

# Increasing Fish Production from Inland Water Bodies through Stock Enhancement: Experience of Thailand

Suchart Ingthamjitr and Boonsong Sricharoendham

Old-age proverbs in Thailand: “ในน้ำมีปลาในนามีข้าว” which means “in the waters are fish and in the field is rice” and “กินข้าวกินปลา” which means “eat fish eat rice” imply that fish and rice are very crucial for the daily nutrition of its people. These proverbs also reflect the abundance of resources in the country that are utilized to produce substantial quantities of fish and supply the demand for food fish of its people especially those living in the rural areas as well as for export. In the past, the people of Thailand had been utilizing the country’s natural inland waters for fisheries such as rivers, canals, swamps, lakes, and other small water bodies and producing large quantities of freshwater fishes. However, after these fishery habitats had been altered for the sake of progress and development, the fishery resources had been reported to be at the verge of depletion. Meanwhile, uncontrolled fishing activities have also led to overfishing that exacerbates the already depleted fishery resources. In an effort to address the concern on dwindling fishery resources, the Department of Fisheries (DOF) of Thailand embarked on stock enhancement programs which had been adopted throughout the country to revive the status of the country’s inland fishery resources. The approach used by DOF is aimed at enhancing the fisheries production from inland water bodies through fisheries law enforcement, habitat rehabilitation, and stocking programs. The experience of DOF and the lessons learned from such efforts are revealed in this article as reported by the authors during the Symposium on Strategy for Fisheries Resources Enhancement in the Southeast Asian Region organized by SEAFDEC in Thailand in July 2015.

## Inland Capture Fisheries in Thailand

The development of inland capture fisheries in Thailand has played very significant role in the country’s national economies, by ensuring people’s food security and stable nutrition, creating livelihoods for rural communities, enhancing local knowledge in sustainable capture fisheries, and increasing the incomes of small-scale fishers. Thailand has been endowed with abundant inland water resources that

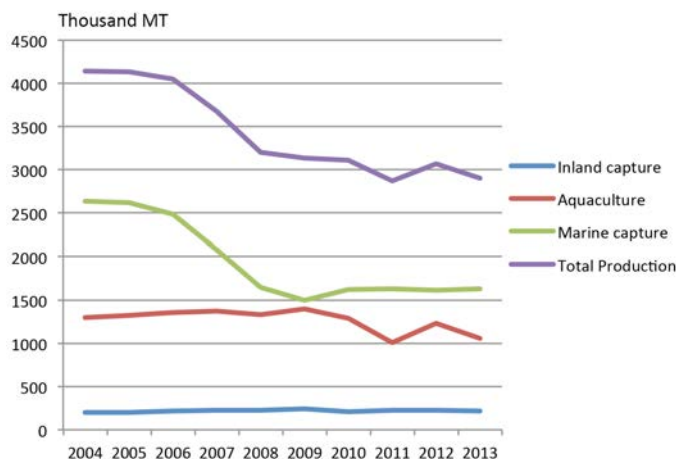


Fig. 1. Trend of fisheries production of Thailand during the ten-year period from 2004 to 2013

Sources: SEAFDEC (2010); SEAFDEC (2015)

its people could utilize not only for their daily life activities but also for them to exploit the fishery resources. Pongsri *et al.* (2015) reported that Thailand has 25 river basins which cover a total area of about 511,300 km<sup>2</sup>; 12,851,980 ha of flood plains; 645,350 ha of dams and reservoirs; and 965,730 ha of other water bodies that could be tapped to improve the country’s total fisheries production from inland capture fisheries. Ingthamjitr and Boonsong (2016) also reported that large areas of swamps and lakes are found in 36 sites throughout the country, and that small water bodies are abundant in more than 14,000 locations in the country.

