

Mercury and Methylmercury in the Everglades

G. Melodie Naja
Everglades Foundation
mnaja@evergladesfoundation.org



Basic Facts

- **Mercury (Hg):**

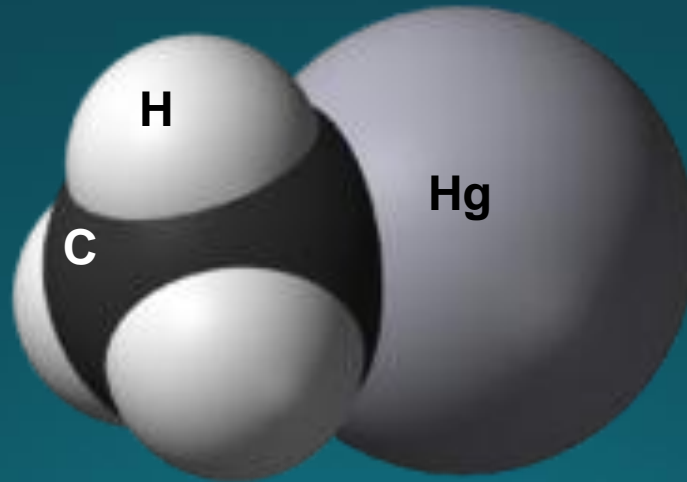
- Inorganic form - silvery white metal
- It volatilizes easily
- It is found in many rocks – and in coal
- Coal-burning power plants are the largest source of **Hg** emissions to the air in the US
- **Hg** can be carried long distances around the world as gas in the atmosphere – and deposited elsewhere



Basic Chemistry

- Methylmercury (MeHg) $\text{CH}_3\text{-Hg}^+$

Organic form



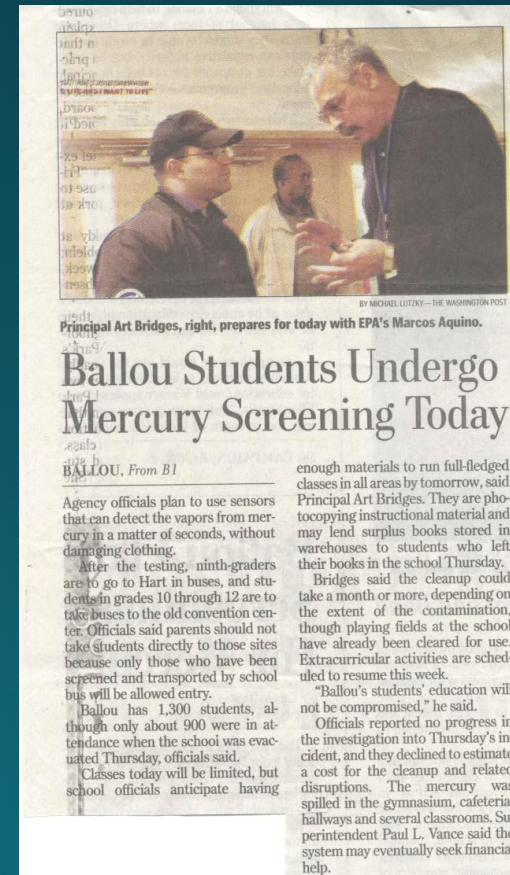
Mercury Toxicity

- **Elemental mercury Hg:**

- Source: thermometers, barometers – vapor more toxic
- Clinical manifestations: lungs (respiratory failure), memory impairment, kidney failure
- USA incidents: Several,...

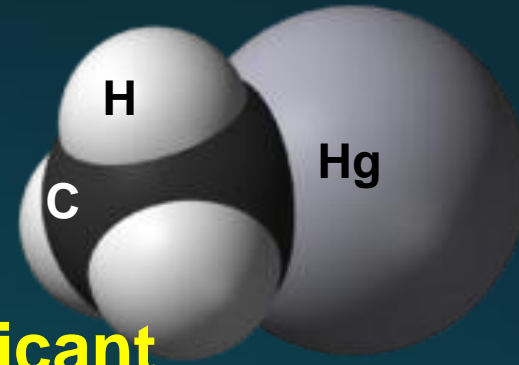
- **Organic methyl mercury $\text{CH}_3\text{-Hg}^+$:**

