

## Nitrogen and Phosphorus Dynamics in the Lower Mississippi River Floodplain: A Comparison of Present and Historic Hydrologic Conditions

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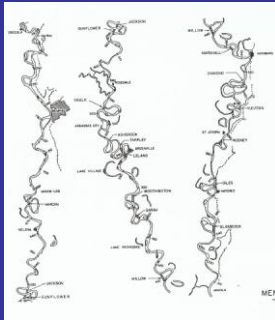
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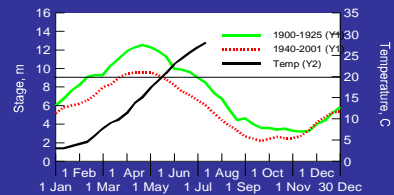


## Bendway cutoffs



- 1929-1942
- 16 bendway cutoffs
- shortened the river by 245 km

## Net effect



## Flood pulse concept (hypothesis)

*Junk, Bailey, Sparks 1989*

- Fish production should be related to area and duration of floodplain inundation
- Few tests, little support in temperate river-floodplain ecosystems
  - Loss of floodplain (*Rutherford et al. 1995*)
- Support when consider temperature (*Schramm et al. 2000; Schramm and Eggleton 2006*)
  - Warm-water fish

## Issue: nitrogen and phosphorus exported to the Gulf of Mexico

- Mississippi River carries runoff from 41% of the contiguous U.S.
- Nitrogen and phosphorus are important contributors to Gulf hypoxia (*Goolsby and Battaglin 2000; Anonymous 2004*)
- Wetlands are used for nutrient removal
- What is the role of the lower Mississippi River floodplain in nitrogen and phosphorus dynamics ?

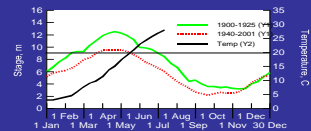
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- Support when consider temperature (*Schramm et al. 2000; Schramm and Eggleton 2006*)
  - Warm-water fish
- What is the effect of a more naturalized hydrograph ?
  - Soils
  - Water
  - Fish
  - Forests

## Objective

- Use conventional wisdom and available models to estimate nitrogen and phosphorus dynamics in the LMR floodplain
  - Present (altered) hydrograph (15 Mar – 15 May)
  - Historical (natural?) hydrograph (15 Mar – 15 June)

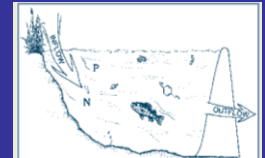


## Methods--soils

- Denitrification
  - 12.8 mg N/kg day @ 30°C (*White and Reddy, 2003*)
  - $Q_{10} = 2$  (*Stanford et al. 1975*)
  - Effective depth of denitrification = 2 cm (*Patrick and Delaune 1972*)
- Phosphorus
  - Solution (immediately available)
  - Labile (adsorbed but potentially available)
  - Sharkey clay soil with phosphorus fertilization (*Walker 2002*)

## Methods—water column and wetland community

- EPA Aquatox model
  - Cahaba River study data used as a baseline to represent LMR backwaters and side channels
  - Supplemented with additional aquatic plants to better represent the floodplain ecosystem



## Methods--fish

- Floodplain (backwater) fishes

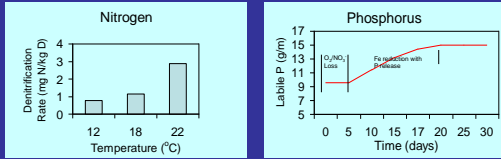
Fish	Diet	
Gizzard shad, 60 g	Detritus	Zooplankton
Smallmouth buffalo, 1000 g	Detritus	Benthos
Blue catfish, 1000 g	Benthos	Fish

- Fish Bioenergetics 3.0 (*University of Wisconsin 1997*)
  - Gizzard shad: Bluegill model,  $P=1.0$
  - Smallmouth buffalo: Bluegill model,  $P=0.8$
  - Blue catfish: Largemouth bass model,  $P=0.5$

## Methods--fish

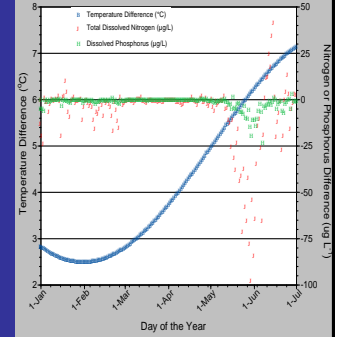
- Floodplain (backwater) fish biomass: 34-911 kg/ha (*Cobb et al. 1984; Lowery et al. 1987*)
  - Set biomass = 200 kg/ha
    - Shad: 100 kg/ha
    - Buffalo: 80 kg/ha
    - Catfish: 20 kg/ha
  - Nitrogen: 10.35% of fish flesh (*Dantas and Attayde 2007*)
  - Phosphorus: 3.05% of fish flesh (*Dantas and Attayde 2007*)

## Results--soils



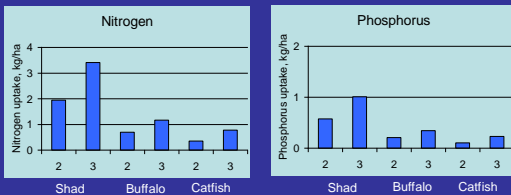
- Denitrification losses from system
  - 2 month inundation = 584 kg N/ha
  - 3 month inundation = 1473 kg N/ha
- Phosphorus losses from system
  - 150 kg P/ha

## Results—water column



- Nutrient Uptake
- Nitrogen
  - 2 month inundation → 6.4 kg ha<sup>-1</sup>
  - 3 month inundation → 57.7 kg ha<sup>-1</sup>
- Phosphorus
  - 2 month inundation → 1.3 kg ha<sup>-1</sup>
  - 3 month inundation → 12.6 kg ha<sup>-1</sup>

## Results--fish



All fish, 200 kg/ha

2 months                      3.0 kg N/ha                      0.9 kg P/ha  
 3 months                      5.4 kg N/ha                      1.6 kg P/ha

## Discussion

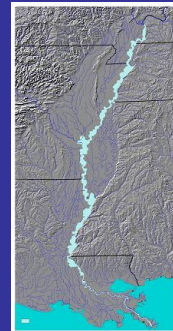
Source	Current hydrograph		Natural hydrograph	
	Nitrogen kg ha <sup>-1</sup>	Phosphorus kg ha <sup>-1</sup>	Nitrogen kg ha <sup>-1</sup>	Phosphorus kg ha <sup>-1</sup>
Soil	584	-150	1473	-150
Water column and wetland community	6.4	1.3	57.7	12.6
Fish	3	0.9	5.4	1.6
Total	~ 593	~ -148	~ 1534	~ -136

## Discussion

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Water column and wetland community	6.4	1.3	57.7	12.6
Fish	3	0.9	5.4	1.6
Forest (annual uptake) (Waldbridge and Lockaby 1994)	15-50 Avg ~ 30	0.2-3.8 Avg ~ 2	-(15-50) Avg - 30	-(0.2-3.8) Avg -2
Total	~ 623	~ -146	~ 1504	~ -138

## Discussion

Source	Current hydrograph		Natural hydrograph	
	N kg ha <sup>-1</sup>	P kg ha <sup>-1</sup>	N kg ha <sup>-1</sup>	P kg ha <sup>-1</sup>
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600,000 ha remain