Conservation efforts of ikan Batak (Tor spp. and Neolissochilus spp.) and its prospects to support ecotourism in Samosir Regency, North Sumatra Indonesia

S Larashati*, Sulastr, I Ridwansyah, A Y Afandi and R Novianti

Research Center for Limnology, Indonesian Institute of Sciences

*Corresponding author
Email: asti@limnologi.lipi.go.id

Abstract. Ikan Batak or ihan refers to fishes of genera Tor and Neolissochilus. They are socioeconomically valuable fishes in North Sumatra and some regions in Indonesia, yet their population in the wild has been declined. In situ conservation is one of the efforts to increase its population in natural habitat. Our previous study proposed Bonan Dolok River in Samosir Regency as the potential site for Ikan Batak in situ conservation. The combination of scenic landscapes and a waterfall in the upstream part of the river, as well as the presence of Ikan Batak in the conservation site, can be a potential ecotourism attraction in Samosir Regency. Ecotourism has many advantages, such as providing financial benefits to local people while sustaining natural resources. Our present study aimed to explore the potentiality of Bonan Dolok River for the conservation site of Ikan Batak and its prospect for ecotourism. The biocological and hydromorphological description of Bonan Dolok River was based on the literature review and a primary study conducted in 2019. People’s perception of the prospect and challenges of developing ecotourism and stakeholder’s role in the management of conservation and ecotourism were identified. The ecological and hydromorphological profile showed the potentiality of Bonan Dolok for conservation site. The local community of Bonan Dolok plays an essential role related to their local customary in environmental management and initiation of ecotourism. Stakeholders’ awareness on conservation of Indonesian native fishes, including Ikan Batak should be enhanced to get a better understanding of conservation management.

1. Introduction

Fishes of genera Tor and Neolissochilus are locally known as Ikan Batak or ihan in North Sumatra, Indonesia. They are popular in the world as mahseer. The fishes are belong to family Cyprinidae and can be distinguished from other cyprinids by the large scales on their body. People have had an interest in mahseers long before century. Pottery painted with a large scale mahseer like-fish from 3000 BC was found in Indus Valley [1]. In some countries, the fishes are sacred, and some people believe that mahseers are God’s fishes [1]. Mahseers are distributed across South and Southeast Asia [2]. Some of the mahseers are known as flagship species such as the golden mahseer of India’s rivers. Mahseer species prefer to live in a clean water habitat and their presence in the water indicates a healthy freshwater ecosystem. The fishes have economic, nutritional, and socio-cultural values. In North Sumatra, these sacred species are part of the socio-cultural life of the Batak tribe. The fishes are
usually served only for the high-level people in the society or as an offering to God in many Batak tribe traditional ceremonies. The fishes are also believed to cure diseases.

There are three species of *Tor (T. tambra, T. tambroides, and T. douronensis)* and four species of *Neolissochilus (N. thienemanni, N. soro, N. sumatranus, and N. longipinnis)* in Indonesia [2]. They are inhabiting freshwater in Java, Sumatra, and Borneo with some endemicity in Sumatra (*N. thienemanni* which is endemic of Lake Toba and *N. sumatranus* which is endemic of Sumatra). According to the International Union for Conservation of Nature (IUCN), *N. thienemanni* is categorized as a vulnerable species [3] and is on the list of protected fish by Ministerial Decree no. 20/2018 [4]. Other species of *Neolissochilus* are assessed as not evaluated. *Tor tambra* and *T. tambroides* are placed as data deficient while *T. douronensis* is not evaluated [5, 6]. Although *Ikan Batak* species other than *N. thienemanni* are not in the risk of extinction, their population in the wild are declining. At present, *Ikan Batak* is rarely seen in Lake Toba and can be found only in the upper streams with reduced population size.

Habitat alteration, water pollution, unwise exploitation, and introduction of exotic species are some factors contributing to the declining of *Ikan Batak* in their natural habitat. Proper management to ensure the sustainability of *Ikan Batak* should be conducted, and in situ conservation is one way to protect *Ikan Batak* and their habitat. The previous study has selected the Bonan Dolok River in Samosir Regency as a potential site for in situ conservation of *Ikan Batak* [7]. Some characteristics which support the potentiality of Bonan Dolok River are the water flows continuously into Lake Toba, 70% of the land is covered by natural forest, and the existence of local wisdom related to environmental protection [7].