- Source: environmental



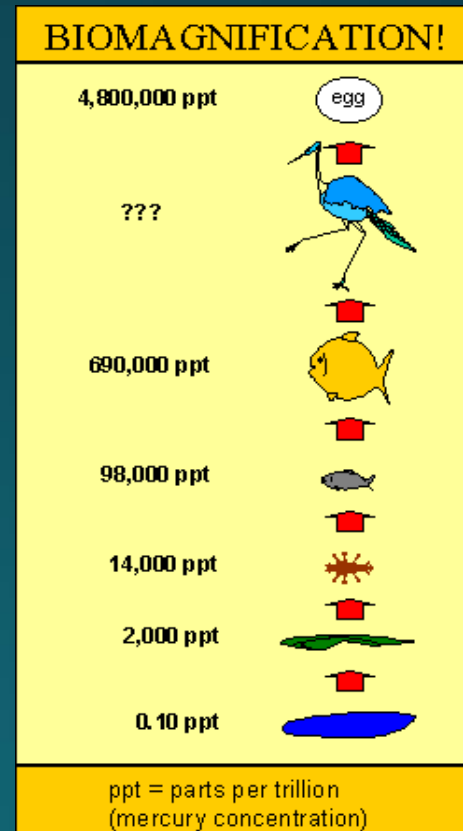
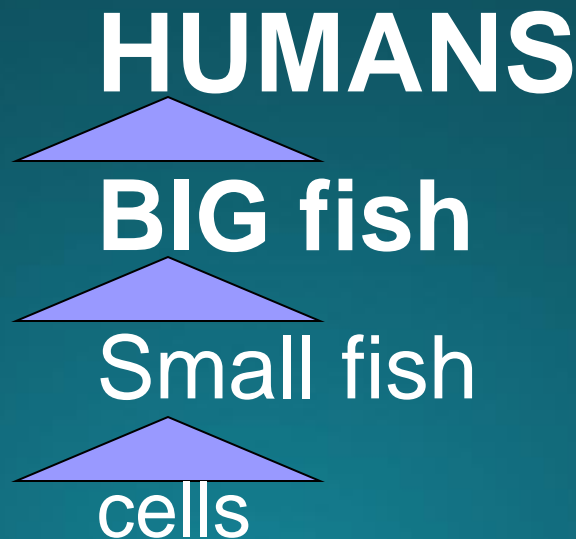
MeHg - methylmercury

- **Extremely Toxic**



- **Bioaccumulative environmental toxicant**
- Microbes provide the **entry** of Hg into living organisms
- Mercury **bio-accumulates** in higher organisms :

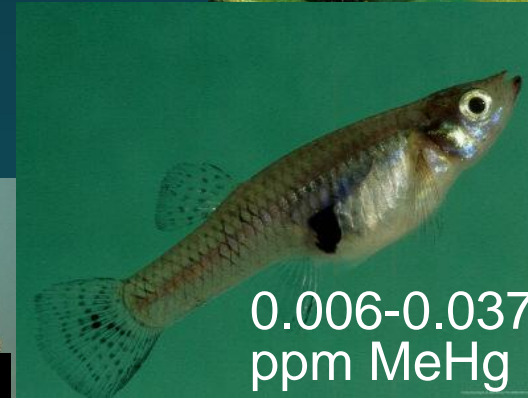
**That's
the problem !**



Methylmercury works its way up the food web



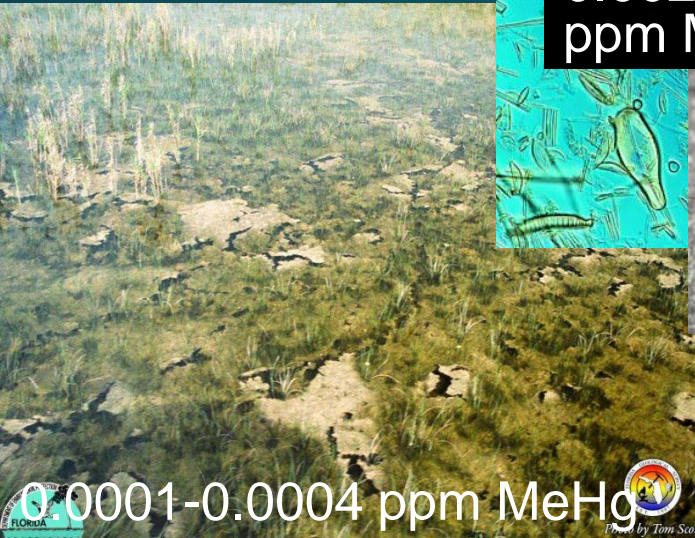
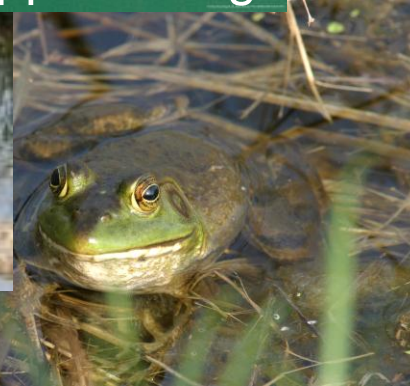
0.4-2.3 ppm MeHg



0.006-0.037 ppm MeHg



0.002-0.003 ppm MeHg



0.0001-0.0004 ppm MeHg



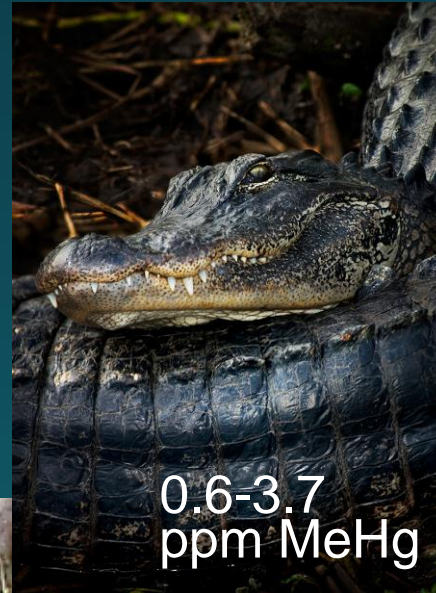
Slide courtesy of Dr. Davis – Everglades Foundation



