

# Establishing Indicators for Sustainable Management of Fisheries *Refugia*

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The project “Establishment and Operation of a Regional System of Fisheries *Refugia* in the South China Sea and Gulf of Thailand” was developed as part of the implementation of the fisheries component of the Strategic Action Programme for the South China Sea. Supported financially by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UNEP) from 2016 to 2022, the Project was executed in the South China Sea area by the Southeast Asian Fisheries Development Center (SEAFDEC) in partnership with the fisheries agencies of the riparian countries of South China Sea, namely: Cambodia, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam. The Project was mainly focused on establishing a regional system of fisheries management areas known as fisheries *refugia* in the South China Sea and Gulf of Thailand. The four components of the Project include 1) establishment of operational management at 14 priority fisheries *refugia*, with community-based *refugia* management plans being the key outputs; 2) strengthening of the enabling environment for the formal designation and operational management of *refugia*; 3) strengthening of information management and dissemination for enhancing the national uptake of best practices in integrating fisheries management and biodiversity conservation, and in improving community acceptance of area-based approaches to fisheries and

coastal environmental management; and 4) strengthening the cross-sectorial coordination for integrated fisheries and environmental management while harnessing national scientific and technical expertise, and knowledge required to promote policy, legal and institutional reforms for fisheries *refugia* management in the participating countries. More specifically, the third component focused on information management which includes supporting activities that involve the development of national knowledge management systems on the use of fisheries *refugia* in capture fisheries management, establishment of a Regional Education and Awareness Centre as a facility for the production and sharing of information and education materials on fisheries and critical habitat linkages in the South China Sea area, development of indicators to monitor the effectiveness of coastal fisheries management systems established for priority fisheries *refugia*, and establishment of a regional program for the compilation of standardized fisheries statistics for identifying and managing fisheries *refugia*. During the implementation of the Project, the participating countries defined the structural frameworks together with criteria and indicators to enhance the effective management of fisheries *refugia* leading to the development of the Regional Guidelines on Indicators for Sustainable Management of Fisheries *Refugia*.

Indicators are crucial for monitoring the complex systems that need to be controlled, forming a critical part of everyone’s life. Indicators are also part of the stream of information used to understand things, make decisions, and plan future actions. For example, fishers scan the sky for weather and sea condition fronts before deciding to leave port for fishing. There are many words for indicator, *e.g.*, sign, symptom, signal, tip, clue, grade, rank, data, pointer, dial, warning light, instrument, measurement, reference point, among others.

The Convention of Biological Diversity (CBD) used the mean trophic level (MTL) and primary production required (PPR) as among the indicators for the management of sustainable fisheries exploitation and understanding the trophic interactions and how these affect fisheries (Hornborg *et al.*, 2013). Environmental health indicators have been identified to give people the idea of whether the environment is getting better or worse, based on analytical frameworks and models (De Wit *et al.*, 2004). In fisheries, indicators are necessary to enhance communication, transparency, effectiveness, and accountability in natural resource management (FAO, 1999). Indicators could be used in assessing the performance of fisheries policies and management at global, regional, national, and local levels, providing readily understood tools for describing the state of fishery resources and fisheries activity,

and for assessing trends regarding sustainable development objectives that could stimulate action to achieve sustainability. Thus, fisheries indicators could be referred to as a practical tool that supports the management of fisheries, provides information on the status and trend of fisheries and resources, and supports decision-making processes (SEAFDEC, 2006).

Indicators have also been increasingly seen as a valuable tool that links policy objectives and sustainable development goals, implying that indicators could include resource, ecological, social, and economic dimensions that support management decisions, fulfilling multiple roles in fisheries systems that could be adapted to a particular use or set of users (FAO, 1999). Given such a background, FAO developed the Guidelines on Indicators for Sustainable Development of Marine Capture Fisheries in 1999, to support the implementation of the Code of Conduct for Responsible Fisheries (CCRF). The Guidelines provide general information on the sustainable development of fisheries to clarify why a system of indicators is needed to monitor the contribution of fisheries to sustainable development, as well as information on the type of indicators and related reference points required (FAO, 1999).

