

Stock Assessment and Management for Longtail Tuna (*Thunnus tonggol*) in the Andaman Sea, Thailand

Orawan Prasertsook* and Sakol Piabpabratana

Fisheries Resource Assessment Group,

Marine Fisheries Research and Development Division, Department of Fisheries, Thailand

*Corresponding author: orawanp.dof@gmail.com

Abstract

The longtail tuna (*Thunnus tonggol*) is a commercially vital neritic tuna species in the Andaman Sea of Thailand, yet maintaining its long-term sustainability requires updated stock assessments and forward-looking management strategies. This study evaluated the historical stock status (2006–2025) and medium-term projections (2026–2035) of longtail tuna relative to Maximum Sustainable Yield (MSY) reference points using a Bayesian state-space surplus production model (JABBA framework). The historical trajectory revealed a robust recovery from localized depletion in the mid-2000s, stabilizing at a healthy biomass level ($B/B_{MSY} > 1.0$). In the 2025 assessment year, the stock remained in a non-overfished and non-overfishing state (Kobe green quadrant probability of 94.8%), with empirical landings (5,725 tonne) operating safely below the estimated MSY (7,699 tonne). However, an upward trend in fishing mortality (F/F_{MSY}) from 2023 to 2025 indicated escalating risk. 10-year forward projections showed that a 20% expansion in fishing effort (120%F) would trigger chronic overfishing starting in 2026 ($F/F_{MSY} = 1.21$). Conversely, conservation scenarios with a 10%–20% effort reduction (80%–90% F) stabilized fishing rates well within safe biological limits ($F/F_{MSY} = 0.70 - 0.80$). To prevent stock degradation, management must shift toward proactive input controls, establishing species-specific quotas, adopting a Multispecies/Multigear (MSMG) framework, and expanding Marine Protected Areas (MPAs).

Key words: Longtail tuna (*Thunnus tonggol*), Stock Assessment and Management, Andaman Sea, JABBA (Just Another Bayesian Biomass Assessment)

1. Introduction

The longtail tuna (*Thunnus tonggol*) is a commercially important neritic tuna species widely distributed across the Indo-West Pacific, playing a crucial role in coastal fisheries, regional food security, and the socio-economic livelihoods of small-scale fishing communities along the Andaman Sea coast of Thailand (FAO, 2024). Unlike oceanic tunas, this species heavily inhabits broad continental shelf waters, making it highly accessible and vulnerable to artisanal commercial gear, primarily coastal purse seiners and gillnets. Over the past decades, regional tuna catch compositions have shifted significantly; global annual landings of longtail tuna surged from approximately 30,000 tonnes in the early 1980s to persistently exceeding 200,000 tonne, driven by escalating seafood demands and processing capacities in Southeast Asia (Griffiths *et al.*, 2019). In Thailand's domestic waters, the annual catch along the Andaman Sea coast has shown high fluctuations, ranging from 1,726 to over 22,000 tonne (Nootmorn, 2015). This intensive exploitation pressure, combined with unassociated purse-seine operations in peripheral fishing grounds, has triggered growing concerns regarding the risk of localized overfishing and stock depletion in the Indian Ocean boundary (Seafood Watch, 2024; SEAFDEC, 2026).

Despite its profound economic footprint, executing a reliable assessment for longtail tuna presents major scientific challenges. Traditional stock assessment methodologies often fail or generate high statistical errors due to data-limited scenarios, high operational uncertainties, and under-reported artisanal landings inherent in small-scale marine fisheries (Griffiths *et al.*, 2019). To overcome these diagnostic bottlenecks, state-space surplus production models have been widely advocated to quantify structural uncertainties within data-deficient fisheries (Froese *et al.*, 2017). Specifically, the Just Another Bayesian Biomass Assessment (JABBA) model has emerged as a powerful, mathematically robust analytical tool, integrating a state-space framework with Bayesian MCMC algorithms to effectively characterize biomass dynamics, estimate process variances, and map prior-posterior probability distributions (Winker *et al.*, 2018). This study applies the JABBA framework, specifically under a Fox surplus production configuration, to evaluate the historical biomass dynamics, current exploitation status, and long-term reference points of longtail tuna in the Andaman Sea of Thailand. Ultimately, the resulting stock assessment establishes critical, data-driven scientific baselines and forward projection scenarios required to formulate effective fisheries management strategies, ensuring the ecological sustainability and optimal socio-economic utilization of this marine resource.

