Aquatic Resource Management and Production in Hinthada District in Ayayarwady Region

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Abstract

Aquatic resource management and production in Hinthada District in Ayayarwady region was studied within the period of October 2014 to May 2016. Seasonal field survey was conducted to record the number of utilized fishing gear, catch species, fishing duration and season, the number of persons who are needed during operation and catch quantity of the fish in respective study region. A total of 27 types of fishing gears belonging to seven groups were recorded to catch 65 fish species belonging to 44 genera under 26 families of 8 orders in studied fishing sites. The utilized number of fishing gears was found vary. Most of the fishermen applied with drift gill net (hmauk pike), beach seine net (Kalar pike/Ballone pike) and stationary bamboo filter trap (Shaw Sel). The highest number of fish species was found to be caught by bag net (Kyar pike), beach seine net (Chay toe pike), beach seine net (Kalar pike/Ballone pike), giant cast net (Mat con) and portable cast net (Let pyit con). Upright fish trap (Parsohn hmyone) and vertical heart-shaped traps (Pa-lote-tote hmyone) were to catch fish in the whole year round. Catch per unit effort (CPUE) of beach seine net (Ballone pike/Kalar pike) was the highest. Estimated annual catch quantity of twenty-seven types of fishing gears varied from 0.04 tonns to 172 tonns. The highest quantity of fish was caught by drift gill net (Hmauk Pike).

Keywords: Fishing gears, CPUE, Catch quantity

I. Introduction

Aqutatic resources management refers to the management and conservation of the aquatic resource base in the context of aquaculture, the concentration and capture of wild fish, as well as foraging for other aquatic resources such as crabs, prawns, snails, insects, aquatic plants, etc. The term is used here to emphasize the broad and flexible approach to improved management that is most relevant to poor people.

Aquatic resources provide livelihood options for many men and women in rural areas of the developing world. The concentration and capture of wild fish are recognised as important to many rural livelihoods, especially those of poor people. The importance of livelihoods thinking is that it places aquatic resources management in the context of poverty i.e., it is not restricted to technology or to forms of aquaculture but includes access to natural stocks of fish and other aquatic organisms and relates to policy, institutions and processes that support and make attractive livelihood strategies involving aquatic resources. (Haylor, *et al*., 2000)

Inland aquatic resources in developing regions around the world are of immense significance in terms of food security as well as economic growth and the alleviation of poverty. However, ever-increasing demand for fish products makes it difficult to maintain the balance between supply and sustainable production. Therefore, the multi-purpose

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nature of inland water use creates a very distinct set of challenges for responsible development and management, and hence the promotion of water, food and environmental security. (Jenness, *et al*., 2007)

A management measure is the smallest unit of the fishery manager's tool kit and consists of any type of control implemented to contribute to achieving the objectives. Management measures are classified as technical measures, input (effort) and output (catch) controls, and any access rights designed around input and output controls. Technical measures can be sub-divided into regulations on gear-type or gear design and closed areas and closed seasons. A minimum legal mesh size, a seasonal closure of the fishery, a total allowable catch (TAC), a limit on the total number of vessels in a fishery, and a licensing scheme to achieve the limit are all examples of management measures. A substantial part of the Guidebook is intended to assist managers in considering and selecting different management measures for a given fishery. (L. Cochrane, 2001)

Fish catching and fish farming are important sources of employment, food and revenue in many countries and communities. Two thirds of the world's six billion people live within 40 miles of an ocean and over one billion people depend on ocean fish as the main source of animal protein. The FAO estimates that about 36 million people were full-time or part-time employed in the primary capture fisheries and aquaculture production sectors in 1998. The top ten aquatic species in world production are all organisms low in the food web such as filter feeders and plants eaters (herbivores or omnivores) (Aerni, 2001).

Although impressive commercial/industrial gears do occur in river fisheries, they are less capital intensive and small-scale operators, and in particular, family-based operations. Part-time fishing is the norm and is invariably mixed with agricultural activities. Average catches per fisher tend to be low, but participation is very high. The diversity of the ecosystem and its components, the general accessibility of aquatic resources to local communities, and the high participation in exploitation and utilisation of aquatic resources are intimately linked. One result of this is the evolution of perhaps the most diverse array of fishing gears known in any fishery. At least 80 categories of gear have been identified in Cambodia alone (Management of Freshwater Capture Fisheries of Cambodia Project, unpublished) and are equally diverse in Lao PDR (Claridge *et al*. 1997). These lists are far from complete and have yet to be compiled systematically for the other countries (Coates, 2002).

There are 131 types of inland fishing gear presently employed in the inland fisheries of Myanmar. Among these about 80 types of fishing gears were mostly applied by the fishermen of Ayeyarwady region. Fishing methods of eight important group namely hook and line, trap, gill nets, surrounding net, falling nets, lift nets, push nets and miscellaneous are also described (Khin Maung Aye, *et al*., 2006). Thus, present research is carried out with the following objectives:

- to know the fish species caught from studied region
- to assess the efficiency of fishing gears
- to evaluate the production of catch fish species

II. Materials and methods

Study site

Ayeyarwady River near Hinthada districts, 17º 20′ N to 18º 31′ N and 94º 48′ E to 95º 47′ E was selected as the study site. It has an area of covers about 6987.82 sq km, embracing four townships and 36 village tracts.