Meanwhile in Southeast Asia, fisheries development has been challenged by various concerns, notably the overexploitation

of the limited resources resulting in the degradation of the fishery resources. To address such concerns, the governments of the countries in the region have committed to support efforts toward sustainable fisheries development and management. In November 2001, the ASEAN Member States (AMSs) adopted the Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region (SEAFDEC, 2001) which was developed with reference to the global CCRF developed by FAO which was subsequently regionalized by SEAFDEC for greater adaptability by the AMSs. Results of the regionalization of the CCRF were a series of publications on Regional Guidelines for Responsible Fisheries in Southeast Asia (SEAFDEC, 2000; SEAFDEC, 2003; SEAFDEC, 2005a; SEAFDEC, 2005b; SEAFDEC, 2006). The Supplementary Guidelines on the Use of Indicators for Sustainable Development and Management of Capture Fisheries in Southeast Asia, which forms part of the Supplementary Guidelines on Co-management Using Group User Rights, Fishery Statistics, Indicators and Fisheries *Refugia* (SEAFDEC, 2006), specifies the need for the AMSs to systematically establish the most critical and proper fisheries indicators and standards for fostering sustainable fisheries management in their respective countries.

## Indicators and Fisheries *Refugia*

The nature of fisheries in the region is mainly characterized as tropical small-scale multispecies and multigear fisheries, and the use of indicators for fisheries management in an adaptive manner could be practical and easily understood and supported by stakeholders. Adaptive management is a broad co-management concept, where fishery managers react on indicators to assess fisheries, resources, and ecosystem instead of classical stock assessment (*e.g.* maximum sustainable yield or MSY and maximum economic yield or MEY).

In an effort to address the concerns related to the widespread overexploitation of fish stocks in the waters of Southeast Asia, especially in the South China Sea and Gulf of Thailand, the 2002–2008 UNEP/GEF Project “Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand” developed the initial concept of fisheries *refugia* (Pernetta *et al.*, 2010). Moreover, the Project which was implemented by SEAFDEC in collaboration with its Member Countries refined the concept and developed a framework for the establishment and operation of a regional system of fisheries *refugia*, targeting priority transboundary, demersal fish, and non-fish resources (UNEP, 2007). Considering that specific habitats and areas are critically important to different stages of the life cycle of each aquatic species, such areas have to be managed to adopt the concept of fisheries *refugia*. The fisheries *refugia* approach is based on the “ecosystem





