Songklanakarin J. Sci. Technol.
42 (4), 795-801, Jul. - Aug. 2020

http://www.sjst.psu.ac.th

Original Article

Fish species composition and catch per unit effort in Nong Han wetland, Sakon Nakhon Province, Thailand

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Received: 6 August 2018; Revised: 19 March 2019; Accepted: 17 April 2019

Abstract

A study on fish species composition and catch per unit effort (CPUE) was conducted at the Nong Han wetland in Sakon Nakhon Province, Thailand. Fish were collected with 3 randomized samplings per season at 6 stations using 6 sets of gillnets. A total of 45 fish species were found and most were in the Cyprinidae family. The catch by gillnets was dominated by *Parambassis siamensis* with an average CPUE for gillnets set at night of 807.77 g/100 m^2/night. No differences were detected on CPUE between the seasonal surveys. However, the CPUEs were significantly different ($P<0.05$) between the stations. The Pak Narmkam station had a higher CPUE compared to the Pak Narmpung station (1,609.25±1,461.26 g/100 m^2/night vs. 297.38±343.21 g/100 m^2/night). The results of the study showed that the Nong Han Wetlands is a lentic lake and the fish abundance was found to be medium. There were a few small fish species that could adapt to living in the ecosystem.

Keywords: fish species, fish composition, abundance, CPUE, Nong Han wetland

1. Introduction

Nong Han wetland is the largest natural lake in the northeast region of Thailand. The lake was declared as a wetland of international importance with an area of 123.23 km^2 (Office of Environmental Policy and Planning, 2002). The wetland is located in two districts of Sakon Nakhon Province and covers nine sub-districts in the Muang District and four sub-districts in Ponnakeaw District with a total of 32 communities surrounding the lake. The Nong Han wetland provides benefits for the communities in Sakon Nakhon area in both direct and indirect ways, such as water retention for agriculture and livestock, water consumption, tourist attraction, and aquatic animal production (Pengsangsee & Kaewnern, 2014). In addition, communities can generate income through sales of fishery products and also provide food resources for the local population (Kunlapapuk, Kulabtong, & Soontornkit, 2014). According to a study by Sanitchon and Jantharachit (2013), an average catch of 204 fishermen households in the Nong Han wetland was estimated to be 3.40 kg/fisher/day. Ngoichansri, Nitsupap, and Sutti-arj (2003) reported that the catch per unit effort (CPUE) for gillnets set at night in Nong Han had an average of 1,423.80 g/100 m^2/night. Between 2009 and 2015, based on the research of Rayan, Naunsang, Ngoichansri, and Chatchavantatri (2016), the average CPUE for gillnets set in Nong Han was 700.90 g/100 m^2/night. However, the CPUE showed the lowest value in 2009, and the highest value in 2012 (266.10 vs. 1,073.80 g/100 m^2/night).

CPUE is a basic measurement to assess the aquatic animal resources and can be used as an indicator of relative abundance for a target fish. A higher value of CPUE indicates a greater abundance of the fish (Panchan & Pankaew, 2010). Changes in the CPUE are used to indicate changes in the

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increase or decrease of the true abundance of a particular species of fish (Trisak, Kaowkaew, & Tanyakitjanuwat, 1997). Sricharoendham, Boothongchuay, and Poomikong (2015) set the standard of CPUE for gillnet into 4 levels: 1) low abundance where CPUE is less than 500 g/100 m^2/night; 2) medium abundance where CPUE is 501–1,000 g/100 m^2/night; 3) high abundance where CPUE is 1,001–2,000 g/100 m^2/night; and 4) very high abundance where CPUE is more than 2,001 g/100 m^2/night, respectively.

Despite consistently monitoring the status of fishery resources in the Nong Han wetland, the collected information is important for long-term fishery management systems and maintaining sustainable yields. Therefore, the objectives of this study were to evaluate the fish species composition, CPUE, and the index of relative importance of dominant fish species caught in gillnets in the Nong Han Wetland of Sakon Nakhon, Thailand.

