How to Achieve High Fish Yields in Tropical Lakes and Reservoirs

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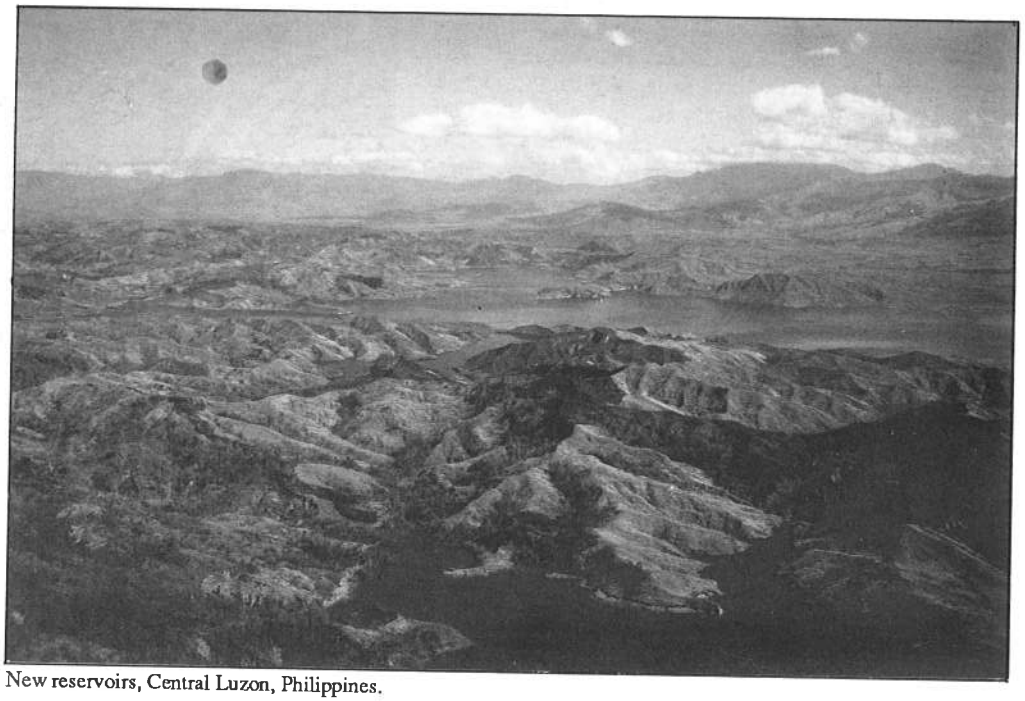

New reservoirs, Central Luzon, Philippines.

Fish yields in tropical lakes and reservoirs vary greatly. In deep, upland lakes and reservoirs they are negligible, while in a portion of Lake Turkana, a yield of 16,000 kg/ha was recorded in 1976, perhaps an unusually favorable year. The comparable annual yields for a Canadian shield lake, U.S. temperate reservoirs (with stocking) and Indian reservoirs (with stocking) fluctuate around 1, 25 and 7 kg/ha, respectively. Fisheries biologists have been aware of these discrepancies for more than half a century. Some of these differences are due to trophic status and morphometry (Morpho-Edaphic Index), low fishing pressure and latitude. Our studies, begun independently in Sri Lanka and Cuba, pointed to another important factor, fish composition. The presence of lacustrine adapted fishes meant high yields. Otherwise, low to very low yields were recorded.

Riverine and Lacustrine Fishes

Rivers are old and lakes are generally young and ephemeral in terms of the geological time scale. Lakes and reservoirs were and still are colonized from rivers by riverine fishes. As riverine species find themselves in a new type of environment under lacustrine conditions, they are able to occupy only the shallow portions, avoiding the pelagic and deeper portions. However, in some lakes where environmental conditions have remained relatively stable over a considerable period, a lacustrine fish fauna has evolved over time. These are usually ancient lakes like L. Baikal and some African rift valley lakes.

We looked at the fish composition in tropical standing waters worldwide. The Australian region is devoid of true freshwater fishes except for a few living fossils like the lung fish. The oriental region has few natural lakes and only one of them, L. Lanao, is old. This lake has (or had) a flock of about 20 endemic fish species and a relatively high fish yield. Lakes in the American tropics are few and none, except L. Titicaca, are old. They do not have lacustrine fish. In L. Titicaca the endemic fishes have been depleted by the introduction of piscivorous fishes. Most

temperate lakes are post-glacial and, except for L. Baikal and L. Ochrid, recent. Lacustrine fishes are restricted to the old lakes. However, even in recent lakes natural colonization of the pelagic zone may occur provided that their watersheds are inhabited by species preadapted for lacustrine conditions. Fishes especially successful in colonizing lacustrine conditions are recruited mostly from families of marine origin (clupeids) or from secondary freshwater fishes (cichlids).

