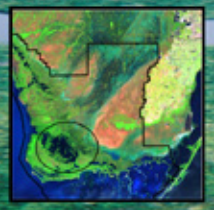
Spatial and Temporal Analysis of Soil Pore Water Nutrients in an Estuarine Fringe Mangrove Forest

Harney RIver Estuary, Everglades National Park

USGS science for a changing world

Everglades National Park



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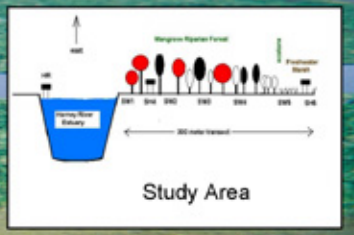
Abstract

Soil pore water nutrient sampling was started near the Harney River, Everglades National Park in the summer of 2002 to better understand the spatial and temporal dynamics between soil nutrients and vegetation across the fringe mangrove-marsh interface. The 300 m sampling transect consists of five soil water sampling sites (SW1...SW5) equally spaced. At each site, soil pore water was sampled at depths of 0 cm, 30 cm and 60 cm. Adjacent river water and shallow groundwater wells were also sampled. Data from three wet season (7/02, 8/02, 7/03) samples and two dry season (1/03, 2/03) samples were analyzed. Preliminary data indicate increased levels of nitrogen (N), carbon (C), and phosphorus (P) at SW3, and increased sulfide, turbidity and ammonia (NH_4) at marsh site SW5. Lower concentrations of most nutrients were observed in the winter samples. The greatest nutrient concentrations were primarily found at 30 cm. Ratios of C:N:P vary widely, with C in great excess of N and P. Color and salinity interference created measurement conflicts between N and P components vs. their totals, especially in summer wet season samples. Future data collection is needed to strengthen the validity of inferred patterns and allow correlations between salinity and nutrient content.



Introduction

April 1997--started soil pore water salinity and temperature monitoring at five sampling sites in a mangrove-marsh ecotone transect (see Anderson, et al.).

July 2002—began first pore water nutrient sample along transect to better identify the dynamics of mangrove soil nutrients.

Interstitial water at 30 and 60 cm represents the dissolved nutrients available for plant root exchange.

Purpose: Observe variation in nutrient concentrations, especially nitrogen (N) and phosphorus (P), with respect to:

Lateral location along mangrove-marsh ecotone transect

Depth—water at 0 cm, 30 cm, 60 cm

Time—seasonal fluxes and/or specific times of greatest change

Study Questions:

What is the observation of N and P across the mangrove-marsh ecotone?

Does P decrease spatially from the estuary?

Is there less N and P in the soil in the dry season?

Is there more N and P in surface water and 30 cm depth than at the 60 cm depth?

Methods

An Array of water nutrient and physical parameters were sampled from the five soil water sites on each of 5 discrete sampling periods—3 wet season, 2 dry.

Water samples were collected utilizing SFWMD and USGS SOP for soil pore water nutrient sampling.

Water samples were collected at the following depths at each site:

30 cm—water from 3 replicate soil tubes was aggregated prior to redistribution to permit sufficient water for sampling, yet maintain interstitial in situ water from the different depths.

60 cm—same process as 30 cm

0 cm (surface water)—collected if present

A Harney River sample and groundwater from 2 permanent and continuously operated monitoring stations were also collected.

Field and equipment blanks were also analyzed.

Physical water quality parameters (conductivity, salinity, temperature, redox, pH, DO) were field analyzed.

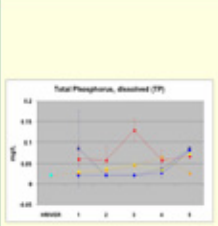
Analysis for the following parameters was conducted as per EPA methodology by the USGS Ocala Water Quality Research Laboratory after overnight shipment:

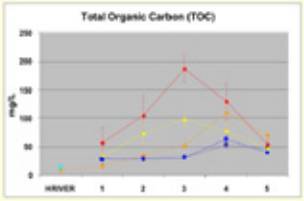
Turbidity	**Sulfide**	**TOC**
NO_2+NO_3	**NO_2**	**NH_3**
TP (dissolved)	**TKN**	**PO_4**

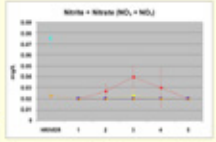
Analysis for activity of the following enzymes was conducted at the Southeast Environmental Research Center:

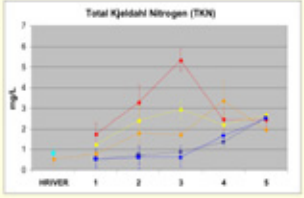
B-1-4-glucosidase (C)
Phosphatase (P)
Acetylglucosaminidase (N)
Sulfatase (S)

