Nutrient Management in Agricultural Ecosystems: Current Issues and Future Needs

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Agricultural Ecosystems

- Agricultural ecosystems
  - Agronomic and horticultural crop production, rangelands, aquaculture, and animal agriculture

- ***Are agricultural practices compatible with sustaining economic crop productivity and preserving quality of our natural resources?***

- ***Are agricultural practices adequate to meet current demands and future needs to sustain economic crop productivity and protect the quality of our natural resources?***

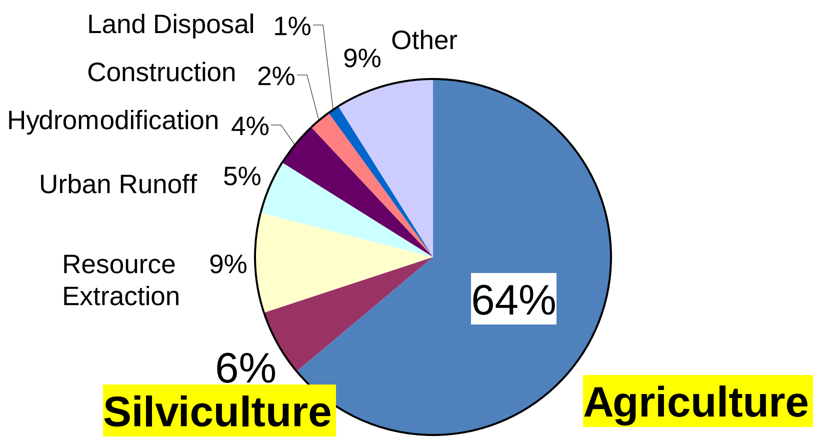
Agricultural Ecosystems

- Current agricultural practices are compatible but may not be adequate to sustain economic crop productivity and protect quality of our natural resources
- During the past decade, implementation of best management practices (BMPs) have helped to improve water quality
- The future of global agriculture depends on:
  - Meeting the food and fiber needs of a world population projected to exceed 10 billion by 2050
  - Maintaining economic productivity of crops
  - Protecting the quality of natural resources for future generations
- Challenge is to develop new or improve practices that are compatible with current needs and future demands

Sources of Pollution

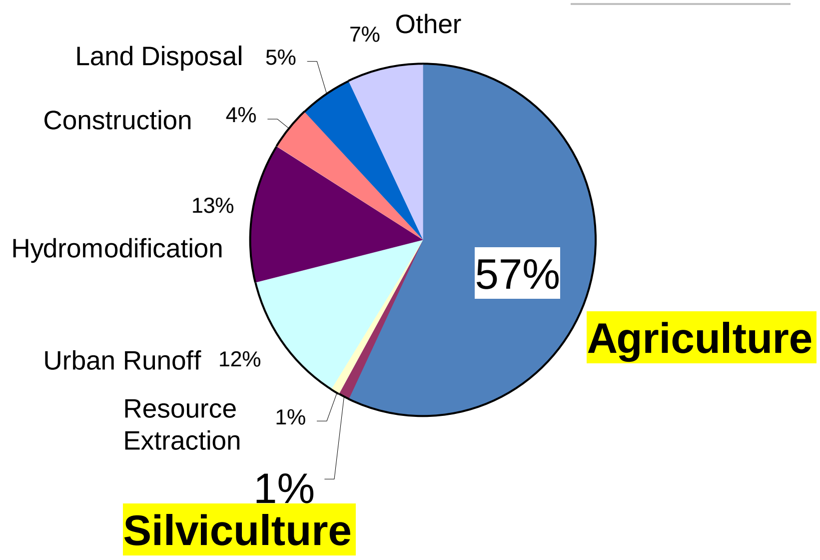
Rivers

266,000 km
[165,000 miles]



Lakes

3.3 million hectares
[8.2 million acres]

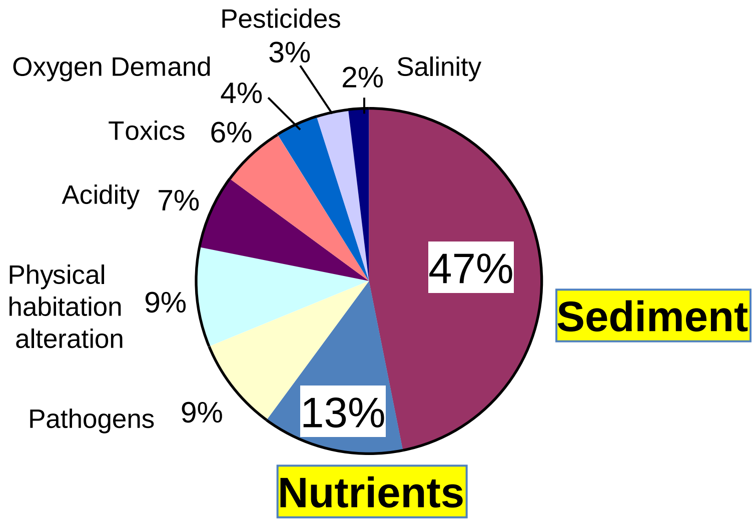


Source: A. E. Carey, 1991

Primary Types of Pollution

Rivers

266,000 km
[165,000 miles]



