Analysis of Water Quality Trends and Evaluation of Climate Change Effects in a Rocky-Mountain Reservoir: A Case Study

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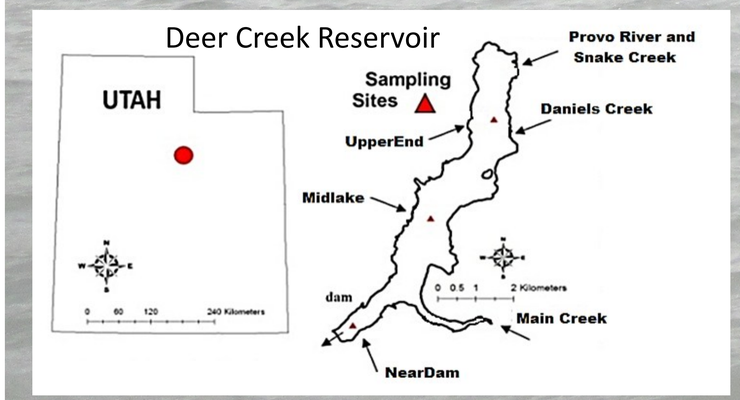
Abstract

A surface water quality assessment was performed for Deer Creek Reservoir in Utah. Temporal trends for this study included water quality data collected from 1980 through 2007 from three different sampling sites. These sampling sites represent the three main zones (lotic, transitional and lentic) of a typical reservoir. Spatial water quality data collection also included measurements at three different depths along the water column (surface, mid-water, and bottom) from each sampling site. These depths were measured using multi-parameter water quality sondes and laboratory methods. Hydro-climatological, physicochemical and biological data were collected and used for the water quality assessment and development of a statistical model. Our water quality analysis included a period of dam reconstruction that created extremely low reservoir levels as well as normal operational levels. The best statistical model was predicted and used to evaluate Deer Creek's water quality induced by different climatic and land use changes. Chlorophyll-*a* concentrations were used as water quality indicator to assess the in-reservoir effects of climate and land used variation produced by meteorological, hydrological and nutrient enrichment changes. We compared the results obtained from our statistical model with previous results from a computational two-dimensional-hydrodynamic and water quality model. Our results from the statistical model showed similar patterns of chlorophyll-*a* compared to the computational model. These results suggest that chlorophyll-a concentrations for Deer Creek were more sensitive to nutrient changes than climatic changes.

Purpose

Use statistical model to evaluate long term changes in Deer Creek reservoir and compare the results with traditional water quality modeling.

Study Area



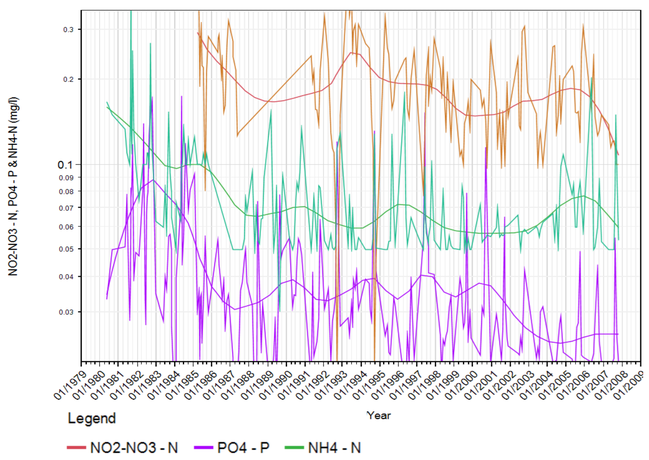
Methods

The statistical model was created using a stepwise variable selection of a saturated 2nd degree model. The software used was JMP 9.0

