Preliminary study of standardized CPUE of albacore tuna (*Thunnus alalunga*) in the eastern Indian Ocean

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Abstract

Albacore tuna (*Thunnus alalunga*) is one of key species in Indonesian longline fishery, important for economic income and exports in the eastern Indian Ocean. This study assesses its stock status using standardized catch per unit effort (CPUE) based on data from 121 trips and 2,863 sets (2005–2021), collected by the Research Institute for Tuna Fisheries of Indonesia. Fishing occurred between 0°–33° South and 75°–130° East, with ~1,300 hooks per set. A generalized linear model standardized CPUE, accounting for hooks, year, month, latitude, and longitude. Both nominal and standardized CPUE peaked in 2008 then showed a declining trend afterwards, with standardized CPUE showing greater fluctuations. These results suggest the need for ongoing monitoring and sustainable management.

Keywords: Albacore tuna, standardized CPUE, longline fishery, eastern Indian Ocean, stock status

Introduction

Albacore tuna (*Thunnus alalunga*) is one of key species in Indonesian longline fishery, representing an important component of the nation tuna fishery due to its significant economic value as both a source of domestic income and an export commodity (Nugroho et al., 2022). The fishery operates primarily in the eastern Indian Ocean, an important fishing ground for tuna group, supporting the livelihoods of many coastal communities and contributing to Indonesian seafood trade (Sadiyah & lskandar Prisantoso, 2011). Given the species economic and ecological importance, effective monitoring of albacore tuna stock status is essential to ensure sustainable management and prevent overexploitation.

Standardized catch per unit effort (CPUE) is a widely recognized tools for assessing fishery stock status, providing insights into population trends and fishing pressure (Maunder & Punt, 2004). By accounting for variations in fishing effort, gear efficiency, and environmental factors, standardized CPUE offers a reliable indicator of stock abundance and health, making it a critical tool for fishery management (Hilborn & Walters, 2013; Hoyle et al., 2014). In the context of tuna fishery, monitoring stock status through standardized CPUE is particularly important due to the species vulnerability to overfishing and the dynamic nature of the eastern Indian Ocean ecosystem (IOTC, 2022).

The objective of this study is to evaluate the stock status of albacore tuna in the eastern Indian Ocean using a standardized CPUE approach. By analyzing catch and effort data from Indonesian longline fishery, this research will provide updated insights into the sustainability of albacore tuna stocks, informing management strategies to support the long-term viability of this valuable fishery resource.

Methods

Data Collection

Data were collected by scientific observers from the Research Institute for Tuna Fisheries of Indonesia. Observers were deployed on longline tuna vessels operating in the eastern Indian Ocean from 2005 to 2011. They recorded comprehensive information on fishing operations, including catch data of albacore tuna and effort metrics (e.g., number of hooks deployed, fishing location, and operation dates). Data collection followed standardized protocols to ensure consistency and accuracy across all observed trips.

Data Analysis

To assess the stock status of albacore tuna, catch per unit effort (CPUE) was standardized to account for variability in fishing effort and environmental factors. CPUE was calculated as the number of albacore tuna caught per 100 hooks deployed. A generalized linear model (GLM) was employed to standardize CPUE, using the following model specification:

glm(formula = log(CPUE + 1) ~ log(number_of_hooks) + year + month_num + Latitude + Longitude, family = gaussian())

In this model, the response variable was the natural logarithm of CPUE plus 1 (to handle zero catches), with the number of hooks (log-transformed), year, month (as a numerical factor), latitude, and longitude included as explanatory variables. The Gaussian family was used to model the distribution of the response variable. Model diagnostics were performed to ensure assumptions of normality and homoscedasticity were met. All analyses were conducted using R software. The standardized CPUE indices were then used to infer trends in albacore tuna stock abundance in the eastern Indian Ocean.

Results

Data from the Indonesian longline fishery, comprising 121 trips and 2,863 sets conducted between 2005 and 2021 in the eastern Indian Ocean, were analyzed to assess albacore tuna (*T. alalunga*) stock trends. Fishing operations utilized an average of 5 to 19 hooks between floats, with an average of approximately 1,300 hooks per set. The spatial extent of the fishing grounds spanned latitudes from 0° to 33° South and longitudes from 75° to 130° East (Table 1).

Nominal and standardized catch per unit effort (CPUE) were calculated to evaluate temporal trends in albacore tuna abundance. Both metrics indicated that the highest catch rates occurred in 2008. Over the study period, both nominal CPUE and standardized CPUE exhibited fluctuating trends from 2005 to 2021 (Figure 1).

However, the standardized CPUE, derived from the generalized linear model (GLM) accounting for variations in fishing effort (log(number_of_hooks)), year, month, latitude, and longitude, displayed greater interannual fluctuations compared to the nominal CPUE (Figure 2). These fluctuations in standardized CPUE likely reflect the model sensitivity to environmental and operational variability, providing a more nuanced representation of stock dynamics in the eastern Indian Ocean.

Table 1. Indonesian longline operations in the Eastern Indian Ocean.