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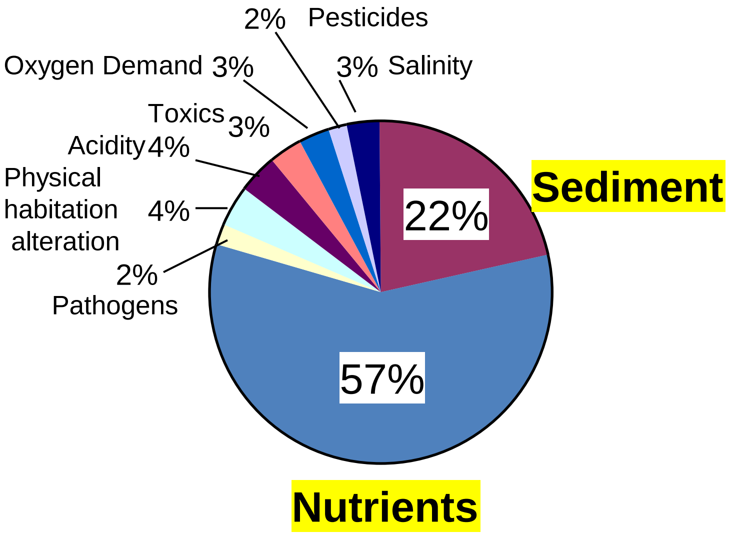
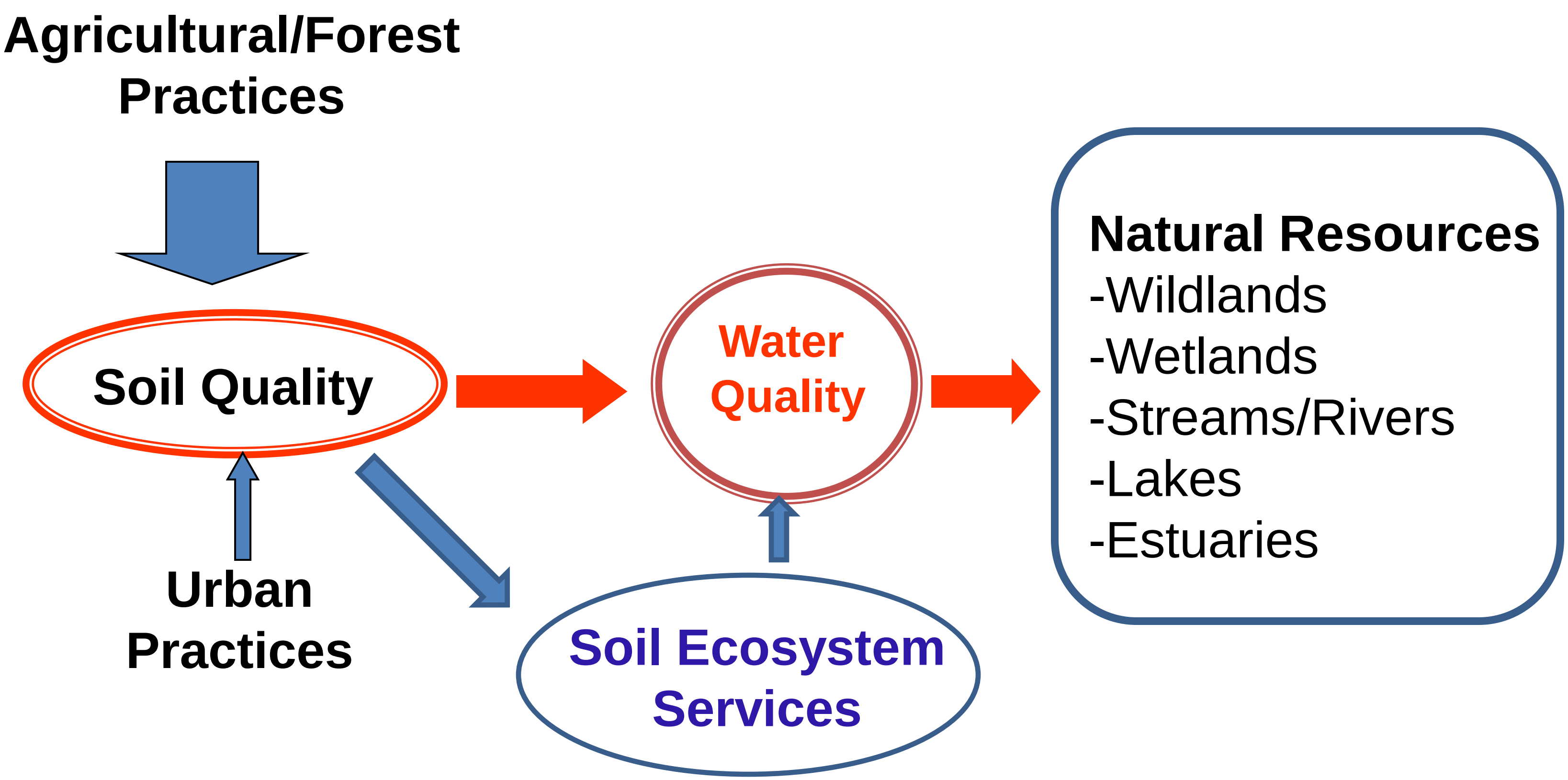


