THE UNIVERSITY OF MANITOBA

Newly Covered Grass As A Habitat For Fish In Bung Boraped, Thailand

by

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A dissertation submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

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DEDICATION

To my mother

KOONYING KRONGTONG SURASWADI

with great respect and my fondest love.

ABSTRACT

The characteristics of the grassy habitat, weed covered habitat and open water habitat are described in relation to succession stages. Fish fauna, stomach contents, benthos, vegetation and associated fauna, water and sediment were determined. The effect of continuous water cover on grass-covered habitat was evaluated, in the attempt to immitate the early succession stage after draining and refilling.

Information about the mechanisms involved in the nutrient cycle and the effects of water level variations on the food chain were obtained. The inter-relationship between flora and fauna, especially the advantage of grasses compared to floating weeds for locally important fish species, was studied. This information will be used to improve management and increase fish production in Bung Boraped and other reservoirs of Thailand.

The established grass-covered habitat represents the early impoundment stage characterized by rapid decomposition, abundance of nutrient, high production of benthic organisms, invertebrates associated with emergent grasses and small fish. The soil had high organic matter and a high phosphorus content. Leersia hexandra, Hymenachne pseudoiterum and Cynodon dactylon were the major macrophytes. The increasing populations of such fish species as Trichogaster pectoralis, T. trichopterus, Cyclocheilichthys enoplos, Amblyrhynchichthys truncatus, Lusionsoma bleekeri and Anabas testudineus indicated high ecological production.

The weed-covered habitat represents the late succession stage, characterized by low production of benthic organisms and fish, and unfertile soil sediment. The obnoxious plants such as Eichornia crassipes, Salvinia cucullata,

Isachne globosa and Coix aquatica were abundant and H_2S occurred underneath the mats,creating anoxic conditions. The carnivorous fish species such as Ophicephalus striatus, Ophicephalus lucius, Ophicephalus micropeltes, Ompox bimaculatus and Wallagonia attu were abundant, indicating a complicated food web and low ecological production.

The open-water habitat represents the intermediate zone characterized by better water quality, abundance of bentho-planktonic forms and versatile planktonic feeders such as Paralaubuca sp. and Cirrhinus micropeltes.

Bung Boraped could be maintained at a highly productive level if much of the natural community were periodically destroyed before it reached the maturation stage. Water level manipulation in summer appears to be appropriate for maximizing fish production. By this process the grass-covered habitat, which is most favourable for fish production, would be re-established.

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TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

TABLE PAGE

LIST OF FIGURES

INTRODUCTION

Bung Boraped covers 208 km^2 in area and is the oldest reservoir in Thailand. It was created in 1930 for use as a water source for irrigation and as a fish sanctuary. Originally, Bung Boraped was to be fished infrequently, or not at all. However, as the demand for fish protein increased, portions of the reservoir were opened to fishermen. An individual catch limit was enforced.

Bung Boraped has been recognized as one of the most potentially productive areas in central Thailand. It had played a significant role in providing 50-80% of the animal protein requirements for the people of the region, but the production declined in 1959.

In the summer of 1959 the Fishery Department decided to drain the reservoir for 1 month. After refilling, fish production was restored and fishing catches remained high for more than 5 years. In 1972 the reservoir had deteriorated, having more than half of its surface area covered with noxious plants. Torgme and Chatmarai (1971) reported plants such as Eichornia crassipes, Coix aquatica and Sulvinia cucullata. In some areas, black reducing sediment had been deposited on the shoreline, subsequently causing increased water temperatures. Plegchavee (1973) reported that fish production had decreased and the fish harvest was lower than in earlier years. The reservoir was again drained during the dry season of 1972 for one and a half months, except for the old stream channels and certain deep areas of the reservoir which were prevented from draining by a mud bar across the outlet. In the interval before the monsoon rains refilled the reservoir, natural grasses became established in most of the drained areas. After refilling, this grassy

habitat became excellent protective cover and a good substrate for benthic organisms, apparently leading to increased food production. This cover formed a good spawning ground for fish populations.

