DOKUMEN KORESPONDENSI
Nur Taufiq-Spj sbg **Corresponding Author** dengan
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RESUME KORESPONDENSI

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3	04/04/2023	Mendapat e-mail balasan dari EJABF	Jam 21.15 mendapat e-mail dari EJABF: 1. Perihal: Acknowledgement of Submission 2. Mendapat nomer refferensi artikel Manuscript #EJABF-2304-3374 3. Bahwa: Our editorial decision will be brought to your attention once the paper has been reviewed due the referees consideration 4. Lihat RESUME 3 hal:	6 – 7
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		dilakukan review artikel	1. Bahwa Manuscript ID: EJABF-2304-3374 Manuscript Title: **New Perspective of Java Eel Conservation: Case Study In Cilacap Riverine and Coastal Area, Central Java – Indonesia** Authors: Nur Taufiq-Spj, Gunawan Widi Santosa, Suryono Suryono, Ambariyanto Ambariyanto: 2. Evaluation process of the above mentioned manuscript has been reviewed. The comments of the reviewer(s) are included at the bottom of this letter. 3. The reviewer(s) have recommended publication, but also suggest some revisions to your manuscript. Therefore, I invite you to respond to the reviewer(s) comments and revise your manuscript within the period of defined time. 4. Lihat RESUME 4.1 (e-mail) dan RESUME 4.2. (Reviewer notes)	
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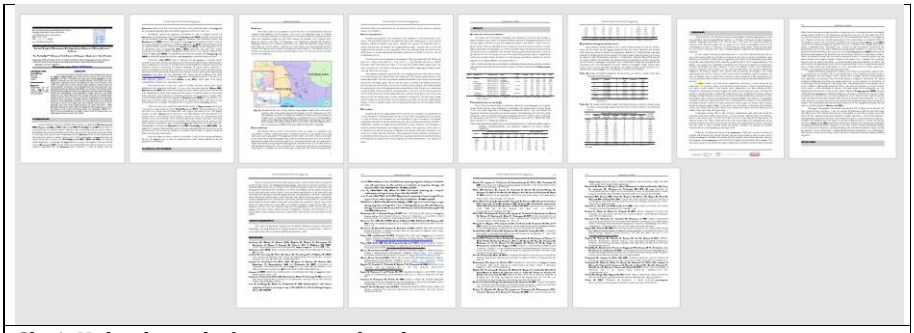
10	27/06/2023	E-mail pemberitahuan dari EJABF bahwa article has been published	Jam: 13.31. 1. Ejabf announcement that the article had been published on line 24/06/2023 2. Lihat RESUME 10: 10.1. Email, 10.2. on line performace.	28 – 29

1. RESUME 1.



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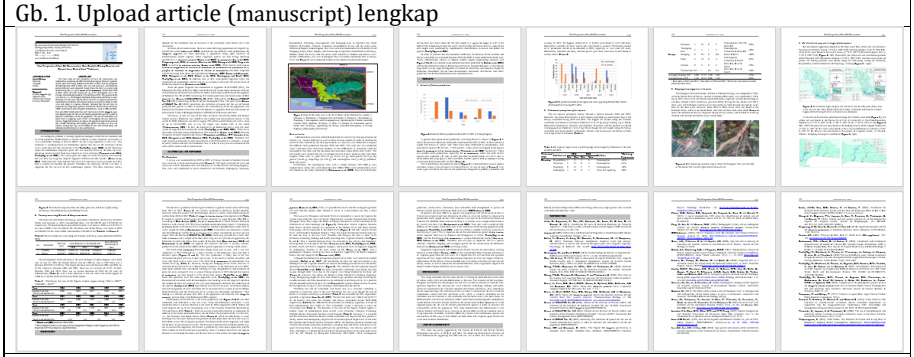

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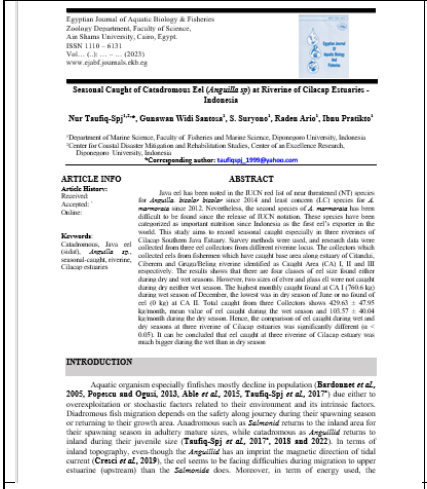

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Seasonal Caught of Catadromous Eel (*Anguilla sp*) at Riverine of Cilacap Estuaries - Indonesia

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ABSTRACT

Java eel has been noted in the IUCN red list of near threatened (NT) species for *Anguilla bicolor bicolor* since 2014 and least concern (LC) species for *A. marmorata* since 2012. Nevertheless, the second species of *A. marmorata* has been difficult to be found since the release of IUCN notation. These species have been categorized as important nutrition since Indonesia as the first eel's exporter in the world. This study aims to record seasonal caught especially in three riverines of Cilacap Southern Java Estuary. Survey methods were used, and research data were collected from three eel collections from different riverine locus. The collectors which collected eels from fishermen which have caught base area along estuary of Citanduy, Cibeurm and Ganas/Beling riverine identified as Caught Area (CA) I, II and III respectively. The results shows that there are four classes of eel size found either during dry and wet seasons. However, two sizes of elver and glass eel were not caught during dry neither wet season. The highest monthly caught found at CA I (760.6 kg) during wet season of December, the lowest was in dry season of June or no found of eel (0 kg) at CA II. Total caught from three Collectors shows 420.63 ± 47.95 kg/month, mean value of eel caught during the wet season and 101.57 ± 40.04 kg/month during the dry season. Hence, the comparison of eel caught during wet and dry seasons at three riverine of Cilacap estuaries was significantly different (α < 0.05). It can be concluded that eel caught at three riverine of Cilacap estuary was much bigger during the wet than in dry season.

INTRODUCTION

Aquatic organism especially finfishes mostly decline in population (**Bardonnet *et al.*, 2005**, **Popescu and Oguzi, 2013**, **Able *et al.*, 2015**, **Taufiq-Spj *et al.*, 2017**[*]) due either to overexploitation or stochastic factors related to their environment and its intrinsic factors. Diadromous fish migration depends on the safety along journey during their spawning season or returning to their growth area. Anadromous such as ***Salmonid*** returns to the inland area for their spawning season in adultery mature sizes, while catadromous as ***Anguillid*** returns to inland during their juvenile size (**Taufiq-Spj *et al.*, 2017**[*]**, 2018 and 2022**). In terms of inland topography, even-though the ***Anguillid*** has an imprint the magnetic direction of tidal current (**Creuci *et al.*, 2015**), the eel seems to be facing difficulties during migration to upper estuarine (upstream) than the ***Salmonide*** does. Moreover, in term of energy used, the

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New Perspective of Java Eel Conservation 155

GRAPHICAL ABSTRACT

New Perspective of Java Eel Conservation: Case Study in Cilacap Riverine and Coastal Area, Central Java – Indonesia

Various efforts to conserve aquatic organisms, especially fin-fishes, usually only involve restrictions on exploitation and fishing or prohibitions on disturbing certain ecosystems. The conservation perspective of an organism should take into account various factors that affect it. Diadromous, especially catadromous species, are initiated from larvae that migrate from the ocean to the coast before entering the river where their parents grow, and eventually return to the deep sea for spawning. Thus, the need for environmental suitability from the coast to the upstream becomes a priority to be considered including the supply of water from the catchment forest area. If there are obstacles in fish migration path, fish-way or fish-ladder facilities must be provided both on the main migration route, and on connecting channels.

