Mass Distribution of Mercury among Ecosystem Components in the Florida Everglades

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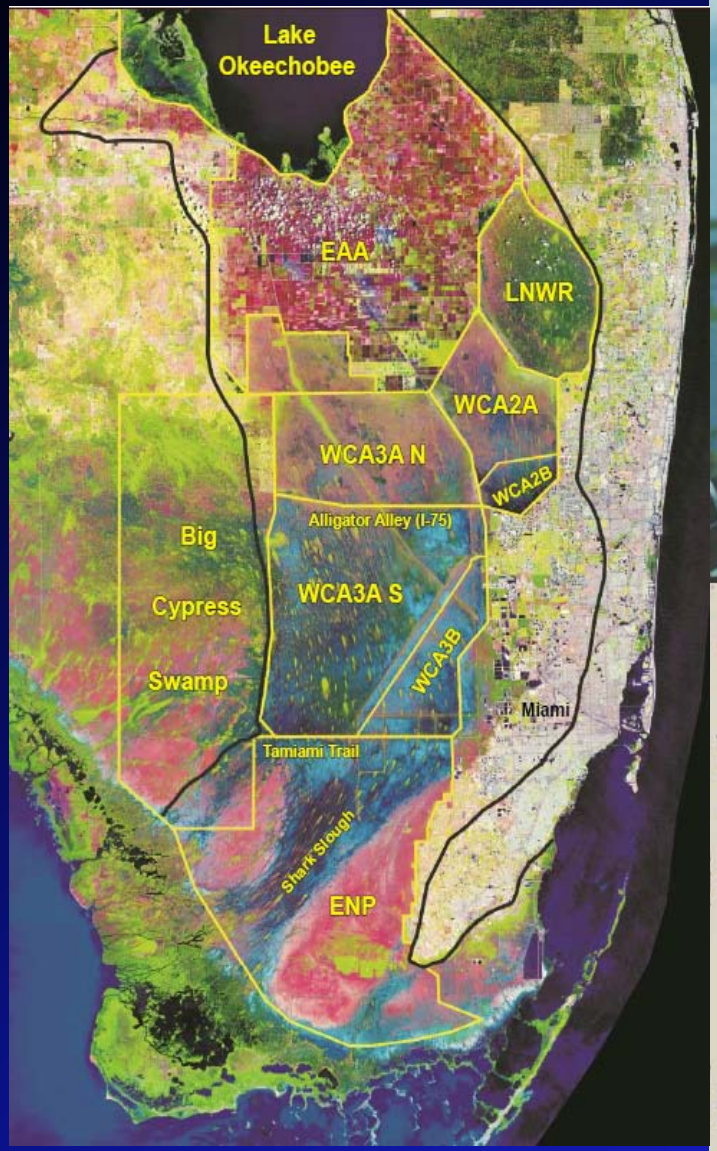
