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Estimation fish stock and composition using mark recapture studies in floodplain lake, Jambi City

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ABSTRACT

Fish stock assessment can be estimated by dependent and independent sampling; Mark-recapture studies is a part of independent sampling method that can be used for it. This study was conducted in 2018 using purposive sampling methods. The purpose of this study was to determine the current status of fish stocks and the composition of fish species in the floodplain/oxbow lake, Jambi city. Interviews were conducted to determine the types of fish in this area as a reference, and then, the composition of fish species, modification of fishing gear and combine with mark-recapture sampling. The total catch was 66.5 Kg, with the dominant compositions were *Hemibagrus nemurus* (42%), *Pangasius sp* (20%), *Channa lucius* (12%) and the others were 26% (*Osteochilus haseselti, Osteochilus bornensis, Barbonymus schwanenfeldi, Labiobarbus festivus, Thynnichthys polylepis, Mystus sp, Cryptopterus spp*, *Bothia macrocanthus, Labeo chrysophekadion, Barbycthys loevis and Macrobrachium rosenbergii*). The conversion result of fish catches with the total area, which has been assessed using Mark-recapture studies, was 558.6 kg/ha. Finally, the total area of the floodplain was estimated at 60–137 ha, and the fish stock was 66.4–151.7 tons. It's showed that, allowable catch should be under this value, and Mark-recapture studies is one simple methods can be used to predict fish stock in floodplain areas.

Introduction

Teluk lake is one of floodplain/oxbow lake in Jambi Province, diverse and seasonal fish species. This complexity creates challenges for monitoring, and consequently, many inland fish stocks have few data and cannot be assessed using methods typically applied to industrial marine fisheries. In such situations, there may be a role for methods recently developed for assessment of poor fish stock data. Lack of data and poor data is challenges for estimation fish stock on inland fisheries especially on floodplain area.

Stock assessment is the part of fisheries science that studies the status of a fish stock for fishery sustainability. It is used to understand if the abundance of a stock is below or above a given target point and thus, whether the stock is over exploited or not; stock assessment can also indicate if a catch level will maintain or change the abundance of the considered stock (Sparre & Venema, 1998; Musick & Bonfil, 2004; Isely & Tomasso, 1998). It can inform many ways to assess fish stock in inland fisheries (Fitzgerald *et al.,* 2018). Inland water fisheries are extremely important to many rural communities but data are limited to unreliable catch statistics that can use for fisheries recommendation (Smith *et al.,* 2004; Welcomme *et al.,* 2010; Costello *et al.,* 2012). For this condition, needed re-crosscheck the data with a rapid estimation approach (Costello *et al.,* 2012). Given the importance of inland water fisheries in many social and ecological dimensions, there is need to develop and apply new assessment methods for this area (Cooke *et al.,* 2016). In fisheries management, exploitation that must be assessed (e.g., by catch, fishing effort or size limits), the management of fish habitat (e.g., river flow regulation, management of aquatic vegetation, etc.), and the use of fisheries enhancements (e.g., stocking of hatchery fish) (Welcomme *et al.,* 2010; Arlinghaus *et al.,* 2016). For optimal management decision making involves

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knowledge of the status of the fishery relative to management targets or limits, and of the possible responses of the fishery to alternative management options. Providing the knowledge, typically in a quantitative form, is the aim of fisheries stock assessment (Hilborn & Walters, 1992; Cowx, 1996; Walters & Martell, 2004). In general, water quality in Teluk lake was to anthropogenic activities, so that need to manage the water quality (Kaban *et al.,* 2018).

Fisheries management in this condition is quantitative information that can support decision making on issues ranging from the sustainability of fisheries exploitation (Isaac & Ruffino, 1996; Pitcher, 2016), to the development of optimal stocking and harvesting strategies for improved fisheries (Lorenzen, 2005; Lorenzen *et al.,* 2016) or fisheries impacts on inland water (Shankar *et al.,* 2005). Mark–recapture techniques have been used to estimate fish populations in enclosed the water bodies for over 100 years (Ricker, 1975). However, the difficulty of capturing, marking, and examining large numbers of animals has generally limited the technique to small water bodies. Development of coded wire tag technology (Isely & Tomasso, 1998) provides the basis for wider-scale application of mark–recapture techniques to fish populations in large water bodies. The purpose of this paper is to inform an application of mark-recapture techniques for assessing the fish composition and population in floodplain area. Gill nets with *kerung* methods (surrounding technic) were used to collect fish for mark and recapture samples, and therefore method requires a limited number of personnel, an abbreviated sampling period, and easily transported sampling gear.