Source: A. E. Carey, 1991

Landuse and Natural Resources



Macronutrients

6 C 12	7 N 14	8 O 16
	15 P 31	16 S 32

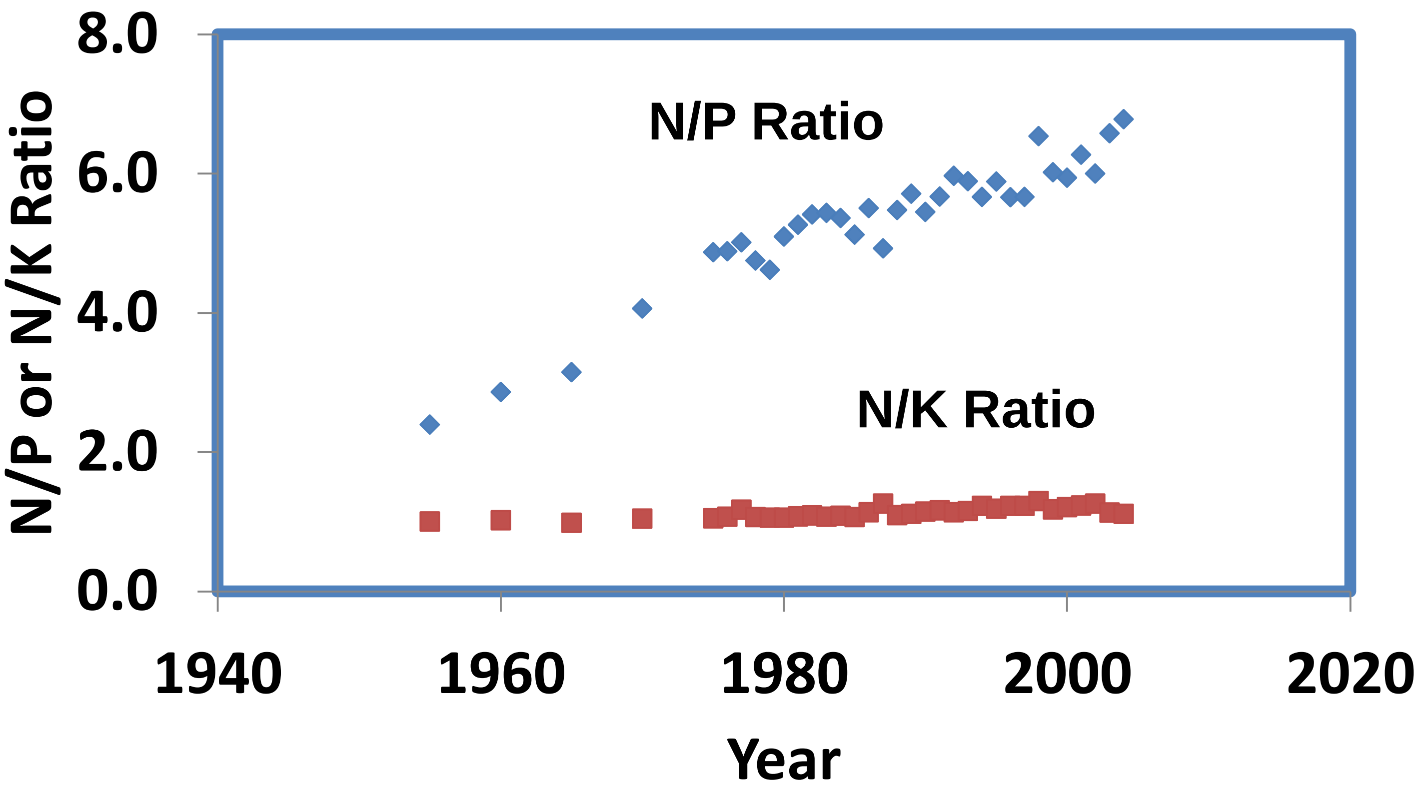
Fertilizers and Manures

- **The World** [Mullins et al., 2005]
  - Fertilizer consumption - N/P ratio = 5.8
  - Manure production - N/P ratio = 1.9
  - Collectable manure nutrients - N/P ratio = 0.9

- **North America** [Mullins et al., 2005]
  - Fertilizer consumption - N/P ratio = 6.2
  - Manure production - N/P ratio = 1.7
  - Collectable manure nutrients - N/P ratio = 0.8

