# Thailand National Ecosystem Assessment

## Marine Biodiversity and Ecosystem Services

Technical Report



CHULA UNISEARCH

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# Abbreviations

| | |
|---|---|
| **ABS** | Advancing Access and Benefit-Sharing |
| **ADB** | Asian Development Bank |
| **AEDP** | Alternative Energy Development Plan |
| **ASEAN** | Association of Southeast Asian Nations |
| **BAU** | Business-as-Usual |
| **BCG** | Bio-Circular-Green Economy |
| **BEDO** | Biodiversity-Based Economy Development Office |
| **BES-Net** | Biodiversity and Ecosystem Services Network |
| **CCME** | Committee for Controlling and Monitoring the Environment |
| **CBD** | Convention on Biological Diversity |
| **CBM** | Community-Based Monitoring |
| **CITES** | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| **COP** | Conference of the Parties |
| **DCCE** | Department of Climate Change and Environment |
| **DEDE** | Department of Alternative Energy Development and Efficiency |
| **DMCR** | Department of Marine and Coastal Resources |
| **DMF** | Department of Mineral Fuels |
| **DNP** | Department of National Parks, Wildlife and Plant Conservation |
| **DOF** | Department of Fisheries |
| **DOPA** | Department of Provincial Administration |
| **DIT** | Department of Internal Trade |
| **DIW** | Department of Industrial Works |
| **DOE** | Department of Employment |
| **DOAE** | Department of Agricultural Extension |
| **EBFM** | Ecosystem-Based Fisheries Management |
| **ECNEQ Act** | Enhancement and Conservation of National Environmental Quality Act |
| **EIAs** | Environmental Impact Assessments |
| **EEC** | Eastern Economic Corridor |
| **EEPSEA** | Economy and Environment Partnership for Southeast Asia |
| **EPAs** | Environmental Protected Areas |
| **EU-ETS** | European Union Emissions Trading System |
| **ES** | Ecosystem Services |
| **FPIC** | Free, Prior, and Informed Consent |

| | |
|---|---|
| **GDP** | Gross Domestic Product |
| **GNP** | Gross National Product |
| **GoT** | Gulf of Thailand |
| **GPP** | Gross Provincial Product |
| **GVA** | Gross Value Added |
| **GWP** | Global Warming Potential |
| **GHGs** | Greenhouse Gases |
| **ICCAs** | Indigenous and Community Conserved Areas |
| **ICZM** | Integrated Coastal Zone Management |
| **IEAT** | Industrial Estate Authority of Thailand |
| **IPBES** | Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services |
| **ILK** | Indigenous and local knowledge |
| **IUCN** | International Union Conservation of Nature |
| **IUU** | Illegal, Unreported, and Unregulated |
| **KMGBF** | Kunming-Montreal Global Biodiversity Framework |
| **LAO** | Local Administrative Organizations |
| **LDD** | Land Development Department |
| **LMMAs** | Locally Managed Marine Areas |
| **Marine BES** | Marine Biodiversity and Ecosystem Services |
| **MD** | Marine Department |
| **MDG** | Millennium Development Goals |
| | Multi-Evidence-Based Approach |
| **MFF** | Mangroves for the Future |
| **MNRE** | Ministry of Natural Resources and Environment |
| **MNPs** | Marine National Parks |
| **MOF** | Ministry of Finance |
| **MOTS** | Ministry of Tourism and Sports |
| **MPA** | Marine Protected Area |
| **M&E** | Monitoring and Evaluation |
| **MSP** | marine spatial planning |
| **MWQI** | Marine Water Quality Index |
| **MWTP** | Mean Willingness to Pay |
| **MCRMP Act** | Marine and Coastal Resources Management Promotion Act |
| **NAP** | National Adaptation Plan |
| **NGOs** | Non-Governmental Organizations |
| **NBSAP** | National Biodiversity Strategy and Action Plan |

| | |
|---|---|
| NSO | National Statistical Office |
| NESDC | Office of the National Economic and Social Development Council |
| NESDP | National Economic and Social Development Plan |
| NEA | National Ecosystem Assessment |
| NMCRC | National Marine and Coastal Resources Management Policy and Plan |
| OECD | Organisation for Economic Co-operation and Development |
| OECMs | Other Effective Area-Based Conservation Measures |
| ONEP | Office of Natural Resources and Environmental Policy and Planning |
| ONWR | Office of National Water Resources |
| PES | Payment for Ecosystem Services |
| PEMSEA | Partnerships in Environmental Management for the Seas of East Asia |
| PA | Protected Areas |
| PFCs | Provincial Fisheries Committee |
| PPP | Public–Private Partnerships |
| PPCPs | Public–Private–Community Partnerships |
| SAC | Princess Maha Chakri Sirindhorn Anthropology Centre |
| SDGs | Sustainable Development Goals |
| SEP | Sufficiency Economy Philosophy |
| SEEA | System of Environmental Economic Accounting |
| SMEs | Small and Medium Enterprises |
| TDRI | Thailand Development Research Institute |
| TSRI | Thailand Science Research and Innovation |
| TEV | Total Economic Value |
| THAI-MECC | Thai Maritime Enforcement Command Center |
| TRF | Thailand Research Fund |
| UN DESA | UN Department of Economic and Social Affairs |
| UNEP | United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNSD | United Nations Statistical Office |
| UNEP-WCMC | United Nations Environment Programme World Conservation Monitoring Division |
| WTP | Willingness to Pay |

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# 1 | Overview of Marine Biodiversity and Ecosystem Services Assessment in Thailand

## 1.1 Background

Thailand became a Contracting Party to the Convention on Biological Diversity (CBD) in 2004 and committed to the conservation and sustainable use of biological diversity. The CBD Conference of the Parties (COP) Decision 14/1 called on all Parties to undertake national assessments of biodiversity and ecosystem functions and services to recognise values and the contribution of biodiversity and ecosystem services across sectors and design plans and strategies for biodiversity management. The assessment should analyse the contributions of biodiversity and ecosystem services to the implementation of the Sustainable Development Goals (SDGs), recognising synergies and trade-offs associated with meeting multiple goals, and the need for balanced integration between the social, economic, and environmental dimensions of sustainable development. This report aims to identify data sources and set out key policy questions, as well as outline how ecosystem assessments and their related values can be undertaken and support the uptake of assessment findings into national decision making.

The United Nations Environment Programme World Conservation Monitoring Centre's (UNEP-WCMC) NEA Initiative has supported 14 countries in conducting or scoping their NEAs. Thailand formally joined the Initiative in April 2021, together with Botswana, the Dominican Republic, and Malawi, and the project will run until September 2026. The assessment process has been divided into four stages: Scoping, Expert Evaluation, Approval, and Dissemination and Use of the Assessment Findings. This assessment assesses the state of knowledge on past, present and future interactions between people and nature, including by highlighting thresholds, feedback, synergies, and trade-offs. The IPBES assessment process (IPBES, 2019) and conceptual framework (Diaz et al., 2015) were used to guide the implementation of Thailand's National Ecosystem Assessment (NEA), to strengthen the science-policy interface and to deliver a widely owned, policy-relevant assessment of knowledge on biodiversity and ecosystem services in Thailand.

In Thailand, the Office of Natural Resources and Environmental Policy and Planning (ONEP) under the Ministry of Natural Resources and Environment (MNRE) is the focal point of the CBD and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). UNEP-WCMC undertook a video conference with country partners including Thailand, from March 2020–June 2020, to encourage the exchange of knowledge of the NEAs Initiative between country partners. In Thailand, this was followed up with an inception meeting organised by ONEP, in February 2021, with key organisations such as the Department of Marine and Coastal Resources (DMCR), the Department of National Parks, Wildlife and Plant Conservation (DNP), Chula Unisearch, and UNEP-WCMC to select the appropriate ecosystem and implementing agency for the ecosystem assessment. This resulted in marine ecosystems being selected for further analysis and Chula Unisearch being selected as the main implementing agency. A Project Steering Committee (PSC) and Management Team were appointed, and a project action plan was developed. These organisational arrangements and the action plan are discussed in more detail in the final chapter of this report. This report is the formal output of the Thailand's NEA, which outlines the background and theoretical framework for the NEA in Thailand as well as the results. The outcome of this process is intended to be improved understanding and management of biodiversity in Thailand in the future. To this end a shorter summary of the report especially aimed at policy makers is also available at NEA initiative website (https://www.ecosystemassessments.net/resource/thailand-national-ecosystem-assessment-summary-for-policymakers/).