Methylmercury accumulation



2.9-17.5
ppm MeHg



0.6-3.7
ppm MeHg



0.8-10.1
ppm MeHg



up to 110
ppm MeHg

Methylmercury is Highly Toxic

- **Minamata disease in Japan:**

disastrous mass poisoning of
Minamata town population
identified in late 1950s



- **Methylmercury poisoning symptoms**

- numbness in hands and feet
- general muscle weakness
- damage of vision, hearing, speech
- insanity, paralysis, coma, death –
- easily crosses placenta, entering fetal circulation

Human Health Issues

- How much Hg is too much ?

EPA: 0.1 μg / kg of bodyweight / day

EPA advisory (children and pregnant women):

Do not eat more than 1 can tuna (chunk light) / 4 days if you weigh 110 -130 lbs

- The entire state of FL is currently under Hg advisories

- 20 freshwater and 60 marine species of fish



Freshwater fish

● Martin County

For a complete list, please check:

<http://www.doh.state.fl.us/floridafishadvice/2011%20Advisories.pdf>

Location	Species	Pregnant or young children	All other individuals
St. Lucie Canal	Largemouth bass, Bowfin, Gar	One per week	Two per week
Lake Okeechobee	Brown bullhead, Channel catfish, Redear sunfish, White catfish	Two per week	Two per week
Lake Okeechobee	Black crappie, Bluegill, Largemouth bass < 13 inches	One per week	One per week
Lake Okeechobee	Bowfin, Gar, Largemouth bass > 18 inches	One per month	One per week

● St-Lucie County

Location	Species	Pregnant or young children	All other individuals
Palm Lake Fish Management Area	Redear sunfish	Two per week	Two per week
Palm Lake Fish Management Area	Channel catfish	One per week	Two per week

Marine and Estuarine Fish

Palm Beach, Martin and St-Lucie Counties

Species	Pregnant or young children	All other individuals
Almaco jack, Snowy grouper	One per month	One per month
Atlantic croaker, Fantail mullet, Striped mullet, Striped mojarra, White mullet	Two per week	Two per week
Atlantic spadefish	One per week	One per week
Great barracuda, Lane snapper, Pinfish, Red drum, Sheepshead, Skipjack tuna, Southern kingfish, Tripletail, Yellow-edge grouper, Yellofin tuna	One per month	Two per week
Atlantic stingray, Black grouper, Bluefish, Bonefish, Crevalle jack, Gafftopsail catfish, Gag, Greater amberjack, Gulf flounder, Ladyfish, Mutton snapper, Red grouper, Sand seatrout, Scamp, Silver perch, Snook, Spanish mackerel, Spotted seatrout, Wahoo, White grunt	One per month	One per week
Atlantic thread herring, Atlantic weakfish, Black drum, Bluntnose sting ray, Dolphin, Florida pompano, Gray snapper, Hardhead catfish, Hogfish, Lookdown, Pigfish, Red snapper, Southern flounder, Spot, Tarpon, Vermillion snapper, Yellowtail snapper	One per week	Two per week
Blackfish tuna, Cobia, King mackerel < 31 inches, Little tunny, Shark < 43 inches	DO NOT EAT	One per month
King mackerel > 31 inches, Shark > 31 inches	DO NOT EAT	DO NOT EAT

