Fishes of Thale Noi and its tributaries, South Thailand

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Abstract. Thale Noi is a small freshwater lake in the Songkhla Lagoon system in south Thailand. Songkhla Lake basin has been developed under the Thailand National Socio-Economic Plan with well-documented recent changes in its physical environment. The objective of this report is to update the current fish species that inhabit the Thale Noi. This report refers to native species only. Fish diversity was assessed along with the environmental alteration. The present study recorded 51 and 49 native species in 1982–1983, and 2005–2009 respectively, with a total of 54 species belonging to 26 families had been listed. The findings of this study could also be of great value as a starting point for further studies. Regular monitoring for species composition of Thale Noi is needed, and it is essential that the current data and all points of view be considered by decision makers.

1. Introduction
Thale Noi is an important freshwater swamp situated as a part of Songkhla Lagoon’s system, located in the southern part of Thailand. This swamp is home for waterfowl, both migratory and breeding residents, and has been declared as Non-hunting Area in 1975, under the Royal Forestry Department of Thailand [1]. Later, part of the Thale Noi Non-hunting Area “Pru Kuan Kee Sian” has been declared as Thailand’s first Ramsar Site since 1998.

Due to increased human settlement, the ecological succession process lead Thale Noi to undergo rapid eutrophication resulted in high levels of aquatic macrophyte biomass [2]. Under the National Economic and Social Development Plan between 1972 and 1981, the Royal Thai Government proposed special policies and development programs for these areas, aims to upgrade the standard of living and income of the people. During the period, this area was classified and designated as a poverty eradication area. The population growth rate of the area and in the vicinity was relatively high, at 2.8% per annum. Rice used to be the main product in this area. In order to have agricultural intensification for rice crops, irrigation development has been executed in the area adjacent to Thale Noi. Several natural inlets “rawa” connecting the Thale Luang and the Gulf of Thailand (figure 1) were permanently shut down to prevent salinity intrusion into Thale Noi, that converted Thale Noi to be freshwater all year round, which led to some adverse impact on Thale Noi by changing salinity regime in the aquatic ecosystem [3]. Such impact affects the natural environment; combined with the rising fishing effort that significantly degrade the lake. This can lead to harmful conditions for living organisms, including increased fish mortality, a decrease in the abundance and diversity of resident biota, and loss of ecosystem function [4, 5, 6].

Several studies on the diversity of fish in Thale Noi have been conducted. Annandale [7] provided a preliminary general zoological account and an overview of the environmental quality of the Songkhla
Lagoon system. In 1916, Dr. Annandale collected a lot of fishes and other aquatic fauna from Songkhla Lagoon system, which were studied and deposited in museums outside Thailand. The earliest ichthyofauna study of the Songkhla Lagoon system by Hora [8] was the result of Annandale’s collection. Furthermore, a small fish collection from Lake Songkhla was made in Thale Luang in the vicinity of Phattalung River by Bernatzik in 1936 and was reported by Koumans [9]. Smith [10] reported the fish assemblages from his visits to various places in Songkhla Lagoon’s system during his tenure in “the Siames Bureau of Fisheries” between 1923 and 1934. Choti Suvatti, an early Thai’s ichthyologist, contributed his work on fish while he held a position in Siames Bureau of Fisheries, to the first edition of Fauna of Thailand [11]. Limpanich and Gongratanakosol [12] conducted a bimonthly survey on fishes of Thale Noi, reported 20 species of fishes. Later, Na-anan et al [13] studied and yield 40 species of fish.

However, as an important and unique freshwater habitat, the fish diversity in Thale Noi should be monitored in order to evaluate the impact and effect of human development on its ecosystem. This report aims to provide the list of fish species inhabits the Thale Noi between 1982 and 2009.

2. Materials and Methods

2.1 Description of the study areas
Thale Noi is the northernmost basin of the Lake Songkhla System (figure 1). It is a perennial lake, situated between Lat 7° 46’ 40” N through 7° 48’ 30” N and Lat 100° 07’ 30” E through 100° 11’ 10” E. Thale Noi covers an area of approximately 28 km², is about 5 km wide and 6 km long and has an average depth of 1.2 m. There are two large Meleleuca peat swamps on the west and north sides of Thale Noi. At the south, there are three canals which connect Thale Noi with the Thale Luang basin. The canals are Klong Nang Rium, Klong Yuan and Klong Ban Klang (figure 1). The water levels in Thale Noi depend entirely on the amount of water entering from the nearby swamps and will vary with the total amount of rainfall in the watershed area of the basin and intrusion of seawater to the lake system.

