Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 4, No. 6, p. 167-177, 2014
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Food habit of hampala (*Hampala macrolepidota* Kuhl & Van Hasselt 1823) and its position in food web, food pyramid and population equilibrium of ranau lake, Indonesia

Safran Makmur[1*], Diana Arfiati[2], Gatut Bintoro[2], Arning Wilujeng Ekawati[2]

[1] *Research Institute for Inland Fisheries, Palembang, Indonesia*

[2] *Faculty of Fisheries and Marine Science, Brawijaya University, Malang, Indonesia*

Article published on June 12, 2014

Key words: Food habit, food pyramid, food web, *Hampala macrolepidota*, population equilibrium, Ranau Lake.

Abstract

Hampala is an important economic fish species living in Ranau Lake. Food habit is closely related with trophic level in food web or food pyramid of fish population in the water. This study was aimed at knowing the position of food habit in food web, food pyramid, and population equilibrium in Ranau Lake. It was carried out in March-November, 2013. Fish samples were collected by experimental gill net of 1½ inch,1¾ inch and 2½ inch mesh size in Banding Agung and Talang Teluk areas. Fish samples were measured and weighed, gut content observed, and digestive tract length measured. Gut content analyses of *Hampala macrolepidota* with total length range of 9.7 cm – 33.3 cm, mean length of 19.17±4.72 cm were encountered 7 food groups, fish, shrimp, crab, insect, mollusc, aquatic plant and food debris. Hampala is a carnivorous fish with major food of fish (IP=58.85%; FK=73.78%). Relative length of the digestive tract to total length was 87.3%. Regression equation between total length (X) and digestive tract length (Y) was Y=1,1757+0,9327X (r=0,93). Hampal, in food web and food pyramid, occurred as tertiary consumer or at the peak of food pyramid. Non-predatory and predatory ratio (F/C) was 1.56 with standard value range of 1.40-10.00 indicating that fish population in Ranau Lake, between predatory and non-predatory fish, was still in equilibrium.

***Corresponding Author:** Safran Makmur ✉ frans_makmur@yahoo.com

Introduction

According to Allison and Sikoki (2013), food is one of the main factors affecting fish population dynamics in aquatic ecosystem. Also, Nikolsky (1963) found that food is an important controlling factor for reproduction, population dynamic, and fish condition in the waters. Food quantity and quality are one of the important factors that can influence the reproductive period, the fecundity at first maturity and the fish survivalship (Priyadharsini, 2012), but not all food sorts are taken by the fish. Factors determining whether a food item is eaten by the fish or not are the food size and the food availability. Basically, fish have high adaptive ability to their food habit and utilizing the available food. Food habit is defined to see how far the fish preferrence to the food type.

Basically, trophic level is a series of food or material and energy exploitation rate as illustrated in the food chain in an ecosystem (Zanden *et al.,* 1999). A food web is usually a pyramid with phytoplankton on the base of the pyramid (Shackell, 2012). Food web, according to Zacharia (2013), is an interconnective form of the ecosystem in a complex pattern. Trophic level describes material or energy transfer steps from one level to the next one strarting from primary producer, primary consumer (herbivores), secondary consumer, tertiary consumer and etc., and finally peak predator (Odum, 1998). The first trophic level is occupied by phytoplankton as primary producer, the second one by herbivorous zooplankton, and the third one by carnivores (Nontji, 1993).

Ranau Lake in located in South Ogan Komering Ulu (south OKU) regency, South Sumatera Province and West Lampung Regency, Lampung Province, Indonesia. The width of Ranau Lake is approximately 12,300 Ha (123 km^2) with average depth of 78 m (P4KSI, 2012). Ranau Lake has maximum depth of 229 m located at ± 540 m above sea level with water volume of approximately 21,950 x 10^6 m^3 (Sulastri *et al.*, 1999). Various fish species live in this lake, in which introductory fish are the most dominant. One of native fish whose population is still high enough and highly economic is Hampala (*Hampala macrolepidota*, Kuhl & Van Hasselt 1823).

Hampala is a carnivorous fish and even a fish predator. In food chain, hampal's position in Ranau Lake is highly important for population equilibrium. According to Foster (2013), predator-prey ratio could be used to observe the fish population equilibrium.

There have not been many studies on Hampala in Indonesian lakes, and even no comprehensive study on Hampala in Ranau Lake has been reported. Previous study was conducted by Sulastri (2002) concerning fish food composition and food web in Ranau Lake, so that this study would be highly contributed to hampala management in Ranau Lake. Therefore, this study was aimed to know the food habit of hampala (*Hampala macrolepidota* Kuhl & Van Hasselt 1823), and its position in food web, food pyramid and population equilibrium in Ranau Lake, Indonesia.