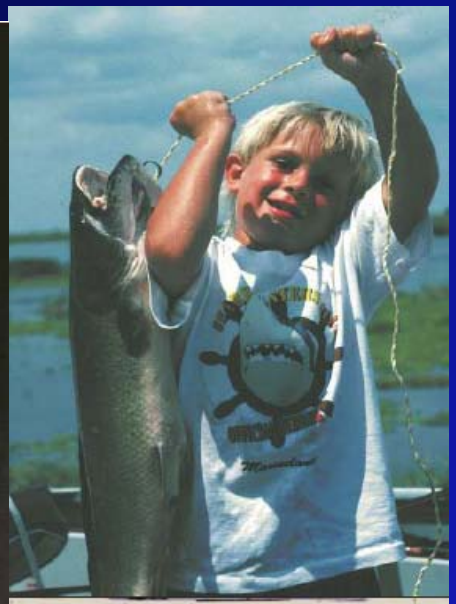
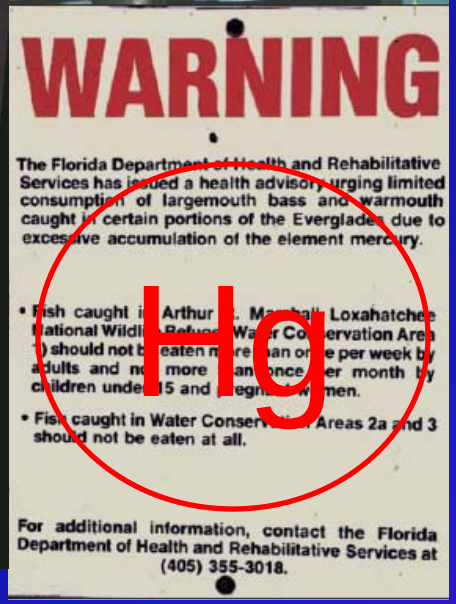
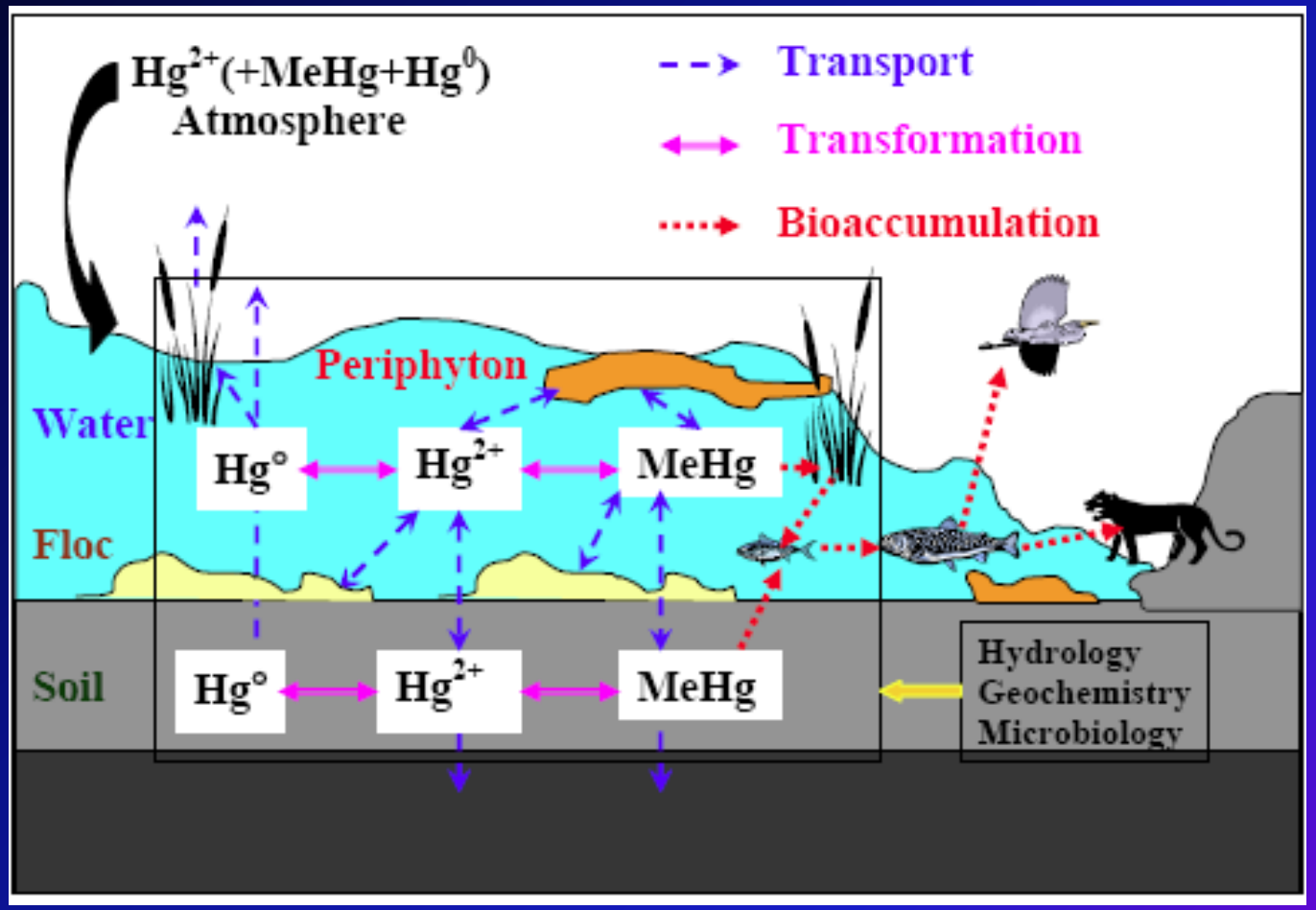
Hg contamination in the Everglades





