

Distribution Of Mercury In Ecosystem Components In The Everglades: A Mass Budget Perspective

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Hg contamination in the Everglades



WARNING

The Florida Department of Health and Rehabilitative Services has issued a health advisory urging limited consumption of largemouth bass and warmouth caught in certain portions of the Everglades due to excessive accumulation of the element mercury.

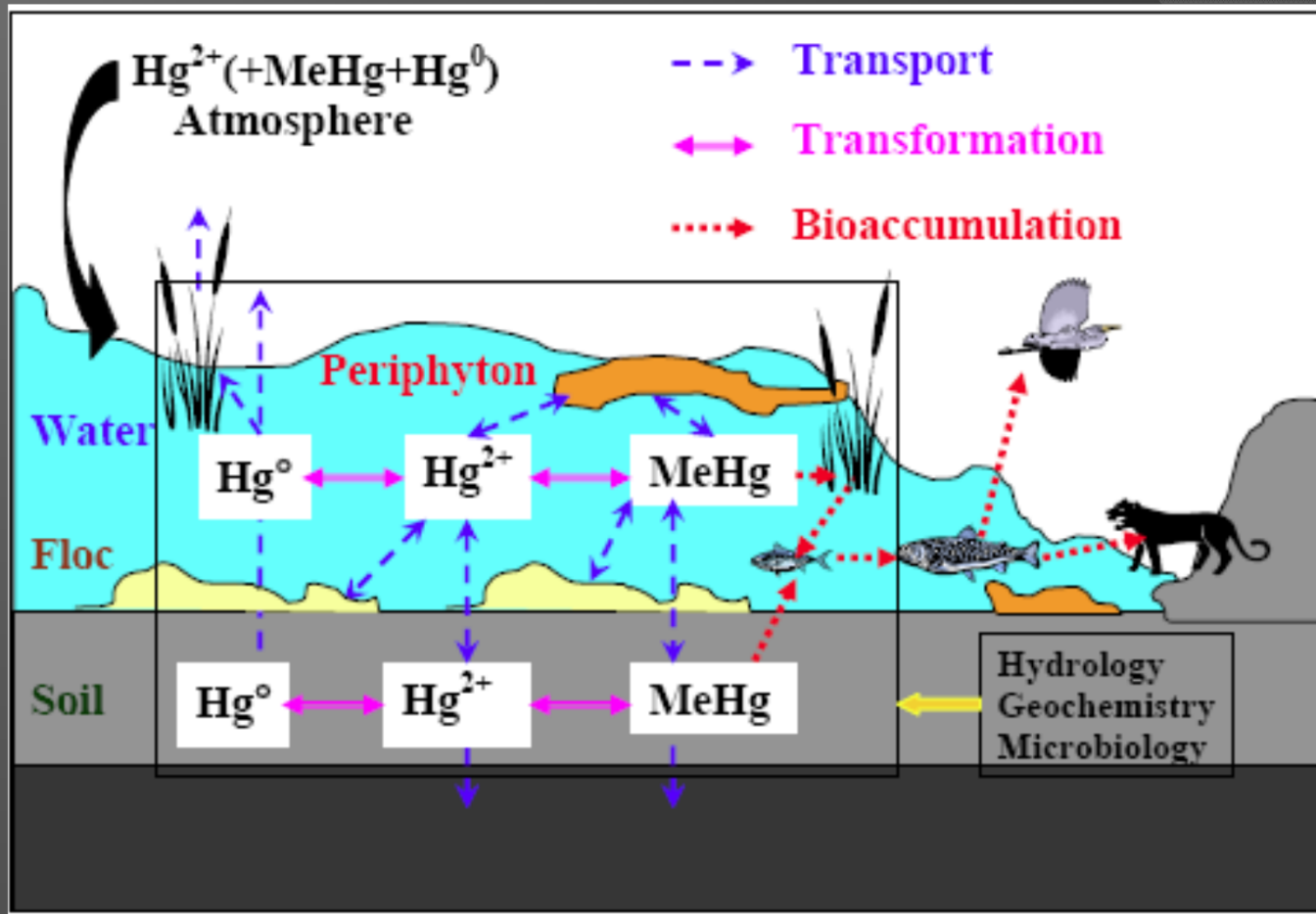
Hg

- Fish caught in Arthur R. Marshall Loxahatchee National Wildlife Refuge Water Conservation Area (1) should not be eaten more than once per week by adults and not more than once per month by children under 15 and pregnant women.
- Fish caught in Water Conservation Areas 2a and 3 should not be eaten at all.

