The Effect of Nutrients from Nile Tilapia (*Oreochromis Niloticus*) Cage Culture on the Benthic Fauna Assemblages

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***Abstract*—**The purpose of this research was to determine the effect of nutrient wastes from Nile Tilapia (*Oreochromis Niloticu*s) culturing in cages on the benthic fauna assemblages in the lower Ping and Nan Rivers. Water, sediment and benthic fauna samples were collected from 6 sites per river from years 2012 to 2013. It was found that the amount of oxygen that microbes need to disintegrate organic matters (BOD_5), NO_3^--N, NH_3-N, and PO_4^{3-} in the water within the culturing areas increased significantly ($p<0.05$) when compared with those in the water in other areas. Levels of total organic matter, total nitrogen and total phosphorus in sediments were significantly higher immediately adjacent to cages compared to reference sites. The abundance and family numbers of benthic fauna were lower at the cage station than at the other site. Finally, differences in some nutrient variables from Nile Tilapia cage culture could be an indication of some environmental changes associated with the benthic fauna assemblages.

***Keywords*—**Cage culture, Nile Tilapia, Ping River, Nan River

I. Introduction

FISH cage culture has become one of the main patterns of intensive aquatic farming in the natural watercourse in Thailand. Fish production from river aquaculture site generates considerable amounts of effluent including nutrients, uneaten food and feces. These effluents can have undesirable impact on the local environment, depending on the amounts released, the time scale over which the releases take place, and the assimilation capacity and flushing ability of the local recipient water body. The most evident effects of fish cages on bottom sediments are the accumulation of organic matter and the progressive transformation of the substrate into a flocculent anoxic environment [1]. Several studies have reported that wastes from fish cage farm can affect nutrient parameters of water and sediment [2] - [5].

Recent studies about the impact of this rearing system on different aspects such as limnological variables, the structure of plankton, fish and benthos. Such changes in the nutrients of water and sediment are in temperate latitudes restricted to the immediate vicinities of the cage culture farming and generally have a strong impact on the structure and characteristics of the phytoplankton [6], zooplankton [7],[8], fish [9],[10] and benthic assemblages [11], indicate discrete alterations related to the rearing of fish in cages. The objective of the research was to investigate effects of nutrient wastes from Nile Tilapia (*Oreochromis niloticus*) cage culture on benthos diversity in the Ping and Nan rivers at Nakhon Sawan province.

II. Materials and Methods

A. Study Area

Nakhon Sawan Province is the place where Ping and Nan Rivers combine together to form Chao Phraya River. The annual maximum rainfall averages 292.2 mm in August and the annual minimum rainfall averages 0 mm during January. The annual average temperature is 27.47 °C (up to 38.2 °C in April and down to 14.5 °C in January) [12]. The total fish productions from cage culture were 2,500 and 2,000 kg in Nan river and Ping river, respectively. The amount of commercial food used during the study was about 5 to 6 tons per farm.

B. Sampling Collection

Water, sediment and benthic fauna samples were collected from cage culture areas in the lower Ping and Nan Rivers (Fig 1) on October, February and June from years 2012 to 2013. All samples were collected from 6 stations per river. Stations 1 and 2 are represented as upstream, Stations 3 and 4 are represented as cage culture areas, Stations 5 and 6 are represented as downstream (Fig 2). The samples collected from each site consisted of 3 composite samples. Water samples were collected manually using polyethylene bottles. Sediment samples were collected by the Smith-McIntyre grab, while offshore samples were collected by the core sampler. Benthic fauna samples were collected from field and taken to the laboratory by fixed with 95% ethanol.

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Fig. 1 Locations of cage Nile Tilapia farms in the lower Ping and Nan Rivers.

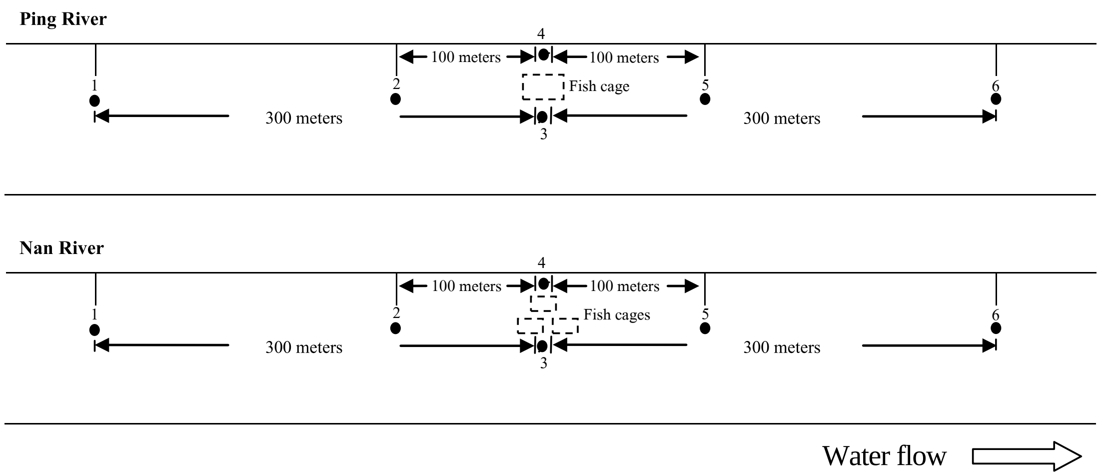

Fig. 2 The sampling site locations in lower Ping and Nan Rivers.