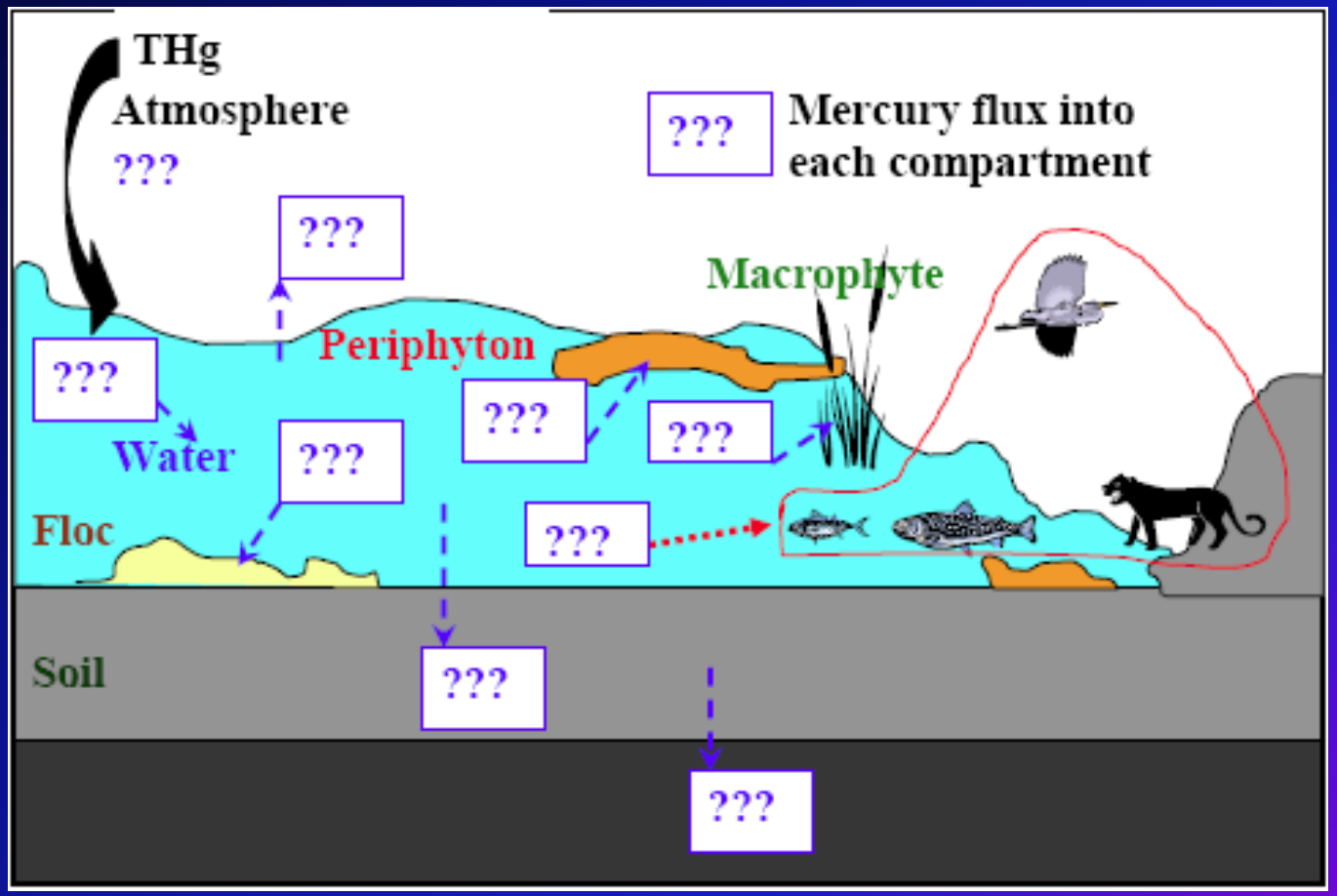




Mercury Cycling in the Florida Everglades

Question

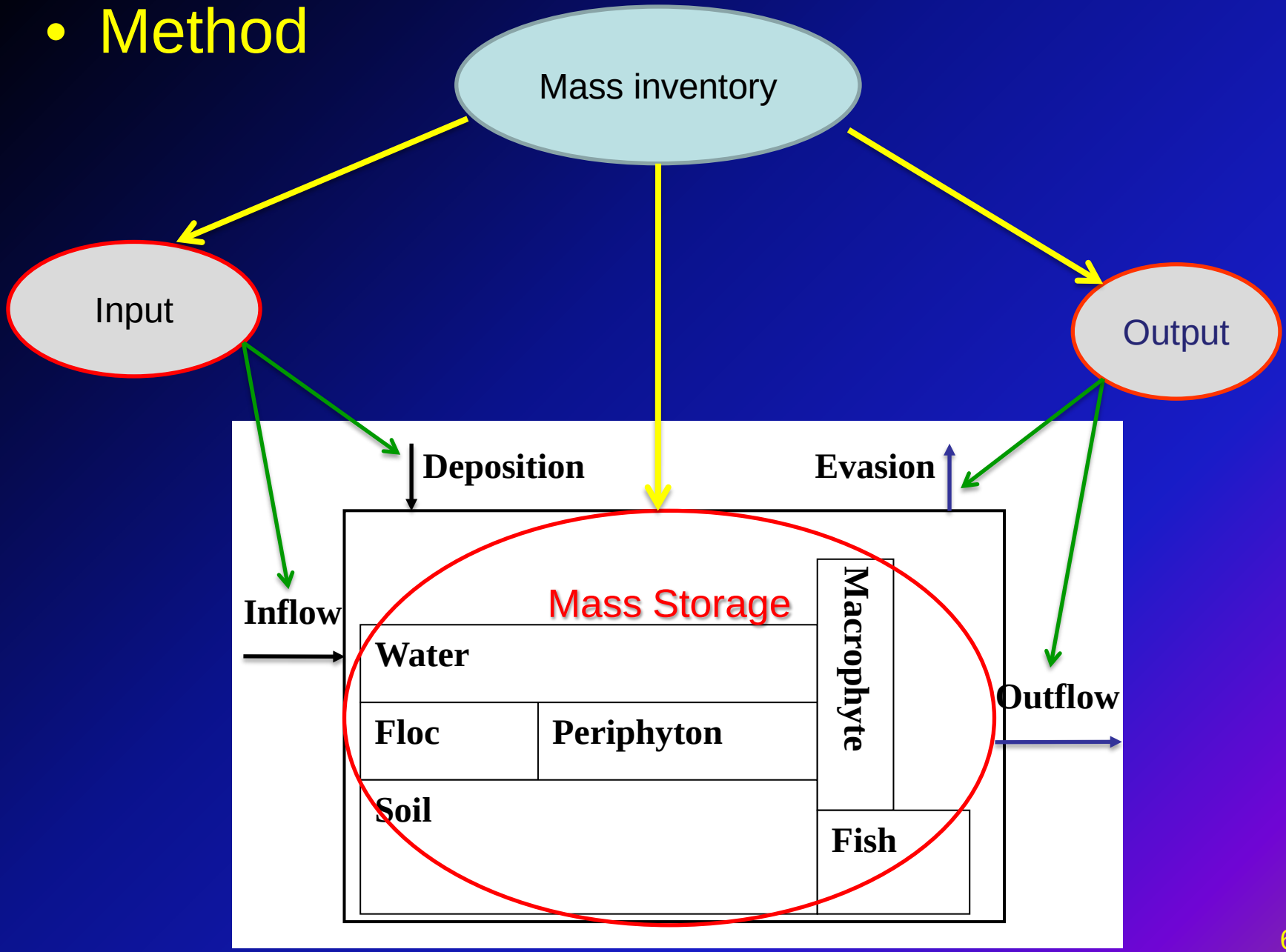
How much Hg is present in each ecosystem component in the Everglades?