For additional information, contact the Florida Department of Health and Rehabilitative Services at (405) 355-3018.



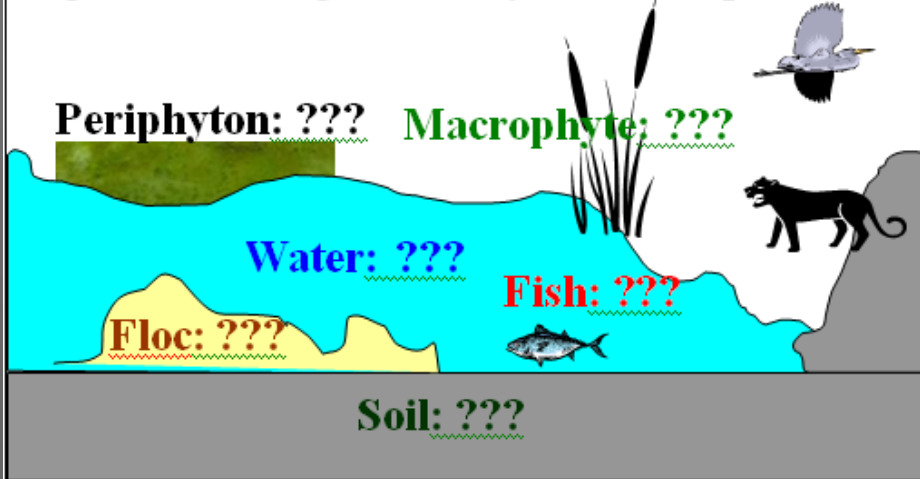
Mercury Cycling in the Florida Everglades



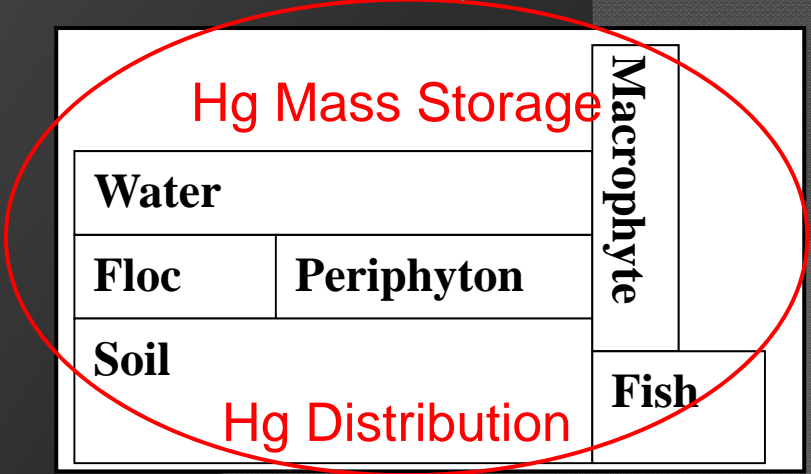
Ecosystem-wide Study



Hg Mass Storage in Ecosystem Components



Simplified Model



Regional Environmental Monitoring and Assessment Program (R-EMAP)

