Fate of Seasonally Deposited Mercury in the Florida Everglades

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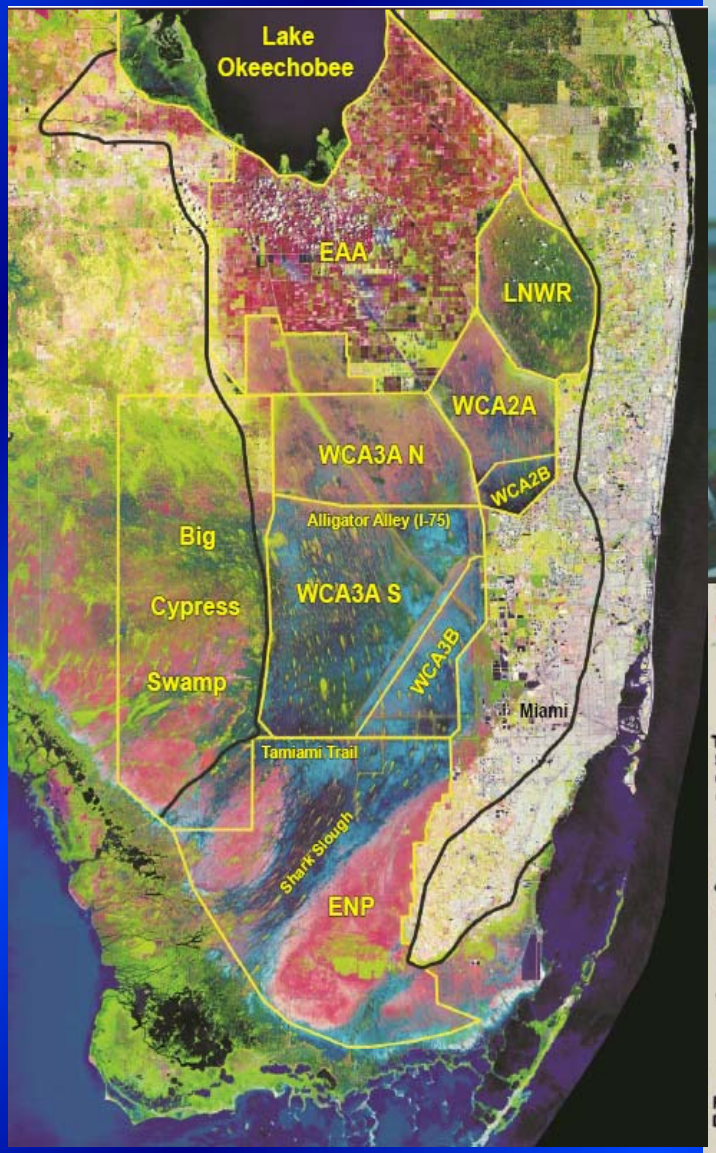
Hg contamination in the Everglades



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

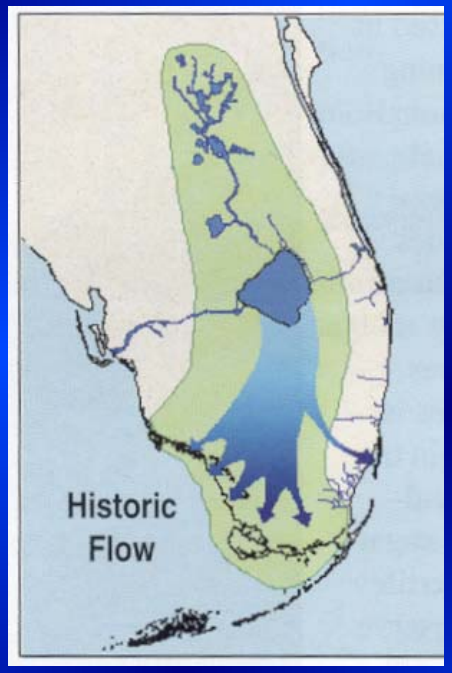
- Fish caught in Arthur [illegible] Loxahatchee National Wildlife [illegible] Water Conservation Area 1 should not be eaten more than one per week by adults and no more than once per month by children under 15 and pregnant women.
- Fish caught in Water Conservation Areas 2a and 3 should not be eaten at all.

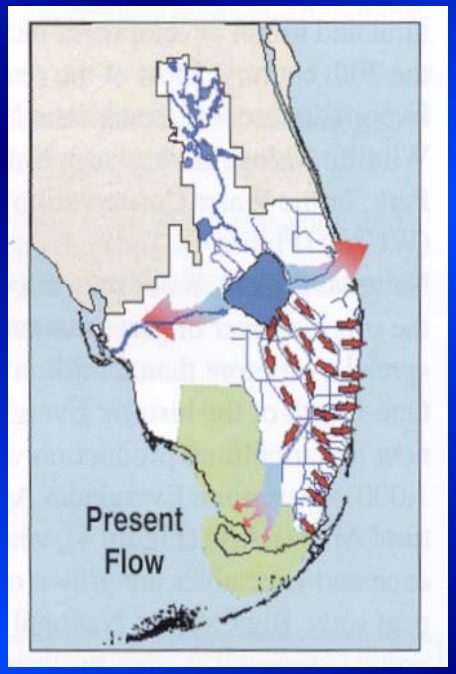
For additional information, contact the Florida Department of Health and Rehabilitative Services at (405) 355-3018.