Although advanced fish culture technologies led to increased production from aquaculture, inland capture fisheries although growing slowly, has always sustained its role in providing cheap protein for the rural poor in remote areas. However, it has become alarming that the total fisheries production of Thailand has been decreasing during the past ten years or so (Fig. 1). Specifically, the country’s production from marine capture fisheries had decreased sharply although aquaculture production has been increasing substantially (Table 1). Nevertheless, there is much potential for increased production from inland capture fisheries which has experienced minimal increases during the past ten years, considering the country’s

Table 1. Total fisheries production of Thailand (in thousand metric tons (MT)), 2004-2013

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Inland capture	199.6	198.8	214.0	225.6	228.6	245.5	209.8	228.5	222.5	213.7
Aquaculture	1,301.5	1,318.4	1,353.0	1,370.4	1,330.8	1,396.0	1,286.1	1,007.9	1,233.8	1,056.8
Marine capture	2,636.0	2,615.6	2,484.8	2,079.4	1,644.8	1,496.2	1,617.4	1,633.7	1,612.1	1,630.1
<b>Total Production</b>	<b>4,137.1</b>	<b>4,132.8</b>	<b>4,051.8</b>	<b>3,675.4</b>	<b>3,204.2</b>	<b>3,137.7</b>	<b>3,113.3</b>	<b>2,870.1</b>	<b>3,068.4</b>	<b>2,900.6</b>

Sources: SEAFDEC (2010); SEAFDEC (2015)

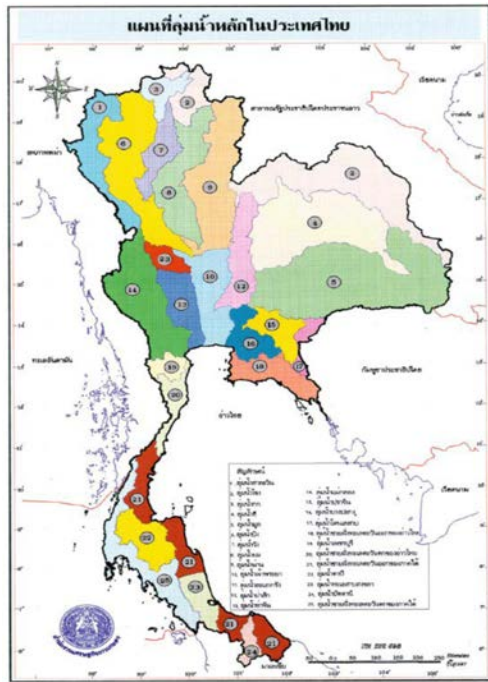


Fig. 2. Map of Thailand showing the locations where stock enhancement activities are being carried out by DOF

vast inland water resources, which could be tapped for sustainable exploitation.

Efforts have therefore been exerted by the Government of Thailand to increase production from inland water bodies through the implementation of stock enhancement programs spearheaded by the Department of Fisheries (DOF) of Thailand, and implemented throughout the country as shown in Fig. 2. The stock enhancement programs focus on three strategies, namely: law enforcement, habitat rehabilitation, and stocking or restocking.

### Issues and Concerns

While the country's abundant fishery resources had in the past, adequately supplied the demand for food fish of Thailand's rural populace, infrastructure developments seem to have impacted on the sustainability of inland fish habitats and resources. It is alarming that with such developments, Thailand's fish supply might not be able to provide the nutrition that its people need especially those in remote rural areas, considering that the country's population had increased from 25 million to 65 million during the last decade. Increasing the production from inland capture is however confronted with many challenges including habitat alteration, overfishing, genetic alteration, interpretation of the national fisheries law, and climate change. Unsustainable production from inland capture fisheries would adversely impact the rural poor who rely on the natural aquatic resources for their livelihoods. Therefore, the potentials of inland fishery resources for development should not be overlooked as these could supply the food fish required by the growing population.

Nonetheless, the factors that influence the sustainable production from inland fisheries should be considered in planning and policy formulations, in order to sustain and/or enhance the production, e.g. appropriate management for the complex interaction of physical, chemical and biological conditions and fishing practices.

These three approaches generally adopted for sustainable fisheries management should therefore be considered, namely: compliance with fisheries regulations such as gear and size restrictions, seasonal closures, limitation on entry, paying of tax levies and property rights; habitat rehabilitation to increase and/or recover available habitats and/or access to key habitats for at least some life stages of a target species which could be accomplished by improving connectivity in rivers, e.g. construction of fish passage, reconstruction of fish habitats, installation of artificial habitats/reefs; and stock enhancement.

