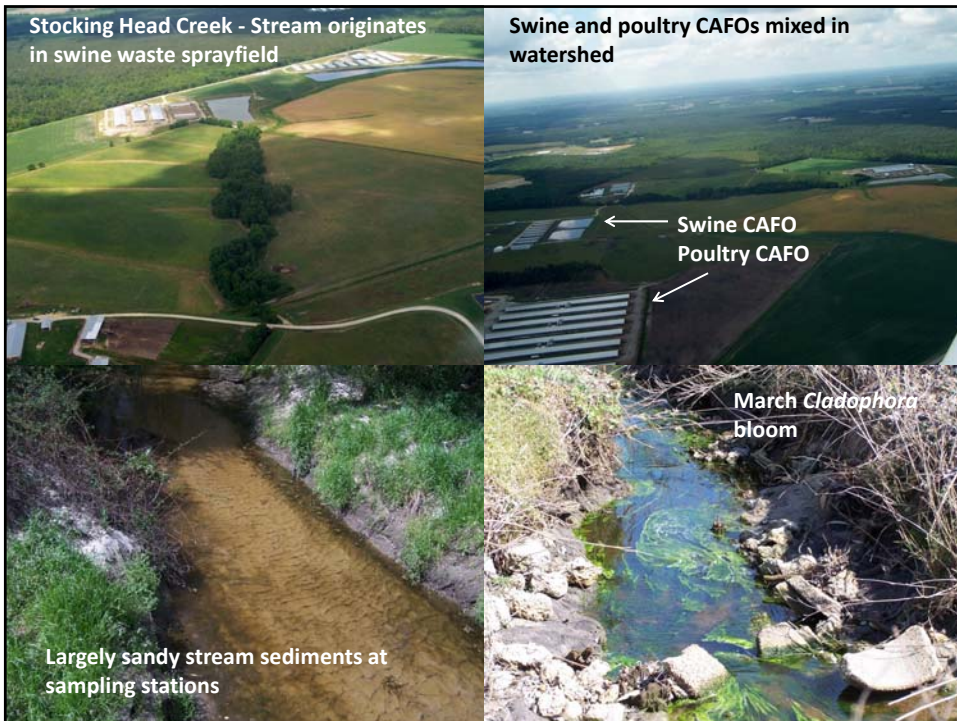


# Season Matters When Sampling Streams for Swine Waste Disposal Impacts

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Stocking Head Creek - Stream originates  
in swine waste sprayfield

Swine and poultry CAFOs mixed in  
watershed

Swine CAFO  
Poultry CAFO

March *Cladophora*  
bloom

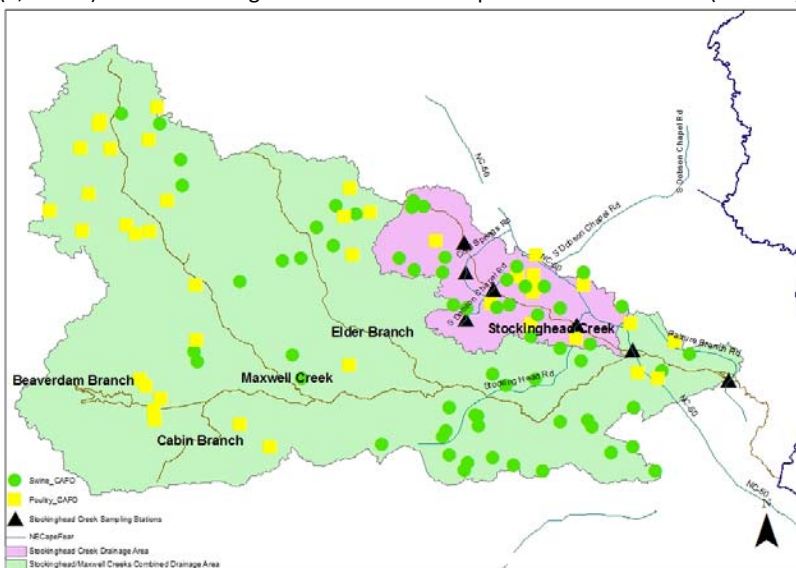
Largely sandy stream sediments at  
sampling stations