In this Fluctuating water level ecosystem Odum (1971) productivity is high when the reservoir is kept at an early succession stage. Odum states that man does not recognize the importance of recurrent natural change in water level. In his opinion this fluctuation, which has been commonly used in rice and fish culturing for centuries, is the analogue of the natural march of the intertidal ecosystem. If this method of nutrient addition could be made easily reproducible, a large scale fish production could be developed thus providing a protein supplement for the protein-deficient countries of the world.

A serious interest in reservoir fishery management in Thailand began less than 30 years ago, although pond fish culture has been practiced for thousands of years. Fish systematics and distribution have been studied by workers such Smith (1945), Suvattii (1950) and Thiemedh (1966). Hydrobiological research has increased in the last few years. Ecology, limnology and fish populations have been studied in the form of exploratory surveys (Sidthimunka et al. 1968, 1970 and 1972). Fish feeding and spawning were investigated by several workers, such as Mizuno and Mori (1970), Potipitak (1970) and Pholprasith (1974).

The need for a conservation-oriented program of fisheries research and management has been increasingly recognized. Water level manipulation (Wood, 1950; Bennett, 1967; Jenkins, 1970 and Bhukasawan, 1973) was tested in Bung Boraped in 1972 in an attempt to control the aquatic weeds (Quenerstedt, 1958, Runstrom, 1960; Lantz et al., 1964 and Junk, 1973).

As a consequence, the reservoir productivity and fish landing statistic increased (anonymous 1973 and 1975). A return of the reservoir to an early stage of succession (Penfound and Schneidau, 1945; Regier, Applegate and Ryder, 1967; Margalef, 1964; Odum, 1971 and Regier and Henderson, 1973) was believed to be the responsible factor. Although the results of this type of manipulation are quite evident, the implications, applications and management techniques are not thoroughly understood.

In November 1974, under the Columbo Plan/NIFI Project, co-operative research was begun by the University of Manitoba, the Department of Fisheries and Marine Service of Canada and The Fishery Department of Thailand. The initial objective was to obtain information about the mechanisms involved in the nutrient cycle, the effect of water level variation, effects on the food chain and the interrelationship between flora and fauna, especially the advantage of grasses over floating weeds for local fish species. It is hoped that this information will help to improve management and lead to higher fish production.

This thesis describes characteristics of the grassy habitat, weed covered habitats and open water habitat. Data are presented on fish fauna, stomach contents, benthos, vegetation and associated fauna, water and sediment analyses.

Figure 1. Map of Thailand showing site of Bung Boraped Reservoir.

