

## Inland Fisheries Resource Enhancement and Conservation Practices in Myanmar

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### **Abstract**

Myanmar has impressive freshwater capture fisheries. Inland freshwater bodies cover 8.1 million ha of which 1.3 million ha are permanent while the rest are seasonally inundated floodplains. There are repeated references to the crucial importance of fish and fish products in the nutrition of the Myanmar people. Over the past few decades, inland fisheries resources have increased pressure from overfishing, use of destructive fishing gear/methods, pollution and environment changes. In order to make a sustainable inland capture fisheries and conservation of aquatic biodiversity as well as nutritional security and improved rural livelihoods, fisheries resource enhancement and conservation measures have long been adopted in Myanmar since 1967, initiated through a seed replenishment program in natural waters, such rivers, lake, dams, even rice fields, etc. However, the institutional, policy, legislative and financial environments under which enhancement and capture fisheries regimes exist are not conducive to the interests of the fishers. Strong tools for valuation of ecosystem goods and services, enabling governance arrangements and estimation of environmental flows are needed. Fishing communities need to be organized into strong co-management/participatory/community regimes in order to ensure that all stakeholders take part in decision-making process and the benefits accrued are shared equitably by all.

**Keywords:** inland fisheries, seed replenishment program, conservation

### **Introduction**

Myanmar is divided into seven major topographical regions, namely; the Northern Hills, Western Hills, Shan Plateau, Central Belt, Lower Myanmar Delta, Rakhine Coastal Region and the Tanintharyi Coastal Strip. Overall, Myanmar possesses a wide range of inland water resources, the major resources being associated with the three river systems, Ayeyarwaddy (2,170 km long), Chindwin (960 km) and Sittaung, and their vast flood plains and deltaic areas. In addition, there

are three large natural lakes: Lake Inle in Shan Plateau, Indawgyi in Kachin State and Indaw in Katha with approximate water areas of 15,500 ha, 12,000 ha and 2,850 ha, respectively. Fish is a very important component of the diet of the people of Myanmar, with an estimated consumption of 43 kg/person/year in 2008-2009, which is one of the highest in the region. Fish is consumed fresh and in various processed forms apart from fermented fish, being a staple part of the daily diet of most people.

All inland waters, except reservoirs, are utilized for inland fish production. However, most remains artisanal. Stock enhancement practices of varying forms were employed since 1967 to increase inland fish production, which currently stands at around 899,430 tonnes. The inland waters of Myanmar also possess a high biological diversity, particularly of finfish. For example, the fish fauna of inland natural lakes exhibits a high degree of endemism, and actions have been launched under the National Fisheries Development Plan and National Resource Management Policy to conserve the biodiversity of inland waters. This review attempts to address the stock enhancement practices in inland waters of Myanmar and the actions taken to conserve biodiversity in the inland waters.

### **Current status of inland fisheries in Myanmar**

In 2012-2013, the total fish production in Myanmar was around 4,716 thousand metric tonnes of which 1,246 thousand metric tonnes is from inland fish and accounting for approximately 26.4% of the total (Table 1). Over the years, the

contribution of inland fish production to the total, as in the case of aquaculture, has gradually increased (Table 1) and consequently become an important means of food fish supply to the population. These increases in fish production have been achieved through the introduction of several measures, one of which is stock enhancement and other measures relevant to biodiversity conservation. The main forms of inland fisheries in Myanmar are open water fisheries and leasable fisheries. Inland fisheries are all regulated by provisions in the Freshwater Fisheries Law (1991).

### **Leasable fisheries**

There are currently 3,717 leasable fisheries in Myanmar of which 3,409 are still exploitable and the licenses are issued by Department of Fisheries (DOF), Myanmar in 2012-2013. Leasable fisheries are key fishing grounds on floodplains which are cordoned off by barrage fences and fished using various methods. The peak fishing season involves capturing fishes migrating out of the floodplain as the water level recedes. This is referred to locally as the “Inn” fishery in Myanmar language. The

Table 1. Trends in fisheries production (in x 1000 tonnes) from 2003-2004 to 2012-2013 in Myanmar.