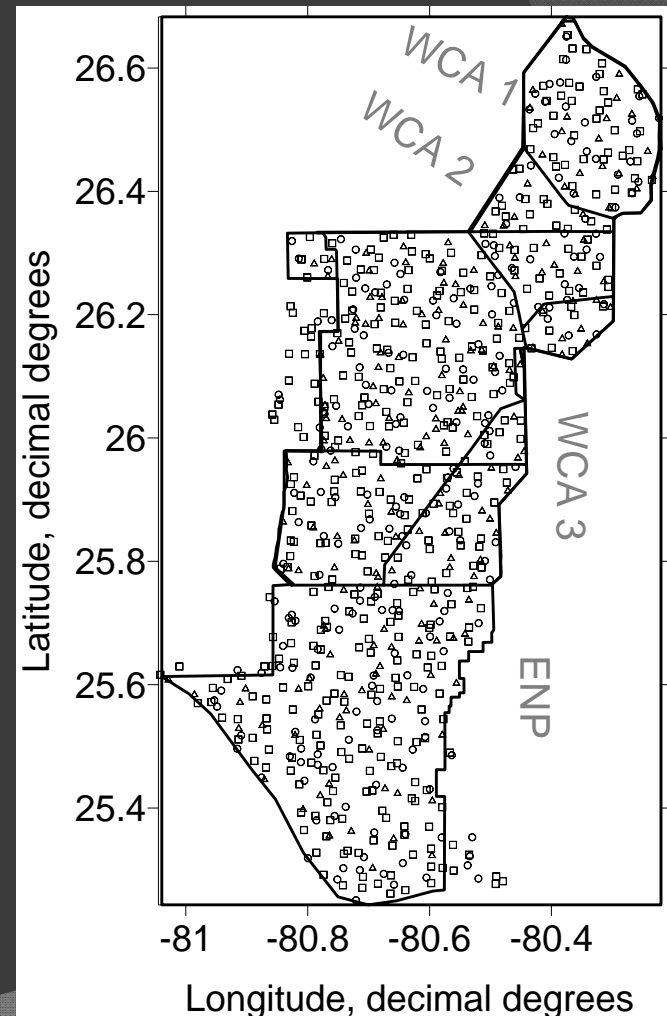
Ecosystem-wide Sampling

Probability Sampling Design

Phase III:
2005

Phase IV:
2013-2014

(Scheidt and Kalla, 2007; Stober et al. 2001)



Hg Mass Storage Calculations

Horvitz-Thompson Theorem

Soil:

THg concentration

Soil mass

THg mass

Inclusion probability

$$M_{SD}^{THg} = \frac{\sum_{i=1}^n C_{SDi}^{THg} \times d_{SDi} \times BD_{SDi}}{\sum_{i=1}^n \left(\frac{1}{\pi_i}\right)} \times A \times 10^6$$

(Horvitz and Thompson 1952; Stober et al. 2001; Liu et al., 2011)

Hg Mass Storage Calculations

Water:

$$M_{SW}^{THg} = \frac{\sum_{i=1}^n \frac{C_{SW}^{THg} \times d_{SWi}}{\pi_i}}{\sum_{i=1}^n \left(\frac{1}{\pi_i}\right)} \times A \times 10^3$$

Periphyton:

$$M_{PE}^{THg} = \frac{\sum_{i=1}^n \frac{C_{PE}^{THg} \times BM_{PEi}}{\pi_i}}{\sum_{i=1}^n \left(\frac{1}{\pi_i}\right)} \times A$$

Floc:

$$M_{FC}^{THg} = \frac{\sum_{i=1}^n \frac{C_{FC}^{THg} \times d_{FCi} \times BD_{FCi}}{\pi_i}}{\sum_{i=1}^n \left(\frac{1}{\pi_i}\right)} \times A \times 10^6$$

Macrophyte:

$$M_{PE}^{THg} = \frac{\sum_{i=1}^n \frac{C_{PE}^{THg} \times BM_{PEi}}{\pi_i}}{\sum_{i=1}^n \left(\frac{1}{\pi_i}\right)} \times A$$

Fish:

$$M_{FS}^{THg} = \frac{\sum_{i=1}^n \frac{C_{FS}^{THg} \times W_{FSi} \times BM_{FSi}}{\pi_i}}{\sum_{i=1}^n \left(\frac{1}{\pi_i}\right)} \times A$$