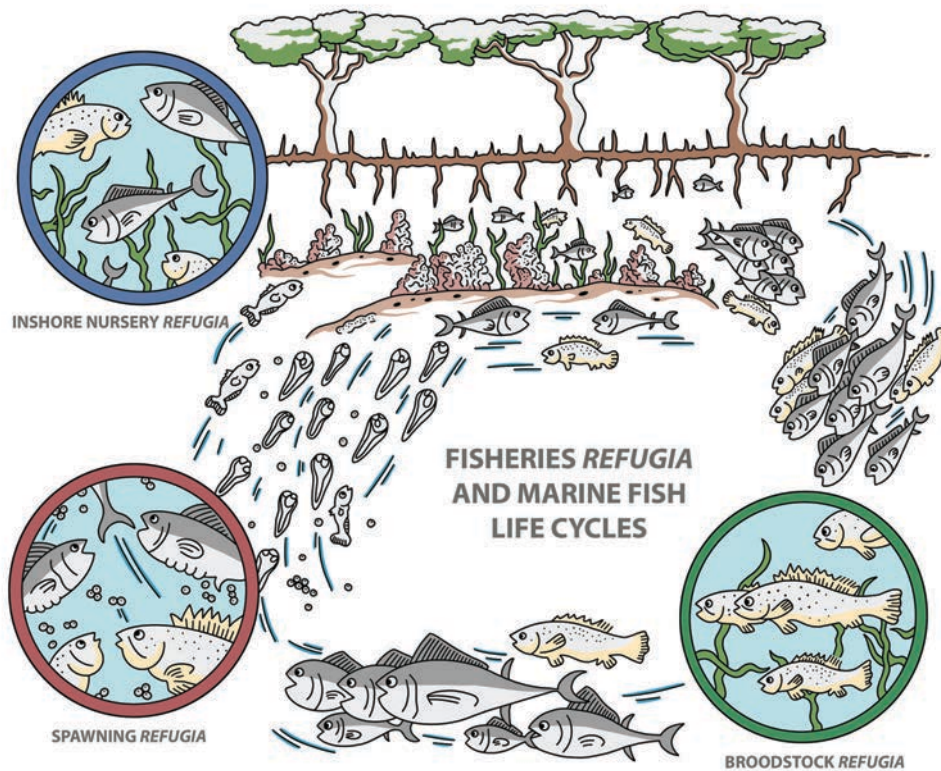


Figure 1. Types of fisheries *refugia* in relation to the generalized life cycle of demersal marine fishes (Pernetta *et al.*, 2010)

approach (EA)” concept like many existing approaches, *e.g.* marine spatial planning (MSP), coastal resource management (CRM), co-management, integrated coastal zone management (ICZM). Although fisheries *refugia* share the same principles and have many commonalities with other approaches, management focus or coverage could be different but support each other.

Thus, the fisheries *refugia* concept was developed as a novel fisheries resource management approach to the identification and designation of priority areas in which to integrate fisheries and habitat management in the context of maintaining fish stocks and critical habitats (Paterson *et al.*, 2012). In the South China Sea and the Gulf of Thailand, there is a need to develop robust and workable solutions to involve stakeholders in establishing and managing fisheries *refugia*. The diverse traditions and cultures in the Southeast Asian region and the vital role of small-scale, coastal, and subsistence fisheries provided an impetus for the development of fisheries *refugia* approaches to stakeholder participation in the management of fisheries at all levels.

In the Southeast Asian context, fisheries *refugia* is defined by the UNEP/GEF/SCS as “spatially and geographically defined, marine or coastal areas in which specific management measures are applied to sustain important species [fisheries resources] during critical stages of their life cycle, for their sustainable use” (Pernetta *et al.*, 2010). Considering the

general commonality of understanding that fisheries *refugia* relate to specific areas of significance to the life cycle of particular species, fisheries *refugia* may be defined in space and time to protect spawning aggregations, nursery grounds, and migratory routes (Figure 1).

### Regional Guidelines on Indicators for Sustainable Management of Fisheries *Refugia*

As of December 2021, the participating countries of the 2017–2022 SEAFDEC/UNEP/GEF Project “Establishment and Operations of a Regional System of Fisheries *Refugia* in the South China Sea and the Gulf of Thailand” have established their respective fishery *refugia* sites (Box 1), where fisheries *refugia* management is being effectively implemented and promoted for certain economically important commodities (Siriraksophon, 2022). While the Project activities are in progress, a regional experts’ group with members who represent the six participating countries was established in 2019 to brainstorm how the fisheries *refugia* approach adopted by the countries could support the sustainable development of fisheries in the South China Sea, including the kinds of information and indicators that would be needed to address the issues and concerns (SEAFDEC, 2022).

The progress of the Project activities in the six participating countries, especially the experiences and lessons learned