Mercury in the Everglades

- Primary source: **atmospheric deposition**

- **Natural:**

- volcanoes, mercury deposits

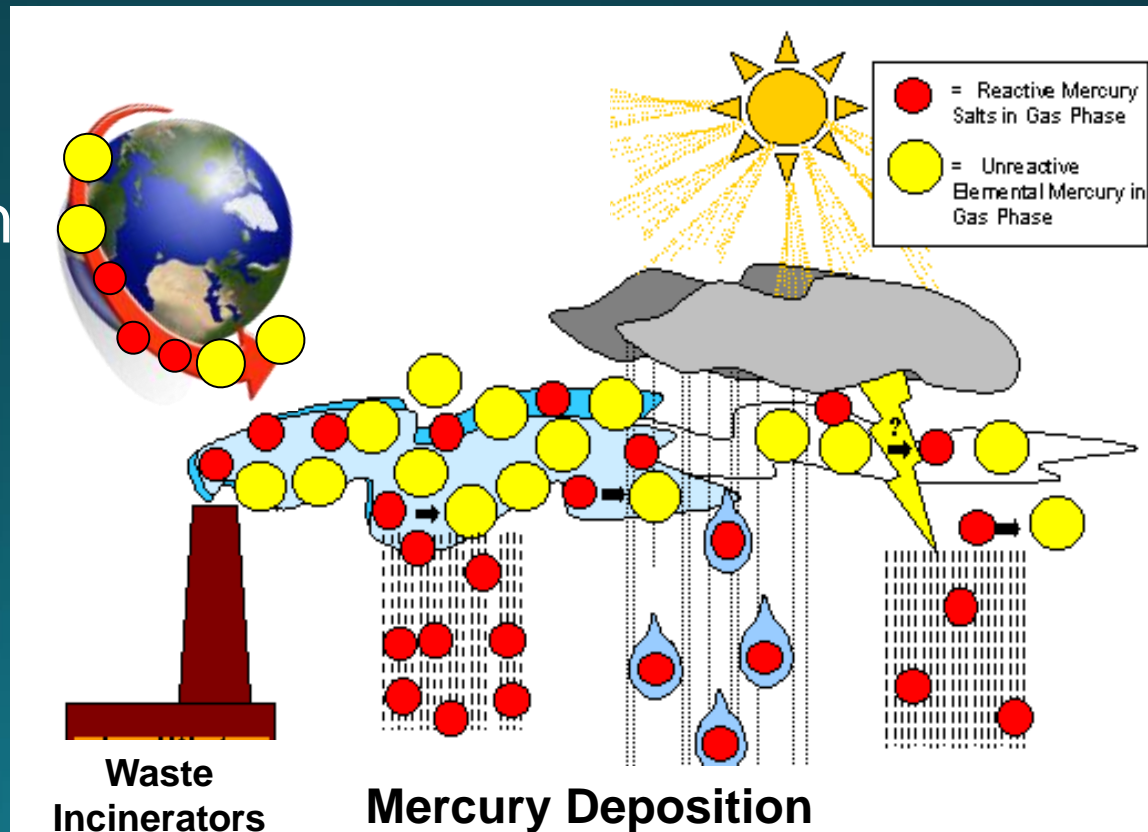
- **Anthropogenic:**

- coal combustion
- waste incineration
- forest burning
- metal processing

- Wet Deposition:

- $\sim 22 \mu\text{g}/\text{m}^2$

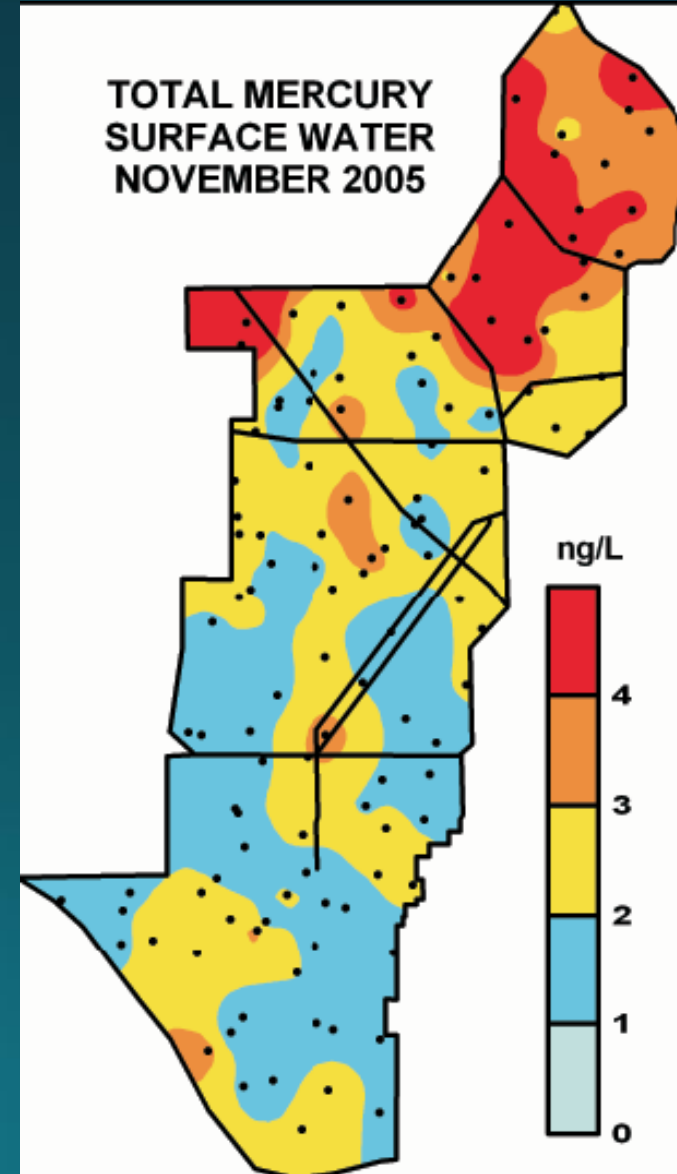
- **Tons of Hg
over a huge area**



Mercury Levels in the Everglades

Source: REMAP 2008

- Mercury levels in Everglades waters are not exceeding **5 ppt (ng/L)**
 - Florida Class III surface water criterion for mercury **12 ppt (ng/L)**
 - No Mercury problem in Everglades waters