Map 1. Study area
Source: Google Earth

Data collection

Field surveys and interviews with local fishermen were seasonally conducted from October 2014 to May 2016. Types of fishing gears, fishing frequency, fishing duration, fishing time, labour requirement per gear and catch quantity of fish, operation of the gears, fishing methods and their complementary equipment were recorded. Fish specimens were collected from the fishermen in the study area. Scaled photographs of specimens were taken immediately after the collection and preserved in 10% formalin for reference. The preserved fish specimens were washed thoroughly with tap water and identified according to Laglar (1977) and Talwar and Jhingran (1991). Fishing gears were classified according to Prado (1990) and Khin Maung Aye, *et al* (2006). Catch Per Unit Effort (CPUE) was taken as the weight of fish per day caught by a type of individual fishing gear. CPUE (kg/day) of fishing gears were calculated to evaluate the effectiveness of fishing gears.

III. Results

All together, 27 types of fishing gears were found to be currently used in the Hinthada District of Ayeyarwady Region. They could be classified into seven groups, consisting gill nets, hook and lines, traps, surrounding net, falling net, lift net and miscellaneous (Figure 1, Table 1).

A total of 65 fish species belonging to 44 genera under 26 families of 8 orders were recorded to catch in fishing grounds of studied regions (Figure 2).

Table.1 Classification of fishing gears in Hinthada district

Sr.No.	Groups of Gears	Common Name	Local Name
1	Gill Nets	(ii) Drift gill net	Hmyaw pike
			Kyar zan pike
			Hmauk pike
			Hlyar chin
		(ii) Set gill net	Tar pike/ Chi Pike
		(iii) Trammel net	Thone htatt hmyaw pike
			Nga chaung pike
			Nga-tha-lauk pike
			Nga pon nar pike
		(iv) Trammel set net	Thone htatt tar pike
2	Hook and Lines	(ii) Long line	Nga hmyar tan
		(ii) Pole and line	Pazun tan
			Nga hmyar tan
3	Traps	(ii) Horizontal fish trap	Yoedayar Hmyone
		(ii) Upright fish trap	Pyit tie htaung hmyone
			Parsohn hmyone
			Bome
		(iii) Vertical heart-shaped trap	Pa-lote-tote hmyone
		(iv) Bamboo fish filter trap	Shawl sae
		(v) Bag net	Kyar latt pike
			Kyar pike
4	Surrounding Nets	(ii) Beach seine net	Kalar pike/Ballone pike
			Chay toe pike
5	Falling Nets	(ii) Portable cast net	Let pyit con
		(ii) Giant cast net	Mat con
6	Lift net	Stationary lift net	Ya gwin gyi
7	Miscellaneous	Small bag net	Khat kwin

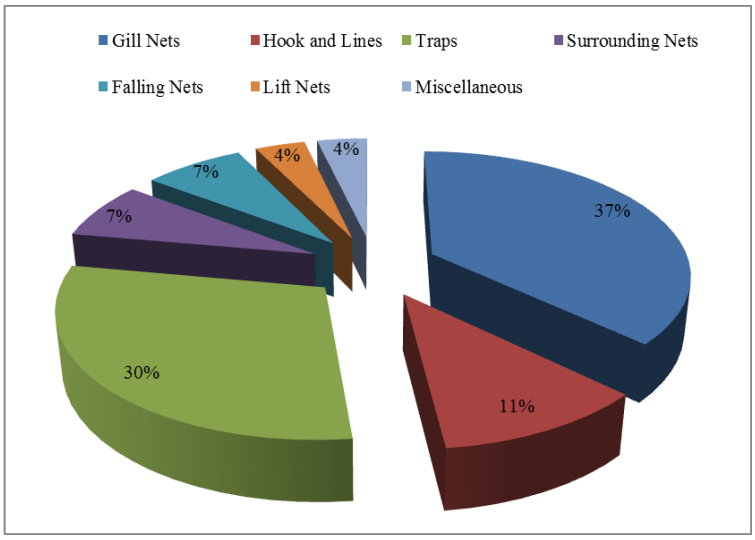

Figure 1. Groups of fishing gears used in studied area (by %)

