# A preliminary investigation of Feral Hog impacts on water quality

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## Introduction

In Mississippi, invasive species such as Feral Hogs (*Sus scrofa)* are known for having such a disruptive behavior that some countries have recognized them as being a "triple threat pest" due to their impacts on agriculture, human health, and initiated competition among native species within their respective ecosystems (Hampton et al., 2004). Feral Hogs can have several sizeable litters a year, which allows for rapid growth in population within a given area. Feral Hogs can greatly increase their populations in a short amount of time, they create more stress on local communities. Behaviors such as: rooting, wallowing, and trampling destroys resources used by native species and can lead to a loss of biodiversity (Dunkell et al., 2011). More research is needed in order to obtain a better understanding of the impacts Feral Hogs have on human and ecological health including detriments to water quality (Dunkell et al., 2011). While much progress has been made in discovering the potential role of feral pigs as disease reservoirs, the waterborne pathogens they potentially excrete in the water catchment areas have remained poorly understood (Hampton et al., 2006). Therefore, the ***objective of this research was to identify how water quality was affected by the presence of Feral Hogs.***

**Figure 1.** Picture of Feral hog enclosure. Hog enclosure contained 0-13 wild hogs within an area of approximately 0.81 ha with 1/3 consisting of riparian hardwoods and the remaining 2/3 is managed pasture.

## Methods

This study was conducted at the Mississippi State University South Farm Research Facility (Figure 1). Samples were collected as follows:

- Following (runoff producing) rain events, samples were collected from all sampling locations. The design of the in-ground samplers is shown in Figure 2.

Once the samples were collected:

- Samples were separated into two containers where one was taken to a USDA lab for microbial testing (Brooks et al. 2010) for the following pathogens or fecal indicators: *Enterococci, Clostridium perfringens, Salmonella, Campylobacter and Escherichia coli*.
- Secondary samples were filtered through 0.45 µm Whatman filters and preserved with 1 mL of 98% $H_2SO_4$ acid that was added to 25mL of a sample. Samples were stored at 3°C until analyzed for nutrient concentrations within 30 days of preservation.
- Nutrients analyses included Nitrate ($NO_3^-$), Nitrite ($NO_2^-$), Ammonium ($NH_4^+$), and Ortho-phosphate ($PO_4^{3-}$) using the Lachat Quick Chem Series 2 Flow Injection Analyzer following described in Baker et al. (2016).

**Figure 2.** Picture of sheet-flow water sampler, an aluminum box (60.96 cm x 30.48 cm. x 5cm) that collects water. During the sampling event, runoff is channeled to a 90° PVC elbow connected to a 32 oz. milk jug that is placed approximately 5 cm below ground level.

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## Results

Sampling over time was uneven in the below pen sampling pair; therefore nutrient concentrations and bacterial abundance were aggregated for each sampling date. From graphical trend analyses (Figure 3):

- Nutrient concentrations and bacterial abundances had greater variance after January 2017 in the below pen samples.
- Nutrient concentrations and bacterial abundances seemed equally or less variable after January 2017 in the upstream and downstream locations.

Results from the regression analysis indicated that:

- Below pen Ammonium had a evidence of change over time of study (i.e., slope differed from zero; $t_{(1, 6)} = 2.73$, $P = 0.03$; Table 1).
- No other variables showed evidence for change over time of study of in differences between upstream and downstream sampling locations (results not shown).

