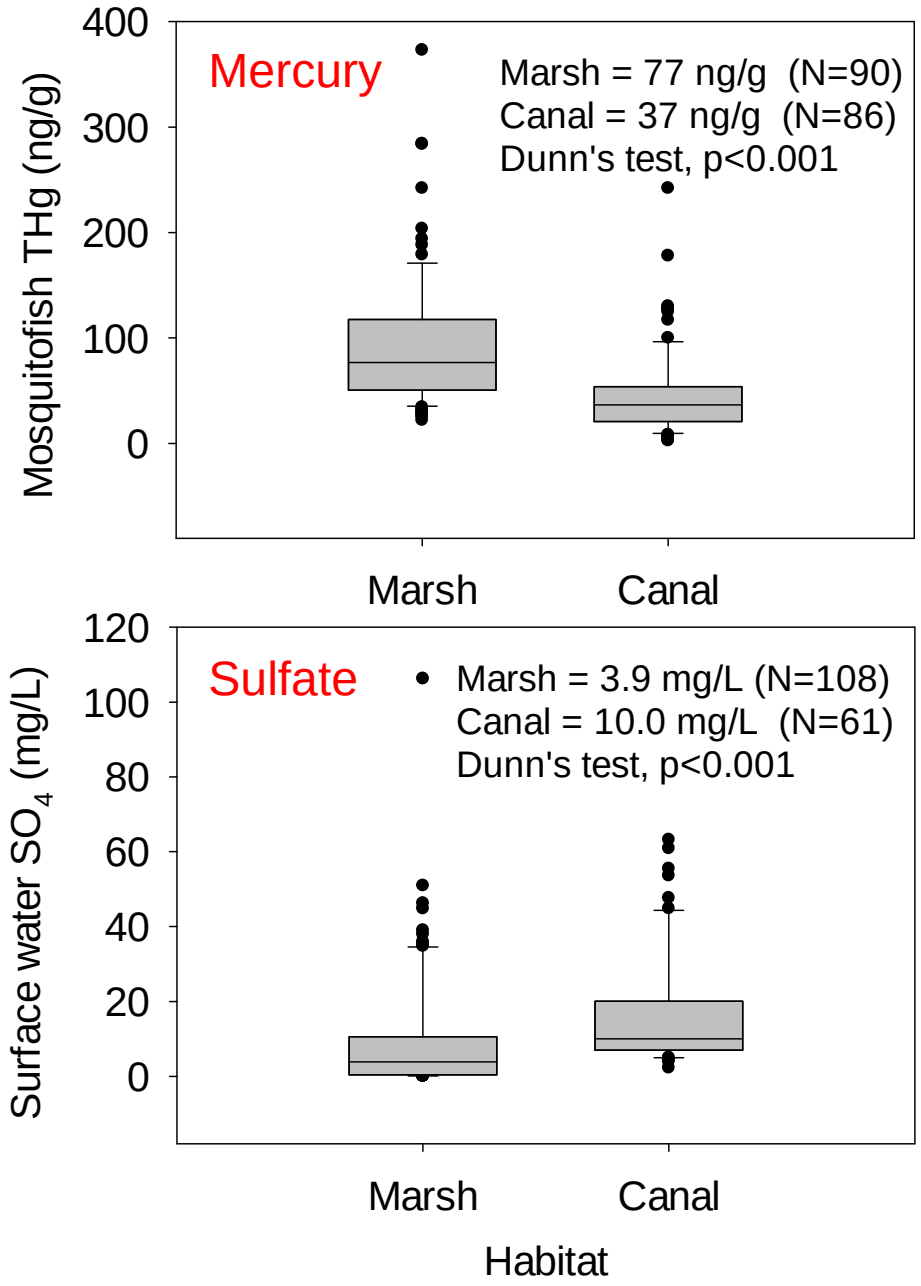
High Sulfate, Low Hg

Median SO4= 40 mg/L
Median THg= 8 ng/g



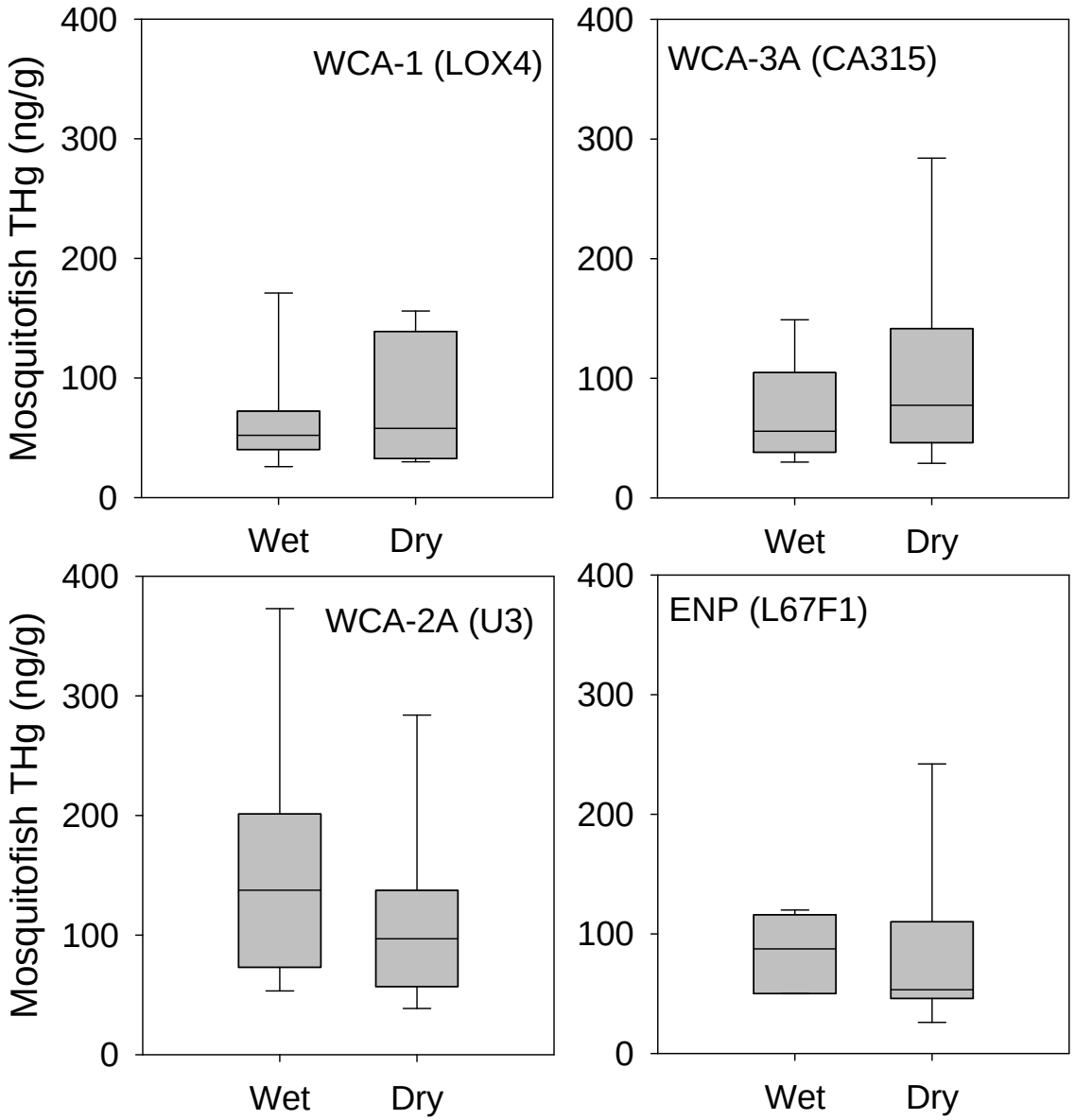
High Sulfate, High Hg

Median SO4 = 35 mg/L
Median THg = 92 ng/g (comparable to those with moderate SO4)



Habitat Differences in Mercury and Sulfate

Variables	Marsh	Canal
THg	High	Low
SO4	Low	High
Nutrients	Low	High
Periphyton	High	Low



Seasonal Differences in Mosquitofish Mercury

- **No dry and wet season difference**
- **No seasonal effect on MeHg production?**
- **No seasonal effect on dietary composition?**
- **Habitat is more important?**

Anomalies of SO4-THg Relationship

1. **Low SO4 (<1 mg/L), High THg in fish**
   - Rapid turnover rate of sulfate
   - High Hg Availability
   - Other microbial guilds responsible for Hg methylation (Bae et al. 2014; Park et al. 2013; Yu et al. 2012,2013)
     - *Iron Reducing Bacteria (IRB)*
     - *Methanogens, etc.*
   - External input of THg or MeHg from other biotic compartments
     - *Feeding area of wading birds*
     - *Tree island/bird guano (Zhu et al. 2013)*

Anomalies of SO4-THg Relationship

2. High SO4 (>40 mg/L), High THg in fish

- High in situ concentration of bio-available Hg
- Host of Hg methylating microbial guilds available to produce MeHg
- External inputs of THg or MeHg from other biotic compartments
- Surface water sulfate not representative?

Conclusions

- About 30% of the mosquitofish composite samples over the past 16 years exceeded USEPA trophic level III fish limit
- There are significant temporal and spatial variations in mosquitofish mercury contents
- Relationships between surface water sulfate and mosquitofish mercury concentrations are weak
- Based on current and previous studies, mosquitofish mercury is likely influenced directly or indirectly by a combination of several environmental factors including ambient sulfate and mercury concentrations, type of diets and fish trophic position

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THANK YOU

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