

Table 57. Estimated exploitation rate (E) of scads in the South China Sea and Andaman Sea (E- Exploitation rate, F-Fishing mortality; Z-Natural mortality, FMA 711-Fisheries Management Area 711, WCPM-West Coast of Peninsular Malaysia)

Country	Fishing ground	Species	Year	Exploitation rate (E=F/Z)	Reference	
South China Sea						
Brunei Darussalam	Brunei waters	<i>Decapterus macrosoma</i>	2003–2005	0.86	Matzaini <i>et al.</i> , 2007	
	Brunei waters	<i>D. maruadsi</i>	2003–2005	0.86	Matzaini <i>et al.</i> , 2007	
Indonesia	Pekalongan Pemangkat	<i>D. russelii</i>	2005	0.55	Wudianto <i>et al.</i> , 2007	
	FMA 711 SCS		2015	0.37	Duto, 2016	
	Pekalongan Pemangkat	<i>D. macrosoma</i>	2005	0.48	Wudianto <i>et al.</i> , 2007	
	FMA 711 SCS		2015	0.72	Duto, 2016	
	Tok Bali		2003–2005	0.59	Samsudin, 2007	
Malaysia	Kuantan	<i>D. macrosoma</i>	2003–2005	0.73	Ahemad & Irman, 2007	
	Kota Kinabalu		2003–2005	0.50		
	Kudat		2003–2005	0.82		
	Tok Bali		2003–2005	0.75		
	Malaysia	Kuantan	<i>D. maruadsi</i>	2003–2005	0.70	Samsudin, 2007
		Sarawak waters		2003–2005	0.76	Hadil, 2007
		Kota Kinabalu		2003–2005	0.27	Ahemad & Irman, 2007
		Kudat		2003–2005	0.59	
Philippines	Tayabas Bay	<i>D. macrosoma</i>	2011	0.32	Ramos <i>et al.</i> , 2018	
		<i>D. maruadsi</i>	2013	0.23		
		<i>D. macrosoma</i>	2012	0.52		
Thailand	Gulf of Thailand	<i>D. maruadsi</i>	2018	0.71	Yamrungrueng <i>et al.</i> , 2018	
Andaman Sea						
Indonesia	Palembang	<i>D. russelii</i>	2005	0.53	Wudianto <i>et al.</i> , 2007	
		<i>D. macrosoma</i>	2005	0.55		
Malaysia	WCPM	<i>Decapterus spp.</i>	2003–2005	0.59	Sallehudin <i>et al.</i> , 2016	
Thailand	Andaman Sea Coast of Thailand	<i>D. maruadsi</i>	2007	0.71	Boonsuk <i>et al.</i> , 2010	

- Lack of statistical database system for catch and effort
- Lack of specific fisheries management plan for scads fisheries including fishing effort, fishery regulation, traceability system, cooperation, among others

Way Forward

The ongoing project “Fisheries Management Strategy for Pelagic Fish Resources in the Southeast Asian Region” (2020–2024) under the JTF VI Phase II project is being implemented by SEAFDEC/MFRDMD and the activities include stock and risk assessments for scads.

1.1.3 Mackerels

Mackerels are under the family Scombridae that feed on plankton, crustaceans, mollusks, fish eggs, and small fishes, and could be found at water depths between 20 m to 90 m, *e.g.* short mackerel (*Rastrelliger brachysoma*) are mostly in the inshore areas while the Indian mackerel (*Rastrelliger kanagurta*) are at the offshore areas (Hadil & Richard, 1991). A study conducted in the South China Sea and the Andaman