2. Materials and Methods

2.1 Study area

A total of 6 sampling stations around the Nong Han wetland were designated. S1 (Tha Rae station) was located at 17°24’31.364”N, 104°20’94.386”E and was located in the upper region to the west with a moderately low water level and high number of inhabitants. This area has been developed as a tourist attraction and is therefore highly affected. S2 (Baan Paen station) was located at 17°20’71.057”N, 104° 19’86.239”E and was located in the upper region to the east with a moderately low water level and small number of inhabitants. S3 (Don Sakham station) was located at 17°21’18.61”N, 104°18’15.436”E and was located in the central region to the west with a high population density and is therefore the most affected. S4 (Don Sawan station) was located at 17°20’66.138”N, 104°18’10.286”E and was located in the central region to the east with the highest water level and a very low number of inhabitants and is therefore the least affected. S5 (Pak Narmpung station) was located at 17°15’ 33.131”N, 104°19’63.923”E and was located in the lower region to the west and is the main watercourse flowing into Nong Han, and therefore the area has a moderately low water level and a small number of inhabitants. S6 (Pak Narmkam station) was located at 17°17’78.025”N, 104°21’24.212”E and was located in the lower region to the east with a moderately high water level and high number of inhabitants, and therefore valves have been installed to control the water levels in the area (Figure 1).

2.2 Sampling period

Samples in the Nong Han wetland were randomized and collected between November 2016 and June 2017. The samplings were divided into 3 seasons, according to Thailand Meteorological Department (2016). Seasons are defined as winter season, which is during the middle of October to the middle of February when the water storage level is at the highest and starts to decline, the water temperature is low, and the water is clear due to sedimentation. The summer season is from the middle of February to the middle of May when the water storage level is at the lowest and the water temperature is at the highest. The rainy season is from the middle of May to the middle of October when rainfall is at the highest when the water storage level starts to increase and the water has high turbidity. The surveys were evaluated in November 2016 (winter), March 2017 (summer), and June 2017 (rainy).

Figure 1. Map and location of the 6 sampling stations in the Nong Han wetland, Sakon Nakhon Province, Thailand.

2.3 Fish sampling

Fish samples were collected at each station using 1.2 m deep gill nets with mesh sizes of 20, 30, 40, 55, 70, and 90 mm. A total of 6 gillnet sets were tied together to form a linear configuration. Three replicates were randomized and performed at each point of the survey between 6:00 pm and 6:00 am (12 h). Fish were taxonomically identified to species. The total length for each fish was measured to the nearest 0.1 mm, and weighed to the nearest 0.1 g. However, unidentified fish species were stored in 10% formalin to identify later according to the modified method of Fish base (2018), Rainboth (1996) and Vidthayanon (2008).

2.4 Data analyses

Fish number, weight, and length were collected from each sampling station during the survey period in the Nong Han wetland. The Shapiro-Wilk test was conducted to test for normality of the data. All data were standardized for comparison by expressing CPUE as g/100 m^2/night and number of fish/100 m^2/night. The data were analyzed for CPUE, species composition, frequency of occurrence, and index of relative importance.

2.5 Catch per unit effort (CPUE)

The use of CPUE as an index of abundance is based on a fundamental relationship widely used in quantitative fisheries analysis and expressed as g/100 m^2/night according to the following formula suggested by Swingle (1950).

$$\text{Catch per unit effort (g/100 m}^2\text{/night)} = \frac{\text{Total weight of fish sample (g)}}{\text{Total net area (100 m}^2\text{) x Fishing period (night)}}$$

The difference of mean CPUE was analyzed using analysis of variance (ANOVA) by area and survey period. Duncan's multiple range test was used to compare and separate means when the main effects were significant ($P<0.05$).