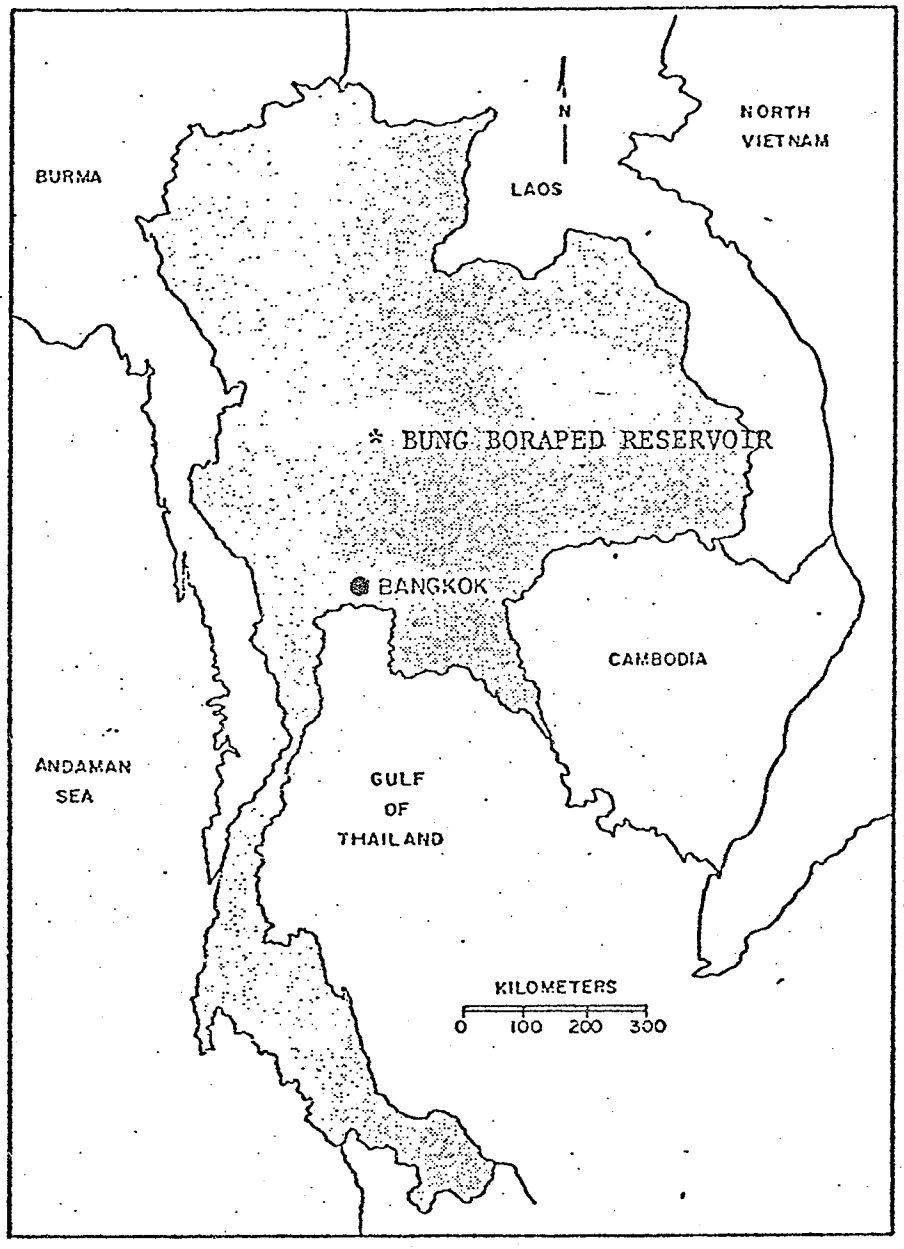
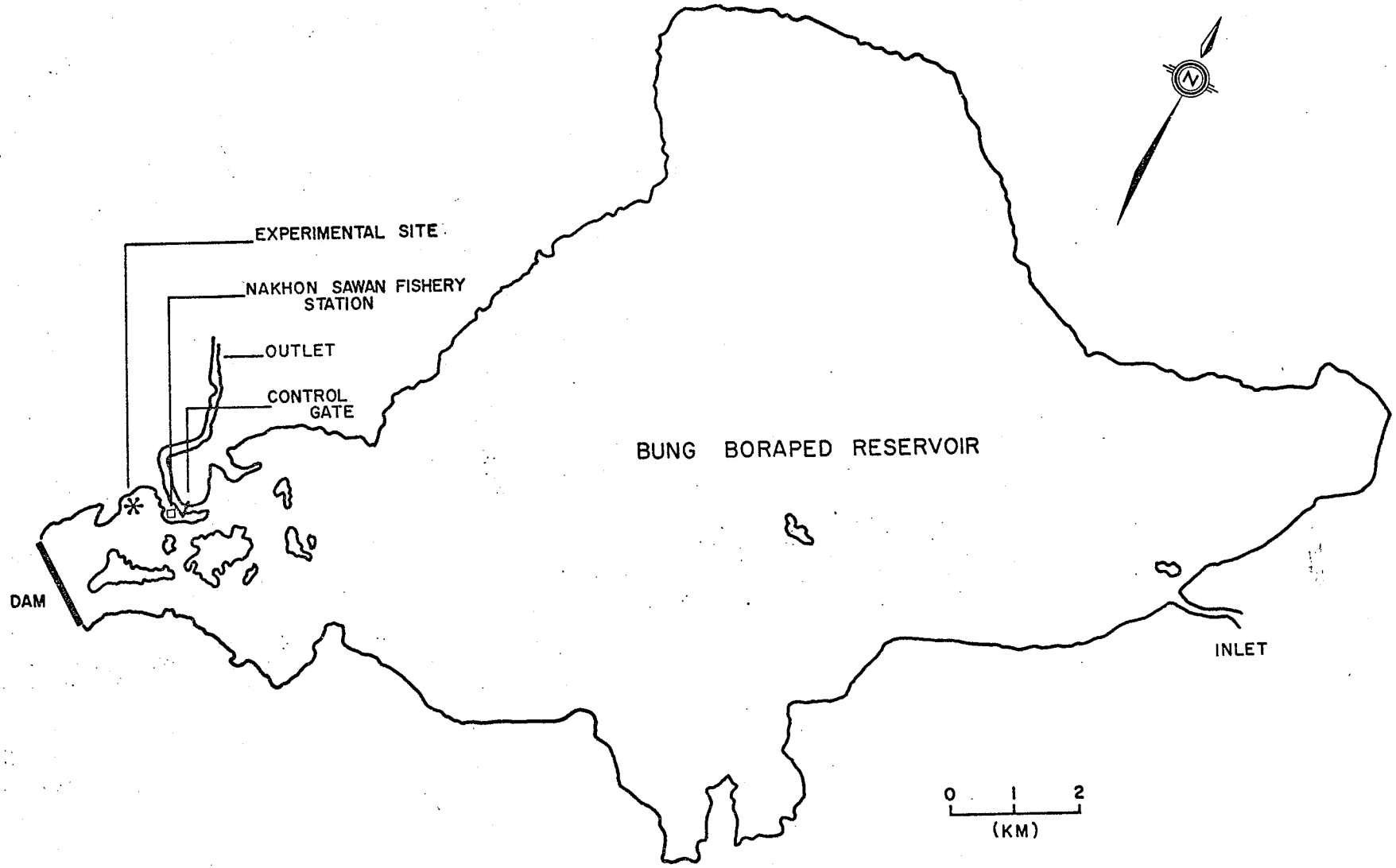