High Level of MeHg is a problem in the Everglades

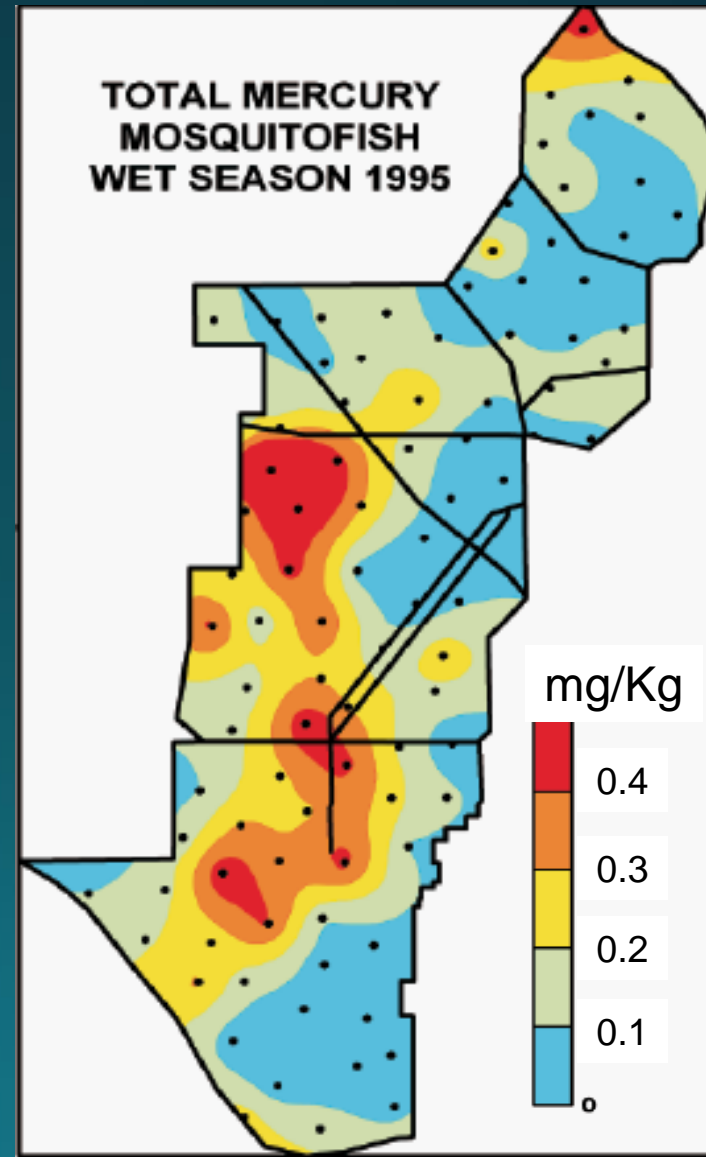
Source: REMAP 2008

- January 2001, EPA published its recommendations for **MeHg**:
 - The criterion is **0.3 mg** MeHg per Kg of fish tissue
- MeHg levels: Up to **3 mg/Kg** in Everglades wildlife

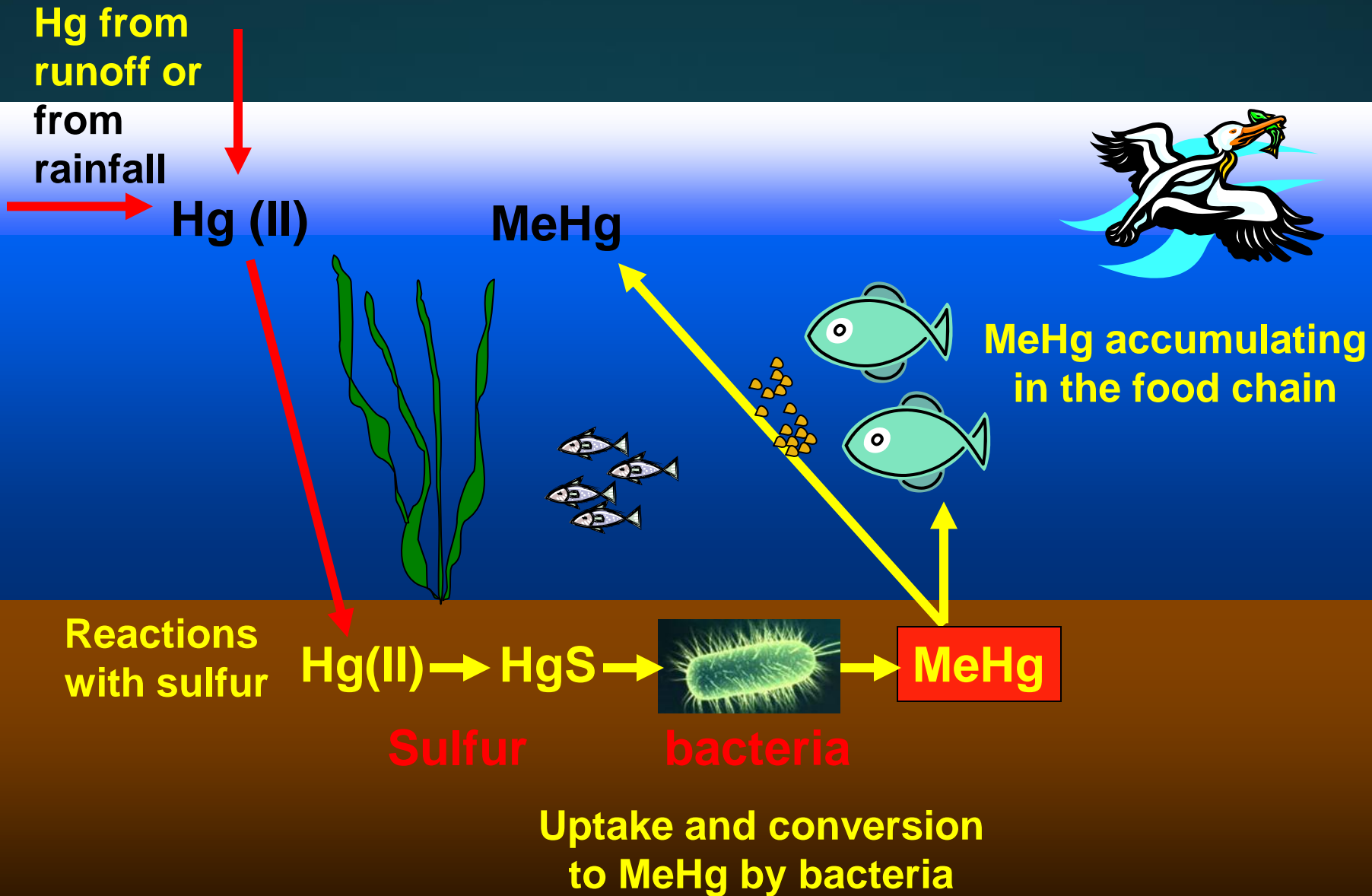
Why ?