Pawaphutanon (1988) reported that stock enhancement is one of the most successful techniques for fisheries management, where stock enhancement could also include not only the aspect of manipulating fish stocks by adding some materials of desired species but also stocking or restocking water bodies to improve their productivity and conserve biodiversity. In the Southeast Asian region, stock enhancement of aquatic species for restocking is generally associated with traditional and religious ceremonies such as merit-making on birthdays, new-year celebrations and many other special occasions. Nevertheless, aquatic animal restocking could be promoted more widely and intensively if fish hatcheries are able to produce considerable volumes of seed stocks of various aquatic species. Furthermore, stock enhancement would only be effective only if the related challenges and concerns are addressed and properly managed.

### Stock Enhancement Program of Thailand

In carrying out the activities under the country's stock enhancement program, DOF has been collaborating with various stakeholders including the Tambon (Local) Administrative Organizations (TAOs), provincial fisheries stations and offices, the Electricity Generating Authority of Thailand (EGAT), private sector involved in inland fisheries development and other government agencies that have also been doing independent stock enhancement programs. Together with the stock enhancement program, DOF has also been promoting various projects to demonstrate the sustainable utilization and management of the fishery resources in inland water bodies, e.g. Village Fisheries Project, School Fisheries Project, *Bamrung Phan Pla Pracha-arsa* Project (Participatory Voluntary Fish Stock Enhancement Project), Small Water Bodies Rehabilitation for Fisheries Project, Large Water Bodies Fisheries Development Project, Seed Production for Stocking Project. In order to support the massive requirements for seeds, breeding activities in several

**Table 2.** Number of seed stocks released for stocking several inland water bodies of Thailand (2006-2014\*)

Year	Freshwater Fishes	Giant Freshwater Prawn	Frog	Turtle	Total
2006	1,227,566,543	309,042,080	1,500	85	1,536,610,208
2007	1,152,855,640	295,722,850	115,740	291	1,448,694,521
2008	1,117,229,393	340,943,455	100,000	308	1,458,273,156
2009	1,111,075,907	356,846,990	129,500	245	1,468,052,642
2010	1,019,923,981	336,838,200	261,000	179	1,357,023,360
2011	1,030,291,348	325,604,747	7,414,647	113	1,363,310,855
2012	1,004,187,891	327,280,910	5,211,050	233	1,336,690,084
2013	994,347,245	330,764,000	8,681,450	392	1,333,793,087
2014*	713,126,794	260,634,150	6,147,000	409	979,908,353
<b>Total</b>	<b>9,370,604,742</b>	<b>2,883,677,382</b>	<b>28,061,887</b>	<b>2,255</b>	<b>12,282,356,266</b>

\*number is for 10-month stocking operations only

fisheries stations all over the country have been intensified. In fact, throughout the years, the annual stocking program of DOF recorded that billions of seeds had been released for stocking in inland water bodies. As shown in **Table 2**, more than 1,333 million seeds of 59 aquatic species had been released in 2013, which include 53 freshwater fish species, six species of frogs, turtles, and giant freshwater prawn.

The progress of the stock enhancement programs had been closely followed up by DOF while the impacts of the programs have been assessed since 1985. Results have indicated overall positive impacts on the sustainable development of the country's inland fisheries. This is considering that the stock enhancement programs being promoted by DOF cover not only restocking inland water bodies but also habitat rehabilitation and law enforcement. Stock enhancement can be carried out using a number of approaches depending on conditions of particular water bodies. Based on the experienced of Thailand, law enforcement on illegal fishing has been successfully promoted in the Yom River Basin, while stocking large number of the giant freshwater prawn has been successful at Pak Mun Dam and community-based fisheries management has been effective at Ubol Ratana Reservoir. These stock enhancement achievements, however, had been greatly influenced by the active participation of local communities that comprise the core aspect in fisheries management.

## Lessons Learnt from the Stock Enhancement Program of Thailand

### Combating illegal fishing in Yom River Basin

Yom River (**Fig. 3**) originates from the mountain range in the north of Thailand and flows through agricultural and communities' plain areas in the lower northern part of the country. Yom River is a main tributary of Nan River that flows into the Chao Phraya River and is the only main river which has no dam impoundments. Since flood always occurs at the



**Fig. 3.** Yom River in Thailand

lower part of the Basin during monsoonal season, flood plain is created covering an area of 500,000-600,000 rai (80,000-96,000 ha) which serves as significant spawning and nursing grounds for various aquatic species. However, it has been observed that illegal fishing gears had been operating in the Basin, e.g. large stationary bag net, small stationary bag net, push net, and giant lift net, and such operations had been increasing during the past years.

