



Stock assessment and fishery management of *Henicorhynchus* spp., *Cyclocheilichthys enoplos* and *Channa micropeltes* in Tonle Sap Great Lake, Cambodia

Nguyen T. Hai Yen ^{a,*}, Kengo Sunada ^a, Satoru Oishi ^a, Kou Ikejima ^{b,1}, Tomaya Iwata ^a

^a Department of Civil and Environmental Engineering, University of Yamanashi, 4-3-11 Takeda, Kofu, Yamanashi, Japan

^b Japan Society for the Promotion of Science (JSPS), 159 Sukumvit Soi 21, Bangkok 10110, Thailand

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ABSTRACT

Tonle Sap Great Lake, in the lower Mekong River basin, contributes 60% of Cambodia's inland fisheries catch. There are four types of fisheries, including the middle-scale fishery. The major species comprising the middle-scale fishery are *Henicorhynchus* spp. (16%), a small-bodied fish caught mainly with small-mesh nets, and *Cyclocheilichthys enoplos* (13%), and *Channa micropeltes* (7%) which are caught with a variety of gear. Here we apply the Schaefer surplus production model to the middle-scale fisheries using monitoring data collected between 1995 and 1999. Model simulations determined that the maximum sustainable yield (F_{MSY}) for *Henicorhynchus* spp., was obtained with the use of 47,206 gillnets (mesh size <50 mm) and 4269 and 1605 fishing boats for *C. enoplos* and *C. micropeltes*, respectively. Over 1995–1999, there was a strong trend of increase in fishing effort and decrease of catch-per-unit-effort in the waters of Pursat, Siem Riep and Kampong Chhnang provinces. These provinces have large population centres located close to the fishing grounds; fishing in these areas should be more strictly regulated.

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Introduction

Tonle Sap (TS) Great Lake of Cambodia is situated in the lower part of the Mekong River Basin (MRB) (Fig. 1). The lake has a catchment area of 81,456 km² (Hak and Piseth 1999, MRC 2003); during the wet season (June to October) the lake has a surface area of over 10,000 km² while in the dry season the lake recedes to 2500 km² (Hak and Piseth 1999, MRC 2003). The TS ecosystem comprises the largest wetland in Southeast Asia. Biodiversity is high with at least 179 fish species caught between 1995 and 2002 (Campbell et al. 2006). It also supports the fourth most productive capture fishery in the world (Rainboth 1996) with the total annual catch estimated to range between 177,000 and 400,000 tonnes (IFReDI 2001, Sverdrup-Jensen 2002, Van Zalinge et al. 2003). TS contributes approximately 60% of the total inland catch of Cambodia (Ahmed et al. 1998), contributes 16% to Cambodia's GDP and is the source of 60 to 80% of Cambodian's consumable animal protein (Ahmed et al. 1998, Baird et al. 2003).

There is strong evidence that fishing pressures are adversely affecting TS fish communities. Fish catches increased from 125,000 tonnes in the 1940s to 235,000 tonnes in 1995–1996 (IFReDI 2001) while the individual fish catch declined from 347 kg/fisherman

in the 1940s to 196 kg/fisherman in 1995–1996. At the same time, the contribution of large fish species to total catch decreased (Van Zalinge et al. 2001) as did the average size of smaller fish in the catch (Hortle et al. 2004).

Water level in TS Lake is highly variable, ranging from 1 m deep in the dry season (November to May) to 14 m deep in the wet season (June to October). This change in depth is strongly influenced by seasonal water outflow and inflow from the Mekong River throughout the 100 km long TS River (Hak and Piseth 1999, MRC 2003). In recent years, river and floodplain fish habitats have been lost, modified or fragmented because of changes in hydrological regimes caused by demands of water resource uses (MRC 2003). Changes in catchment land use, increases in agro-chemical usage for agriculture, and increases in urban and industrial waste are believed to be adversely affecting fish quality and quantity (MRC and UNEP 1997). Annual bag net (Dai) fish catch and maximum water level in the TS Lake have been shown to be positively correlated with one another (Lieng et al. 1995; Van Zalinge et al. 2003). Other studies have explored the relationship between bag net fish catch, hydroecology, and water quality (Nguyen et al. 2007, 2008). Exploitation however, may be a more important threat to freshwater fish, including those inhabiting flood plains such as TS Lake (Welcomme 1979). On average, freshwater species worldwide are more imperiled than marine species because of adverse anthropogenic impacts on river and lake watersheds, in addition to fishing pressures (Arthington et al. 2003).

