Influences of cattle on amphibians in a predator-rich environment

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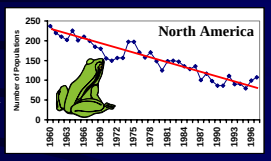
Amphibian Declines and Anthropogenic Stressors

Science 306:1783-1786

Biological Conservation 125: 271-285



Nature 404:752-755

Biotropica 37:163-165

Agricultural Cultivation

Timber Harvesting

Influences of Cattle on Amphibians

Most Quantitative Research Correlative

Biological Conservation 109:207-219	Ecological Applications 14:669-684	Australian J. Ecology 22:270-278

Negative correlation between grazing intensity and amphibian richness and abundance

Hypotheses:

- Negatively influence vegetation structure
- Negatively influence water quality

Importance of Cattle Farming and Agricultural Wetlands to Amphibians

•$37.8 Billion in Annual Revenues

Largest Producer of Beef Products

•1.05 Million Farms

•96.7 Million Head

Forage and Water Source

Herpetological Journal 9:55-63

Ecological Applications 14:669-684

Biological Conservation 102:155-169

53% Loss in US

Research Objectives

To Determine the Influences of Cattle Access in Farm Wetlands on:

1) Relative abundance of postmetamorphic amphibians

2) Shoreline vegetation structure and composition

3) Water quality

Determine which environmental cofactors associated with cattle land use explain the greatest variation in abundance.