These destructive fishing gear operations result not only in decreasing fish abundance but also creating unfair exploitation of the fishery resources that increased the conflicts among the resource users. Through its project implemented in 2008-2011, DOF managed to reduce the number of destructive fishing gears in the Lower Yom River Basin. Stock enhancement was initiated on the first year of the project with the involvement of government agencies and enhanced participation of local administration agencies, communities and fishers. The project was mainly aimed at reducing fishing effort while research was conducted to assess the stocks of the fishery resources and catch production of different types of fishing gears operating in the Basin (**Fig. 4**), i.e. 123 units of large and small stationary bag nets, 40 units of giant push nets, 30 units of giant lift nets, 22 units of small bag nets, 25 units of bamboo fence installations, and 8 electro-fishing equipment.





Fig. 4. Samples of illegal structures in Yom River: giant lift net (above) and bush-park (below)

Prior to the assessment, the project focused on reduction of fishing effort based on an agreement with fishers to reduce the use of large stationary bag nets by 25% during 3-12 December 2008. The results in 2009 showed that the fisheries production increased by 84,000 kg which is equivalent to 12.20 million fish fingerlings that were saved from the 25% reduction of fishing effort of the large stationary bag nets (Table 3). The value of the increased production could be about 2.55 million Baht at conservative level while the maximum value could reach up to 12 million Baht. From 2009 to 2011, the project tried to reduce the number of illegal fishing gear operations by training fishers on participatory fisheries management, developing collaborative fisheries management plan with the participation of government agencies and fisheries communities, strict enforcement of regulations and tougher punishment, buying-back of large stationary bag nets, providing support in construction of fingerlings and cage culture facilities to those volunteering to stop the use of large stationary bag nets, and developing the fish habitats for fish broodstock conservation purposes.

### Stocking of giant freshwater prawn in Pak Mun Dam

Located in Ubon Ratchathani Province, Pak Mun Dam was constructed in 1994 to impound the Lower Mun River stretch. The dam is located about 4-5 km away from the confluence of the Mun and Mekong Rivers. An apparent decrease in fish abundance was observed due to the obstruction of fish migration of aquatic species from the Mekong River to the Mun River (Fig. 5).

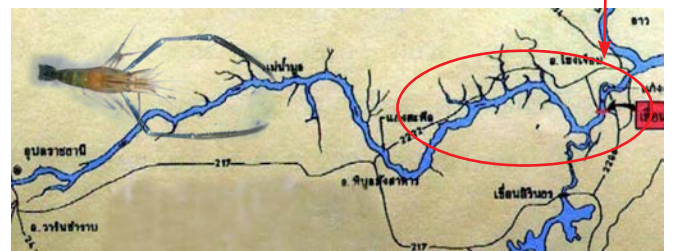
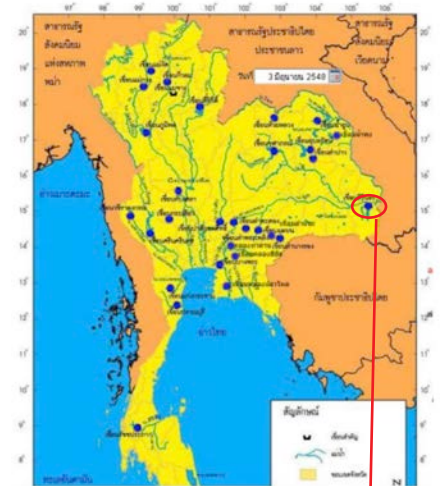


Fig. 5. Pak Mun Dam restocked with giant freshwater prawn and other economically important fish species

Fish ladder was installed at Pak Mun Dam as an attempt to facilitate fish migration but the design appeared inefficient. For years, local fishers who had been encountering the negative impacts from the dam-impoundment through the communities' Poor Association, asked the Government that their concerns on the decreasing fishery resources should be addressed. As a solution, the Government announced a compromised solution in 2003 by regulating the dam operations, *i.e.* closing for 8 months to generate electricity and opening for 4 months