Materials and methods

Study area

This study was carried out in 2013 in Ranau Lake, South Sumatera, Indonesia. Fish samples were collected from gill-net catches (1½, 1¾ and 2½ mesh size) in two fishing grounds (Fig.1), Silabung Downstream or Banding Agung (04°48.920' S, 103°55.193' E) and Talang Teluk (04°49.318'S, 103°54.769'E).

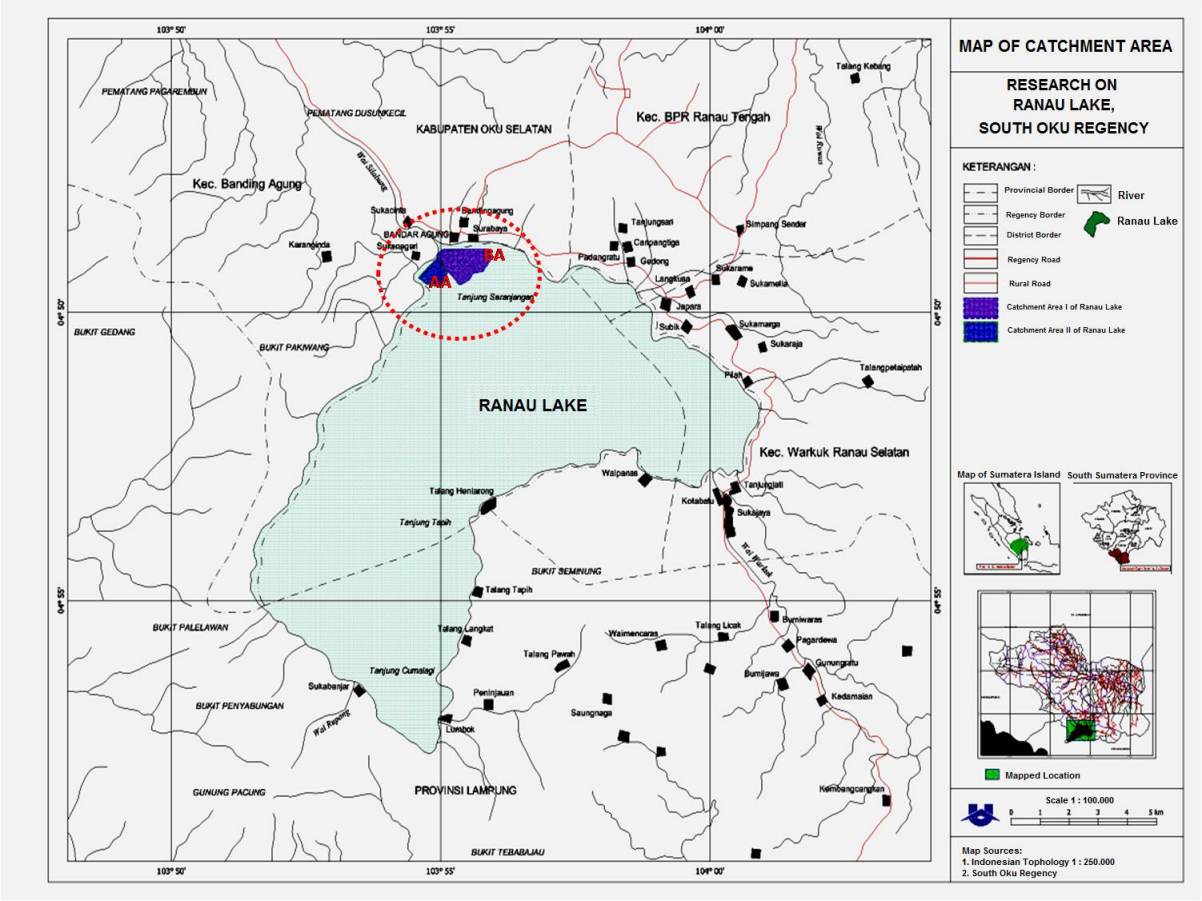

Fig. 1. Map of Ranau Lake Study Site, South Sumatera, Indonesia.
sampling sites: AA=Talang Teluk, BA=Banding Agung.

Data collection

The fish samples were recorded their total length and weighed, then dissected to observe the stomach content following Pouilly *et al.* (2006). Empty stomachs were not used. The length of digestive tract was measured (1 mm accuracy) and preserved in 4% formaldehyde. The stomach content was then taken out and measured the volume, then directly observed under an enlargement glass or binocular microskope with minimum enlargement. The food types were identified and grouped into fish, shrimp, mollusc, insect and digested groups (for unidentified digested parts) (Safi *et al.*, 2013).