## 1.2 Status and trends of Marine BES

Thailand's marine ecosystems are among its most valuable natural assets, supporting biodiversity, economic development, and societal well-being. These ecosystems, which include mangroves, seagrass beds, coral reefs, and estuarine zones, provide essential services such as carbon sequestration, coastal protection, fisheries and tourism. They also serve as critical habitats for endangered species like dugongs, sea turtles, and numerous cetaceans. In 2014, the economy of Thailand's ocean sector, underpinned by these ecosystems, was valued at THB 24 T, highlighting their immense contribution to Thailand's economic and ecological security.

However, these vital ecosystems are increasingly under threat. Pressures from economic development, population growth, climate change, and unsustainable development practices are degrading their health and resilience. While mangrove forests have seen modest gains in coverage due to conservation efforts, they remain vulnerable to pollution, land-use changes, and coastal development. Seagrass beds, over 70% of which are in poor to fair condition, are deteriorating due to sedimentation, wastewater discharge, sea-based activities and climate change. Coral reefs are similarly imperiled, suffering from bleaching events, unmanaged tourism, and untreated wastewater discharge. Without targeted action, the continued degradation of these ecosystems will undermine their ability to sustain biodiversity and provide critical services to people and the economy.

Recognising the urgency of these challenges, the science-policy interface has emerged as a pivotal tool for bridging knowledge and action. The IPBES provides a global framework for assessing biodiversity and ecosystem services (BES) and informing policy responses. In 2021, Thailand joined the Biodiversity and Ecosystem Services Network (BES-Net) initiative to conduct its first NEA, focused on marine ecosystems. This initiative aligns with Thailand's commitments to the CBD, the Sustainable SDGs, and the Kunming-Montreal Global Biodiversity Framework (KMGBF).

The NEA aims to evaluate the status and trends of biodiversity and ecosystem services, identify the benefits they provide to people, assess the pressures they face, and explore policy options for sustainable management. By synthesising existing knowledge and engaging multiple stakeholders, the NEA will help raise awareness of the value of biodiversity, identify critical knowledge gaps, and provide actionable insights to inform policy and decision-making.

A key feature of the NEA is its recognition of diverse knowledge systems. Scientific knowledge will be complemented by Indigenous and local knowledge (ILK), which reflects the lived experiences and long-standing ecological practices of communities who coexist with Thailand's coastal environments. Mobilising ILK will provide a more comprehensive understanding of ecological changes and foster inclusive and effective conservation strategies.

By strengthening the science-policy interface, the NEA process offers a powerful mechanism for addressing biodiversity loss, building resilience, and securing a sustainable future for both nature and people in Thailand.

## 1.3 Thailand Marine BES

Thailand is located between the Indo-Chinese peninsula and the Malay Archipelago, and bordered by Myanmar to the west, Laos and Cambodia to the east, and Malaysia to the south. There are 15 mountain ranges spread throughout the nation, making up a variety of ecosystem landscapes and habitats. The Mekong River, Gulf of Thailand (GoT), and Andaman Sea, as well as the watersheds and major river basins that are related to these water bodies, serve as a nexus for the dispersion of plant and animal species, from China and the Himalayas, tropical species from Indochina, and other species from other parts of Asia.

Thailand has a high biodiversity due to its complex geography, Thailand is one of the most biodiversity-rich countries in Southeast Asia. Thailand's main ecosystems are classified into seven ecosystems, with agriculture and forest ecosystems accounting for approximately 55.73% and 31.68% of the overall country area, respectively (2018 data). The remainder include marine ecosystems, island ecosystems, inland water ecosystems, dry and semi-humid ecosystems, and mountain ecosystems.

Species diversity had also been assessed (ONEP, 2020), with about 12,050 plant species of which 10,531 species have been biologically classified. Some 1,185 plant species have been assessed for their status with 1,002 found to be under threat. There are 5,001 vertebrate species reported, an increase of 270 species since 2017, with 694 threatened species divided into 345 mammals (126 threatened), 1,071 birds (191 threatened), 461 reptiles (52 threatened), 184 amphibians (18 threatened) and 2,940 fish (301 threatened).

Over 6,928 invertebrate species have been classified in Thailand. There are 3,277 Arthropoda species, 2,535 Mollusca species, 458 jellyfish and coral species, 381 Echinodermata species, 227 Annelida species, 49 Porifera species, and 1 Hemichordate species. Three groups have been assessed for status with 107 coral species in the jellyfish and coral group, 14 crustaceans in the Arthropoda group, and 183 Mollusca species under threat. Moreover, researchers estimated that there are over 200,000 species of microorganisms, but only one in ten were utilised for research and study purposes (ONEP, 2020)

Thailand has two coastlines that extend for 3,148 km across 23 provinces. This coastal zone includes the GoT on the eastern part of the country, the innermost part of the western Pacific Ocean, and on the western part of the country is the Andaman Sea, the easternmost part of the Bay of Bengal of the Indian Ocean. Thailand is a coastal state with a maritime zone covering 323,488.32 km². Thailand's maritime zone covers more than two-thirds of its 513,000 km² continental area and is divided into four zones: internal water, territorial water, contiguous zone, and EEZ (Figure 1.1).

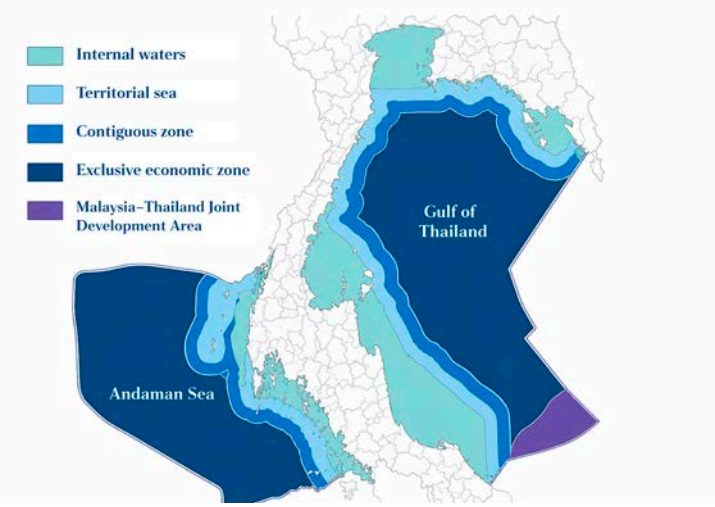



**Figure 1.1: Maritime zone of Thailand (Source: Marine knowledge Hub, 2025)**

## 1.4 Theoretical framework and relevant concepts

Two frameworks were used for conducting the Assessment including the conceptual framework of the IPBES and the Drivers-Pressures-State-Impacts-Responses (DPSIR) framework. Thailand's NEA team has integrated these frameworks into the assessment process.

### 1.4.1 IPBES conceptual framework

The IPBES conceptual framework provides a structured approach with a common vocabulary for understanding the complex relationships between people and nature. Widely used in NEAs, it guides the integration of diverse knowledge systems and supports policy-relevant analyses. The framework is built around the concept of "nature's contributions to people", which encompasses the benefits (ecosystem services) that flow from ecosystems to human societies. It recognises multiple knowledge systems—including scientific, indigenous, and local

knowledge—as valid and complementary sources of understanding. By doing so, the IPBES framework facilitates collaboration across disciplines and stakeholders, creating a shared understanding of how ecosystems function and why they matter for human well-being (IPBES, 2013; Díaz et al., 2015).

The IPBES framework integrates natural, social, and economic dimensions into a single structure, emphasising the interdependence between people and nature. There are six interconnected components that operate at various scales in time and space, including (1) nature, (2) nature's benefits to people, (3) anthropogenic assets, (4) institutions and governance systems and other indirect drivers of change, (5) direct drivers of change, and (6) good quality of life (Figure 1.2).