2.6 Species composition (%)

The species composition is expressed as the survival efficiency of the fish community. The composition can be calculated as percentage composition by number (%N) and percentage composition by weight (%W) (Kolding, 1989).

$$\%N = \frac{\text{Number of fish species}}{\text{Total of fish number}} \times 100$$

$$\%W = \frac{\text{Weight of fish species}}{\text{Total of fish weight}} \times 100$$

2.7 Frequency of occurrence (%F)

The frequency of occurrence is indicated as the frequency or chance of discovering a fish species during a certain time of the study. This value represents the spatial and temporal distribution of a fish species reported in percentage (Kolding, 1989).

$$\%F = \frac{\text{Number of times each fish species was found}}{\text{Total number of samplings}} \times 100$$

2.8 Index of relative importance (IRI)

The index of relative importance (IRI) is specified from the total number of fish, total weight of fish, and the frequency of occurrence of each fish species (Caddy & Sharp, 1986).

$$IRI = (\%N + \%W) \times \%F$$

Where; IRI = Index of Relative Importance
%N = Percentage composition by number
%W = Percentage composition by weight
%F = Percentage frequency of occurrence

3. Results and Discussion

3.1 Species composition caught with gillnets

Fish samples were randomized and evaluated from 6 sampling stations around the Nong Han wetland between November 2016 and June 2017. A total of 18 families with 45 fish species were found. The most abundant family was Cyprinidae (20 species [44.44%]). The second dominant family was Clariidae (3 species [6.67%]). Families of Notopteridae, Bagridae, Siluridae, Nandidae, Cichlidae, and Tetraodontidae were recorded with 2 species each (4.44%). The rest of the families were identified with a total of 1 species for each family (Figure 2).

3.2 Fish community structure

The fish community structure was analyzed by a 3-dimentional analysis with fish abundance, weight biomass, and frequency of occurrence. All data were calculated based on the index of relative importance to enable a comparison with one value. The greatest percentages of fish species abundance (%N) were *Parambassis siamensis*, *Sikukia gudgeri*, and *Puntius brevis* at 48.30%, 30.50%, and 7.03%, respectively. Therefore, the percentage composition by weight (%W) of fish species was 82.53%. The top ten fish species by weight composition were *S. gudgeri* (20.08%), *P. siamensis* (17.69%), *Cyclocheilichthys apogon* (9.04%), *P. brevis* (8.20%), *Hampala dispar* (6.61%), *Oxyeleotris marmorata* (6.39), *Pao leiurus* (4.15%), *Pristolepis fasciata* (3.79%), *Osteochilus vittatus* (3.65), and *Coptodon zillii* (2.93%).

The total IRI was 82.80%. Among the highest percentages of IRI were *P. siamensis* (42.07%), *S. gudgeri* (14.33%), *P. brevis* (9.71%), *C. apogon* (8.01%), *H. dispar* (4.90%), and *O. marmorata* (3.88%) (Table 1).

3.3 Catch per unit effort (CPUE)

The average CPUE was 807.77±688.98 g/100 m^2/night. The results indicated that the seasons had no effect ($P>0.05$) on the CPUE. The averages of CPUE during winter,

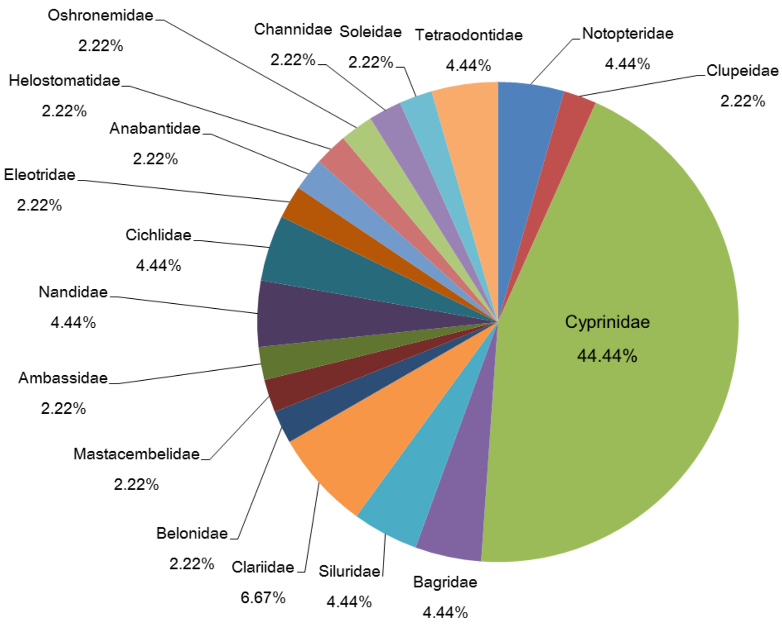

Figure 2. Composition of fish families caught by gillnets in the Nong Han wetland from November 2016 to June 2017.

