EXECUTIVE SUMMARY

Global ecosystems face unprecedented crises in habitat fragmentation, destruction and ultimately extinction (Groves, 2003), and of all the varying ecological systems rivers are the most neglected and endangered (Groves, 2003; Driver, et al., 2005; Roux et al., 2005). The greatest threat to these systems is the loss or degradation of natural habitat and processes (Driver et al., 2005), and water temperatures, after flow volumes, are a primary abiotic driver of species patterns within river systems. Stuckenberg (1969) highlighted the links between temperature, topography and faunal assemblages, while Rivers-Moore et al. (2004) highlights the major impacts of water temperatures on organisms, and illustrate how water temperatures are one of the primary environmental drivers structuring fish communities in the Sabie River, arguably the most icthyologically species-rich river in South Africa.

The National Water Act (Republic of South Africa, 1998) provides legal status to the quantity and quality of water required to maintaining the ecological functioning of river systems, through the declaration of the "ecological Reserve" (see Chapter 3, Part 3 of the National Water Act of 1998). To date, no methods have been developed for the water temperature component of the Reserve, although the importance of water temperatures in maintaining river systems is fully recognised (Poole and Berman, 2001; Johnson, 2003). Understanding temporal variability of temperature time series, regional variation, and how aquatic macroinvertebrates respond to thermal regimes both spatially and temporally, are central to determining ecological Reserves and in defining policies to manage river systems. This fundamental understanding must occur to inform policies since sound decisions rely on the best available scientific evidence (Brundtland, 1997). Ecological Reserve determination for rivers in South Africa presently does not include a water temperature component in spite of its importance in determining species distribution patterns. To achieve this requires an understanding of how lotic thermographs from South African rivers differ from northern hemisphere rivers.

The broad temperature classifications of potamon and rithron are suggested as being useful starting points to an initial water temperature contribution to the ecological Reserve. Notwithstanding the lack of available data and the inherent problems with simulating time series in highly variable systems, it is nevertheless worthwhile to characterize system variability since it is this aspect of a thermal regime that enables aquatic organisms with different tolerances to co-exist within a single reach of river. Based on the various techniques utilized within this study, the coefficient of variation is sensitive to extreme values which characterize flow rate time series but not water temperature time series to the same degree. As a simple first approach, the coefficient of variation is probably adequate in characterizing annual flow rates and water temperatures between rivers. Agglomerative techniques, such as the use of duration curves using successive days within class intervals, have potential for defining management targets such as Environmental Flow Requirements. What should emerge as a guiding principle is that a suite of different metrics should be used simultaneously to characterise water temperatures. In a country where river systems are highly variable, and often defined by extremes rather than averages, the importance of understanding variability and how this relates to the ecological Reserve cannot be overemphasized.

Hourly water temperatures from 20 sites in four river systems, representing a range of latitudes, altitudes and stream orders, were assessed using a range of metrics. These data were analysed using Principal Components Analyses and multiple linear regressions to understand what variables a water temperature model for use in ecoregions within South Africa should include. While temperature data are generally lacking in low and higher order, South African rivers data suggest that South African rivers are warmer than northern hemisphere rivers. Water temperatures could be grouped into cool, warm and intermediate types. Based on temperature time series analyses, this report argues that a suitable water temperature model for use in ecological Reserve determinations should be dynamic, include flow and air temperature variables, and modified by a heat exchange coefficient term. The inclusion of water temperature in the determination and management of river ecological reserves would allow for more holistic application of the National Water Act's ecological management provisions.