2. Material and Methods

2.1 Data sources

The empirical data utilized for the stock assessment encompass the total catch volumes (measured in tonnes) and corresponding fishing effort records of longtail tuna (*Thunnus tonggol*) from 2006 to 2025. The dataset covers both artisanal and commercial fisheries, utilizing purse seines as the standard gear. All primary data were officially recorded and compiled by the Department of Fisheries (DOF) of Thailand.

2.2 JABBA model

The Maximum Sustainable Yield (MSY) and stock status analyses in this study were executed using the Just Another Bayesian Biomass Assessment (JABBA) model (Winker et al., 2018), which is openly accessible via GitHub (github.com). The state-space surplus production framework incorporated the Fox, Schaefer, and Pella-Tomlinson production functions. These functions were parameterized using structured prior distributions for key biological and fishery variables, specifically the carrying capacity (K), the intrinsic rate of population increase (r), and the initial depletion state of the longtail tuna stock.

3. Result

3.1 Stock Status and Exploitation Trajectories

The historical stock status and exploitation dynamics of longtail tuna (*Thunnus tonggol*) in the Andaman Sea of Thailand were evaluated from 2006 to 2025 relative to the Maximum Sustainable Yield (MSY) biological reference points.

3.1.1 Biomass Dynamics (B/B_{MSY})

As illustrated in Figure 1, the estimated median biomass ratio (B/B_{MSY}) initiated in 2006 at a level below the target reference point (B/B_{MSY} < 1.0), suggesting that the stock was historically under localized depletion during the mid-2000s. However, the resource exhibited a rapid and robust recovery phase from 2006 to 2011, driven by a strong upward trajectory that firmly crossed the sustainability threshold line (B/B_{MSY} = 1.0) around 2007. From 2011 through 2023, the longtail tuna stock stabilized in a highly favorable condition, persistently fluctuating at a healthy level between 2.0 and 2.2 times the biomass required to produce MSY. Notably, a slight downward trend is observed in the final years of the historical series (2023–2025), with the median biomass ratio terminating at approximately 1.95

in 2025. Throughout this historical timeline, the 95% Bayesian credible intervals (shaded grey area) remained securely above the limit reference point, confirming that the stock was not in an overfished state

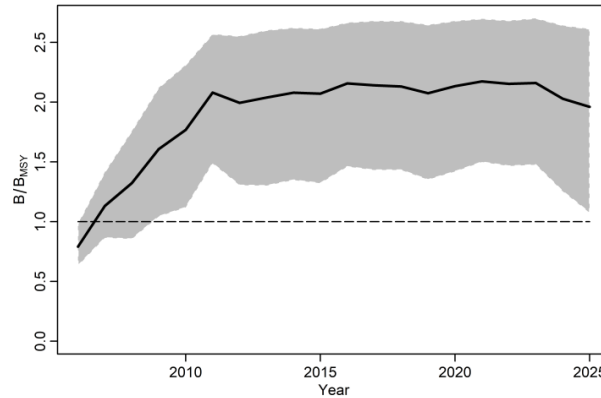


Figure 1. B/B_{MSY} of Longtail tuna in Andaman Sea, Thailand

3.1.2 Fishing Mortality Trends (F/F_{MSY})

The corresponding exploitation rate (Figure 2) mirrors the healthy status of the biomass. The median fishing mortality ratio (F/F_{MSY}) remained consistently and significantly below the overfishing threshold line ($F/F_{MSY} = 1.0$) across almost the entire assessment period. Following a peak in 2007, the fishing pressure dropped and stabilized at a low level, fluctuating between 0.2 and 0.4. This indicates that the longtail tuna fishery in the Andaman Sea was operating under sustainable fishing intensities. However, a progressive increase in fishing pressure is apparent from 2022 to 2025, where the median (F/F_{MSY}) climbed toward approximately 0.38, while the upper bound of the 95% credible interval expanded beyond the overfishing threshold line in 2025. This expansion indicates an escalating risk of overfishing in recent years, despite the median remaining within safe biological limits.