Study Area and Duration

Cumberland Plateau

University of Tennessee Plateau Research and Education Center

Crossville, TN

8 Wetlands

4 Access >10 years

4 Non-access Never

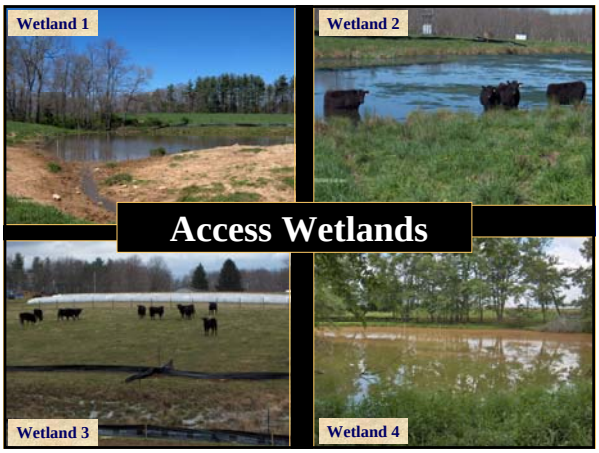
Other Characteristics

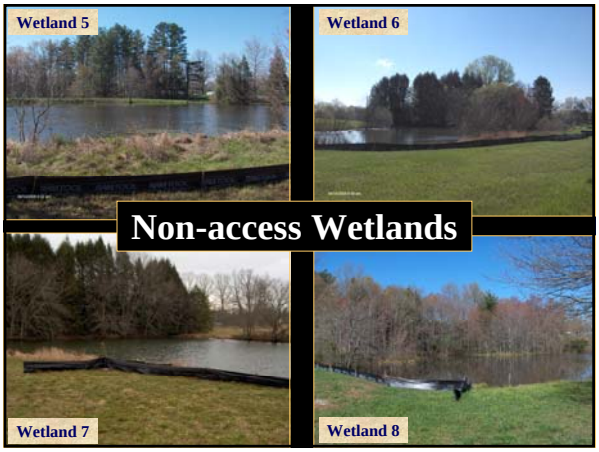
0.153–1.29 ha

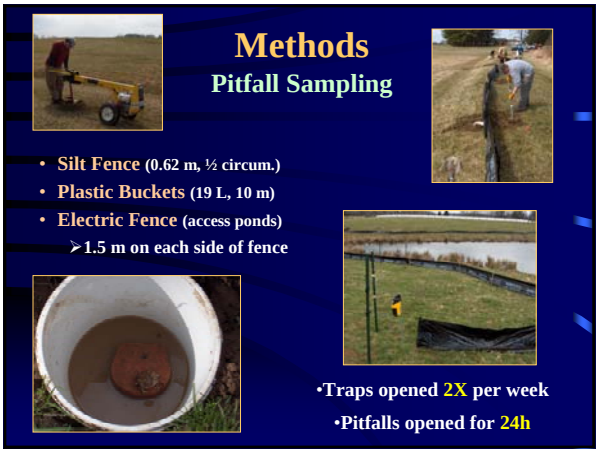
<1.5 km Separation

All ponds have fish

**28 March – 26 August 2005 27 March – 25 August 2006


Wetland 1
Wetland 2
Access Wetlands
Wetland 3
Wetland 4


Wetland 5
Wetland 6
Non-access Wetlands
Wetland 7
Wetland 8


Methods
Pitfall Sampling
• Silt Fence (0.62 m, ½ circum.)
• Plastic Buckets (19 L, 10 m)
• Electric Fence (access ponds)
➢1.5 m on each side of fence
•Traps opened 2X per week
•Pitfalls opened for 24h

Methods
Pitfall Sampling: Captures

- Measure (SVL)
- Weigh
- •Toe clipping
- •Alpha-numeric tags



Methods
Vegetation Sampling

- Vegetation Structure & Height
  - Measured with graduated profile board
- Percent Horizontal Cover
  - Ocularly estimated in a 1-m^2 plot
- Plant Species Richness
  - Enumerated in 1-m^2 plot

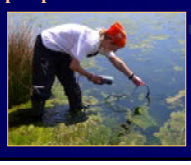

Measured once per month

Midpoint of shoreline vegetation zone along a random azimuth in 2 opposing quadrants


Methods
Water Quality

Variables Measured

- Specific conductivity, temperature, dissolved oxygen and pH:
  - YSI® meters
- Turbidity:
  - LaMotte® colorimeter
- Ammonia nitrogen, nitrite, nitrate and phosphate:
  - LaMotte® water quality testing kit



Measured every 2 weeks

Along a cardinal azimuth, 1 m from shore

Methods

Statistical Analyses

Amphibians

- **Response**: Mean total capture (unique individuals)
- **Effects**: Access Treatment, Species
  - –Two-way ANOVA (Trt*Species, $P<0.05$)
  - –Two-sample T-tests (by Species)

Vegetation & Water

$\alpha = 0.05$

- **Response**:
  - *Vegetation*: Percent Vertical & Horizontal Cover, Height
  - *Water*: Water Quality Parameters
- **Effects**: Access Treatment, Month
  - – Repeated Measures ANOVA
  - (Monthly Trends not Presented)

Methods

Statistical Analyses

$$y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki} + \varepsilon_i$$

Y = Total capture per wetland

X = Significant Vegetation and Water Variables

Multiple Linear Regression with Stepwise Selection

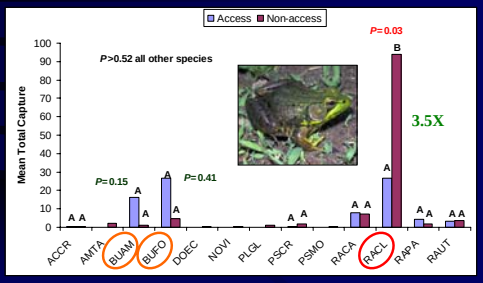
For amphibian species where mean total capture differed between access treatments, how much variation in abundance was explained by significant environmental cofactors?