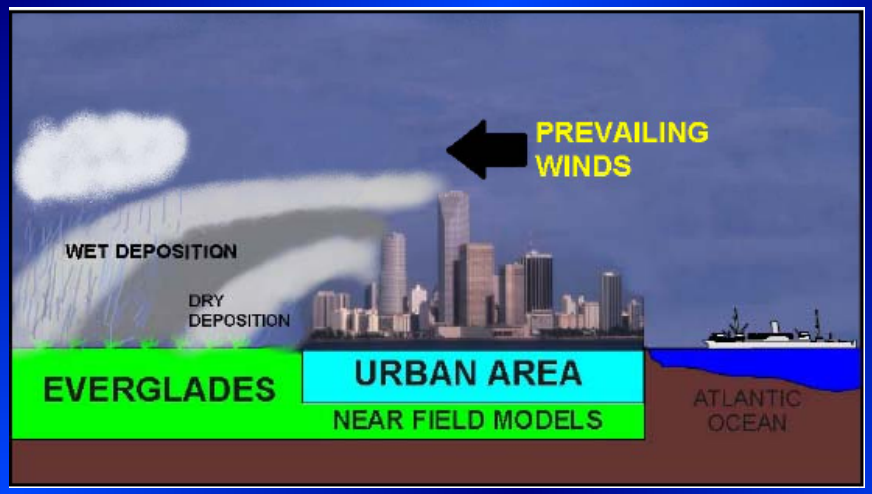
Everglades wading birds population significantly declined during 1900s.

A Florida panther might have died from Hg toxicity in 1989.

Where does Hg come from?

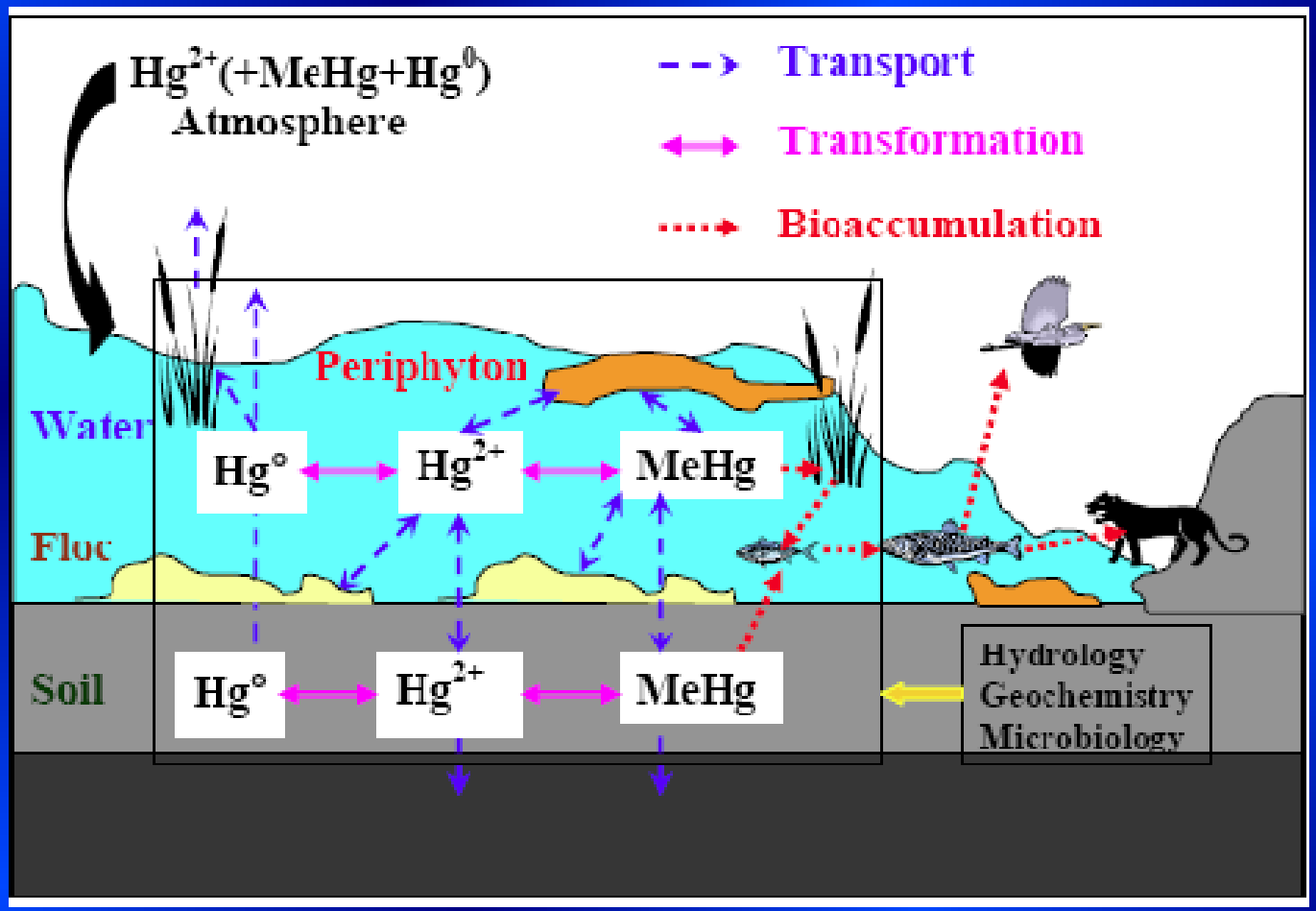






- No source of industrial Hg discharge
- Possible sources:
  - Deposition
  - Water flow
  - Peat decay
  - Fire
  - Rock erosion