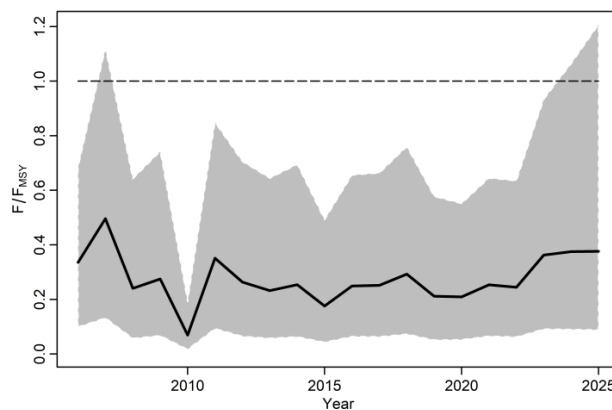


Figure 2. F/F_{MSY} of Longtail tuna in Andaman Sea, Thailand

3.1.3 Kobe Plot Stock Status

In 2006 (the white square), the stock status initiated inside the bottom-left yellow quadrant ($(B/B_{MSY} = 0.81)$, $(F/F_{MSY} = 0.35)$). This indicates a state where the stock was not subject to overfishing but was already overfished due to historical depletion prior to the assessment period. Following 2006, the stock trajectory quickly moved eastward, crossing the threshold into the sustainable green quadrant ($(B/B_{MSY} > 1.0)$, $(F/F_{MSY} < 1.0)$) within a single year (2007). By 2019 (the white circle), the stock had achieved an optimal condition, positioning itself deep within the safe biological zone. In 2025 (the white triangle) shows the stock remains securely inside the green quadrant ($(B/B_{MSY}$ approx 1.95), $(F/F_{MSY}$ approx 0.38)). This confirms that the current status of the longtail tuna resource in the Andaman Sea is neither overfished nor undergoing overfishing. This sustainable biological standing is robustly supported by the catch dynamics; in 2025, the estimated Maximum Sustainable Yield (MSY) for the stock was quantified at 7,699 tonnes, whereas the actual empirical landing recorded for the fishery was safely capped below the sustainable limit at 5,725 tonne. (Figure 3)

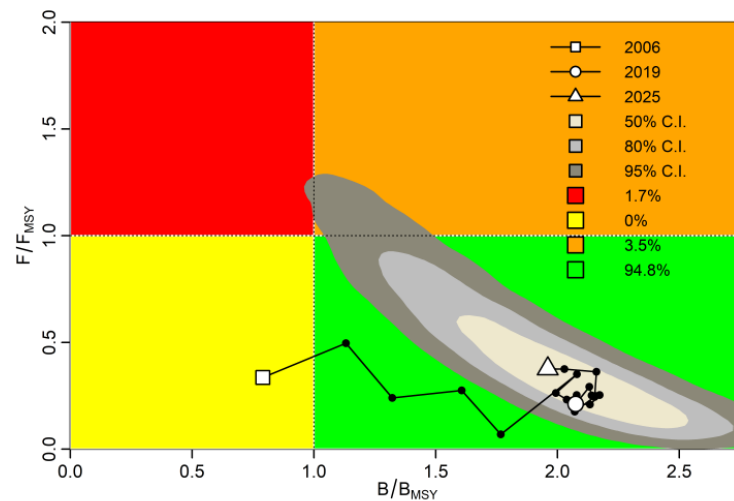


Figure 3. Kobe plot of the assessment of stock status for Longtail tuna in Andaman Sea, Thailand

Furthermore, the Bayesian posterior uncertainty for the 2025 terminal stock status, represented by the concentric credible interval rings (50%, 80%, and 95% C.I. ellipses), reveals high statistical probability toward long-term sustainability. The joint prior-posterior probability distribution is overwhelmingly concentrated within the safe operating space, with 94.8% residing in the green quadrant. The remaining probabilities are distributed at 3.5% in the orange quadrant (overfishing occurring but stock not yet overfished) and a minor 1.7%

risk in the red quadrant (both overfished and undergoing overfishing), while the probability of being in the yellow zone is 0%. These findings provide robust empirical support that the current Longtail tuna fishery operates within safe biological limits, though vigilance is required as the trajectory has begun slightly shifting toward the orange boundary in recent years.

3.2 Medium-Term Fishing Mortality Projections (2026–2035)

To evaluate the future sustainability of the longtail tuna fishery under different management strategies, a 10-year forward projection (2026–2035) of the fishing mortality ratio (F/F_{MSY}) was conducted based on four distinct effort-based scenarios (Figure 4). The historical trajectory (2006–2025, denoted by the solid blue line) demonstrates that the median exploitation rate consistently remained below the overfishing threshold ($F/F_{MSY} < 1.0$). However, the final historical years showed an alarming upward trend, with the upper bound of the 95% credible interval (shaded purple area) breaching the threshold line in 2025 ($F/F_{MSY} = 1.28$), underscoring the urgent need for proactive effort regulations.