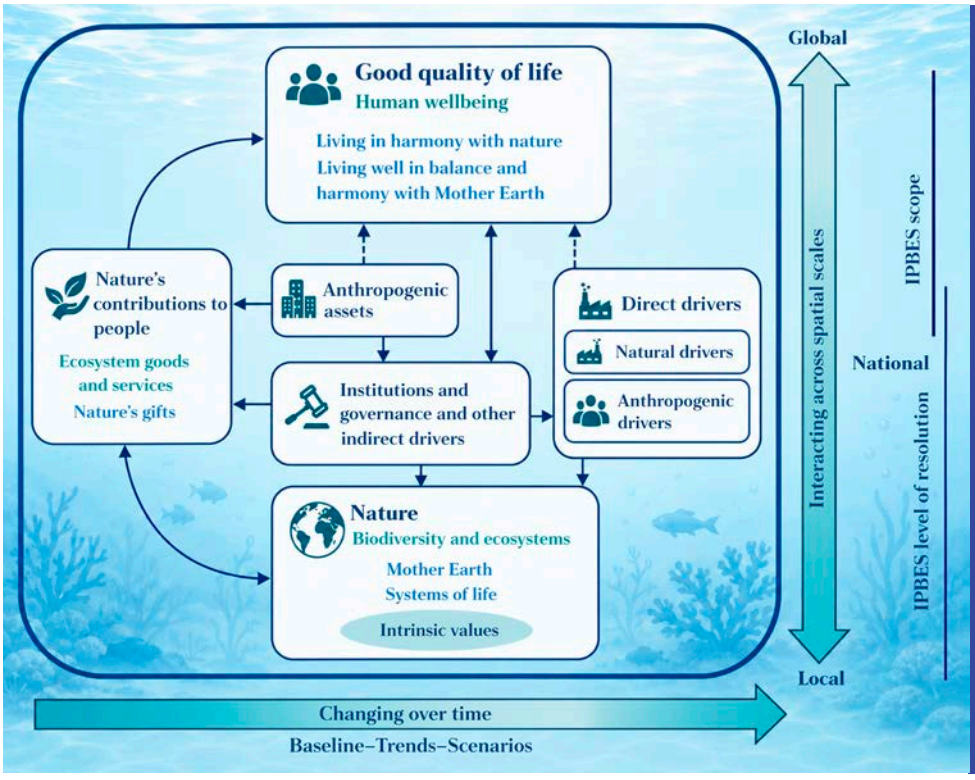



**Figure 1.2: IPBES conceptual framework**

**(Source:Díaz et al., 2015)**

1. **Nature:** Refers to biodiversity and ecosystems, including genes, species, populations, communities, and ecosystems. Nature provides the ecological foundation for all ecosystem services and human well-being.

2. **Nature's Contributions to People (NCP):** Encompasses the benefits that people derive from nature, similar to ecosystem services. NCP includes: **material contributions:** Food, water, raw materials, non-material contributions: Spiritual, cultural, and recreational benefits and **regulating contributions:** Climate regulation, pollination, flood control.

3. **Anthropogenic Assets:** Includes human-made systems, such as infrastructure, technology, and knowledge, which interact with ecosystems and enhance or degrade ecosystem service flows.

4. **Good Quality of Life:** Refers to the well-being of individuals and communities, including economic, social, health, and cultural dimensions. This emphasises the multidimensional nature of human well-being.

5. **Institutions and Governance Systems:** Represents the rules, laws, policies, and cultural norms that influence how ecosystems are managed and how benefits are distributed. Institutions play a critical role in regulating the interaction between people and nature.

6. **Drivers of Change:** Divided into two categories: **indirect drivers:** Social, economic, and cultural factors (e.g., population growth, governance, and technological advancements). **direct drivers:** Physical actions or changes affecting ecosystems (e.g., deforestation, pollution, climate change).

By applying the IPBES framework, the Thailand NEA technical report systematically evaluated how changes in marine and coastal ecosystems affect the flow of benefits to people (e.g., how coral reef degradation might impact fisheries and tourism incomes, or how mangrove restoration can improve coastal protection and carbon sequestration). It also helped to identify indirect drivers such as economic development policies or population trends that underlie direct pressures on ecosystems. Recognising the role of governance, the assessment considered existing policies and institutional arrangements (at national to local levels) that influence marine resource management. Overall, the IPBES framework ensured the assessment remained policy-oriented, highlighting options for interventions (responses) that can sustain or enhance nature's contributions to Thai society. It also provided a means to incorporate ILK by valuing community observations and cultural services, thereby enriching the scientific analysis with local perspectives.

### 1.4.2 DPSIR framework

The Drivers-Pressures-State-Impacts-Responses (DPSIR) framework is a structured approach commonly used in NEA to analyse the complex relationships between human activities and ecosystems. It helps identify the causes of environmental change, the effects on ecosystems and human well-being, and appropriate responses to address these changes. **Drivers** are the overarching forces (often socio-economic) that lead to environmental change; **Pressures** are the direct stresses caused by drivers (e.g., pollution, resource extraction); **State** refers to the condition of the environment or ecosystem; **Impacts** denotes the effects of environmental state change on ecosystems and human well-being; and **Responses** are the actions taken by society or authorities to prevent, mitigate, or adapt to changes (policies, regulations, initiatives).

DPSIR framework is an adaptive management tool used for analysing environmental problems by establishing cause-effect relations between anthropogenic activities and their environmental and socio-economic consequences. It brings together natural science and social science including economics in one framework for adaptive management and considers human activities as an integral part of the ecosystem. The causal links start with driving forces, pass through pressures to state of the environment and impacts on ecosystem functions and human welfare, eventually leading to societal responses (Gari et al., 2015)

Figure 1.3 describes the five components of the DPSIR Framework for Thailand marine ecosystems and their interconnectedness. Chapter 2 discusses the state and trend of Marine BES, while Chapter 3 covers drivers, pressures, and impacts and the relation among these elements. Chapters 4 and 5 highlight the importance of economic values and the role of ILK in the assessment process as well as improving the effectiveness of the decision-making process. Chapter 6 on governance illustrates how the response component can assist maintaining and conserving Marine BES, by avoiding negative and enhancing positive changes.