Sea has voted for a single unit stock for the management purpose of the Indian mackerel (*R. kanagurta*) since the fish species in the South China Sea and the Andaman Sea share the same stock with high genetic variation (Akib *et al.*, 2015; Wahidah *et al.*, 2013). A single genetic stock of *R. brachysoma* has also been identified in the Gulf of Thailand. The mixed-stock analysis revealed that the Samut Songkhram population has been the major contributor (52.71 %) to the total catch from the Inner Gulf of Thailand. The Surat Thani population dominantly contributes 46.23 % to the total catch from the lower part of the Central Gulf of Thailand, where the fishing ground surrounds its spawning ground. The populations from Cambodia and Malaysia corporately contribute 70.95 % and 87.88 % to the total catches from the Eastern Gulf of Thailand and upper part of the Central Gulf of Thailand, respectively (Kongseng *et al.*, 2021). A study on the distribution and density of mackerel larvae *Rastrelliger spp.* in the northwest coast of Peninsular Malaysia (Yan, Kedah) found that the highest density occurs in September compared to August and October (Nur-Hidayah *et al.*, 2020).

The production of mackerels including the Indian mackerel (*R. kanagurta*), short mackerel (*R. brachysoma*), Indian mackerels *nei* (*Rastrelliger* spp.), and mackerels *nei* (Scombridae) of Southeast Asia between 2008 and 2019 is shown in **Figure 58**. In Fishing Area 57 (Indian Ocean, Eastern), the production trend was stable with an average of 291,836 mt/year in 2008–2018 but declined significantly to 178,512 mt in 2019. Production in Fishing Area 71 (Pacific, Western Central) had a gradually increasing trend from 2008 (432,259 mt) to 2013 (548,629 mt), but the production decreased significantly in 2019 (231,130 mt).

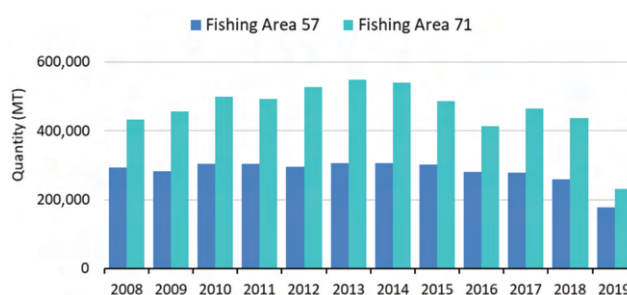


Figure 58. Production of mackerels of the Southeast Asian countries between 2008 and 2019 from Fishing Area 57 and Fishing Area 71 by quantity (mt)

Source: SEAFDEC, 2022

Table 58. Estimated exploitation rates of mackerels (*R. kanagurta* and *R. brachysoma*) in the South China Sea and Andaman Sea

Country	Site	Year	Species	Exploitation rate	References
South China Sea					
Brunei Darussalam	Brunei waters	2003–2005	<i>R. kanagurta</i>	0.72	Matzaini <i>et al.</i> , 2007
	Tok Bali, Kelantan	2003–2005	<i>R. kanagurta</i>	0.65	Samsudin, 2007
Malaysia	Tok Bali, Kelantan	2016–2020	<i>R. kanagurta</i>	0.64	Mohammad-Faisal <i>et al.</i> , 2021a
	Kuantan, Pahang	2003–2005	<i>R. kanagurta</i>	0.68	Samsudin, 2007
	Endau, Johor	2017–2018	<i>R. kanagurta</i>	0.41	Mohammad-Faisal <i>et al.</i> , 2021b
	Kota Kinabalu, Sabah	2003–2005	<i>R. kanagurta</i>	0.65	Ahemad & Irman, 2007
	Kudat, Sabah	2003–2005	<i>R. kanagurta</i>	0.77	Ahemad & Irman, 2007
	Kunak, Sabah	2003–2005	<i>R. kanagurta</i>	0.70	Ahemad & Irman, 2007
	Marudu Bay, Sabah	2013	<i>R. kanagurta</i>	0.45	Amin <i>et al.</i> , 2014
	Sarawak waters	2003–2005	<i>R. kanagurta</i>	0.75	Hadil, 2007
	Sarawak waters	2003–2005	<i>R. brachysoma</i>	0.86	Hadil, 2007
	Philippines	Davao Gulf	2004	<i>R. kanagurta</i>	0.64
Davao Gulf		2004	<i>R. brachysoma</i>	0.59	Armada, 2004
Rosario		2003–2005	<i>R. brachysoma</i>	0.64	Rafael <i>et al.</i> , 2007
Rosario		2003–2005	<i>R. kanagurta</i>	0.74	Rafael <i>et al.</i> , 2007
Navotas		2003–2005	<i>R. brachysoma</i>	0.61	Rafael <i>et al.</i> , 2007
Navotas		2003–2005	<i>R. kanagurta</i>	0.69	Rafael <i>et al.</i> , 2007
Dagupan		2003–2005	<i>R. brachysoma</i>	0.54	Rafael <i>et al.</i> , 2007
Dagupan		2003–2005	<i>R. kanagurta</i>	0.41	Rafael <i>et al.</i> , 2007
Manila Bay		2017	<i>R. brachysoma</i>	0.70	Santos <i>et al.</i> , 2017
Thailand		Gulf of Thailand	2012	<i>R. kanagurta</i>	0.52
	Eastern Gulf of Thailand	2017	<i>R. kanagurta</i>	0.56	Koolkalya, 2017
Andaman Sea					
Indonesia	Malacca Strait	2014	<i>R. brachysoma</i>	0.79	BOBLME, 2015
	Malacca Strait	2014	<i>R. kanagurta</i>	0.62	BOBLME, 2015
Malaysia	Northern Part of West Coast of Peninsular Malaysia	2016–2020	<i>R. brachysoma</i>	0.78	Effarina & Fathul, 2021
	Northern Part of West Coast of Peninsular Malaysia	2016–2020	<i>R. kanagurta</i>	0.86	Effarina & Nor-Bariah, 2021