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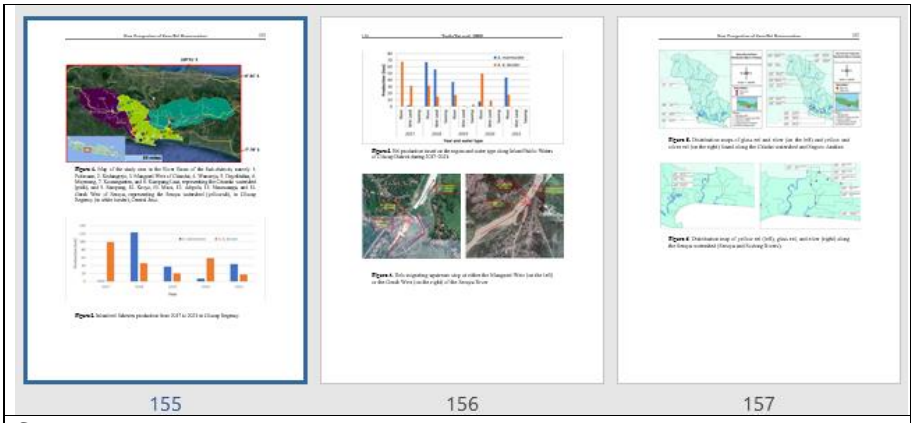

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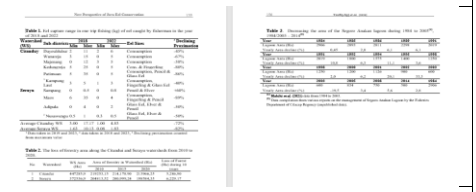

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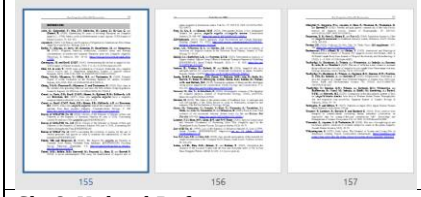

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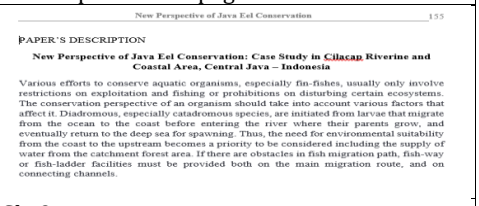

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PAPER'S DESCRIPTION

New Perspective of Java Eel Conservation: Case Study in Cilacap Riverine and Coastal Area, Central Java – Indonesia

Various efforts to conserve aquatic organisms, especially fin-fishes, usually only involve restrictions on exploitation and fishing or prohibitions on disturbing certain ecosystems. The conservation perspective of an organism should take into account various factors that affect it. Diadromous, especially catadromous species, are initiated from larvae that migrate from the ocean to the coast before entering the river where their parents grow, and eventually return to the deep sea for spawning. Thus, the need for environmental suitability from the coast to the upstream becomes a priority to be considered including the supply of water from the catchment forest area. If there are obstacles in fish migration path, fish-way or fish-ladder facilities must be provided both on the main migration route, and on connecting channels.

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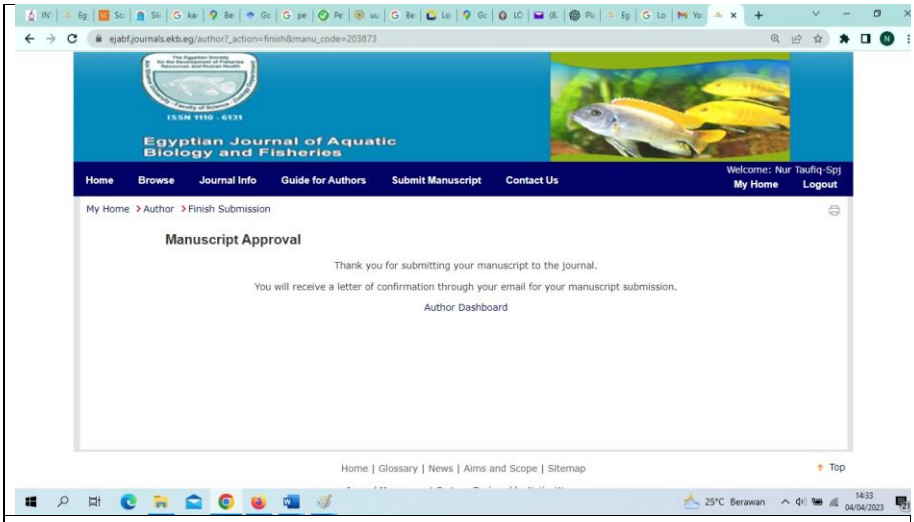

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Sel, 4 Apr jam 21.15

Manuscript ID: EJABF-2304-3374

Manuscript Title: **New Perspective of Java Eel Conservation: Case Study In Cilacap Riverine and Coastal Area, Central Java – Indonesia**

Authors: Nur Taufiq-Spj, Gunawan Widi Santosa, Suryono Suryono, Ambariyanto Ambariyanto

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Reviewer Comment For Author:

The manuscript discussed a very interesting point of research just needs some revision for the language by native English

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New Perspective of Java Eel Conservation: Case Study In Cilacap Riverine and Coastal Area, Central Java – Indonesia

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ABSTRACT

The Case study on new perspective of Java eel conservation was conducted by examining the decline trend of eel capture fisheries in general inland waters of Cilacap, Indonesia from 2017 to 2021, and the perception of fishermen from 2018 to 2022. Site visits and interviews with fishermen and eel collectors were conducted. Results show that there is a similar trend of decreasing eels (i.e., *A. b. bcolor* and *A. marmorata*) catches from 2018 to 2022, where the catch of glass eel up to the consumption size in the Citandui Watershed decreased by 72% and Serayu 82%. The presence of the river barriers, i.e., the Manganti and Gerak Serayu dams, decreases in water discharge over the years and the failure of elvers to migrate upstream has contributed to the decline. Distribution of glass eel and elver found in other rivers and along its irrigation channels, indicated that the eels have an escape for their migration upstream. The decrees of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia, issued in 2020 and 2021, have provided limited protection and conservation of eels (*Anguilla* spp.) and imposed quotas for the use of limited protected fish species in order to maintain sustainability of the eel population. The role of watersheds with forest areas in supplying water to the river throughout the year need to be concern. Suggested solutions to improve the population and conservation of eels include controlling and limiting the pattern of yellow to silver eel catches,

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creating fish ways or fish ladders on the walls of both dams, and reforestation of lost forests in the watershed area.

INTRODUCTION

An ecological problem is causing significant damage to both the environment and its living organisms. Deforestation is causing a decline in water resources, particularly in river watersheds, leading to adverse effects on the living organisms in the river. This condition is wreaking havoc on diadromous species that rely on the continuity of the river's water flow for their migration cycle (**Taufiq-Spj *et al.*, 2022**). In the beginning stages of catadromous migration, glass eels are naturally drawn to the flow of rivers, migrating counter-current from low estuaries to rivers upstream (**Trancart *et al.*, 2014; Taufiq-Spj *et al.*, 2021**). This newly glass eel stage will enter the estuary area towards the river flow by using the "imprint magnetic direction of tidal current" (**Cressi et al., 2019**). While the elver stage and the pencil size will continue to swim upstream until they find a suitable environment for growth. Therefore, the continuity of the river flow is important for the survival of this catadromous species. This flow continuity mainly depends on the catchment area of rainwater in the watershed, where forest area is the main factor.

In terms of eel conservation, there are some declining populations of Anguilla sp. around the world. **Aalto *et al.* (2016)** reported that the fisheries yield of European eel (*Anguilla anguilla*) has been declining in population along eight countries of Mediterranean coastal lagoons. Other important species are also facing declining populations: i.e. *Anguilla japonica* **(Chang *et al.* 2018)**; *A. marmorata* (**Lee *et al.*, 2018; Pangerang *et al.*, 2018**), *A. rostrata* (**Gress *et al.*, 2008; Chang *et al.*, 2020; Feng *et al.*, 2022**) as well as *A. nebulosa nebulosa* (**Lukas *et al.*, 2022**). Other species such as *A. b. bicolor*, *A. bengalensis*, *A. australis*, *A. borneensis*, *A. celebesensis*, *A. ancentralis*, *A. b. pacifica*, *A. interioris*, *A. megastoma*, *A. labiata*, *A. mossambica* and other Anguillid species also need to be taken into consideration **(Aoyama, 2009; Fahmi and Hirnawati, 2010; Minegishi *et al.*, 2012; Fahmi *et al.*, 2013; Castonguay and Durif, 2016; Taufiq-Spj *et al.*, 2021)**. In addition, due to their wide-spread migration cycle, the importance of catadromous species can act as surrogate species for the conservation of freshwater biodiversity **(Itakura *et al.*, 2020**).