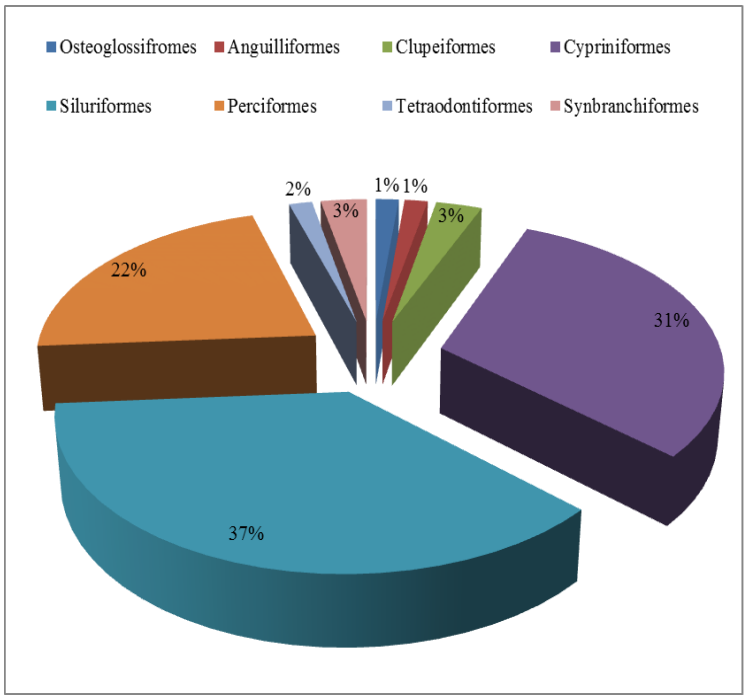

Figure 2. Fish species composition caught in studied regions

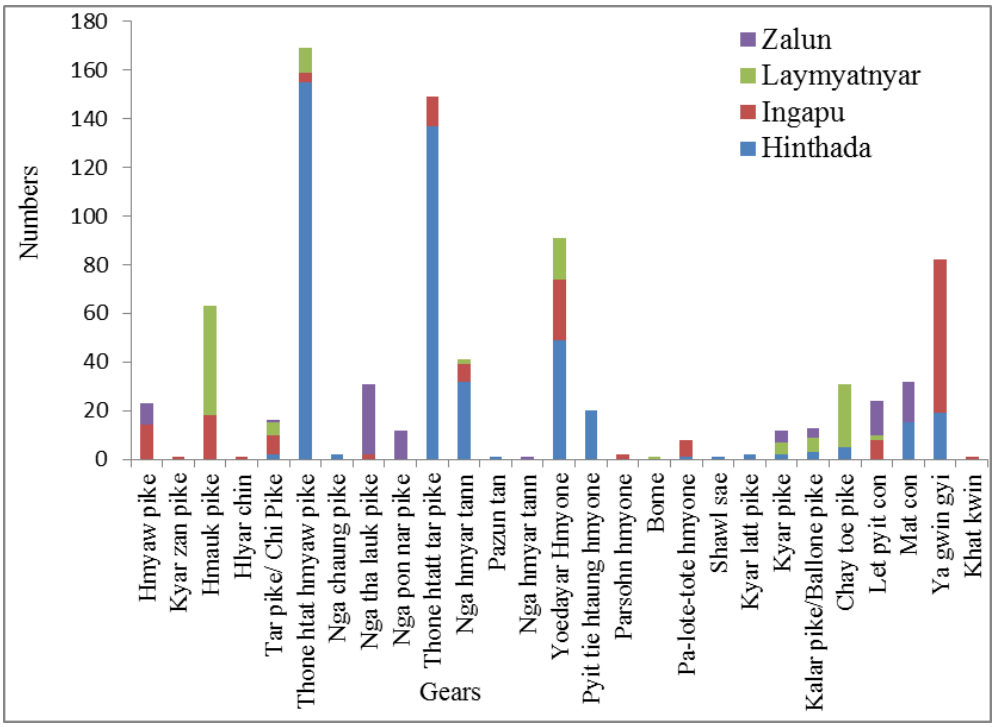

Figure 3. Number of fishing gears used in respective study sites

Amongst 27 types of recorded fishing gears, 16 types (59%) were used in Hinthada environs which was followed by Ingapu environs about 15 types (56%) and 10 types (37%) of fishing gears were used in Laymyatnyar and Zalun environs respectively.

In four regions of the study area, the number of trammel net (Thone htat hmyaw pike) (155) was the most in use, followed by trammel set net (Thone htat tar pike) (137) in Hinthada environs, Stationary lift net (63) in Ingapu while the lowest number used are drift gill net (Kyar zan pike), (Hlyar chin), set gill net (Tan pike), pole and line (Nga hmyar tan) and (Pazun tan), vertical heart-shaped trap (Pa-lote-tote hmyone), stationary bamboo filter trap (Shaw Sel), upright fish trap (Bome) and small bag net(Khat kwin) in various regions (Figure 3.).