What ?

How ?



Mercury Cycling and Formation of MeHg



Parameters impacting Hg methylation

~~Hg inputs~~

Sulfur inputs

pH

Eh

Soil type

Water depth and flow rate

Dissolved organic carbon

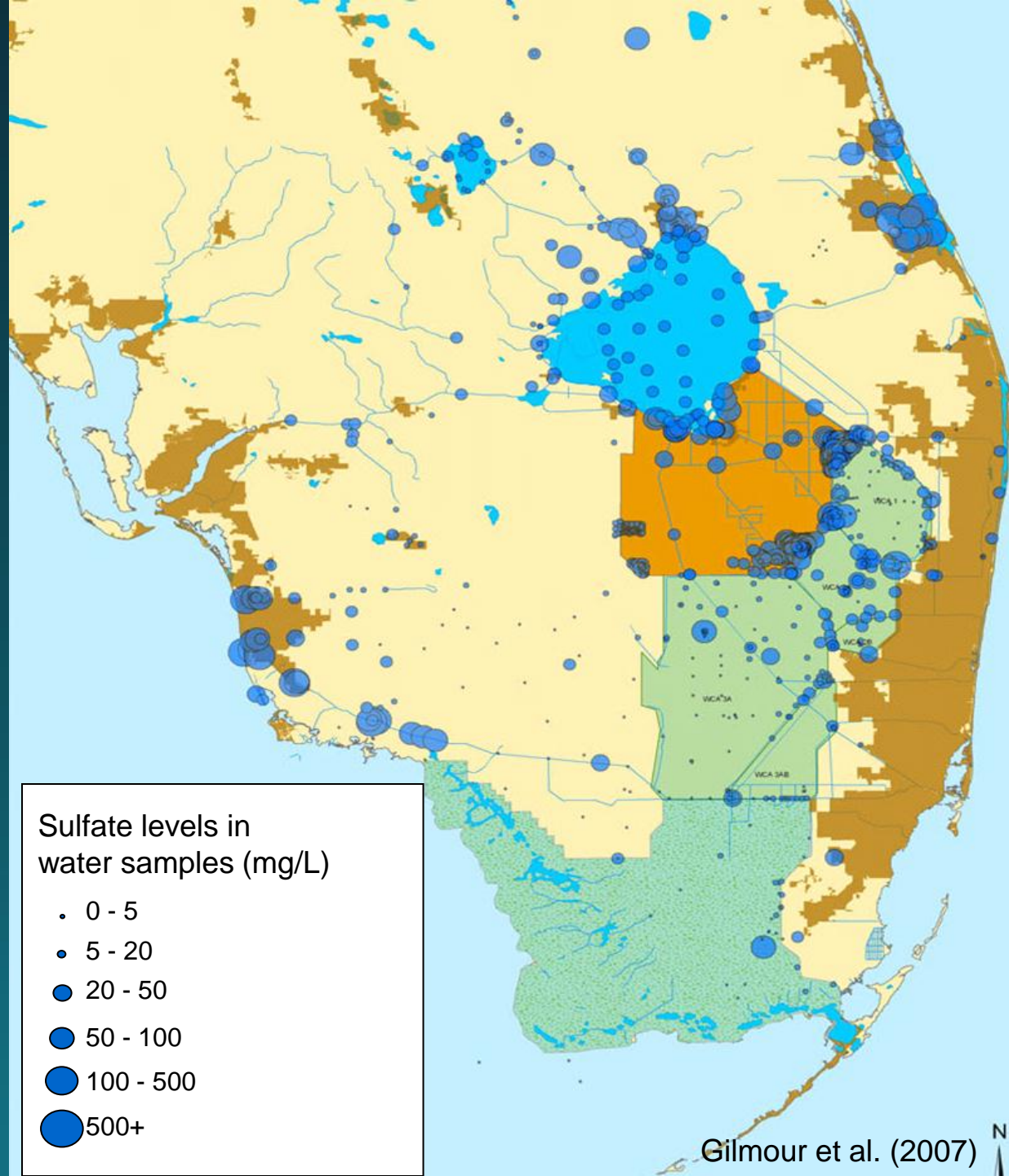
...