N
NORTH
VIETNAM
BURMA
LAOS
BUNG BORAPED RESERVOIR
BANGKOK
CAMBODIA
ANDAMAN
SEA
GULF
OF
THAILAND
KILOMETERS
0 100 200 300

Figure 2. Map of Bung Boraped Reservoir, Nakhon Sawan Province, Thailand.


EXPERIMENTAL SITE
NAKHON SAWAN FISHERY STATION
OUTLET
CONTROL GATE
BUNG BORAPED RESERVOIR
DAM
INLET
N
0 1 2
(KM)

MATERIALS AND METHODS

Description of the Study Areas

The Bung Boraped Reservoir

At the confluence of the Ping and Nan Rivers, which form the Chao Phyo River after their junction at Paknampo in Nakhon Sawan Province (Figure 1) lies the Boraped Swamp which is well known in Thailand (15^{o} 50' N, 100^{o} 10' E; 24 m. above mean sea level). At periods of high water level, the whole Boraped Swamp formed a big lake of 640 km^2 area (Anonymous, 1956) which was used by fish for spawning. In the dry season many small swampy depressions remained in a plain which was overgrown with bushes and grasses. Following the advice of Dr. H. M. Smith who was the advisor to the Fishery Department at the time, a dam was built between 1926 and 1930. This transformed part of the swamp into a lake of area 208 km^2 area which has been known as Bung Boraped (Luther and Rzaska, 1971). As the terrain is flat, the lake area changes extensively with water level fluctuations. The dam wall serves in places as a railway embankment. There are several outflows and weirs at Klong Boraped, leading into a winding canal which represents the previous main outlet of the swamp area into the Nan stream. A Fishery Department Station, Nakhon Sawan Fishery Station, situated at the weir is concerned with investigating the problems relating to fishery biology in the lake.