Exploitation Rate

Several studies on the exploitation rates of *R. kanagurta* and *R. brachysoma* had been carried out in various sites of the countries around the South China Sea and Andaman Sea. The results (Table 58) show that in the South China Sea, the highest exploitation rate of *R. kanagurta* (0.77) was recorded in Kudat, Sabah in 2003–2005, and the highest exploitation rate of *R. brachysoma* (0.86) was recorded in Sarawak, Malaysia in 2003–2005. In the Andaman Sea, the highest exploitation rate of *R. kanagurta* (0.86) was recorded in the Northern Part of West Coast of Peninsular Malaysia, Malaysia in 2016–2020, and the highest exploitation rate of *R. brachysoma* (0.79) was recorded in Malacca Strait, Indonesia in 2014. Most of the exploitation rate values are higher than the optimization (E_{opt}) criterion of 0.5 (Gulland, 1983) for sustainable exploitation of the fisheries. Based on the results, both *R. kanagurta* and *R. brachysoma* had been fully exploited by fishing activities in the South China Sea and Andaman Sea during the study period except for Endau (Johor, Malaysia), Dagupan (Philippines), and Marudu Bay (Sabah). Therefore, management strategies must be urgently implemented to ensure sustainable exploitation and enhance the management of the fisheries.

Regional Action Plan for Management of Indo-Pacific Mackerel

The ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region (RES&POA), the first of which was adopted by

the ASEAN-SEAFDEC Member Countries in 2001, the second in 2011, and the third in 2020, recognize the need to strengthen cooperative efforts among countries toward the sustainable utilization of Indo-Pacific mackerel, a critical transboundary resource in the Gulf of Thailand. The series of RES&POA had also paved the way for the development of the “Regional Action Plan (RAP) for Management of Transboundary Species: Indo-Pacific Mackerel (*Rastrelliger brachysoma*) in the Gulf of Thailand Sub-Region,” which was approved and endorsed by the SEAFDEC Council during its Fifty-second Meeting in 2021 with the goal of achieving sustainable Indo-Pacific mackerel fisheries in the Gulf of Thailand sub-region through science-based management for the shared benefit of the other AMSs by 2030. The RAP for Management of Indo-Pacific Mackerel is a non-legal binding document which is meant to serve as a foundation to identify the practices and processes that support the implementation of the relevant RES&POA. The expected outcomes of the RAP for Management of Indo-Pacific Mackerel include: 1) healthy Indo-Pacific mackerel resources through the implementation of the fishery management plan of the Gulf of Thailand; 2) accurate and comprehensive information on Indo-Pacific mackerel of the Gulf of Thailand, and 3) model for the development of management plan for Indo-Pacific mackerel that could be applicable to other sub-regions. The actions would focus on the dimensions of governance, social, economic, ecosystem, and climate change that are aligned with the concept of the ecosystem approach to fisheries management (EAFM) as in Box 2.