Year	Total	Culture	Leasable	Open	Marine
2003-2004	1,986.96	400.36	122.28	331.98	1,132.34
2004-2005	2,217.47	485.22	136.79	366.75	1,228.71
2005-2006	2,581.78	574.99	152.69	478.43	1,375.67
2006-2007	2,859.86	616.35	170.10	548.09	1,525.32
2007-2008	3,193.92	687.67	191.05	625.44	1,689.76
2008-2009	3,542.19	775.25	209.72	689.71	1,867.51
2009-2010	3,921.97	858.76	237.46	764.97	2,060.78
2010-2011	4,163.46	830.48	250.04	913.12	2,169.82
2011-2012	4,478.21	898.96	282.64	963.82	2,332.79
2012-2013	4,716.20	929.36	290.00	1,012.97	2,483.87

Note that leasable and open fisheries are the main forms of inland fisheries.

leases are auctioned yearly, but DOF has extended the lease period up to nine years to promote improved long-term management (3 years x 3 lease terms). The management systems of leasable fisheries are normally handled by the DOF, mainly through the auctions which are conducted in conjunction with townships and regional authorities.

In this leasable fishery, the lessee has the obligation and the right to exploit all the fish resources, using any form of gear. The lessee is obliged to adopt stock enhancement practices, often provided by the DOF. The peak fishing season is August to October, when the flood waters recede. The production from leasable fisheries have increased, albeit gradually, through the year. Leasable fisheries could vary in intensity, from the management and production view point, some being treated in a manner similar to large fish ponds or small reservoirs, and taking the form of culture-based fisheries. For example, the leasable fishery of Kan Daw Gyi (300 ha; permanent water body in Mandalay Division) has adopted an exclusive stocking (2-3 million fingerlings of major carps per year) and recapture 500 to 600 thousand full grown fish every year, averaging approximately 4,200 kg/ha/yr (FAO-NACA, 2003). In contrast, the leasable fishery of Thaug-Tha-Man (600 ha; in Mandalay township), 60% of the yield is of the exotic Nile tilapia *Oreochromis niloticus* and the rest being of stocked species such as rohu, mrigal, etc., with an overall average yield of 2,800 kg/ha/yr (FAO-NACA, 2003).

### **Open water fisheries**

Open water fisheries in Myanmar refer to all forms of inland fisheries, except the leasable ones and reservoirs. Almost all

open water fisheries in inland waters are artisanal, and fishing is often conducted using non-motorized, traditional wooden crafts. The permit or right to fish license is issued by DOF, Myanmar. All fishing gears require a respective implementation license. There is a set fee for most licensees. Some of the larger gears such as “stow net” set in rivers is allocated by tender system. Fees are variable between locations according to the production levels and capacities. License fees for small gears are low. All gear licensees are expected to report the daily catches to DOF. In some of the lakes, such as in Inle Lake, the gears that are used are unique to that body of water; for instance the use of a conical bamboo device surrounded by a moveable and maneuverable small-meshed net is typically used to catch fish by driving it to the bottom and lifting it gradually while closing the net.

### ***Social dimensions of inland fisheries in Myanmar***

The great bulk of open water fisheries in Myanmar are artisanal and subjected to a licensing system for use of any form of gear. However, there is an increasing tendency to auction the fishing rights of selected areas of lakes and such open waters, in a manner comparable to that of lease fisheries of flood plain areas. In general, the leasable fisheries, though in existence for over five decades, tend to marginalize the use of the water bodies by the community, as often the more productive areas being leased are held on an almost continuous basis by the richer more powerful segments of the society. This situation will be further exacerbated by the new plans to increase the lease period up to nine years. On the other hand, a long-term lease will induce the leasees to improve the production of the

water bodies, adhere to more productive measures of stock enhancement, encourage more people be engaged in day-to-day management, harvesting, marketing and other activities.