Table 3. Preliminary results of the stock enhancement program in Yom River

Project Operation Period	Results				
	Stationary Bag Net	Small Bag Net	Purse Net	Giant Lift Nets	Electro-fishing
2008-2009	<ul style="list-style-type: none"> <li>• 25% reduction in fishing effort of giant stationary bag nets</li> <li>• 12.2 million fingerlings survived and increased in natural stocks</li> </ul>				
2009-2010					
Existing number in 2008	123	22	40	30	8
Target reduction (%)	73%	50%	50%	25%	95%
Target reduction (number)	32	11	20	22	8
2011 (total number left)	0	0	35	27	0

**Table 4.** Stocking of giant freshwater prawn in Pak Mun Dam, Ubon Ratchathani Province, Thailand

Year	Number stocked (million/year)	Cost (USD)	Catch/Landing (kg)	Value of Catch (USD)	Recapture (%)	Return of Investment
1995-1998	5	19,110	11,675	113,827	1.0%	5.96
2003-2006	40	182,000	90,108	1,062,000	2.4%	5.84

during fish migration period to allow the migratory fish to enter Mun River from the Mekong River. The Government also assigned EGAT in collaboration with DOF to enhance the fisheries production at the lower Mun River stretch by stocking 50 million fingerlings or juveniles of aquatic species annually for 5 years from 2003 until 2007. In response, DOF stocked 40 million giant freshwater prawns and another 10 million of economically important freshwater fishes annually during that particular period. Post stock assessment revealed an apparent increase in production, especially the production of giant freshwater prawn with recapture rate of about 2.4% (Table 4). Moreover, prawn production accounted for more than 90 metric tons during the 8-month culture period, valued at 35 million Baht with return of investment of about 584%.

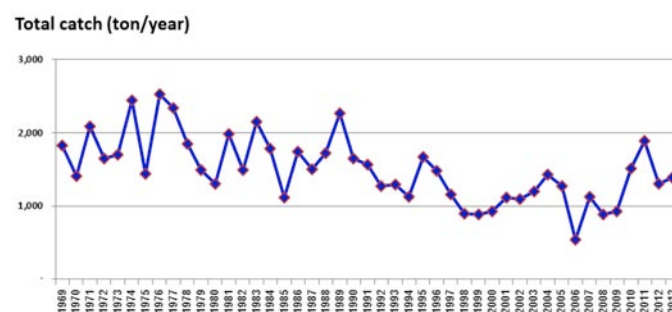
### Community-based fisheries management in Ubol Ratana Reservoir

Located in Khon Kaen Province of Thailand, Ubol Ratana Reservoir is a multi-purpose dam constructed in 1966 and was the first hydro-electric power project developed in the north-eastern part of Thailand (Fig. 6). The annual fish production in Ubol Ratana Reservoir had showed a declining trend over the past 40 years. Specifically, the annual catch production decreased after 12 years of operation of the impoundment. The CPUE (kg/boat/day) in the wet season is less than that of the dry season. Two measures were employed for fisheries management to mitigate the situation, *i.e.* closed season (16 May -15 September) and mesh size limitation (not less than 2.5 cm). However, trend of the catch continued to decline year by year, so that in 2009, the catch was only about 21.4 kg/ha/yr and with very high fishing effort. More than 5,000 fishing households in 101 villages are located around the Reservoir.