Data analysis

Stomach content was analyzed on the basis of occurrence frequency (Hynes, 1950; Hyslop, 1980; Junior and Goitein, 2001; Oso, 2006; Agbabiaka, 2012).

$$Fi = 100\ ni/n$$

Description:

F_i = *occurrence frequency of food* i

n_i = number of food *i*

n = total number of digestive tract containing food

Index of Preponderance was employed to know the main food eaten, an integration of occurrence frequency method and volumetric analysis Index. Preponderance index was determined following Natarajan and Jhingran (1961):

$$IP = \frac{Vi \times Oi}{\sum(Vi \times Oi)} \times 100$$

Description:

V_i = *percent volumn of food* i

O_i = percent occurrence frequency of food *i*

$\Sigma\ (V_i\ x\ O_i)$ = Total of $V_i x\ O_i$ of all food types

IP = Index of Preponderance (%).

The relative weight of food content in the stomach was calculated following Hyslop (1980):

$$\text{Relative weight of stomach content} = \frac{\text{Total weight of all stomach content}}{\text{Total weight of all fish}} \times 100$$

The relationship between total length and total digestive tract length was analyzed using linear regression equation: Y= a+bX, where X= fish total length and Y= total length of digestive tract, a= ordinate intercept and b= regression coefficient (Azadi *et al*., 2009; Manon and Hossain, 2011; Singh *et al*., 2012).

Food web analysis was also done based on secondary data of Sulastri (2002) in Ranau Lake and modification of present update data in this study. Fish species data were gained from fishermen's catches by gill-net, net and spear.

Population equilibrium status was obtained by grouping the fish samples into 3 groups based on size, small (< 50 g), medium (50 – 100 g) and large (> 100 g) and the fish utilizing habit as food into predatory and non-predatory fish. Fish population equilibrium status was calculated using the creteria of Swingle (1950) and Swingle (1961):

F/C = Non-predatory and predatory fish ratio.
(Standard value ranges from 1.40 to 10.00).
Y/C = small non-pradatory fish and large predatory fish ratio.
(Standard value ranges from 0.02 to 4.80).
A_T = Percent total weight of large fish (non-predator and predator) to total sample weight.
(Standard value ranges from 33.00 to90.00).
A_F = Percent weight of large non-predatory fish to total weight of non-predatory fish.
(Standard value ranges from 18.20 to 99.60).
I_F = Percent weight of medium-sized non-predatory fish to total weight of non-predatory fish sample.
(Standard value ranges from 0.00 to 41.40).
SF = Percent weight of small-sized non-predatory fish to total weight of non-predatory fish.
(Standard value ranges from 0.40 to 80.90).

Results

Food habit

Number of Hampala (*Hampala macrolepidota*) whose gut contents were analyzed were 225 individuals or 22.91% of total 982 fish observed (Table 1). Fish with empty stomach were 757 individuals or 77.09% of the total number. High number of fish with empty stomach could result from that fish whose gill was entangled spew the stomach content so that food in the stomach is rarely in undamaged condition. The fish size whose stomach was analyzed ranged from the total length of 9.7 cm to 33.3 cm with an average of 19.17±4.72 cm long.

Based on stomach content analysis, there were 7 food groups (Table 1), fish, shrimps, crabs, insects, molluscs, aquatic plants, and digested parts. In general, the organism condition in the stomach was not complete, such as head, bone, scale, wing, foot or other body parts. Only shrimps, insects and some fish were in undamaged condition**.** Fish (including body parts such as head, bone or scale) dominated food in hampal's stomach in which almost every month was found fish group in the stomach, approximately 23.81% - 90.31% or averagely 56.85%.

The second food group dominating hampala's stomach was shrimp. As fish, shrimps were almost always recorded in monthly observation, but in June insects dominated the fish stomach in which 1.75 inch-mesh sized gill net fishing in Talang Teluk found more insects than shrimps with IP of 13.81% for shrimps and IP of 25.44% for insects, respectively.

Stomach content observation in June indicated that hampala's stomach contained moths or termites (*Macrotermes gilves*), especially reproductive caste. June is estimated as the beginning of rainy season in which termites will grow their wings and fly out of

their colony to breed, and they highly like or are attracted by light at the lake side in Banding Agung and Talang Teluk which is people residential area so that many of them approach the lamp light, fall to the water, and become fish food, such as hampala.

Table 1. Index of Preponderance (%) of Hampala (*Hampala macrolepidota*) with sampling station and gill-net used in Ranau Lake.