The government of Indonesia is committed to build the area of Lake Toba into one of major tourist destinations. Samosir Regency is one tourist place in North Sumatra that has been visited by domestic and foreign tourists. Samosir island, which is located in the middle of Lake Toba offers several kinds of tourist destinations related to historical, religious, and ecotourism. Bonan Dolok Village, where the river is situated, has a scenic landscape which already attracted some tourists. *Ikan Batak* habitat in Bonan Dolok and the conservation activity to protect *Ikan Batak* in the wild are the potential to be developed as ecotourism. The local government of Samosir Regency has already a plan for combining the in situ conservation activity of *Ikan Batak* and tourism. However, there is no scientific information to support the plan. This study is aimed to explore the potentiality of Bonan Dolok River for the conservation site of *Ikan Batak*, identify the prospects and challenges of ecotourism development in Bonan Dolok Samosir Regency, and assess stakeholder’s knowledge related to their future roles in ecotourism. The findings of the study will contribute to the policymakers for planning and developing in situ conservation of *Ikan Batak* and ecotourism in Samosir Regency.

2. Materials and Methods

2.1 Study sites

The study area was 1 km along the Bonan Dolok’s main river, Samosir Regency is stretching from upstream to downstream (figure 1). Sampling sites were determined based on the interview to local community and field survey. Four sampling sites represent the upstream (1), middle part (2), downstream (3), and river mouth (4).
2.2 Water quality and Ikan Batak species composition

Some water quality parameters which include temperature (°C), dissolved oxygen (mg/L), conductivity (mS/cm), pH, salinity (ppt), and oxidation-reduction potential (mV) were measured in April and July 2019 on the site using Water Quality Checker (Horiba U20). Ten individual samples of Ikan Batak were collected in July 2019 using a gill net with a mesh size of 2.5 inches. Morphological identification was carried out in Zoology Department-Research Center for Biology LIPI, referring to Kottelat et al [2] and Webber & Beaufort [8].

2.3 Data collection for identifying potentials and challenges of conservation/ecotourism in Bonan Dolok Samosir Regency and stakeholder’s role in ecotourism develop

Respondents involved in data collection were representative of Samosir Regency government officers and Bonan Dolok villagers. Respondents were selected based on a snowball method. focused group discussion was performed to collect data by semi-structured questionnaires. Potentials and challenges of conservation/ecotourism development were identified using SWOT (strengths, weaknesses, opportunities, and threats) analysis. Influences and interests of relevant stakeholders were assessed using the stakeholder analysis method.

3. Results and Discussion

3.1 The ecological condition and Ikan Batak species composition in Bonan Dolok River

There are several stages needed to develop a conservation area which includes a survey to identify potential habitat and fishery status [9]. Water color along the sampling sites of Bonan Dolok was generally clear although the appearance of the water was slightly brown. Some parameters of water quality measured in Bonan Dolok River such as temperature (18.9–29.0 °C), pH (6-8), dissolved oxygen (7.20–8.61mg/L), and conductivity (0.023–0.152 mS/cm) were in the range where Neolissochilus and Tor usually live (table 1). Both genera require cold temperature; highly oxygenated water; and habitat heterogeneity such as the presence of riffle, pool, and run [10]. Such characteristics are commonly found in the hilly stream like the Bonan Dolok River which is situated on 930 m above sea level. Ali et al [11] reported that river with riffle-pool habitats are preferred not only by N. wynaadensis but also riffle beetle and chironomid, which are the food source for N. wynaadensis. The physicochemical water properties measured in this study also seem to support the production of phytoplankton, periphyton, and benthic macroinvertebrate which form the ecosystem food chain and provide food sources for Ikan Batak [12, 13].
Genera *Neolissochilus* and *Tor* favor living in a clear rocky water with slow to swift current [11, 14]. Based on our previous study in 2016, the river bed of Bonan Dolok consists of boulder and gravel with a water current of 0.12 m/s [7]. Adult mahseers usually inhabit deep pools with rocky bottom and slow to moderate current [12]. The villagers of Bonan Dolok mentioned that *Ikan Batak* are usually observed along Bonan Dolok River and Lake Toba. As a migratory species, adult mahseers migrate upstream for spawning. Typical habitat for spawning comprises of shallow water and substrates of gravel and sand [12].