Material dan Methods

Location and time research

This study was conducted in Teluk lake year of 2018, fish population abundance was estimated in floodplain area of Teluk lake, located in Jambi City, Jambi Province (Figure 1). Population abundance was estimated by Mark and recapture using *kerung* methods (fishing gears). There were steps for Mark-recapture methods: (a) fish collection for tagging (Dominant fish) (b) preparing for kerung methods (fishing gear experiment) (c) released fish marked on the fishing gear experiment) and (d) fishing and fish recapture. Fish in the mark sample can be collecting by fishing (Ricker, 1975). In this study, fifteen fish species were mark and release in fishing area to estimate fish and abundance of fish in floodplain area.

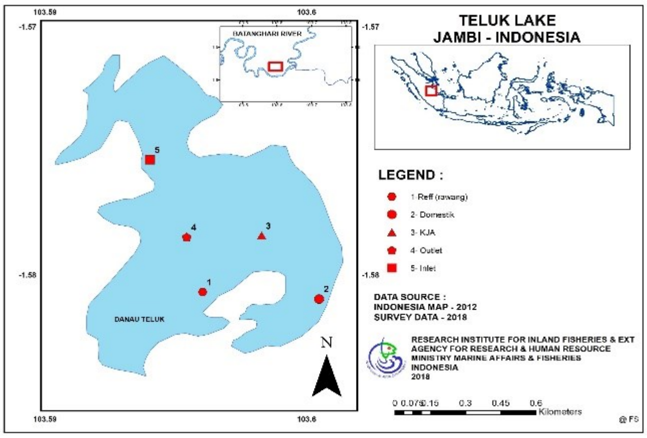

Figure 1. Map of sampling sites

Data Analysis

Petersen estimates were obtained using the unbiased estimator (Chapman modification) suggested previously (Chapman & Robbins, 1951; Seber, 1982).

$$N = \frac{(M+1)\ (C+1)}{(R+1)} - 1 \quad (1)$$

Where: M = Number of individuals marked during the tagging period
C = Total number of individuals captured during the recapture period
R = Number of marked individuals caught during the recapture period.
To determined sustainable maximum yield (MSY) was used analytical method approach using the value of biomass and total mortality of fish with the following equation

$$MSY = 50\% \times Z \times B \qquad (2)$$

Where: Z = Total Mortality (from Length base frequency)
B = Biomass

Result

Mark recapure experiment

The results showed that from 189 fish that were tagged and released and found 45 fish were caught (Table 1). Type of fish were caught such as *Hemibagrus nemurus* (42%), *Pangasius sp* (20%), *Channa lucius* (12%) and the others were 26% (*Osteochilus haseselti, Osteochilus bornensis, Barbonymus schwanenfeldi, Labiobarbus festivus, Thynnichthys polylepis*, *Mystus sp, Cryptopterus spp, Bothia macrocanthus, Labeo chrysophekadion, Barbycthys loevis and Macrobrachium rosenbergii*) (Table 2).

Table 1. Mark recapture experiment

No	Type of fishes	Number of fish release	Fish recapture
1	*Thynnichthys* polylepis	85	13
2	*Barbichthys laevis*	17	2
3	*Oxyeleotris marmorata*	3	1
4	*Labeo chrysophekadion*	3	1
5	*Barbonymus schwanenfeldi*	6	2
6	*Hemibagrus nemurus*	4	0
7	*Osteochilus sp*	2	0
8	*Osteochilus haseselti*	4	0
9	*Osteochilus vittatus*	1	0
10	*Ompok hypophthalmus*	1	0
11	*Mystus sp*	2	0
12	*Parambassis spp*	1	0
13	*Parachela oxygastroides*	2	0
14	*Helostoma temminckii*	3	1
15	*Oreochromis niloticus*	55	25
	Total	189	45

Total catch using *kerung* methods obtained 66,5 Kg, the dominant fish is *Hemibagrus nemurus*. Total catch the conversion of fish catches with the total area which have been assessed by using mark-recapture studies was 555,6 kg/ha.