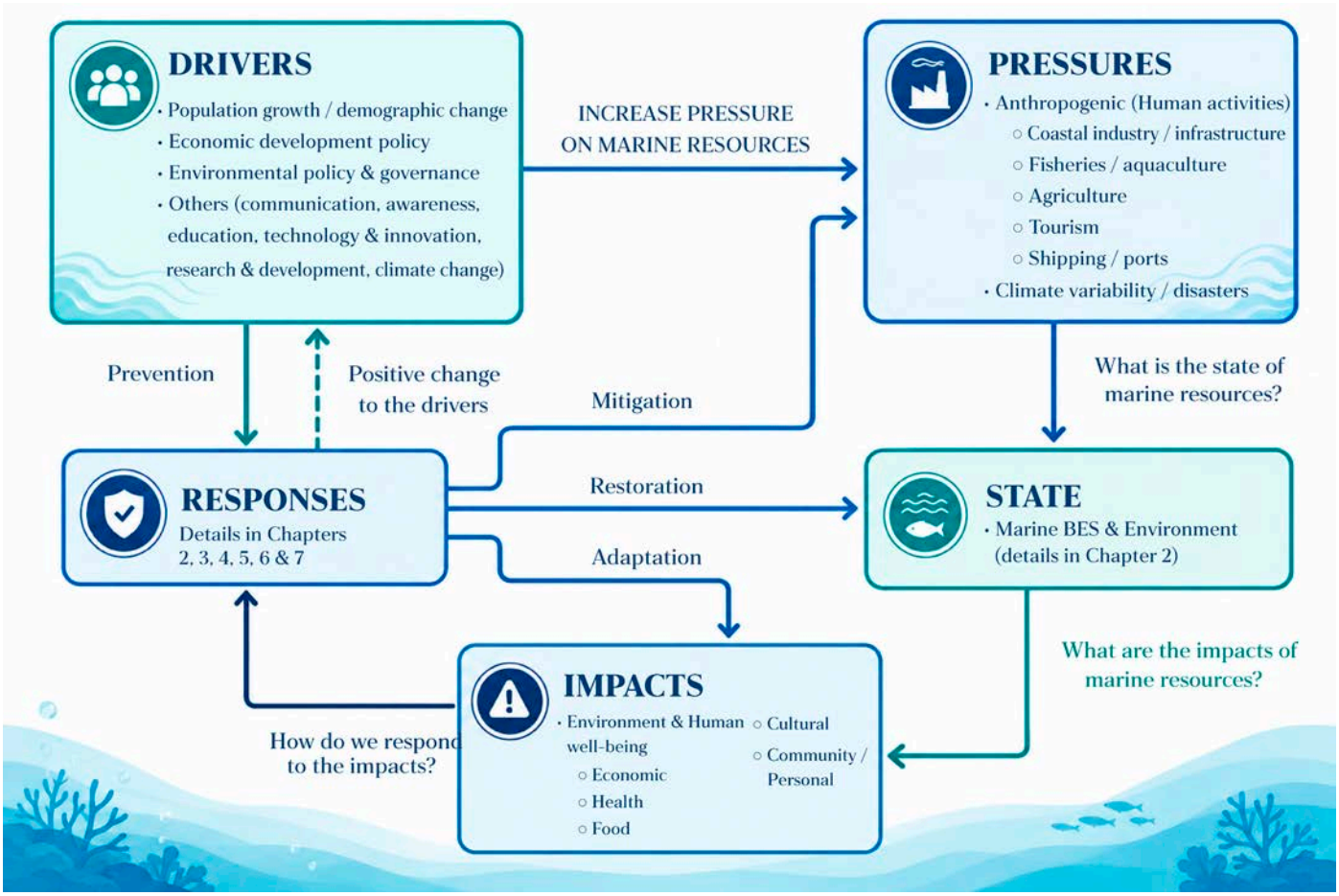



**Figure 1.3: DPSIR analysis of Thailand's marine and coastal ecosystems**

By integrating DPSIR with the IPBES framework, the NEA team linked the science findings to policy response options more explicitly. The DPSIR helped identify where interventions are needed most–for instance, whether the priority is to address a drivers (e.g., unsustainable tourism practices) or a pressure (e.g., sediment runoff), and what kind of response (regulatory, economic incentive, restoration project, etc.) would target the root cause of degradation. This approach aligns with Thailand's interest in evidence-based policymaking, as it clearly shows how specific issues (like marine pollution or habitat loss) can be traced back to economic sectors or practices, and thus which agencies or stakeholders should be involved in the response. In summary, the DPSIR framework added a problem-solving orientation to the assessment, ensuring that the NEA's findings are not just a status report but also a guide to practical management and policy actions.

## 1.5 Past ecosystem assessment in Thailand

Thailand's approach to assessing marine and coastal ecosystems has evolved over the past few decades, moving from broad environmental reporting toward more focused and regular evaluations. Initially, assessments of the marine environment were embedded within general State of the Environment reports, which covered the country's environmental conditions across various domains. Over time, with growing recognition of marine issues and institutional changes, dedicated assessment processes emerged. This section reviews Thailand's ecosystem assessment efforts at national and international levels, highlighting key findings and identifying critical gaps. Thailand has established regular, institutionalised assessments as part of its environmental governance; however, these remain uneven in scope. They tend to focus on prominent ecosystems (mangroves, coral reefs, seagrasses), while other important habitats (coastal wetlands, sandy beaches, mudflats) and integrative dimensions, such as ecosystem service valuation and cross-ecosystem interactions, are not yet comprehensively covered. The Thailand NEA seeks to address these gaps through a more integrated and comprehensive assessment approach.

### 1.5.1 National assessment report

Development of national assessments of Marine BES, driven largely by the enactment of key environmental legislation, can be divided into three periods (Figure 1.4).

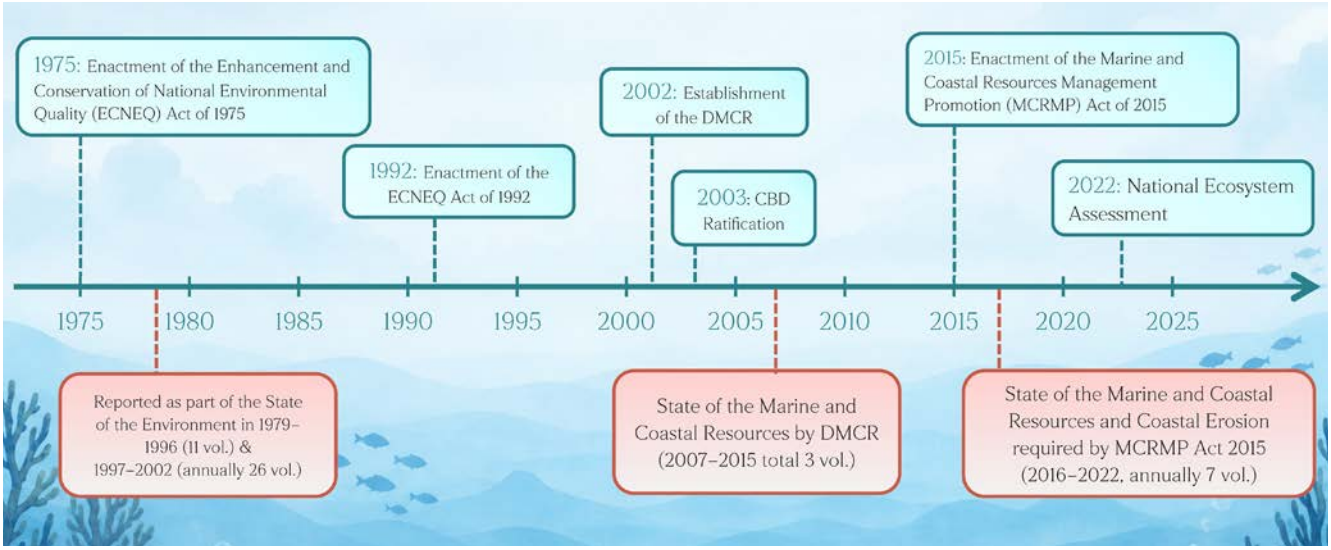



**Figure 1.4: Timeline of marine ecosystem assessment in Thailand**

***Early period (1970s–2002):*** Formal environmental reporting in Thailand began after the enactment of the Enhancement and Conservation of National Environmental Quality Act (ECNEQ Act), B.E. 2518 (1975), which required the National Environment Board to submit annual environmental quality reports to the Cabinet. In practice, during the late 1970s through 1990s, these State of the Environment (SoE) reports included information on natural resources and pollution nationwide, but marine ecosystems were not covered consistently unless a pressing issue arose. For example, during the 1980s when mangrove deforestation became acute due to conversion to shrimp farms, the SoE reports of those years documented the decline in mangrove area as a significant concern. However, in years without high-profile marine incidents, coastal ecosystems received little attention, leading to sporadic reporting. In summary, marine ecosystem assessment in this early period was fragmented and problem-driven, lacking a continuous, comprehensive focus.

***Institutional changes and intermediate period (2002–2014):*** A significant milestone was the establishment of the DMCR in 2002 under the reorganisation that created the MNRE. With a dedicated agency, Thailand saw its first national report on the State of Marine and Coastal Resources, published by DMCR in the early 2000s. Although these reports were not produced annually at first, they represented a major step toward regular, detailed assessments of key coastal ecosystems (mangroves, coral reefs, seagrasses, etc.), including data on habitat extent, health indicators, and emerging issues like coral bleaching. The DMCR reports in this period provided baseline information and raised awareness of marine conservation needs. However, publication was intermittent (often depending on available resources and urgency of issues), and not all ecosystem types or regions were equally covered.

***Current period (2015–present):*** The Marine and Coastal Resources Management Promotion (MCRMP) Act B.E. 2558 (2015) strengthened the mandate for systematic assessments. Under this law, DMCR now produces annual reports on the state of marine and coastal resources at both national and provincial levels. These annual reports have expanded in scope and consistency, covering major ecosystems and including specific requirements such as reporting on coastal erosion (a notable impact of concern). The annual reporting has improved the availability of up-to-date information and provides a more continuous record of trends. By making the reports a statutory duty, Thailand has institutionalised marine ecosystem assessment as part of its environmental governance. That said, even the current annual reports have limitations–they tend to focus on the most prominent ecosystems (mangroves, coral reefs, seagrasses) and issues, while some habitat types (like coastal wetlands, sandy beaches, and mudflats) and integrative aspects (like ecosystem services valuation or cross-ecosystem interactions) are not yet comprehensively covered. The NEA can thus be seen as a complementary effort, aiming to provide a more holistic assessment that fills these gaps and aligns the findings with policy questions.