sampling 2013	station	Net (inch)	N (total)	N (content)	`% content	Index of Preponderance (%)						
						Fish	Shrimp	Crab	Insect	mollusc	Aq. plant	Digested
March	BA	1,5	7	2	28,57	79,17						20,83
		1,75	22	7	31,82	41,02	17,99	4,98	10,56			25,45
		2,5	23	6	26,09	70,7	13,13		4,17			12
	TT	1,5	9	4	44,44	71,28	14,47					14,25
		1,75	38	8	21,05	66,25	15,3					18,45
April	BA	1,5	8	3	37,50	40,08	24,17			9,04		26,71
		1,75	11	4	36,36	38,82	9,42					51,76
		2,5	17	11	64,71	57,76	11,81					30,43
	TT	1,5	32	3	9,38	37,75	12,26					49,99
		1,75	14	2	14,29	62,5						37,5
May	BA	1,5	0		0,00							
		1,75	33	4	12,12	82,7	5,7					11,6
		2,5	9	2	22,22	52						48
	TT	1,5	0		0,00							
		1,75	32	5	15,63	62,09	4,14					33,77
June	BA	1,5	7	3	42,86	23,81			40,48			35,71
		1,75	31	9	29,03	26,5			34,47			39,03
		2,5	19	6	31,58	30,67			50,54			18,79
	TT	1,5	11	3	27,27	30			37,75			32,25
		1,75	16	6	37,50	38,69	13,81		25,44			22,06
August	BA	1,5	36	5	13,89	59,86	22,68					17,46
		1,75	12	4	33,33	57,54	27,78					14,68
		2,5	23	6	26,09	76,36	2,86				3,78	17
	TT	1,5	18	7	38,89	53,12	22,71					24,17
		1,75	13	3	23,08	64,1	16,85					19,05
September	BA	1,5	29	4	13,79	83,25	2,5					14,25
		1,75	53	10	18,87	78,7	6,77					14,53
		2,5	19	5	26,32	90,31		3,88				5,81
	TT	1,5	19	5	26,32	68,29	25,71					6
		1,75	45	9	20,00	61,22	4,41	25				9,37
October	BA	1,5	43	8	18,60	34,38	58,1					7,52
		1,75	33	6	18,18	24,59	50,97	17,03				7,41
		2,5	28	7	25,00	43,72	44,23					12,05
	TT	1,5	27	9	33,33	33,74	51,48					14,78
		1,75	45	8	17,78	39,53	51,14					9,33
November	BA	1,5	47	14	29,79	74,85	14,2					10,95
		1,75	47	7	14,89	90,31	3,57					6,12
		2,5	6	2	33,33	66,47	7,87					25,66
	TT	1,5	49	8	16,33	76,56	11,46					11,98
		1,75	51	10	19,61	71,69	18,5					9,81
Total			982	225								
Mean			24,6	5,63								

Notes : TT=Talang Teluk, BA=Banding Agung

As a whole, fish is the most food types found in hampala's stomach with Index of Preponderance (IP) of 58.85% and Occurrence frequency (OF) of 73.78%, followed by shrimps (IP=17.27% and OF = 32.44%), and then insects (IP=4.59% and FK=8.89%). The digested group as much as IP=17.06% and OF= 45.78% is high enough, the food origin cannot be known due to being food debris (Fig. 2). Based on the IP value, fish is major food of hampala (>40%), shrimps and insects as complementary food (4-40%), and other food types, such as molluscs and crabs as additional food (<40%). The digested food group, despite unidentified, is also taken as part of hampala's food since it is part of hampala's gut content as well.

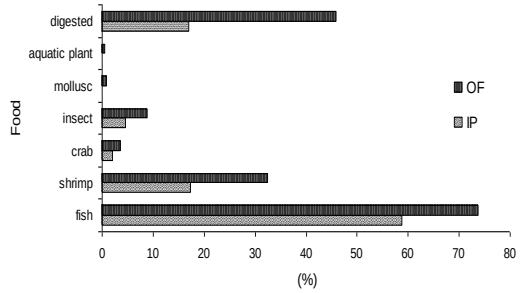

Fig. 2. Histogram of occurrence frequency (OF) and Index of Preponderance (IP) of Hampala in Ranau Lake.

Fish weight and stomach content weight ratio of hampala were as follows: Body weight ranged between 10.05-350 g, mean weight was 175±75.76 g or total weight of entire fish samples was 20,065.25 g (N=225 individuals) and total stomach content weight was 276.85 g, relative stomach content weight was 1.38 g or mean weight of stomach content was only about 0.8% of fish body weight.

Relationship between total fish length and digestive tract length

Based on Fig. 3, total fish length is longer than total digestive length, 8.1-32.7 cm long or mean length of 19.18±4.72 cm for total fish length and 8.1-30.9 cm long or mean length of 16.71±4.57 cm for digestive tract length, respectively. Digestive tract length and total length ratio of hampala in Ranau Lake was 1:1.15. According to Tamsil (2000), relative length is fish digestive tract length expressed in percent of total body length. Percent of digestive tract length of hampala was 87.13% of the total length. The regression equation between total length (X) and digestive tract length (Y) was Y= 1.1757+0.9327X with correlation coefficient (r) of 0.93 .