Various aquatic macrophytes occur and serve as habitats, feeding grounds, spawning grounds for aquatic organisms and nesting sites for various waterfowl. These include emergent plants such as water lilies Nymphaea spp., sacred lotus Nelumbo nucifera, sedges Eleocharis dulcis and Lepironia articulata, reeds Paspalum spp.; floating species as water-hyacinths Eichhornia crassipes, Bakong Rimba Hanguana malayana and submerged plants Hydrilla verticillata, Ceratophyllum demersum and Utricularia spp. These aquatic plants are scattered and cover approximately 60% of the total surface area of Thale Noi.

2.2 Data collection
A series of fish collections from Thale Noi were conducted on a monthly basis for one and half years between January 1982 and May 1983, under the Thale Noi Project [2]. Fishes were collected by Thale Noi Project and local fishermen using a seine net with an 8 mm stretch mesh size and gill net, respectively. In addition, other field surveys were carried out, between October 2005 and September 2009, across various localities of Thale Noi tributaries (figure 1) using multiple methods including seine, cast nets, hand nets, hook, and line, and lift nets. Selected voucher specimens were fixed and preserved in 10% neutral formalin. The collections were identified with the latest taxonomic literatures and deposited in Prince of Songkla University Zoological Collection (PSUZC) at the Princess Maha Chakri Sirindhorn Natural History Museum, Prince of Songkla University in Hat Yai, Songkhla, Thailand.

The classification of orders and families was made by systematically followed listed evolutionarily arrangement given in the California Academy of Science’s Catalog of Fishes [14]. Genera and species are listed alphabetically with their families. The spelling of scientific names and species, including the author and year for traceability, was validated following Fricke et al [14].
Figure 1. Thale Noi and its tributaries in Songkhla Lagoon’s system. Sample sites taken between January 1982 and June 1983 (★) and between 2005 and 2009 (▲).

3. Results
3.1. Taxonomic composition of the ichthyofauna
A total of 58 species of fish were identified, representing 47 genera in 26 families (Table 1). Of these, 51 species are native species occurring in Thale Noi and southern Thailand and they are widely distributed throughout South-east Asia. The remaining species: *Barbounymus gonionotus*, and *Trichopodus pectoralis* are native species in Thailand but their natural distributions are not included in the south, while *Ctenopharyngodon idella, Cyprinus carpio, Labeo rohita, Osphronemus goramy*, and *Oreochromis niloticus* are introduced species from elsewhere (as shown in Table 1).

A few families dominated the fish fauna of Thale Noi at present. The five most diverse families were Cyprinidae (8), Danionidae (5), Bagridae (4), Osphronemidae (4) and Channidae (4). These families accounted for approximately 52.9% of the total species.

Thirteen species were relatively abundant and of high commercial value for local communities. These were *Notopterus notopterus*, *Cyclocheilichthys apogon*, *Hampala macrolepidota*, *Osteochilus vittatus*, *Hemibagrus capitulum*, *Ompok siluroides*, *Clarias macrocephalus*, *Channa lucius*, *C. micropeltes*, *C. striatus*, *Pristolepis fasicatus*, *Anabas testudineus*, and *Trichopodus trichopterus*. The remaining 38 species are either relatively smaller in size or very rare species.

Two near threatened fish species listed by IUCN Red List of Threatened Species, namely *Boraras urophthalmoides* and *Syncrossus beauforti*, were collected in this study. *Boraras urophthalmoides* was very common with small size, less than 20 mm in body length, while *S. beauforti* was larger but it was collected only once. Nearly all species of the list in Table 1 are freshwater species, only *Corica soborna* was a brackish species.
Table 1. A comparative checklist of fish species in Thale Noi, Songkhla Lagoon’s system, south Thailand.