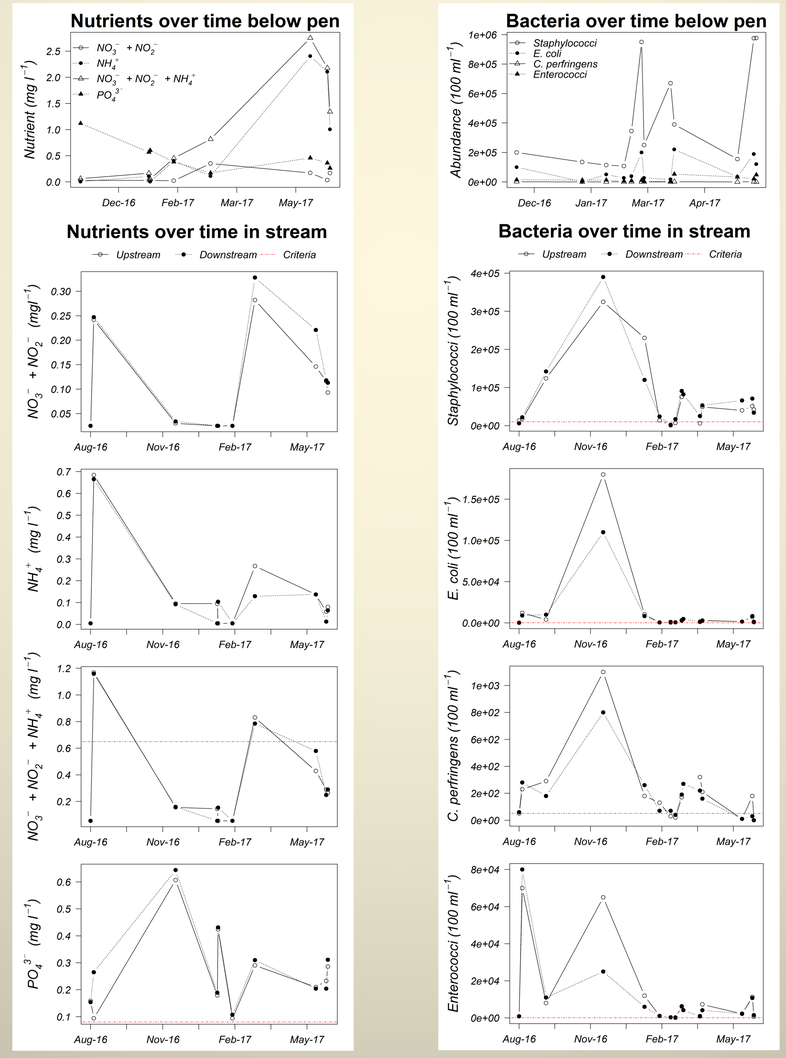


**Figure 3.** Nutrient concentration and bacterial abundance plots analyzed for graphical trends. Nutrient thresholds are based on preliminary criteria of MDEQ (MDEQ, 2007); Enterococci and E . coli thresholds are based on EPA criteria; C. perfringens and Staphylococcus thresholds were determined based on previous environmental data.

**Table 1. Summary of regression results for nutrient concentrations and bacterial abundance in below hog pen runoff over time.**

| Response Variable | Coefficient | $t_{(ndf, ddf)}$ | $P$ – value | Effect Size ($f^2$)† |
|---|---|---|---|---|
| **Nutrient (n = 8)** | | | | |
| $NO_3^-$ - N + $NO_2^-$ - N | $6.88 \times 10^{-9}$ | $0.95_{(1, 6)}$ | 0.22 | 0.01 |
| $NH_4^+$ - N | $1.31 \times 10^{-7}$ | $2.73_{(1, 6)}$ | 0.03 | 1.94 |
| $PO_4^{3-}$ - P | $-3.24 \times 10^{-8}$ | $-1.60_{(1, 6)}$ | 0.16 | 0.65 |
| **Bacteria (n = 12)** | | | | |
| Staphylococci | $4.31 \times 10^{-2}$ | $1.96_{(1, 10)}$ | 0.08 | 0.41 |
| E. coli | $4.92 \times 10^{-3}$ | $0.93_{(1, 10)}$ | 0.37 | <0.01 |
| C. perfringens | $-4.37 \times 10^{-5}$ | $-0.64_{(1, 10)}$ | 0.54 | 0.02 |
| Enterococci | $1.88 \times 10^{-3}$ | $1.72_{(1, 10)}$ | 0.12 | 0.28 |

Notes: Heteroscedasticity-consistent standard errors (HC3) were used (Hayes & Cai, 2007)

†$f^2$, Cohen's standardized effect size; small = 0.02, medium = 0.15, large = 0.35 (Cohen, 1988).

## Discussion

Acknowledging this study's limited sample size and the inherent environmental variability, results suggest instream sampling results give little support to the presence of Feral Hogs adversely impacting nutrient concentrations and bacterial abundances in water samples. Although, graphical trend analysis (reflected in diagnostic plots of fitted models) suggest that nutrient concentrations and bacterial abundances in below pen samples became more variable with time. Greater variation in nutrient concentration and bacterial abundance immediately below the feral hog enclosure is likely the result of feral hog presence. This variation was weaker in instream samples, including those downstream of the pen. Instream sample locations were separated by approximately 30 m of riparian vegetation, which poses the potentially to filter contaminants from overland runoff before reaching the stream. The riparian buffer, along with dilution effects once runoff entered the stream likely contributed to dampening contaminant concentrations and variation. However, in realistic scenarios, Feral Hogs are not fenced out of stream and riverine channels. Alternatively, Feral Hogs utilize such aquatic habitats for drinking, and wallowing to regulate body temperature, especially regions that experience high temperatures such as the southeast United States. To expand on this data set and investigate feral hog watershed utilization patterns, further research is warranted.

**Figure 4.** Feral Hogs in experimental enclosure.

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