

# Establishing a baseline for seasonal nutrient dynamics in ten Cumberland Plateau streams of differing human impact

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## Introduction

- Streams on top of the Cumberland Plateau are ecologically important to the surrounding upland forest communities, although they are largely unstudied.
- Stream nutrient dynamics in these streams would provide critical insight into the coupling of carbon, nitrogen and phosphorus dynamics between riparian and terrestrial ecosystems in this region.

## Objectives

- Characterize seasonal baseline nitrogen (N) and phosphorus (P) concentrations in ten upland streams representing three land-use covers (undisturbed forest, urban forest and effluent treated- the Sewanee Utility District SUD watershed).
- Assess the effect of effluent application on upland forested streams in the SUD watershed as compared to undisturbed forested streams.

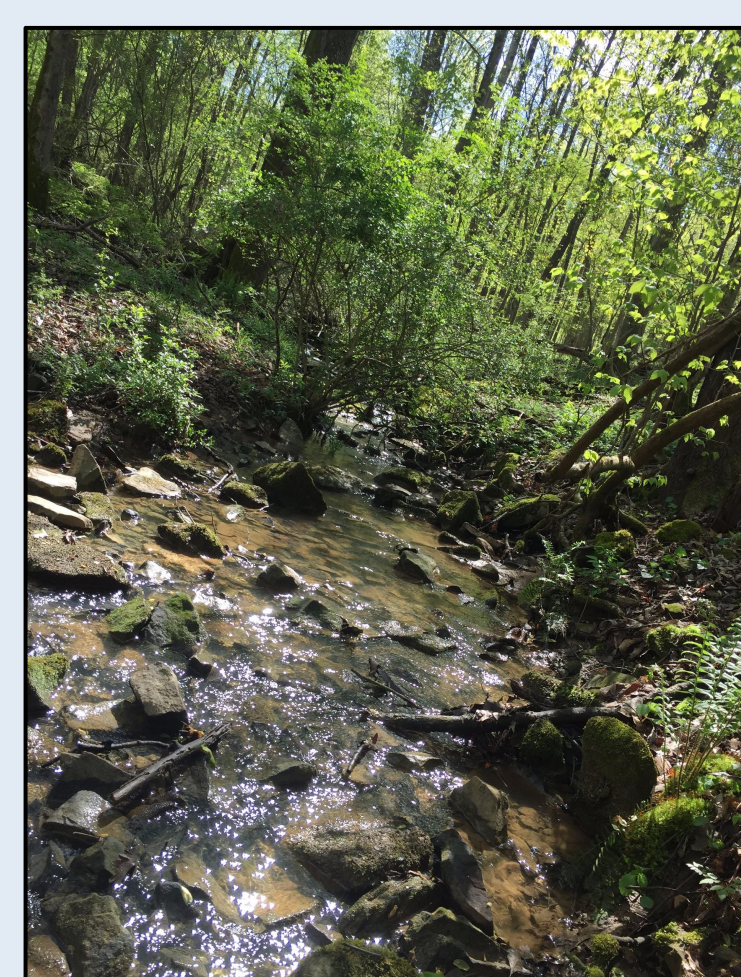


Fig. 1. SUD Stream



Fig. 2. Forest Stream



Fig. 3. Urban Stream

## Methods

- Ten streams, representing three landcover types (forest n=4, urban n=3 and SUD effluent-treated n=3) were sampled four times during the winter and spring months of January - April 2019 (Fig 1).
- Three grab samples were collected for each stream and analyzed chemically for nitrogen, phosphorus, pH, conductivity, and turbidity.
- Nitrate, nitrite and phosphate were extracted and measured colorimetrically using a Hach photospectrometer.
- Ammonia, conductivity, and pH were measured using Beckman probes and turbidity was measured using a turbidimeter.



Fig. 4. Student researchers Gill, Chenault and McCoy conducting laboratory analyses.