Tabel 2. Total catch by using experiment fishing

Type of fish	Total Catch (Kg)
Channa lucius	8
Pangasius sp	13,5
Hemibagrus nemurus	28
Macrobrachium rosenbergii	2
Osteochilus haseselti	0,7
Osteochilus bornensis	2,1
Labiobarbus festivus	0,8
Thynnichthys polylepis	2,0
Cryptopterus spp	2,6
Mystus sp	2,2
Labeo chrysophekadion	0,8
Barbycthys loevis	1,1
Bothia macrocanthus	0,2
Barbonymus schwanenfeldi	2,5
Total Catch	66,5

Length base frequency distribution

The data analysis on length base frequency of *Hemibagrus nemurus* shown that the maximum length value (L∞) = 55.6 cm, growth coefficients (K) = 0.86, average temperature 29.5 °C. Natural mortality (M) = 1.135, Fishing Mortality (F) = 2.887, Total Mortality (Z) = 3.987 and Exploitation rate (E) = 0,71. The distribution of the length base frequency of it based on the Von Bertalanffy equation in the floodplain area lake showed in the figure 2.

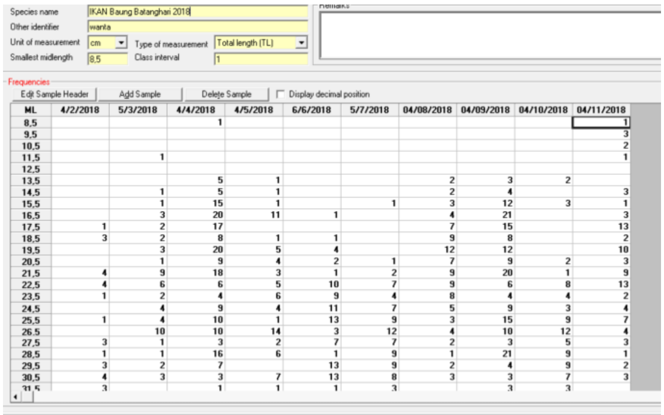

Figure 2. Length base Frequency distribution of *Hemibagrus nemurus*

Analysis of the length converted Jones and Van Zalinge Plot model obtained a total mortality (Z) of 3.987 per year (Figure 3).

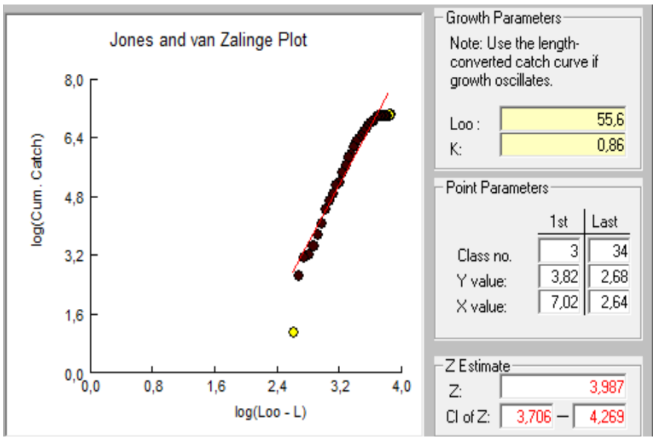

Figure 3. Analyze of Z value Hemibagrus nemurus in floodplain lake area

The exploitation rate of *Hemibagrus nemurus* in floodplain lake areas is due to the relatively high price and important economic value, besides that, it is very popular in Jambi Province. It's the reason the fishing mortality is greater than natural mortality. Fish stock calculation base on analytical methods in floodplain lake area, with an area around 60-137 Ha, total mortality 3.987 and biomass value of fish 555.6 kg/Ha was 66.4-151.7 tons

Discussion

There were found 18 types of fish in the floodplain of Teluk Lake, Jambi. *Hemibagrus nemurus, channa, and white fish,* as the main dominant species in the lake by using surrounding net modification. Hikmah, (2013) states that the Barbonymus schwanenfeldii is a dominant fish by using a few catch tools (lift net, gill net, trap dan cash net). The conversion result of fish catches with the total area which have been assessed by using Mark-recapture studies was 558.6 kg/ha. Finally, the total area floodplain was estimated 60-137 hectare and fish stock of 66.4-151.7 tons. It's showed that, allowable catch should be under this value, and Mark-recapture studies is one simple method can be predicted for rapid fish stock on inland waters (Fitzgerald *et al.,* 2018; Costello *et al.,* 2012). The data of dynamic population shown that the fishing mortality (F) of *Hemibagrus nemurus* is greater than natural mortality (M) and Exploitation rate (E) more than 0,5. The condition shown that, the fish was over fishing, so that in the future needed arrangement and management of this fish in the floodplain lake area.

Conclusion

Mark-recapture with the swept area method is an approach that can be used to determined composition and fish stocks in floodplain area. There were 18 fish species in floodplain area with the *Hemibagrus nemurus* as the dominant species. Fish stock estimation using *Hemibagrus nemurus* simulation was obtained at 66.4-151.7 tons. It's shown that allowable catch should be under this value, which can be used as a baseline for fish management in these waters.

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