**Table 1.** Water condition in Bonan Dolok River and habitats of *Neolissochilus stracheyi* and *Tor*

| Parameters       | Bonan Dolok River | N. stracheyi habitat [14] | T. dongnaiensis habitat [14] | T. tambroides habitat [12] |
|------------------|-------------------|--------------------------|-----------------------------|--------------------------|
| Temperature (°C) | 18.9–29.0         | 17–26                    | 21–26                       | 25–31                    |
| pH               | 6–8               | 6.5–7.66                 | 7.00–7.66                   | 6–7                      |
| Dissolved oxygen (mg/L) | 7.20–8.61        | 6.53–7.32               | 6.2–6.75                   | 5.8–8.5                 |
| Conductivity (mS/cm) | 0.023–0.512  | 0.01–0.034              | 0.032–0.034                | No data                 |

*Ikan Batak* collected from Bonan Dolok River consists of two species, nine individuals of *N. sumatranus* and one individual of *T. douronensis*. The range of total length and weight for *N. sumatranus* was 15.1–24 cm and 27.59–137.66 g, respectively. The total length and weight of *T. douronensis* captured was 19.7 cm and 74.01 g, respectively. Kottelat *et al.* [2] mentioned that *N. sumatranus* distribution range is only in Sumatra. *Neolissochilus sumatranus* is commonly found in some rivers in North Sumatra such as the Tulas River and Asahan River [15, 16]. So far, there are no reports of *N. sumatranus* habitat elsewhere North Sumatra. *Tor douronensis* has wider distribution than *N. sumatranus*, which inhabits freshwater of Sundaland and Indochina [2]. *Ikan Batak* captured in Bonan Dolok River is not for selling in the market, they are usually for self-consumption or serving in the traditional ceremonies. In this study, because of some limitations in time and human resources, we did not analyze the density and distribution of *Ikan Batak* corresponding to their habitats. Therefore, we cannot describe the population status of *Ikan Batak* in Bonan Dolok River.

Kottelat *et al.* [2] stated that 272 species inhabiting Sumatra of which are native and endemic. *Rasbora tobana* and *N. thienemanni* are the two endemic species of Lake Toba [2]. Some of them are of economic importance and known for nutritional and cultural value. Nevertheless, many species have not been explored and identified however, environmental threats from anthropogenic activities are increasing [17].

Management efforts to protect native and endemic species can be carried out by developing and implementing a conservation area [9]. To date, there have been no conservation areas established by local government (Province or Regency) of North Sumatra [18] while the population of some native fishes including endemic species are decreasing or threatened for extinction. As an indicator of a healthy freshwater ecosystem, protecting *Ikan Batak* means to protect a wide number of species that depend on the same habitat as *Ikan Batak* [10].

### 3.2 Potentials and challenges of conservation area and ecotourism development in Bonan Dolok Samosir Regency

Samosir Regency offers some natural spots enjoyed by tourists. According to the Tourism Office of Samosir Regency, the number of tourists visiting Samosir Regency has increased continually during 2014–2018 and foreign tourists have always been the highest visitors compared to domestic tourists. White sand beaches of Parbaba, Tele Tower, and Efrata Waterfall are the three most visited objects in
2018. Decided to be the top five Indonesian major tourist destinations, the local and central government are enduring to develop and improve tourist objects surrounding Lake Toba. In the news page of the official website of Indonesia tourism, Lake Toba is planned to be one of the ten top tourist destinations by 2019 and developed into one of the ecotourism destinations in Indonesia [19].

The International Ecotourism Society (TIES) defines ecotourism as a responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education [20]. One strategy for long term management of the ecosystem is to link the conservation activity and tourism through ecotourism. Mahseer ecotourism in India is developed in a variety of activities like mahseer watching, fish sanctuaries, and recreational fishing [21].

Potentialities of the Bonan Dolok Village for Ikan Batak ecotourism are described in the strengths and opportunities component of SWOT analysis (table 2). Surrounded by the scenic landscape of Lake Toba, Sitapigagan Waterfall which is part of Ikan Batak habitat, has attracted domestic and foreign tourists. Ikan batak, the aquatic biota with conservational value, can still be found in Bonan Dolok River. Aside from that, we also observed fish that is categorized as protected fish by Government Regulation no. 7/1999, namely Homaloptera gymnogaster.

The Bonan Dolok villagers are enthusiastic about ecotourism development in their area. The villagers seem to understand about ecotourism eventhough the knowledge was obtained during focused group discussion. Customary rules related to environmental protection along the river are applied by the community and must be obeyed by the visitors. A customary worship ceremony in a traditional hut near the waterfall before capturing Ikan Batak can be created into an exciting attraction. Ex-situ conservation by domesticating mahseer species has been conducted and this would provide Ikan Batak sources for restocking in the wild. The local government has already designed the master plan for tourism in Samosir Regency and ecotourism of Ikan Batak in Bonan Dolok can be planned to be part of Samosir ecotourism.