### **Biodiversity of inland waters**

The biodiversity aspects of inland waters in Myanmar is best documented with respect of its three large natural lakes, Inle, Indawgyi and Indaw. Perhaps, the best documentation among these being that of Lake Inle. Early studies (Annandale, 1917) reported 23 to 42 species are found in Lake Inle and its inflows and outflows, which included two endemic cyprinid genera, *Inlecypris* and *Sawbwa*. More recent data indicated that there are 36 species of which 16 are endemic to the Lake (Table 2), as well as seven species have been introduced into it. The most extensive survey of the fishes to date in Lake Indawgyi is by Prashad and Mukerji (1929) in which 43 finfish species were recorded. They considered that three of these, *Barbus sewelli* (redescribed as *Puntius orphoides*), *Burbas myitkyinae* (redescribed as *Hypsibarbus myitkyinae* and *Indostomus paradoxus* were endemic to the lake. However, all three of these species have also been found in other localities. A total of 67 species were recorded in the Indawgyi Lake basin when inflowing streams and marshy areas were included. The endemic species found in the lake (after further surveys and taxonomy changes) was the catfish *Aky prashadi*. However, there are several endemics that Prashad and Mukerjin recorded from pools and streams in the Indawgyi lake basin: *Gudusia variegata* (Clupeidae) which is mainly found in rivers in Myanmar, *Esomus altus* (Cyprinidae) and *Salmostoma sladoni* (Cyprinidae).

### **Stock enhancement practices of inland waters in Myanmar**

Stock enhancement of inland waters has been conducted since 1967, some of which are obligatory for certain fisheries. For example, in leasable fisheries, the lessees are obliged to stock seeds as recommended by the government. However, these are often provided by the government, consisting of both suitable indigenous species to augment the natural recruitment and alien species which are fast growing and capable of utilizing the food resources in the leased area. The latter species primarily consist of Indian and Chinese major carps, and in specific instances even tilapia (FAO-NACA, 2003). Stock enhancement of rivers is regularly conducted using mainly rohu, *Labeo rohita*, fingerlings of 7 to 10 cm in length. Such enhancement is conducted on an annual basis, and in certain instances, required fingerlings are provided at a subsidized price to private owners of water bodies. The water bodies where the activities are mostly implemented are the main rivers viz: Ayeyarwaddy, Chindwin and some other river locations. In Kachin State, stock enhancement is mainly conducted in reservoirs and lakes. The fingerling requirements for stock enhancement purposes are produced in 27 government-owned hatcheries spread across the country in different water sheds (Table 3). The fish release program is also linked to a program of replenishment of broodstock of the major cultured species, in particular rohu and mrigal, *Cirrhinus cirrhosus*. In addition, other species are also used for stock enhancement purposes of open waters in Myanmar, these being *Cyprinus carpio*, *Catla catla*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, *Tilapia*

Table 2. Fish species list of Inle Lake, Myanmar.

Non-endemics	Endemics	Introduced or Status uncertain
<i>Notopterus notopterus</i>	<i>Cyprinus carpio intha</i>	<i>Colisa labiosa</i>
<i>Clarias batrathus</i>	<i>Neolissochilus nigrovittatus</i>	<i>Parambassis</i> sp.
<i>Monopterusuchia</i>	<i>Cirrhinus lu</i>	<i>Parambassis lala</i>
<i>Monopterus albus</i>	<i>Physoschistura brunneana</i>	<i>Labeo rohita</i>
<i>Channa striata</i>	<i>Physoschistura shanensis</i>	<i>Ctenopharyngodon idellus</i>
<i>Ophicephalus butleri</i>	<i>Yunnanilus brevis</i>	<i>Glossogobius</i> sp.
<i>Chaudhuria caudate</i>	<i>Sawbwa resplendens</i>	<i>Trichogaster pectoralis</i>
<i>Lepidocephalichthys berdmorei</i>	<i>Microrasbora rubescens</i>	<i>Clarias garipinus</i>
<i>Acanthocobitis botia</i>	<i>Microrasbora erythromicron</i>	
<i>Physoschistura rivulicola</i>	<i>Barilius auropurpureus</i>	
<i>Puntius stoliczcanus</i>	<i>Danio erythromicron</i>	
<i>Amphipnousuchia</i>	<i>Inlecypris auropurpurea</i>	
<i>Lepidocephalus berdmorei</i>	<i>Poropuntius schanicus</i>	
	<i>Poropuntius</i> sp.	
	<i>Percocypris compressiformis</i>	
	<i>Gerra gravely</i>	
	<i>Silurus burmanensis</i>	
	<i>Channa harcourtbutleri</i>	
	<i>Macrognathus caudicellatus</i>	
	<i>Nemachilus brevis</i>	
	<i>Nemachilus brunncanus</i>	
	<i>Discognathus lamta</i>	
	<i>Cirrhina latia</i>	
	<i>Barbus sarana caudimarginatus</i>	
	<i>Barbus scnanicus</i>	
	<i>Barbus stedmanensis</i>	