## 1.5.2 International assessment report

In addition to national reporting, Thailand is obligated under various **Multilateral Environmental Agreements (MEAs)** to report on biodiversity and ecosystems, including aspects of marine ecosystems. Under the CBD, Thailand submits National Reports on the implementation of the convention (per Article 26) and prepares National Biodiversity Strategy and Action Plans (NBSAP, per Article 6). Thailand signed the CBD in 1992 and became a Party in 2004. Notably, even before formal ratification, Thailand showed commitment by submitting its first CBD national report in 2000, followed by a second report in 2002 (Figure 1.5). After joining the CBD, Thailand has consistently submitted national reports roughly every four years–up to the Sixth National Report in 2018. (The Seventh and Eighth reports have beɯaen postponed to 2026 and 2029, respectively, as per CBD COP decisions. (ONEP, 2025). These reports provide a broad overview of biodiversity status and actions in the country, but they are not specifically focused on marine ecosystems. Typically, they include nationwide species counts, threat status, and progress on biodiversity targets, without disaggregating by ecosystem type. Consequently, while the CBD reports confirm Thailand's marine biodiversity is part of the national heritage, they offer limited detail for marine ecosystem assessments beyond listing certain marine species or general trends.

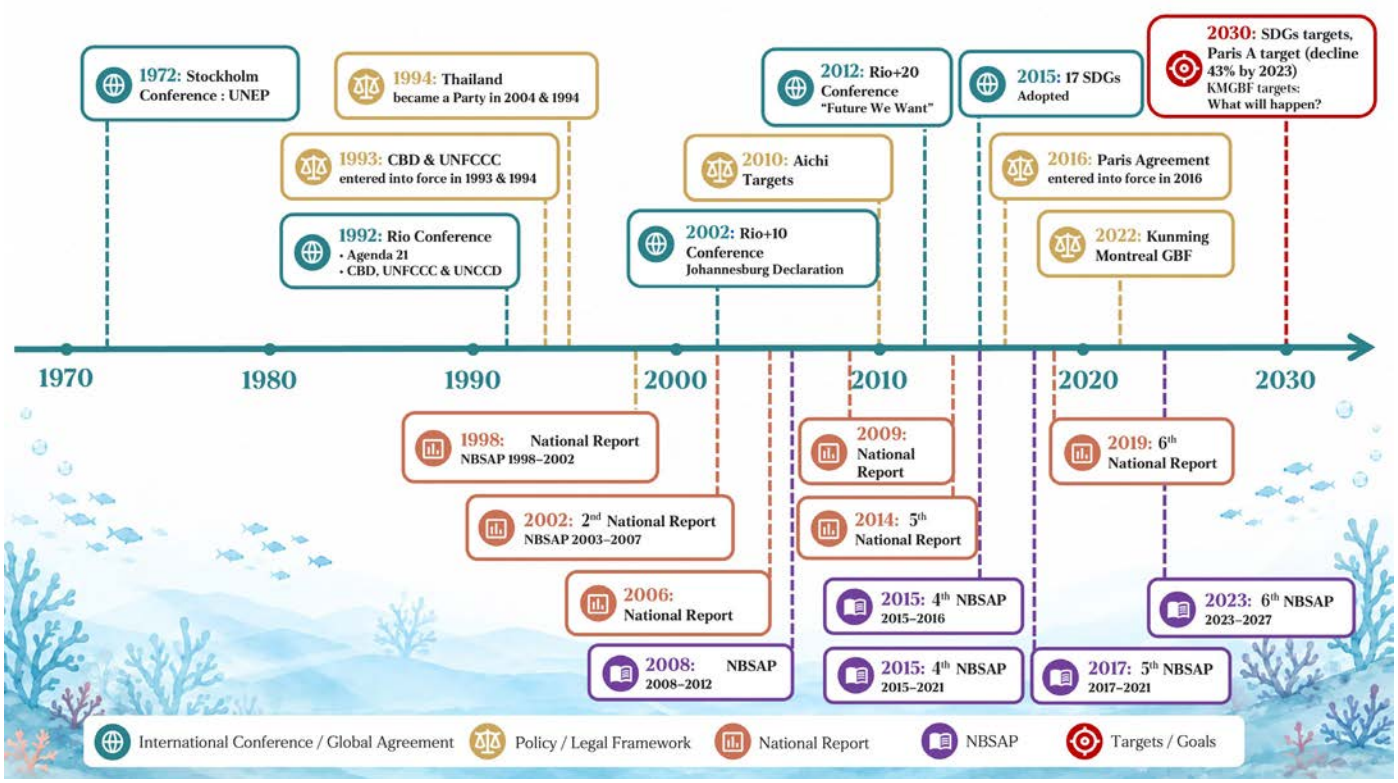



**Figure 1.5: Timeline of international assessment report**

Thailand's NBSAP, meanwhile, are strategic planning documents. Since 1998, Thailand has developed five NBSAP (the latest being the 5th NBSAP 2017-2021, with a 6th NBSAP for 2023-2027 in preparation). In early years, the NBSAP were included in the national CBD reports (the first two NBSAP were attached to the 1st and 2nd CBD reports). Post-2006, they became standalone plans (3rd NBSAP 2008-2012, 4th NBSAP 2015-2021, etc.). However, NBSAP are policy and action plans and do not provide the scientific status or trends data one would find in an assessment. They set goals (e.g., increase Marine Protected Areas (MPAs) coverage, restore mangroves) but don't detail the baseline condition or quantitative progress in each marine ecosystem. Thus, while Thailand's international reporting (CBD reports and NBSAP) demonstrates commitment to marine biodiversity, neither format offers a comprehensive assessment of marine ecosystem health. This reinforces the need for dedicated assessments (like the NEA) to feed into and inform these international reports and plans, ideally creating a two-way exchange where national assessments provide the data for international reporting, and international commitments guide the focus of national assessments.

Thailand has initiated the NBSAP since 1998, It has developed a total of five NBSAP. Thailand's the 1st NBSAP (1998-2002) and 2nd NBSAP (2003-2007) were also included in these first two CBD national reports. The succeeding NBSAP was developed separately from the CBD national report i.e., the 3rd NBSAP (2008-2012), the 4th NBSAP (2015-2021), the 5th NBSAP (2017-2021) and the current plan— the 6th NBSAP (2023–2027).

However, the contents of both CBD national reports and NBSAP are not directly relevant to marine ecosystem assessment. That is the CBD national reports provide information of biodiversity in overall throughout the country, especially the number of species found/recorded, but not specify or classify in each type of ecosystems while NBSAP focuses on strategy and action plan, not providing the information of biodiversity. However, NBSAP are policy and action plans and do

not provide the scientific status or trends data one would find in an assessment. They set goals (e.g., increase MPAs coverage, restore mangroves) but do not detail the baseline condition or quantitative progress in each marine ecosystem. Thus, while Thailand's international reporting (CBD reports and NBSAP) demonstrates commitment to marine biodiversity, neither format offers a comprehensive assessment of marine ecosystem health. This reinforces the need for dedicated assessments (like the NEA) to feed into and inform these international reports and plans, ideally creating a two-way exchange where national assessments provide the data for international reporting, and international commitments guide the focus of national assessments.
Beyond the CBD, Thailand is also a party to other marine-related conventions and initiatives (e.g. CITES for species trade, Ramsar Convention for wetlands, UNEP's Regional Seas Programme through COBSEA, and the SDG 14 reporting under the UN). These all generate information and commitments relevant to marine ecosystems. However, similar to the CBD context, the information is often fragmented by issue (species trade, wetlands, pollution, etc.). The integrated nature of an NEA can add value by consolidating these strands into one comprehensive narrative and evidence base.