C. Determination of water quality and benthic fauna biodiversity

The water quality parameters at each site were measured in the field and in the laboratory as follows: BOD_5 ,NO_3^--N, NH_3-N, and PO_4^{3-}. All analysis was carried out according to the procedures by American Public Health Association [13]. Total organic matter, Total nitrogen and Total phosphorus in sediment were analyzed according to the methods described by Jackson [14], Breamner [15] and Anderson [16], respectively. While benthic fauna identification key written by Sangpradub and Boonsoong [17] was used to identify the collected specimens to the family level. The species diversity and the evenness of benthic fauna in all rivers were calculated from the Shannon-Wiener's Index and Pielou's evenness index respectively.

D. Statistical analysis

Nutrient wastes affected on water and sediment were evaluated with the one way analysis of variance (one - way ANOVA) and the post-hoc test and the Duncan test ($P<0.01$).

III. Results and Discussion

A summary of the Nutrient wastes in water of all study sites from the year 2012 to 2013 in the lower Ping and Nan Rivers are presented in Fig 3. In comparison with the surface water quality standard of Thailand, water quality of all study sites is medium clean, except for BOD_5 is shown without water quality standards of Thailand. The BOD_5 , nitrate-nitrogen (NO_3^-N), ammonia -nitrogen (NH_3-N), and orthophosphate (PO_4^{3-}) in the water within the culturing areas are increased significantly ($p<0.05$) when compared with the other areas. The results indicate that overall, the cage culturing seems to have the most impact on declining quality of water in the rivers. The nutrient concentrations of water in cage culture areas were higher than the average in studies of Mallasen *et al*. [18] but lower than those observed by Miod *et al*. [19]. While total organic and nutrients in sediment of all study sites are depicted in Fig 4. Levels of total organic matter, total nitrogen and total phosphorus in sediments were significantly ($p<0.05$) higher immediately adjacent to cages compared to reference sites.

Nan River

Ping River

Fig. 3 The BOD_5 and inorganic nutrients in water of the study by BOD_5, NO_3^--N, NH_3-N and PO^{3-}_4

Nan River

Ping River

Fig. 4 The total organic and inorganic nutrients in sediment of the study sites by total organic, total nitrogen and total phosphate

All nutrients in water were found at low levels, but it could be accumulated at high levels in the sediment. The accumulations of all nutrient wastes in sediments were not consistent with nutrient concentrations in the water. The reason was the greatly change of accumulation mechanisms by the composition and structure of sediment, water flow conditions and pollution duration could greatly change the accumulation mechanisms [20]. Although water analysis is useful in the assessment of river pollution, sediments can also serve as pollution indicators [21].

Three Phyla of benthic fauna (Mollusca, Arthropoda and Annelida) were recorded during the study period. The number of families is 8 and 14 families in the Nan River and Ping River, respectively. The results show that Atyidae are found at almost every site in every season, but Corixidae is the most abundant group. The numbers of family and specimen were lower at the farm sites (Fig 5).

Nan River

Ping River

Fig. 3 Comparison of family numbers ( ) and specimen numbers ( ) from cage culture areas in the lower Ping River and Nan River.

Moreover, the diversity indices and evenness indices of benthic fauna in the upstream, downstream and cage culture area are presented in Table I. The high diversity and evenness indices of benthic fauna are found in higher amounts in upstream and the lower in cage culture area. Species diversity indices show the tendency to indicate nutrient concentration in sediment and water, the water quality of control site still in good quality that suitable for normal growth of benthic faunas. Benthic fauna responds directly to the nutrient levels in water and sediment, which is similar to the findings of Karaca and Pulats [22] in Kesikkopru dam lake, Turkey.

TABLE I
SUMMARY OF DIVERSITY INDICES AND EVENNESS INDICES OF BENTHIC FAUNA FOR THE NILE TILAPIA FARMS, UPSTREAM AND DOWNSTREAM

Index	Nan River			Ping River		
	upstream	cage culture	downstream	upstream	cage culture	downstream
Diversity Index's Shannon-Wiener	0.64	0.29	0.79	1.12	0.53	1.03
Pielou's Evenness index	0.16	0.12	0.18	0.37	0.20	0.25

IV. CONCLUSION

Benthic fauna communities are important to river ecosystem in that they serve as a food supply to the most of fresh water organism. The Nile Tilapia cage culture was the most evident affected of water and sediment quality degradation. Nutrient wastes from cage culturing can cause a loss of abundance and diversity in benthic fauna communities. The distribution of the benthic fauna in the study sites was observed to be influenced by the nutrients in sediment and water.

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