spp., *Puntius* spp., *Pangasius hypothalamus*, etc. Overall, large numbers of seeds have been stocked over the years to enhance fisheries of open inland waters in Myanmar (Table 4). In areas where seed is released, such as along the Ayeyarwaddy River and associated floodplains, there is an

agreement that fishers should in turn provide to the hatcheries certain number of potential broodstock candidates of major stocked species such as rohu, mrigal, etc., to partially replace poorly performing broodstocks with frequency of replacement ranging from every one to five years

Table 3. Finfish hatcheries in states and divisions in Myanmar and the production of seed stock used for stock enhancement in 2012-2013.

Location of hatcheries	Numbers	Production (Millions)
Yangon division	3	1,487.75
Bago division	3	595.49
Mandalay division	5	2,327.25
Ayeyarwaddy division	5	954.14
Magwe division	2	22.82
Kachin state	2	71.00
Sagaing division	3	187.07
Mon state	1	27.98
Shan state	2	19.40
Kayin state	1	6.04

depending on the hatcheries (Aung *et al.*, 2010). Often, brood stocks of seven or more years old become less productive and are discarded, and the younger broodstocks are recruited periodically based on this practice. The practices described above, however, have been undertaken without detailed understanding of the genetic structure of the species and the impacts of the practices on wild and cultured stocks remain unknown. This process, a practical experience and welcome strategy, though open to science-based improvement, has avoided inbreeding of stocks and maintenance of genetic diversity to a very large degree (Aung *et al.*, 2010).

### **Other enhancement practices**

In addition to stock enhancement through the release of seed stocks there are other measures that are adopted for stock enhancement of inland waters. The main such measure is the implementation of closed seasons. All open fisheries are generally closed during June, July and August to permit spawning and recruitment. However, in a specific

geographic area, closure could be different during the above period. This means that a closed season can be enforced in selected areas during spawning periods, through the prohibition of fishing in certain areas. These closed season provisions are enacted under the Fisheries Law of 1991. The Freshwater Fisheries Law also prohibits some types of destructive fishing and activities which may have adverse impacts on fish stocks. Specifically, use of explosives and poisons are banned all together as well as some unspecified methods and equipment. Within a fishing area, it is prohibited to cut undergrowth or light a fire, to alter the natural flow of water or to cause pollution. The Law also states that “No one shall cultivate agricultural crops within the boundary of a fisheries creek.”

### **Impacts of major enhancement and conservation activities**

Impact assessment studies on stock enhancement have not been undertaken in Myanmar. However, at least so far, there was no evidence of negative impacts on the natural fish populations because of stock

Table 4. The number of seeds stocked (in millions) in different inland waters of Myanmar, 2003-2013 (Source: DOF Myanmar).

Years	Numbers of seeds stocked					Total
	Dams		Natural rivers and streams	Ponds	Rice-Fish culture	
	Number of dams	Number of seeds stocked				
2003-2004	105	1,100	600	430	33	2,163
2004-2005	164	1,087	633	598	48	2,366
2005-2006	218	1,178	562	255	62	2,057
2006-2007	228	860	444	60	65	1,429
2007-2008	219	906	804	32	70	1,812
2008-2009	228	1,032	917	34	71	2,054
2009-2010	240	1,229	824	25	80	2,158
2010-2011	249	1,880	673	27	81	2,661
2011-2012	236	1,185	1,182	228	89	2,684
2012-2013	197	397	538	204	74	1,213

replenishment programs in the nation. On the positive side, there are indications of higher catch rates by artisanal fishers in the villages near rivers. For instance in Inle Lake, grass carp are released on a regular basis to prevent the spread of aquatic macrophytes, which in turn also serve as feed for grass carp pond culture in the surrounding areas.