summer, and rainy seasons were 534.84±256.17, 1,225.80 ±1,046.03, and 665.12±355.12 g/100 m^2/night, respectively. On the other hand, CPUE was significantly different ($P<0.05$) between the sampling stations. Station 6 had the highest CPUE ($P<0.05$) compared to station 5 (1,609.25±1,461.26 vs. 297.38±343.21 g/100 m^2/night). However, those stations were not significantly different compared to the other stations: station 1 (726.75±154.11 g/100 m^2/night), station 2 (508.54 ±72.81 g/100 m^2/night), station 3 (637.95±208.35 g/100 m^2/night), and station 4 (1,071.63±227.73 g/100 m^2/night) (Figure 3).

4. Discussion

The study found a total of 18 families with 45 fish species and the most abundant family was Cyprinidae (20 species [44.44%]). This was similar to a study between 2009 and 2015 by Rayan *et al.* (2016) who discovered 22 species of Cyprinidae family (40.00%). The three most abundant fish species by number were *P. siamensis*, *P. brevis*, and *C. apogon*. Rayan, Ngamsnae, and Ngoichansri (2014) also found 23 species (44.23%) of Cyprinidae family with *P. siamensis*, and *P. brevis* as the most abundant by number. In 1999, a total of 46 species were identified which were 17 species of the Cyprinidae family (39.96%). The greatest fish species composition caught by gillnets in the Nong Han wetland was the Cyprinidae family (Ngoichansri *et al.*, 2003). A study by Duangsawasdi *et al.* (2003) also found that the Cyprinidae family was the most abundant in the Nong Han wetland. Fish in the family of Cyprinidae are able to adjust well to the environment and tolerate changes in the ecosystem which increases the fish species composition and the dominant fish species in catch (Panchan & Pankaew, 2010). Some fish species are able to adapt their reproductive behavior from lentic to lotic ecosystems (Jutagate, Lamkom, Satapornwanit, Naiwinit, & Petchuay, 2001).

Fish species based on the IRI and the most dominant species from gillnets were *P. siamensis*, *S. gudgeri*, *P. brevis, C. apogon*, *H. dispar*, and *O. marmorata*. Ngoichansri *et al.* (2003) reported the top ten dominant fish species in the Nong Han wetland were *C. apogon*, *P. brevis*, *P. siamensis*, *H. dispar*, *Oreochromis mossambicus*, *Pristolepis fasciata*, *Osteochilus vittatus*, *Notopterus notopterus*, *Channa striata*, and *Nandus nandus*. Similar to Tanasomwang (2013), who studied the Nong Han wetland in 2010, the most abundant fish species were *P. siamensis*, *P. brevis*, and *C. apogon*. The greatest biomass of fish species was *C. apogon*, *P. brevis*, and *O. mossambicus*. Consistent with Rayan *et al.* (2016), the most three fish species composition were *P. siamensis*, *P. brevis*, and *C. apogon*. According to the results, the dominant fish species composition had changed little among the time periods in the Nong Han wetland and most of the fish species were small fish. Catch composition and changes in the dominant fish species may occur due to several factors, such as fish community structure and the water resources of the ecosystem (Panchan & Pankaew, 2010). However, the fishery resources in the Nong Han wetland has deteriorated overtime (Duangsawasdi *et al.*, 2003), and is severely imbalanced. In this regard, *P. siamensis* was the most dominant fish species which are of small size, short-lived, and low in economic value (Tanasomwang, 2013).

The average CPUE was 807.77 g/100 m^2/night. However, several studies have reported the CPUE in the Nong Han wetland. In 1999, the CPUE in the Nong Han wetland had an average of 1,423.80 g/100 m^2/night using 5 gillnet sets (Ngoichansri *et al.*, 2003). In 2010, the average CPUE was 732 g/100 m^2/night (Tanasomwang, 2013). During 7 consecutive years between 2009 and 2015 the CPUE had

Table 1. Fish species composition percentages by number (%N), percentage by weight (%W), frequency of occurrence (%F), and index of relative importance (IRI) of the Nong Han wetland.