Objective

- To establish mass inventory for THg and MeHg in the four management units of the Everglades.
  - WCA 1
  - WCA 2
  - WCA 3
  - ENP

- Method


Mass inventory
Input
Output
Deposition
Evasion
Inflow
Mass Storage
Water
Floc
Periphyton
Soil
Macrophyte
Fish
Outflow

❖Mass Storage
(at sampling: Nov 2005)

Water:

THg concentration

Water volume

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

THg mass

inclusion probability

Soil:

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

Floc:

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

Periphyton:

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

Macrophyte:

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

Fish:

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

❖Input
(during 2005 wet season: May-Nov)

Deposition:

THg deposition

Wet deposition

Dry deposition

$$M_{BD}^{THg} = M_{WD}^{THg} + M_{DD}^{THg}$$

Inflows:

Mean THg Conc

Total water inflows

$$M_{IF}^{THg} = \overline{C}_{IF}^{THg} * \sum_{i} V_{IF}^{i}$$

❖Output
(during 2005 wet season: May-Nov)

Evasion:

$$M_{EV}^{THg} = 2(ng/m_2/h)*10(h/d)*180(d)*A$$

Management unit	Inflow Structures	Outflow Structures
WCA 1	G310, G301, G300, G251, S362, ACME1, ACME2	S10, G94, S39, G301
WCA 2	S10, S7, G335	S34, S38, S11
WCA 3	S11, S8, S9, S140, S150, S190	S12, S31, S142, S333, S343, S344, G69
ENP	S12, S18, S174, S332, S333-S334	C111, Taylor River Slough, Shark River Slough, Trout Creek, Taylor Creek,

Outflows:

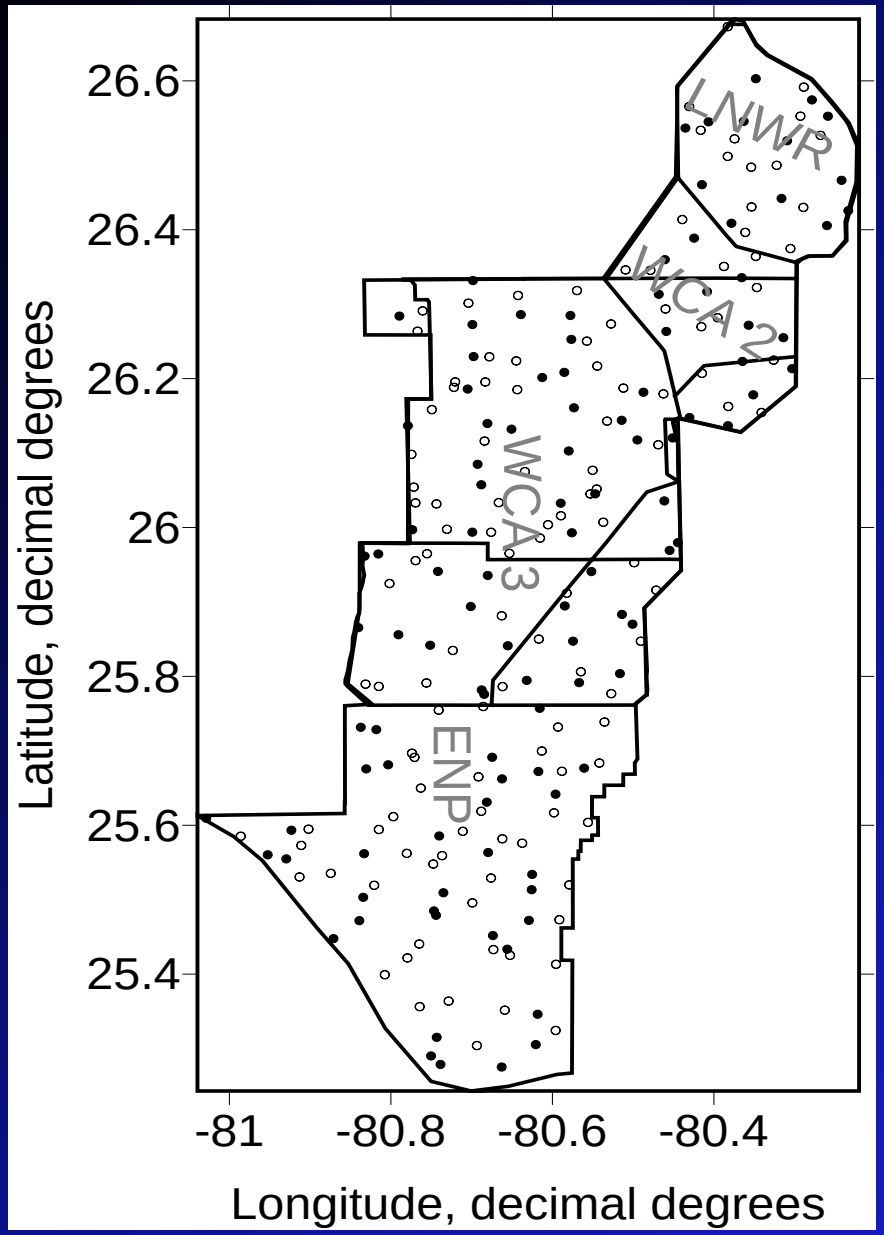
Mean THg Conc

Total water outflows

$$M_{OF}^{THg} = \overline{C}_{OF}^{THg} * \sum_i V_{OF}^i$$

Databases

- EPA Everglades R-EMAP (2005)
- MDN
- USGS ACME
- SFWMD DBHRDRO
- Others



- 2005 R-EMAP

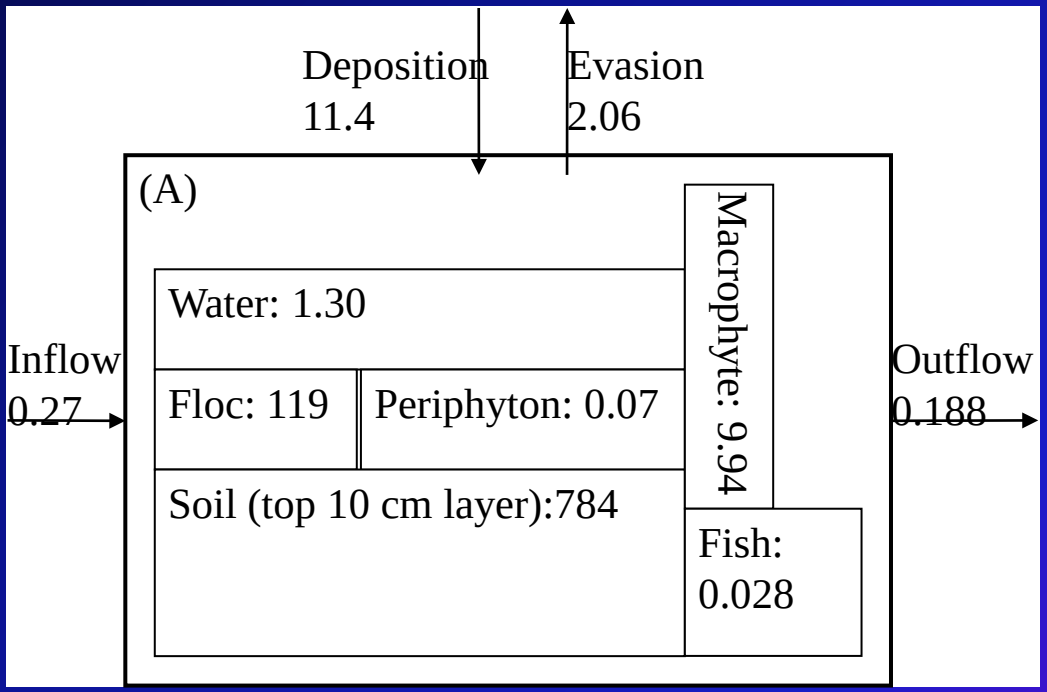
Ecosystem-wide sampling

Probability sampling design