| Scientific Names | Order | Family | Scientific Names | Habitat | IUCN Status | 1982-1983 | 2005-2009 | Limp. & Gongr. (1996)§ | Na-anan et al (2011)§ |
|------------------|-------|--------|------------------|---------|-------------|-----------|-----------|------------------------|-----------------------|
| Order Osteoglossiformes |       |        |                  |         |             |           |           |                        |                       |
| Family Notopteridae |       |        |                  |         |             |           |           |                        |                       |
| Notopterus notopterus (Pallas 1769) |       |        |                  |         |             |           |           |                        |                       |
| Order Clupeiformes |       |        |                  |         |             |           |           |                        |                       |
| Family Clupeidae |       |        |                  |         |             |           |           |                        |                       |
| Corica soborna Hamilton 1822 |       |        |                  |         |             |           |           |                        |                       |
| Order Cypriniformes |       |        |                  |         |             |           |           |                        |                       |
| Family Botiidae |       |        |                  |         |             |           |           |                        |                       |
| Syncrossus beauforti (Smith 1931) |       |        |                  |         |             |           |           |                        |                       |
| Family Cobitidae |       |        |                  |         |             |           |           |                        |                       |
| Lepidocephalichthys hasselii (Valenciennes 1846) |       |        |                  |         |             |           |           |                        |                       |
| Family Cyprinidae |       |        |                  |         |             |           |           |                        |                       |
| Barbonyxus gonionotus (Bleeker 1849) |       |        |                  |         |             |           |           |                        |                       |
| Barbonyxus schwansenfeldi (Bleeker 1854) |       |        |                  |         |             |           |           |                        |                       |
| **Ctenopharyngodon idella (Valenciennes 1844) |       |        |                  |         |             |           |           |                        |                       |
| Cyclocheilichthys apogon (Valenciennes 1842) |       |        |                  |         |             |           |           |                        |                       |
| **Ctenopharyngodon idella (Valenciennes 1844) |       |        |                  |         |             |           |           |                        |                       |
| **Cyprinus carpio Linnaeus 1758 |       |        |                  |         |             |           |           |                        |                       |
| Hampsala macrolepidota Kuhl & van Hasselt 1823 |       |        |                  |         |             |           |           |                        |                       |
| **Labeo rohita (Hamilton 1822) |       |        |                  |         |             |           |           |                        |                       |
| Labiobarbus lepiocellus (Valenciennes 1842) |       |        |                  |         |             |           |           |                        |                       |
| Osteochilus vittatus (Valenciennes 1842) |       |        |                  |         |             |           |           |                        |                       |
| Puntigrus partipentazona (Fowler 1934) |       |        |                  |         |             |           |           |                        |                       |
| Puntius brevis (Bleeker 1849) |       |        |                  |         |             |           |           |                        |                       |
| Systomus orphoides (Valenciennes 1842) |       |        |                  |         |             |           |           |                        |                       |
| Family Danionidae |       |        |                  |         |             |           |           |                        |                       |
| Boraras urophthalmoides (Kottelat 1991) |       |        |                  |         |             |           |           |                        |                       |
| Esomus metallicus Ahl 1924 |       |        |                  |         |             |           |           |                        |                       |
| Rasbora borapetensis Smith 1934 |       |        |                  |         |             |           |           |                        |                       |
| Rasbora paviana Tirant 1885 |       |        |                  |         |             |           |           |                        |                       |
| Rasbora trilineata Steindachner 1870 |       |        |                  |         |             |           |           |                        |                       |
| Family Xenocyprididae |       |        |                  |         |             |           |           |                        |                       |
| Parachela maculateda (Smith 1934) |       |        |                  |         |             |           |           |                        |                       |
| Parachela oxygastroides (Bleeker 1852) |       |        |                  |         |             |           |           |                        |                       |
| Order Siluriformes |       |        |                  |         |             |           |           |                        |                       |
| Family Bagridae |       |        |                  |         |             |           |           |                        |                       |
| Scientific Names                              | Habitat | IUCN Status List [15] | 1982-1983 | 2005-2009 | Limp. & Gongr. (1996)§ | Na-anan et al (2011)§ |
|----------------------------------------------|---------|-----------------------|-----------|-----------|------------------------|----------------------|
| *Trichopodus pectoralis* (Regan 1910)        | F       | LC                    | X         | X         | -                      | X                    |
| Trichopodus trichopterus (Pallas 1770)        | F       | LC                    | X         | X         | -                      | X                    |
