The effects of a single freshwater release into the Kromme Estuary. 3: Estuarine zooplankton response

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Abstract

Natural patterns of zooplankton variability (temporal and spatial) in the Kromme Estuary have broken down due to persistent euhalinity (salinity values above 28‰) throughout the estuary. These conditions occur as a consequence of freshwater retention by a large reservoir. Only 2 x 10^6 m^3 (<2% of the mean annual runoff (MAR) from the catchment) is allocated to the estuary per annum, and the present study was undertaken to evaluate estuarine zooplankton response to a single release of the full reserve. The experimental release was predicted to create freshwater conditions throughout the upper half of the estuary. Instead, the water column became highly stratified for about two weeks after which salinity profiles rapidly returned to prerelease conditions. The freshwater pulse elicited no significant change in distribution or abundance in any of the dominant copepod populations. It is concluded that the <2% of MAR released in a single pulse had no direct nor indirect advantage for the endemic copepods at the population level. Similarly, no significant change was observed in zooplankton community structure after the release. Mixing of the water column and development of a permanent but dynamic longitudinal salinity gradient is a key mechanism regulating estuarine zooplankton dynamics. A regular base flow in addition to intermittent releases of freshwater pulses into the estuary is required. Because of freshwater attenuation, the Kromme Estuary is deprived of a key mechanism that regulates spatial and temporal variability of estuarine endemic copepod populations.

Introduction

River discharge into estuaries is characteristically variable under natural conditions, influencing composition and dynamics of planktonic communities in the receiving waters (Ambler et al., 1985; Cronin et al., 1962; Haertel and Osterberg, 1967; Herman et al., 1968; Hodgkin and Rippingale, 1971; Mallin et al., 1993; Miller, 1983; Nyan and Ritz, 1978). However, large storage reservoirs bring about changes in volume, quality and distribution of water flowing downstream (Davies and Day, 1998). In South Africa, reservoirs now have the capacity to retain >50% of the mean annual runoff (MAR) from catchments (Department of Water Affairs, 1986). This degree of water retention has serious implications for the structure and functioning of estuaries in a region also characterised by highly variable and unpredictable river flow patterns (Davies et al., 1993).

The warm temperate Kromme Estuary is a prime example of a South African system deprived of freshwater due to the construction of storage reservoirs in the catchment. The larger Mpofu Dam (construction completed in 1983 with a capacity 100 x 10^6 m^3) is 18 km from the coast and 4 km above the tidal head of the estuary. A second reservoir is located higher up in the catchment. The combined storage capacity of the two reservoirs is 133 x 10^6 m^3, exceeding the MAR of 106 x 10^6 m^3 from the catchment basin (Department of Water Affairs, 1986). Present management policy provides for a total annual freshwater allocation of 2 x 10^6 m^3 for the estuary, unless natural overtopping of the dam occurs. However, overtopping is infrequent, and years may pass between overspill events.

Severe drought at the end of the 1980s and early 1990s resulted in the reservoir levels falling below 30% of capacity (Jury and Levey, 1993). Freshwater was then released on a monthly basis in order to prevent hypersalinity developing in the upper estuary.

During the latter part of the drought and up to the present time, no freshwater was released for environmental purposes. Because of the severe reduction in the natural supply of freshwater, marine conditions now dominate the estuary for extended periods (years). During summer, the upper reaches become hypersaline (salinity exceeds that of seawater).

Legislation recently promulgated requires the development and implementation of resource-directed measures for the protection of the water resources in South Africa. Part of the process involves the determination of the freshwater reserve required to sustain structure and function of individual estuaries, according to specific management requirements. The Kromme Estuary has been much studied in recent years and provided an opportunity to audit the present freshwater allocation to the estuary. Thus, a multidisciplinary study was commissioned to:

- evaluate the response (magnitude and persistence) of abiotic and biotic estuarine components to a single release of freshwater (2 x 10^6 m^3) from the dam; and
- make recommendations regarding future freshwater discharges to the Kromme Estuary.

The present study reports on the estuarine zooplankton, with particular focus on the endemic copepod community.

Study site

The Kromme Estuary (Fig. 1, Table 1) has a constricted but permanently open tidal inlet. Tides are semi-diurnal with a small diurnal inequality. Mean spring tide differences outside the inlet is about 1.75 m, while neap tides average 0.57 m. A flood tidal delta extends 5 km from the mouth, but additional sand is derived from an adjacent dunefield. Aperiodic floods of sufficient magnitude scour estuarine channels, but reservoirs in the Kromme catchment dampen or filter out all floods smaller than the 1-in-30 year event

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