- **Florida**
  - Fertilizer consumption – N/P ratio = 6.8

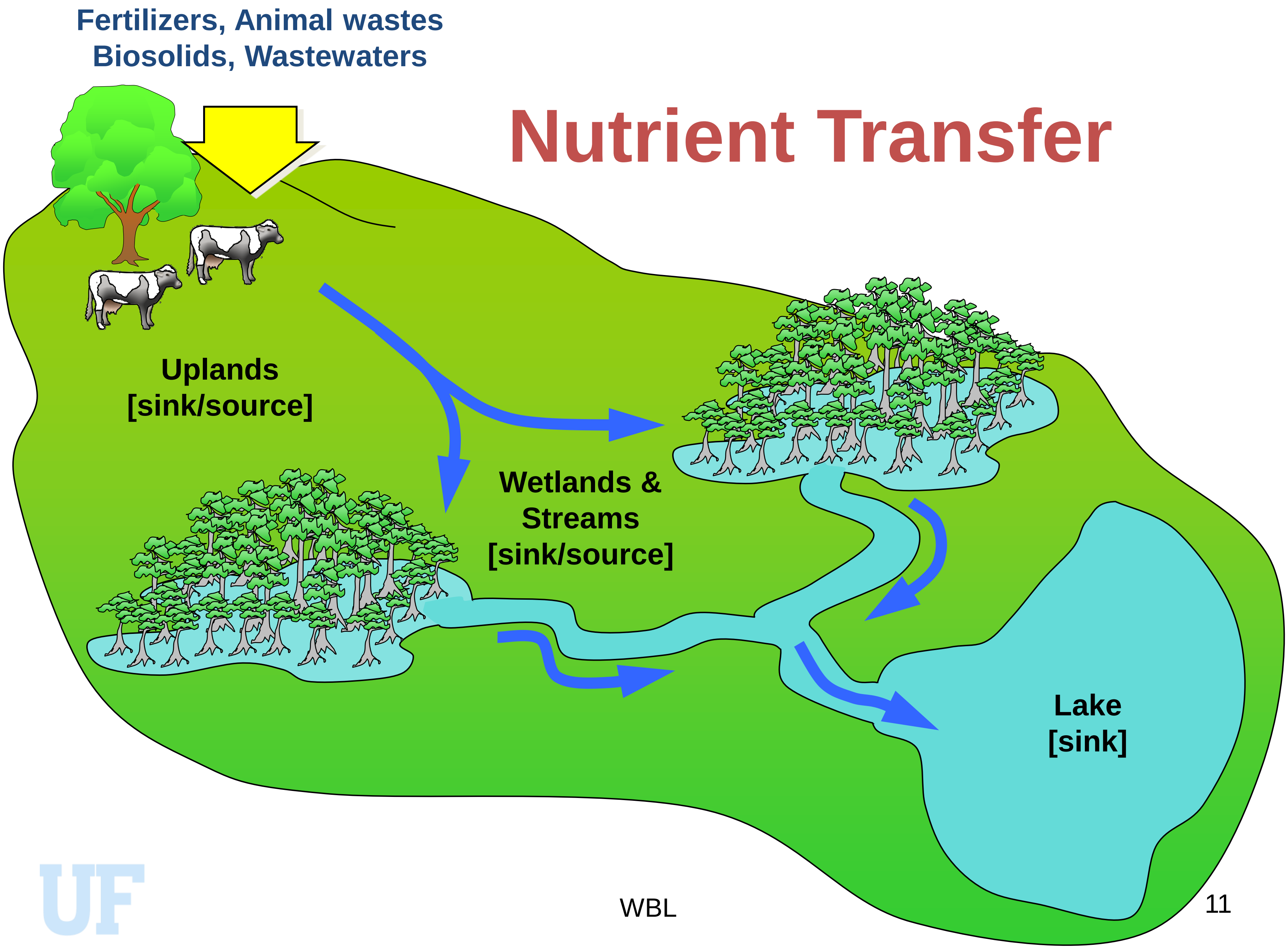
Fertilizer Consumption in Florida



Lands used for Production Agriculture

- Long-term application of fertilizer P has resulted in substantial accumulation of P in soils
- Land application of manures and other organic wastes
  - Nitrogen basis…results in excess P load
  - Phosphorus basis… increases land area requirements
- In many areas response to added fertilizer P appears to be poor

Nutrient Transfer



Nutrient Budgets

- ✓ Why do we need to know nutrient budgets for a cropping system ?
- ✓Accounting of various sources nutrients available will aid in proper management of resources
  - ✓ improved nutrient use efficiency by crops
  - ✓ reduction of non-harvestable nutrients

Macronutrients

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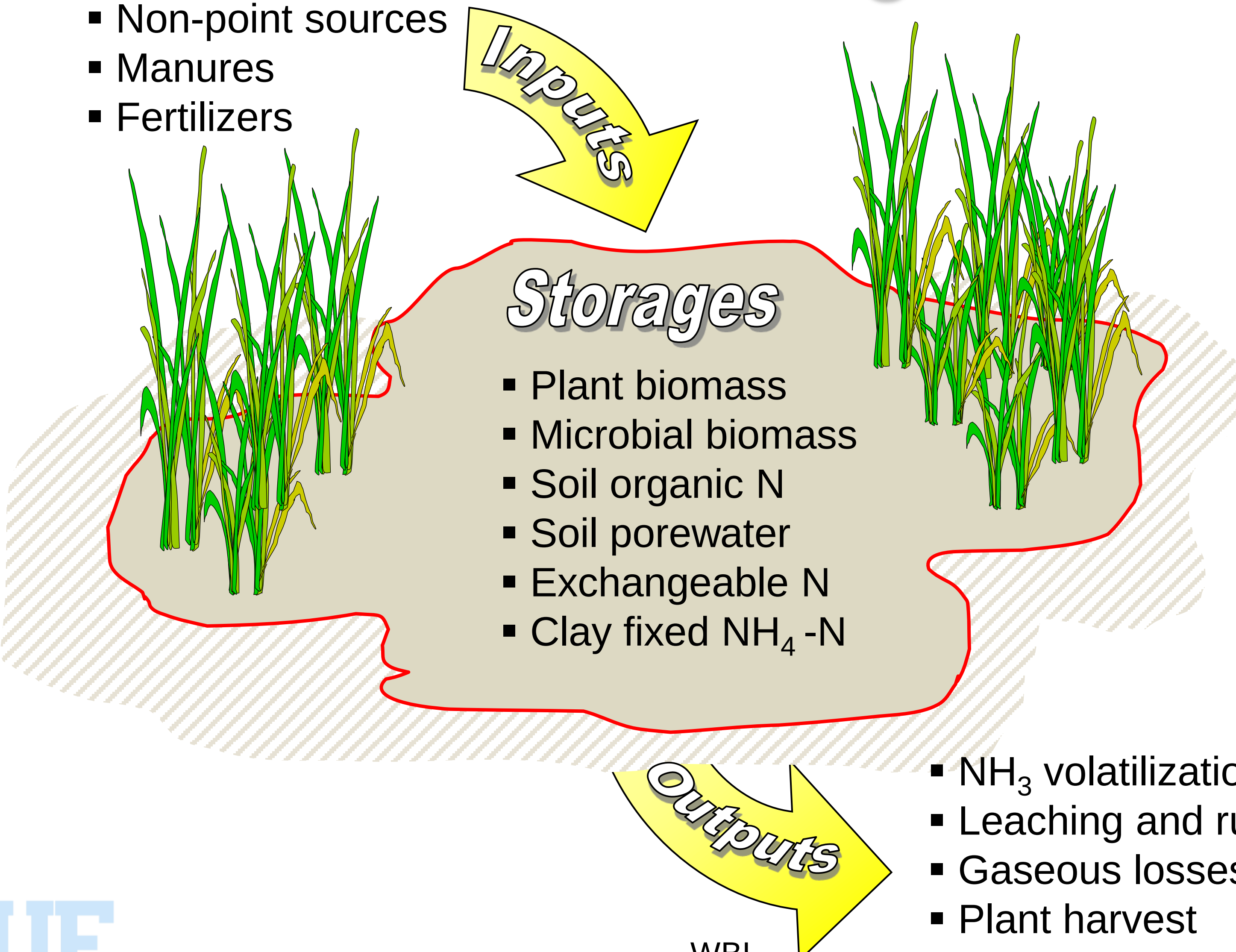
Nitrogen Budget