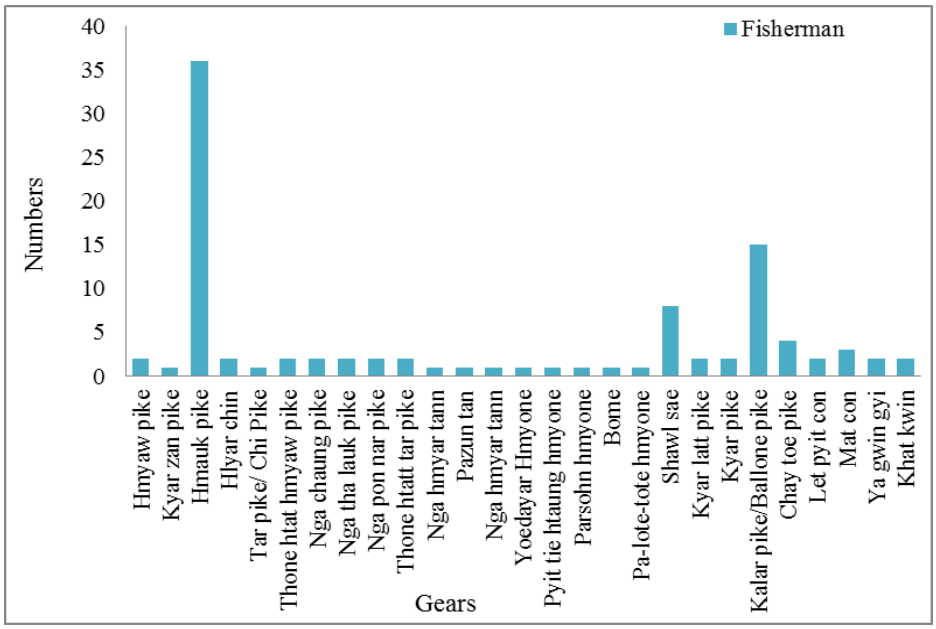

Figure 4. Operated fisherman in recorded fishing gears

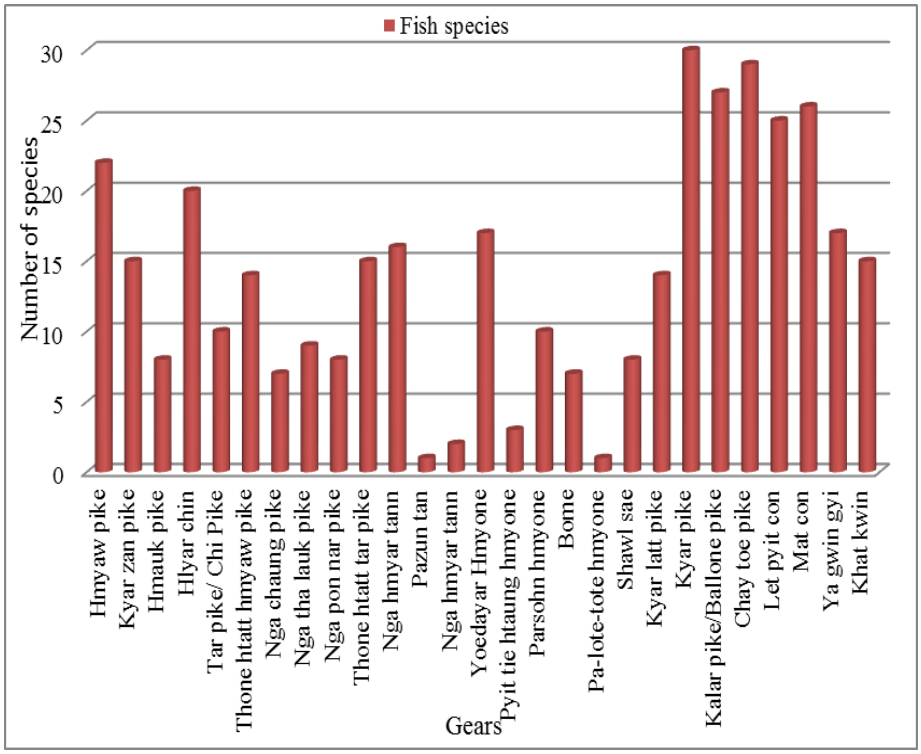

Figure 5. Number of fish species caught by recorded fishing gears

Among the studied regions, the same numbers of operated fishermen were found. The largest number of fishermen (35) applied with drift gill net (hmauk pike) was recorded in study area followed by beach seine net (Kalar pike/Ballone pike) (15) and stationary bamboo filter trap (Shaw Sel) (8), while the smallest number of fishermen were found to use in drift gill net (Kyar zan pike), set gill net (Tan pike), long line, pole and line (Nga hmyar tan), (Pazun tan), horizontal fish trap (Yoedayar hmyone), upright fish trap (Pyit

tie htaung hmyone) (Parsohn hmyone), vertical heart-shaped trap (Pa-lote-tote hmyone) and upright fish trap (Bome) (Figure 4.).

The highest number of fish species (30) was found to be caught by bag net (Kyar pike) followed by beach seine net (Chay toe pike) (29), beach seine net (Kalar pike/Ballone pike) (27), giant cast net (Mat con) (26) and portable cast net (Let pyit con) (25) and the least number of fish species (1) were caught by pole and line (Pazun tan) and vertical heart-shaped trap (Pa-lote-tote hmyone) (Figure 5.).