Box 1. Established fisheries <i>refugia</i> under the 2017-2022 SEAFDEC/UNEP/GEF Project	
Cambodia	<ul style="list-style-type: none"> <li>Blue swimming crab <i>refugia</i> in Koh Po and Koh Tonsay Archipelago, Kep Province</li> <li>Indo-Pacific mackerel <i>refugia</i> in Peam Krasob, Koh Kong Province</li> <li>Grouper <i>refugia</i> in Prek Thnaot, Kampot Province</li> </ul>
Indonesia	<ul style="list-style-type: none"> <li>Mitre squid <i>refugia</i> in Bangka Belitung Province</li> <li>Indian white shrimp <i>refugia</i> in West Kalimantan Province</li> </ul>
Malaysia	<ul style="list-style-type: none"> <li>Spiny lobster <i>refugia</i> in Tanjung Leman, Johor State</li> <li>Tiger prawn <i>refugia</i> in Miri, Sarawak State</li> </ul>
Philippines	<ul style="list-style-type: none"> <li>Bolinao <i>refugia</i> site at Bolinao coastal area in Pangasinan Province for siganid species</li> <li>Masinloc <i>refugia</i> site at Masinloc coastal area in Zambales Province for <i>Auxis thazard</i> (frigate tuna or 'tulingan'), <i>Pterocaesio tessellata</i> (one-stripe fusilier or 'terong'), and <i>Sardinella fimbriata</i> (fringe scale sardine or 'bilis')</li> <li>Coron <i>refugia</i> site off Coron Islands, Palawan Province for <i>Caesio cunning</i> (red-belly yellowtail fusilier) and <i>Decapterus maruadsi</i> (white-tipped scad)</li> </ul>
Thailand	<ul style="list-style-type: none"> <li>Indo-pacific mackerel <i>refugia</i> off Trat Province</li> <li>Blue swimming crab <i>refugia</i> around Koh Sed, Surat Thani Province</li> </ul>
Viet Nam	<ul style="list-style-type: none"> <li>Spiny lobster and shark <i>refugia</i> off Bach Long Vi Island, Viet Nam</li> <li>Spiny lobster and Japanese eel <i>refugia</i> off Con Dao Island, Viet Nam</li> </ul>

from the establishment of fisheries *refugia*, the challenges and issues encountered as well as the achievements attained so far were referred to during the discussion which was aimed at coming up with the Regional Guidelines on Indicators for Sustainable Management of Fisheries *Refugia*.

Considering that the South China Sea area has been subjected to high and increasing levels of fishing pressure, the regional experts' group defined the structural framework for enhancing the effective sustainable management of fisheries *refugia* which included four dimensions comprising twelve targets (Figure 2). Moreover, the corresponding indicators and criteria for the sustainable management of the fisheries *refugia* had also been identified (Box 2) (SEAFDEC, 2022).

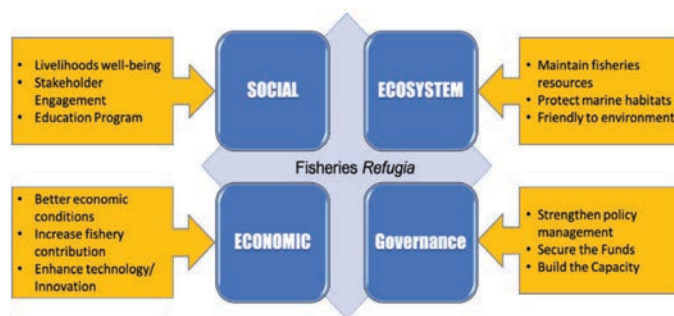


Figure 2. Structural framework for enhancing the effective sustainable management of fisheries *refugia*

