An Evaluation of Fish Species and Genetic Diversity of the Tonle Sap Great Lake, Cambodia

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Summary

Fish has long been critical to all Cambodians. It is a major source of nutritious food in the daily diet, a primary source of income and has strong cultural and religious significance. Fisheries matter a great deal to the millions of people who live on the banks of the country's rivers, particularly those living in and around the Tonle Sap Great Lake. Cambodians are considered one of the highest per capita consumers of freshwater fish in the world (a recent estimate of 67 kg per person per year from household surveys). Freshwater fisheries contribute 10 to 12% of the Cambodia's GDP accounting for 31 percent of the GDP contribution of the primary sector. Since 2000 Cambodian freshwater capture fisheries ranks fourth in the world in terms of total catch (i.e. 400,000 tons per year). This is considerable as the country is rather small (181,035 km^2) and its population is also small (13.6 million in 2005). Actually, with an average 30 kilograms of freshwater fish caught per Cambodian per year, the country has the most intense freshwater fisheries in the world.

The contribution of various ecotones to global biodiversity reaches in Southeast Asia the status of hotspot. The Indo-Burma region, including the Mekong River basin, is no exception. The aquatic resources of the basin represent an enormous biodiversity with at least 1,200 fish species. Its extremely diverse fish community reflects past climatic and geological processes, which have brought together the fauna of several river systems, and places the Mekong among the top three rivers in the world (after the Amazon and the Zaïre/Congo). Cambodia's Mekong River basin harbors approximately 500 fish species, of which, about 200 fish species are found in the Tonle Sap Great Lake (the largest and most productive lake in Southeast Asia, being formed by subsidence about 5,700 years ago). The Tonle Sap Great Lake is the center of Cambodian fish production and it is globally significant ecologically, being nominated as a Biosphere Reserve in 1997 under the Man and Biosphere Program of UNESCO.

Fisheries from the Tonle Sap Great Lake contribute over 60 percent of the total freshwater fish catch in Cambodia. The Tonle Sap Great Lake has some of the smallest and largest freshwater fishes in the world, from the minute carp *Oreichthys parvus* (maximum length 2.5 cm), to huge species such as the Mekong giant catfish *Pangasianodon gigas* (maximum length 300 cm) and the giant barb *Catlocarpio siamensis* (maximum length 200 cm). The more familiar fish groups comprise carps (Cyprinidae – 39%), catfishes (Akysidae, Ariidae, Bagridae, Clariidae, Pangasiidae, Siluridae and Sisoridae – 24%), herring (Clupeidae – 3%), snakeheads (Channidae – 2%), featherbacks (Notopteridae – 2%), gouramis (Osphronemidae – 2%), and climbing perch (Anabantidae – 1%). The remaining 27% consists of needlefishes or garfishes, tongue fishes, soles, leaf fishes, archerfishes, drums, threadfins, snooks, anchovies, eels and many other fish species. A very recent first research result is that "white" fish species constitute about 37% of the total numbers of Tonle Sap Lake fish species, "grey" fish species 50%, and "black" fish species 13%. The catch composition of "white" fishes and "grey" fishes is about 60% of total catch, while "black" fishes contribute about 40% to total fish catch. The previous estimates of composition of catches of top ten fish species (i.e. *Henicorhynchus lobatus/siamensis*, *Channa micropeltes*, *Cyclocheilichthys enoplos*, *Labiobarbus spp.*, *Osteochilus spp.*, *Cirrhinus microlepis*, *Pangasianondon hypophthalmus*, *Barbonymus gonionotus*, *Paralaubuca typus*, and *Channa striata*) in commercial fisheries (i.e. large- and meddle-

scale fisheries) by Mekong River Commission – Fisheries Program reveal that "white" fishes (i.e. six of the top ten fish species) contribute about 45% of total catch and 27% of total value, "grey" fishes (i.e. two of the top ten fish species) 7% of total catch and 4% of total value, and "black" fishes 11% of total catch and 25% of total value.