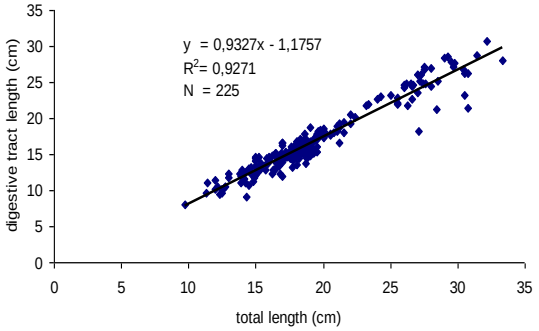

Fig. 3. Linear regression between total length and digestive tract length of Hampala (*Hampala macrolepidota*) from Ranau Lake.

Food web and food pyramid

Based on fishermen's catches, there were 10 fish species n Ranau Lake waters (Table 2). The fish could be separated into their tropic groups with food habit. The fish food web and food pyramid in Ranau Lake (Fig. 4 and 5) consisted of herbivorous group as primary consumer represented by *Oreochromis mossambicus*, *Osteochilus vittatus*, *Puntius* sp1, *Puntius* sp2 and *Tor* sp., omnivorous group or secondary consumer represented by *Hemibagrus nemurus, Notopterus notopterus*, *Cyclocheilichtyes apogon* and *Pristolepis grooti,* and tertiary consumer or predator represented by *Hampala macrolepidota*. The lowest position of the food web and food pyramid was represented by other food group, such as shrimp, insect, mollusc, detritus, nematode, plankton and aquatic plant.

Table 2. Fish species in Ranau Lake and its group trophic.

No.	Local Names	Scientific Names	Trophic Group
1	Hampal	*Hampala macrolepidota*	Carnivore
2	Kepor	*Pristolepis grooti*	Omnivore
3	Tilapia	*Oreochromis mossambicus*	Herbivore
4	Palau	*Osteochilus vittatus*	Herbivore
5	Selibak	*Puntius* sp1	Herbivore
6	Baung	*Hemibagrus nemurus*	Carnivore
7	Kepiat	*Cyclocheilichtyes apogon*	Omnivore
8	Putak	*Notopterus notopterus*	Carnivore
9	Keperas	*Puntius* sp2	Herbivore
10	Semah	*Tor* sp	Herbivore