Fisheries in the TS ecosystem are complex and consist of limited access fisheries consisting of large-scale fishing, and open access

* Corresponding author. Tel.: +81 55 220 8522.

E-mail addresses: trhyen2001@yahoo.com (N.T.H. Yen), sunada@yamanashi.ac.jp (K. Sunada), tetsu@yamanashi.ac.jp (S. Oishi), kou.ikejima@gmail.com (K. Ikejima), tiwata@yamanashi.ac.jp (T. Iwata).

¹ Tel.: +66 2 661 6453.

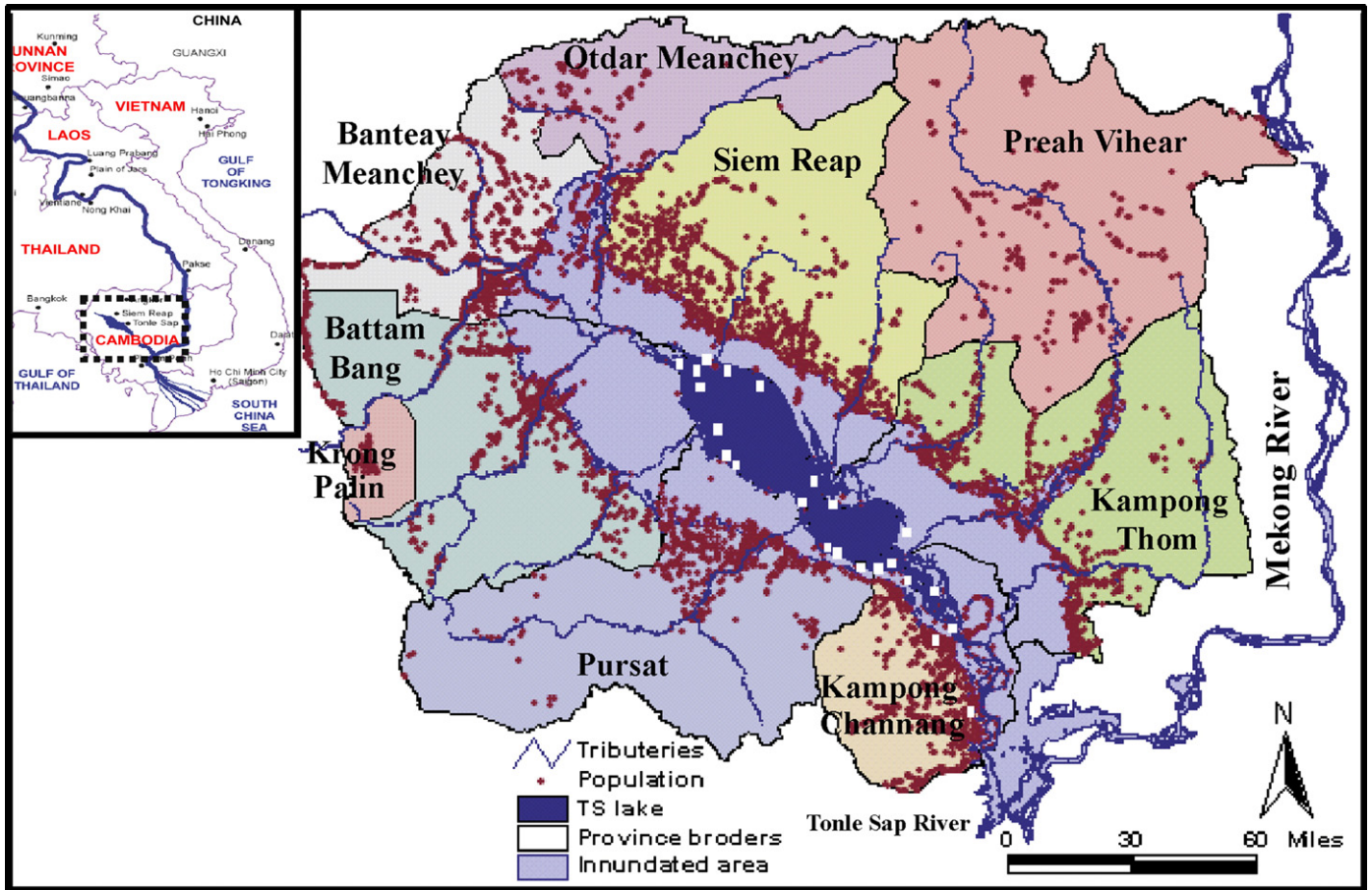


Fig. 1. Tonle Sap ecosystem, its catchments and mobile gear fishing survey locations (white dots).

fishing consisting of middle-scale and small-scale fishing. Within these categories are four types of fisheries:

- 1) Fishing lots which typically encompass several thousand hectares and are located in the floodplain areas of the lake and the lake delta.
- 2) The middle-scale fishery which uses about ten types of basic gear including gillnets, traps, seine nets, trawls, hook and line, bagnets, pushnet, liftnets, cast nets and brush park (Table 1). Fishermen operate these gears in the open access areas of the lake.
- 3) Dai lots which are based on the use of a stationary trawl (dai or bagnet) placed in the TS river to capture fish migrating downstream.
- 4) The small-scale fishery, which is a subsistence fishery not requiring a license.

The fishing rights of the lot and bag net fisheries are auctioned off to commercial operators by the Government of Cambodia for a two-year period. The middle-scale fishing gears are seasonally licensed by the government (The Cambodia Draft Fishing Law 2006). The open season is from October to May and the closed season is from June to September.

A fishery monitoring program was established in TS in the early 1940s under the French colonization. Unfortunately, no fishery data were recorded between the late 1940s and 1980 following the French revolution. Since the late 1980s, the Cambodian Department of Fisheries (CDoF) collected fishery catch data, although some question its reliability (Van Zalinge