Since the genus Anguilla was announced in Appendix II of CITES (2017), the Indonesian Minister of Marine Affairs and Fisheries has issued some regulations. Starting with the Decree of the Minister of Marine Affairs and Fisheries (MMAF) of the Republic of Indonesia No. 80 of 2020 concerning the limited protection and conservation of Eels *Anguilla* spp. (**Decree of MMAF-RI No. 80,** 2020) , followed by the **Decree of MMAF No. 118** (2021) concerning the Eel Fisheries Management Plan. The most recent **Decree of MMAF No. 12** (2022) concerning the collection of quotas for the use of limited protected fish species in order to maintain the sustainability of the eel population was based on the National Provisions and Fish Species in Appendix II of the Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora.

Contrarily, as eels are one of the most nutritious non-starchy foods and famous protein sources, Indonesia was ranked as the number one eel-exporting country in the world. In 2020, Indonesia was able to supply 25% of the world's frozen eel with a value of up to $13,239,000,

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and its live eel export was ranked 14th in the world (**Widyaningrum, 2021**). In fact, the biodiversity of Indonesian eels is also the most varied of Anguillid eels around the world (**Taufiq-Spj *et al.*, 2020; 2021**). There are at least eight Anguillid species of Indonesian eels reported by **Fahmi, *et al.* (2013)** from the 18 species of world Anguillid eels known (**Tomiyama and Hibya, 1977; Leander et al., 2012; Minegishi *et al.*, 2012; Kottelat, 2013; Taufiq-Spj *et al.*, 2022**). Therefore, this study aims to evaluate the current status of eels in the Cilacap District, especially in terms of yearly catches and their environmental cues, in order to carry out an evaluation of the status of this species and its conservation.

MATERIALS AND METHODS

The Study Area

A survey was conducted from 2018 to 2023 in Cilacap, located in Southern Central Java, covering riverine and estuarine areas (**Figure 1**). The study involved site visits and interviews with 47 fishermen and 7 eel collectors in 12 Sub-districts of Cilacap Regency. Site visits were conducted to seven sub-districts of Patimuan, Kedungreja, Wanareja, Dayeuhluhur, Majenang, Kawunganten, and Kampung Laut to represent the inland fisheries of Citandui, Ciberem, Cimeneng, Grugu/Beling Rivers and the saline water fisheries of Segoro Anakan lagoon. Site visits were also conducted to five Sub-districts of Sampang, Kroya, Maos, Adipala, and Nusawungu to represent inland fisheries of Serayu, Sodong, Gatel, Ijo Rivers and the saline water fisheries at Sodong and Serayu river-mouths. Additionally, site visits to Manganti Weir at Citandui and Gerak Weir at Serayu River (see **Figure 1**) were conducted to observe the mechanism of eel movement.

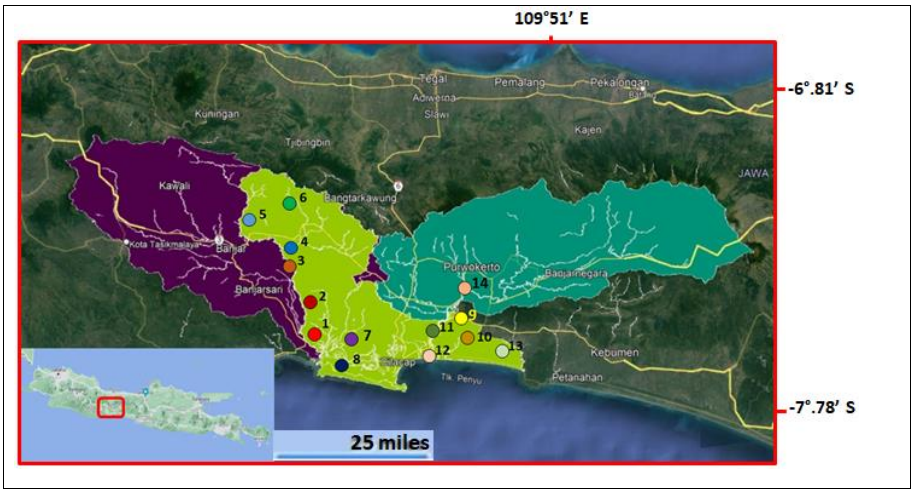

Figure 1. Map of the study area in the River Basin of the Sub-districts, namely 1. Patimuan, 2. Kedungreja, 3. Manganti Weir of Citandui, 4. Wanareja, 5. Dayehluhur, 6. Majenang, 7. Kawunganten, and 8. Kampung Laut, representing the Citandui watershed (purple), and 9. Sampang, 10. Kroya, 11. Maos, 12. Adipala, 13. Nusawungu, and 14. Gerak Weir of Serayu, representing the Serayu watershed (blue-green), in Cilacap Regency (yellow-green), Central Java.

Data collection

Additional data were also collected from fisheries statistics by local governments of Cilacap (i.e., capture fisheries) as well as from previous studies. In order to confirm the statistical data released by the local government, an interview was conducted to explore the different catch production between 2018 and 2022. This interview was conducted using a focused group discussion method, so that differences in perception could be concluded at that time with the minimum and maximum values of the catch results. The eels caught were categorized into six commercial-size classes, based on their individual weights. These were i.e., glass eels (<1 g), elvers (1-5 g), small pencils (6-15 g), big pencils (16-50 g), fingerlings (51-150 g), and consumption sizes (>150 g) (Rohman, 2018, Pers.com.).

Furthermore, the consumption sizes with a weight between 150–1,000 g were categorized as yellow eels, while those between 1,000–2,000 g were categorized as silver eels (based on the study conducted by **Rahmawati *et al.* (2022**). Due to the fishermen having their own local names for the eels caught (i.e., *pelus* and *sidat*) as well as the official fish nomenclature from the yearly statistical data of Cilacap District, some of the eels caught were confirmed by morphometric identification to ensure and define the species (**Taufiq-Spj *et al.* 2021**).

In order to evaluate the environmental conditions, the forestry of the Citandui and Serayu watershed was evaluated between 2010 and 2020 in terms of declining forest area. Yearly sedimentation velocity in Segoro Anakan lagoon (impounding seawater, (see **Figure 1 No. 8**) was counted using sedimentation data published by **Hakiki *et al.* (2021)** and the data from the Fisheries Department of Cilacap (unpublished data). A distribution map of eel in every stage development was based on where they were found or caught by fishermen. Henceforth, the eel stage development, movement, distribution, and yearly production can be described based on environmental cues.

RESULTS

1. Inland eel fisheries production

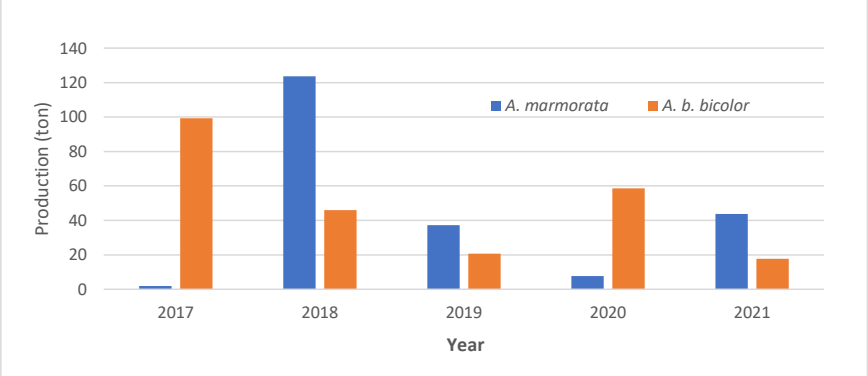

Figure 2. Inland eel fisheries production from 2017 to 2021 in Cilacap Regency

A general description of eel production in Cilacap District is shown in **Figure 2**. It shows that the eel production trend tends to decline from 2017 to 2021. Fishers who have caught fish known as "pelus" and "sidat" have been confirmed by morphometry with anno dorsal ratios (A/D) of 14.2 - 17.2% and 0.2 - 3.6%, which correspond to the species *Anguilla marmorata* and *A. bicolor bicolor* (**Watanabe *et al.*, 2008**) respectively. There are unstable catch

productions, especially for *A. marmorata*, where the catch of this species only produced 1.81 tons in 2017 and then increased steeply to 123.71 tons in 2018, before declining again in 2019 and 2020. Another species of *A. b. bicolor* is facing a consistent decline from 2017 to 2021 (**Figure 2**).