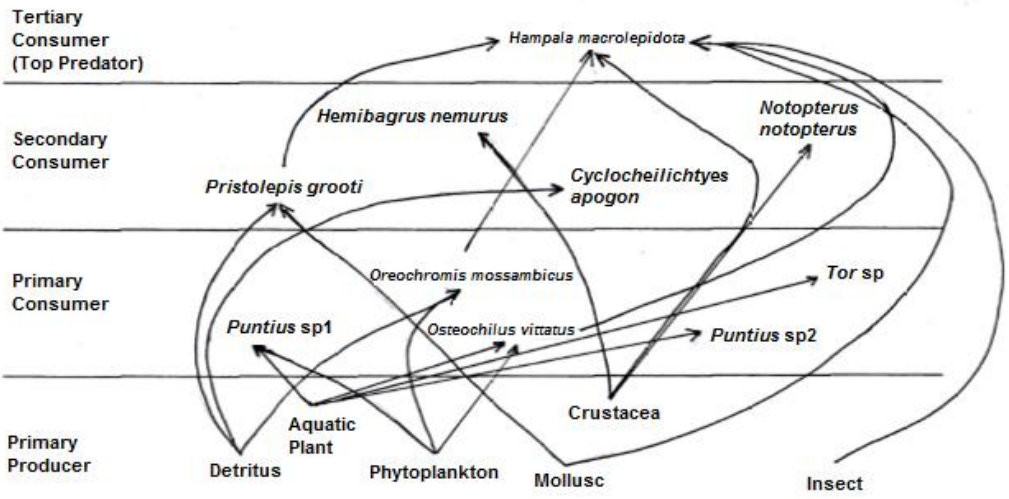

Fig. 4. Fish Food Web in Ranau Lake

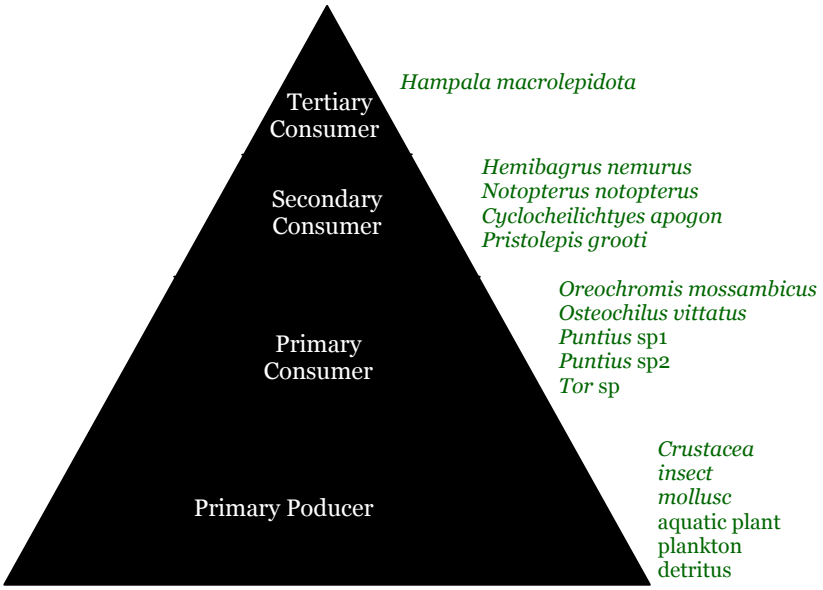

Fig. 5. Fish Food Pyramid in Ranau Lake

Population equilibrium

Fish community structure in Ranau Lake waters is dominated by large-sized predatory fish and small-sized non-predatory fish (Table 3). This study found that non-predatory and predatory (F/C) ratio was 1.56 and small-sized and large-sized predatory fish ratio (Y/C) was 0.90. Percent total weight of large-sized fish to total sample weight (A_T) was 40.39, percent weight of medium-sized non-predatory fish to total weight of total sample weight of non-predatory fish (I_F) was 40.09, and percent weight of small-sized non-predatory fish to total weight of non-predatory fish (S_F) was 84.23, respectively. All values were still in standard range and only percent weight of large-sized non-predatory fish to total fish weight (A_F) was beyond the standard (A_F = 2.1) (Table 4).

Table 3. Predatory and Non-predatory fish composition in Ranau Lake.

Size	Fish Species	Fish weight (g)		Total
		non predator	predator	
small (50 g)	Hampala (*Hampala macrolepidota*)	5688,58		5688,58
	Kepor (*Pristolepis grooti*)	16728,68		16728,68
	Palau (*Osteochilus vittatus*)	636,7		636,7
	Tilapia (*Oreochromis mossambicus*)	1995,99		1995,99
	Selibak (*Puntius* sp1)	596,83		596,83
	Baung (*Hemibagrus nemurus*)			
	kepiat (*Cyclocheilichtyes apogon*)	2384,71		2384,71
	Keperas (*Puntius* sp2)	177,98		177,98
	Semah (*Tor* sp)			
	putak (*Notopterus notopterus*)	92,83		92,83
	Sub-total	28302,3		28302,3
medium (50-100 g)	Hampala (*Hampala macrolepidota*)	16084,37		16084,37
	Kepor (*Pristolepis grooti*)	1816,38		1816,38
	Palau (*Osteochilus vittatus*)	1373,22		1373,22
	Tilapia (*Oreochromis mossambicus*)	167,67		167,67
	Selibak (*Puntius* sp)			
	Baung (*Hemibagrus nemurus*)	56,74		56,74
	kepiat (*Cyclocheilichtyes apogon*)			
	Keperas (*Puntius* sp2)	55,81		55,81
	Semah (*Tor* sp)	73,81		73,81
	putak (*Notopterus notopterus*)			
	Sub-total	19628		19628
large (>100 g)	Hampala (*Hampala macrolepidota*)		31448,7	31448,7
	Kepor (*Pristolepis grooti*)			
	Palau (*Osteochilus vittatus*)	690,55		690,55
	Tilapia (*Oreochromis mossambicus*)			
	Selibak (*Puntius* sp1)			
	Baung (*Hemibagrus nemurus*)	334,46		334,46
	kepiat (*Cyclocheilichtyes apogon*)			
	Keperas (*Puntius* sp2)			
	Semah (*Tor* sp)			
	putak (*Notopterus notopterus*)			
	Sub-total	1025,01	31448,7	32473,71
	Total	48955,31	31448,7	80404,01

Table 4. Fish Population Equilibrium in Ranau Lake

Criterion	Equilibrium Ratio	
	Standard	Observation
F/C	1,40 – 10,00	1,56
Y/C	0,02 -- 04,80	0,90
A_T	33,00 – 90,00	40,39
A_F	18,20 – 99,60	2,10
I_F	0,00 – 41,40	40,09
S_F	0,40 – 80,90	57,81

Discussion

Food habit

Based on the food habit of hampala in Ranau Lake, mean total length of 19.18 cm belongs to carnivorous fish with fish as major food, the Index of Preponderance (IP) is higher than 40% (58,85%). Welcomme (1979) grouped *Hampala macrolepidota* into predatory fish group which preys on fish, shrimps, and insects. Based on previous study (Abidin,1984) in Zoo Lake, Malaysia, hampala is is a carnivorous fish whose main food types are fish and shrimps. Similar finding was also recorded by Jubaedah (2004) in Cirata Reservoir, West Java, that hampala with size between 15.01-24 cm long is carnivorous fish whose major food is fish (IP=71,22%). In Jatiluhur Reservoir, a 13.64 cm long-sized hampala has started prey on fish (Tjahyo, 1993).