Parameters impacting Hg methylation

Sulfur inputs

Sulfur is a major water quality problem facing the Everglades

60 % of
freshwater
Everglades
has higher
sulfate levels
than
background
concentration
(1 mg/L)



Sulfur use in agricultural applications

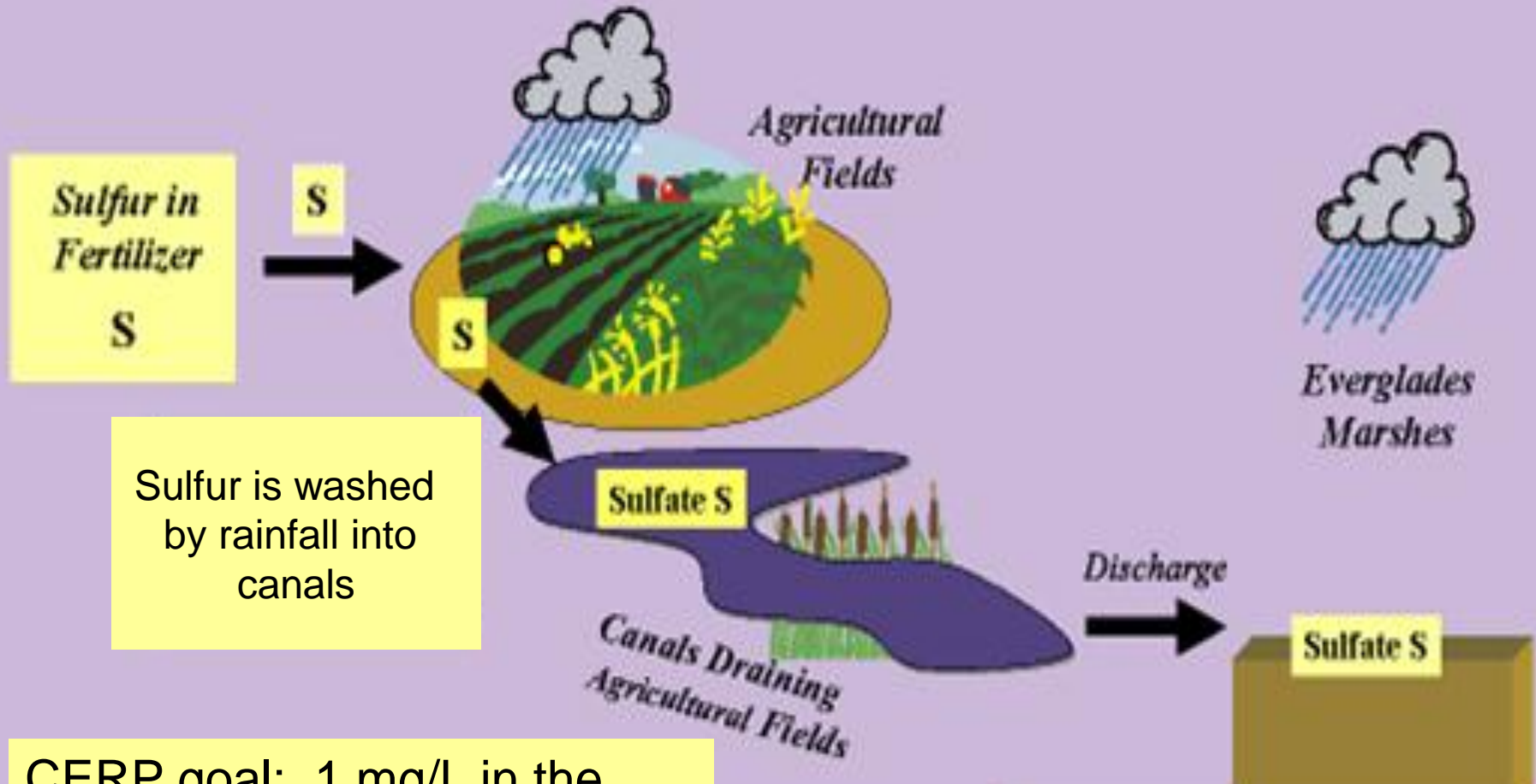
EAA farmers are spreading sulfur:

- In fertilizers (MgSO_4 , $(\text{NH}_4)_2\text{SO}_4$, K_2SO_4 , ...)
- In fungicides (CuSO_4)
- To decrease soil pH and make phosphorus bioavailable (agricultural sulfur)



Sulfur stimulates MeHg production

Source: USGS



CERP goal: 1 mg/L in the Everglades Protection Area (Background concentration)

Sulfate contaminated canal water is discharged into Everglades marshes. It stimulates mercury methylation.