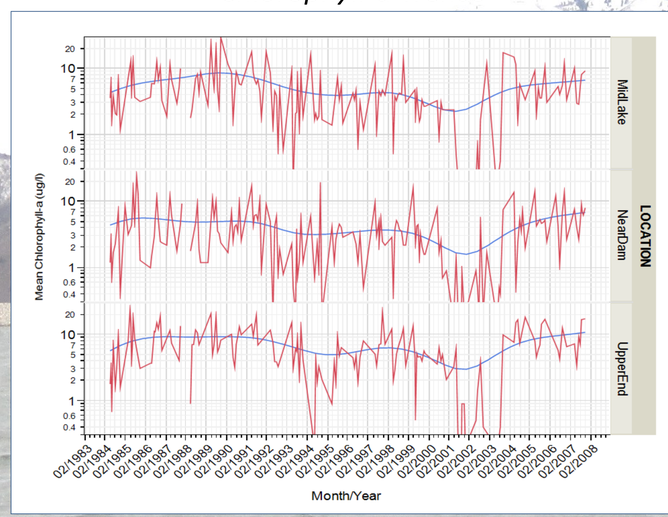
We compared the results from the statistical model with the results of CE-QUAL-W-2.

Results

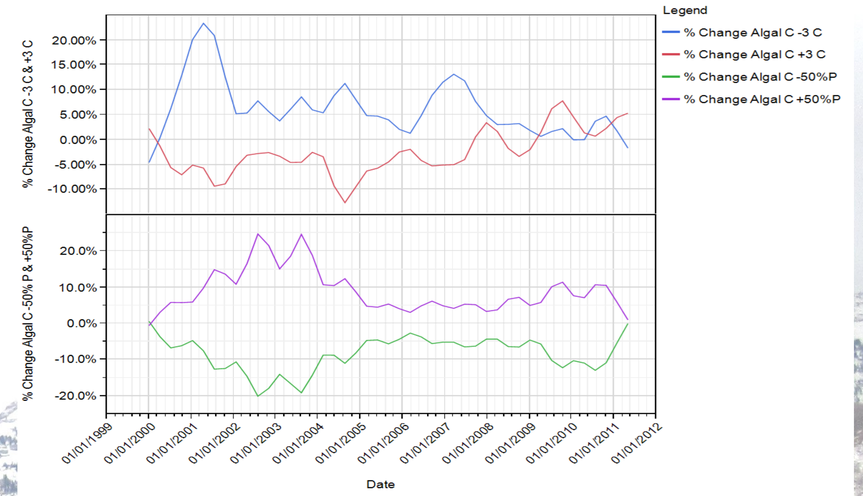
Nutrient Trends



Chlorophyll-a Trends



Results: CE-QUAL-W2 Model



Analysis of CE-QUAL-W2 Model

A 3° C increase in air temperature will decrease the algal concentration in the reservoir.

A 50% increase in phosphate loads will increase the concentrations of algae by 10 % on average.

Results: Statistical Model

Effect Test

Source	DF	Sum of Squares	F Ratio	Prob > F
PO4-P	2	8.06	8.9	0.0002*
NO2-NO3-N	2	7.42	8.2	0.0003*
NH4-N	2	4.9	5.42	0.0048*
MONTH	11	25	5.02	<.0001*
LOCATION	3	17	12.5	<.0001*
PRECIP (cm)	1	29.3	64.7	<.0001*
PRECIP (cm) *PRECIP (cm)	1	23.7	52.5	<.0001*
DEPTH (m)	1	7.94	17.5	<.0001*
AV. AIR TEMP (C)	1	0.8	1.77	0.184

Analysis of Statistical Model

Nutrients showed statistical significance for this model. Between the three nutrients measured, phosphates were the ones that explained most of the variability.

Air temperature was not statistically significant.

Most of the variability is explained by other variables, like precipitation and time of year.

Conclusions

There is a decrease in the nutrient concentrations in the reservoir.

On average, chlorophyll-a levels have remained steady during all the sampled years.

The statistical model showed that nitrogen and phosphorus were statistically significant when predicting chlorophyll-a concentrations, on the other hand, the model showed that temperature was not statistically significant when predicting chlorophyll-a concentrations.

While temperature does have an impact, phosphate levels have a greater influence in the increase of chlorophyll-a concentrations.

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