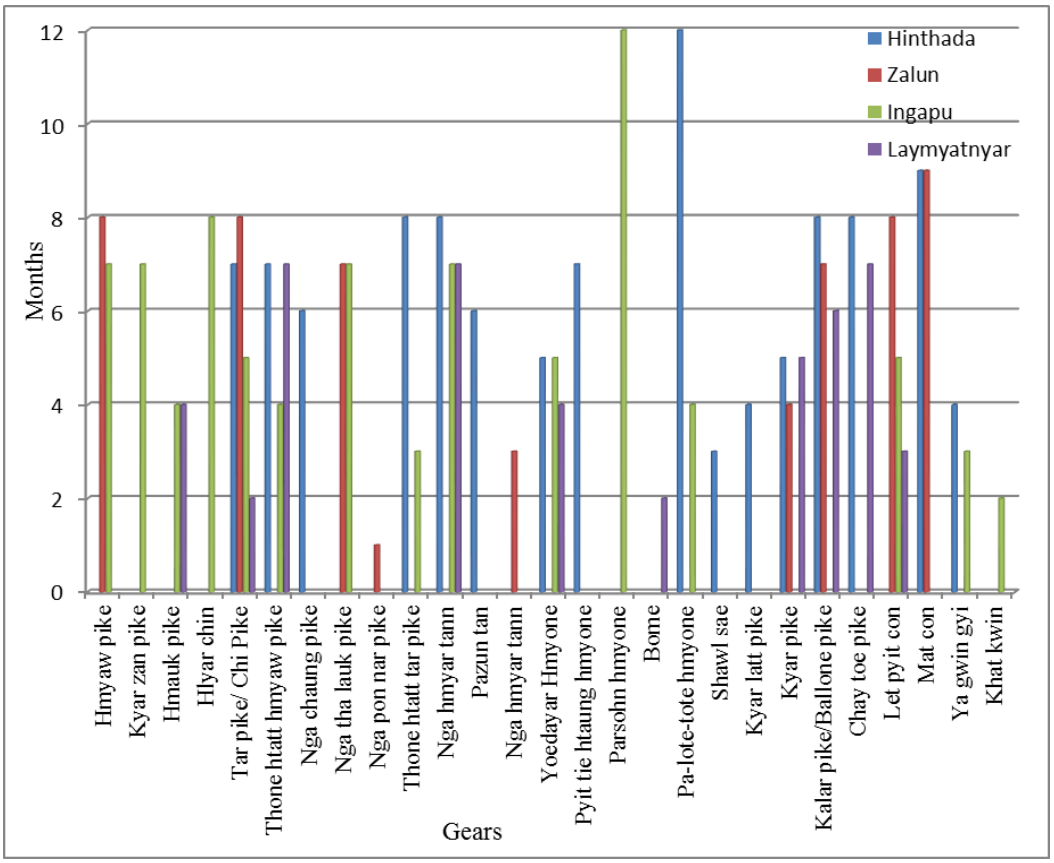

Figure 6. Active fishing month of recorded fishing gear

Upright fish trap (Parsohn hmyone) and vertical heart-shaped trap (Pa-lote-tote hmyone) were recorded to be utilized to catch fish in the whole year round in Ingapu and Hinthada environs. This was followed by giant cast net (nine months) in Zalun environs. Also in Zalun environs, fishing activity of trammel net (Nga pon nar pike) was the lowest (one month) (Figure 6.).

Catch per unit effort (CPUE) of beach seine net (Ballone pike/Kalar pike) was the highest (65.09 kg/day) in Laymyatnyar region, followed by trammel set net (Thone htatt tar pike) (44.14 kg/day) in Ingapu region, drift gill net (Hmauk Pike) (31.8 kg/day) in Laymyatnyar region and stationary bamboo filter trap (Shaw Sel) (20.37 kg/day) in Hinthada environs. But the lowest was recorded in bag net (Kyar pike) (0.33 kg/day) in Zalun environs (Figure 7.).