Databases

- ◎ EPA Everglades R-EMAP
- ◎ USGS ACME
- ◎ SFWMD DBHRDRO
- ◎ Others

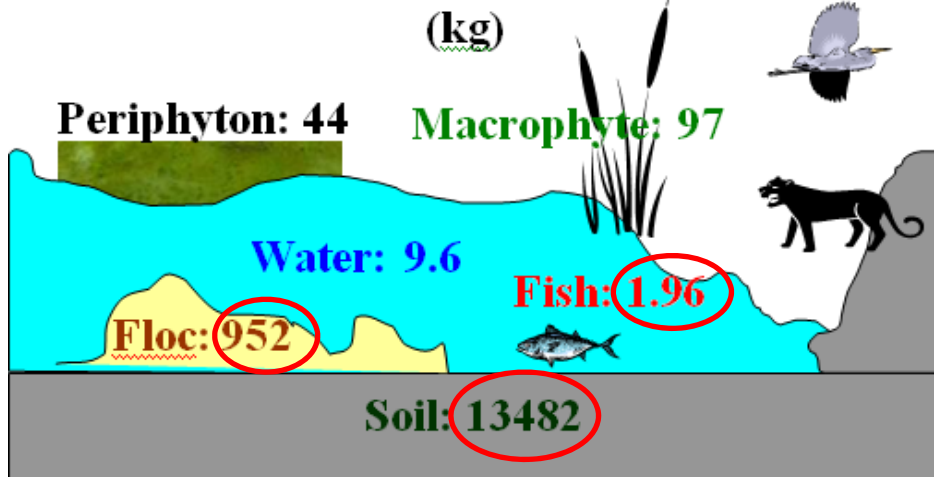
(Gaff et al., 2004; Gaiser, 2008; Gilmour et al., 2006; McCormick et al., 1998)

Hg mass storage in the Everglades

THg (kg)

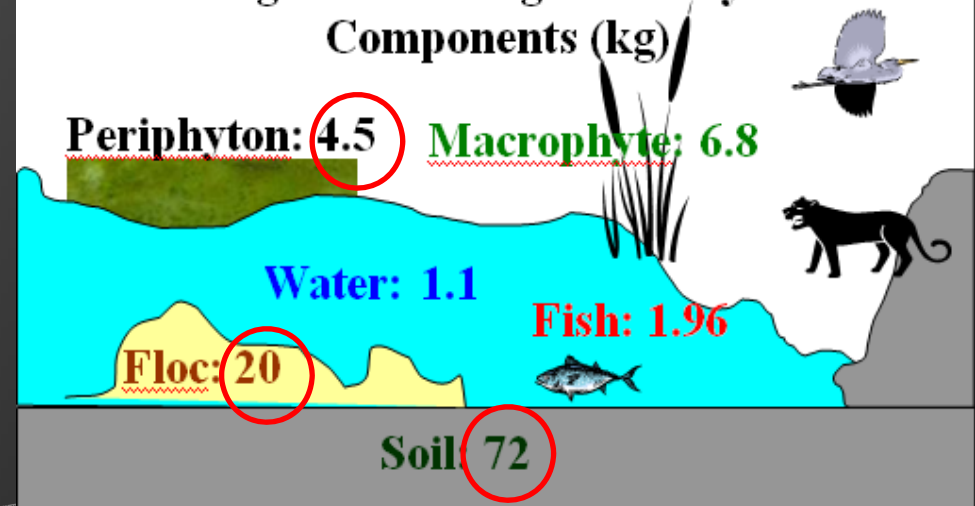
2005

Hg Mass Storage in Ecosystem Components (kg)



MeHg (kg)

MeHg Mass Storage in Ecosystem Components (kg)

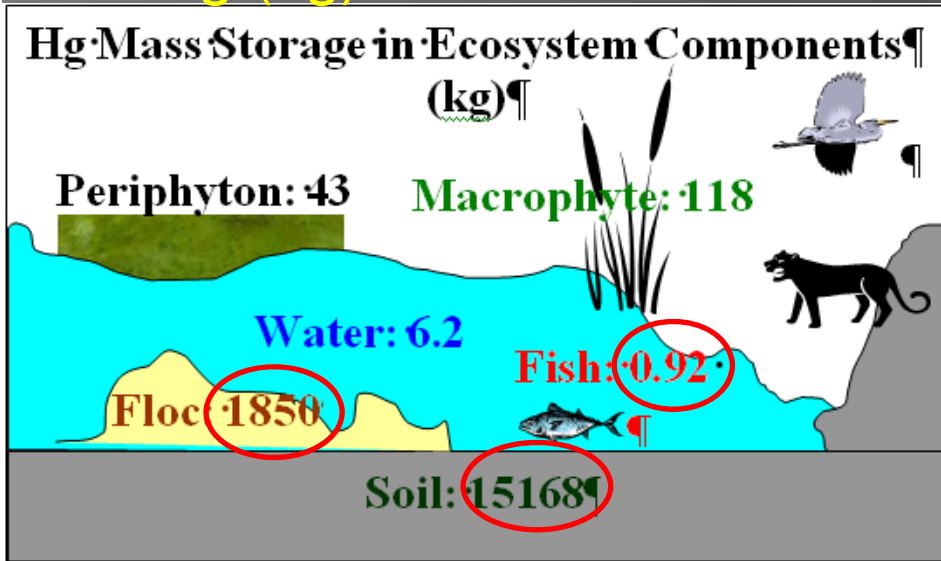


(Liu et al., 2011)