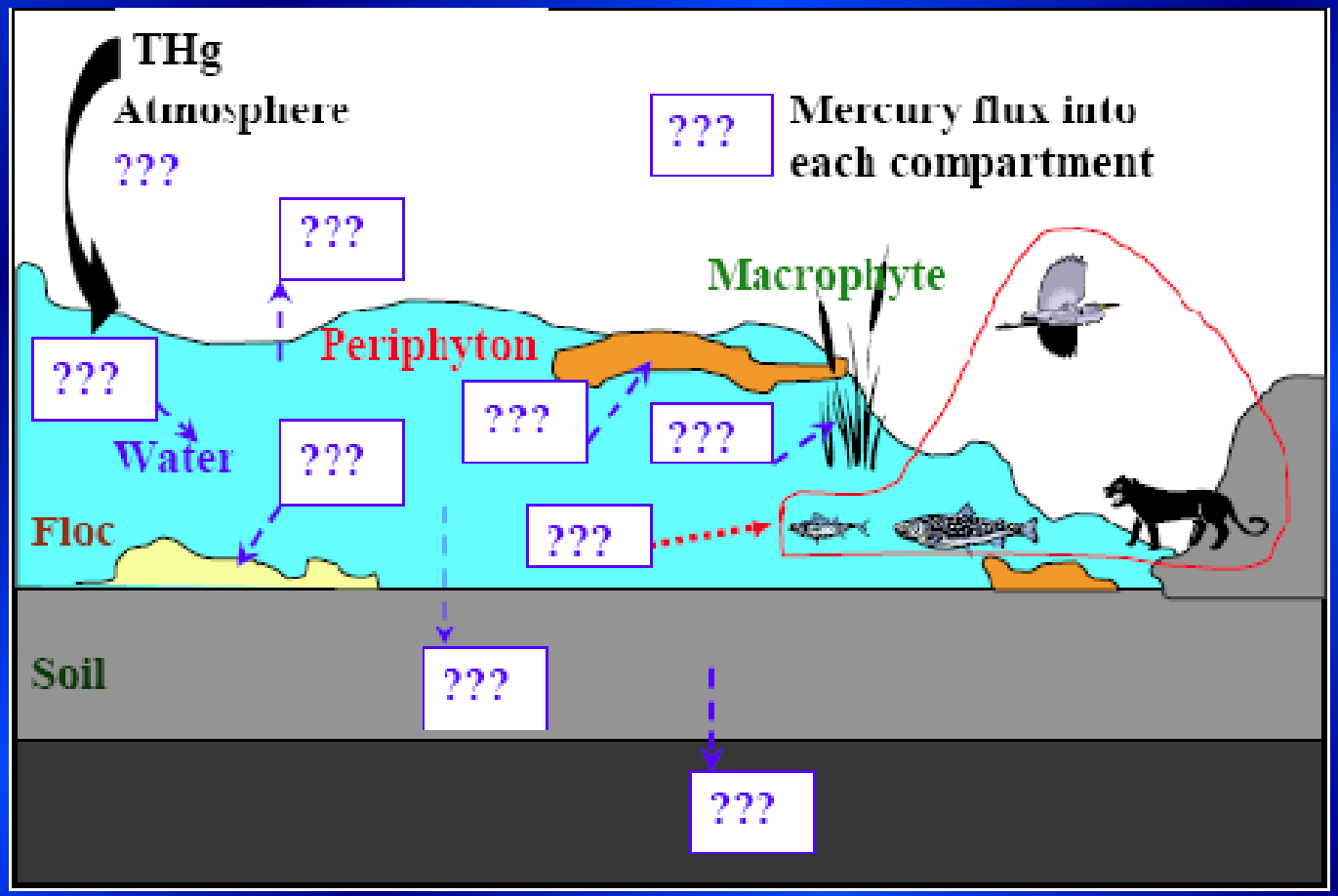
Where does Hg go post deposition?



Mercury Cycling in the Florida Everglades

Question:

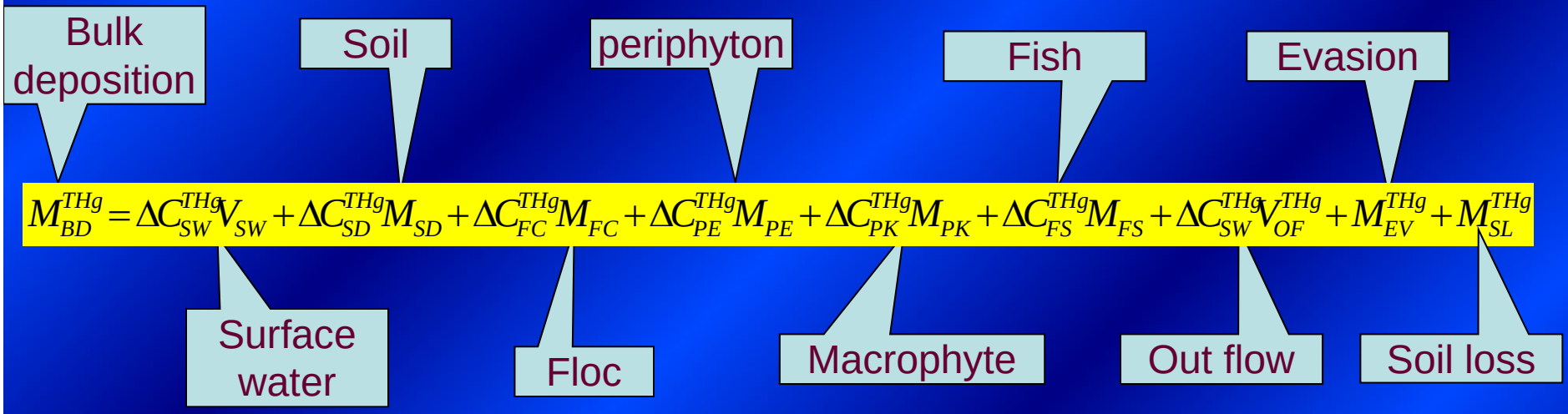
How much NEW-Hg is entering each ecosystem component of the Everglades during a season?



Objective

- To construct mass budget of seasonally deposited Hg for each management unit of the Everglades
  - WCA 1
  - WCA 2
  - WCA 3
  - ENP

Method



Assumptions:

1) New Hg will be compartmentalized into each ecosystem component post deposition;

2) New Hg will result in an increase in Hg concentration of that component;

3) Compartmentalization of new Hg will follow the same patterns in which the legacy Hg is present

$$M_{BD}^{THg} = \Delta C_{SW}^{THg} V_{SW} + \Delta C_{SD}^{THg} M_{SD} + \Delta C_{FC}^{THg} M_{FC} + \Delta C_{PE}^{THg} M_{PE} + \Delta C_{PK}^{THg} M_{PK} + \Delta C_{FS}^{THg} M_{FS} + \Delta C_{SW}^{THg} V_{OF}^{THg} + M_{EV}^{THg} + M_{SL}^{THg}$$