## Field and Laboratory Methods

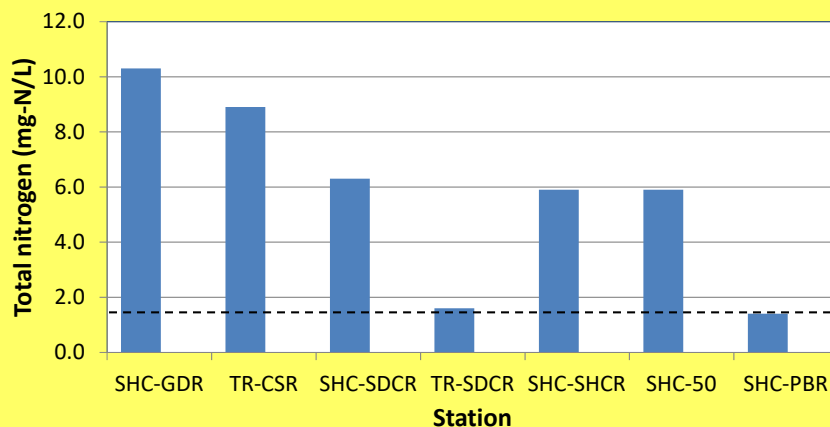
- Surface water samples were collected at 7 stream stations on 5 sampling runs within a 30 day period in spring (March 2016) and a 30 day period in summer (August 2016)
- Sampling was performed using procedures required by NCDEQ for assessment of use support of NC waters for fecal coliform concentrations.
- Statistical analysis (t-tests) was performed after log-transformation to determine if CAFO-derived pollution varied according to season.
- Nutrients and fecal coliform analysis were performed at a state-certified contract lab and field parameters were performed by the UNCW-CMS Aquatic Ecology Laboratory, which is state-certified for field parameters. UNCW follows QA/QC procedures of the Lower Cape Fear River Program and is audited annually by NCDEQ.

Stocking Head Creek, Duplin County, North Carolina. Catchment area is 4,893 acres (1,980 ha) and stream length to the Northeast Cape Fear River is 13.7 mi (22.1 km).



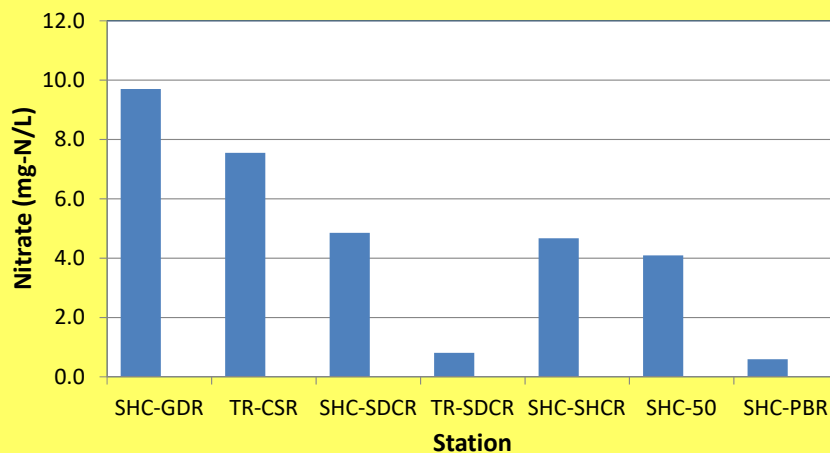
Contains 40 swine CAFOs permitted for 94,068 head of swine. Poultry estimated (by UNCW) as broilers or other chickens approximately 1.3 million birds in SHC watershed.

