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Title: Factors Affecting Nutrient Availability and Primary Productivity in Black Hills Reservoirs

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Abstract

Lakes are an important surface water resource in South Dakota. Many lakes are used as water supplies for human and livestock use. They also support boating, fishing, swimming and other recreational activities. Water quality in Pactola and Deerfield reservoirs is considered very good with high transparency and relatively low primary productivity (German 1997). Factors that limit nutrient availability and primary productivity in Black Hills Reservoirs, however, are not well understood. In Pactola Reservoir, the upper Castle Creek drainage flows through natural bog iron deposits. While considered a local water quality problem, high iron content in downstream water may be important in reducing phosphorus availability in Pactola Reservoir. Under aerobic conditions, iron is the most important agent immobilizing dissolved, reactive phosphorus in aquatic environments. When the hypolimnion of lakes and reservoirs become anoxic phosphorus is released into solution contributing to increased reservoir nutrient concentrations and increased productivity. Hence, iron concentrations and dissolved oxygen levels could play an important role in limiting phosphorus availability and maintaining water quality in Black Hills reservoirs. Sheridan and Stockade reservoirs may be particularly susceptible to 'internal' nutrient loading because the hypolimnion in these systems can become anoxic in summer months (German 1997). Moreover, these reservoirs are located in different watersheds than Pactola and Deerfield

reservoirs where nutrient availability may not be regulated by high iron content in the water.

Biological communities of lakes and reservoirs can also have an important influence on primary productivity and resulting water quality (Carpenter et al. 1985). Food web structure, for example, can play an important role in regulating the abundance and composition of phytoplankton. While fish abundance and composition are well documented, the role of fish planktivory on zooplankton biomass in Black Hills reservoirs has not been documented.

This proposal involves collecting sediment, biological, and water quality samples to explore relationships among iron concentrations, nutrient availability, primary productivity and zooplankton abundance in four, Black Hills reservoirs (Pactola, Deerfield, Sheridan and Stockade). Specific objectives are to:

1) Quantify iron and phosphorus content in lake sediments.
2) Determine seasonal nutrient availability and phytoplankton biomass.
3) Measure species composition and size structure of planktonic zooplankton in 4 Black Hills Reservoirs.

4)Determine if lake trophic state has degraded in these lakes since the 1991-1995 study.

Sediment cores will be collected in each reservoir seasonally from October 2000 to December 2001. Iron and total phosphorus will be measured in surficial sediments to determine iron-to-phosphorus ratios for each reservoir (Jensen et al. 1992). Iron:phosphorus ratios will then be compared to phosphorus concentrations in the water column to derive empirical relationships for predicting nutrient availability in each reservoir (Jensen et al. 1992).

In-lake water quality samples will be collected with a Van Dorn type water sampler within six days of mid-month in June, July and August in 2001. Water samples will also be collected from several discreet locations in each reservoir to determine spatial variability of total phosphorus concentrations. Vertical profiles of several parameters will also be collected at the deepest point in each reservoir using a YSI DataSonde. Surface and bottom water samples will be collected and analyzed for soluble reactive phosphorus (SRP) and chlorophyll-a biomass. Other parameters that will be collected seasonally include; vertical profiles of temperature, dissolved oxygen, pH, conductivity, total dissolved solids, turbidity, ammonium, nitrate, and secchi depth.

To complete the third objective and to quantify size-structure and composition of planktonic zooplankton, samples will be collected with a Wisconsin net at seasonal intervals from October 2000 to December 2001. The ratio of small-to-large cladocerans (e.g. Bosmina:Daphnia) will be used to assess the relative magnitude of 'top-down' food web interactions in each reservoir. Data on fish

composition and abundance will be compared to zooplankton size-structure and biomass. Estimates of chlorophyll-a and zooplankton biomass will be used to examine relationships with Fe:P ratios and phosphorus availability in each reservoir.

The fourth objective will be completed by comparing data collected in 2001 with data collected in the 91-95 study.