### 1.5.3 Key findings of the past assessment process in Thailand

Past assessment efforts in Thailand have yielded important insights into specific ecosystem types. Although the depth and continuity of data vary, the evolution of marine ecosystem assessments in Thailand has continually improved over time. In the initial period of assessment, some specific marine ecosystems such as mangroves, coral reefs and seagrasses were intermittently reported, focusing mainly on their area coverage. The establishment of the DMCR in 2002 has reflected the importance of marine and coastal resources and the need to ensure the sustainable development of these resources. Therefore, the second period initiated specific report in marine and coastal ecosystems, which include health status. However, the assessment has not been done annually, maybe because of a lack of human and financial resources. In the current phase, the DMCR in mandated to submit annual national reports on the state of marine and coastal resources as stated in MCRMP Act of 2015. The reports include specific data on marine ecosystems, including species diversity and its index, and annual records of several marine endangered species (sea turtles, dugongs, whales, and dolphins), phytoplankton and algal bloom frequency, and oil spill frequency have been recorded in the reports since 2015. Additionally, in-depth specific assessment has been conducted in certain areas and issues such as an offshore rocky reef ecosystem (Koh Losin), populations of endangered species such as whale sharks and manta rays, and adverse impacts of marine debris on species and ecosystems. In spite of the improvements there are still gaps and room for further improvement. Detailed assessment of the status and trend of Marine BES, can be found in Chapter 2.

These findings from the past provide a foundation and rationale for the present NEA–to compile, update, and analyse this information holistically, draw conclusions about where Thailand's marine and coastal ecosystems are headed, and what can be done from a policy standpoint to ensure their sustainability.

### 1.5.4 Relevant information based on academic and research publications

In preparing the NEA, a substantial review of academic literature and research reports was undertaken to complement official data. Since 2015, at least 142 scientific publications and reports relevant to Thailand's marine and coastal ecosystems have been reviewed. These include peer-reviewed journal articles, theses and dissertations, government research reports, and international

project reports. The information from these sources was categorised into five thematic groups for the assessment:

**1. Status, trends, and future dynamics of marine ecosystems:** Studies in this category provide data on habitat extent, species population trends, and modeling of future changes. For example, remote sensing analyses of mangrove cover change, coral growth rate studies, or climate projection impacts on fisheries fall here. This group constituted a large share of publications, indicating strong research interest in biophysical monitoring.

**2. Pressures, impacts, and responses:** This includes research on pollution impact (e.g., effects of microplastics on marine life), overfishing and its ecological consequences, impacts of coastal development, as well as evaluations of management responses (like the effectiveness of MPAs or restoration projects). A significant portion of literature covers these human-environment interactions, reflecting Thailand's concern with not just measuring ecosystem states but understanding the causes and testing solutions.

**3. Socio-economics and human well-being:** These publications address how changes in marine ecosystems affect communities and economies–for instance, studies on the economic valuation of mangrove services, the dependence of local fisheries on reef health, or the well-being of coastal communities facing resource decline. Fewer studies were available in this category compared to biophysical ones, suggesting a need for more interdisciplinary research linking ecology and socio-economics.

**4. ILK:** Some publications document local knowledge systems, traditional practices for coastal resource management, and community perceptions of environmental change. While Thailand has rich local knowledge (e.g., traditional fishery management, spiritual values attached to certain species or sites), relatively few academic works have captured ILK in the context of marine biodiversity. Strengthening this area is important for a comprehensive assessment.

**5. Policy, governance, and institutional arrangements:** These works examine the frameworks governing marine resources–analyses of laws, marine policy implementation, co-management case studies, and institutional performance. They provide insight into the science-policy interface itself, evaluating how well scientific knowledge is incorporated into policymaking and what governance gaps exist. This was another smaller category in sheer number of publications, indicating an opportunity for more research on governance effectiveness.

The literature review revealed that categories (1) and (2) – biophysical status/trends and pressures/impacts – dominate research efforts (together making up the majority of publications). This means we have considerable data on what is happening to ecosystems and why, but comparatively less on the social dimensions, ILK, and governance aspects. Figure 1.6 and Figure 1.7. Visualise the breakdown of research by category and by ecosystem type. Notably, a large proportion of studies were "not specified" to a particular ecosystem type–many were broad (e.g., studies on GoT fisheries or on general marine biodiversity) rather than ecosystem-specific. Of those focused on specific ecosystems, coral reefs, islands, and mangroves were the top three, collectively about 27% of studies, while others (seagrass, swamp forest, coastal lagoon, and estuaries) had relatively few dedicated studies. This underscores some research bias toward more "charismatic" ecosystems (coral reefs) or easily accessible ones, whereas critical but less-studied systems (mudflats and coastal wetlands) may be under-represented in literature.

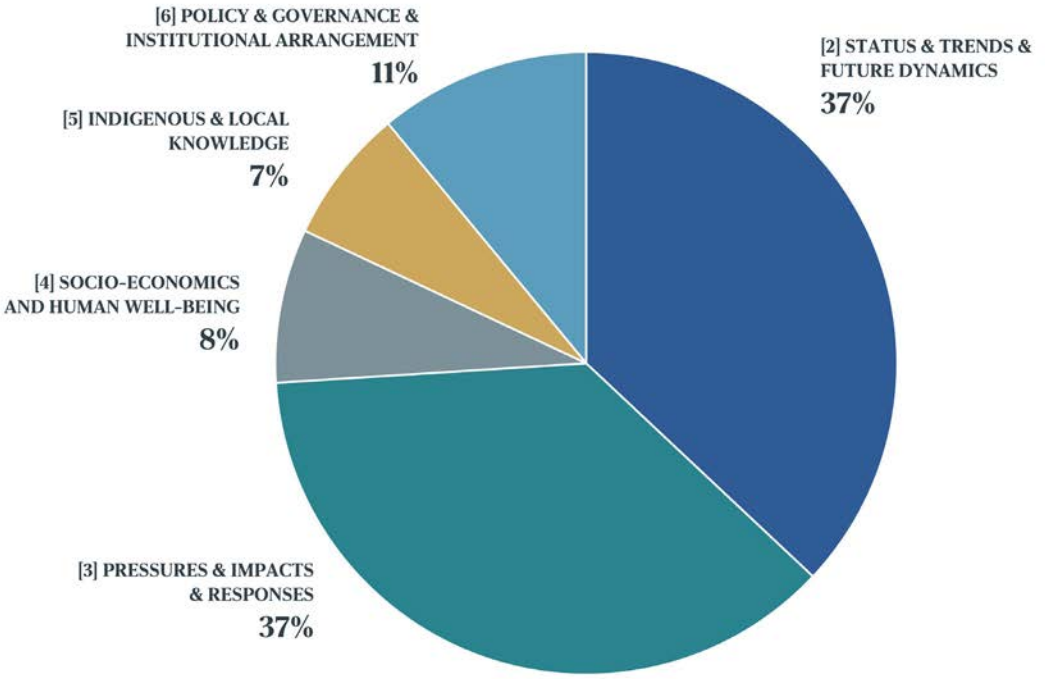



**Figure 1.6: Percentage of academic and research publications in Thailand's databases based on research category during 2015- 2023**

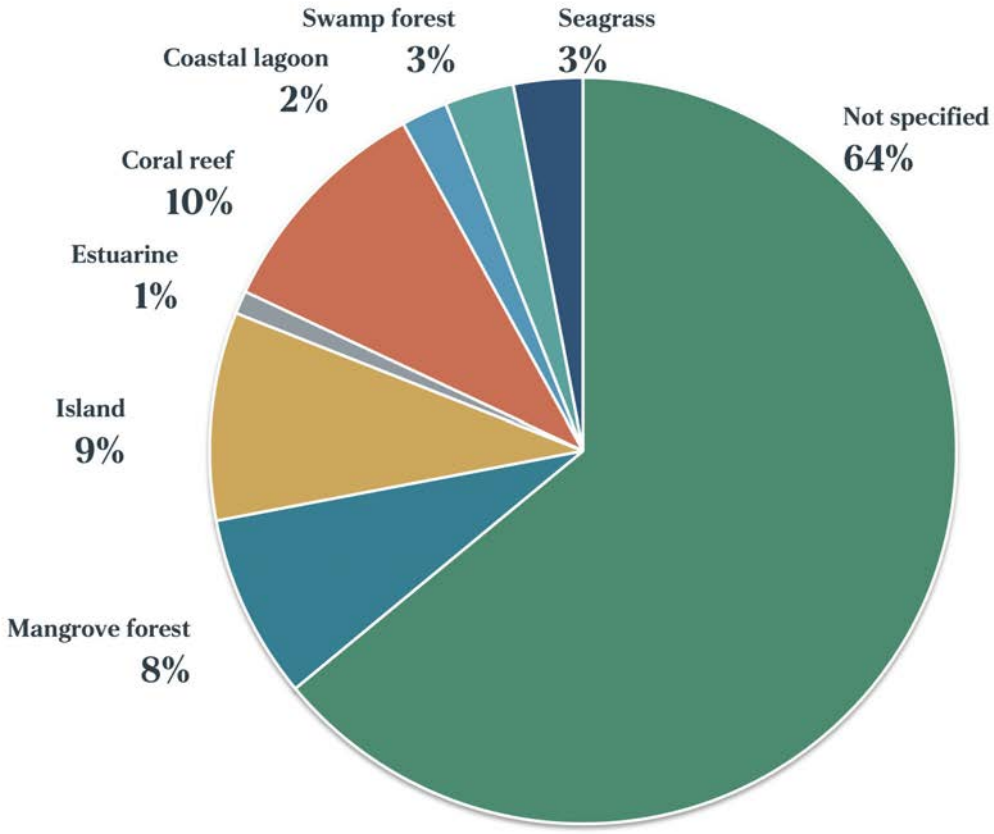



**Figure 1.7: Percentage of academic and research publications in Thailand's databases based on type of marine ecosystems during 2015-2023**