Distribution ratio

(R)

Compartmentalization process

- Soil (SD)
- Floc (FC)
- Periphyton (PE)
- Macrophyte (PK)
- Fish (FS)

$$R_{SD} = \frac{Hg_{SD}}{Hg_{SW}}$$

$$R_{FC} = \frac{Hg_{FC}}{Hg_{SW}}$$

$$R_{PE} = \frac{Hg_{PE}}{Hg_{SW}}$$

$$R_{PK} = \frac{Hg_{PK}}{Hg_{SW}}$$

$$R_{FS} = \frac{Hg_{FS}}{Hg_{SW}}$$

$$\Delta C_{SD}^{THg} = \Delta C_{SW}^{THg} * R_{SD}$$

$$\Delta C_{FC}^{THg} = \Delta C_{SW}^{THg} * R_{FC}$$

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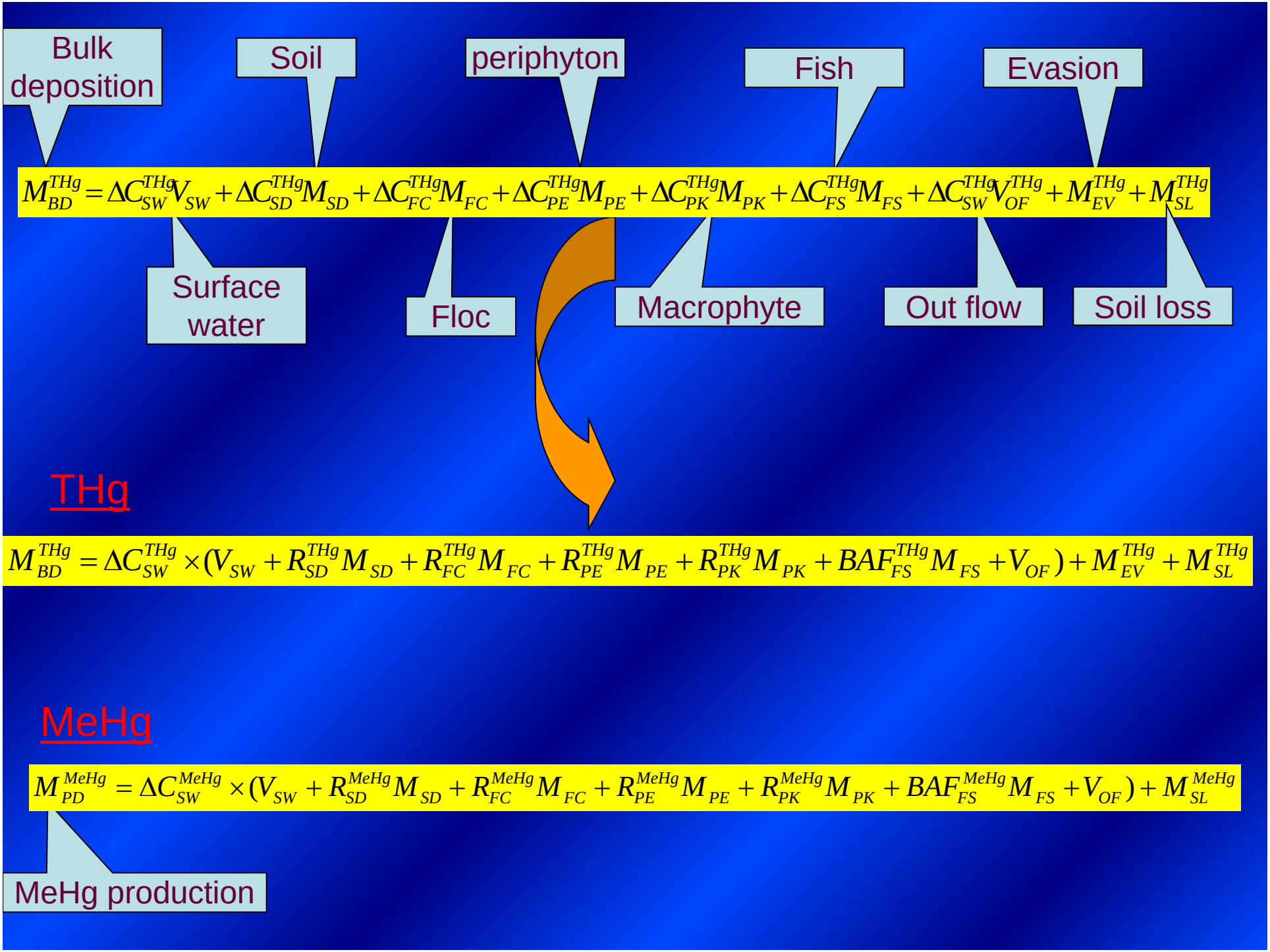
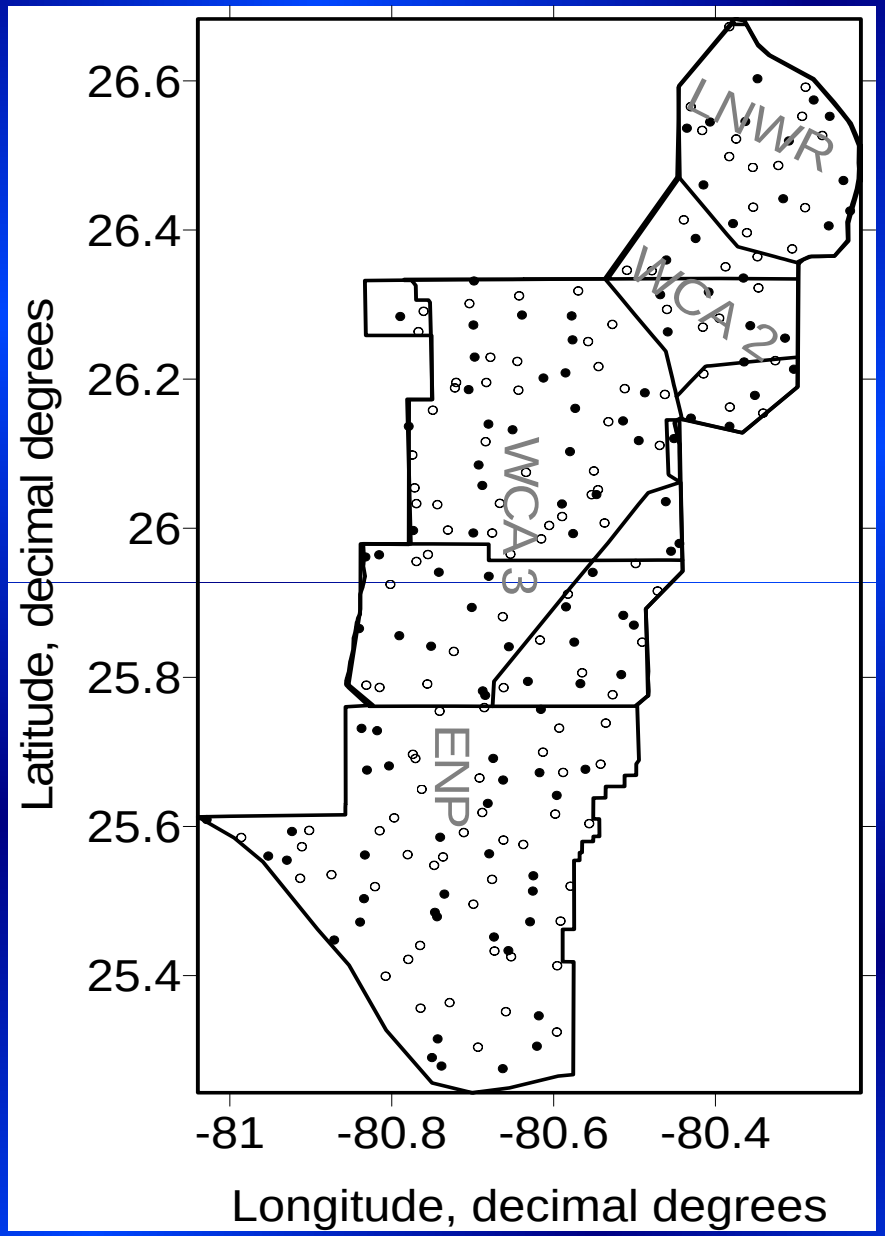