ID	Common name	Scientifics name	%N	%W	%F	IRI	%IRI
1	Siamese glassperch	*Parambassis siamensis* (Fowler, 1937)	48.30	17.69	100.00	6,599.02	42.07
2	Sikuk barb	*Sikukia gudgeri* (Smith, 1934)	30.50	20.08	44.44	2,248.40	14.33
3	Swamp barb	*Puntius brevis* (Bleeker, 1849)	7.03	8.20	100.00	1,523.09	9.71
4	Beardless barb	*Cyclocheilichthys apogon* (Valenciennes, 1842)	4.26	9.04	94.44	1,256.12	8.01
5	Spotted hampala	*Hampala dispar* Smith, 1934	1.54	6.61	94.44	769.19	4.90
6	Marble goby	*Oxyeleotris marmorata* (Bleeker, 1852)	0.46	6.39	88.89	609.43	3.88
7	Malayan leaffish	*Pristolepis fasciata* (Bleeker, 1851)	1.73	3.79	94.44	521.17	3.32
8	-	*Pao leiurus* (Bleeker, 1850)	1.16	4.15	88.89	472.42	3.01
9	Nilem carp	*Osteochilus vittatus* (Valenciennes, 1842)	0.56	3.65	94.44	397.98	2.54
10	Bronze featherback	*Notopterus notopterus* (Pallas, 1769)	0.28	2.64	88.89	259.07	1.65
11	Redbelly tilapia	*Coptodon zillii* (Gervais, 1848)	0.11	2.93	55.56	168.52	1.07
12	Freshwater garfish	*Xenentodon cancila* (Hamilton, 1822)	0.58	2.12	55.56	150.02	0.96
13	Snail eating barb	*Puntioplites proctozystron* (Bleeker, 1865)	0.18	1.65	61.11	112.01	0.71
14	Gangetic leaffish	*Nandus nandus* (Hamilton, 1822)	0.67	0.67	83.33	111.52	0.71
15	Striped dwarf catfish	*Mystus mysticetus* Roberts, 1992	0.47	1.29	55.56	97.55	0.62
16	-	*Pao suvattii* (Sontirat & Soonthornsatit, 1985)	0.10	1.49	55.56	88.02	0.56
17	Butter catfish	*Ompok bimaculatus* (Bloch, 1794)	0.15	1.23	55.56	76.82	0.49
18	Striped snakehead	*Channa striata* (Bloch, 1793)	0.09	1.11	50.00	59.74	0.38
19	Dusky face carp	*Osteochilus lini* Fowler, 1935	0.14	0.55	44.44	30.57	0.19
20	Long fin carp	*Labiobarbus lineatus* (Sauvage,1878)	0.16	0.54	38.89	27.08	0.17
21	Siamese mud carp	*Henicorhynchus siamensis* (Sauvage, 1881)	0.12	0.55	33.33	22.46	0.14
22	Silver barb	*Barbonymus gonionotus* (Bleeker, 1849)	0.03	0.53	33.33	18.93	0.12
23	Philippine catfish	*Clarias batrachus* (Linnaeus, 1758)	0.03	0.48	27.78	14.17	0.09
24	-	*Parachela williaminae* Fowler, 1934	0.47	0.33	11.11	8.92	0.06
25	Peacock eel	*Macrognathus siamensis* (Günther, 1861)	0.08	0.23	22.22	6.95	0.04
26	-	*Paralaubuca riveroi* (Fowler, 1935)	0.12	0.21	16.67	5.47	0.03
27	North African catfish	*Clarias gariepinus* (Burchell, 1822)	0.01	0.29	16.67	5.07	0.03
28	Silver rasbora	*Rasbora argyrotaenia* (Bleeker, 1849)	0.14	0.16	16.67	5.03	0.03
29	Clown featherback	*Chitala ornata* (Gray, 1831)	0.02	0.17	22.22	4.24	0.03
30	Red cheek barb	*Systomus rubripinnis* (Valenciennes, 1842)	0.06	0.26	11.11	3.58	0.02
31	Red tailed tinfoil	*Barbonymus altus* (Günther, 1868)	0.02	0.15	16.67	2.93	0.02
32	Spiny barb	*Mystacoleucus marginatus* (Valenciennes, 1842)	0.21	0.22	5.56	2.40	0.02
33	Hampala barb	*Hampala macrolepidota* Kuhl & Van Hasselt, 1823	0.02	0.08	16.67	1.65	0.01
34	-	*Henicorhynchus ornatipinnis* (Roberts, 1997)	0.05	0.08	11.11	1.47	0.01
35	-	*Phalacronotus apogon* (Bleeker, 1851)	0.01	0.08	16.67	1.46	0.01
36	Climbing perch	*Anabas testudineus* (Bloch, 1792)	0.01	0.07	16.67	1.46	0.01
37	Thai river sprat	*Clupeichthys aesarnensis* Wongratana, 1983	0.04	0.00	16.67	0.78	0.00
38	Bighead catfish	*Clarias macrocephalus* Günther, 1864	0.00	0.08	5.56	0.46	0.00
39	Three spot gourami	*Trichogaster trichopterus* (Pallas, 1770)	0.02	0.02	11.11	0.46	0.00
40	Nile tilapia	*Oreochromis niloticus* (Linnaeus, 1758)	0.00	0.07	5.56	0.40	0.00
41	Kissing gourami	*Helostoma temminckii* Cuvier, 1829	0.00	0.04	5.56	0.24	0.00
42	Highfin barb	*Anematichthys armatus* (Valenciennes, 1842)	0.01	0.03	5.56	0.18	0.00
43	-	*Brachirus siamensis* (Sauvage, 1878)	0.01	0.02	5.56	0.14	0.00
44	Long fin mystus	*Mystus singaringan* (Bleeker, 1846)	0.00	0.02	5.56	0.13	0.00
45	-	*Paralaubuca typus* Bleeker, 1864	0.02	0.01	5.56	0.13	0.00
	Total		100.00	100.00		15,686.87	