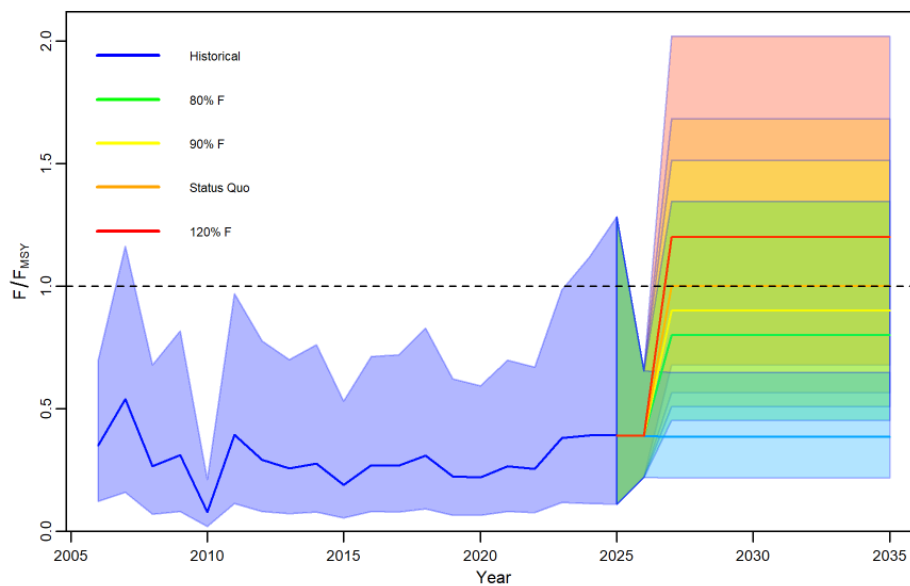


Figure 4. Projected trajectories of the fishing mortality ratio (F/F_{MSY}) for longtail tuna from 2026 to 2035 in Andaman Sea, Thailand

Future projections from 2026 onwards reveal highly divergent outcomes based on the simulated scenarios: The 80% F (Green) and 90% F (Yellow) Conservation Scenarios: Implementing a 10% to 20% reduction in fishing effort relative to the current baseline effectively mitigates the risk of overfishing. Under both scenarios, the median (F/F_{MSY}) ratio quickly decreases and stabilizes at a highly sustainable level—approximately 0.80 for the 90% F scenario and 0.70 for the 80% F scenario. Most importantly, their

corresponding 95% Bayesian credible intervals (shaded green and yellow boundaries) remain safely below the critical overfishing threshold line ($F/F_{MSY} = 1.0$), guaranteeing a resilient and biologically safe harvesting regime throughout the decade.

The Status Quo Scenario (100% F - Orange): Maintaining the current fishing intensity leads to an immediate and permanent elevation of the risk profile. Under this scenario, the median trajectory shifts upward, stabilizing directly at the baseline level. Although the median line stays within biological limits, the wider credible interval bands reflect escalating structural uncertainty, suggesting a substantial cumulative probability that the fishery could experience periods of overfishing. And the 120% F Scenario (Red): A 20% expansion in fishing effort triggers an immediate regulatory violation. The median projected fishing mortality ratio surges dramatically, crossing the threshold in 2026 and stabilizing at a dangerous level of 1.21 from 2027 through 2035. Under this intensive harvesting strategy, the entire upper bound of the credible interval expands heavily into the critical zone (exceeding 2.0), providing robust empirical proof that a 20% increase in effort will plunge the longtail tuna fishery into chronic, long-term overfishing.

4. Discussion

The Bayesian state-space stock assessment implemented via the JABBA framework provides critical operational insights into the status and exploitation dynamics of longtail tuna (*Thunnus tonggol*) in the Andaman Sea of Thailand. The historical trajectories (2006–2025) demonstrate a robust recovery phase following localized depletion in the mid-2000s, subsequently stabilizing at a healthy biomass level ($B/B_{MSY} > 1.0$). This positive biological standing is strongly reinforced by the current yield metrics evaluated for the terminal year 2025. Specifically, the estimated Maximum Sustainable Yield (MSY) was quantified at 7,699 tonnes, while the empirical fishery landing remained safely capped at 5,725 tonnes. Operating below the MSY threshold suggests that the input controls and regional management measures executed by the Department of Fisheries over the last decade including seasonal closures and strict vessel licensing have been effective in preventing catastrophic recruitment overfishing for neritic tunas (Nootmorn, 2015; SEAFDEC, 2026). Furthermore, the Kobe plot matrix confirms this optimistic status, showing a 94.8% joint probability that the resource currently resides within the safe, non-overfished green quadrant.