Bulk deposition
Soil
periphyton
Fish
Evasion
$M_{BD}^{THg} = \Delta C_{SW}^{THg} V_{SW} + \Delta C_{SD}^{THg} M_{SD} + \Delta C_{FC}^{THg} M_{FC} + \Delta C_{PE}^{THg} M_{PE} + \Delta C_{PK}^{THg} M_{PK} + \Delta C_{FS}^{THg} M_{FS} + \Delta C_{SW}^{THg} V_{OF}^{THg} + M_{EV}^{THg} + M_{SL}^{THg}$
Surface water
Floc
Macrophyte
Out flow
Soil loss
THg
$M_{BD}^{THg} = \Delta C_{SW}^{THg} \times (V_{SW} + R_{SD}^{THg} M_{SD} + R_{FC}^{THg} M_{FC} + R_{PE}^{THg} M_{PE} + R_{PK}^{THg} M_{PK} + BAF_{FS}^{THg} M_{FS} + V_{OF}) + M_{EV}^{THg} + M_{SL}^{THg}$
MeHg
$M_{PD}^{MeHg} = \Delta C_{SW}^{MeHg} \times (V_{SW} + R_{SD}^{MeHg} M_{SD} + R_{FC}^{MeHg} M_{FC} + R_{PE}^{MeHg} M_{PE} + R_{PK}^{MeHg} M_{PK} + BAF_{FS}^{MeHg} M_{FS} + V_{OF}) + M_{SL}^{MeHg}$
MeHg production

Data Sources:

- EPA Everglades R-EMAP (2005)
- MDN (Hg wet deposition)
- Literature

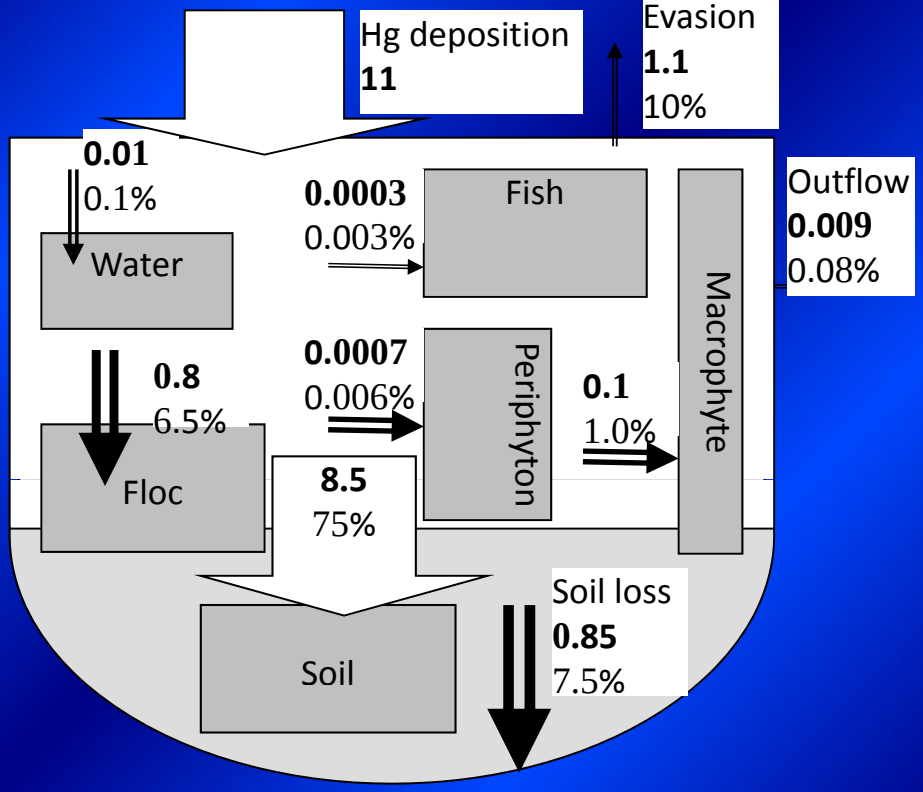


- 2005 R-EMAP

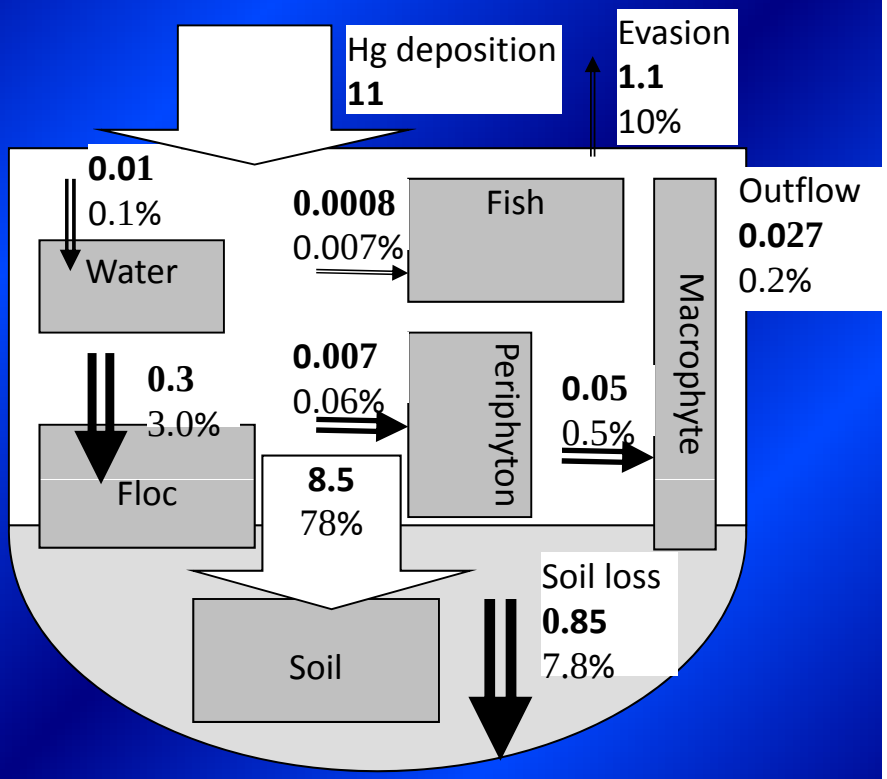
Closed circle: May, 109

Open circle: November, 119

Results

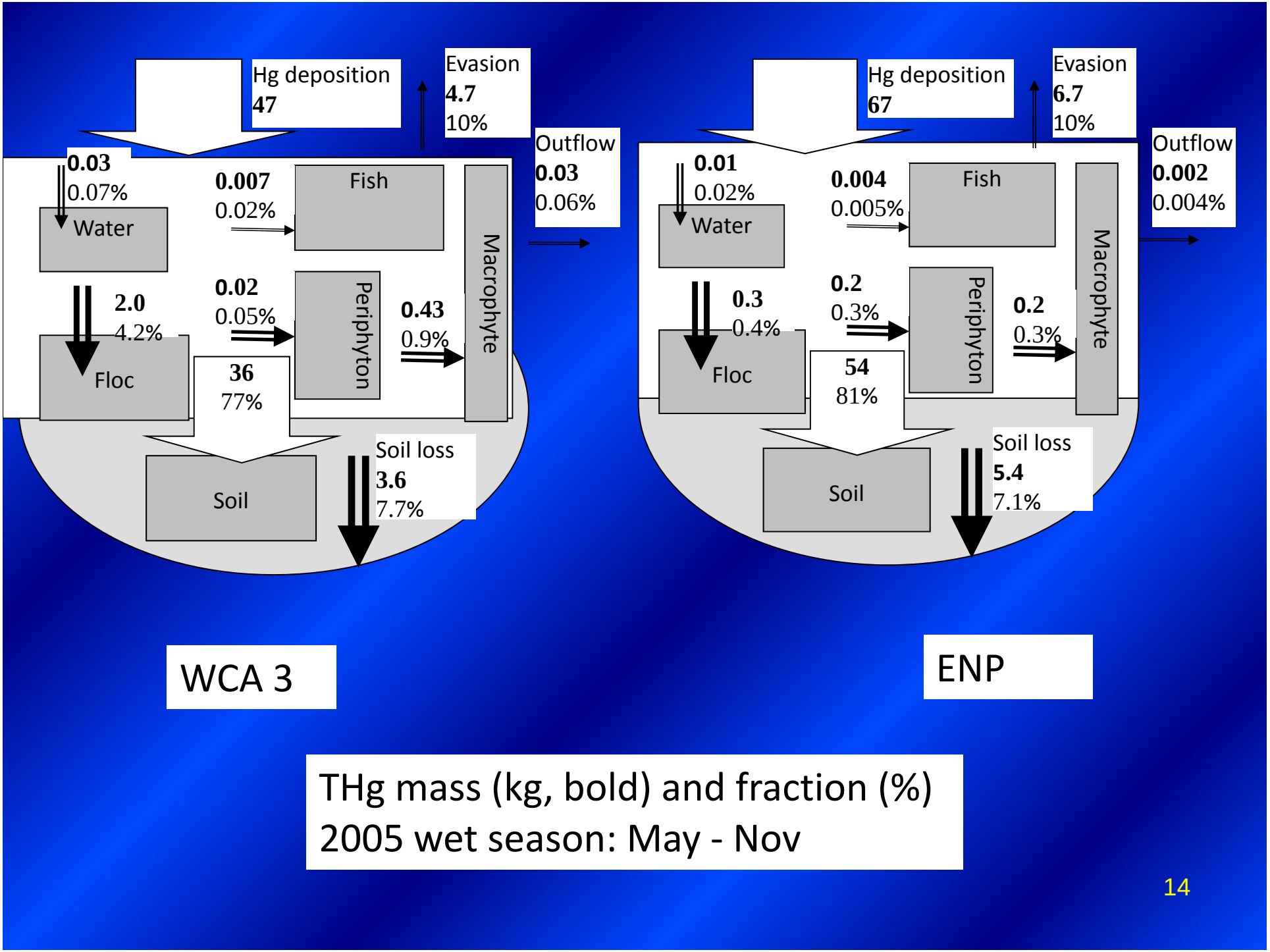


WCA 1



WCA 2

THg mass (kg, bold) and fraction (%)
2005 wet season: May - Nov



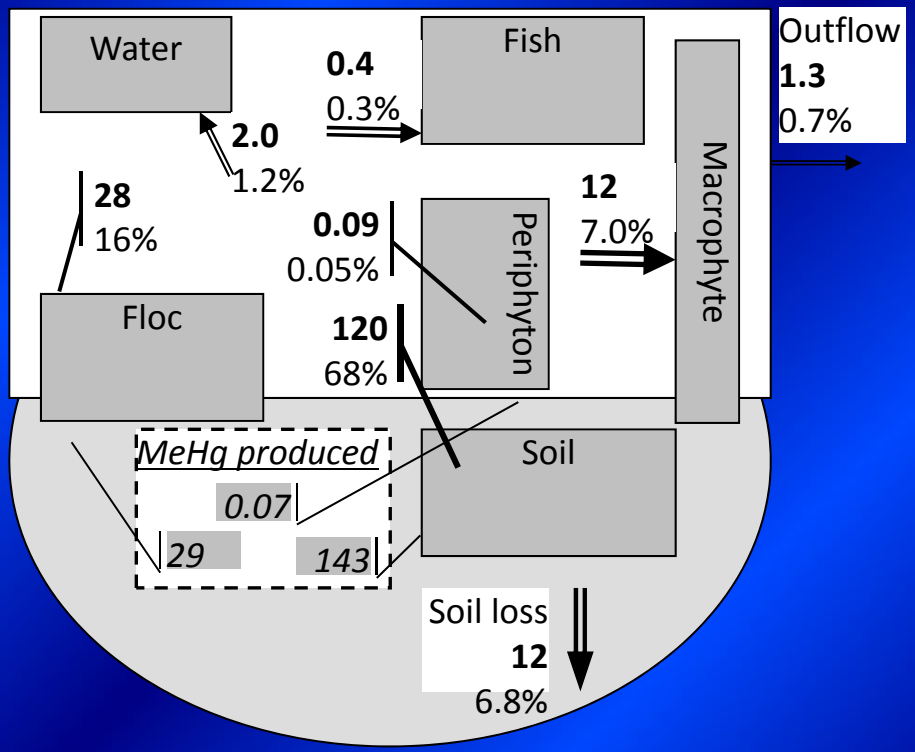
THg mass (kg, bold) and fraction (%)
2005 wet season: May - Nov