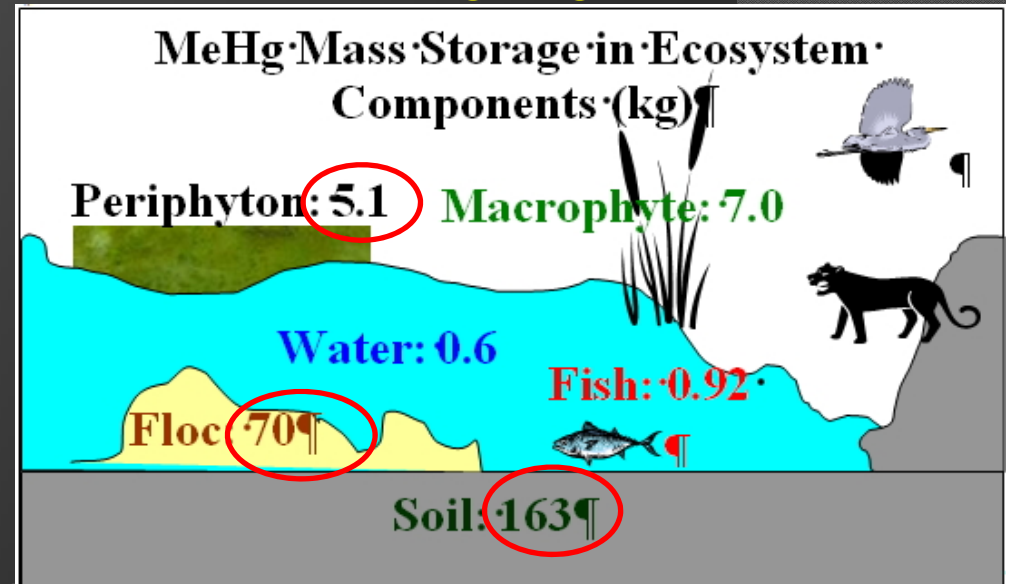
Hg mass storage in the Everglades

THg (kg)

2014



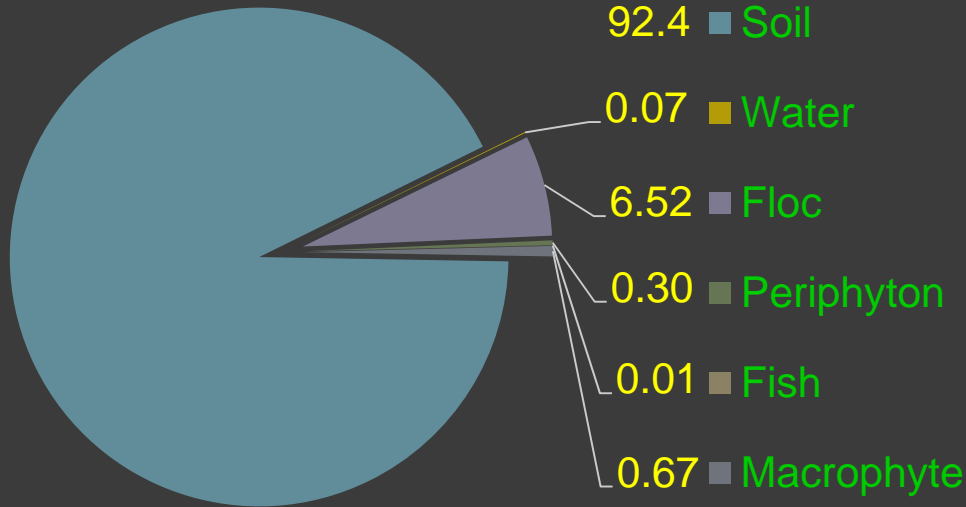
MeHg (kg)



