Fisheries of the Yangtze River Show Immediate Impacts of the Three Gorges Dam

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Three Gorges Dam (TGD), currently the largest hydropower project in the world, was completed in June 2006 but has been impounding and altering river flow since 2003. Large dams impact river ecosystems and services, and aquatic biota are affected by flow and temperature modifications, water chemistry changes, and migration blockage (McAllister et al. 2001; Nilsson et al 2005). Xie (2003) warned specifically of potential impacts of TGD to ancient fish species of the Yangtze, and Fu et al. (2003) similarly warned of impacts to a broad array of native species. Consistent with these predictions, four major commercial carp species (silver carp *Hypophthalmichthys molitrix*, bighead carp *Aristichthys nobilis*, grass carp *Ctenopharyngodon idella*, and black carp *Mylopharyngodon piceus*) are now showing effects of altered river ecology below the dam.

Public release of data from ongoing studies of TGD impacts is generally restricted until 2009 by the central government, but some preliminary results have been posted to a TGD-monitoring program website (Anonymous 2006). Annual harvest of these commercial carps below TGD during 2003–2005 was 50–70% below a 2002 pre-dam baseline (Table 1). Even more alarming is a decline of up to 95% in the abundance of drift-sampled carp eggs and larval carp over the same period; undoubtedly carp harvest will decline even more in the next few years as recruitment-to-catchable stocks declines. Reproduction of the carps is likely being affected by TGD-altered river temperatures and annual flow regimes that have modified seasonal cues for migration and reproduction. Figure 1 shows that the annual flow regime below TGD, as modified by dam operations, is a fairly close approximation of normal flow patterns. However, there are subtle changes that seemingly are having rapid and drastic impacts on resident fishes. TGD operations slightly increase flow downstream before the normal spring/summer flow increase (Figure 1), in order to increase reservoir storage capacity and reduce downstream flooding during the coming summer rainy season. This flow increase may stimulate carps to initiate upstream spawning runs (Anonymous 1976) in late spring before eggs are suitably mature. Concurrently, TGD's hypolimnetic discharge lowers downstream river temperatures year-round, and likely retards in-vivo egg maturation during winter and spring even further. In fall,

Table 1. Annual commercial harvest (x 1,000 metric tons) of four species of carp (silver, bighead, grass, black), and numbers (millions) of drift-sampled carp (*Cyprinidae*) eggs and larvae below the Three Gorges Dam (Yangtze River, People's Republic of China) before (1997 and 2002) and after (2003–2005) river impoundment began (adapted from Anonymous 2006; time units for drift sampling were not reported).

Year	1997	2002	2003	2004	2005
Commercial harvest	NA	3360	1350	1010	1680
Eggs and larvae	250	190	40.6	33.9	10.5

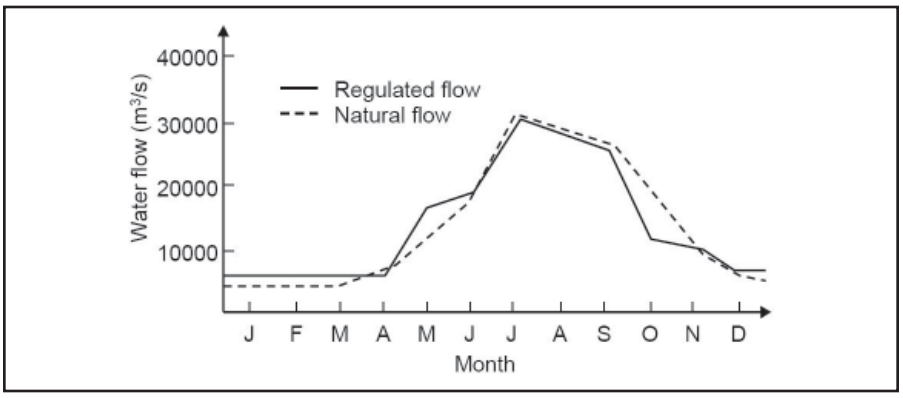

Figure 1. Annual flow regime of the Yangtze River is modified by the Three Gorges Dam (adapted from Anonymous 1997).

dam operations begin to reduce discharge through the dam earlier than the natural dry-season flow decrease in order to store water for peak power production over the winter (Figure 1). Again, carps stimulated by these abnormally early flow reductions may migrate from feeding areas in floodplain lakes back to the mainstem river (Anonymous 1976) before rebuilding energy stores needed for overwintering and successful reproduction during the subsequent spring. The precipitous decline of carp recruitment in the Yangtze River demonstrates that even seemingly subtle changes to river flow regimes may have drastic ecological effects.

Planning is underway for more than 20 additional hydropower dams in the Yangtze basin (Chen et al. 2006) to support burgeoning economic development in China. Design and operational changes from the TGD model must be considered if basin-wide impacts on commercial and subsistence fisheries, and subsequent socioeconomic detriments, are to be avoided.

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