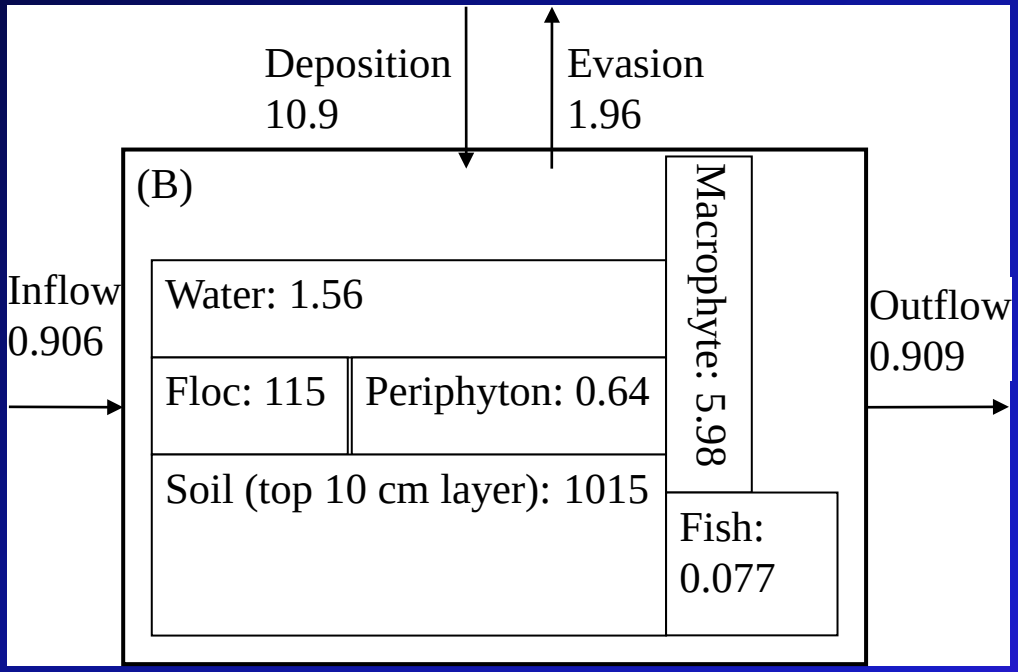
Closed circle: May, 109

Open circle: November, 119

- Results

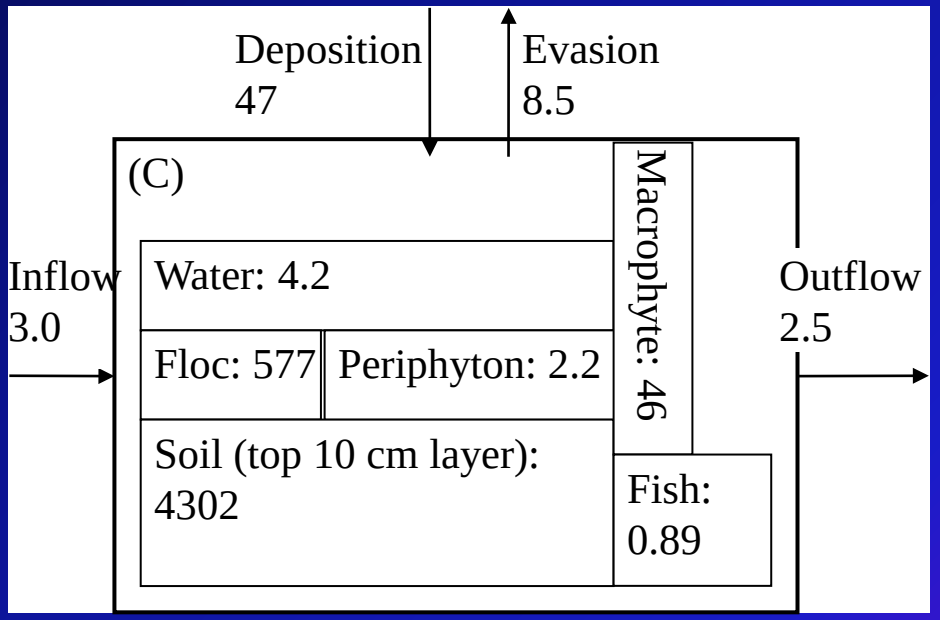


WCA 1

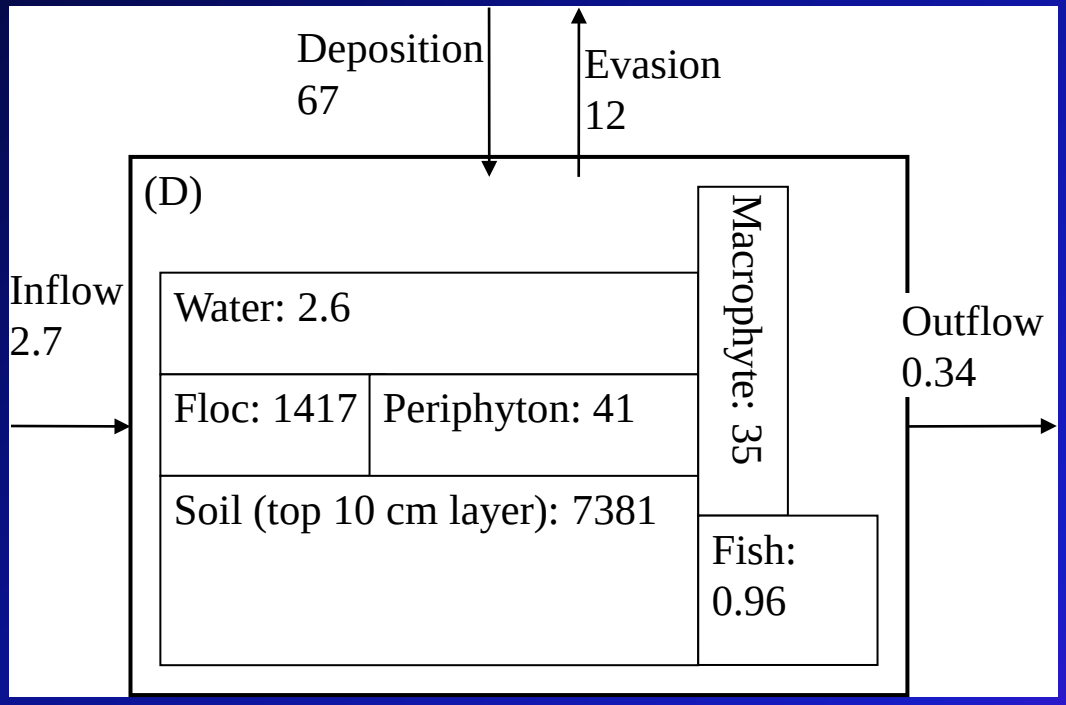


THg mass (kg) inventory

WCA 2



WCA 3



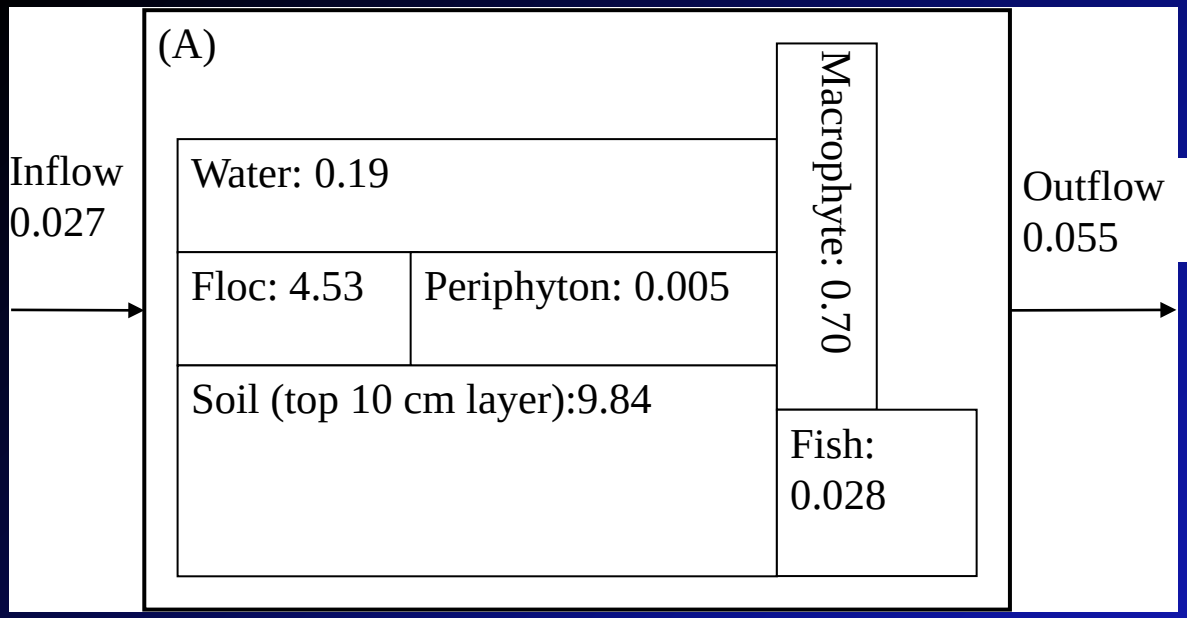
ENP

THg mass (kg) inventory

THg mass (kg) inventory