- Biological N_2 fixation
- Dry and wet deposition
- Non-point sources
- Manures
- Fertilizers

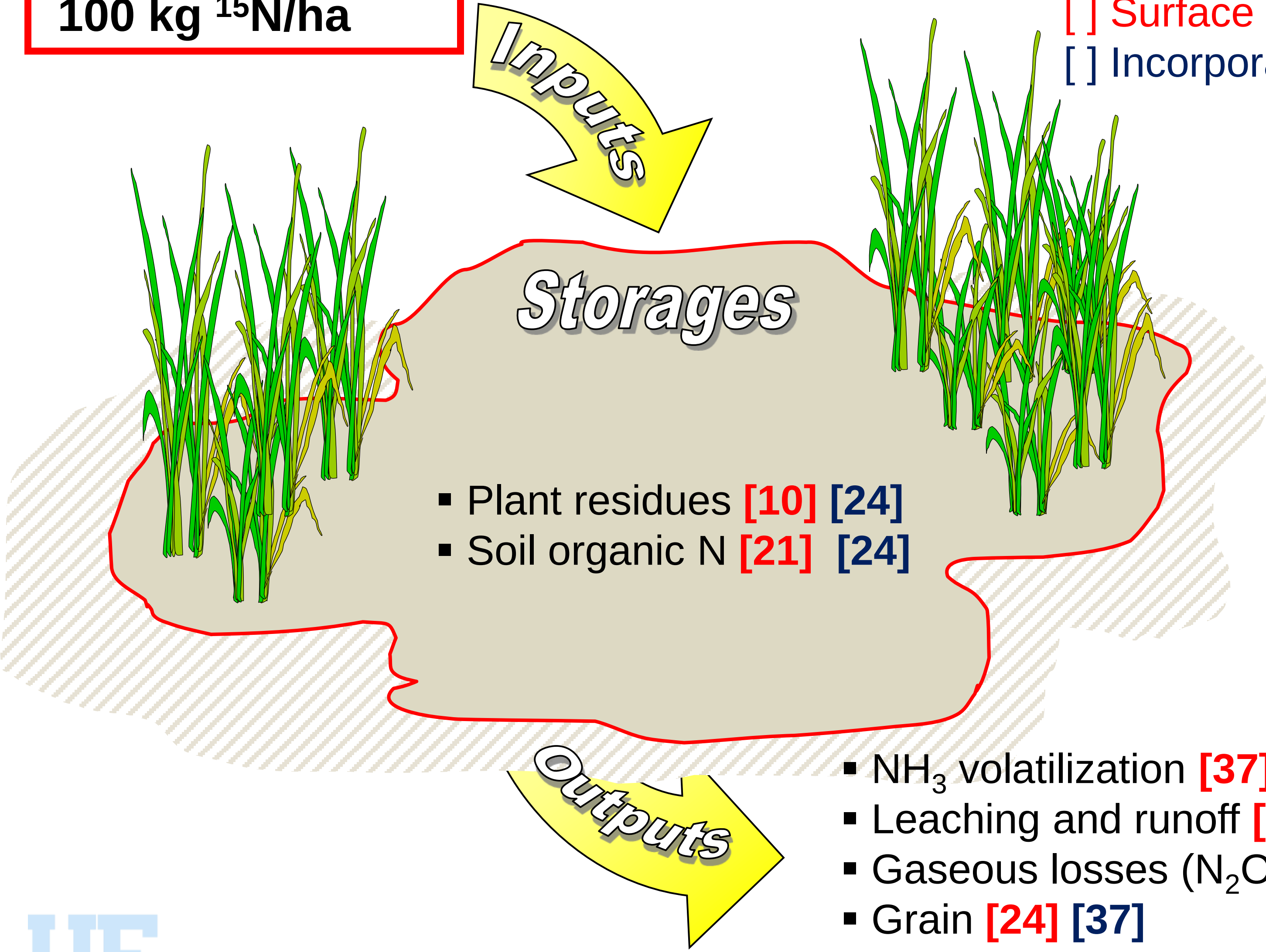


- NH_3 volatilization
- Leaching and runoff
- Gaseous losses (N_2O, N_2)
- Plant harvest

Nitrogen Budget -Rice

Fertilizers (Urea)
100 kg ^{15}N/ha

[ ] Surface application
[ ] Incorporated into Soil



- Plant residues **[10] [24]**
- Soil organic N **[21] [24]**

- NH_3 volatilization **[37] [0]**
- Leaching and runoff **[?]**
- Gaseous losses (N_2O, N_2) **[8] [14]**
- Grain **[24] [37]**