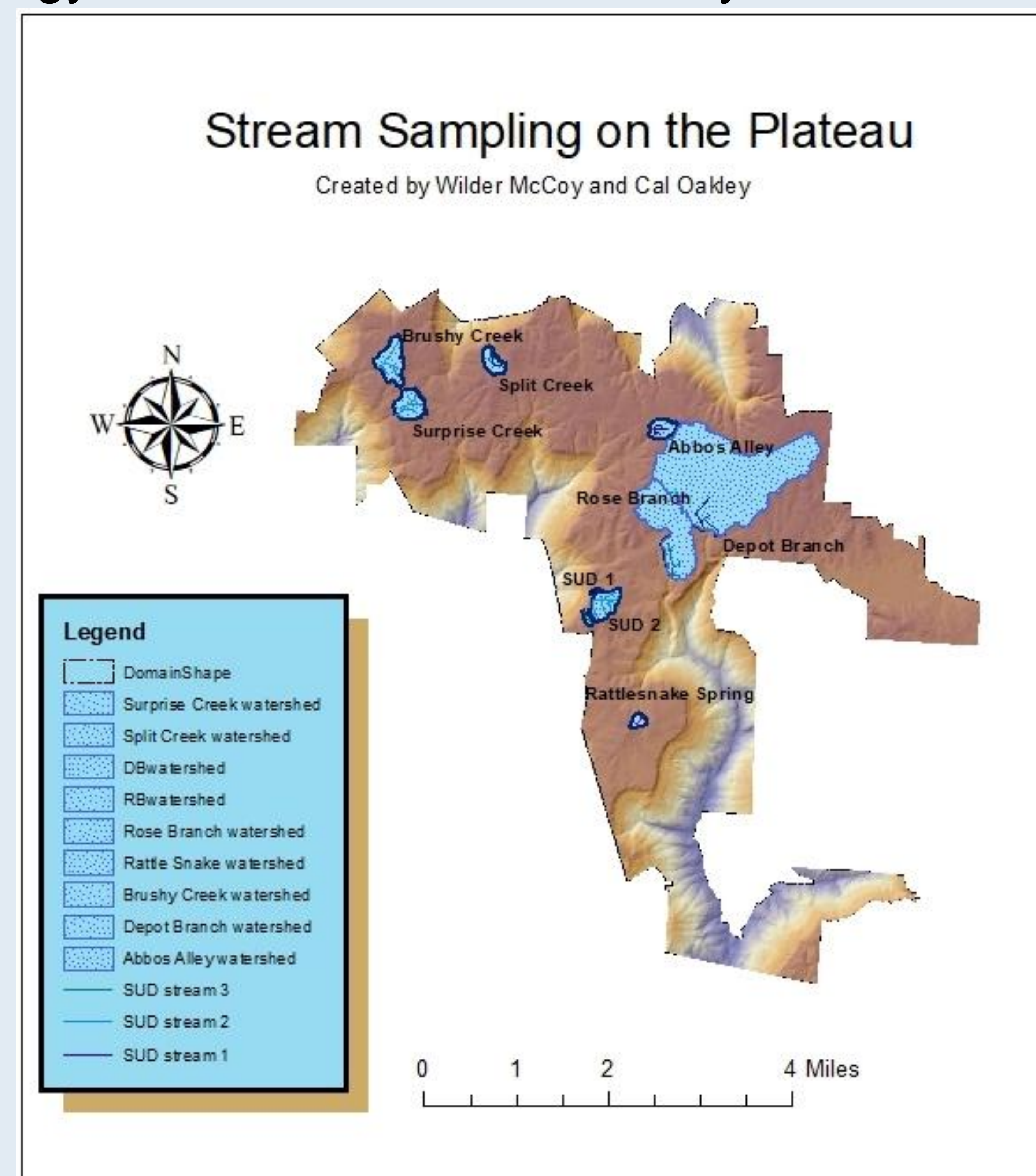


Fig. 5. Watershed map with ten upland stream sampling sites in Franklin County, TN.

## Results

- Although nutrient concentrations varied significantly by month, concentrations of all forms of N and P were higher by almost an order of magnitude in the SUD streams, compared to those in undisturbed and urban forest (Table 1).
- Both nitrate and nitrite concentrations were significantly higher in the SUD streams across all months due to N-enriched treated wastewater effluent sprayed on the hardwood forests in the SUD watershed (Figs 6 and Table 1,  $p < 0.001$ ).
- Nitrite concentrations increased in months of March and April, suggesting higher N mineralization with warmer spring temperatures.
- Nitrate, in contrast, declined in all landcover types during the transition from February to March, likely due to uptake by terrestrial vegetation with spring leaf out. The decline in nitrate concentrations in early spring occurred in streams in all landcover types.
- Across all stream types, there was a significant season effect on total P with concentrations increasing during the warmer spring months of March and April ( $p < 0.001$ , Fig 7). We hypothesize that the warmer temperatures triggered a pulse of P in streams with higher microbial and detritivore break down of organic matter.