In Africa one sees a vivid contrast as regards the relative proportion of riverine and lacustrine fishes. The rift valley lakes are of varying ages, the oldest being L. Tanganyika (circa 15 million years). In this and other old lakes there has been a proliferation of lacustrine species.

The lacustrine environment has been extended considerably in recent years by the construction of reservoirs. African lacustrine fishes or fishes preadapted for lacustrine conditions have been introduced into almost all tropical regions. These include littoral species (mainly tilapias) and pelagic species (clupeids). No deepwater species have been introduced so far.

Fishing boats and bamboo rafts, Jatilhur Lake, West Java, Indonesia.

Raising Fish Yields

Fisheries management in lakes and reservoirs is a new science and its application has been confined to temperate regions till very recently. Fish stocking and various restrictions on fishing have been applied together with the introduction of exotic species which were self-propagating. In India, stocking of reservoirs with indigenous fishes has been practiced for some time at considerable financial cost and relatively poor returns. The most effective and cheapest way to increase fish yields is by constructing a lacustrine fish fauna using high-producing herbivorous littoral and planktivorous species. During the past 35 years sustained increases in fish yields have resulted from the introduction of African lacustrine fishes in Africa, Asia, Australasia and South America. In some cases these increases have been spectacular (Fernando and Holcík 1982, in Hydrobiologia 87:127-140).

The enterprise of fish introductions is risky when sufficient care is not taken to ensure that only desirable and nondestructive (to indigenous fish) species are used. Much damage has already been done to lake fisheries by the introduction of piscivorous fishes in America, Africa and Asia. There is also the ever-present danger of the transfer of disease-producing organisms.

Fish introductions have been carried out worldwide over the past 100 years or so. Most of these introductions have been haphazard, i.e., without a scientific framework of reference. Our theory is that lacustrine fishes are very unevenly distributed and localized largely in Africa. If the lacustrine environment is to be exploited adquately by fishes, then the appropriate lacustrine fishes must be present. Large and even spectacular increases in fish yields have been recorded in tropical areas when African lacustrine fishes have been introduced. These fishes include the highly productive shallow-water-inhabiting tilapias and pelagic clupeids (herrings). Deepwater lacustrine fishes although present in the large and deep African lakes have not been transferred to other lakes or reservoirs in Africa or elsewhere. This remains an enterprise for the future.

The Rationale for Introductions and Cautions

Freshwater fish evolved independently on each continent. With regard to the tropics, only in Africa is there a lacustrine component of any magnitude. The presence of man-made lakes has created an extensive lacustrine environment throughout the world including the tropics. To obtain high yields of fish from the lacustrine environment, lacustrine fish are a prerequisite. These fish are available predominantly, almost exclusively, in Africa and, secondarily, from lacustrine/marine fishes, mainly herrings.

It is generally accepted, with good reason, that transfers of living organisms transcontinentally must be done only with utmost care and for very weighty reasons. This principle must be borne in mind before any transfer of fish is undertaken. Also, experience has shown that the transfer of piscivorous fishes is contra-indicated under almost any circumstance.

On the other hand, the transfer of herbivorous or omnivorous fishes has generally been beneficial and has raised fish yields spectacularly in some regions. In recent years, African dung beetles have been transferred to Australia to help reduce dung accumulation created by introduced placental mammals (Waterhouse 1974, in Scientific American 230:100-109). In Central America, horses which dispersed seeds before they became extinct in the Pleistocene 10,000 years ago, have reassumed this role after their introduction by the Spaniards (Janzen and Martin 1982, in Science 215:19-27).

Perhaps we should consider this sort of introduction as a construction or reconstruction of a balanced fauna, rather than as a disruption of the fauna composition. To ban all introductions of alien species is hardly scientific. However, introduction of alien species carries serious risks and should be undertaken only for a greater good, both in the short and long term, and only after careful and objective assessment of previous introductions and local conditions. Where rich and varied lacustrine faunas occur, no introductions should be made at all. ●