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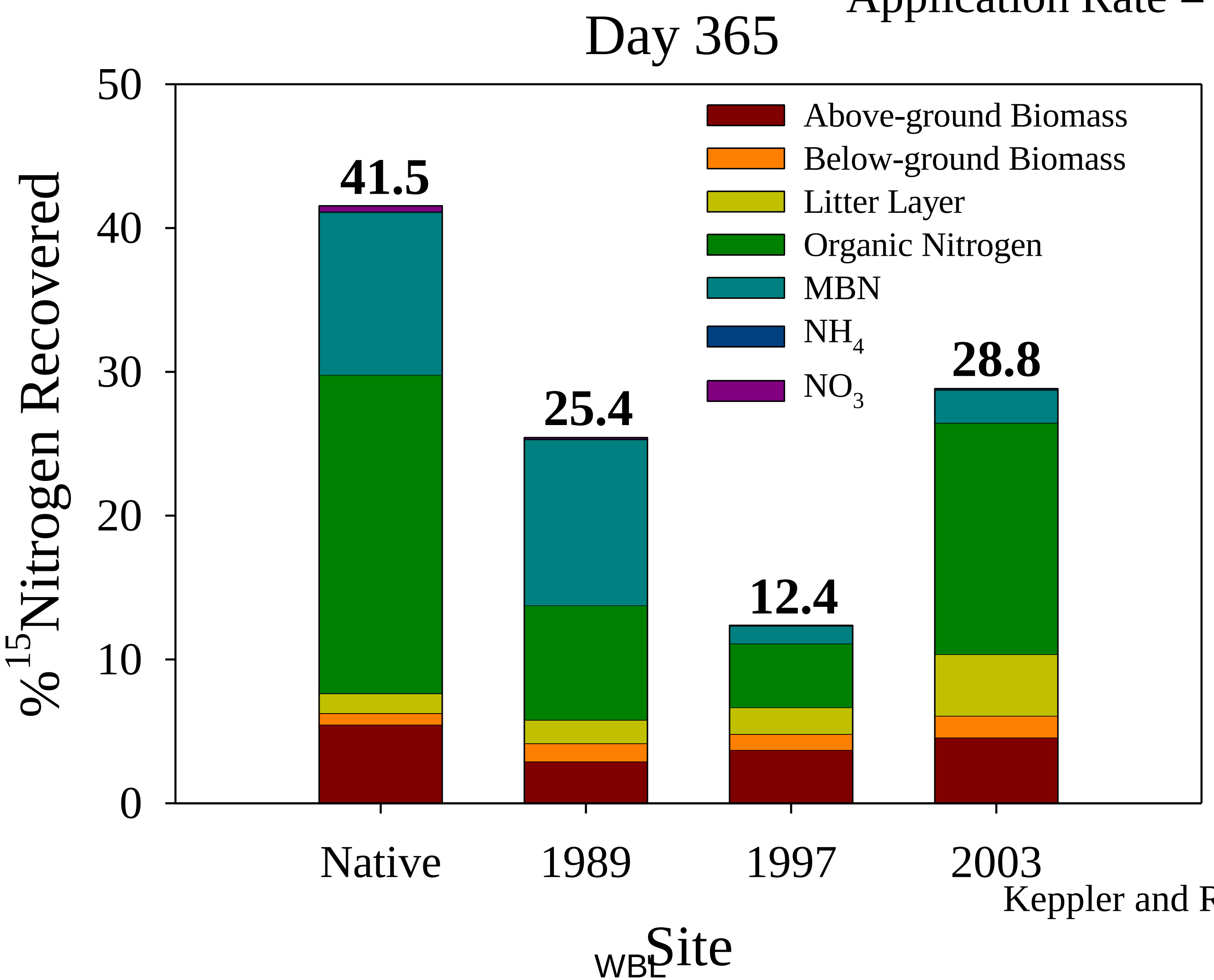
^{15}N Budget – Wetlands

Application Rate = 650 mg m^{-2}



Keppler and Reddy, 2012

WBL

Macronutrients

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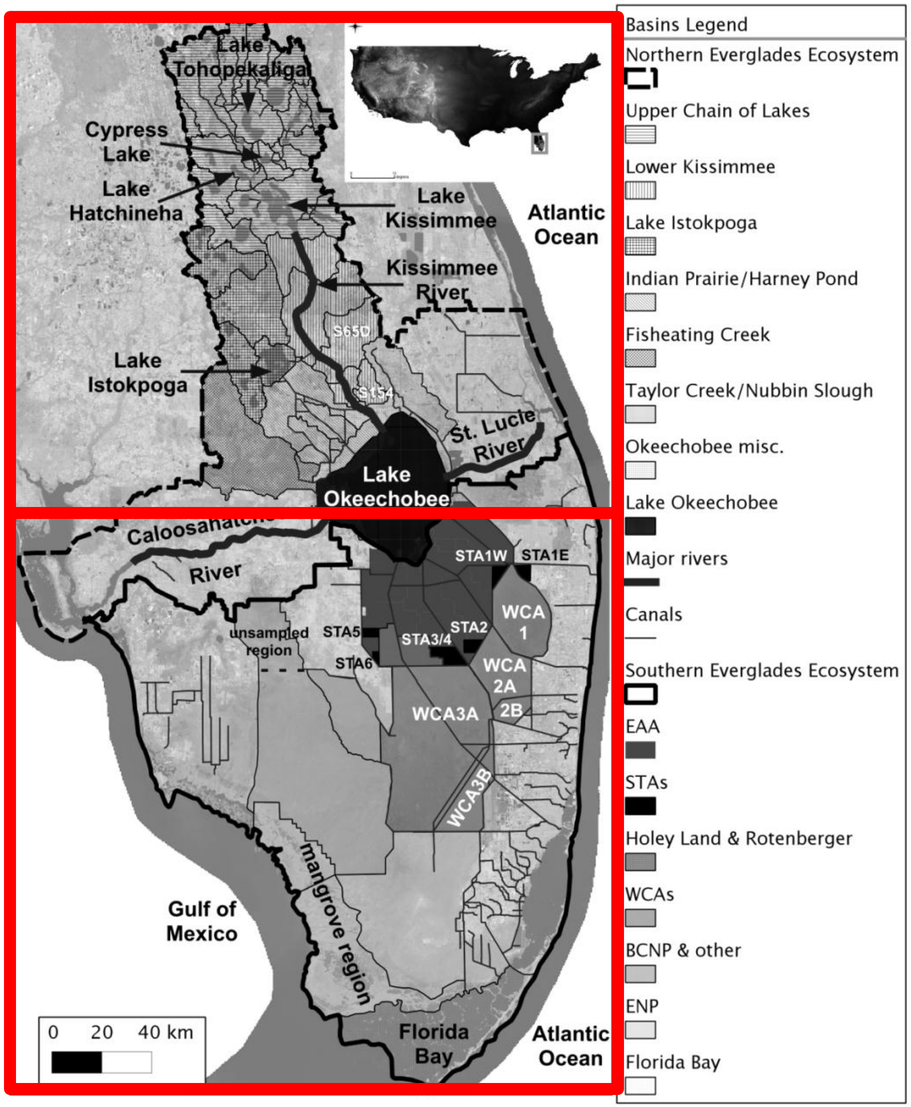
Greater Everglades Ecosystem