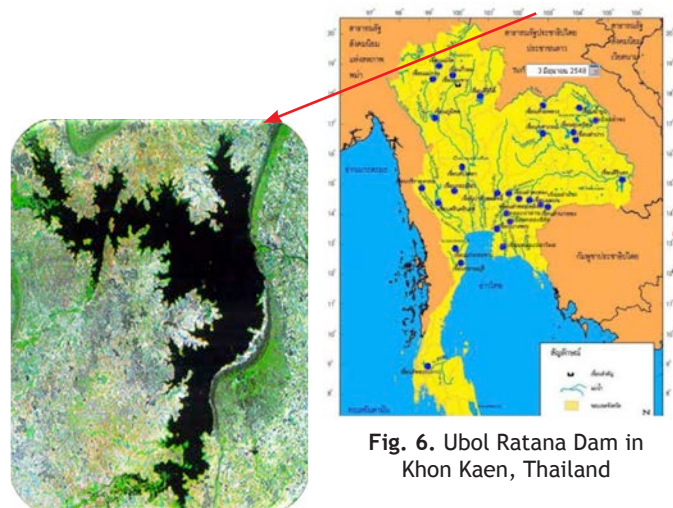
In an effort to mitigate the issue, DOF introduced Community-Based Fisheries Management in the Ubol Ratana Reservoir since 2009 to improve the fish habitats with the involvement of local communities and government agencies.

The project was intended to encourage relevant stakeholders to participate in the fisheries management of the Reservoir, especially the Tambon Administrative Organizations (TAOs), resource users and government agencies, by co-managing the Reservoir's fishery resources. The 3-year project (2009-2011) commenced by organizing a stakeholders' meeting for the development of the project management plan with fisheries resources enhancement as the ultimate goal.

During 2010–2011, DOF established 30 Fish Conservation Zones (1 habitat/village) in the Reservoir to increase the fish sanctuary area for broodstock enhancement. Together with fish habitats construction, restocking was introduced to enhance the fish production. Since then, fish production had markedly increased in 2010 and 2011 as results of the new fisheries management strategies introduced (Fig. 7).



**Fig. 7.** Trend of fish production in Ubol Ratana Dam, Khon Kaen, Thailand



**Fig. 6.** Ubol Ratana Dam in Khon Kaen, Thailand

### Conclusion

In summary, it could be gleaned from the stock enhancement programs of Thailand that changes in production from inland capture fisheries because of various reasons could have adverse impacts on the livelihoods and food supply of the rural communities especially the rural poor. Stock enhancement is therefore necessary to maintain the productivity of inland water bodies, in order that the rural poor would have something to rely on. However, the strategies to enhance fish stocks would depend largely on the conditions of particular inland water bodies, hence the need to conduct environmental

studies the results of which would serve as scientific evidence for stock enhancement activities. Moreover, participatory approach through co-management should be promoted as it is the key element in successful stock enhancement programs.

## Recommendations and Way Forward

Wild capture fisheries could tremendously impact on the livelihoods of peoples especially the rural poor in remote areas near river basins. Basin-wide fisheries management has been promoted worldwide and among the strategies promoted under such management is fisheries stock enhancement, which is always taken as a top priority. Basin-wide fisheries management include water management as well as management of the other concerned sectors and stock enhancement, and is also sometimes known as integrated water resources management (IWRM). For effective IWRM, data and information together with knowledge on hydrology, aquatic ecology and fish biology associated with each type of water, are crucial in undertaking appropriate planning and implementing such plans. In this regard, human resource and institutional capacity building is necessary, particularly enhancing the capability of stakeholders in planning and implementing basin-wide fisheries management. Fisheries law and regulations to control illegal fishing is necessary but law enforcement alone does not function completely due to limitation of budget and number of officials required. Therefore, fisheries co-management with participation of local communities in fishery resources management is the best option, as it has shown its effectiveness and efficiency in many pilot areas. In addition, compliance with laws and regulations and effective enforcement are essential factors for successful fish stock enhancement.

As noticed worldwide, fish habitats and species diversity of aquatic animals, the essential basic elements for fisheries production, have been deteriorated by a number of influential factors including basin development projects and natural phenomenon like climate change. Holistic approach of basin development through IWRM is a promising strategy in order to maintain and/or increase fisheries production from inland

water related activities and optimize their potentials. Stocking and/or restocking aquatic species will continue its crucial role in stock enhancement but focus on the stocking or restocking of indigenous aquatic species is highly recommended

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### About the Authors

**Dr. Suchart Ingthamjitr** is Professor from the Faculty of Fisheries, Kasetsart University, Kampaengsaen Campus, Nakhon Pathom, Thailand (email: [sucharting@gmail.com](mailto:sucharting@gmail.com)).

**Mr. Boonsong Sricharoendham** is from the Department of Fisheries, Ministry of Agriculture and Cooperatives, Bangkok, Thailand.