| Family Siluridae                              |         |                       |           |           |                        |                      |
| Ompok siluroides Lapeède 1801                | F       | NA                    | X         | X         | X                      | X                    |
| Family Clariidae                              |         |                       |           |           |                        |                      |
| Clarias batrachus (Linnaeus 1758)             | F       | LC                    | X         | X         | -                      | -                    |
| Clarias macrocephalus Gunther 1864           | F       | NT                    | X         | X         | X                      | X                    |
| Family Ariidae                                |         |                       |           |           |                        |                      |
| Arius maculatus (Thunberg 1792)              | B       | NA                    | -         | -         | -                      | X                    |
| Order Syngnathiformes                        |         |                       |           |           |                        |                      |
| Suborder Syngnathoidei                       |         |                       |           |           |                        |                      |
| Family Syngnathida                           |         |                       |           |           |                        |                      |
| Doryichthys boaia (Bleeker 1850)             | F       | DD                    | X         | X         | -                      | X                    |
| Doryichthys deokhatoides (Bleeker 1854)      | F       | DD                    | X         | X         | -                      | -                    |
| Order Gobiiformes                            |         |                       |           |           |                        |                      |
| Family Eleotridiae                           |         |                       |           |           |                        |                      |
| Oxyeleotris marmoratus Bleeker, 1852          | F       | NA                    | X         | X         | -                      | X                    |
| Family Gobiidae                               |         |                       |           |           |                        |                      |
| Brachygobius xanthomelas Herre 1937          | F       | DD                    | X         | X         | -                      | -                    |
| Gobiopterus brachypterus (Bleeker 1855)       | F       | DD                    | X         | X         | -                      | -                    |
| Order Synbranchiformes                        |         |                       |           |           |                        |                      |
| Suborder Synbranchioidae                     |         |                       |           |           |                        |                      |
| Family Synbranchidae                         |         |                       |           |           |                        |                      |
| Macrognathus circmuncinctus (Hora 1924)       | F       | LC                    | X         | X         | -                      | X                    |
| Suborder Synbranchioidae                     |         |                       |           |           |                        |                      |
| Family Synbranchidae                         |         |                       |           |           |                        |                      |
| Monopterus albus (Zuiew 1793)                | F       | LC                    | X         | X         | X                      | X                    |
| Order Anabantiformes                          |         |                       |           |           |                        |                      |
| Suborder Anabantoidei                        |         |                       |           |           |                        |                      |
| Family Anabantidae                           |         |                       |           |           |                        |                      |
| Anabas testudineus (Bloch 1792)              | F       | DD                    | X         | X         | X                      | X                    |
| Family Osphronemida                           |         |                       |           |           |                        |                      |
| Betta imbellis Ladiges 1975                  | F       | LC                    | X         | X         | -                      | -                    |
| Betta cf. pugnax (Cantor 1849)                | F       | LC                    | X         | -         | -                      | -                    |
| *Trichopodus pectoralis* (Regan 1910)        | F       | LC                    | X         | -         | -                      | X                    |
| Scientific Names | Habitat | IUCN Status List [15] | 1982-1983 | 2005-2009 | Limp. & Gongr. (1996)§ | Na-anan et al (2011)§ |
|------------------|---------|-----------------------|------------|------------|------------------------|----------------------|
| Trichopsis vittata (Cuvier 1831) | F | LC | X | X | X | – |
| Suborder Channoidei | | | | | | |
| Family Channidae | | | | | | |
| Channa limbata (Cuvier 1831) | F | NA | X | X | – | – |
| Channa lucius (Cuvier 1831) | F | LC | X | X | X | X |
| Channa micropeltes (Cuvier 1831) | F | LC | X | X | X | – |
| Channa striatus (Bloch 1797) | F | LC | X | X | X | X |
| Suborder Nandoidei | | | | | | |
| Family Nandidae | | | | | | |
| Nandus nebulosus (Gray 1835) | F | LC | X | X | – | X |
| Family Pristolepididae | | | | | | |
| Pristolepis fasciata (Bleeker 1851) | F | LC | X | X | X | X |
| Order Cichiliformes | | | | | | |
| Family Cichlidae | | | | | | |
| **Oreochromis niloticus (Linnaeus 1758) | | | X | X | – | – |
| Order Cyprinodontiformes | | | | | | |
| Suborder Aplocheiloidei | | | | | | |
| Family Aplocheilidae | | | | | | |
| Aplocheilus panchax (Hamilton 1822) | F | LC | X | X | – | – |
| Order Beloniformes | | | | | | |
| Family Beloniidae | | | | | | |
| Xenentodon cancilloides (Bleeker 1853) | F | LC | X | X | X | X |
| Family Zenarchopteridae | | | | | | |
| Dermogenys siamensis Fowler 1934 | F | LC | X | X | – | X |
| Hyporhamphus limbatus (Valenciennes, 1847) | F | LC | X | X | – | – |
| Zenarchopterus ectuntio (Hamilton 1822) | F | NA | X | X | – | – |
| Order Tetraodontiformes | | | | | | |
| Suborder Tetraodontoidei | | | | | | |
| Family Tetraodontidae | | | | | | |
| Pao cochinchinensis (Steindachner 1866) | F | LC | X | X | – | – |
| Pao palembangensis (Bleeker 1851) | F | DD | X | X | X | X |
| Order Perciformes | | | | | | |
| Suborder Percoidei | | | | | | |
| Family Ambassidae | | | | | | |
| Parambassis siamensis (Fowler 1937) | F | LC | X | X | – | X |