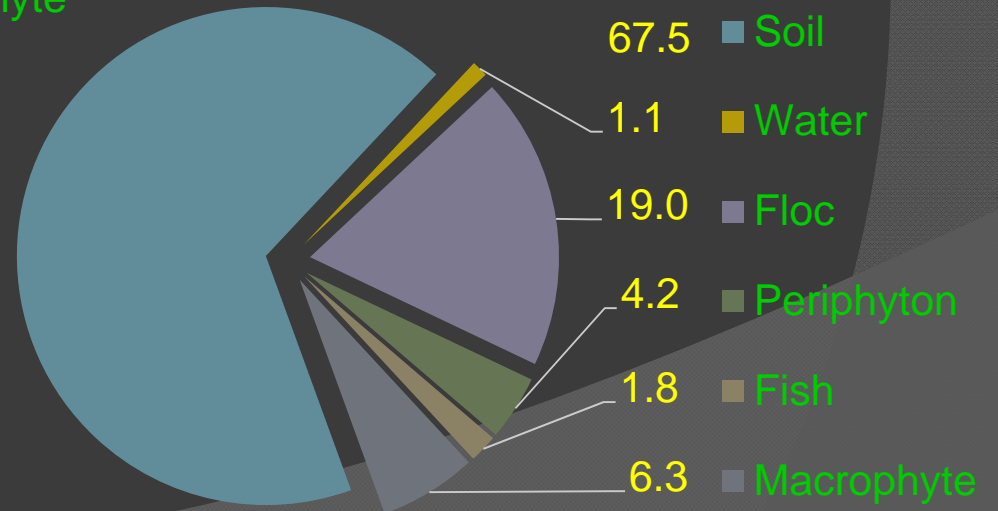
Hg distribution in ecosystem components

2005

THg (%)



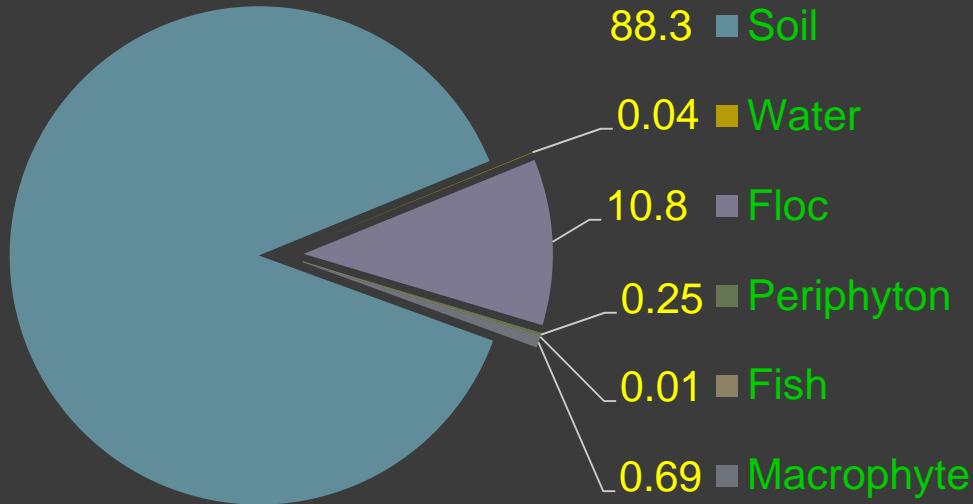
MeHg (%)



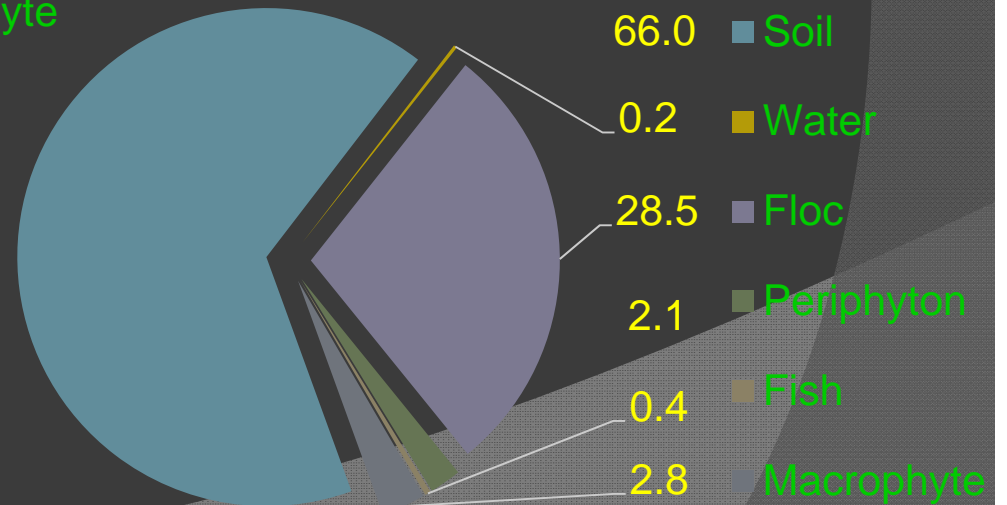
Hg distribution in ecosystem components

2014

THg (%)