Box 2. Actions for the RAP for Management of Indo-Pacific Mackerel		
1. Governance Dimension		
Objectives	Knowledge Gaps/Issues	Actions
Fisheries management mechanism developed and approved (including fisheries management plan and arrangement, the effect of regulation)	Fisheries Management Mechanism (including fisheries management plan and arrangement, the effectiveness of the regulation)	Develop fisheries management plan for short mackerel at national and subregional levels
		Initiative on development of harvesting strategy
		Establish regional cooperation on monitoring, control and surveillance
		Raise awareness of both small-scale fishers and commercial-scale fishers <ul style="list-style-type: none"> • Policy and regulations • Management measures • Sustainable utilization • Involvement the participation, considering gender sensitivity
		Promote stakeholders’ consultations among researchers, managers and stakeholders on EAFM
	Conduct habitat conservation and rehabilitation and conduct stock enhancement programs	
	Flexibility of regulations to respond to science advice	Encourage periodic evaluation of policies and regulations
Management schemes/arrangements including transboundary aspects		Develop management schemes/arrangements at sub-regional areas including transboundary aspects
		Support establishment of regional cooperation/management mechanism (non-legal binding and scientific advisory committees)

Box 2. Actions for the RAP for Management of Indo-Pacific Mackerel (Cont'd)

Data management system is enhanced and considered and regional/sub-regional standardization data management system in place	Insufficient catch and landing data	Develop the SOP/technical guidance for data collection (including catch data, biological data)
		Further develop catch documentation
		Harmonization/standardized on data collection and develop database system
Standard for assessing fishing effort for large, medium and small-scale fishery agreed	Insufficient biological data collection	Conduct capacity building program on data collection for enumerators, scientists, researchers
		Conduct time series data collection based on standardized methods
Understanding of national laws and management schemes within the sub-regional which are communicated and applied	Insufficient data on fishing effort (include commercial and small scale)	Link to catch documentation (include commercial and small-scale fishery (as available))
		Regular monitoring and data collection on fishing effort, capture production (include commercial and small scale)
Impact of unregulated and unreported fishing assessed	Understanding national laws and regulations	Comparative review of national laws and regulations, (including local wisdom)
		Disseminate knowledge and information on the conservation and management of Indo-pacific mackerel to fisheries communities and students
Catch documentation system applied as a tool to improve traceability of the short mackerel fishery	Illegal, Unregulated and Unreported Fishing	Assess the impact of illegal, unregulated and unreported fishing
		Strengthen the Monitoring, Control and Surveillance network against illegal fishing (none legal binding)
	Traceability system for fish and fishery products (using electronic logbook, etc.)	Develop catch documentation suitable for traceability system, e.g. electronic logbook, etc.
2. Social Dimension		
Objectives	Knowledge Gaps/Issues	Actions
Understanding the social condition of people involved in the fishery at the local and national levels	Social and economic aspect at local and national levels	Conduct a baseline survey based on available information on social and economic at local and national levels
	Traditional fishing (indigenous knowledge and social responsibility)	Improve and disseminate the best practice to others (e.g. indigenous people)
Increased participation and involvement of stakeholders at various levels.	People engagement in fishery activity (include small scale fishery and large scale/commercial fishery, processing)	Conduct stakeholder analysis for understanding the important and influence of stakeholder in various level
	People engagement in policy making (fisherfolk organization, academy, private sector)	Promote Public Private Partnership Promote multi stakeholder engagement in policy making
	Social structure (community small scale and large scale, gender, migrant labor, and fisher)	Encourage gender equality based on understanding of social structure in communities
Resolved conflict on land and resource use	Conflict on land and resource use	Promote stakeholder consultation
		Promote marine spatial planning and coastal zone management
Awareness and capacity at all level built	Awareness raising	Distribute brochures or any media (e.g. digital media) to promote fisheries management and regulations)
		Capacity building and experts exchange
		Fishing gear technology for eco-friendly (reduce bycatch, cost and expenditures)
3. Economic Dimension		
Objectives	Knowledge Gaps/Issues	Actions
National government and private sector commitment for long-term funding and support ensured	Funding	To ensure the national government commitment for long-term funding and support
		Explore various potential donor
		Promote capital access through microfinance scheme
		Promote corporate social responsibility

