Trophic Status and Potential Production Estimates of Fish Littoral Waters Maninjau Lake West Sumatra

Junaidi [1], Hafrijal Syandri [1], Azrita [2], and Yuneidi Basri [1]

[1)] Faculty of Fisheries and Marine Sciences University of Bung Hatta, Padang
[2)]. Faculty of Teacher Training and Education University Bung Hatta Padang

ABSTRACT

Tropics status is a picture of the fertility of the water, while fish production potential in an aquatic ecosystem is the ability of these waters to produce fish. Research on tropics status and estimates of fish production in littoral waters Maninjau was carried out in March and July 2013 with the purpose of the study to determine the tropics status of the lake littoral waters and fish production estimates. The results show that in March 2013 the value of the average phosphorus level was 418 ± 55.40 mg / L, water transparency 1.7 ± 0.35 meters, chlorophyll-a levels of 256 ± 0.38 mg / L in order to obtain the average value of the index status trophics of 76.61 ± 2.02 with the value of the trophic waters classified as severe. Meanwhile, in July 2013 the average value of 605 ± 4.79 Phosphorus levels ug / L, water transparency 1.3 ± 0.18 m, chlorophyll-a levels of 271.3 ± 2.65 mg / L in order to obtain the average value index of tropics status amounted to 78.62 ± 1.15 with the value of the trophics waters classified as severe. The estimated value of fish production in March 2013 by an average of 45.51 ± 2.81 kg / ha / year and in July 2013 an average of 44.99 ± 2.96 kg / ha / year.

Keywords: Maninjau, littoral areas, water quality, trophic status, estimates of fish production

INTRODUCTION

Maninjau is an ecosystem that has a water surface area of approximately 9737.50 acres has undergone many changes mainly result from human activities contained in the surrounding. This lake is a water resource that has a value which is very important in terms of ecological functions, hydrology, and economic functions such as fisheries, aquaculture and the generation of hydroelectric power energy Maninjau (Syandri., 2003). In this lake living 17 economically important fish species (PSLH Unand, 1994), while now it is reduced to 13 species (Syandri., 2004; Azwir., 2010). Equally important is Maninjau function as a tourist area well known to foreign countries and the potential for development of tourism in the province of West Sumatra (Ardika, 1999).

Of various studies in Maninjau indicates that there has been a decline in water quality, particularly in locations that many of the affected community activities such as fishing effort with floating cages (KJA), which already amount to as many as 13,000 plots (Syandri et al., 2005). Even Trianto et al., (2011) reported a total of 15,000 plots and Syandri et al (2012) reported 15 860 plots. Cultivation of fish in floating net (KJA) in inland public waters can produce organic matter and in the end will result in a high nitrite compounds in water through the process of nitrification (Tjahjo et al.,2001; Tjahjo and Purnamaningtyas., 2008; Krismono and Kartamihardja., 2010).

KJA activity can also boost the phosphorus compounds, and nitrogen Orthophosfat causing changes in the trophic status of waters (Nomosatryo and Lukman, 2011). According to Henny (2009) fish farming activities with KJA has led to the accumulation of a variety of chemical compounds that ultimately created the conditions for toxic to fish farming. Authochnous organic and generally consists of three forms of organic matter in the form of coarse particles, smooth and dissolved. The third organic matter will affect the flow of energy on public land and aquatic ecosystems will affect biodiversity, water productivity and fish production (Braioni et al., 2001). It is therefore important to investigate the trophic status of waters and fish production potential in littoral waters Maninjau.

MATERIALS AND METHODS

Data collected by survey and analysis in the laboratory. Observations and measurements of water quality at each station research conducted in March and July 2013 representing the dry season and the rainy season of the year. Determination of the location of the research station established by the presence of the inlet-outlet, area travel / hotel, the location of the KJA and fishing areas. The location and name of the research station can be seen in Table 1 and Fig 1.