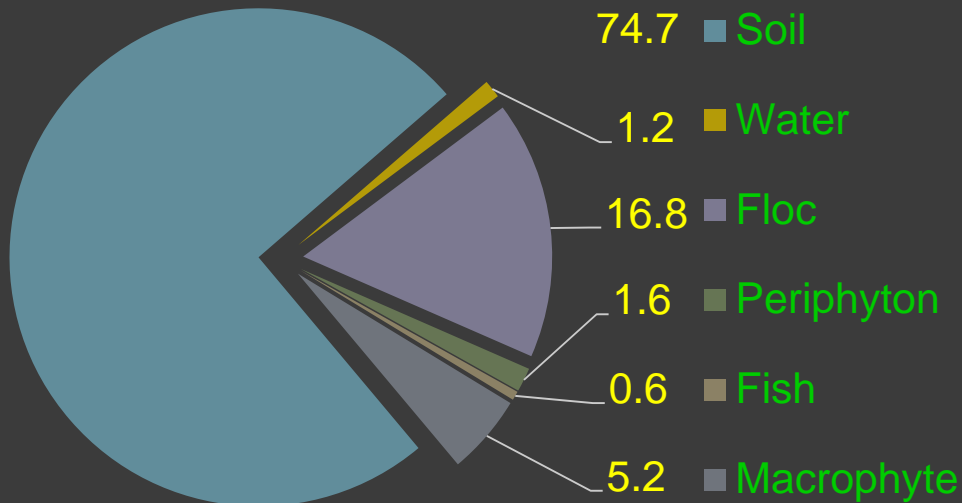
MeHg (%)



Hg distribution in ecosystem components

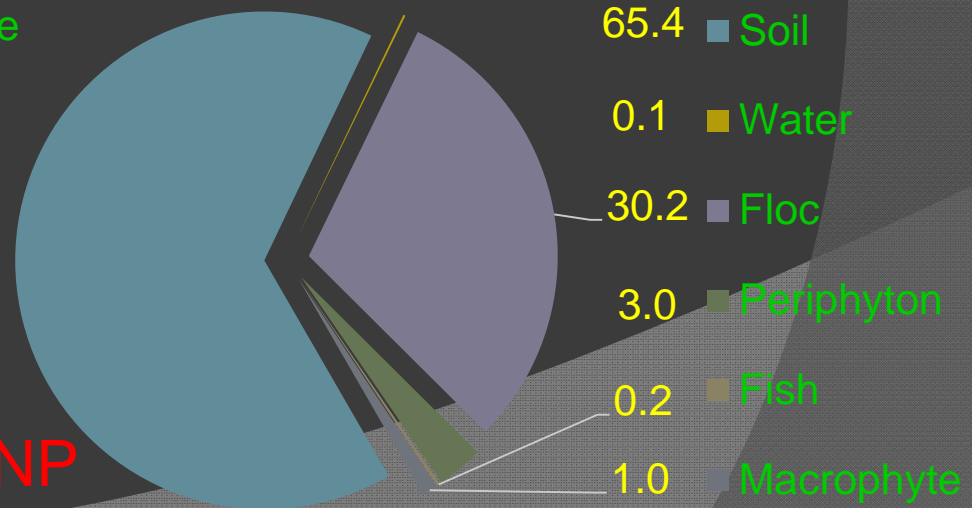
Spatial differences

MeHg (%)



WCA2

MeHg (%)



ENP

Summary

- THg mass: Soil (and floc)
- MeHg mass: Soil, floc, macrophyte, and periphyton
- Hg storage: More complete mass budget of Hg;
Hg distribution: Implication on Hg cycling and accumulation

Acknowledgements

- EPA Office of Research and Development
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- National Park Service
- Army Corps of Engineers
- Florida Department of Environmental Protection