The inland fishery eel production above (**Figure 2**.) is obtained from various regions and from various types of waters in Cilacap District. As can be seen in **Figure 3**, river water types contribute the most to eel production compared to puddles (wetlands) and swamps. In 2017, the biggest catches of A. b. bicolor were found in rivers (68 tons), followed by wetlands (32 tons), and no eels were found in swamps. The biggest catches of A. marmorata started to be obtained in 2018, especially in river areas (67 tons), followed by wetlands (56 tons), and during this year there were also no eels found in swamp waters (**Figure 3**).

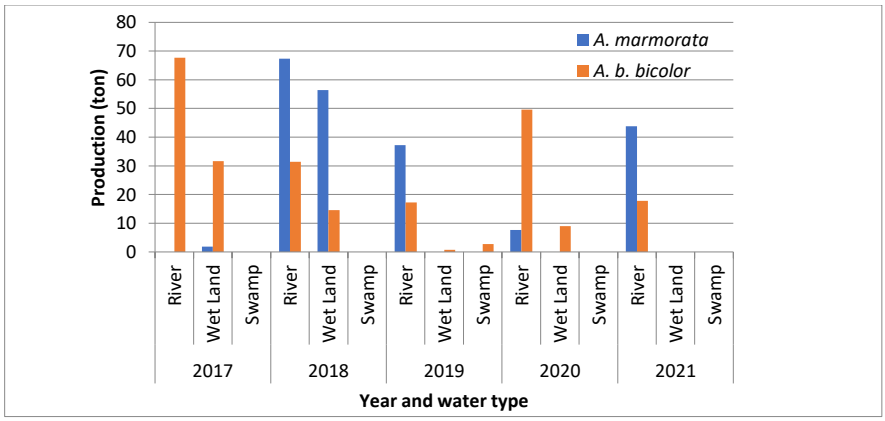

Figure 3. Eel production based on the region and water type along Inland Public Waters of Cilacap District during 2017–2021.

2. Fishermen's perceptions of eel capture

The eel capture perception mostly showed a decline between 2018 and 2022. Generally, the range of eel catches in the Citandui watershed was much bigger than in the Serayu watershed during 2018 and 2022. The biggest eel catches along the Citandui watershed were found in Patimuan Subdistrict (5 to 35 kg eel per fishing trip in 2018), followed by Kedungreja, Wanareja, Dayeuhluhur, Majenang, and the smallest was found in Kampung Laut Subdistrict (3 to 5 kg). Even though the eels caught along the Serayu watershed were much smaller in Sampang, Adipala, and Nusawungu, eel fishing in Maos was as big as that in Patimuan (**Table 1**).

Table 1. Eel capture range in one trip fishing (kg) of eel caught by fisherman in the year of 2018 and 2022

Watershed (WS)	Sub-districts	2018		2022		Eel Sizes	[3] Declining Proximation
		Min	Max	Min	Max		
Citanduy	Dayeuhluhur	2	11	2	6	Consumption	-45%
	Wanareja	3	15	0	5	Consumption	-67%

	Majenang	0	12	3	5	Consumption	-58%
	Kedungreja	5	25	0	5	Cons. & Fingerling	-80%
	Patimuan	5	35	0	5	Consumption, Pencil & Glass Eel	-86%
	[1] Kampung Laut	3	5	1	3	Consumption, Fingerling & Glass Eel	-40%
Serayu	Sampang	0	0.5	0	0.8	Pencil & Elver	+60%
	Maos	6	35	0	4	Consumption, Fingerling & Pencil	-89%
	Adipala	0	4	0	2	Glass Eel, Elver & Pencil	-50%
	[2] Nusawungu	0.5	1	0.3	0.5	Glass Eel, Elver & Pencil	-50%
Average Citanduy WS		3.00	17.17	1.00	4.83		-72%
Average Serayu WS		1.63	10.13	0.08	1.83		-82%

[1] Data taken in 2019 and 2023, [2] data taken in 2018 and 2023, [3] Declining proximation counted from maximum value

3. Stopping elver migration at the weirs

The Manganti Weir of Citandui, located in Sidareja-Cilacap, was completed in 1987, while the Gerak Weir of Serayu, located in Kebasen-Banyumas, was completed in 1996. Up to 2015, elvers were still found around both dams, especially around the drainage or overflow channels (Weir technician, pers.com 2018). During the dry season until 2017, there were still fishermen catching elvers that failed to climb through the leaking water flow on the dam walls. However, from 2018 to 2022, elvers were still found at the Manganti Dam, while at the Gerak Dam, they had not been seen since 2018. **Figure 4** shows the mechanism of elver migration during the dry season, which failed to climb up the dam wall through the leaking water at both dams.

Figure 4. Eels migrating upstream stop at either the Manganti Weir (on the left) or the Gerak Weir (on the right) of the Serayu River

4. Eel distribution map and its stages of development

Eel movements apparently depend on the fresh water flow. Glass eels were found in the estuaries of Platar Agung (-7°.69 S, 108°.79 E) and Majingklak (-7°.67 S, 108°.8 E), while

elvers were found at the Cise'el estuary (7°.6 S, 108°.74 E) and Manganti Weir (-7°.45 S, 108°.72 E) (**Figure 5**– left). Meanwhile, the yellow eel was also found upstream of the Manganti Weir Bojongsari Kedung (-7°.45 S, 108°.72 E), and then seven points of yellow eel fishing grounds were found along the Meluwung swamp of Wanarejo, Dayeuhluhur, and the Subdistrict of Majenang – Cilacap (**Figure 5** – right).

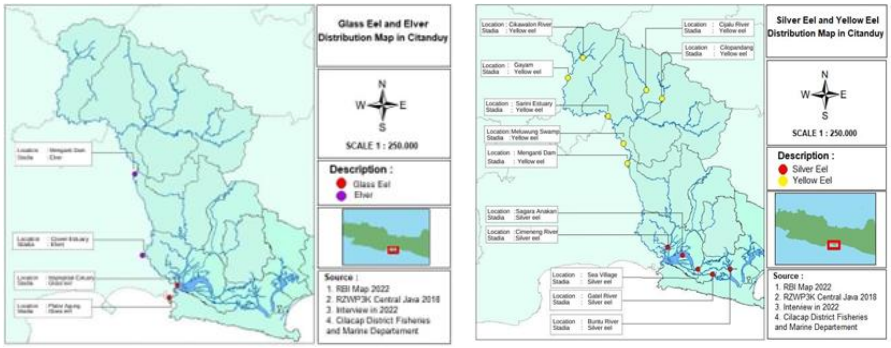

Figure 5. Distribution maps of glass eel and elver (on the left) and yellow and silver eel (on the right) found along the Citadui watershed and Segoro Anakan lagoon of the Cilacap District in Central Java, Indonesia

As for the eel distribution performance along the Citandui watershed (**Figure 5**.), the yellow eel was found in the Serayu River (Fig. 6), especially in the Maos/Kesugihan Subdistrict (-7°.59' S, 109°.14' E; -7°.60' S, 109°.14' E; -7°.60' S, 109°.13' E) (**Figure 6** left). While the glass eel was only found at the Sodong estuary of the Adipala Subdistrict (-7°.69' S, 109°.16' E), elvers were found in the riverine of Doplang at Adipala (-7°.66' S, 109°.19' E). Elvers were also found in five points of irrigation canals, i.e. Mernek, Sidasari, Sampang, Karang Jati, and Buntu (**Figure 6**, right).