Fate of THg deposited in the 2005 wet season

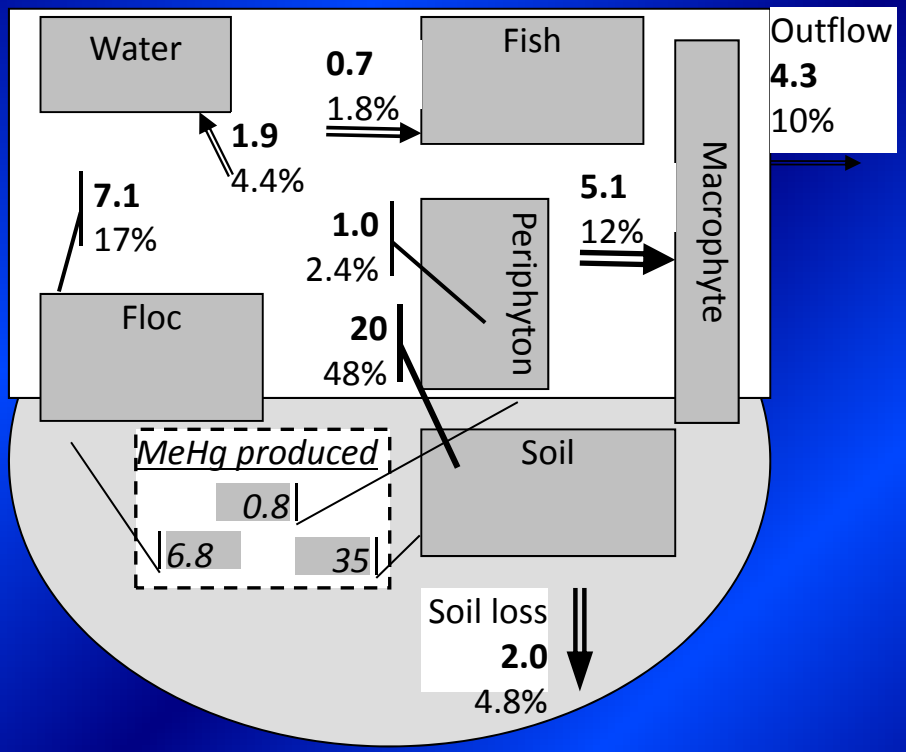
Fraction (%)

Ecosystem Component	WCA 1	WCA 2	WCA 3	ENP
Water	0.12	0.11	0.072	0.020
Soil	75	78	77	81
Floc	6.5	3.0	4.2	0.44
Periphyton	0.19	0.061	0.052	0.16
Macrophyte	0.99	0.49	0.91	0.30
Mosquitofish	0.003	0.007	0.015	0.005

- ✓Soil is the major sink
- ✓Floc is another major sink for WCAs
- ✓Small fraction is accumulated in fish
- ✓80% of deposited THg accumulates in the system