Results

Amphibian Abundance

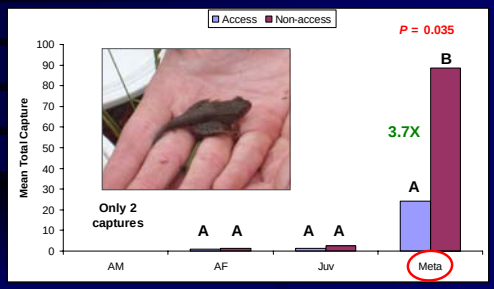
Trt*Spp, $P<0.001$

Trt Effect by Species



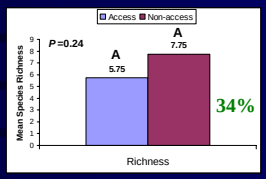
Results

Green Frog Demographics



Results

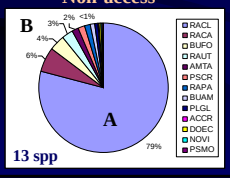
Species Richness and Composition



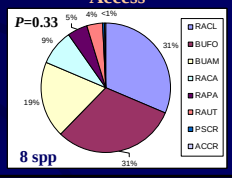
Non-access

Access

P < 0.001



13 spp

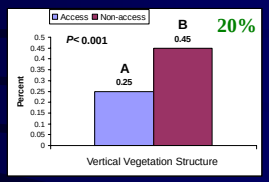


8 spp

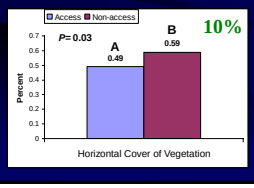
Results

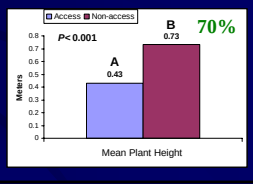
Vegetation Responses

Access

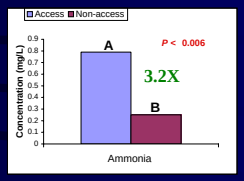


Non-access

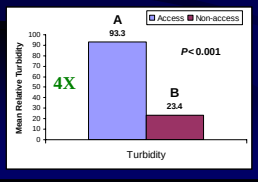


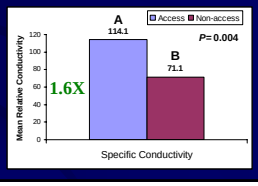


Results
Water Quality



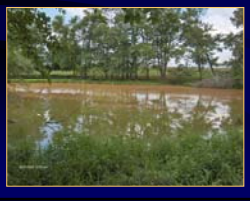
P>0.19 for all other variables





Water Quality Differences

Access **Non-access**



Results
Modeling Green Frog Metamorph Abundance

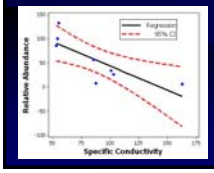
Significant Environmental Cofactors:

Vegetation: Percent Horizontal and Vertical Cover, and Plant Height

Water: NH_3, NH_4^+, Turbidity and Specific Conductivity

$$\text{Capture} = -0.77(\text{SpCond}) + 0.41(\text{HorzCover})$$

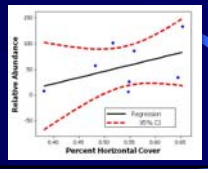
CN & VIF ≈ 1



$R^2_{adj} = 0.73$

64% = SpCond

9% = HorzCov



Summary of Results

- Green frog metamorph abundance was negatively associated
- Vegetation structure and horizontal cover was less in cattle-access wetlands
- Water quality appeared to be negatively influenced by cattle
- Specific conductivity and horizontal cover of vegetation explained the greatest variation in green frog metamorph abundance.



Discussion

Horizontal Cover: (Breeding Habitat)

- Breeding sites
- Foraging and escape cover

Jansen & Healey (2003), Healey et al. (1997)

Specific Conductivity: (Tadpoles)

- Fecal particulate matter & chemicals associated with OM decomposition
- Negative correlation between conductivity and Rana tadpole abundance

Hecnar & McCloskey (1996), Stumpel & van der Voet (1998)

Ammonia (NH_3): (Tadpoles)

Cattle Wetlands 0.80 mg/L

Sublethal Effects?

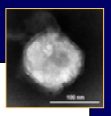
>0.5 mg/L

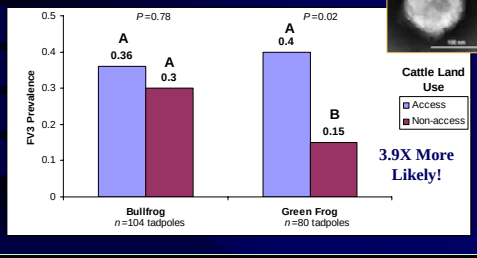
- Increase in malformations
- Decrease in egg & tadpole survival

Jofre and Karasov (1999)

Another Possible Mechanism

Frog Virus 3



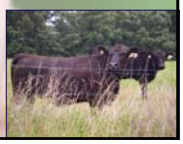


3.9X More Likely!

Increased prevalence of FV3 in green frog tadpoles may have resulted in reduced metamorph recruitment

Conservation Implications

- Cattle may be contributing to amphibian declines
- Exclusion of cattle from wetlands and adjacent habitat
- Partially fencing cattle from wetlands and providing alternative food and water sources



Future Research & Analyses

- Egg Mass and Breed Call Surveys
- Tadpole Demographics
- Data collection ongoing in 2006

- Grazing Intensity Experiments
- Controlled Aquaria Experiments
- Controlled Experimental Infections

Acknowledgments

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