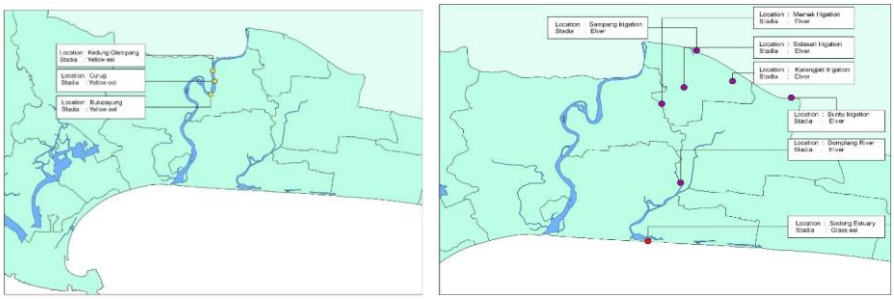

Figure 6. Distribution map of yellow eel (left), glass eel, and elver (right) along the Serayu watershed (Serayu and Sodong Rivers).

5. Forestry area along Citandui & Serayu watershed

The total area of Citandui and Serayu watersheds, released by the Ministry of Public Works and Housing in 2015 (unpublished data), are 447,285.90 and 372,536.90 Ha respectively. The digitized forest map of the Citandui river basin in 2010 was 219,253.15 Ha, and in 2020 it was

213,966.25 Ha. The forest area of the Serayu river basin in 2010 was 204,813.52 Ha, and in 2020 it decreased to 198,584.35 Ha (**Table 2**, see **Figure 1**).

Table 2. The loss of forestry area along the Citandui and Serayu watersheds from 2010 to 2020.

No	Watershed	WS Area (Ha)	Area of forestry in Watershed (Ha)			Loss of Forest (Ha) during 10 years
			2010	2015	2020	
1	Citandui	447285,9	219253,15	214,178.90	213966,25	5,286,90
2	Serayu	372536,9	204813,52	200,999,24	198584,35	6,229.17

The development of the decrease in the area of Segoro Anakan Lagoon varies from year to year. In 1984, the lagoon had an area of 2,906 ha, and in 1985 there was a decrease of 0.45% to 2,893 ha. The largest decrease occurred between 2002 and 2003, by 33.3%. However, between 2003 and 2005, there was an increase of 19.5%. Overall, between 1984 and 2014, there was an annual decrease of 2.8% for 30 years of sedimentation (**Table 3**), with a total reduction in the sea water area of the lagoon of 2,406 ha, or 82.8% of the original area of the lagoon.

Table 3. Decreasing the area of the Segoro Anakan lagoon during 1984 to 2003[(1)], 1984/2005 – 2014[(2)]

Year	**1984**		**1985**		**1986**		**1989**		**1991**
Lagoon Area (Ha)	2906		2893		2811		2298		2019
Yearly Area decline (%)		0,45		2,8		6,1		6,1	
Year	**1991**		**1992**		**1994**		**1995**		**1998**
Lagoon Area (Ha)	2019		1800		1575		1400		1250
Yearly Area decline (%)		10,8		6,3		11,1		3,6	
Year	**1998**		**2000**		**2001**		**2002**		**2003**
Lagoon Area (Ha)	1250		1200		1126		900		600
Yearly Area decline (%)		2,0		6,2		20,1		33,3	
Year	**2003**		**2005**		**2008**		**2014**		**1984**
Lagoon Area (Ha)	600		834		750		500		2906
Yearly Area decline (%)		-19,5		3,4		5,6		2,8	

(1) **Hakiki *et al.* (2021)** data from 1984 to 2003.

(2) Data compilation from various reports on the management of Segoro Anakan Lagoon by the Fisheries Department of Cilacap Regency (unpublished data).

DISCUSSION

The decline in production of eel capture fisheries in general inland waters of Cilacap from 2017 to 2021 (**Figure 2**) was initially attributed to declining market demand. However, from discussions with the fishermen, there is a similar trend of decreasing eel catches from 2018 to 2022 (**Table 1**). *Anguilla bicolor bicolor* consumption-sized (**Table 1**) caught in general inland waters of Cilacap generally in range between 200-1000 g. According to **Chai & Arai (2018**), that *A. b. bicolor* found in North Western Peninsula Malaysia with sizes of 179-798 g have reached gonad maturation stages V. Meanwhile, *A. bicolor* found in the Serayu River Cilacap has reached a gonadosomatic index of 4.37 with a weight of 1,026 g (**Rachmawati *et al.*, 2022**). From these two statements it seems that the fishermen's catches for *A. b. bicolor* are in yellow approaching to silver eel size stages. With the Decree of **MMAF No. 80 (2020)** which only provides for a catch limit of *A. b. bicolor* with a weight of no more than 2 kg, this will provide an opportunity for fishermen to catch eels below that weight. If the data from **Chai and Arai**

(2018) and **Rachmawati *et al.* (2022)** are applied, the minister's decision is actually counter-productive to the conservation efforts of this species especially in Cilacap inland waters.

The catch of *A. marmorata* fluctuates steeply from year to year, with a very low production in 2017 followed by a sharp increase in the following years and then a decrease again (**Figures 2 and 3**). This low production is likely due to the low recruitment of glass eels two to four years prior, or the massive catches of yellow and silver eels three to five years prior. The catch of *A. marmorata* of consumption size reaches 0.5-2 kg (**Table 1**). However, during the dredging of the Mrica reservoir in upstream of the Serayu River in Banjarnegara Regency at the beginning of April 2022, some giant mottled eels were found reaching 5-15 kg. Morphometric measurements of glass eel, elver, and pencil size in various Cilacap estuaries in 2019 showed that species *A. marmorata* was only found in 3.7% of the total sample (**Taufiq-Spj *et al.*, 2021**). Since eels generally have the same migration cycle (**Taufiq-Spj *et al.*, 2022**), the fluctuation of increased catch of consumption size reaching silver eel stage will decrease the number of glass eels entering the river and subsequently decrease the production of this species. **Jacoby *et al.* (2015)** reported that over the last 36 years, recruitment of glass eels and escapement of silver eels from the St. Lawrence River system to the Caribbean Gulf of Mexico and the Mississippi River system, has decreased significantly. Thus leading to a decline of more than 50% in the population of American eels (*Anguilla rostrata*), placing them in the Endangered (EN) category.

Confirmation of the decline in eel catch production (see **Figures 2 & 3**) was then conducted with fishermen in the two rivers. From the fishermen's perception, it was stated that there is a drastic decrease in eel catch by 2022 compared to 2018. Where, the catch of glass eel up to the consumption size in the Citandui Watershed decreased by 72% and Serayu 82% (**Table 1**). There are several causes of this decline in production. In addition to the causes mentioned above, one of them is the presence of the river barriers, i.e., the Manganti and Gerak Serayu dams (**Figure 4**) which are decreasing in water discharge over the years. Because the presence of both dams does not have fish ways or fish ladders, elvers fail to migrate upstream. The failure of this direct migration will make the eel face various alternative events. The first one is that the elvers look for another way out to continue the migration, the second is predation by carnivorous organisms, and the third is death. In the first alternative possibility, there is evidence that elvers can migrate between rivers through the ocean, but this fact occurs in the yellow eel stages of *Anguilla japonica* (**Kume et al., 2021**). Thus, it is possible that elvers who fail to migrate upstream will still look for another small channel or return to a downstream area that is more suitable.