The many fish species of the Tonle Sap Great Lake encompass 90 genera and 32 families with a diversity of form, feeding habits and modes of reproduction. As a result of the high diversity in the Tonle Sap Great Lake, fish occupy all available aquatic habitats and exploit many kinds of foods. Biodiversity is a crucial element in high fishery production, providing to some extent a natural "safety-valve" each season, so that loss of any species (e.g. from a disease or over-fishing) will be compensated for by increased production of other species. The high diversity of species, the great range of habitats, and the variation in catches over time and space make wild freshwater fish available to a wide range of people, thus a high degree of participation in Cambodian fisheries.

Within fish species diversity might be partitioned into variation within and among populations. It is necessary to maintain both types of variation to minimize the frequency of extirpation of local populations and to sustain species stability since genetic diversity is a requisite for evolutionary adaptation to a changing environment. So far, genetic stock structure and differentiation at the population levels has proven to be the best method to manage the conservation of species, including fisheries. However, their application, particularly in tropical regions, is still in its infancy. In Cambodia, there is very little scientific knowledge of fish population genetics (i.e. genetic diversity and stock structure). The first research study is on population genetics of the two large migratory Pangasiid catfish species *Pangasianodon hypophthalmus* and *Pangasius bocourti* in the Mekong River (including Cambodia, Laos, Thailand and Vietnam) using both mtDNA and microsatellite markers by Cambodian Department of Fisheries and Belgian KULeuven. The recent study on mtDNA stock structure of the two small migratory Mekong River carp species *Henicorhynchus siamensis* and *H. lobatus*, collected throughout Cambodia, Thailand and Vietnam, is conducted by MRC/QUT/ACIAR. In addition, there is an on-going mtDNA phylogenetic study on the Mekong giant catfish *Pangasianodon gigas* by NACA. These genetics studies revealed that the natural Khone Falls are not an effective natural barrier to the above white fish species. In other words, the lower and middle Mekong basins are, in fact, interconnected, which is in agreement with some ecological studies on fish migration in the Mekong River by MRC.

So far in the Mekong region, there are nine microsatellite markers in the SE Asia catfishes *Pangasianodon hypophthalmus* (4) and *Claria batrachus* (5) developed in 1999, twenty-seven microsatellites for the migratory Asian catfish family Pangasiidae (i.e. five species: *Pangasius krempfi*, *P. bocourti*, *P. conchophilus*, *P. pleurotaenia*, and *Helicophagus waandersii*) in 2002, and recently eleven microsatellites in the captive Mekong giant catfish *Pangasianodon gigas* in 2006. In the past one decade, there are several studies on population and phylogeographic structure in SE Asia fish, i.e. the catfish *Hemibagrus nemurus* in SE Asia using mtDNA markers published in 1995, the climbing perch *Anabas testudineus* in Thailand using allozymic markers in 2000, Pangasiidae catfishes in SE Asia using both allozymic and mtDNA markers in 2000 and using mtDNA markers in 2003, the four species of the catfish genus *Clarias* (i.e. *C. batrachus*, *C. macrocephalus*, *C. gariepinus*, and *C. meladerma*) in Thailand using allozymic markers in 2002, the river catfish *Hemibagrus nemurus* in Malaysia using microsatellite DNA markers in 2003, and the cyprinid fish *Barbonymus gonionotus* in SE Asia using mtDNA and microsatellite markers in 2004.

To date, genetic approach for identifying discrete gene pools (i.e. stocks or populations) of fish, and hence effective management units, has not been trialed in Cambodia and so the basis for developing management principles and practices is limited. Therefore population genetics programs are needed to (1) demonstrate the utility of molecular population genetic data for fisheries and aquaculture management in Cambodia, particularly in the Tonle Sap Great Lake and (2) develop both human (expertise) and physical (DNA laboratory) capacity in Cambodia in undertaking and interpretation of such programs. This approach will provide a major boost to the level of scientific knowledge available to managers for developing successful long-term management plans for Tonle Sap Great Lake fish species. In parallel it will develop expertise in Cambodia in the practice and interpretation of such data sets in fisheries and aquaculture management where previously it was largely absent. Together this should provide a powerful impetus to develop and apply similar technologies more widely on Lower Mekong River Basin fish species and ultimately promote the level and quality of fish stock management in the region.