### Median TN concentrations in Stocking Head Creek, Duplin Co., August 2016 (n = 5 for each station)

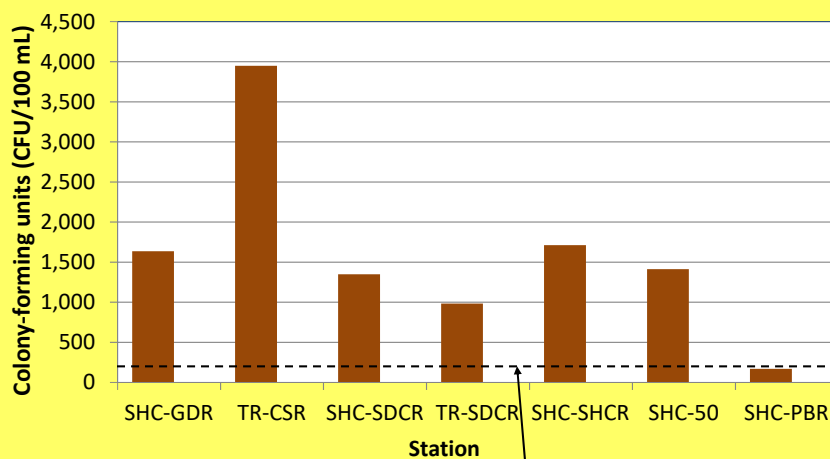


For perspective, using a large data set of 1,070 streams Dodds et al. (1998) determined that TN concentrations > 1.5 mg/L were characteristic of eutrophic conditions. Dodds, W.K., J.R. Jones and E.B. Welch. 1998. Suggested classification of stream trophic state: distributions of temperate stream types by chlorophyll, total nitrogen, and phosphorus. *Water Research* 32:1455-1462.

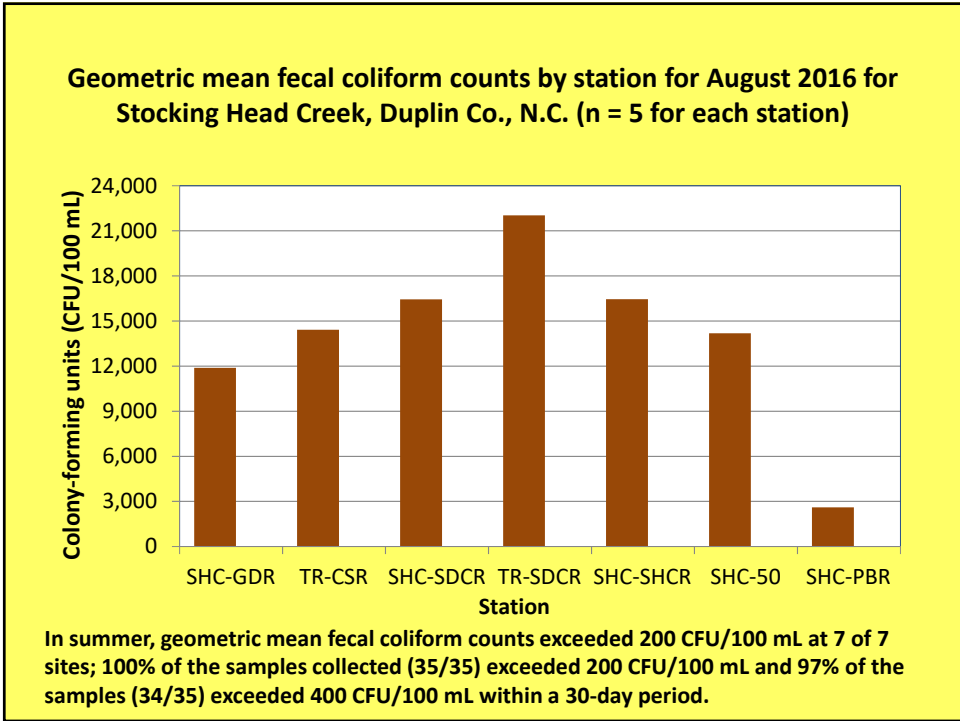
**Median nitrate concentrations in Stocking Head Creek, Duplin Co., August 2016 (n = 5 for each station)**



**Geometric mean fecal coliform counts by station for March 2016 for Stocking Head Creek, Duplin Co., N.C. (n = 5 for each station)**



Spring geometric mean fecal coliform counts exceeded 200 CFU/100 mL at 6 of 7 sites; 86% of the samples collected exceeded 200 CFU/100 mL, and 80% of the samples exceeded 400 CFU/100 mL.