Data









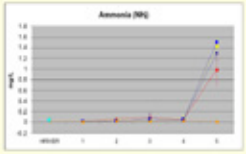
Legend
summer-30
summer-60
summer-0
winter-30
winter-60
winter-0

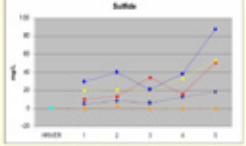
Average seasonal nutrient concentration in mg/L at each depth (0, 30, 60 cm) at each site across ecotone (SW1 in mangrove, SW5 in marsh), indicating a general trend of increased C, N and P at SW3 and at 30 cm in wet season (summer) and an increase towards the marsh with little depth differentiation in dry season (winter). Error bars represent standard deviation of the sampling periods from the mean. Note the very high scale for TOC and the very low scale for TP and NO_2 + NO_3 (detection limit=0.02)

Correlation coefficients for certain pairs of parameters, indicating strong (green) and moderate (blue) relationships between many parameters in groundwater (GW) and surface water (SW)

Parameters	Wet	Dry	30 cm	60 cm	0 cm	GW	Total
TOC, TKN	0.8686	0.6099	0.8625	0.7716	0.9297	0.957	0.8658
TOC, TP	0.6139	0.0857	0.5758	0.2461	0.8453	0.6259	0.5139
TKN, TP	0.7362	0.2842	0.6209	0.6884	0.8566	0.5404	0.614
Sulfide, NH_3	0.8585	0.691	0.6319	0.8382	-0.227	0.9925	0.7525
Sulfide, TKN	0.3905	0.7278	0.6331	0.3994	0.9996	0.9988	0.5211
Sulfide, TP	0.4761	0.5751	0.6647	0.8797	0.9869	0.9902	0.5118
Sulfide, Turbidity	0.6947	0.3301	0.5665	0.0429	0.9065	0.9437	0.5218
Sulfide, Redox	-0.6184	-0.6529	0.6647	-0.4796	-0.127	-0.8386	-0.5238
C-enzyme, N-enzyme	0.969	0.5071	0.1662	0.9999	0.9674	0.9161	0.6057

Graphs showing ammonia and sulfide following similar general patterns (highly correlated)—high concentrations in all depths except surface water at marsh site (SW5) in all sampling periods





Results and Discussion

Spatial and Temporal relationships:

Most nutrients follow a trend of high concentration at SW3 in summer wet seasons and towards the marsh in the winter dry season. The trend at SW3 may be correlated with the tree density there, which is generally less than that of SW1 and SW2.

Many nutrients have higher concentration in pore water of 30 cm depth.

Most nutrients have higher concentrations in summer. However, sulfide, turbidity, and ammonia have winter values greater than or equal to those in summer, especially at 30 cm.

Enzyme activity was very low overall and showed only a trend of higher activity in surface water during summer for all enzymes except phosphatase. This may be because 30 cm and 60 cm is too deep for enzyme activity in pore water.

Relationships Among Measured Parameters:

The ratios between TOC, TKN, and TP did not seem to follow the predicted Redfield ratio of 105:16:1 for C:N:P, but were highly varied, with C in great excess of N and P, usually by 2 instead of 1 orders of magnitude. C:P ratios ranged from 193 to 3450. N:P ratios ranged from 10 to 115. C:N ratios ranged from 16 to 160.

Overall, the relationship of correlations between measured parameters was greatest in groundwater, followed by surface water, then pore water at 30 cm and 60 cm, respectively.

TOC and TKN were very highly correlated, whereas TP was only moderately correlated with these two nutrients, suggesting that P may cycle independently of C and N.

Enzyme activity did not correlate with respective nutrient concentrations. This was contrary to expected relationships of low phosphatase activity and high _-1-4-Glucosidase, Acetylglucosaminidase, and sulfatase activity with high TP concentration.

There appears to be an inverse relationship between major nutrients (TOC, TKN, TP, NO_2+NO_3) and conductivity, especially at 30 cm.

Some discrepancy existed between NO_3 and TKN and between PO_4 and TP—in several instances, reported values of the component parameter were greater than reported values of the total parameter. This was caused by interference of the dark color of samples with the process of analysis.

Future Work:

Because of the limited number of samples, standard deviation and confidence intervals were rather large, therefore rendering most results preliminary observations and suggesting the need for at least one more year of sampling twice during each season. Since June appears to be the time of greatest transition between 30 and 60 cm for conductivity (see Anderson, et al.), sampling for nutrients at that time is suggested for the future.

An alternative method for analyzing PO_4 and NO_3 may be needed to decrease error in future sampling.

When current biomass data is available and analyzed, it will be possible to determine relationships between nutrients and vegetation along the transect.

Possibly sampling other sites in the Shark River E-W transect may strengthen results.

Acknowledgements

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