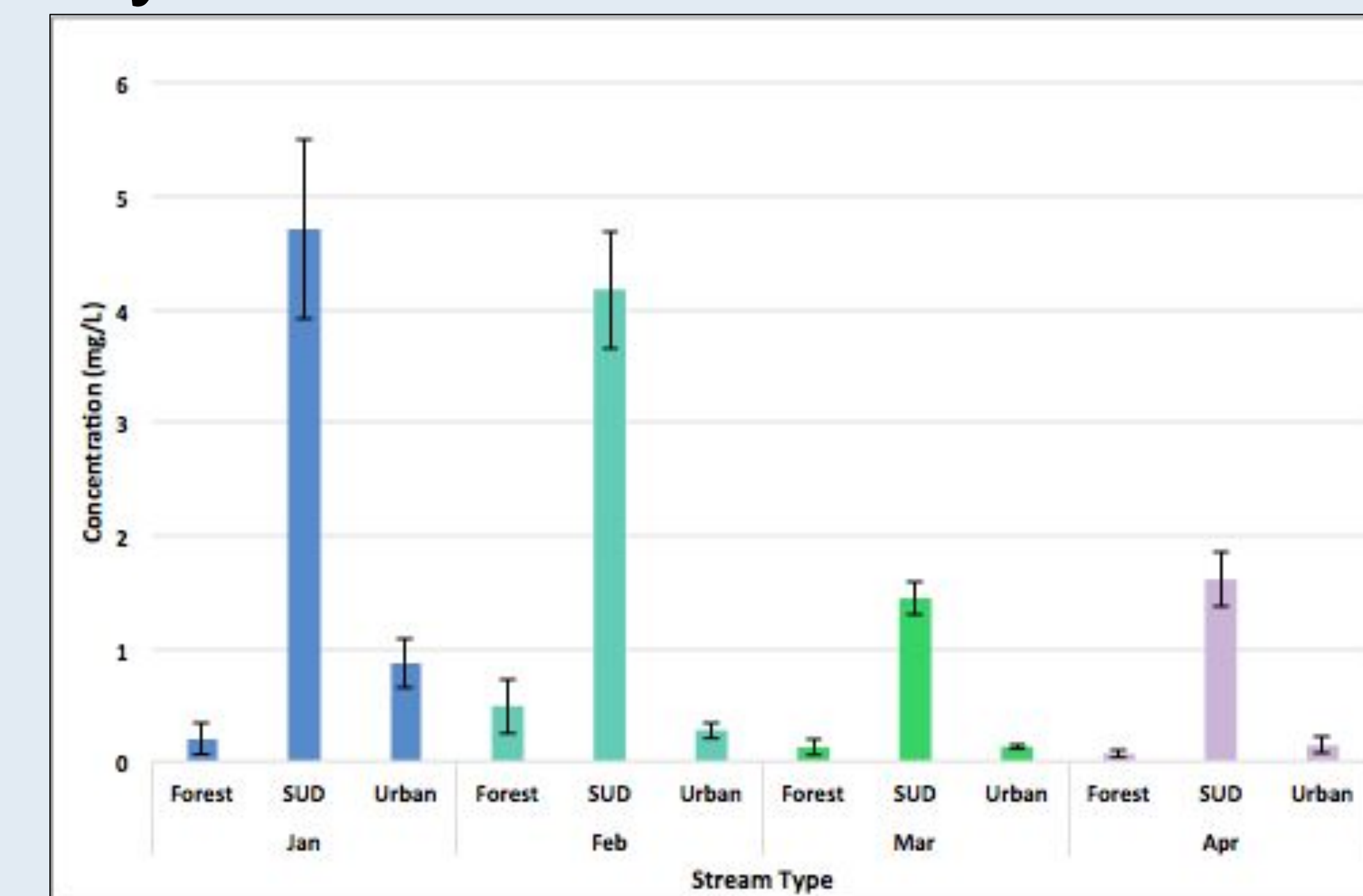


Fig. 6. Nitrate concentrations in three stream types sampled in winter and spring 2019.

