TECHNICAL REPORT SERIES

A PREDICTION OF IMPOUNDMENT POTENTIALS FOR FLOWING WATERS OF THE DUCK RIVER IN THE VICINITY OF COLUMBIA, TENNESSEE

REPORT NO. WR(70)-40-2-80.2
January 1981
Division of Water Resources
Office of Natural Resources
Tennessee Valley Authority

EXECUTIVE SUMMARY

The purposes of this report are to (1) identify and evaluate limiting nutrient species and nutrient cycling dynamics, (2) describe biological response phenomena to nutrient enrichment assays, and (3) describe the implication of nutrient availability and biological response on relative trophic classification of the proposed Columbia Reservoir.

A summary of report findings and conclusions is presented below:

1. Nitrogen is the primary limiting nutrient in this system. Biological response in the form of carbon uptake, chlorophyll production, biomass development, and standing crop counts support this statement.
2. Each of the biological response measurements suggests an accelerated productive status for impounded waters in the Duck River System.
3. Nitrogen:Phosphorus ratio in unenriched water was observed to be approximately 6:1, which indicates nitrogen as the primary limiting nutrient within the system. Nutrient ratios may have a greater influence on plankton community structure than actual concentration when both nitrogen and phosphorus are sufficient for exponential growth.
4. Nitrogen-fixing blue-green algae will be abundant during summer months under low nitrogen-high temperature conditions, particularly in sheltered embayment areas.
5. Although algal assays can be used to evaluate algal growth potentials in impounded waters, it should be recognized that nutrients added singularly and in combination in this assay are in excess of concentrations that are naturally present in the Duck River. Laboratory assay experiments, with nutrient concentrations similar to those observed in the Duck River, also indicate nitrogen as the primary limiting

nutrient, but total phytoplankton growth is less than observed in the field assay.

6. The extent of nutrient cycling in the reservoir epilimnion will influence the duration of the green algae dominance during the spring.
7. Phosphorus, in forms suitable for algal assimilation was never observed to be below threshold levels necessary for exponential growth.
8. Nitrate concentration was observed to be below assimilatory threshold levels after initial exponential growth.
9. Periodic increases in allochthonous nutrient inputs (e.g., runoff events) will contribute to subsequent exponential algal growth, and hence, potential bloom conditions.

A Prediction of Impoundment Potentials for Flowing Waters of the Duck River in the Vicinity of Columbia, Tennessee

Division of Water Resources
Tennessee Valley Authority

Abstract

Replicate polyethylene bags were filled with 60 liters of river water and inoculated singly and in various combinations with K_2HPO_4, $NaNO_3$, Na_2EDTA, and CO_2. The bags were then monitored _in situ_ for 14 days to determine (1) impoundment effects on algal growth dynamics, and (2) nutrients limiting to phytoplankton production. Interpretations were based upon Carbon-14 estimates of primary production and _in vivo_ and _in vitro_ estimates of algal biomass. A total standing crop for each bag was also gravimetrically determined. Results indicate that the addition of phosphorus had no stimulatory effect upon plankton production. However, phosphorus and nitrogen in combination or in the presence of Na_2 EDTA promoted accelerated algal growths. Phosphorus in combination with Na_2 EDTA promoted a bloom (1×10^7 cells/liter) of blue-green algae (_Anabaena_) when nitrogen levels became limiting to the chlorophyte-dominated indigenous community.

INTRODUCTION

Flowing waters generally support a sparse plankton community when compared to standing water bodies such as ponds, lakes, or reservoirs. However, this phenomenon may be primarily a function of retention time, so that the productivity potential of flowing waters is often unrealized. As Hynes (1969) points out, low fertility of flowing waters rarely limits production. When a dam is placed across a flowing stream, the