Box 2. Actions for the RAP for Management of Indo-Pacific Mackerel (Cont'd)		
Understanding of the structure and ownership of assets within the fishing industry (large, medium, and small scale) raised	Structure and ownership of asset within the fishing industry (large and small scale)	Review structure and ownership of assets within the fishing industry (large, medium and small scale) for management responses
Maximized economic benefit return for management response and reduced unequal distribution	Benefits and economic returns and unequal distribution	Assess benefit and economic returns throughout the value chain
	Increase of cost (fuel and other inputs)	To ensure the fuel and other inputs exist for local fishermen
	Fisheries employment revenue	To create the alternative work Require the contract among people engaged in fishing
4. Ecosystem Dimension		
Objectives	Knowledge Gaps/Issues	Actions
Current status understood and knowledge of short mackerel resources improved for scientific-based management	Migratory route	Conduct tagging program, e-DNA, DNA
	Spawning and nursery grounds (including dispersion and distribution of fish larvae)	Conduct comprehensive larvae survey (e.g. ichthyoplankton)
		Conduct comprehensive larvae survey (e.g. ichthyoplankton)
	Seasonal changes	Conduct reproductive biology study
		Conduct DNA study, otolith, tagging, etc.
	Stock structure	Conduct DNA study, otolith, tagging, etc.
	Stock status at national and regional of <i>R. brachysoma</i> (distribution and abundance)	Conduct stock assessment at national, sub-regional or regional level
		Share data, information and findings from scientific research to relevant stakeholders
		Standardized data collection for regional stock assessment
		Develop modelling for stock assessment
	Species identification	Provide capacity building on species identification of small size (juvenile) and larval fishes
	Status and Trends	Investigate the trend of short mackerel catch at national, sub-regional levels
Population dynamics (Growth parameters, mortalities etc.)	Conduct survey on fisheries biology	
Impact of fishing effort on stock structure (multi-fishing gears to harvest)	Conduct study on impact of fishing effort on stock structure (Multi-fishing gears to harvest) to improve the fishery management	
Stock assessment and distributions for transboundary species	Enhance the cooperation for information sharing among the bordering countries	
Capacity building and experts exchange	Training, workshop, conference and experts exchange	
Various habitats of short mackerel throughout its life cycle understood	Migratory route	Update, further define and confirm the migratory route at national, sub-regional or regional area
	Spawning and nursery grounds (including dispersion and distribution of fish larvae)	Study on critical habitats
		Conduct oceanography survey
	Physical and chemical oceanographic conditions and ocean circulation	Develop oceanographic modelling
		Conduct satellite imagery (GIS, remote sensing) analysis
	Impact of fishing effort on stock structure (Multifishing gears to harvest)	Enhance Fishing gear technology for ecofriendly (Reduce bycatch, cost and expenditures)
Capacity building and experts exchange	Training, workshop, conference and experts exchange	

Box 2. Actions for the RAP for Management of Indo-Pacific Mackerel (Cont'd)