The two weirs (Manganti and Gerak Weir) are intended as a source of irrigation for various areas along the two river basins. Some branch irrigation channels from Citandui (Manganti Weir) that irrigate the fields in Sidareja Sub-district will be connected to the Ciberem River and Cimeneng (see **Figure 5**). Meanwhile, branch irrigation channels from Serayu towards Adipala are connected to the Sodong River and those towards Nusawungu will be connected to the Gatel River (**Figure 6**) and then towards the Ijo River, which borders Kebumen Regency. Thus, the spatial distribution of each stage can be seen not only in the two rivers (Citandui and Serayu), but also in other rivers (Ciberem, Cimeneng, Sodong, and Gatel) and along their irrigation channels (See **Figure 5**, and **6**). This is possible because elvers are attracted to low salinity and rheotropic, allowing them to swim against the flow (**Trancart et al., 2014; Taufiq-Spj et al., 2022**). In other words, eels have a magnetic compass, which gives clues to migration triggered by endogenous rhythms in the early stages of life (**Cressi et al., 2017**), and a geomagnetic compass, which gives clues to migration triggered by the Earth's magnetic field in the later stages of life (**Katsumi et al., 2020**).

Although the mechanisms of migration of glass eel to other rivers need to be studied separately (**Bolliet et al., 2017**), the distribution of glass eel and elver found in the Sodong

River and irrigation channels all seem to be heading towards the weir for further upstream travel to the Serayu River (**Figure 6**). This indicates that the migration loop of the eel (**Taufiq-Spj et al., 2022**) has been successfully completed, even though they had to pass through other rivers due to the original river being blocked by the dam wall (**Figure 4**). However, the yellow eel found in Maos Sub-district (Kedung glempang, Curug, Bulupayung) might be elver that failed to go upstream and kept searching for suitable locations until they found the curves and bends in the Serayu River. It is possible that the meandering form of the river (see **Figure 6** left) creates a food-trapping situation for the organisms living in it, thus creating a stable food chain for the eel.

Therefore, the role of watersheds with forest area as a rainwater catchment is important in supplying water to the river throughout the year, even though the area of forests in Citandui and Serayu watersheds (**Table 2**) has exceeded the 30% requirement specified in legislation **Law No. 41 (1999**). The fact that there was 5,286.9 and 6,229.17 Ha of forestry lost along the Citandui and Serayu watersheds during 2010–2020 respectively (**Table 2**) has affected the downstream environment, especially in terms of high sedimentation rate (Table 3). This presumably causes a decrease in glass eel recruitment (see **Table 1**). The decrease in the area of the Segoro Anakan lagoon is another result of sedimentation from several rivers (Citandui, Ciberem, Cimeneng, Cikonde, Beling, Sapuregel) that flow into the lagoon (**Table 3**). However, it is expected that the restoration of the lost forests in both watersheds will improve the flow pattern in the dry season and subsequently improve the recruitment pattern of glass eel. At the Joint Environment and Climate Ministers' Meeting (2022), the G20 has agreed to promote and increase mainstream ecosystem restoration, including land and forest restoration on all types of ecosystems, involving public-private partnerships, into recovery policies and plans. Therefore, it is hoped that the loss of eel population above can be recovered in line with the UN Decade on Ecosystem Restoration 2021–2030, which encompasses protection, conservation, restoration, and sustainable land management in pursuit of fighting climate change and halting biodiversity loss (**G20-Indonesia, 2022**).

In general, the main efforts to improve the population and conservation of eels in Cilacap are to control and limit the pattern of yellow to silver eel catches by reducing the permissible catch weight of eels. This requires a revision of the Ministerial Decree of Fisheries No. 80/2020, from a ban on catching A. b. bicolor with a weight of more than 2 kg, to only less than 1 kg (**Rachmawati *et al.*, 2022**). Thus, eels with a weight of 150-1000 g can be caught. Meanwhile, due to the indication of decreasing population of *A. marmorata* (**Taufiq-Spj *et al.*, 2021**), a ban on catches is needed in Cilacap waters for at least the next 3 years. This is important due to the wide migration pattern of *A.b. bicolor*, which migrates from Java to Sumatra and Madagascar in Africa (**Taufiq-Spj *et al.*, 2022**), and the distribution of *A. marmorata* in various Indo-Pacific regions (**Lee et al., 2018**, **Itakura *et al.*, 2020**). Therefore, eels will play an important role as a species indicator, umbrella, flagship, and surrogate species for the conservation of freshwater biodiversity (**Itakura *et al.*, 2020**) in Cilacap waters.

Population improvement and conservation of eels can also be achieved by creating fishways or fish ladders (**Porcher, 2002**) on the walls of both dams (Citandui and Serayu) or irrigation gates from the two weirs. It is hoped that this will facilitate the upstream migration of elver stages and the downstream migration of silver eel stages. Similarly, reforestation of lost forests in the watershed area will improve the flow of water during the dry season, as well as reduce the rate of sedimentation, and is expected to improve the Segoro Anakan lagoon and Serayu River estuary area.

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CONCLUSION

This study concludes that the status of eels in Cilacap has declined due to the catch of yellow either silver eel and deforestation in the area. The presence of the two dams, Manganti and Gerak, has forced glass eel and elver to take an alternative route for their upstream migration. By utilizing the rivers Ciberem, Cimeneng, Sodong, and Gatel, which are connected to the irrigation channels of Citandui and Serayu, thus, completing the eel migration loop. The continuity of the river flow is essential for the survival of the catadromous species and their migration cycle, which is primarily dependent on the catchment area of rainwater in the watershed, and the forest area is the main factor. In 2020 and 2021, the Minister of Marine Affairs and Fisheries of the Republic of Indonesia issued decrees providing limited protection and conservation of Eels (*Anguilla* spp.) and imposed quotas for the use of limited protected fish species in order to maintain the sustainability of the eel population. This study demonstrates that deforestation in the Cilacap Regency of Central Java is having an adverse effect on the environment and its living organisms. Hereafter, to further effectively conserve the catadromous species, the construction of fish ways or fish ladders on both dams and irrigation gates of the two rivers must be done immediately.

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5. RESUME 5

5.1.E-mail to EJABF Editor

Manuscript #EJABF-2304-3374 (R1) Corrected

Yahoo/Email Masuk

Nurtaufiq Spj
Dari:taufiqspj@gmail.com
Kepada:mtkhalil52@hotmail.com
Cc:taufiqspj_1999@yahoo.com
Kam, 27 Apr 2023 jam 20.30

Dear: Dr. Magdy Tawfik Khalil Ibrahim

Here I enclosed:

A corrected manuscript ID: EJABF-2304-3374 entitled New Perspective of Java Eel Conservation: Case Study In Cilacap Riverine and Coastal Area, Central Java – Indonesia.

I am looking forward hearing from you

Sincerely Yours

Nur Taufiq-Spj
Fac. of Fisheries and Marine Science
Diponegoro University
Semarang - Indonesia
e-mail: taufiqspj_1999@yahoo.com

Unduh semua lampiran sebagai file zip

EJABF-2304-3374-2-2glvh[um_corrected.doc
6.1MB

5.2. Corrected manuscript as reviewer needs (comment 1 of R1: give the full name, Answer A: agreed, has already change. Comment 2 of R1: italic, Answer: ok, however the genus name commonly not using italic).

[redacted]
Egyptian Journal of Aquatic Biology & Fisheries
7. Zoology Department, Faculty of Science,
8. Ain Shams University, Cairo, Egypt.
9. ISSN 1110 – 6131
10. Vol. … (--): … – … (2023)
11. www.ejabf.journals.ekb.eg
12.
13. [redacted]

14. New Perspective of Java Eel Conservation: Case Study In Cilacap Riverine and Coastal Area, Central Java – Indonesia

15.

ARTICLE INFO

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Keywords:
Java Eel, *Anguilla* spp., migration cycle, Conservation, Cilacap Riverine, Watershed.