averages of 458.40, 266.10, 749.10, 1,073.80, 877.70, 749.80, and 731.40 g/100 m^2/night, respectively (Rayan *et al.,* 2016). The CPUE of the fish community in the Nong Han wetland improved when water input and water retention increased (Rayan *et al.,* 2016). Those results were similar to this study in which no statistically significant differences in the CPUE were found between the seasons ($P>0.05$). However, the CPUE was significantly affected by the sampling areas. Station 6 had a significantly higher CPUE ($P<0.05$) compared to station 5 (1,609.25±1,461.26 vs. 297.38±343.21 g/100 m^2/night). This was possibly due to the characteristics of the Nong Han wetland that consisted of flat, pan-shaped basins and deep water channels between sandbars with a depth of 0.5 m (Piumsombun *et al.,* 2011). The deepest area was 4.5 m in the southwest part of the Don Sawan Station (Suvannachai, 2000) where station 6 was located. Aquatic plant distribution in the Nong Han wetland was quite abundant (Kownaruemit, Sanitchon, & Upakarat, 2014), and thus a build up of detritus that was a good area for fishing. Detritus is organic material suspended in water such as dead aquatic plants collected together into larger piles (Pengsangsee & Kaewnern, 2014) and typically transported by water flow. The size of the detritus can be more than several square meters. The detritus was able to move from the headwater to the Nong Han wetland area during the beginning of summer and stayed there for 4–6 months. Afterward, the detritus moved downstream