et al. 1998). However, since 1995, the Mekong River Commission (MRC) in collaboration with CDoF and supported by the Danish International Development Agency (Danida) has conducted a fisheries monitoring program for bag net, lot, and middle-scale fisheries. The bag net fishery data are available from

1995 to the present, while the lot and middle-scale fisheries data are only available between 1995 and 1999. There are no monitoring data available for the small-scale fishery. The fishing effort of both the lot (a defined area) and bag net (63 bags) fisheries did not change between 1995 and 1999.

Over 50 fish species were recorded from middle-scale fishery between 1995 and 1999. Three species dominated the middle-scale

Table 1

Fishing gear categories and types used in the Tonle Sap Great Lake between 1995 and 1999.

Gear category	Description of gear types by categories (number in the parentheses was number of samples recorded)
1 Lift net	Giant lift net
2 Push net	Push net
3 Cast net	Cast net: mesh size 20–60 mm, and 5–6 m long (1108); Giant cast net: the same mesh size as cast net, but the length of net is bigger and up to 50 m long (205)
4 Brush park	Brush bundle basket (14); Brush park (359). Areas of brush park largely varied from an area of 5–8 m wide and 15–20 m long to approximately 1 ha
5 Bag net	Mosquito netting mesh size
6 Trawl	Deep dragged trawl (571); Pair trawl (26)
7 Seine net	Seine net (635); Encircling seine net (434), Hand dragged seine net (85)
8 Trap	Trap (1586); Arrow shaped trap (1553); Horizontal trap for catfish (192); Horizontal trap for Gourami (8); Horizontal trap for shrimp (454); Rice field horizontal trap (96); Snakehead trap (20); Vertical trap for catfish (94)
9 Hook and line	Hook and line of hook size 6–20: (2590); Hook and long line (54)
10 Gill net	Mesh size <50 mm (6650); mesh size 50–70 mm (2197); mesh size >70 mm (799); Encircling gill net (293); Hand dragged gill net (129)

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