TOTAL SPECIES 51 49 18 31

Limp. & Gongr. (1996): Limpanich and Gongratanakosol [12]. §: Exclude introduced species and doubtful identification; *: Translocation within Thailand; **: Introduced species from elsewhere
4. Discussion

The total number of species observed is the simplest statistic to interpret, but its value is strongly dependent on the chance of encountering at least one individual of the rare species. The distribution of the ichthyofauna in Thale Noi is summarised in Table 1. It is interesting to note that the author’s collection yielded more species than Limpanich and Gongratanakosol \[12\] and Na-anan et al \[13\] possibly due to small mesh size seine nets and more efforts were allocated to fringing aquatic plants. In comparisons, Limpanich and Gongratanakosol \[12\] and Na-anan et al \[13\] reports were either directed mainly at economically important species or represented from large scale fishing gears. For example, Na-anan et al \[13\] employed gill nets of 20, 30, 40, 55, 70 and 90 mm mesh size. These factors may have resulted in missing both small and non-economical important species.

Based on the collection obtained from main Thale Noi between January 1982 and June 1983, combined with a collection taken from tributaries of Thale Noi between 2005 and 2009, it was expected that there was an annual seasonal migration of fish between Thale Noi and its surrounding by species associated with flooded forest or inundation swamp \[16\]. These movements are possibly correlated with spawning activity. From the inundation forests, the new-born juveniles find their way to the adjacent flood-plain that serves as their refuge habitats while the spent adults return to the main lake. After the peak of floods or starting of the low water period, disperse migrations of these new recruits to the lake community take place. In extreme dry years, the dry areas of the terrestrial environment and inundation swamp at the edge of water bodies tend to expand as well as a decrease in depth, volumes, and limited lateral flooding. At these times Thale Noi fish appear to be limited to restricted areas. Species specifically associated with inundation swamp are likely to move downwards to the lake and colonize new areas, thus more species richness and diversity are expected.

During the flooding season in the peat swamp areas around Thale Noi, leaching of humic acid, and dissolved organic carbon from the decomposition process of tree debris and aquatic vegetation make the swamp waters deoxygenated, darkly stained with humic acids and depletion of pH. In 1981, ONEB \[1\] reported pH from Thale Noi ranged from 1.2 - 8.1. Such a low pH level may be marginal for some narrow pH tolerance range organisms. On the other hand, there are at least some small species that satisfy the aforementioned conditions. Lowe-McConnell \[17\] and Khan et al \[18\] mentioned that small cyprinids, particularly Rasbora spp. and some Puntius spp., may enter and prey as predominant fishes in the acidic and “blackwater” bodies. This is supported by more diversity in Rasbora spp. and osphronemids (Betta spp., Trichopsis spp. and Trichopsis spp.) in the present records (table 1), while Hora \[8\] found most Rasbora spp. in small pools and ditches near the edge of the lake.

These scientific findings on the Thale Noi fish community should not be the final step in the scientific process but could also be of great value as a starting point for further studies, a management tool, and a source of information to the public and resource managers. Conserving the fish population of Thale Noi requires maintaining the natural water tables of the surrounded peat swamp with seasonal flooding and preventing salinity intrusion from Thale Luang. Peat swamps become vulnerable to destruction by bush fire when the area dries out due to drainage and habitat conversion to agricultural land. On the other hand, salinity intrusion may lead to the migration of more brackish species into Thale Noi.

5. Conclusion

The high diversity of fishes in Thale Noi and its tributaries was due to the existence of a various types of habitats, i.e. limnetic, littoral, and vegetated zones. The present study indicated that applying small mesh seine nets at the tributaries and fringing habitats of Thale Noi yielded better results and more efficient to discover smaller sizes and rare fish species than larger mesh gill nets. Efforts should be made to protect these species in Thale Noi and further ichthyofaunal research should be carried out to relate their occurrence, abundance, and health status to the surrounding environment that may be important for future management and conservation program.
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