ABSTRACT

The Case study on new perspective of Java eel conservation was conducted by examining the decline trend of eel capture fisheries in general inland waters of Cilacap, Indonesia from 2017 to 2021, and the perception of fishermen from 2018 to 2022. Site visits and interviews with fishermen and eel collectors were conducted. Results show that there is a similar trend of decreasing eels (i.e., *Anguilla bicolor bicolor* and *Anguilla marmorata*) catches from 2018 to 2022, where the catch of glass eel up to the consumption size in the Citandui Watershed decreased by 72% and Serayu 82%. The presence of the river barriers, i.e., the Manganti and Gerak Serayu dams, decreases in water discharge over the years and the failure of elvers to migrate upstream has contributed to the decline. Distribution of glass eel and elver found in other rivers and along its irrigation channels, indicated that the eels have an escape for their migration upstream. The decrees of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia, issued in 2020 and 2021, have provided limited protection and conservation of eels (*Anguilla* spp.) and imposed quotas for the use of limited protected fish species in order to maintain sustainability of the eel population. The role of watersheds with forest areas in supplying water to the river throughout the year need to be concern. Suggested solutions to improve the population and conservation of eels include controlling and limiting the pattern of yellow to silver eel catches, creating fish ways or fish ladders on the walls of both dams, and reforestation of lost forests in the watershed area.

Commented [s3]: Give the full name

16. INTRODUCTION

17.

18. An ecological problem is causing significant damage to both the environment and its living organisms. Deforestation is causing a decline in water resources, particularly in river watersheds, leading to adverse effects on the living organisms in the river. This condition is wreaking havoc on diadromous species that rely on the continuity of the river's water flow for their migration cycle (**Taufiq-Spj *et al.*, 2022**). In the beginning stages of catadromous migration, glass eels are naturally drawn to the flow of rivers, migrating counter-current from low estuaries to rivers upstream (**Trancart *et al.*, 2014; Taufiq-Spj *et al.*, 2021**). This newly glass eel stage will enter the estuary area towards the river flow by using the "imprint magnetic direction of tidal current" (**Cressi et al., 2019**). While the elver stage and the pencil size will continue to swim upstream until they find a suitable environment for growth. Therefore, the continuity of the river flow is important for the survival of this catadromous species. This flow continuity mainly depends on the catchment area of rainwater in the watershed, where forest area is the main factor.
19. In terms of eel conservation, there are some declining populations of Anguilla sp. around the world. **Aalto *et al.* (2016)** reported that the fisheries yield of European eel (*Anguilla anguilla*) has been declining in population along eight countries of Mediterranean coastal lagoons. Other important species are also facing declining populations: i.e. *Anguilla japonica* **(Chang *et al.* 2018)**; *A. marmorata* (**Lee *et al.*, 2018; Pangerang *et al.*, 2018**), *A. rostrata* (**Gress *et al.*, 2008; Chang *et al.*, 2020; Feng *et al.*, 2022**) as well as *A. nebulosa nebulosa* (**Lukas *et al.*, 2022**). Other species such as *A. b. bicolor*, *A. bengalensis*, *A. australis*, *A. borneensis*, *A. celebesensis*, *A. ancentralis*, *A. b. pacifica*, *A. interioris*, *A. megastoma*, *A. labiata*, *A. mossambica* and other Anguillid species also need to be taken into consideration **(Aoyama, 2009; Fahmi and Hirnawati, 2010; Minegishi *et al.*, 2012; Fahmi *et al.*, 2013; Castonguay and Durif, 2016; Taufiq-Spj *et al.*, 2021)**. In addition, due to their wide-spread migration cycle, the importance of catadromous species can act as surrogate species for the conservation of freshwater biodiversity **(Itakura *et al.*, 2020**).

20. Since the genus *Anguilla* was announced in Appendix II of CITES (2017), the Indonesian Minister of Marine Affairs and Fisheries has issued some regulations. Starting with the Decree of the Minister of Marine Affairs and Fisheries (MMAF) of the Republic of Indonesia No. 80 of 2020 concerning the limited protection and conservation of Eels *Anguilla* spp. (**Decree of MMAF-RI No. 80,** 2020) , followed by the **Decree of MMAF No. 118** (2021) concerning the Eel Fisheries Management Plan. The most recent **Decree of MMAF No. 12** (2022) concerning the collection of quotas for the use of limited protected fish species in order to maintain the sustainability of the eel population was based on the National Provisions and Fish Species in Appendix II of the Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora.
21. Contrarily, as eels are one of the most nutritious non-starchy foods and famous protein sources, Indonesia was ranked as the number one eel-exporting country in the world. In 2020, Indonesia was able to supply 25% of the world's frozen eel with a value of up to $13,239,000, and its live eel export was ranked 14th in the world (**Widyaningrum, 2021**). In fact, the biodiversity of Indonesian eels is also the most varied of Anguillid eels around the world (**Taufiq-Spj *et al.*, 2020; 2021**). There are at least eight Anguillid species of Indonesian eels reported by **Fahmi, *et al.* (2013)** from the 18 species of world Anguillid eels known (**Tomiyama and Hibya, 1977; Leander et al., 2012; Minegishi *et al.*, 2012; Kottelat, 2013; Taufiq-Spj *et al.*, 2022**). Therefore, this study aims to evaluate the current status of eels in the Cilacap District, especially in terms of yearly catches and their environmental cues, in order to carry out an evaluation of the status of this species and its conservation.
22.

23. MATERIALS AND METHODS

24.

25. *The Study Area*
26. A survey was conducted from 2018 to 2023 in Cilacap, located in Southern Central Java, covering riverine and estuarine areas (**Figure 1**). The study involved site visits and interviews with 47 fishermen and 7 eel collectors in 12 Sub-districts of Cilacap Regency. Site visits were conducted to seven sub-districts of Patimuan, Kedungreja, Wanareja,

Commented [s4]: italic

6. RESUME 6

3374

Yahoo/Email Masuk

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Magdy Khalil
Dari:mtkhalil52@hotmail.com
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Jum, 5 Mei 2023 jam 15.37

Dear Authors,
Please revise carefully your article before Language editing and publishing
Please put the name of the Authors and their affiliations

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7. RESUME 7

7.1. E-mail ke Journal Editor

NurTaufiq SPJ
Dari:taufiqspj_1999@yahoo.com
Kepada: Magdy Khalil
Cc: NurTaufiq SPJ
Bcc: Gunawan Widi Santosa
Sen, 8 Mei 2023 jam 23.16

Dear Dr. Magdy Tawfik Khalil Ibrahim

Here I attached the revised article **ID: EJABF-2304-3374 entitled: "New Perspective of Java Eel Conservation: Case Study in Cilacap Riverine and Coastal Area, Central Java – Indonesia"** as your suggestion and I have change the map (Figure 1) in a better performance, hence I also enclosed the Figure page (file) as attached (due to the file size, I used compressed format of figure page in PDF, and you still used the original size format in the revised article).

thankyou
Looking forward hearing from you
Sincerely yours

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Tampilkan pesan asli

Unduh semua lampiran sebagai file zip

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  Figure page comp.pdf
  271.2kB

7.2. Revise figures (map)

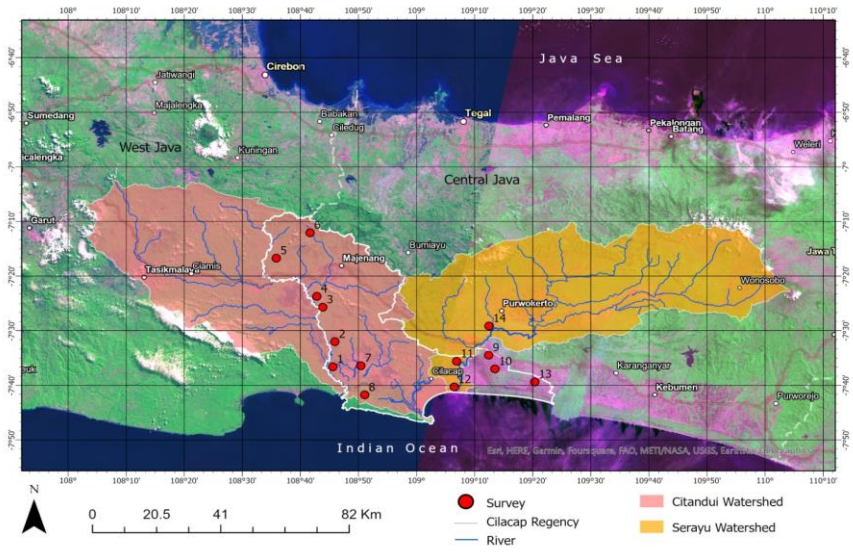

Figure 1. Map of the study area in the River Basin of the Sub-districts, namely 1. Patimuan, 2. Kedungreja, 3. Manganti Weir of Citandui, 4. Wanareja, 5. Dayehluhur, 6. Majenang, 7. Kawunganten, and 8. Kampung Laut, representing the Citandui watershed (pink), and 9. Sampang, 10. Kroya, 11. Maos, 12. Adipala, 13. Nusawungu, and 14. Gerak Weir of Serayu, representing the Serayu watershed (yellowish), in Cilacap Regency (in white border), Central Java.