Fish species identified as hampala's food in Ranau Lake were tilapia (*Oreochromis mossambicus*), kepor (*Prestolepis grooti*), and palau (*Osteochillus vittatus*), and they are still abundant in Ranau Lake waters. According to Sulastri (2002), tilapia and palau in Ranau Lake are herbivorous fish while kepor is omnivorous. Shrimp species found in hampala's stomach was *Macrobrachium* sp. mostly living the littoral zone of the lake where there are many aquatic plants, *Hydrilla* sp.

Insects identified in hampala's stomach was termites (*Macrotermes gilvus*) of reproductive caste. June is transitional season from dry to rainy season and beginning of spawning activity of reproductive termites so that its population is very high at night searching for light source. The insects falling into the water (littoral area with high human residence) will become fish food. The presence of aquatic plant in fish stomach could result from being eaten when hampala preys on food hidden around the aquatic plant in the lake margin.

Relationship between fish total length and digestive tract length

Based on the composition or the comparison between fish total length and digestive tract length, hampala has shorter digestive tract than total length with percent relative digestive tract length to fish total length of 87.13%. Based on Singh *et al.* (2012), carnivorous fish possess relative length of digestive tract shorter than their total length.

Food web and food pyramid

Fish food web in Ranau Lake consisted of primary consumer fish group, secondary consumer, and tertiary consumer or predatory fish. Based on Sulastri (2002), these groups reflect the completeness of the fish food web components. The food web could be built to know the fish food habit that their trophic group could be recognized. Food habit and important food are known to understand the fish role in an ecosystem, especially fish functional role in their ecosystem (Luna *et al.*, 2008; Motlagh *et al.*, 2012).

Population equilibrium

Large-sized predatory fish dominated fish population in Ranau Lake. Non-predatory and predatory fish ratio (F/C) of 1.56 based on the standard values (Swingle, 1950; Swingle, 1961), in the range of 1.40 - 10.00, means that fish population in Ranau Lake is still in equilibrium category between predatory and non-predatory fish. Kunto and Tjahjo (2003) found that in Rawa Taliwang, West Nusa Tenggara, the F/C value was 1.38 or poor condition.

The herbivorous fish population, especially Tilapia whose population growth is very fast could be controlled by hampala whose population is still high enough in Ranau Lake. Based on Balik *et al.* (2006), the prey fish population is directly influenced by the

presence of predatory fish. Predator could reduce the prey population even at lower trophic level.

Based on their food habit, Hampala (*Hampala macrolepidota*) is a carnivorous fish whose major food is fish. In fish food web and pyramid, Hampala is a tertiary consumption fish in Ranau Lake or located at the peak of food pyramid. Hampala plays a good role in maintaining the population equilibrium between predatory and non-predatory fish.

Acknowledgement

The author would like to thank the Research Team of Ranau Lake, Research Institute for Inland Fisheries, Palembang, South Sumatera, Indonesia.

References

Abidin ABZ. 1984. Some aspect of the biology of *Hampala macrolepidota* (Van Hasselt) with reference to its food feeding habits and reproduction from Zoo Negara Lake Kuala Lumpur, Malaysia. Master Thesis. University of Putra Malaysia, 115p.

Agbabiaka LA. 2012. Food and feeding habits of *Tilapia zilli* (Pisces: Cichlidae) in River Otamin South-Eastern Nigeria. Bioscience Discovery **3** (2), 146-148.

Allison ME, Sikoki FD. 2013. Food and feeding habits of *Parailia pellucida* (Boulenger, 1901) (Schilbeidae) in the fish water reach of the Nun River at the Niger Delta Nigeria. International Journal of Advanced Fisheries and Aquatic Science **1**, 1-14.

Azadi MA, Nasruddin M, Rahman ASMS. 2009. Food and feeding habits of Clupeid *Gonialosa manmina* (Ham) from The Kaptai Lake Bangladesh. The Chittagong University Journal Biology of Science **4** (1), 53-61.

Balik I, Cubuk H, Karasahin B, Ozkok R, Vysae R, Alp A. 2006. Food and feeding habits of the pikeperch, *Sander lucioperca* (Linneaeus, 1758), population from Lake Egirdir (Turkey). Turkey Journal Zoology **30**, 19-26.

Foster J. 2013. Fisheries management: matching expetations to reality, diet for a small lake. Second Edition Chapter **5**, 1-21.

Hynes HBN. 1950. The food of the freshwater stricklebacks (*Gasterosteus aculeatus* and *Pygosteus pungitius*) with a review of methods used in the studies of the food of fishes. Journal of Animal Ecology **19**, 36-58.