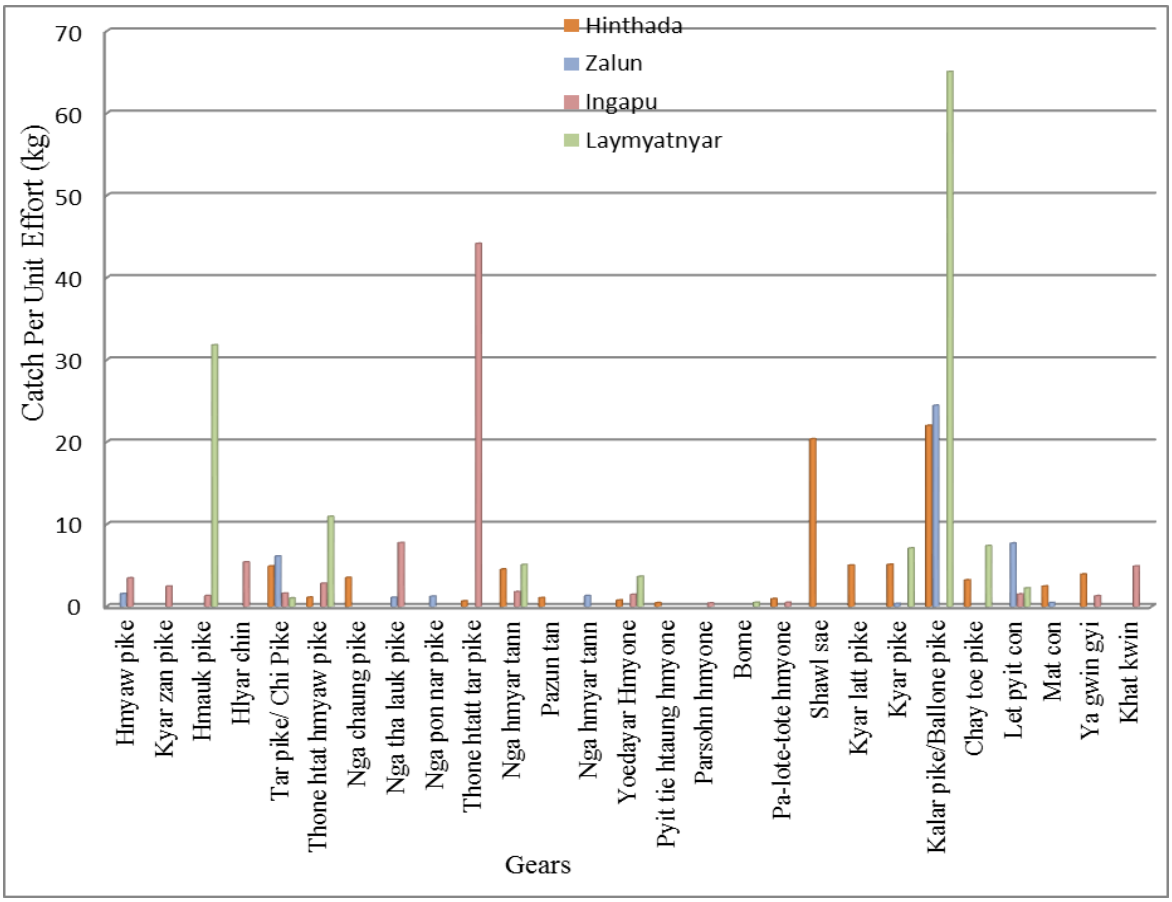

Figure 7. Catch per unit Effort (CPUE) by respective fishing gears

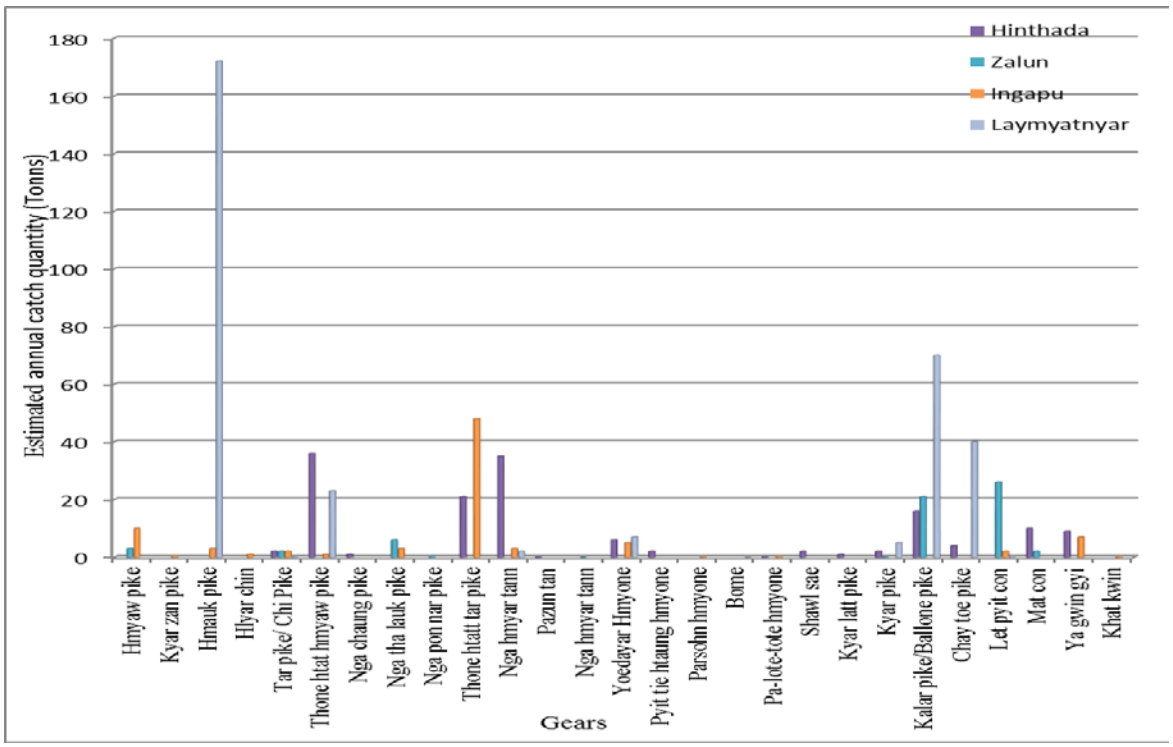

Figure 8. Estimated annual catch quantity by recorded fishing gears

Table 2. Resource management activities related with fishermen status

Sr. No	Types of gears	Gear size (Length x Width) m/mm	Mesh size mm	Cost of gear (Kyats)	Fishing frequency (time/day)	Target species	Fishing ground	Total income per day (Kyats)	Possession
1	Drift gill net (Hmyaw pike)	36 x 3.6	12.5 -150	50000-300000	2 (day+ Night)	Miscellaneous	Nan Ka Thu Chaung, Nga-won River	3000 - 7500	TV, Radio, Bicycle, Motorcycle
2	Drift gill net (Kyar zan pike)	36 x 3.6	50	12000	2 (day+ Night)	*Sperata aor*, *Wallago attu*	Nga-won River	2700	TV, Bicycle,
3	Drift gill net (Hmauk pike)	135 x 5.4	150	110000	2 (day+ Night)	*Sperata aor*, *Wallago attu*, *Cirrhinus mrigala*, *Catla catla*	Nga-won River	1700 - 7000	Radio
4	Drift gill net (Hlyar chin)	73 x 3.6	25	80000	2 (day+ Night)	Miscellaneous	Ka-nyin Chaung &Nga -won River	5000	TV, Fan, Motorcycle
5	Set gill net (Tar pike/ Chi Pike)	9 x 1.8 - 72 x 3.6	25 – 150	30000-100000	2 (day+ night)	*Sperata aor*, *Wallago attu*	Nga-won River, Ayeyarwady river	2700 - 25000	TV, Bicycle, Motorcycle
6	Trammel net (Thone htatt hmyaw pike)	23 x 5.8 - 180 x 8.8	25 x 150 - 75 x 400	70000 - 450000	2 (day+ night)	Miscellaneous	Nga-won River, Ayeyarwady river	3000 - 10000	TV, Radio, Phone
7	Trammel net (Nga chaung pike)	158 x 9	150 x 650	70000	2 (day+ night)	*Sperata aor*	Nga-won River	5000 - 8000	NA
8	Trammel net (Nga-tha-lauk pike)	81 x 4.5 - 126 x 2.7	50x15 - 163, 800	50000-750000	2 (day+ night)	*Hilsa (Tenualosa) ilisha*	Nga-won River, Ayeyarwady river	2600 - 10000	Radio, Motor cycle
9	Trammel net (Nga pon nar pike)	27 x 1.8	25x250	400000	2 (day+ night)	*Polynemus paradiseus*	Ayeyarwady river	5000	NA