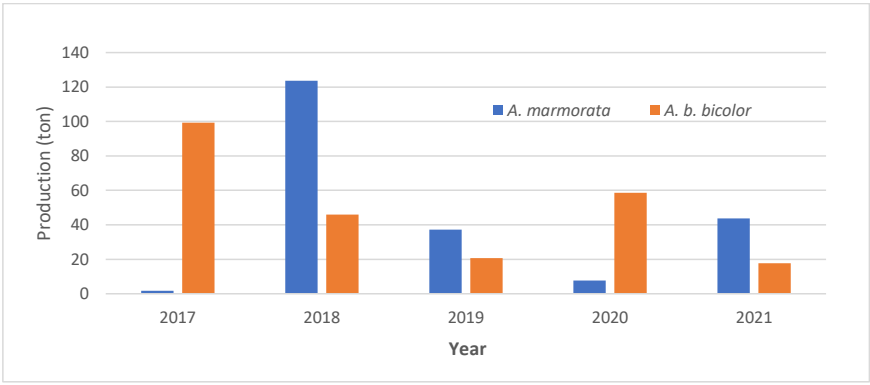

Figure 2. Inland eel fisheries production from 2017 to 2021 in Cilacap Regency

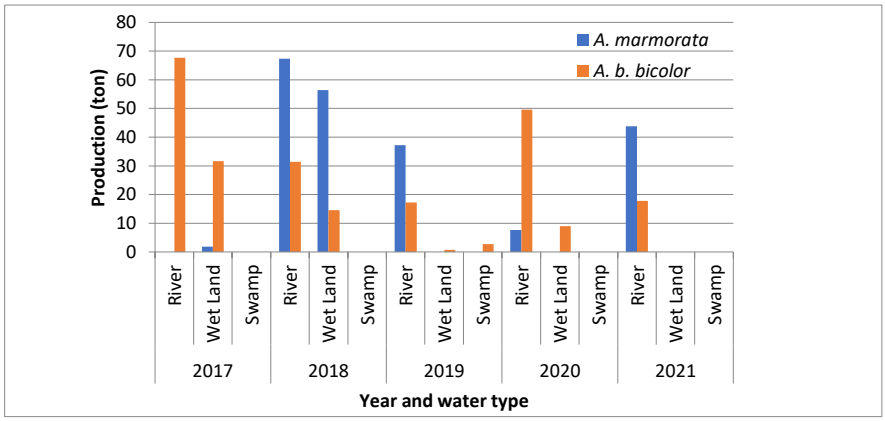

Figure 3. Eel production based on the region and water type along Inland Public Waters of Cilacap District during 2017–2021.

Figure 4. Eels migrating upstream stop at either the Manganti Weir (on the left) or the Gerak Weir (on the right) of the Serayu River

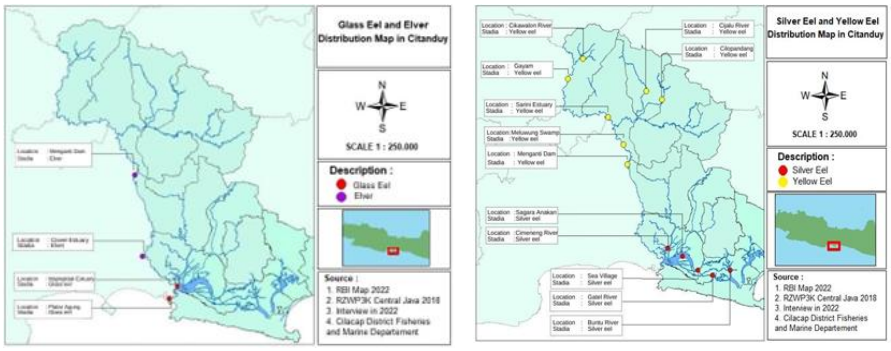

Figure 5. Distribution maps of glass eel and elver (on the left) and yellow and silver eel (on the right) found along the Citadui watershed and Segoro Anakan

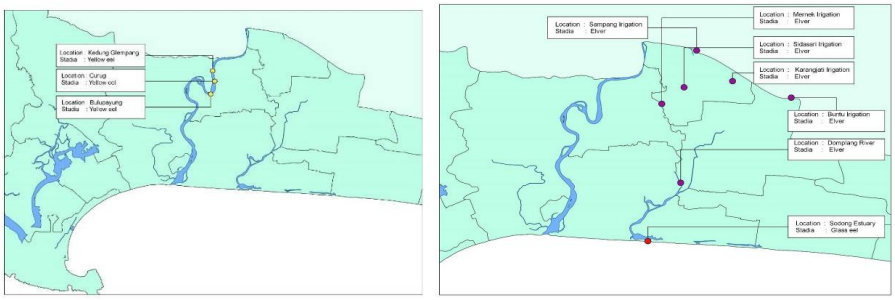

Figure 6. Distribution map of yellow eel (left), glass eel, and elver (right) along the Serayu watershed (Serayu and Sodong Rivers).

8. RESUME 8.

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Dear Authors,
Your article is in the final process; English language reviewing.
Regards

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9. RESUME 9. **NurTaufiq SPJ**

Dari:taufiqspj_1999@yahoo.com
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Rab, 14 Jun 2023 jam 14.23
Thank you for your responses. I am looking forward to my article being published soon.

sincerely yours

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10. RESUME 10

10.1. Email

Issue 39: 3374 (3rd revised article)
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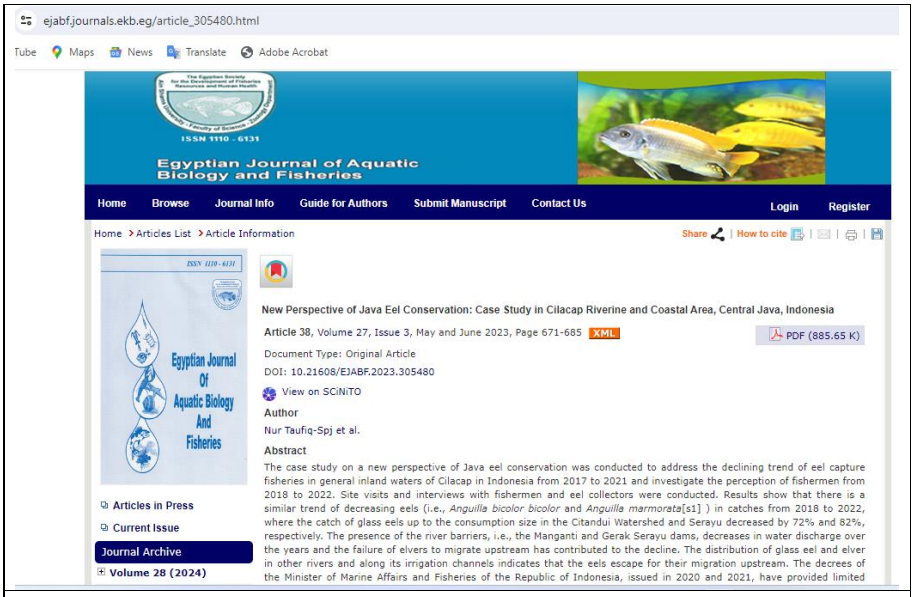
885.6kB

10.2. On line performance of the article, in the EJABF



Gb. 11. On line performance article yg ter publish on line pada 24/06/2023 di EJABF