Despite the current healthy status, the final years of the historical series (2023–2025) reveal an alarming trend: a progressive decline in the median biomass ratio concurrent with an expansion of fishing mortality (F/F_{MSY}) uncertainty, where the upper 95%

credible interval breached the overfishing threshold in 2025. This structural shift provides empirical justification for the medium-term forward projections (2026–2035) conducted in this study. The divergent outcomes under simulated effort regimes indicate that the longtail tuna fishery is highly sensitive to changes in commercial purse-seine and gillnet pressure (Griffiths *et al.*, 2019). The 120% F scenario serves as a stark warning, showing that a mere 20% escalation in fishing effort will trigger an immediate regulatory violation, driving the median (F/F_{MSY}) ratio to a chronic overfishing state of 1.21 from 2027 onwards. This conforms to general fisheries paradigms where open-access or unregulated expansions rapidly destabilize resilient tuna stocks, accelerating resource depletion (Froese *et al.*, 2017).

Consequently, the projection data heavily supports the implementation of proactive, effort-based management strategies over catch-only limits. The 80% F and 90% F conservation scenarios demonstrate that a 10% to 20% reduction in fishing mortality will successfully steer the fishery away from the overfishing boundary, stabilizing the harvesting rate at highly sustainable levels (0.70 and 0.80, respectively) and securing narrow, predictable credible intervals. In the context of Thailand's fisheries governance, maintaining the Status Quo (100% F) carries a long-term risk due to rising environmental fluctuations and market demands in Southeast Asia (SEAFDEC, 2026).

Therefore, to safeguard the economic livelihoods of coastal communities and ensure supply chain stability for the domestic processing sector, the Department of Fisheries should shift from reactive monitoring to proactive control of inputs. Current resource management based on species groups may be insufficient to protect the status of individual aquatic species; thus, it is recommended to establish standardized annual quotas for purse seine vessels by incorporating species-specific stock assessment results, adopting Multispecies/Multigear (MSMG) fisheries management approach, and expanding expanded Marine Protected Areas (MPAs) to maintain longtail tuna stocks within safe biological limits.

5. Conclusion

This study highlights the successful recovery and sustainable standing of longtail tuna (*Thunnus tonggol*) in Thailand's Andaman Sea, with 2025 landings (5,725 tonne) remaining safely below the estimated Maximum Sustainable Yield ($MSY = 7,699$ tonne) and a 94.8% probability of residing in the safe Kobe green quadrant. However, recent escalations in fishing mortality (2023–2025) pose emerging risks. 10-year projections (2026–2035) demonstrate that a 20% effort expansion (120% F) will lead to immediate,

chronic overfishing, whereas a 10%–20% effort reduction (80% - 90% F) secures long-term stock resilience. To safeguard this resource, fisheries management must shift toward proactive input controls, including species-specific quotas, a Multispecies/Multigear (MSMG) framework, and expanded Marine Protected Areas (MPAs).

6. References

- Department of Fisheries (2025). Fisheries statistics of Thailand 2025. Fisheries Development Policy and Strategy Division, Department of Fisheries, Ministry of Agriculture and Cooperatives, Thailand.
- FAO. (2024). Thailand - Fisheries and Aquaculture Country Profile. FAO Fisheries and Aquaculture Department, Rome.
- Froese, R., Demirel, N., Coro, G., Kleisner, K. M., & Winker, H. (2017). Estimating fisheries reference points from catch and resilience. *Fish and Fisheries*, 18(3), 506-526.
- Griffiths, S. P., Leadbitter, D., Willette, D., & Leadbitter, M. (2019). Longtail tuna, *Thunnus tonggol* (Bleeker, 1851): a global review of population dynamics, ecology, fisheries and considerations for future conservation and management. *Reviews in Fish Biology and Fisheries*, 29(4), 733-766.
- Nootmorn, P. (2015). The Status of Longtail Tuna (*Thunnus tonggol*) Resource and Fisheries in Thailand. IOTC–2015–WPNT05–13 Rev_1. Department of Fisheries, Thailand.
- Seafood Watch. (2024). Longtail tuna caught by Thai fleets in the Indian Ocean: Seafood Recommendation. Monterey Bay Aquarium. Longtail tuna Tuna seafood recommendation.
- SEAFDEC. (2026). Integrated Assessment of Neritic Tuna Resources in Southeast Asia. Southeast Asian Fisheries Development Center, Bangkok.
- Winker, H., Carvalho, F., & Kapur, M. (2018). JABBA: Just Another Bayesian Biomass Assessment. *Fisheries Research*, 204, 275-288.