10	Trammel set net (Thone htatt tar pike)	20 x 3.6 - 203 x 4.5	50x15-75x450	100000-500000	2 (day+ night)	Miscellaneous	Nga-won River, Ayeyarwady river	5000 - 10000	Motorcycle
11	Long line (Nga hmyar tan)	90 - 180	No:8, 15	3500, 15000	2 (day+ night)	Miscellaneous	Nga-won River, Ka-nyin creek, Ayeyarwady river,	2000 - 8000	NA
12	Pole and line (Pazun tan)	2	No:7	2000	1(day)	*Macrobrachium*	Nga Wonn river	4000	NA
13	Pole and line (Nga hmyar tan)	2.7 x2.7	No:6	500	1(day)	Channa spp.	Field	3000	NA
14	Horizontal fish trap (Yoedayar hmyone)	0.45 x 0.75	12.5	2500 - 5000	A whole day	*Macrobrachium*	Inn, Creek, River	1000 - 3500	Radio, TV, Bicycle
15	Upright fish trap (Pyit tie htaung hmyone)	0.22 x 0.16	12.5	2000	2 (day+ night)	*Macrobrachium*	Creek, River	1000 - 3000	NA
16	Upright fish trap (Parsohn hmyone)	0.75 x 0.27		2500	2 (day+ night)	Shrimp	Inn, Creek, River	2500 - 6000	TV, Fan, Bicycle
17	Upright fish trap (Bome)	0.6 x 0.9 x 1.95		2500	A whole day	Miscellaneous	Nga Wonn river	3000	NA
18	Vertical heart-shaped trap (Pa-lote-tote hmyone)	1 x 0.5	12.5 x 10	6000	2 (day+ night)	*Macrobrachium*	Nga Wonn, Ayeyarwady river	2000	NA
19	Bamboo fish filter trap (Shawl sae)	54 x3.6		3,000,000	A whole day	Miscellaneous	Creek	30,000	Boat
20	Bag net (Kyar latt pike)	12.15 x 4.05		750,000	A whole day	Miscellaneous	Da tha hmyang Inn	11,000	TV, Radio
21	Bag net (Kyar pike)	13.5x7.2–90x11	12.5 - 150	100000-400000	A whole day	Miscellaneous	Nga Wonn river	3000 - 8500	TV, Bicycle, laptop, solar

									battery
22	Beach seine net (Kalar pike / Ballone pike)	39.6 x 7 - 234 x 8.1	0.25,12.5 , 25	150000-6,000,000	10 times	Miscellaneous	Nga Wonn river, Ayeyarwady river	6000 - 15000	TV, Motorcycle, phone
23	Beach seine net (Chay toe pike)	41.4 x 2.7 - 108x5.4	12.5 – 50	100000-300000	2-4 times	Miscellaneous	Nga Wonn river	6000 - 20000	TV, Bicycle, Phone, Motorcycle
24	Portable cast net (Let pyit con)	5.85 x 5.4 x 8.1	25x50x75	50000 - 150000	2 (day+ night)	Miscellaneous	Nga Wonn river	4000 - 20000	Cycle, TV,Laptop
25	Giant cast net (Mat con)	36 x 9	25,37.5,50,62.5,75	200000	2 (day+ night)	Miscellaneous	Ayeyarwady river	5000 - 30000	TV, Motorcycle, Bicycle
26	Stationary lift net (Ya gwin gyi)	2.7 x 2.7	10	50000 - 130000	A whole day	Miscellaneous	Nga Wonn river, Ayeyarwady river	1000 - 3000	TV, Radio, Bicycle
27	Small bag net (Khat kwin)	3 x 3.5	13	100000	A whole day	Miscellaneous	Nga Wonn river	9000	TV, Motorcycle, Motor

Estimated annual catch quantity of twenty-seven types of fishing gears varied from 0.04 tonns to 172 tonns. The highest quantity was observed in drift gill net (Hmauk Pike) (172 tonns), followed by beach seine net (Ballone pike/Kalar pike) (70 tonns). These are found in Laymyatnyar region and trammel set net (Thone htatt tar pike) (48 tonns) in Ingapu while that of the lowest was found in upright fish trap (Bome) (0.03 tonns) of Laymyatnyar region (Figure 8.).

Table (2) showed the resource management activities related with fishermen status. The fishermen of respective regions operated various gear sizes and mesh sizes. Fishing was done twice a day found in gill nets groups, long line, some of the traps and cast nets groups. Most of the traps, lift nets and small bag net were used the whole day while surrounding nets were applied 4 times and ten time per day. Only pole and line gears were applied once a day.

Most of the gill nets group were selective gears except drift gill net (Hmyaw pike and Hlyar chin), trammel net (Thone htatt hmyaw pike) and trammel set net (Thone htatt tar pike). Pole and line (Pazun tan), horizontal fish trap (Yoedayar hmyone), upright fish trap (Pyit tie htaung hmyone and Parsohn hmyone) and vertical heart-shaped trap (Pa-lote-tote hmyone) were used to catch *macrobrachium spp* only. Pole and line (Nga hmyar tan) was used to catch channa spp only. The other fifteen types were non selective fishing gears.

Long line (Nga hmyar tan), pole and line (Nga myar tan) and most of the trap types such as horizontal fish trap (Yoedayar hmyone), upright fish trap (Pyit tie htaung hmyone), (Parsohn hmyone) and bamboo fish filter trap (Shawl sae) were set in rice fields and creeks while bag net (Kyar latt pike) was set in da tha hmyang Inn. The rest of other gear types were operated in rivers of Ayeyarwady and Ngawon.