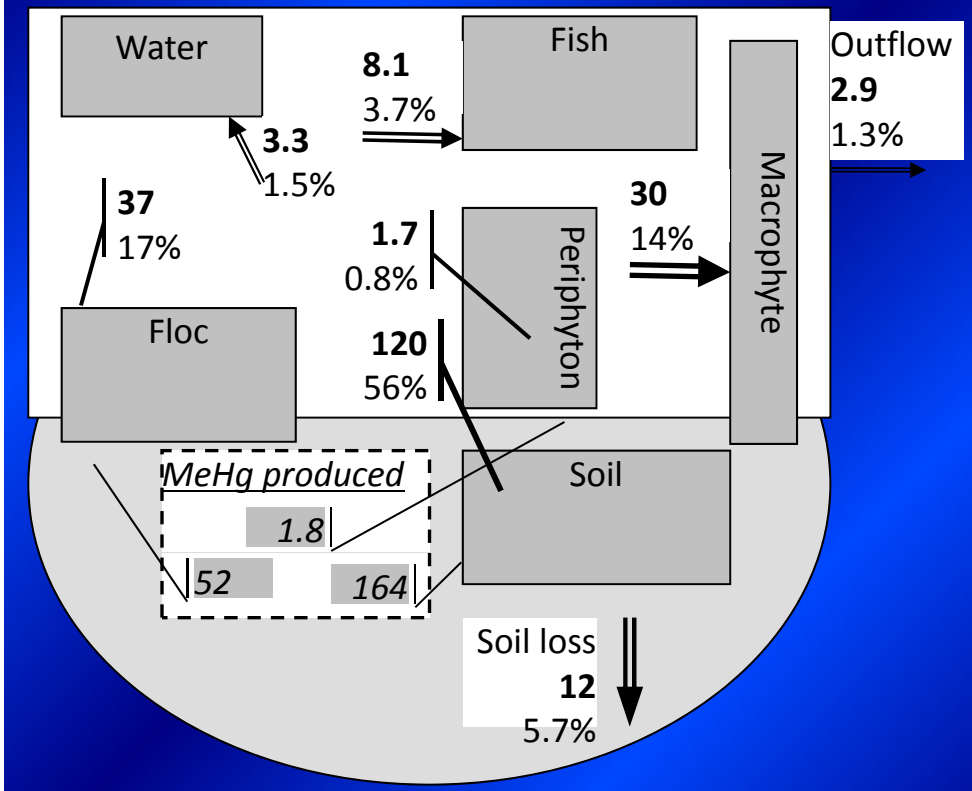


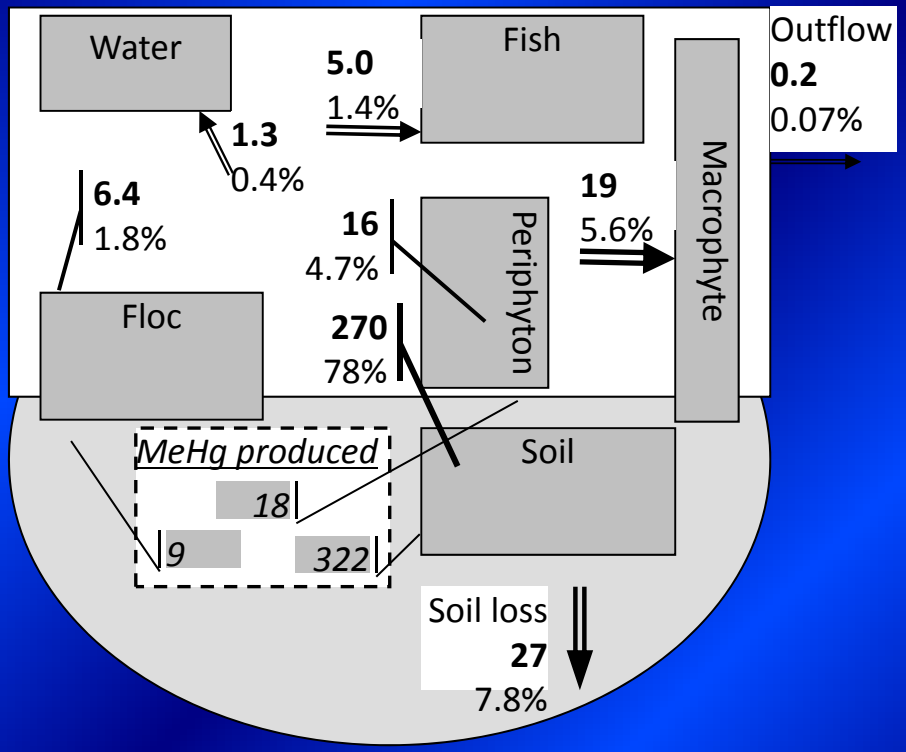
WCA 1



WCA 2

MeHg mass (g, bold) and fraction (%)
2005 wet season: May - Nov





WCA 3

ENP

MeHg mass (g, bold) and fraction (%)
2005 wet season: May - Nov

Fate of MeHg produced from Hg deposited in 2005 wet season

Fraction (%)

Ecosystem Component	WCA 1	WCA 2	WCA 3	ENP
Water	1.1	4.4	1.5	0.38
Soil	66	48	56	80
Floc	16	16	16	1.9
Periphyton	1.6	2.4	0.79	2.9
Macrophyte	6.8	12	14	5.6
Mosquitofish	0.25	1.7	3.6	1.5

- Soil is the major sink, but the fraction may be low
- Floc is another major sink for WCAs (16% of MeHg)
- Macrophyte can be important in retaining MeHg
- Small fraction is accumulated in fish
- Output of MeHg is generally small

Implications

- Different patterns of THg and MeHg compartmentalization
  - In addition to soil, floc and macrophyte can retain considerable fractions of MeHg
- Spatiality of Hg cycling
  - Mass and fraction of Hg entrapped in ecosystem components vary with management units, in particular between WCAs and ENP
- Seasonality of Hg cycling
  - Mass and fraction of Hg in ecosystem components vary between seasons

Acknowledgements

- EPA Office of Research and Development
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