### **Biodiversity conservation**

Myanmar has been actively engaged in biodiversity conservation practices in inland waters. The leasable fisheries in flood plain areas are productive. In the same manner, these also are crucial to biodiversity conservation as these habitats, being the nursery grounds for maintaining the viable populations of indigenous wild stocks. The government realized the importance of some leasable fisheries to biodiversity conservation and has promulgated protective measures for

these fisheries and transformed these areas to fish sanctuaries. Myanmar remains one of the few, if not the only country, in the region that does not have a reservoir fishery. This decision is based on the fact that development of reservoir fisheries will impact the reservoir catchment biodiversity, the catchments being under the jurisdiction of the Ministry of Agriculture and Irrigation. Myanmar also has been active regarding introductions and the movement and use of alien species in fishery and aquaculture activities. For example, there is a complete ban on the use of the African catfish *Clarias gariepinus* including its use in aquaculture and even its sale in popular markets. Areas in selected waters are being designated as conservation areas and the habitats thereof are often improved to provide favorable nursery and spawning grounds for selected indigenous species. In addition specific notifications are enforced for conservation purposes. For example:

**Notification 2/92**

This notification prohibits the catching or keeping in captivity of spawners, breeders, and fingerlings of freshwater fishes in the months of May, June, July and August without permission of the Director General of DOF.

**Notification 2/95 and 3/95**

It prohibits the catching, for any purpose, of spawners and fingerlings of the freshwater prawn *Macrobrachium rosenbergii*, and *M. malcolmsonii* in the months of May, June and July, unless permitted by the Director General of DOF, Myanmar. If caught accidentally, these should be released immediately.

**Constraints and problems**

The main constraints encountered in stock enhancement programs in Myanmar are the limitations in seed stock availability, and particularly for stocking in remote places which are far from the hatcheries. These constraints are also associated with the cost of transportation and materials needed for effective transportation. In addition, hatcheries may not be able to function at full capacity, particularly when electricity supply is interrupted. The situation with regard to fry and fingerling availability is further exacerbated by the demand of the aquaculture sector, which perhaps at present is witnessing one of the fastest growth rates in the region. Although not a direct constraint, it is important to improve public perceptions on the benefits of stock enhancement and the associated stocking programs, particularly at the implementation or release sites. In this regard, there is a need to educate communities on the long-term advantages

of stock enhancement, and the basis of implementation of other strategies such as closed seasons, conservation areas, etc.

**Recommendation**

Much technological advancement is needed to place stock enhancement programs in inland waters in Myanmar on a firmer footing. For example, a variety of techniques, ranging from culture to support capture fisheries, to intensive aquaculture can be used to compensate for decline in the productivity of the fisheries due to overfishing, environmental changes or inadequacies in the natural ecosystem (Welcomme and Bartley, 1998) and some of these have to be adopted in Myanmar. Introduction of the new species to exploit underutilized niches of the food chain and to compensate for loss of species due to environmental disturbance is needed.

Equally, there is need for engineering of the environment to improve levels of reproduction, shelter, food resources and vital habitats of the major species in the inland fisheries, as well as eliminate unwanted species that either compete with or predate upon target species. So far, there is no evidence to support that stock enhancement strategies have brought about a reduction in genetic diversity of the wild stocks. There is a need for constant and regular monitoring of this aspect using modern molecular genetic tools. However, it should be noted that the current practices adopted in Myanmar in respect of replenishment of broodstocks, though not conducted strictly on a scientific basis, has been lauded as a good interim strategy which could be improved upon relatively easily with the application of modern scientific tools and approaches (Aung *et al.*, 2010).



There is an urgent need for improvement of operation and impact assessments in relation to stock enhancement in inland waters of Myanmar, which has been lagging behind most countries in the region.

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