Drift Gill net (Hmyaw pike)

Drift gill net (Kyar zan pike)

Drift gill net (Hmauk pike)

Drift gill net (Hlyar chin)

Set gill net (Tar pike/Chi pike)

Trammel net (Thone htat myaw pike)

Trammel net (Nga chaung pike)

Trammel net (Nga tha lauk pike)

Trammel net (Nga ponar pike)

Trammel set net (Thone htat tar pike)

Long line (Nga myar tan)

Pole and line (Pazun tan)

Pole and line (Nga myar tan)

Horizontal trap (Yoedayar hmyone)

Upright fish trap (Pyit tie htaung hmyone)

Upright fish trap (Parson hmyone)

Upright fish trap (Bome)

Vertical heart-shaped trap

Bamboo fish filter trap (Shawl sae)

Bag net (Kyar latt pike)

Bag net (Kyar pike)

Beach seine net (Ballone pike/Kalar pike)

Beach seine net (Chay toe pike)

Portable cast net (Let pyit con)

Giant cast net (Met con)

Stationary lift net (Ya gwin gyi)

IV. Discussion

A total of 27 types of fishing gears belonging to seven groups were recorded in the study sites of Ayeyarwady Region. Among these, 37% of gears were gill nets, which were followed by traps (30%) and hook and line (11%). Each gear category can be further sub-divided by dimensions, mesh size and construction material, not to mention the mode, location and timing of deployment. This finding indicated that the above mentioned gears were regarded to be the most common use in fishing activities of the study sites.

Regarding species composition of the total catch by all gears, order Siluriformes (37%), Cypriniformes (31%) and Perciformes (22%) were recorded to be the highest percentages in the total catch. The order Clupeiformes (3%), Synbranchiformes (3%), Tetraodontiformes (2%), Anguilliformes (1%), and Osteoglossiformes (1%) were the lowest in the total catch.

Hinthada environs and Ingapu environs were located aside the big river of Ayeyarwady and Ngawon. So the fishermen in these environs have more chance to get their earning by fishing.

Regarding the utilized number of fishing gears, trammel net (Thone htat hmyaw pike) and trammel set net (Thone htat tar pike) were mostly used in the study sites. It can be assumed that this type of net may be provided to catch more fish with no chance of escaping.

Fishermen were found to use mostly drift gill net (hmauk pike), beach seine net (Kalar pike/Ballone pike) and stationary bamboo filter trap (Shaw Sel) in relation to other types of gears. Hence, it may be assumed that not only the size of these types of gear but also the catch sizes of fish were the biggest between other types of gears. The smallest ten gears mostly traps group were operated by only one fisherman and these may be regarded as small scale fishing gears because most of these were usually operated in rice fields and creeks.

Regarding the number of species caught by gear categories, 30 species were found to be caught by bag net (Kyar pike), 29 species by beach seine net (Chay toe pike), 27 species by beach seine net (Kalar pike/Ballone pike), 26 by giant cast net (Mat con) and 25 by portable cast net (Let pyit con). Depending on these findings, it may be concluded that a wide range of species were vulnerable to the mentioned fishing gears.

Upright fish trap (Parsohn hmyone) and vertical heart-shaped traps (Pa-lote-tote hmyone) were operated the whole year either during the day or at night. The life of respective target *macrobrachium* species may be disturbed by this gear types in their respective regions.

The numbers of utilized fishing gears were found to be lesser in beach seine net (Ballone pike/Kalar pike) except from Ingapu region but the number of catch species and the catch per unit effort (CPUE) were high in this gear. Similar results were also found in trammel set net (Thone htatt tar pike) in Ingapu region and stationary bamboo filter trap (Shaw Sel) that are operated in Hinthada region. The above mentioned three gears may be regarsded as the most effective fishing gears in their respective region.

Both the number of utilized fishing gears and the catch per unit effort (CPUE) were found to be also high in drift gill net (hmauk pike), but the numbers of catch species were lesser. Hence, the above mentioned gears are found to be fairly effective fishing gears in Laymyatnyar environs. Although the number of utilized fishing gears were found to be higher, the number of catch species and the catch per unit effort (CPUE) were lesser in trammel net (Thone htat hmyaw pike), trammel set net (Thone htatt tar pike) in Hinthada region, stationary lift net (Ya gwin gyi) in Ingapu region and horizontal fish trap (Yoedayar hmyone) in Hinthada region. The remaining eighteen gears were lowest in both number and the catch per unit effort (CPUE) values. These results indicated that the efficiency of these gears were low.

The results obtained from the estimated annual catch quantity of gear types showed that the highest level was produced by the drift gill net (Hmauk Pike) and beach seine net (Ballone pike/Kalar pike) in Laymyatnyar region; trammel set net (Thone htatt tar pike) in Ingapu, beach seine net (Chay toe pike) in Laymyatnyar region, trammel net (Thone htat hmyaw pike) and long line (Nga myar tan) in Hinthada regions respectively. Based on these findings, the efficiency level is assumed to be highest in the above mentioned fishing gears in their respective area.

Pole and line (Pazun tan), horizontal fish trap (Yoedayar hmyone), upright fish trap (Pyit tie htaung hmyone), (Parsohn hmyone), vertical heart-shaped trap (Pa-lote-tote hmyone) gears were provided to catch prawn with no chance of escaping. However, the estimated annual catch quantities of these gears were the lowest.

The present finding indicated that many of the gears are habitat specific and their usage can be highly seasonal. Some gears such as bag net, beach seine net and cast net are unspecific and they a wide variety of species, while others are species specific.

The effectiveness of each gear type was showing their relative threats to the sustainability of the fishery. The seasonality of gear used also influences the potential technical interactions between different gears. Various fish species may be over-exploited by the effective fishing gears. Thus, heavy exploitation of fishes may affect the sustainable yield. Some guidelines for conservation of fish resources should therefore be considered. Finally, variations in the seasonal effectiveness of gears are shown to be strong and highly dependent on local ecological and social conditions.

The role of aquatic resources in rural livelihoods is characterised by diversity of resources, environments resource users and the ways in which they exploit resources and incorporate them into their livelihoods. Aquatic resources management tends to be one component of often complex and dynamic livelihood systems.

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