

The impact of a paper mill effluent spill on the fish populations of the Elands and Crocodile Rivers (Incomati System, Transvaal)

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Abstract

During September 1989, 700 000 l of black liquor from a paper mill was spilled into the Elands and Crocodile Rivers on the Eastern Transvaal escarpment. The impact of this effluent on the fish populations of these two rivers was monitored. Observations three days after the spill indicated massive fish mortalities in both rivers for a distance of 40 km downstream from the point of discharge down to the town of Nelspruit. A detailed survey in October 1989 indicated that the fish in the Elands River below the spill were largely decimated. Mortalities in the Crocodile River downstream to Nelspruit were lower. Downstream between Nelspruit and the Kruger National Park boundary, mortalities were observed in one species only. In total 14 fish species were affected in the river from the paper mill down to Nelspruit. One threatened species (*Chiloglanis bifurcus*) suffered serious mortalities while another (*Opsaridium zambezense*) was only marginally influenced. During November 1989 and March and June 1990, surveys were undertaken to assess the success of the natural recolonisation of fish in the affected areas. Surveys were primarily undertaken in fast-flowing water and indicated that, although recolonisation is taking place, the species richness and population density in the Elands River in particular is still considerably lower than the numbers found during surveys since 1978. An intensive survey, which duplicated that done in October 1989, was undertaken in September 1990. This survey confirmed that recolonisation of the affected area is taking place. A survey during October 1991 which was limited to the affected part of the Elands River, confirmed the results of the September 1990 survey in this section. It is estimated that the river will probably only recover after several years. Translocation of fish to the most damaged section of the Elands River is an option which will be considered if future surveys do not indicate improved recolonisation rates. The importance of conserving fish refugia as centres from which recolonisation can occur is emphasised by this disaster.

Introduction

On 23 September 1989 a spill of 700 000 l (Regional Court Records, Nelspruit, March 1990) of an effluent generally known as "black liquor" (McKee and Wolf, 1963) and originating from a paper mill, was accidentally released into the Ngodwana River (Incomati System). Approximately 1 km downstream from the mill, this effluent flowed into the Elands River and eventually into the Crocodile River (Fig. 1). Shortly after the spill occurred the paper mill released water from their storage dam in the Ngodwana River, while water was also released from the Braam Raubenheimer Dam in the Crocodile River. The purpose of these water releases was to dilute the effluent and minimise its detrimental effects on the river. The spill lasted for 2 h and caused massive fish mortalities in the Elands and Crocodile Rivers.

The paper mill is situated at the confluence of the Ngodwana and Elands Rivers and generates an average of 25 million l of effluent per day which is disposed of by means of a treatment system (Regional Court Records, Nelspruit, March 1990). The Kraft process is employed by which wood is pulped in digesters with a concentrated solution of sodium hydroxide which also contains sodium sulphate and sodium sulphide. The concentrated alkaline solution which is washed from the wood is known as black liquor. The toxicity of black liquor to aquatic life is mainly related to the sulphur-containing substances, in particular the mercaptans, and the resins and fatty acid components. In addition black liquor has a high biochemical oxygen demand (McKee and Wolf, 1963).

Surveys were conducted to assess the extent to which the fish populations were damaged and also to decide on appropriate management actions.

Methods

Surveys

The Transvaal Chief Directorate of Nature and Environmental Conservation was informed of the situation two days after the spill had occurred. A preliminary survey was conducted on 26 September and on 27 September 1989 an aerial survey to determine the location of the main concentration of effluent was undertaken. On 28 and 29 September 1989 additional observations were made in the vicinity of Localities 13 and 14 in order to determine the movement of the polluted water (Fig. 1).

From 2 to 4 October 1989 a detailed survey was undertaken. This survey covered 14 sampling localities in the Elands and Crocodile Rivers (Fig. 1):

Sampling Localities 1 to 3: These three localities served as reference localities as they were situated upstream from the confluence of the Elands and Ngodwana Rivers and were not affected by the spill. The habitat consisted of rapids, stony runs and riffles with a limited extent of quiet water in the form of small stony pools and backwaters.

Sampling Locality 4: This locality was situated about 800 m downstream of the confluence of the Elands and Ngodwana River. It consisted of a pool, a strongly flowing, stony rapid, riffles, runs and backwaters.

Sampling Locality 5: Was situated a small distance upstream from the Lupelule tributary of the Elands River and comprised strongly flowing, rocky rapids with small backwater areas.

Sampling Locality 6: Situated in the Elands River, approximately 4 km upstream from its confluence with the

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