Hyslop EJ. 1980. Stomach contents analysis a review of methods and their application. Journal Fish Biology **17**, 411-429.

Jubaedah I. 2004. Distribution and food of Hampala (*Hampala macrolepidota* C.V) in Cirata Reservoir, West Java. Master Thesis. Bogor Agricultural University. 82 p.

Junior SEL, Goitein R. 2001. A new method for the analysis of fish stomach contents, Journal Maringa **23** (2), 421-424.

Luna VR, Naula AF, Rubio EA. 2008. Food habits and feeding ecology of an estuarine fish assemblage of northern Pacific Coast of Ecuador. Pan American Journal of Aquatic Sciences **3** (3), 361-372.

Manon MR, Hossain MD. 2011. Food and feeding habit of *Cyprinus carpio* Var. Specularis. Journal Science Foundation **9** (1&2), 163-181.

Motlagh AT, Hakimelahi M, Shojaei MG. 2012. Feeding and stomach contents of silver sillago, *Sillago sihama*, in the Northern Persian Gulf. Iranian Journal of Fisheries Sciences **11** (4), 892-901.

Natarajan AV, Jhingran AG. 1961. Index of Preponderance a method of grading the food elements in the stomach analysis of fishes. Indian Journal of Fish **8** (1), 54-59.

Nikolsky GV. 1963. The Ecology of Fishes. Academic Press, New York, 352p.

Nontji A. 1993. Laut Nusantara. Djambatan Jakarta. 367 p.

Odum EP. 1998. Fundamentals of ecology. 3rd Ed. Samingan T, Srigandono B, Transl. Gajah Mada University Press. Yogyakarta. 697 p.

Oso JA, Ayodele IA, Fagbuaro O. 2006. Food and feeding habits of *Oreochromis niloticus* (L) and *Saratherodon galilaeus* (L) in Tropical Reservoir. World Journal of Zoology **1** (2), 118-121.

Pouilly M, Barrera S, Rosales C. 2006. Changes of taxonomic and trophic structure of fish assemblages along an environmental gradient in the upper Beni Watershed (Bolivia). Journal of Fish Biology **68**, 156-173.

Priyadharsini S, Manoharan J, Varadharajan D, Subramaniyan A. 2012. Interpretation of the food and feeding habits of *Dascillus trimaculatus* (Ruppell, 1829) from Gulf of Manner, South East Coast of India. Archives of applied Science Research **4** (4), 1758-1762.

Kunto P, Tjahjo WH. 2003. Several fisheries ecological aspects in Taliwang Swamp, Wwest Nusa Tenggara. JPPI Resources and Fishing Edition **9** (3), 21-29.

Pusat Penelitian Pengelolaan Perikanan dan Konservasi Sumberdaya Ikan (Research Centre of Fisheries Management and Fish Resources Conservation). 2012. Bathymetric and Hidroacoustic Surveys. Field Survey Report. 10p.

Safi A, Khan MA, Khan MZ, Hasmi MVA. 2013. Observations on the food and feeding habits of striped pissy. *Pomadasys striclens* (Foriskal, 1775) (Family: Pomadasyidae) from Karachi Coast, Pakistan. International Journal of Fauna and Biological Studies **1** (1), 7-14.

Shackell N. 2012. Trophic structure. State of The Scotian Shelf Report Fisheries and Oceans Canada. 29p.

Singh CP, Ram RN, Singh RN. 2012. Food and feeding pattern of *Channa punctatus* in two different habitats at Tarai region of Uttarakhand. Journal of Environmental Biology **34**,789-792.

Sulastri M, Badjoeri, Sudarso Y, Syawal MS. 1999. Physo-chemical and biological conditions of Ranau Lake waters, South Sumatra. Research and Development Centre of Limnology. Indonesia Science Institute. Limnotek **VI** (1), 25-38.

Sulastri. 2002. Fish food composition and webs. Monograph No.2. Research Centre of Limnology, LIPI, 99-108.

Tamsil A. 2000. Study on pre-spawning reproductive characteristics and artificial spawning possibility of Bungo (*Glossogobius aureus*) in Tempe Lake and Sidenreng Lake, South Sulawesi. PhD Thesis. Bogor Agricultural University.

Tjahyo DWH. 1993. Utilization strategy of juvenile hampala's food (*Hampala macrolepidota*) in Jatiluhur Reservoir, West Java. Master Thesis, Bogor Agricultural University, 71p.

Welcomme RL. 1979. Fisheries ecology of floodplain rivers. Longman, London and New York, 317p.

Zacharia PU. 2013. Trophic level and food chain. Demersal Fisheries Division CMFRI, Kochi, 36 p.

Zanden MJV, Shuter BJ, Lester N, Rasmussen JB. 1999. Patterns of food chain length in lakes; A stable isotope study. The American Naturalist **154** (4), 406-416.