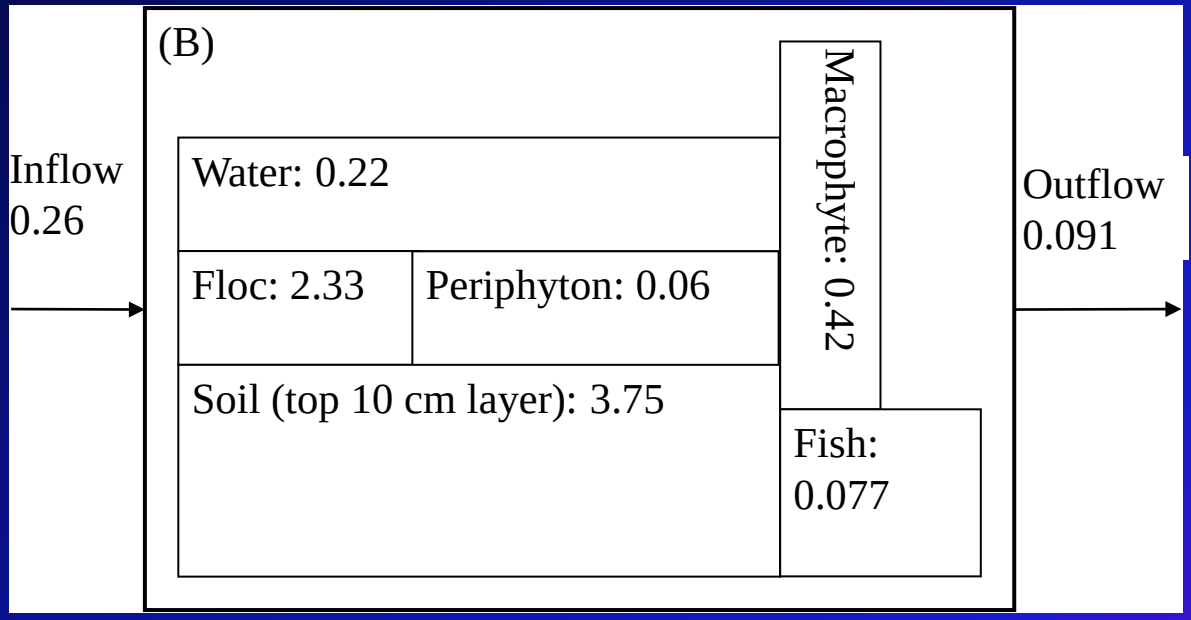
Compartment	In (kg)	Out (kg)	Total accumulated (kg)	Legacy Hg (kg)	Legacy Hg / area (g/m2)
WCA 1	11.7	2.2	9.4	914	1.6
WCA 2	11.8	2.9	8.9	1138	2.1
WCA 3	50.3	11.1	39.2	4931	2.1
ENP	69.9	12.4	57.5	7602	2.3

- **Legacy Hg is huge**
- **Soil and floc are main sinks**
- **THg transport is limited**
- **Inputs > outputs**