Table 1. Descriptions of each station measurements of water quality parameters in Lake Maninjau

Station name	Geographical Position	Description / Specification
Muko-Moko	S: 00^{0}17'58, 5 " E: 100^0 09 '47.3"	outlet area, hydropower intakes, air base substrate of sand there are a lot of fishing activity and garbage waters " that floats around the intake.
Sigiran waters	S: 0^{o}18'21, 58 " E: 100^{o}11'18, 98"	Precipitous littoral waters, many are submerged aquatic vegetation and substrate dominated by mud. Maintenance There KJA for tilapia and carp, there are several public houses at the edge of the lake
Bayur waters	S: 0^{o}19'57, 89 "- E: 00^{o}12'39, 85	ramps littoral waters with sandy mud substrate and are maintenance tilapia, carp in floating net system.
Koto Kaciek waters	S: 0^{o}16'37, 15 " E: 100^{o}12'07, 41 "	littoral waters, is KJA, the base substrate dominated by mud. Part lakeside lots of rice, and littoral areas overgrown with water hyacinth.

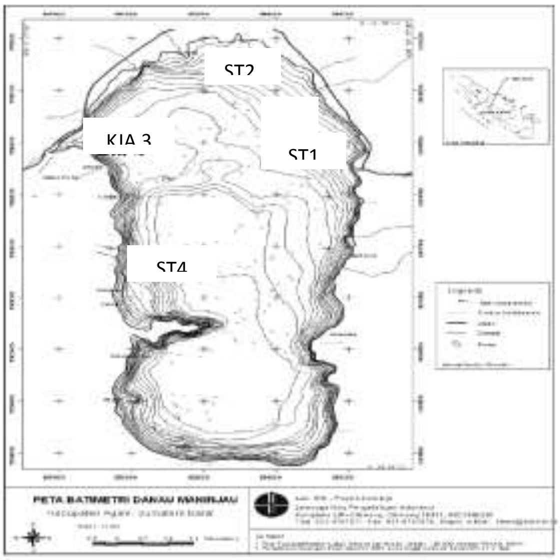

Fig 1. Research location in Maninjau lake

At each station, conducted water sampling inspection parameters for physics, chemistry and biology waters. Water samples were taken from a boat motor from the water surface using a Kemmerer water sampler. Water samples will be analyzed in the field (temperature, pH, brightness, color) and analyzed in the laboratory electrical conductivity, color, dissolved oxygen, carbon dioxide, alkalinities, hardness, nitrate levels, ammonia, phosphate and levels of chlorophyll-a. analysis water quality using a method that is standard (APHA, 1981) can be seen in Table 2

Table 2. Testing methods and tools for the analysis of water quality parameters in the body (Government Regulation no. 82 Years 2001)

No	Unit	Paramete r	Method and Apparatus
I	**Fisika**		
1	Temperature	^{0}C	Thermometer
2	Residue dissolved (TDS)	mg/L	Gravimetric
3	Residue suspended (TSS)	mg/L	gravimetric
4	brightness	m	Insitu, Plate Sachii
II	**Chemical**		
5	pH	unit	Insitu, pH paper
6	BOD	mg/L	Labor Analysis, Winkler
7	COD	mg/L	Potassium dichromate reflux method
8	DO	mg/L	Elektokimia, OT-meter
9	Total Phosphate	mg/L	Ascorbic acid, Spectrophotometer
10	Orthopospat (PO_4-P)	mg/L	Laboratory analysis Spectrophotometer
11	TOM	mg/L	Laboratory analysis, , Spectrophotometer
12	DOM	mg/L	Laboratory analysis Spectrophotometer
13	POM	mg/L	Laboratory analysis, , Spectrophotometer
14	Nitrate as N	mg/L	Laboratory analysis Spectrophotometer
			ratory analysis, , Spectrophotometer
			ratory analysis Spectrophotometer
			ratory analysis, , Spectrophotometer

18	Hardness	mg/L	Laboratory analysis Spectrophotometer
19	Alkalinity	mg/L	Laboratory analysis, , Spectrophotometer
20	Electrical conductivity	ms/cm	Laboratory analysis Spectrophotometer
21	Chlorophyll a	mg/m^3	Laboratory analysis, , Spectrophotometer
22	Oils and fats	µg/L	Gravimetrik, neraca analitik
23	Detergent as MBAs	mg/L	Biru metilena, Spektrofotometer
24	Free clorine (Cl 2)	mg/L	Analisis labor, Spektrofotometer
25	Total chrome	mg/L	Analisis labor, Spektrofotometer
26	Dissolved iron (Fe)	mg/L	Analisis labor, Spektrofotometer
27	Lead (Pb)	mg/L	Analisis labor, Spektrofotometer
28	Copper (Cu)	mg/L	Analisis labor, Spektrofotometer
29	Zinc (Zn)	mg/L	Analisis labor, Spektrofotometer
30	Cadmium (Cd)	mg/L	Analisis labor, Spektrofotometer