Year	Number of trips	Number of sets	Average hooks between floats	Average hooks per set	Lattitude (S)			Longitude (E)		
					min	average	max	min	average	max
2005	9	114	19	1,469	12	14	16	107	111	116
2006	21	469	12	1,426	4	15	32	102	115	128
2007	13	275	14	1,489	4	16	33	78	105	131
2008	4	53	13	1,930	11	17	19	75	78	114
2009	13	294	12	1,145	0	11	32	95	113	120
2010	6	172	14	1,329	0	11	15	95	113	120
2011	6	136	11	1,044	4	12	30	95	118	128
2012	7	192	14	1,484	9	19	33	85	104	117
2013	8	215	12	1,103	9	12	14	100	114	121
2014	7	191	15	1,180	6	11	13	97	105	120
2015	3	101	15	1,150	2	10	13	87	99	102
2016	1	23	5	1,078	11	12	13	113	114	116
2017	4	142	15	1,391	8	14	32	92	98	111
2018	6	207	15	1,354	5	14	32	92	104	115
2019	7	105	9	1,255	7	12	21	99	106	115
2020	2	66	13	1,382	12	18	22	106	108	111
2021	4	108	11	1,452	8	16	22	104	110	116
Total	121	2,863								

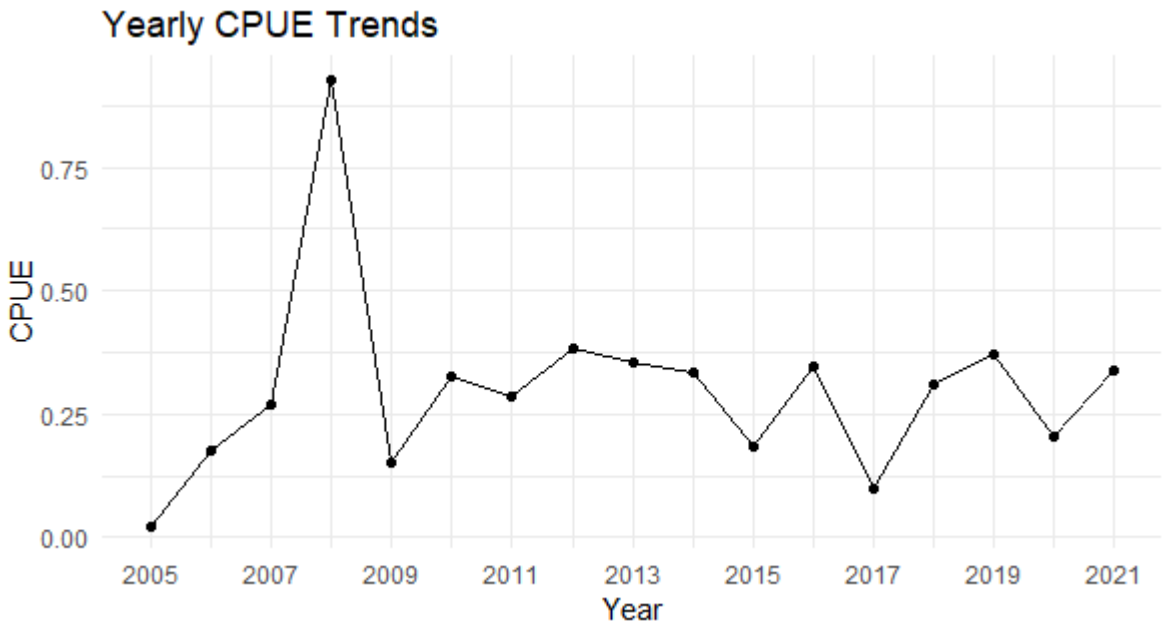

Figure 1. Nominal catch per unit effort (CPUE) of albacore tuna (*T. alalunga*) in the eastern Indian Ocean.

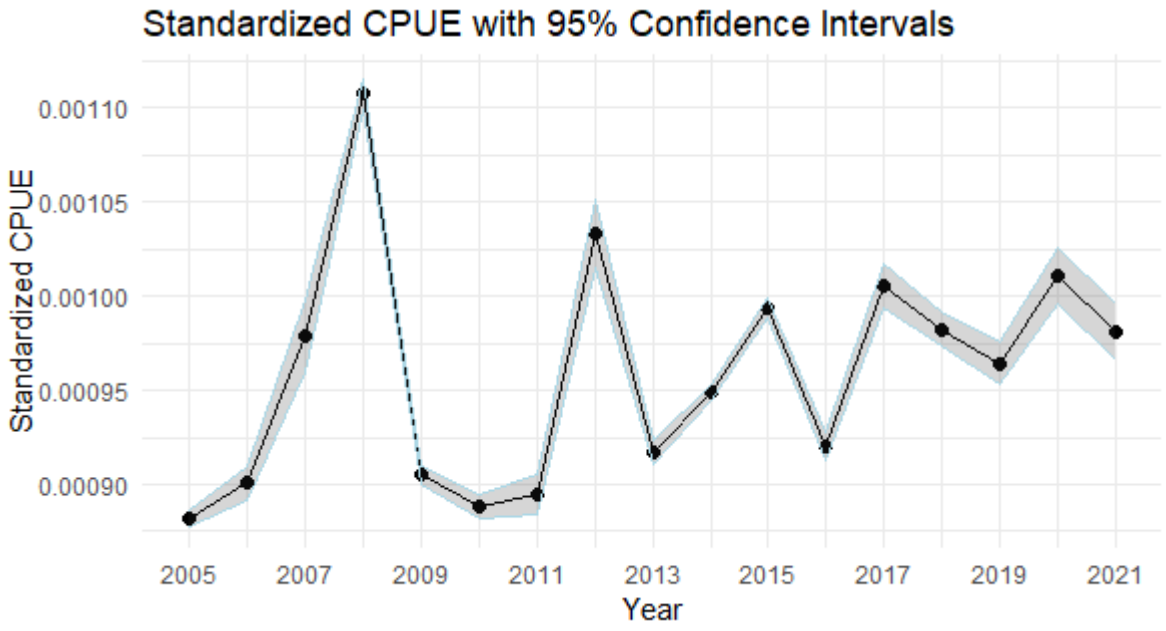

Figure 2. Standardized catch per unit effort (CPUE) of albacore tuna (*T. alalunga*) in the eastern Indian Ocean.

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