There are approximately 30,000 people living around the lake with an average of 6 persons per family. The majority of these people gain their livelihoods from both farming and fishing. Due to the intensive fishery activity in Bung Boraped the per capita income of people in this area is higher than the average per capita income of people in other rural areas. The people living around

the lake obtain food from rice cultivation, fishing, cattle raising and lotus propagation.

Bung Boraped can be morphologicaly divided into 3 areas (Figure 2): (1) the outflow area near the Fishery Station which is studded with several flat islands occupied largely by terrestrial and semi-aquatic macrophytes, (2) the central area which is a large area of open water, and (3) the inflow area which is also characterized by the presence of small islands, merging into a system of channels which during the dry season end in rice fields.

At the period of high water levels, September-December, the entire low area is flooded and is interconnected with the lake in many places. When the water level falls, the lake is again isolated from the surrounding water bodies. The drop in water level of 2-3 m which occurs before the flooding period is primarily due to evaporation. At low water levels the lake is an average of 3-4 m deep, with some depressions and channels up to 6 m deep in areas formerly occupied by ponds and overflows. The open water is dark brown in color and sometimes quite muddy. The Secchi disc readings range from 0.60 to 1.80 m and the pH values to 6.6 to 7.9. The O_2 content of the entire lake is fairly high, 3.0 - 8.0 ppm, because of the frequent mixing of the water in the monsoon season. The electric conductivity range from 109 to 170 µmho/cm (Table 1). The average annual rainfall in this area is about 1250 mm (Figure 3). The average monthly temperatures range from 12.0°C in December to 34.0°C in May.

There are luxurious stands of aquatic macrophytes in Bung Boraped: 40 species from 21 families. Among the floating plants Coix aquatica, Isachne globosa, Leersia hexandra, Eichornia crassipes and Salvinia cucullata are the most common. The submerged plants Hydrilla verticerrata,

Ceratophylum demersum and Utricularia flexuosa occur most of the year in the whole area, but only in small quantities (Table 2). Annelids, snails and insect larvae such as Ephemeroptera, Diptera, Coleoptera, etc. are the dominant groups of benthos in the lake basin. During the study period 10 species of Gastropoda and 13 species of Pelecypoda were observed (Table 3 and 4). There are 148 species of fish in Bung Boraped and among these the Notopteridae, Cyprinidae, Siluridae, Schilbeidae, Ophicephalidae and Eleotridae are the most important groups (Table 5). According to the statistical reports from the Nakhon Sawan Fishery Station (1976), 723,048 kg. of fish were landed in 1975 compared with 862,445 kg in 1965 and 1,081,665 kg in 1972 when fishing was intensified because of the draining manipulation (Table 6). Of 723,048 kg of fish landed in 1975, 184,306 kg was Ophicephalus, 113,728 kg Ostiochilus, 45,978 kg Pristolepis, and 42,656 kg Puntius.

The study areas

Three different types of habitat within the lake outflow region were selected for study and designated as the grass habitat, the weed-covered habitat and the open water habitat. The grass habitat was located on the shelf of the shoreline with some extension into the water. The habitat represented the early stage of succession and would simulate some characteristics of the grass-covered area that was established during the water-level manipulation in 1972. The weed-covered habitat served as the transition zone between the grass and the open water and represented the second stage of succession. The open water habitat was located in the deeper part of the lake. Three study areas designated as B, C, and D were located within those three habitats for experimental purposes (Figure 4).