Some challenges in developing ecotourism are described in the weakness and threats section of table 2. The local people have limited knowledge about conservation, and they only understand that conservation means to restrict fish capture. Access to Bonan Dolok from district capital can only be reached by motorboat. The local government has insufficient knowledge about ecotourism. As a result, a limited budget is allocated for developing eco-tourism. The local government regulation related to ecotourism has not been established and there is a lack of attention from the local government to improve Bonan Dolok tourism.
Some recommendations to increase the potentialities and overcome the challenges are to educate the local people about in situ conservation activities and ecotourism; provide procurement of educational support facilities for tourists (Ikan Batak conservation); conduct training and workshop about ecotourism, and promote the Bonan Dolok ecotourism through cooperation with travel and tourism agencies.

3.3 Stakeholder perceptions towards their roles in conservation activity/ecotourism development in Bonan Dolok Samosir Regency

Stakeholders play an essential role in conservation and ecotourism planning. Multiple stakeholders’ engagement can provide different viewpoints and perspectives which lead to a more effective outcome, create a harmonious process and avoid conflicts, and improve the quality of a decision by gathering many sources of information [22]. A stakeholder analysis is usually performed before the stakeholders are involved in a process. In the stakeholder analysis, relevant stakeholders are identified, and their opinions of their interest in the resource or proposed project as well as their capacity to monitor, evaluate, and manage, are evaluated [23].

Based on our field survey in Samosir Regency and discussion with staff from the Tourism Office, we identified relevant local government stakeholders. They are staff of the Tourism Office, Environmental Office, Agriculture Office, Public Works and Human Settlements Office, and Regional Development Planning Agency. The Fishery section of Agriculture Office may propose types of ecotourism while an improvement on the amenities at the proposed location and promotion are performed by Tourism Office. Public Works and Human Settlements Office is involved in building and improving infrastructure. Regional Development Planning Agency takes part in designing a master plan for ecotourism. Representative offices of the relevant stakeholders except the Public Works and Human Settlements Office participated in data collection. Stakeholders' perception about their roles and influences in the conservation of Ikan Batak and ecotourism are shown in table 3.

| Internal Factor | WEAKNESS |
|-----------------|----------|
| STRENGTHS       |          |
| 1. Enthusiasm of local people to ecotourism. | 1. Limited knowledge of the local people about conservation. |
| 2. Natural resources (Sitapigagan waterfall as an attractive tourist spot. | 2. No accessibility by cars and limited amenity. |
| 3. Conservational value of Ikan Batak. | 3. Limited budget for ecotourism development, inadequate knowledge of local government in ecotourism planning. |

| External Factor | THREATS |
|-----------------|--------|
| OPPORTUNITIES   |        |
| 1. Local ceremony before capturing Ikan Batak. | 1. No local government regulation on ecotourism. |
| 2. Ex-situ conservation by the local community from other locations has been started. | 2. Lack of attention on Bonan Dolok tourism. |
| 3. Local community understands about ecotourism. | |
| 4. Masterplan for tourism development. | |
Table 3. Stakeholders’ perception of their roles in the conservation and ecotourism of Ikan Batak.

| No | Stakeholder                                | Roles                                                                                                                                 |
|----|--------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| 1  | Tourism Office                             | - To plan on the conservation and ecotourism of Ikan Batak.                                                                           |
|    |                                            | - To establish the rules and policies related to conservation and ecotourism.                                                          |
|    |                                            | - To coordinate with other government offices related to conservation and ecotourism of Ikan Batak.                                    |
|    |                                            | - To be actively involved in the implementation.                                                                                      |
|    |                                            | - To monitor and evaluate.                                                                                                            |
|    |                                            | - To provide protection and license.                                                                                                  |
|    |                                            | - To provide human resources, facilities, funds, and information.                                                                      |
| 2  | Agriculture Office                         | - To plan activities together with other government offices.                                                                           |
|    |                                            | - Assist the implementation of conservation and ecotourism activities.                                                                  |
|    |                                            | - Provide human resources.                                                                                                            |
| 3  | Environmental Office                       | - To plan activities together with other government offices.                                                                           |
|    |                                            | - To establish the rules and policies related to conservation and ecotourism.                                                          |
|    |                                            | - Provide human resources.                                                                                                            |
| 4  | Regional Development Planning Agency       | - To plan on the conservation and ecotourism of Ikan Batak.                                                                           |
|    |                                            | - To establish the rules and policies related to conservation and ecotourism.                                                          |
|    |                                            | - Assist the implementation of conservation and ecotourism activities.                                                                  |
|    |                                            | - To coordinate with other government offices related to conservation and ecotourism of Ikan Batak.                                    |
|    |                                            | - To provide human resources, facilities, funds, and information.                                                                      |
| 5  | Bonan Dolok Villagers                      | - To plan on the conservation and ecotourism of Ikan Batak.                                                                           |
|    |                                            | - To coordinate with other stakeholders.                                                                                               |
|    |                                            | - To be actively involved in the implementation.                                                                                      |
|    |                                            | - To monitor and evaluate.                                                                                                            |
|    |                                            | - To contribute to human resources.                                                                                                   |
|    |                                            | - To provide protection and license.                                                                                                  |