Figure 1.6 shows percentage of publications based on the research category, namely [1] Status, trends, and future dynamics of marine ecosystems, [2] Pressures, impacts, and responses to marine ecosystems, [3] Socio-economics and human well-being, [4] ILK, and [5] Policy, governance, and institutional arrangement. Category 1 and 2 combined has the highest percentage indicate strong research interest in these two categories. On the other hand, the other three categories were less interesting to researchers, therefore further support is needed to fill information gaps.
Academic and research publications have been invaluable in filling information gaps and providing localised studies that official national reports might miss. They bring in advanced methodologies (e.g., satellite monitoring, ecological modeling, and socio-economic surveys) and often test hypotheses that shed light on cause-effect mechanisms. The NEA integrates these research insights with government data to ensure the assessment is robust, up-to-date, and reflective of both scientific knowledge and ground realities.

### 1.5.5 Gaps Marine BES and past assessment in Thailand

Despite improvements over time, previous assessment efforts in Thailand have left several knowledge and process gaps. Addressing these gaps is a key objective of the NEA to enable more effective policy guidance. The main gaps identified include:

- **Temporal and spatial data gaps:** Long-term and continuous data are lacking for many parameters. For example, there were periods with no data for mangrove extent (e.g., 1986-1991, 2000-2004), making it hard to determine trends or recovery rates over decades. Monitoring has often been project-based and discontinuous. Some ecosystems (like offshore reefs or deep-water habitats) have very sparse data because past assessments focused on easily observable coastal sites. *Spatially*, data collection has been uneven–concentrated in certain provinces or popular sites, while other areas remain understudied. Recently, there have been a few surveys of offshore areas (around oil platforms, submerged banks like Losin), but coverage is far from complete. This patchy data situation means our understanding of national status is incomplete. The NEA attempts to compile disparate datasets and, where possible, use modeling or proxies to infer conditions in data-poor areas, but establishing more regular and widespread monitoring is a recommendation going forward.

- **Drivers and Pressures analysis:** Past reports have largely focused on describing the state of ecosystems (e.g., coral cover, water quality metrics, species counts). There has been much less systematic analysis of the drivers and pressures causing changes. For instance, while marine debris or water pollution might be noted, the sources (industrial discharge, upstream land use, etc.) and causal pathways are not thoroughly examined. Emerging threats like ocean acidification, marine invasive species, or the cumulative impacts of climate change (bleaching, sea temperature rise, and hypoxia events) have not been deeply analysed in national assessments. This gap can hinder effective response, as policies need to target root causes. The NEA addresses this by explicitly linking observed changes to Drivers/Pressures in the DPSIR framework, but it also highlights the need for more research on cause-effect (e.g., linking specific agricultural runoff to coastal nutrient hotspots or tracing marine plastic debris to its land-based sources) to inform targeted policy measures.

- **Interconnectedness of ecosystems:** Historically, assessments looked at each ecosystem type in isolation–mangroves in one section, coral reefs in another, etc. There has been little examination of the ecological linkages between these systems. In reality, coastal ecosystems

function as interdependent mosaics (the "ridge-to-reef" or "source-to-sea" concept). For example, mangroves, seagrass beds, and coral reefs often form connected habitats supporting species that migrate among them; upstream watershed activities affect estuarine and reef conditions (land-sea interface issues). Without assessing these linkages, management may miss cumulative effects or opportunities for integrated solutions. The NEA places emphasis on ecosystem-based management perspectives, considering cross-ecosystem interactions (e.g., how mangrove loss might exacerbate coral reef sedimentation? or how healthy seagrass beds can support coral reef fisheries?). One suggestion is to enhance future state-of-environment reports with seascape or landscape-level assessments rather than just habitat-by-habitat reporting.

- **Ecosystem services evaluation:** While past assessments enumerate physical and biological aspects, they have inadequately captured the value and dynamics of ecosystem services. National reports might qualitatively mention that mangroves provide coastal protection or that coral reefs support tourism, but there are few quantitative valuations (economic or otherwise) of these services. Consequently, the critical contributions of ecosystems to livelihoods, disaster risk reduction, climate mitigation, and culture may be underappreciated in policy decisions. There is a need to strengthen the link between natural science data and socio-economic outcomes. For instance, how does a decline in fish habitat translate to impacts on fisheries yield and incomes? How much economic benefit does a hectare of mangrove provide in flood protection? The NEA includes a preliminary attempt to assess and, where data allow, value certain ecosystem services (e.g., carbon sequestration of blue carbon ecosystems, tourism revenue from reefs, shoreline protection value of mangroves) to illustrate their importance in concrete terms. Building capacity for natural capital accounting and integrating ecosystems into national accounting systems is a recommended step (also aligning with the global push for accounting ecosystems in decision-making).

- **Inclusion of ILK:** Previous national assessments have been largely expert-driven and science-focused, with minimal integration of ILK. Indigenous communities (like the sea nomads of the Adang archipelago) and local fishing communities possess detailed knowledge of species, seasonal patterns, and sustainable practices that is valuable for assessments. However, there has been a lack of formal mechanisms to incorporate ILK into national reporting. Local community engagement in assessment design or policy planning has also been limited. This gap potentially leads to missed insights (for example, fishermen's knowledge of spawning seasons or traditional coastal management practices). It can also result in lower buy-in for conservation measures if local stakeholders feel their knowledge is ignored. The NEA process has tried to bridge this gap by consulting stakeholders at various stages and recognising ILK in scenario development and findings (e.g., including community testimony on changes in fish catches or coastal erosion observations). Going forward, establishing a more permanent National Biodiversity Platform or forums where scientists, policymakers, and local knowledge holders regularly interact would strengthen the science-policy-society interface and ensure assessments and resulting policies are well-informed and locally relevant.

- **Science-policy interface weaknesses:** Perhaps the most consequential gap is the limited translation of scientific assessment findings into concrete policy measures and action. Past reports, even when rich in data, often stopped short of providing clear policy recommendations. Consequently, the connection between assessment and policymaking was weak. While Thailand's NBSAP and other strategies exist, there is often a disconnect–the NBSAP might not fully utilise the detailed findings of state-of-environment reports, and the reports might not be structured to answer specific policy questions. There is also inadequate evaluation of policy effectiveness in the reports (e.g., do mangrove protection laws result in mangrove

recovery? Are fisheries regulations reducing overfishing?). Compliance and enforcement issues are not rigorously assessed or reported. The NEA is directly attempting to strengthen this interface by formulating its assessment around key policy questions (see next section) and drafting recommendations as part of the assessment output. This is complemented by engaging policy stakeholders (ministries and local governments) throughout the process so that findings are understood and owned by those in a position to act. Ultimately, establishing
- a cycle where each assessment feeds into policy revision (and policy outcomes feed back into the next assessment) is the goal. Building capacity among stakeholders to understand and use assessment results, and ensuring assessments address the right questions, are part of closing this gap.

In summary, Thailand's journey in marine ecosystem assessment has progressed, but addressing these gaps will be critical to make assessments truly impactful. The NEA seeks to provide a baseline for improvement–not only updating the knowledge on marine biodiversity and ecosystem services, but also demonstrating a more integrated, policy-relevant approach that can be institutionalised beyond the life of this project.