Trophic status of waters are characterized by a high low nutrient content, such as N and P as well as the abundance of phytoplankton or chlorophyll concentration. Carlson (1977) proposed an index of trophic status of waters based on water transparency readings of pieces secchi (secchi disk), the content of total phosphorus and chlorophyll-a content. Based on the proposed trophic status index, the index of trophic status of the lakes studied index is calculated using the formula of Carlson's trophic status (Carlson's trophic state index, TSI) (Carlson, 1977), namely:

TSI-TP = 14,42 * Ln [TP] + 4,15 where TP = total phosphorus in ug / l
TSI-SD = 60 - 14,41 * Ln [SD] where SD = brightness of the water in meters
TSI-Chl = 30,6 + 9,81 * Ln [Chl] where Chl = chlorophyll-a concentration in µg / l
Mean-TSI = (TSI-TP+TSI-SD+TSI-Chl)/3
TSI-TP = Value Trophic Status Index for Total Phosphorus
TSI-SD = Value Trophic Status Index for Secchi Disk Depth
TSI-Chl = Value Trophic Status Index for chlorofil-a

To get the value of total phosphorus use formulas Jones and Bachmann (1976) in Hilman, et al (2008) that: Log (Chlorofil-a) = -1,09 +1,46 Log TP, where (chlorofil-a) is chlorofil-a concentration in units of ug / L and TP is total phosphorus in units of ug / L.

To estimate the magnitude of potential fish production (kg / ha / year) in Maninjau using the formula proposed by Henderson and Welcomme (1974) in Moreau and De Silva (1991) is Y = 14.314 MEI 0'4681, where: Y = the potential production fish in units of kg / ha / year, MEI = Morpho Edhaphic Index is the value of electrical conductivity (conductivity) in units umhos divided by the average depth of the lake in meters. At each station research, literal water depth was measured at three points, namely: 1) at the edge, 2) in the middle, 3) at the area near the border with limnetik.

Table 3. Trophic Status Categories Based on Carlson's Trophic Status Index (1977)

Score	Status	Specification
<30	Ultraoligotropik	Clear water, high dissolved oxygen concentrations throughout the year and reached the zone hipolimnion
30-40	Oligotrofpik	Clear water, possible restrictions on the anoxic zone periodically hipolimnetik (DO = 0)
40-50	Mesotropik	Moderate water clarity, increased the changing nature hipolimnetik anoxic zone, the aesthetic is still support for water sports activities
50-60	Mild eutrophic	Decrease in water transparency, are anoxic zone hipolimnetik, there is a problem of water plants, only fish that can live in warm water, to support water sports activities but need handling
60-70	Eutrophic being	Dominated by blue-green algae, occur clumping, water plants already extensive problem
70-80	Heavy eutrophic	Heavy algal blooms occur, forming a layer of water plant beds as conditions hypereutrophik
>80	Hypereutropik	Clumps of algae, dead fish, water plants slightly dominated by algae

RESULTS AND DISCUSSION

Results of water quality measurements during the study showed a variation in the value of the small parameter water quality between sites and between the observation period (Appendix Table 1). Results of analysis of water quality parameters at four stations in Maninjau shows that the total number Phosphorus March 2013 ranged from 39.0 to 58.0 mg / L and in July 2013 ranged from 55.0 to 65.0 mg / L, water clarity by March 2013 ranged from 1.2 to 2.0 meters and water 5 meters, chlorophyll-a figure in March 2013 013 ranged between -29.701 23.603 mg / L he months of observation can be caused by a lot of rain water and water springs that increase the volume of water reaching the lake so that the lake elevation of 463.20 meters above sea level, while the water of the river is not a lot that goes into this lake, because the lake catchment area does not have a river large.