Northern Everglades

Lake Okeechobee

Southern Everglades



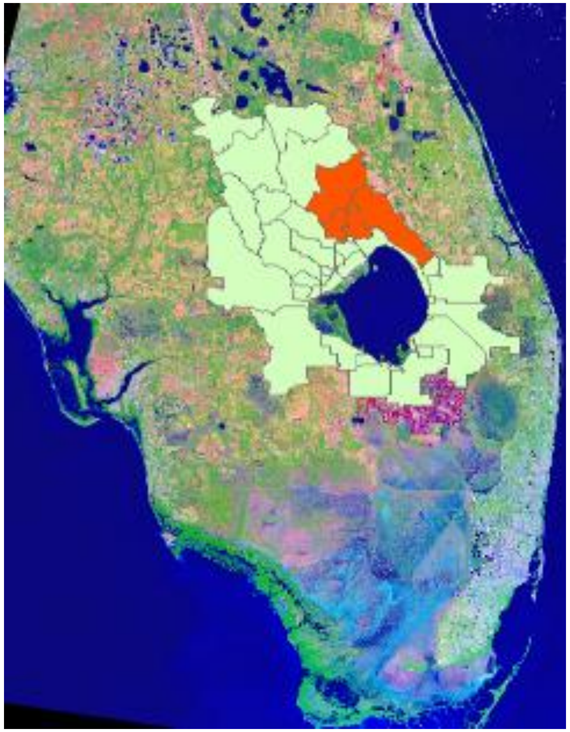
WBL

High [~600 ug/L]

Phosphorus Gradient

Low [~10 ug/L]

Northern Everglades: Okeechobee Drainage Basin



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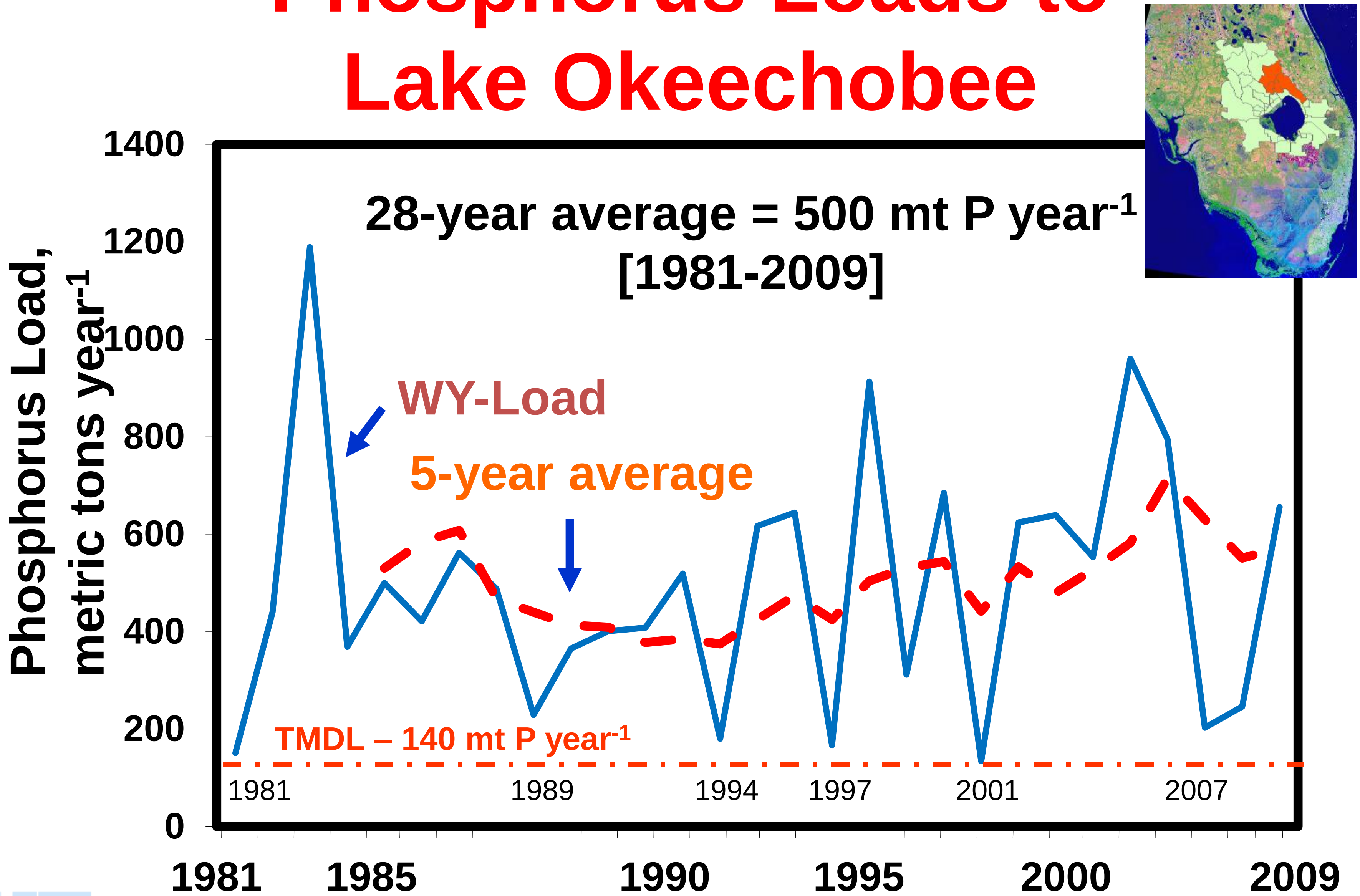
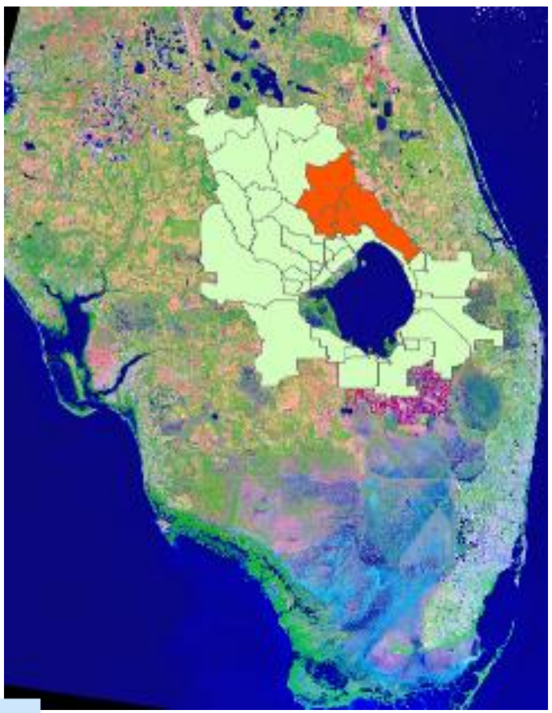
Phosphorus Loads to Lake Okeechobee