How to control sulfur in the EAA ?

- **BMP implementation in the EAA for sulfur reduction**
 - Examining alternatives for sulfur-containing fungicides
 - Replacing fertilizers using sulfate (ex. MgSO_4 , K_2SO_4)
 - Examining means of lowering soil pH without using sulfur
- **STA design**
 - Reducing the flow-rate and increase the residence time to improve STA capacity of removing sulfate
 - Investigate the possibility of adding iron to increase the sulfate precipitation process
- **Other technologies:**
Permeable reactive barriers, nanofiltration ...

Recommended Actions

- Regular and comprehensive fish monitoring in the Everglades
- “NO NEW SULFATE” in the EAA
- New Numeric Standards for Sulfate in South Florida

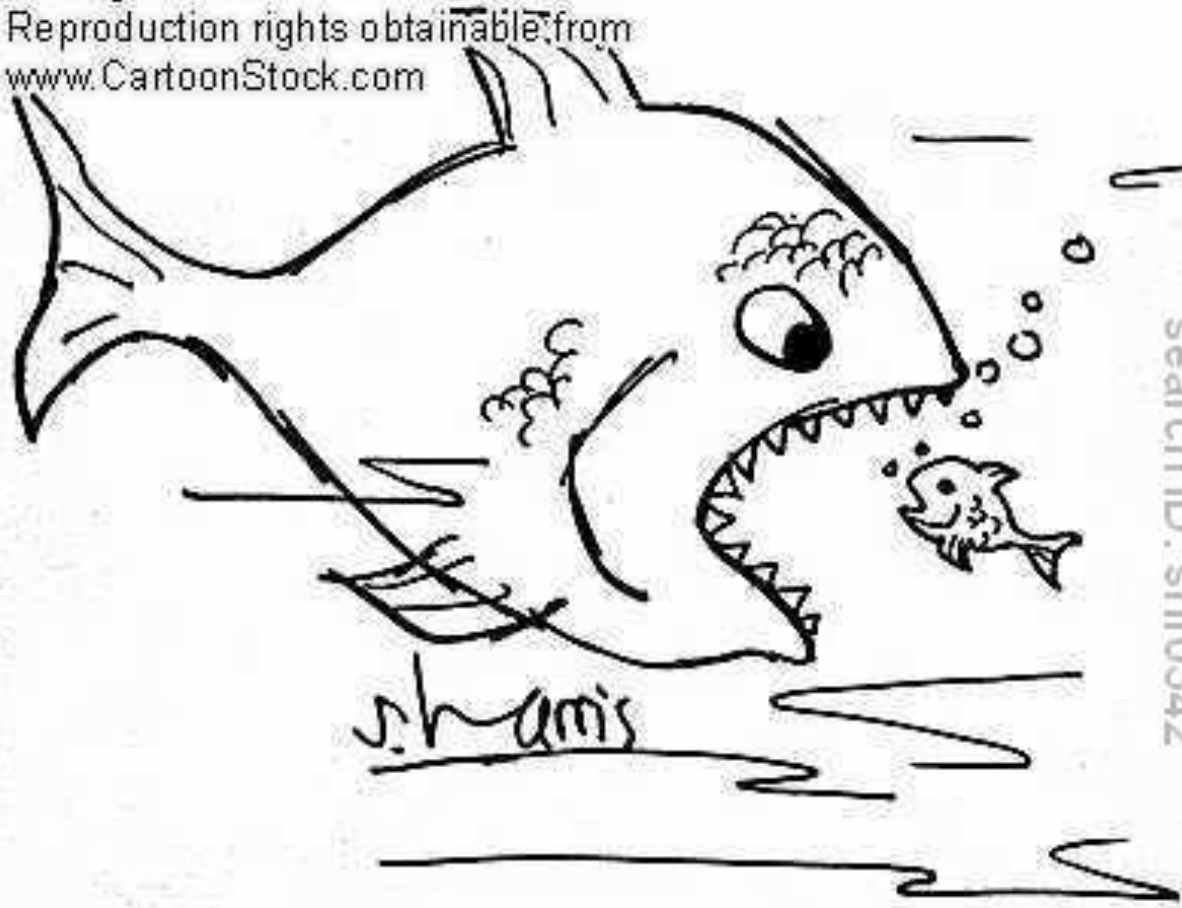


PICK YOUR POISON:
If One Pollutant Doesn't
Take Down the Everglades,



Another Might

© Original Artist
Reproduction rights obtainable from
www.CartoonStock.com



search ID: shr0342

“Idiot—I’m full of mercury.”

Mercury and Methylmercury in the Everglades

G. Melodie Naja
Everglades Foundation
mnaja@evergladesfoundation.org