Trophic status of waters characterized by high and low content of nutrients such as N and P as well as the abundance of phytoplankton or khlorofil concentration. Carlson's (1977) proposed an index of trophic status of waters based on the brightness of the waters of pieces secchi readings. content of total phosphorus and chlorophyll-a content. Based on the value of the trophic status index (TSI) Maninjau waters surveyed in March 2013 ranged from 57.57 to 58.66, while the study in July 2013 ranged from 59.82 to 61.78. Based on the value of the trophic status index (TSI) Maninjau waters surveyed in March 2013 ranged from 57.57 to 58.66, while the study in July 2013 ranged from 59.82 to 61.78. Maninjau fertility levels were high due to the high load of nutrients such as P and N from sewage floating net which is released into the waters. Syandri et al (2012) stated that the number of KJA in Maninjau in 2012 was as much as 15 860 plots and used as many as 12 688 active plot with the amount of feed used 76. 128 tonnes / year and is predicted to become organic waste as much as 72.69 tons / day. Lake Toba in levels of total phosphorus and total nitrogen are found mostly in the waters there are many floating net (Nomosatryo and Lukman, 2011). This is because the waste of fish feed and fish feces containing organic material and high nutrient that gets discharged into the waters (Johnsen et al, 1993). According to McDonald et al (1996) as many as 30% of the amount of feed given inedible and 25-30% of the food eaten is excreted.

The measurement results some other water quality parameters such as pH value between 7.5 to 5.5 (the surface) shows a lake littoral waters is wet. This is reinforced by the value of alkalinity waters to four stations ranged from 23.69 to 112.34 mg / L $CaCO_3$-eq can classify Maninjau lake waters have moderate productivity. Means waters classified as having moderate alkalinity and productivity also. According to Swingle (1968) alkalinity values between 0-10 mg / l $CaCO_3$ eq indicates highly acidic waters, between 10-50 mg / l $CaCO_3$ eq relatively less productive waters, between 50-200 mg / l $CaCO_3$ eq waters have moderate productivity. In contrast to the trophic status of Lake Ranau South Sumatra is mesotropik with brightness levels ranging between 3.5-4.5 meters and pH ranged from 8.0 to 8.5 meters (Samuel, 2011). A difference alkalinity waters may be caused by differences in the source and amount of organic matter contained in these waters. According to Kaplan and Newbold (1993) Organic matter plays an important role as a source of energy and nutrient cycle in inland public waters. On public waters, organic matter derived from the water itself (authochnous) or from outside (allocthonous) is a fundamental component in the waters metabilisme (Whitten et al., 1987 in Husna and Arisna., 2010).

Electrical conductivity (EC) is a numerical illustration of the ability of water to continue the flow of electricity. The more soluble salts that can be ionized, the higher the value DHLnya. Boyd (1979) states that the value of natural waters around 20-1500 DHL umhos / cm, while the ocean waters could have a very high value DHL because of the salts dissolved in it. DHL value Maninjau waters ranged from 33.04 to 45.67 umhos / cm. This means the waters of the lake waters are classified as having a low DHL. For comparison the value DHL Musi river in the upstream zone ranges between 40-60 umhos / cm and the downstream zones that have been affected by the salinity of sea water ranged from 61-74 umhos / cm (Samuel et al, 2004). DHL nlai Citarum river and its tributaries ranged between 20-30 umhos / cm (Kartamihardja et al, 1987 in Samuel et al, 2004)), while the value DHL Kampar river and flood ranged from 5.00 to 5.50 umhos / cm (Azrita et al, 2011).

Measurement potential of fish production in littoral waters Maninjau using Morpho Edhaphic Index (MEI) which is the result of electrical conductivity parameter value (DHL) divided by the average depth to the littoral waters of the lake. Consideration because Maninjau is volcano-tectonic litoralnya waters have many aquatic plants such as water hyacinth, water spinach, grass, kumpai, water spikes, Hydrilla and other areas that are productive for fish life and activities of catching fish. On the primary productivity of littoral waters is not only derived from phytoplankton, but also from the water plant. The results of measurements of water depth, DHL parameter values in the two observation times (March and July 2013) are listed in Tables 6,7,8 and 9.

Observation and measurement results prove the potential number of fish production in Lake Maninjau ranged from 37.75 ± 3.56 to 44.995 ± 2.96 kg / ha / year. This figure is almost equal to the potential fish production in Lake Laut Tawar in Aceh which is an average 43.73 kg / ha / year (Kartamihardja et al, 1995) and smaller than the value of the potential fish production in Lake Ranau average of 91.513 kg / ha / year (Samuel, 2011). Effect from the research will be increase the economic activity for fisherman in Maninjau lake. Difference in the value of fish production tatus of waters caused by the amount of load ing Braioni et al (2001) Organic matter and allocthonous authochnous generally consist of three forms of organic matter in the form of coarse particles, smooth and dissolved. The third organic matter will affect the flow of energy on public land and aquatic ecosystems will affect biodiversity, water productivity and fish production.