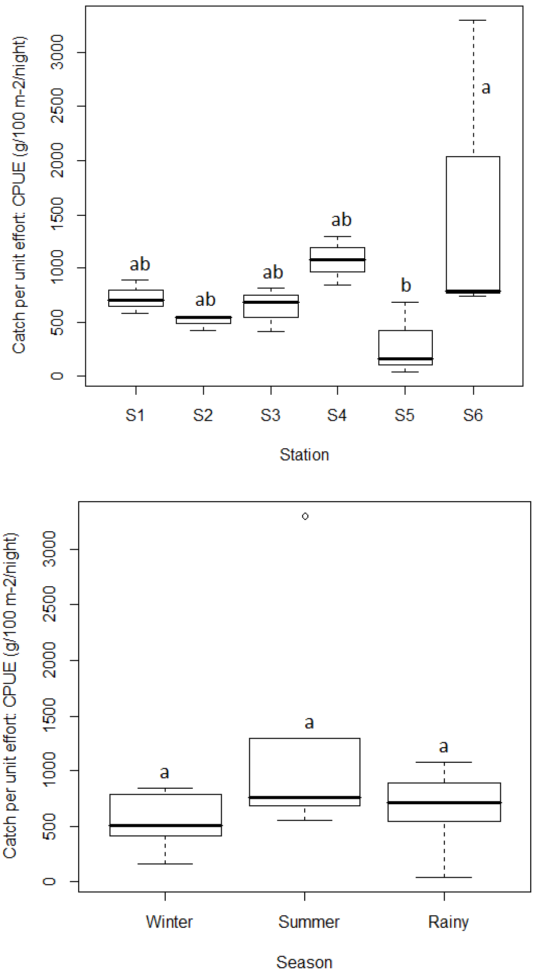

Figure 3. Average CPUE (g/100 m^2/night) in the Nong Han wetland from November 2016 to June 2017.

and became submerged during the rainy season. This cycle occurs every year as a result of fish abundance in this area (Kunlapapuk *et al.,* 2014). The greatest catch yielded fish herbivores which accounted for the highest CPUE at the Pak Narmkam station.

The average CPUE was 807.77 g/100 m^2/night from a study in 2017. When we consider the CPUE during the 7 consecutive years from 2009 to 2015, the lowest CPUE was in 2009 and higher CPUE occurred in 2010 and 2011 (Rayan *et al.*, 2016). This was possibly due to severe flooding at the end of 2010. The CPUE was lower from 2013 to 2016 (877.70, 749.80, and 731.40 g/100 m^2/night, respectively). However, the CPUE improved to 807.77 g/100 m^2/night (as 9.45% CPUE of the previous year) in 2017, due to government management that included measures of habitat improvement and spawning grounds of aquatic animals between 2008 and 2017 by dredging (272,852 m^3/year) and weeding (73,278 ton/year), according to the Nong Han Dredging and Weeding Unit (personal contact). Fishing was prohibited during the spawning seasons to allow for stocking of aquatic animals to increase productivity from 2007 to 2016 with more than 21.36 million fish or 2.37 million fish/year (Sakon Nakhon Inland Fisheries Research and Development Center, 2016). In addition, measures of plant conservation and preservation of the Nong Han wetland were announced at the Suratsawadee floodgate, which is controlled by the government, conservation areas of Chom Chaeng Temple, Baan Paen Village, Ponnakeaw District, and the conservation areas of Donkeaw Temple, Muang Lai Village, and Muang District that are controlled by the local communities (Rayan *et al.,* 2016). Those measures that belong to the community and the participation should be emphasized in such a way that the community truly owns their fishery resources. This is an important strategy for community cooperation to be used wisely, such as community monitoring, surveillance of illegal fishing, establishment of rules and regulations for fishing in community water supplies, and implementation of breeding ground conservation or fish larvae rearing ponds for a continuous supply of aquatic animals to the community (Tanasomwang, 2013). Those will be important milestones in the management and utilization of sustainable fisheries resources in the Nong Han wetlands.

5. Conclusions

This research found a total of 18 families with 45 fish species and the most abundant fish family was Cyprinidae (20 species [44.44%]). The abundant fish species was *P. siamensis* (48.30%). In addition, fish species weight composition was 20.08% for *S. gudgeri*. The IRI was 42.07 of which *P. siamensis* was the most dominant fish species. The average CPUE in the Nong Han wetland was 807.77 g/100 m^2/night. This was classified as a moderate level of fish abundance with a tendency of decreasing productivity. In addition, the production of water sources is caused by only 2–3 species of small fish which indicates that the habitat was beginning to deteriorate. Therefore, measures for the use of fishery resources in the Nong Han wetland should be defined. As a guideline to prevent the reduction of fish production in water sources, the government sector should set measures to control the use of appropriate fishing equipment, fish release to increase production capacity, and restore water resources. In addition, the public sector or community should set the criteria for resource utilization, monitoring illegal fishing, and create awareness of the use of water resources in order to achieve sustainable productivity.

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