Based on the score of interests and influences, the stakeholders are plotted in the graph of figure 2.
Figure 2. Graph of stakeholders’ interest and influence in the conservation and ecotourism of Ikan Batak. 1: Tourism office, 2: Agriculture Office which includes four sections (plantation, land and water management, food crops and horticulture, and fishery), 3: Environmental Office, 4: Regional Development Planning Agency, 5: Bonan Dolok Villagers.

Concerning to the planning and implementation of conservation and ecotourism activities, stakeholders included in quadrant I (subject) have a high level of interest but have less influence. Stakeholder in the subject quadrant is Environmental Office. Stakeholders in quadrant II (players) have a high level of interest and influence, and they are the Tourism Office, Regional Development Planning Agency, and the Bonan Dolok Villagers. Stakeholders in quadrant III (bystanders) have a low level of interest and influence, which occupied by the Agriculture Office. None of the stakeholders has a high level of influence but less interest (quadrant IV/actor).

Some of the stakeholders, such as the Tourism Office, Regional Development Planning Agency, and Bonan Dolok Villagers already understand how they should actively be involved in the planning and implementation of conservation activity and ecotourism. Tourism Office is responsible for planning, formulating policy, implementing, and monitoring of the conservation activity and ecotourism. Moreover, the Tourism Office can build a network with other government offices. Besides, the Tourism Office plays a role in providing human resources, funds, facilities, and information. Regional Development Planning Agency also takes part in planning and implementing conservation activity and ecotourism. The agency also contributes to the funds and facilities. Also, they have a high interest because ecotourism can increase regional income, open job opportunities, and at the same time maintaining the sustainability of Ikan Batak. Local community interest is high because the location of the proposed conservation site or ecotourism is in their home village. The local people are practicing local wisdom to protect the environment and Ikan Batak. The local community involvement also ensures that the programs organized by the government can be in line with the values of their local customs.
The position of the Environmental Office should be in quadrant II. Environmental Office should be able to influence the direction of management policies to achieve effective conservation and ecotourism planning and implementation. Besides, the Environmental Office should also provide education to the community regarding the importance of Ikan Batak conservation and ecotourism activities in Bonan Dolok Village. Agriculture Office should also become the player. Agriculture Office should be able to influence Ikan Batak conservation and ecotourism activities. In this case, the policies applied by the Agriculture Office must support and be in line with conservation and ecotourism activities. Such supporting policies are to use organic fertilizers and reduce the use of pesticides that can pollute the river. Agriculture Office is in charge of the fishery section, but it seems that the conservation of native fishes including Ikan Batak is not their concern.

The stakeholder analysis gives preliminary information on stakeholders’ knowledge about their roles when conservation and ecotourism are planned and implemented. Capacity building can increase awareness of their roles and responsibilities and improve knowledge and skills about the conservation of native fishes among stakeholders. Some limitation which influence the validation of data is the number of respondents involving stakeholders from government officer and the local community was not equal, absence of one stakeholder from government officials, and the time length for focused group discussion was only one day with no deep interview. In the future, deep interview to all respondents should be conducted followed by focused group discussion for having the same perception of their roles and responsibilities.

4. Conclusions

Conservation efforts of Ikan Batak will have to include scientific studies for the establishment and management of conservation area, customary rules and belief as part of the conservation management and ecotourism, and participation of relevant stakeholders by co-management. The present study describes the status of potential habitat through the ecological condition and Ikan Batak composition in the Bonan Dolok River. Ikan batak species collected in Bonan Dolok River consists of N. sumatr anus and T. douromensis and the water condition generally support for the life of Ikan Batak. However, further bioecological studies in Bonan Dolok River to collect complete information are needed for determining the conservation areas. The local community of Bonan Dolok plays an essential role related to their local customary in environmental management and initiation of ecotourism. Stakeholders’ awareness on conservation of Indonesian native fishes, including Ikan Batak should be enhanced to get a better understanding of conservation management.

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