Box 2. Structural framework for enhancing the effective sustainable management of fisheries <i>refugia</i>			
Dimension	Target	Criteria	Indicator
Ecosystem	Fisheries resources are preserved and maintained	<ul style="list-style-type: none"> <li>Abundant stock/fishing effort</li> <li>Biological parameter</li> <li>Catch structure</li> </ul>	<ul style="list-style-type: none"> <li>Biomass estimation (MSY, MEY, CPUE, CPUA, catch, Lc, Lm, sex ratio, SPR, length frequency, exploitation rate, gonadosomatic index, dominant species, number of species, main economic/commercial species, bycatch composition)</li> </ul>
	Marine habitats are protected	<ul style="list-style-type: none"> <li>Health</li> <li>Condition</li> <li>Area</li> </ul>	<ul style="list-style-type: none"> <li>Size coverage, habitat health index, target habitat density (IUCN reference)</li> </ul>
	Fisheries practices are friendly to the environment	<ul style="list-style-type: none"> <li>Pollution</li> <li>Eutrophication</li> <li>Anthropogenic (human activity)</li> <li>Erosion</li> </ul>	<ul style="list-style-type: none"> <li>Standard water quality (COD, BOD)</li> <li>Phytoplankton abundance, phosphate, nitrate concentration (nutrient load)</li> <li>Coastal reclamation area</li> <li>Level of maritime activity</li> <li>Level and distribution of sedimentation</li> <li>Loss of habitat</li> </ul>
Social	Livelihood opportunities are generated for the well-being of stakeholders	<ul style="list-style-type: none"> <li>Choice of occupation</li> <li>Fish consumption</li> <li>Nutrition</li> </ul>	<ul style="list-style-type: none"> <li>Number of options, occupation, work (alternative, permanent, or subsistence)</li> <li>Fish consumption per capita per year</li> <li>Percent animal protein (if appropriate)</li> </ul>
	Stakeholders' engagement is enhanced	<ul style="list-style-type: none"> <li>Participation</li> <li>Local organization</li> <li>Networking</li> </ul>	<ul style="list-style-type: none"> <li>Ratio of number of participations (gender and IP)</li> <li>Number of organizations</li> <li>Number of best practices applied</li> <li>Number of networking</li> <li>Type/way of direct or indirect communication</li> <li>Number of agreements</li> </ul>

Box 2. Structural framework for enhancing the effective sustainable management of fisheries *refugia* (Cont'd)

Dimension	Target	Criteria	Indicator
	Education programs are developed and promoted for all stakeholders	<ul style="list-style-type: none"> <li>Awareness program (e.g. information center, information education campaign)</li> <li>Capacity building</li> </ul>	<ul style="list-style-type: none"> <li>Number of information centers</li> <li>Number of consultations</li> <li>Number of best practices,</li> <li>Number of awareness programs</li> <li>Number of understandings by stakeholders</li> <li>Number of training/extensions</li> </ul>
Economic	Economic conditions of communities are improved	<ul style="list-style-type: none"> <li>Poverty incidence</li> <li>Capital accessibility</li> <li>Income</li> </ul>	<ul style="list-style-type: none"> <li>Poverty Index</li> <li>Multidimensional poverty index</li> <li>Number of accessible financial services</li> <li>Income per household</li> </ul>
	Contribution of fisheries to the economy is improved due to increased production	<ul style="list-style-type: none"> <li>Contribution of target species and availability</li> </ul>	<ul style="list-style-type: none"> <li>Value of contribution or production</li> </ul>
	Promotion of fisheries technology innovations are enhanced	<ul style="list-style-type: none"> <li>Effectiveness of fishing gear</li> <li>Cost-effectiveness</li> <li>Environment-friendly (green technology)</li> <li>Investment</li> </ul>	<ul style="list-style-type: none"> <li>Level of CPUE</li> <li>Cost reduction, time, human power</li> <li>Reduced fuel consumption</li> <li>Reduced bycatch</li> <li>Number of investments, fishing fleet, processing, ship builder, management tools/software, new domestic products</li> </ul>
Governance	Fisheries management policies are strengthened at all levels	<ul style="list-style-type: none"> <li>Management mechanism</li> <li>Coordination mechanism</li> <li>Fishery Law enforcement</li> </ul>	<ul style="list-style-type: none"> <li>Management board/committee, transboundary committee</li> <li>RPOA for <i>refugia</i> in place</li> <li>Linkage to the existing management/conservation framework (e.g. MPAs)</li> <li>Inter-agency coordination in place</li> <li>Number of joint operations</li> <li>Level of enforcement</li> <li>Frequency of regular patrol</li> <li>Number of violation prosecution</li> </ul>
	Funds are secured for infrastructures, enforcement, and relevant operating costs	<ul style="list-style-type: none"> <li>Sustainability</li> <li>Source of funding (incentive, soft loan, donations, corporate social responsibility)</li> <li>Incentives</li> </ul>	<ul style="list-style-type: none"> <li>Long-term commitment of the government to finance</li> <li>Number of donors</li> <li>Type of funds</li> <li>Type and number of incentives</li> <li>Number of activities</li> <li>Number of best practices</li> </ul>
	Capacity of stakeholders is built and/or enhanced	<ul style="list-style-type: none"> <li>Best practices</li> <li>Maritime policy and regulation, international policies</li> </ul>	<ul style="list-style-type: none"> <li>Adoption of best practices in place</li> <li>Number of training/workshops</li> </ul>

