7 Predicting the Water Requirements of River Fisheries

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7.1 Introduction

The past decade has seen a steady increase in international attention given to the crisis facing the world's water resources and the urgent need for more efficient use of this increasingly scarce resource (Baron et al. 2002). In the developing world in particular, such improvements in water use efficiency have been widely regarded as essential for improved food security and poverty alleviation. However, to date most of the attention being given to improved water productivity has been restricted to irrigated plant crops, and less to the importance of natural freshwater ecosystems and fisheries in sustaining food production and generating employment and income. In addition to supporting food crop security, increasing demands are being placed on water for a wide range of other human uses, including industry, domestic supply power generation, navigation, flood control, and land reclamation for urban development and agriculture, which may not consume water directly but influence the patterns of flow and, through this, the form and ecological function of river systems.

Landscape changes such as deforestation or poor agricultural practice can change river hydrographs by influencing the speed of runoff and the capacity of infiltration and storage capacity of soils. Such changes do not substantially alter the quantity of water flowing through a system during the year or the timing of flood peaks, but are likely to affect the magnitude and duration of peak flows (i.e., shorter, larger flood peaks). Large dams that store water for power generation, and abstractions that remove large quantities of water from rivers, exert major control over flow, affecting the total amount of water in the system and the timing with which the remainder is discharged (World

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Commission on Dams 2000). Such changes in discharge patterns affect the species composition, abundance, and viability of river biota and may damage the sustainability of river fisheries (Poff et al. 1997; Bunn and Arthington 2002). These fisheries are of critical importance for rural development and food security in many developing countries. Widely dispersed and easily accessible to marginal and/or isolated communities, they provide alternative sources of income and food when the others are lacking.

Efforts are now being expended globally to provide for environmental flows (EFs) that satisfy the needs for sustainability of fish and other aquatic organisms in rivers. These (EFs) may be defined as *that portion of the original flow of a river that is needed to maintain specific, valued features of its ecosystem* or *the quantity of water that must be maintained in a river system at all times to protect the species of interest for fisheries or for conservation of the environments on which they depend*. The process of evaluating these needs concentrates on: first, calculating the amount of water that can be withdrawn from a river as part of the process of granting licenses for water abstraction; second, assessing the impact of new dams and river control structures on future flow quantities and patterns; and third, calculating discharges from reservoirs for the express purposes of conserving the aquatic environment downstream. This paper is arranged in two parts. The first summarizes technical issues surrounding such assessments, briefly reviews the water requirements of river fish and fisheries, and examines some of the ways for predicting these requirements. The second part examines practical experiences in southern Africa by outlining ten general principles that can guide the environmental flow assessment process.

7.2 The Hydrological Regime and Fisheries in Rivers

Natural hydrographs depend on rainfall and the nature and area of the river basin for their seasonal variations in discharge. Variations in flow can be very rapid in small basins as they respond to local rainfall but, as river order increases, the flood curve becomes smoother as the varied flows of numerous tributaries in the larger catchment combine into the main channel flow. Most natural flow regimes consist of two components: (a) base flows, when water is confined to the main channel and remnant floodplain water bodies, and (b) the flood, when high flows overbank and flood the surrounding seasonal wetlands (floodplains), reconnecting isolated floodplain water bodies and the main channel. Human activities typically alter the natural hydrograph by reducing the absolute amount of water available to the river, by changing the timing of peak discharges, or by suppressing them partially or completely, so that the water is confined to the main river channel. Such control is not always complete, however, and occasional catastrophic floods do