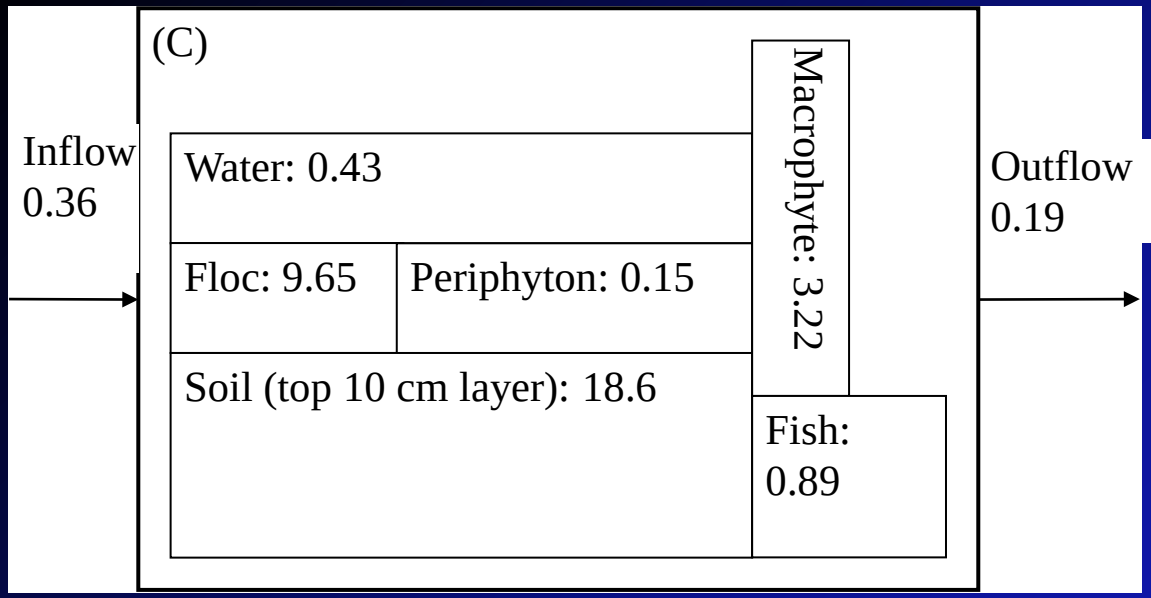


WCA 1

MeHg mass (kg) inventory

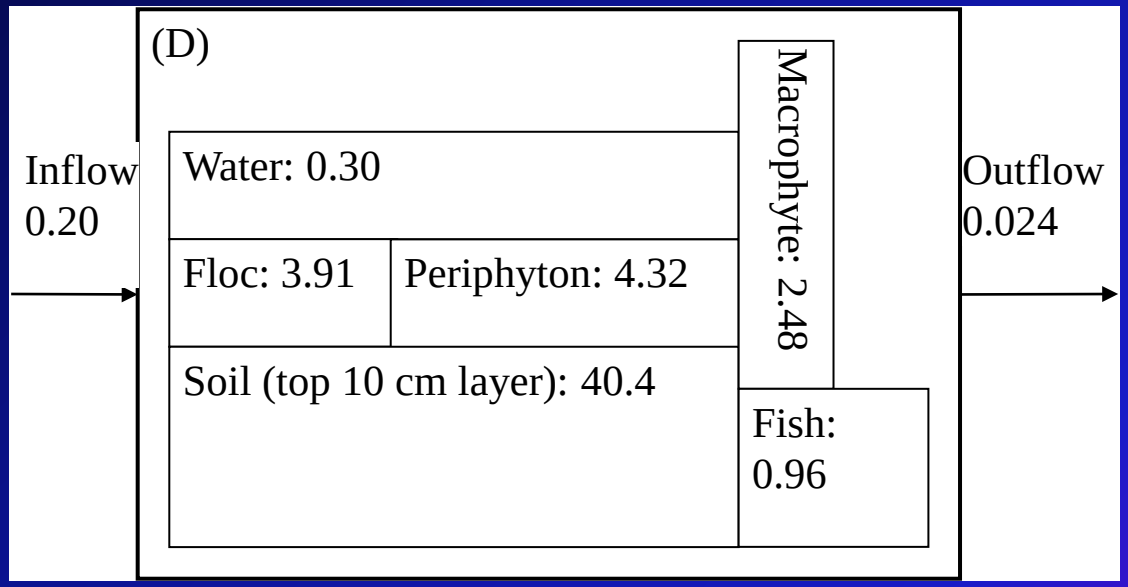


WCA 2



WCA 3

MeHg mass (kg) inventory



ENP

MeHg mass (kg) inventory

Compartment	In (kg)	Out (kg)	Accumulated (kg)	Legacy (kg)	Legacy MeHg / area (g/m2)
WCA 1	0.027	0.055	0.028	15	0.027
WCA 2	0.26	0.091	0.17	6.8	0.012
WCA 3	0.36	0.19	0.17	32	0.014
ENP	0.20	0.024	0.18	51	0.015

- **Large legacy MeHg**
- **Soil, floc, and macrophyte are main sinks**
- **Transport across management unit may be limited, except for WCA 2**

Uncertainty - THg

		WCA 1	WCA 2	WCA 3	ENP
Water	Mass storage (kg)	1.3	1.6	4.2	2.6
	Uncertainty (%)	17	17	7.3	11
Soil	Mass storage (kg)	784	1015	4302	7381
	Uncertainty (%)	10	15	4.1	6.7
Floc	Mass storage (kg)	119	115	577	141
	Uncertainty (%)	42	37	30	31
Periphyton	Mass storage (kg)	0.067	0.64	2.2	41
	Uncertainty (%)	25	25	10	14
Mosquitofish	Mass storage (kg)	0.028	0.077	0.89	0.96
	Uncertainty (%)	17	25	11	11

Uncertainty - MeHg

		WCA 1	WCA 2	WCA 3	ENP
Water	Mass storage (kg)	0.19	0.22	0.43	0.30
	Uncertainty (%)	33	19	12	14
Soil	Mass storage (kg)	9.8	3.8	18	40
	Uncertainty (%)	37	29	12	18
Floc	Mass storage (kg)	4.5	2.3	9.6	3.9
	Uncertainty (%)	57	57	30	30
Periphyton	Mass storage (kg)	0.0050	0.057	0.15	4.3
	Uncertainty (%)	28	28	11	19

Summary

- Everglades is a sink for Hg, with Hg legacy in WCA1, WCA2, WCA3 and ENP being 749 kg, 1250 kg, 3920 kg and 9340 kg, respectively.
- Different patterns in mass storage between THg and MeHg
  - THg: Soil >> floc
  - MeHg: Soil > floc > macrophyte
- Transport of Hg across regions plays a limited role in Hg cycling, except for WCA 2

Acknowledgements

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