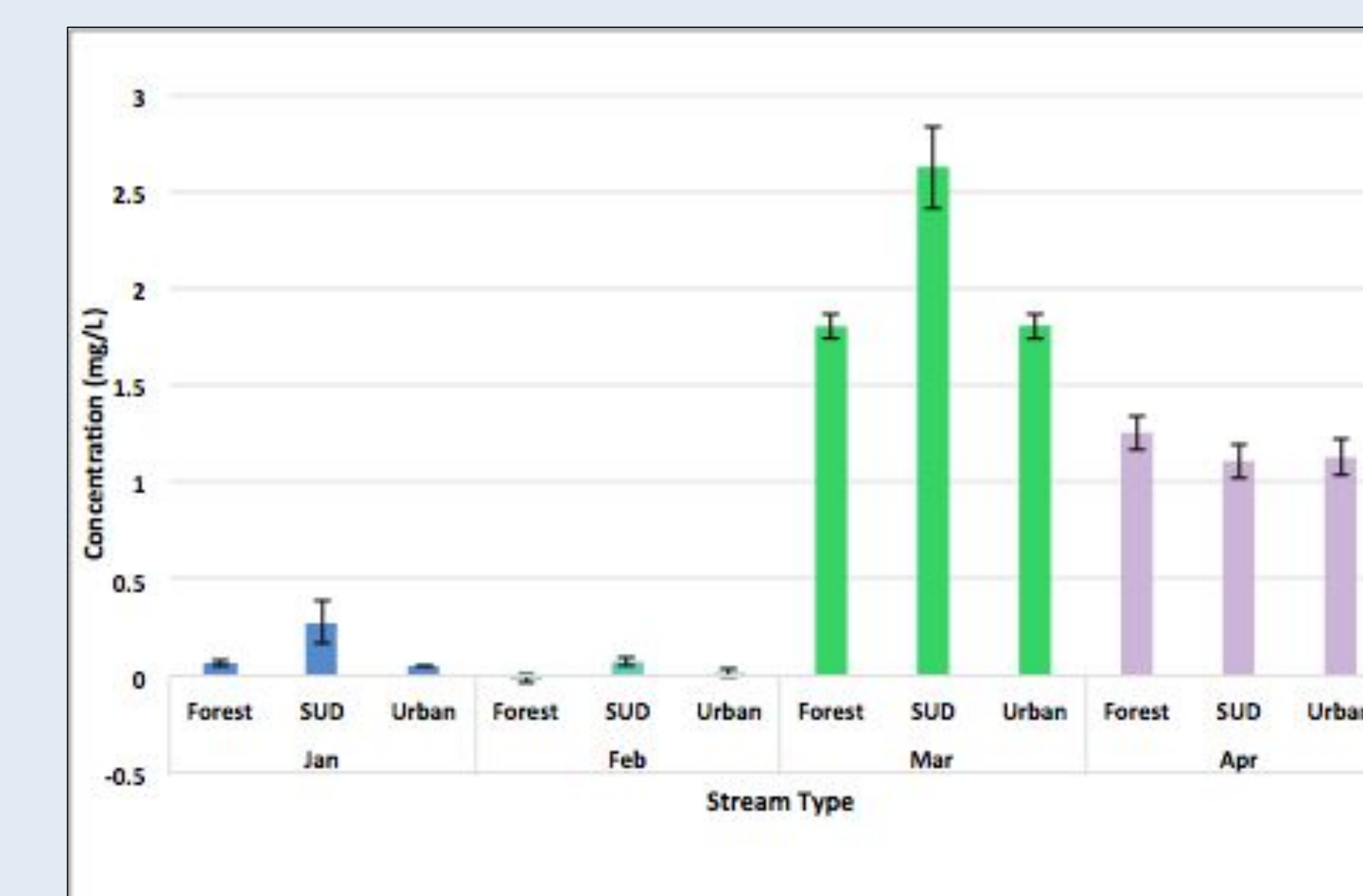


Fig. 7. Total P increased in March and April in all three stream types sampled.

## Conclusions

Application of treated wastewater effluent adds considerable nitrogen to upland forest streams, which are otherwise very nitrogen- and phosphorus-poor.

Given the significant nitrogen additions, SUD streams likely process nitrogen, phosphorus and carbon differently than the oligotrophic streams of both undisturbed and urban forest.

Long term study is needed to quantify baseline concentrations throughout summer and fall months, as well as over years to determine if the patterns seen in this study are representative of upland streams in this region.

Table 1. A comparison of chemical properties in three stream types on top of the Cumberland Plateau in Franklin County, TN. Data collected January-April 2019 from 3 grab samples/stream.

	Forest n=4	Urban n=3	SUD n=3	GLM p-value
<b>Ammonia</b>	0.04 ± 0.03	0.03 ± 0.001	0.45 ± 0.08	< 0.0001
<b>Nitrite</b>	0.003 ± 0.0004	0.031 ± 0.003	0.005 ± 0.001	< 0.0001
<b>Nitrate</b>	0.22 ± 0.07	2.98 ± 0.34	0.36 ± 0.08	< 0.0001
<b>Phosphate</b>	0.03 ± 0.02	0.008 ± 0.002	0.26 ± 0.11	< 0.0001
<b>pH</b>	5.48 ± 0.07	7.65 ± 0.11	6.99 ± 0.06	< 0.0001
<b>Conductivity</b>	24 ± 3	124 ± 9	124 ± 3	< 0.0001
<b>Turbidity</b>	1.5 ± 0.2	2.2 ± 0.2	10.1 ± 1.38	< 0.0001