New Hampshire EPSCoR

PIE LTER | Water Systems Analysis Group | NH Agricultural Experiment Station

What controls the percentage of nitrogen that is exported downstream from a man-made reservoir?

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Background

There are 3070 active dams in the state of New Hampshire, many of which are being considered for removal. Mill pond on the Oyster river, and the Wiswall reservoir on the Lamprey River have been previously studied. Both reservoirs were observed to behave differently in regards to observed nitrate exports, which is possibly due to the different reservoir geomorphology. This led us to ask the question: What factors (biological, chemical, geophysical etc.) control the percentage of nitrogen inputs that are exported from the reservoir?

Experimental Design

Eight reservoirs were selected within four different watersheds in NH and MA

- Little Hale Pond, Beards Pond, and Mill Pond in the Oyster River watershed, NH
- Wiswall Dam and Macallen Dam on the Lamprey River, NH
- Ipswich Mills Dam and South Middleton Dam on the Ipswich River, MA
- Central Street Dam on the Parker River, MA

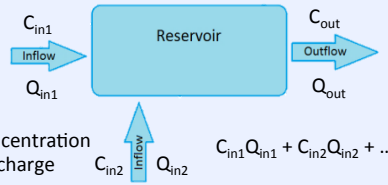
Sampling occurred three times for each reservoir, at a two week interval.

- Sampling at reservoir outflows and inflows
- Measurements of conductivity, dissolved oxygen, and water temp with handheld sensor
- 1 liter grab sample for TSS
- Filtered 60 mL grab sample for DOC, TDN, NH_4, PO_4, NO_3, NO_2, and Cl^-
- I liter grab sample for chlorophyll at each dam outflow

Sensors deployed at outflows of each reservoir

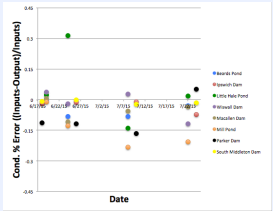
- Conductivity, dissolved oxygen, and temperature every 15 minutes
- Used to examine diurnal patterns in dissolved oxygen concentrations

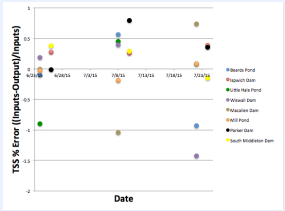
Results



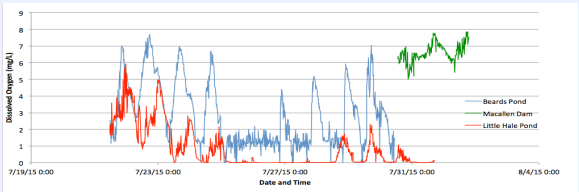
C = Concentration
Q = Discharge

$$C_{in1}Q_{in1} + C_{in2}Q_{in2} + \ldots = C_{out}Q_{out}$$

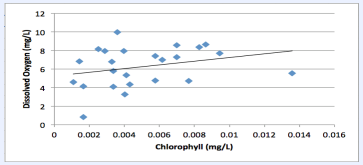




Because we can not measure discharge at all sites, watershed area was used as a proxy for discharge. Of the 32 total mass balances calculated, the inputs and outputs differed by less than 15% 28 times. TSS inputs and outputs differed by less than 15% only 6 out of 24 times. DO inputs and ouputs differed by less than 15% 14 out of 24 times.



All three reservoirs experienced diurnal variation in dissolved oxygen levels.



In general, during the day, DO increases with Chlorophyll (r2=0.08). This can likely be attributed to photosynthesis from algal presence. However, the time series indicates that at night DO declines considerably.

Conclusions

- Watershed area is a good proxy for discharge, indicating reservoirs are near equilibrium
- Dissolved oxygen and total suspended solids do not act conservatively, suggesting that reservoirs act as sources and sinks, depending upon other variables
- High levels of chlorophyll correspond with high daytime dissolved oxygen but also anoxic nighttime conditions.
- Dissolved oxygen concentrations increase with Chlorophyll concentration during the day.

Future Work

- Analysis of nutrient mass balance relative to conductivity mass balance.
- A continuation of biweekly sampling to capture a range of flow conditions.
- Land use classification for each watershed as explanatory variable
- Redeployment of sensors to examine how season affects diurnal DO patterns.
- Calculation of nutrient retention and understand causes or variation.

Acknowledgements

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