

The effects of a single freshwater release into the Kromme Estuary.

2: Microalgal response

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Abstract

The release of freshwater from the Mpopu Dam in November 1998 resulted in a short-term (6 d) longitudinal and vertical gradient of both salinity and nitrate in the estuary. There was no significant increase in phytoplankton chlorophyll *a* during the period of the study. The phytoplankton communities were dominated (> 10%) by diatoms and flagellates throughout the study. The average number of diatoms increased significantly from 301 cells·ml⁻¹, prior to the release, to a maximum of 3 856 cells·ml⁻¹ by the end of the first spring tidal cycle. The average number of flagellates increased from 1 903 cells·ml⁻¹, before the release, to a maximum of 3 300 cells·ml⁻¹ after two spring tidal cycles. There was no change in subtidal benthic chlorophyll *a* biomass but intertidal benthic chlorophyll *a* increased from 35.6 mg·m⁻², before the release, to 63.3 mg·m⁻² by the sixth day. The conclusion is that the amount of freshwater released was insufficient to increase the nutrient content of the water to a level that resulted in a significant increase in primary productivity. The length of time that the freshwater influence was present also prevented a significant increase in microalgal growth.

Introduction

The Kromme Estuary is narrow and extends for 14 km from a permanently open mouth to a rock sill that forms the tidal head of the estuary. The mouth stays open by virtue of a large tidal prism. An average channel depth of 1.5 m characterises the lower reaches of the estuary (6.6 km upstream of the mouth). Depths of between 3 to 5 m are common in the middle and upper reaches. A sandbar extends across the estuary between Sites 2 and 3 (Fig. 1) and is exposed during spring low tide.

There are two dams above the estuary and their combined holding capacity (Mpopu Dam 107 x 10⁶ m³ and the Churchill Dam 33.3 x 10⁶ m³) exceeds the mean annual runoff (MAR) of the Kromme River (105 x 10⁶ m³). The Mpopu Dam is 4 km upstream from the tidal head of the estuary, so that practically the entire runoff from the Kromme River catchment area is retained in the dam in a normal season (Reddering, 1988).

The Department of Water Affairs and Forestry (DWAF) annually releases 2 x 10⁶ m³ of water from the Mpopu Dam for the "ecological requirements" of the Kromme Estuary and particularly to maintain the salinity at, or less than, 35‰. If the 2 x 10⁶ m³ of water were to be discharged continuously, it would flow at 0.063 m³·s⁻¹. However, in the recent past, the water has been released as equal monthly amounts of almost 167 000 m³. As a result of this small amount of freshwater entering the estuary, the water column has generally been well mixed with the salinity averaging 32‰ or more, throughout the estuary (Bickerton and Pierce 1988). The present state of the estuary is considered by some ecologists as a sheltered arm of the sea rather than a fully functional estuary. Because of this, it has a low productivity relative to other permanently open estuaries that receive a constant freshwater flow.

The aim of this project was to determine the biomass and biodiversity response of estuarine microalgae to a single 2 x 10⁶ m³ release of water from the Mpopu Dam into the freshwater-starved, but permanently open, Kromme Estuary. This volume represented the full annual water allocation being released on a single occasion.

The intention was to recreate a normal estuarine salinity profile to determine whether there would be an increase in the biomass of pelagic and benthic microalgae. Three hypotheses were proposed before the study commenced. These were tested using data collected for a period starting 5 h before the water release and ending 50 d after the start of the release.

Hypotheses

The release of 2 x 10⁶ m³ of water from the Mpopu Dam:

(i) *Will result in a fourfold increase (5 to 20 µg·l⁻¹) in average water column (pelagic) chlorophyll *a* after three spring tidal cycles (42 d).*

Average water column chlorophyll *a* concentrations in the estuary from previous sampling sessions in 1997 and 1998 were 5.6 µg·l⁻¹ (average salinity of 21.5 g·l⁻¹) and 2.1 µg·l⁻¹ (average salinity of 33.2 g·l⁻¹) respectively. Hilmer (1990) working in the nearby Sundays Estuary showed that three spring tidal cycles were required after a freshwater pulse to produce the maximum chlorophyll *a* content in the water column.

(ii) *Will change the structure of the phytoplankton groups from being flagellate-dominated, to a condition where diatoms will be dominant. Later, as the freshwater input dissipates and the water column once again becomes well mixed, flagellates will regain their dominance. As a result, phytoplankton group diversity (*H'*) and evenness (*J'*) will increase to above 0.1 and 0.03 respectively for the period when diatoms are dominant.* Diatom counts and diversity indices, in brackets, of the 1997 and 1998 sampling sessions were 60.7 cells·ml⁻¹ (*H'* = 0.085, *J'* = 0.027) and 110 cells·ml⁻¹ (*H'* = 0.091, *J'* = 0.025) respectively. Flagellate counts during the same sessions were 1 381 and 3 833 cells·ml⁻¹ respectively.

(iii) *Will result in a twofold increase in average benthic microalgal chlorophyll *a*.*

This would be the result of the increase in mineral nutrient concentration within the water column. Average benthic chlorophyll *a* concentrations during previous sampling sessions had been 32.2 (subtidal) and 41.8 mg·m⁻² (intertidal) in 1997 and 53.3 (subtidal) and 82.4 mg·m⁻² (intertidal) for 1998.

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Received 3 November 1999; accepted in revised form 9 June 2000.