## References

- De Wit, J., Lafere, J., & Hens, L. (2004): Indicators for Sustainable Development and Environmental Health Indicators for Flanders (Northern Belgium). *Human Ecology Special Issue No. 12*: 131-141
- FAO. (1999). Indicators for sustainable development of marine capture fisheries. *FAO Technical Guidelines for Responsible Fisheries. No. 8*. Rome, FAO. 1999. 68p
- Hornborg, S., Belgrano, A., Bartolino, V., Valentinsson, D., & Ziegler, F. (2013): Trophic indicators in fisheries: a call for re-evaluation. *Biol Lett* 9: 20121050. <http://dx.doi.org/10.1098/rsbl.2012.1050>
- Paterson, C.J., Pernetta, J.C., Siraraksophon, S., Kato, Y., Barut, N.C., Saikliang, P., Vibol, O., Chee, P.E., Nguyen, T.T.N., Perbowo, N., Yunanda, T., & Armada, N.B. (2012): Fisheries *Refugia*: A novel approach to integrating fisheries and habitat management in the context of small-scale fishing pressure, *Ocean & Coastal Management*, <http://dx.doi.org/10.1016/j.ocecoaman.2012.12.001>
- Pernetta, J.C., Paterson, C. J., & Siriraksophon, S. (2010). Fisheries *Refugia* and Marine Protected Areas: Can they help sustain the contribution of fisheries towards food security in Southeast Asia? *Fish for the People* 8 (2). Southeast Asian Fisheries Development Center, Bangkok, Thailand; pp 15-23



- SEAFDEC. (2000). *Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Fishing Operations*. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 71 p
- SEAFDEC. (2001). *Resolution and Plan of Action on Sustainable Fisheries for Food Security in the New Millennium*. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 12 p
- SEAFDEC. (2003). *Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Fisheries Management*. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 69 p
- SEAFDEC. (2005a). *Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Aquaculture*. Second Edition. Aquaculture Department, Philippines. Southeast Asian Fisheries Development Center; 43 p
- SEAFDEC. (2005b). *Regional Guidelines for Responsible Fisheries in Southeast Asia: Post-harvest Practice and Trade*. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 58 p
- SEAFDEC. (2006). *Regional Guidelines for Responsible Fisheries in Southeast Asia: Supplementary Guidelines on Co-management Using Group User Rights, Fishery Statistics, Indicators and Fisheries Refugia*. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 84 p
- SEAFDEC. (2022). Establishment and Operation of a Regional System of Fisheries *Refugia* in the South China Sea and Gulf of Thailand, Regional Guidelines on Indicators for Sustainable Management of Fisheries *Refugia*. Southeast Asian Fisheries Development Center, Training Department, Samutprakarn, Thailand. 35p
- Siraraksophon, S. (2022). Integrating habitat conservation and fishery management in the South China Sea and Gulf of Thailand through fisheries *refugia*. *Fish for the People* 20(1), 2–5.
- UNEP. (2007). Procedure for Establishing a Regional System of Fisheries *Refugia* in the South China Sea and Gulf of Thailand in the context of the UNEP/GEF project entitled: “Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand.” South China Sea Knowledge Document No. 4. UNEP/GEF/SCS/Inf.4

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