Table 4. Trophic Status Index (Carlson's trophic state index, TSI, 1977) waters Maninjau March 2013

Research Station	Total Phosphorus (mg / L)	Brightness (meters)	chlorophyll-a (ug / L)	Average TSI (Score)	Trophic Status
Muko-Moko	390	2.0	252.66	75.01	Heavy eutroph
Sigiran	402	1,3	255,01	77,26	Heavy Eutrofik
Bayur	380	2,0	260,15	74,98	Heavy Eutrofik
Koto Kaciek	500	1,2	297,01	79,19	Heavy Eutrofik
The average value	418±55,40	1,7±0,35	256±0,38	76,61±2,02	Heavy Eutrofik

Table 5. Trophic Status Index (Carlson's trophic state index, TSI, 1977) waters of Lake Maninjau in July 2013

Research Station	Total Phosphorus (mg / L)	Brightness (meters)	chlorophyll-a (ug / L)	Station Average TSI (Score)	Trophic Status
Muko-Moko	550	1,5	236,03	77,82	Heavy Eutrofik
Sigiran	640	1,2	267,20	77,58	Heavy Eutrofik
Bayur	580	1,4	285,02	79,03	Heavy Eutrofik
Koto Kaciek	650	1,1	297,01	80,08	Heavy Eutrofik
The average value	605±4,79	1,3±0,18	271,3±2,65	78,62±1,15	Heavy Eutrofik

Table 6. The average depth (meters) Maninjau littoral waters in March and July 2013

Research Station	Depth Point 1		Depth point 2		Depth Point-3		Average	
	March	July	March	July	March	July	March	July
Muko-Moko	2,5	1,5	6,5	4,5	10,0	7,0	6,33±3,75	4,33±2,75
Sigiran	3,0	1,0	8,0	4,0	12,0	6,0	7,66±4,50	3,66±2,51
Bayur	1,2	0,7	5,0	3,0	7,0	5,0	4,4±2,95	2,90±2,15
Koto Kaciek	1,5	1,2	5,0	3,0	7,0	5,0	4,5±2,78	3,06±1,90

Table 7. DHL measurement results (umhos) in three layers of water stratification Maninjau in March and July 2013

Research Station	Boundary meters		Brightness (3 meters)		Surface depth (15 meters)		DHL Average	
	March	July	March	July	March	July	March	July
Muko-Moko	24,01	21,87	45,50	40,00	67,20	60,20	45,67	40,69
Sigiran	25,85	21,87	58,85	48,60	71,90	65,50	52,20	45,32
Bayur	22,94	25,48	32,50	36,50	43,70	39,00	33,04	33,66
Koto Kaciek	29,11	30,14	46,70	39,00	65,80	50,50	47,20	39,88

Table 8. Estimates of potential fish production (PPI) Maninjau littoral waters in March 2013 (lake elevation 463 masl)

Research Station	Average Depth (m)		Average electrical conductivity		MEI		PPI (Kg/ha/years)	
	March	July	March	July	March	July	March	July
Muko-Moko	6,33±3,75	4,33±2,75	40,69	40,69	9,39	9,39	40,83	40,83
Sigiran	7,66±4,50	3,66±2,51	45,32	45,32	12,38	12,38	46,47	46,47
Bayur	4,4±2,95	2,90±2,15	33,66	33,66	11,60	11,60	45,08	45,08
Koto Kaciek	4,5±2,78	3,06±1,90	39,88	39,88	13,03	13,03	47,60	47,60
The average estimate of potential fish production							45,51±2,81	44,99±2,96

PPI : $Y = 14{,}314.MEI^{0{,}4681}$

CONCLUSION

1. Trophic status of the littoral waters of Lake Maninjau in March (rainy season) and July 2013 (dry season) classified as heavy eutrophic to the value of Trophic Status Index (TSI) ranged from 76.61 ± 2.02 to 78.62 ± 1.15.
2. The estimated value of fish production in March 2013 by an average of 37.75 ± kg / ha / year and in July 2013 an average of 44.99 ± kg / ha / year.

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