## Summary – human health and ecological issues

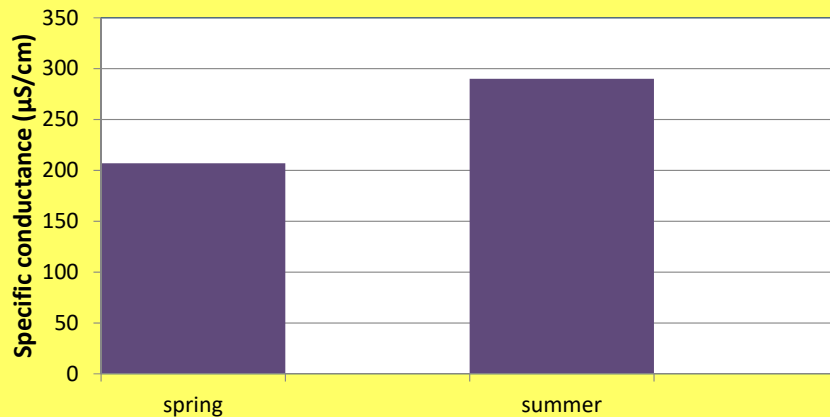
- *The North Carolina protocol states that fecal coliform counts shall not exceed a geometric mean of 200 CFU/100 mL based on at least five consecutive samples during any 30 day period, nor exceed 400 CFU/100 mL in more than 20% of the samples examined during such period.*
- During both spring and summer Stocking Head Creek fit all criteria for non-support of designated use due to excessive fecal coliform pollution, and should be candidate for inclusion on the 303(d) list.
- Total nitrogen and total phosphorus concentrations for this creek place it in the eutrophic category in academic texts analyzing large numbers of streams in the U.S. and Europe (Wetzel 2001; Dodds et al. 1998).
- In-stream nitrate concentrations periodically exceed the US EPA standard for “blue-baby syndrome”, 10 mg/L.
- Coastal Plain soils often are porous with a high water table, exacerbating groundwater pollution!

## Season Matters

- Spraying of animal waste on fields planted in Bermudagrass (the most popular land cover for swine sprayfields) is permitted from March 1 through September 30 (NCDAS 1996).
- Thus, it might be suspected that stream pollutant concentrations vary according to season.
- There was no significantly different seasonal difference in ammonia, orthophosphate, or total phosphorus.
- However, conductivity, nitrate, total nitrogen, total organic carbon and fecal coliform bacteria all showed significantly higher concentrations in August as opposed to March.



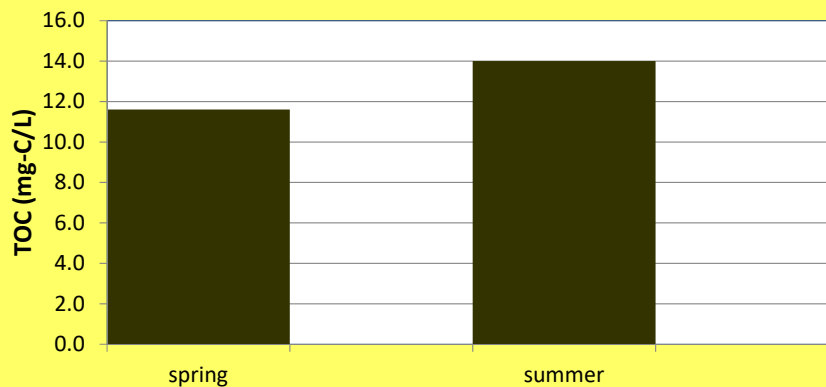
**Median conductivity values for all 7 sites in Stocking Head Creek, Duplin Co., spring (March) vs summer (August) 2016**



**Medians (n = 35), summer > spring (p < 0.001)**

In a large scale USGS study (Harden 2015), mean conductivity was significantly elevated in CAFO-impacted streams compared with non-impacted streams, attributed to elevated dissolved magnesium, potassium, sodium and chloride concentrations.