5. Climate Change Dimension		
Objectives	Knowledge Gaps/Issues	Actions
Adaptive management measures in place in response to the impact of climate change and disaster on short mackerel fisheries and habitats	Impact of climate change to fish migration route	Assess the impact of climate change/disaster/ anthropogenic activities to fish migration route, habitat and behavior
		Study effect of environmental changes on the migratory pattern and spawning patterns based on climate change
	Sensitivity of species on critical habitats and environment impact to ecosystem (pollution, climate change, etc.)	Conduct study on sensitivity of species on environment change (pollution, climate change, etc.) to support the management response
		Study on the critical habitats (spawning and grounds)
		Study effect of environmental changes on the migratory pattern and spawning patterns
Capacity building and experts exchange	Data sharing (assign focal person to share information)	
Capacity building and experts exchange	Training, workshop, conference and experts exchange on CC impacts	
Mitigation and precautionary measures adopted to compensate for the effects of climate change	Impact of climate change to fish migration route	Share information from the findings of scientific research to both fisheries managers and fishers
	Capacity building and experts exchange	Training, workshop, conference and experts exchange on CC impacts

Issues and Challenges

- Inadequate regular collection of data on capture fishery production
- Insufficient data and information on fishery characteristics including catch and effort and biology
- Inadequate information on stock status and population dynamics including distribution and abundance
- Changing of fishing gear used to catch pelagic fishes especially mackerel
- Absence of fisheries management plan including fishery regulations, co-management, traceability system, among others
- Need for strengthened regional cooperation on standardized and integrity of data collection for regional stock assessment, data sharing, management body to develop the transboundary management plan

1.1.4 Anchovies

Anchovies are small pelagic fishes that belong to the family of Engraulidae, under the order of Clupeiformes which has 151 species and 17 genera (Eschmeyer *et al.*, 2017). Like other small pelagic fishes, anchovies are widely distributed in the Southeast Asian region. Anchovies are found in the neritic zone or shallow coastal waters where the shorthead anchovy (*Encrasicholina heteroloba*) and Indian anchovy (*Stolephorus indicus*) are the two dominant species found in the Southeast Asian region. Fishing grounds are located in the South China Sea and the Andaman Sea. The South China Sea had higher production compared to the Andaman Sea. Indonesia, Malaysia, Philippines, Singapore, and Thailand are the countries that catch anchovies in the South China Sea. Meanwhile, the countries that fish for anchovies in

the Andaman Sea are Indonesia, Malaysia, Myanmar, and Thailand. Anchovies have ecological importance due to the large biomass in the food web in coastal areas and the transfer of energy from plankton and small organisms to large-sized fish (Ganias, 2014). Most species of anchovies are commonly found in coastal areas (Young *et al.*, 1995) and are usually present in shallow waters from 5 m to 35 m depths with the highest densities around island areas (Fricke *et al.*, 2011).

The production of anchovies including the *Stolephorus* anchovies (*Stolephorus* spp.) and anchovies *nei* (Engraulidae) of the Southeast Asian region during 2008–2019 is shown in **Figure 59**. In Fishing Area 57 (Indian Ocean, Eastern), the production trend was constant with an average of 107,561 mt/year ranging from 44,492 mt in 2019 to 143,626 mt in 2017. In Fishing Area 71 (Pacific, Western Central), the production had an average of 312,088 mt per year with the range between 232,636 mt in 2019 and 356,446 mt in 2009.

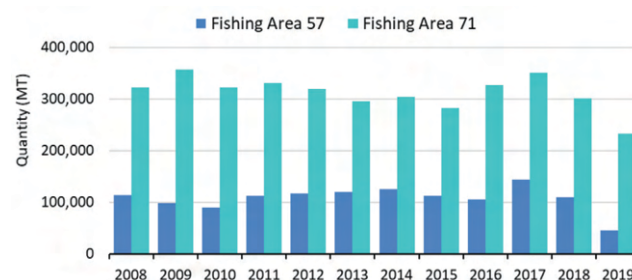


Figure 59. Production of anchovies of the Southeast Asian region between 2008 and 2019 from Fishing Area 57 and Fishing Area 71 by quantity (mt)
Source: SEAFDEC, 2022