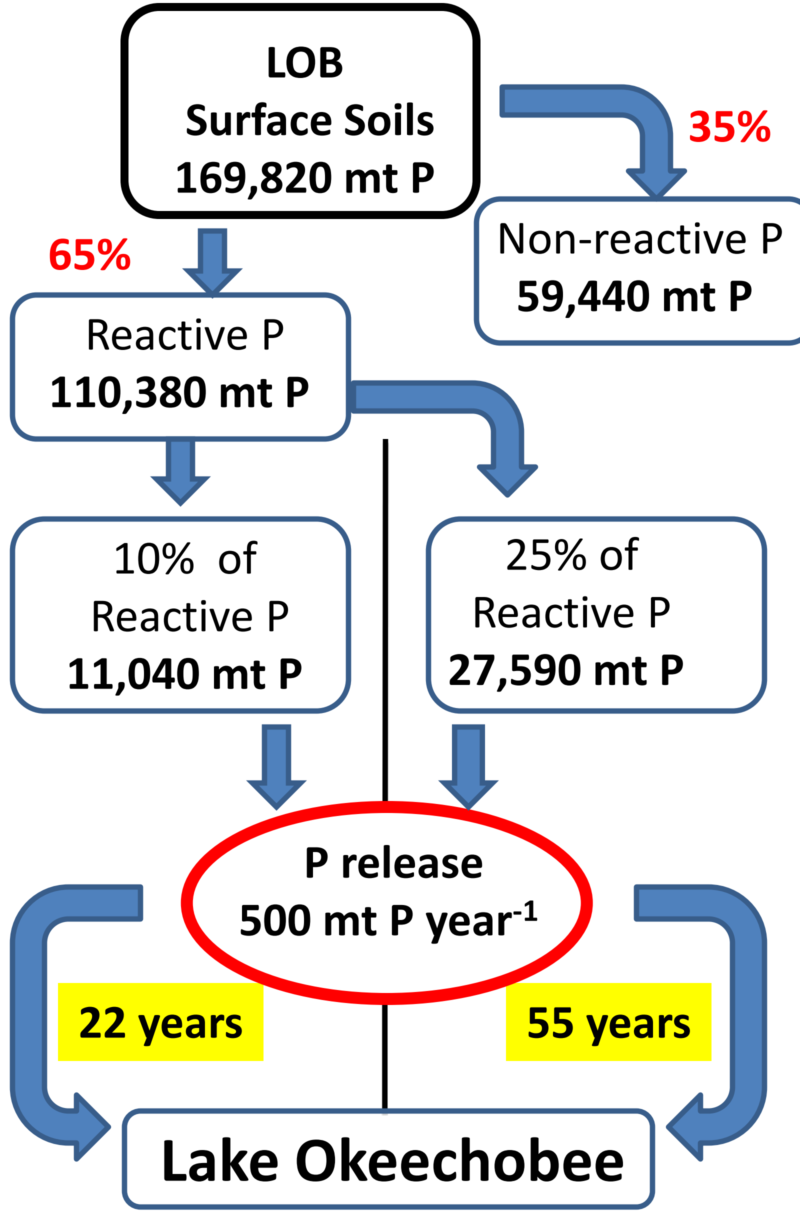


Source: SFWMD, 2010

Legacy Phosphorus

Okeechobee Basin





Reddy et al., 2011

Restoration Implications

- Legacy P in the drainage basin can increase the lag time for recovery… can extend for several decades
- In-situ immobilization of soil phosphorus is needed to reduce P loads
- Constructed wetlands are effective buffers in reducing P loads, but they must managed for long-term sustainability
- Phosphorus reactivity and mobility is linked to other associated nutrients

Agricultural Ecosystems: Nutrient Management

- Long-term goals of ecosystem management should include conservation and enhancement of soil quality
- Policies to reduce nutrient loads from ecosystems should seek to improve soil quality as a first step to improve water quality
- Develop indicators to assess soil ecosystem services

Agricultural Ecosystems: Nutrient Management

- Develop of soil and nutrient management practices that are compatible with extreme climatic change events
- Estimate economic values of soil ecosystem services and tradeoffs associated with changes in soil and nutrient management practices
- Protecting soil quality, like protecting air and water quality, should be a fundamental goal of national environmental policy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