**Median total organic carbon (TOC) concentrations for all 7 sites in Stocking Head Creek, Duplin Co., spring (March) vs summer (August) 2016**

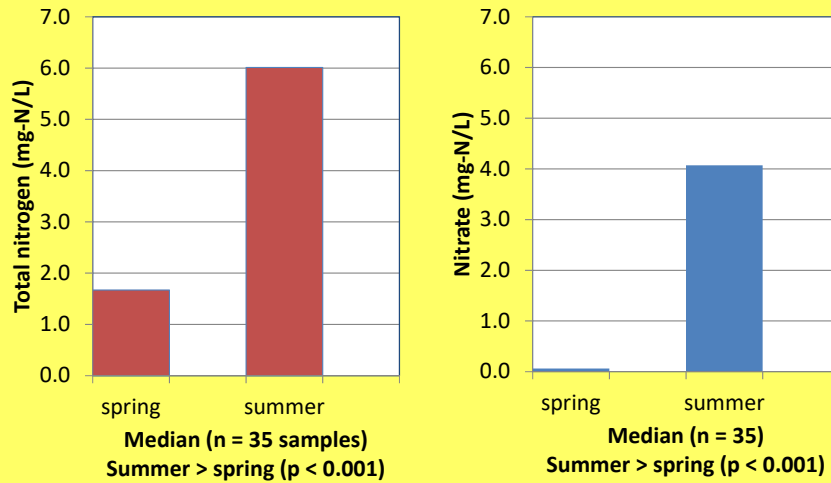


**Medians (n = 35)**

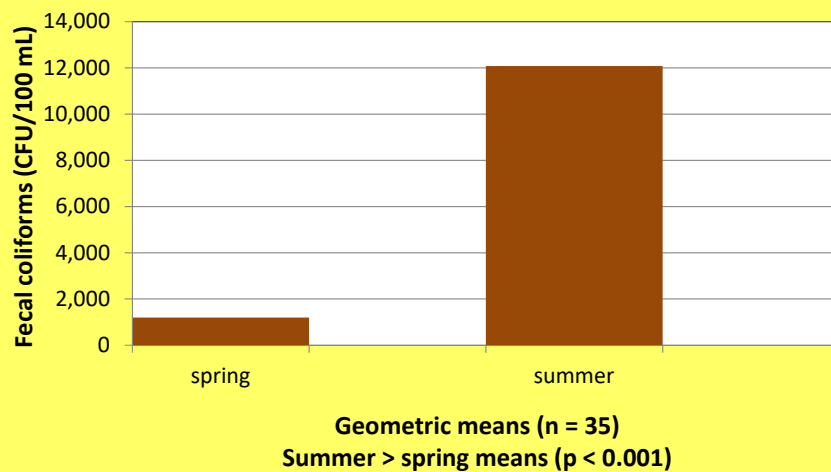
**Summer > spring means (p = 0.008)**

Note that in an earlier study (Mallin et al. 2015) TOC was strongly correlated with BOD in this stream

**Median concentrations of TN (left) and nitrate-N (right) for all 7 sites combined in Stocking Head Creek, Duplin Co. 2016**



**Geometric mean fecal coliform bacteria concentrations for all 7 sites in Stocking Head Creek, Duplin Co., spring (March) vs summer (August) 2016**





## Implications

- The data have important implications for proposed sampling schemes to determine water quality impacts of swine CAFO facilities.
- If stream sampling is limited in number by decree or funding, sampling should be concentrated in summer when swine waste spraying has been ongoing for several months.
- Sampling in winter or early spring will miss the major impacts of this disposal method and yield biased results.
- Note that seasonal differences will be less pronounced in subbasins dominated by poultry CAFOs because poultry waste is spread as dry litter rather than liquid spraying.

## Acknowledgements

- We thank Lauren Bohrer and Nick Iraola for field sampling assistance.
- We thank the Waterkeeper Alliance for funding.
- We thank Gray Jernigan and Kelly Foster of Waterkeeper and Kemp Burdette , Cape Fear Riverkeeper, for project facilitation

*Note that a 2013 study on this watershed has recently been published:*

Mallin, M.A., M.R. McIver, A.R. Robuck and A.K. Dickens. 2015. Industrial swine and poultry production causes chronic nutrient and fecal microbial stream pollution. *Water, Air and Soil Pollution* 226:407, DOI 10.1007/s11270-015-2669-y.