## 1.6 Methodology and scope of work

The Thailand NEA was conducted through a participatory, policy-oriented process designed to produce credible science while directly engaging the policy community. The methodology and scope of work were structured as follows:

- **Governance and oversight:** A National PSC was established by ONEP at the outset to guide the assessment. The PSC included representatives from key government agencies (ONEP, DMCR, DNP, Department of Fisheries (DOF), Office of the National Economic and Social Development Council (NESDC), etc.), academic experts, and international partners (UNEP-WCMC). Chaired by the Secretary General of ONEP, the PSC's role was to ensure the assessment remained aligned with national priorities, approve draft outputs, and facilitate the uptake of findings into policy channels (for example, by submitting the final report to the National CBD Committee for endorsement). This high-level oversight linked the NEA directly to Thailand's environmental policy apparatus, underscoring a commitment that the assessment would inform decision-making (and not remain an academic exercise).

- **NEA team and technical work:** A dedicated NEA Thailand Team (comprising lead authors, chapter scientists, and technical contributors from universities and agencies) carried out the day-to-day work of the assessment. This team was interdisciplinary, including marine ecologists, environmental economists, social scientists, GIS specialists, and others, to ensure a holistic evaluation of both biophysical and socio-economic dimensions. The NEA team's tasks included data collection and review (from government databases and literature, as described in Section 1.5.4), stakeholder consultations, writing of assessment chapters, and development of scenarios and response options. Throughout, the team coordinated closely with the PSC for guidance and to periodically validate that emerging findings resonated with policy realities.

- **Scoping and stakeholder engagement:** The NEA process began with a scoping phase to define key questions, thematic scope, and stakeholders' needs. An initial Kick-off Meeting and an academic forum (at the 7$^{th}$ Marine Science Conference) were held to gather input from scientists and practitioners on priority issues for the assessment. A formal Scoping Workshop followed, bringing together representatives from government, academia, Non-Governmental Organizations (NGOs), and community groups. In this workshop, participants reviewed preliminary information on marine

biodiversity and helped identify focal topics and gaps to address. Notably, the scoping phase was informed by the gaps identified from past assessments (Section 1.5.5) for instance, participants emphasised the need to include climate change, blue carbon ecosystems, and socio-economic valuation, which aligned with current conservation trends. The result was a scoping report outlining what the NEA would cover (e.g., specific ecosystems, ecosystem services, scenarios) and the key policy questions it should answer (see Section 1.6.1 below). By engaging stakeholders early, the NEA ensured the assessment scope was relevant and had buy-in from those who would later use the results.

- **Capacity building and policy integration:** A unique aspect of the methodology was incorporating capacity-building events that doubled as information-gathering and dissemination opportunities. For example, in 2023 the NEA collaborated with a national research project to host a MSP Forum titled "From Policies to Practices". This event, organised by a leading Thai university with support from the National Research Council, brought international and national experts to discuss how MSP can operationalise marine and coastal policies at local levels. It served to introduce concepts like spatial zoning, marine tenure, and cross-sector planning to Thai stakeholders. The discussions and case studies from the MSP forum fed into the assessment (for instance, highlighting the need for spatial data and governance coordination, which the NEA then examined). Another example is Thailand's participation in the 11th Asia-Pacific Forum on Sustainable Development (APFSD) 2024, where the NEA team held a side event. This raised awareness of the NEA in the context of regional SDG 14 (Life Below Water) efforts and allowed the team to glean insights on regional best practices and commitments which were incorporated into the assessment's regional analysis (as reflected in Section 1.2.1). These activities ensured that the NEA remained in sync with current conservation trends—such as the emphasis on Nature-based Solutions (NbS), integrated coastal zone management (ICZM), and aligning climate action with ocean health––and that the team built the necessary skills (like scenario analysis and spatial planning) to address those topics.

- **Scenario analysis workshops:** To address the future outlook of marine ecosystems under different development pathways, the NEA conducted scenario planning exercises. Two Scenario Workshops (late 2024 and early 2025) were held with experts and stakeholders. In the **1st Scenario Workshop**, participants developed initial qualitative scenarios for the future of Thailand's marine ecosystems, exploring storylines like "Business-as-Usual (BAU) vs Sustainable Growth vs Degradation" with different mixes of drivers (economic trends, climate change, policy enforcement levels). They identified and ranked the key drivers and pressures likely to shape outcomes (e.g., rate of climate impacts, tourism growth, technology uptake in conservation). In the **2nd Scenario Workshop**, the NEA team refined these scenarios, incorporating feedback and additional data. Outcomes included adjusted scenario narratives better tailored to Thailand's context (e.g., distinguishing regional differences between the Andaman coast and GoT under certain futures) and identifying what policy actions today could lead toward the more sustainable scenarios. These scenario analyses are presented in a later chapter of the report, but the methodology is highlighted here as a crucial part of the scope—it moves beyond current state assessment to considering possible futures, which is valuable for policy planning (such as climate adaptation strategies and long-term coastal development plans).

- **"Trialogue" multi-stakeholder dialogues:** Embracing an approach championed by BES-Net, the NEA convened Trialogue meetings—interactive dialogues among scientists, policymakers, and civil society/community representatives (hence a "three-group dialogue")—to foster mutual learning and co-generate solutions. A Mini-Trialogue in 2024 tested this approach on specific themes, demonstrating how bringing diverse voices together can strengthen stakeholder engagement.

The pinnacle was a national Trialogue Workshop in 2025, after the first draft of the assessment report was prepared. In this workshop, the NEA team presented preliminary findings and each chapter's draft recommendations. Stakeholders from local communities (e.g., small-scale fishers, coastal community leaders), provincial officials, academia, and national policymakers discussed and provided feedback on the content and proposed policy recommendations. They shared on-the-ground perspectives for example, confirming whether certain recommended actions were feasible or highlighting additional issues like local conflict over resources that the draft might have missed. This iterative dialogue ensured the final report's recommendations were grounded, practical, and had broader acceptance. It is a novel step for national assessments in Thailand, making the NEA as much a process of consensus-building as a scientific endeavor.

- **Linking with National Policy Processes:** To maximize policy uptake, the NEA process was timed and coordinated to feed into ongoing national policy updates. During 2024, Thailand was in the process of formulating its 6$^{th}$ NBSAP. The NEA team engaged with this by participating in the Draft NBSAP consultation meetings. At one such meeting, NEA findings on coastal biodiversity were shared and the team gathered information on the draft NBSAP targets related to marine ecosystems. This two-way exchange allowed the NEA to tailor some analyses to directly support NBSAP objectives (e.g., providing data for marine indicators) and ensured that the NBSAP writers were aware of emerging NEA recommendations (potentially to integrate them into the strategy). Similarly, the NEA aligned with Thailand's climate change policy timeline—2025 is when the next NDC update is due; hence the assessment's insights on blue carbon and coastal adaptation can inform that update. By synchronizing with policy cycles, the NEA increases its relevance. The scope of work explicitly included preparing policy briefs and summary for policymakers in late 2025 to ensure key messages are distilled for decision-makers in time for those processes.

- **Assessment scope (Content):** The technical scope of the NEA covers marine and coastal ecosystems of Thailand up to the EEZ, focusing on mangroves, coral reefs, seagrass, estuaries/coastal wetlands, beaches and dunes, coastal waters (pelagic zone), and small islands. It evaluates the status and trends of these ecosystems (extent, condition, biodiversity), the direct drivers of change (land-based pollution, overfishing, habitat destruction, climate change, invasive species, etc.), and the indirect drivers (socio-economic factors, governance, cultural attitudes). A special focus is given to ecosystem services provided by these systems–provisioning (fisheries, aquaculture products), regulating (coastal protection, carbon sequestration, water purification), cultural (tourism, recreation, spiritual values), and supporting services (nursery habitats, nutrient cycling). The assessment timeframe includes historical trends (since around 1970s where data available), current status, and future projections (through scenarios to 2030/2050). Geographically, it considers national-level aggregation as well as regional distinctions (Andaman vs GoT differences in ecosystems and pressures). The NEA also includes a policy analysis component–reviewing existing laws, policies, and institutional frameworks affecting marine ecosystems–and a chapter on options for responses (actions and interventions) that Thailand can consider. Throughout, the approach is multiscale: acknowledging local case studies (e.g., a successful community mangrove project) up to Thailand's commitments in global frameworks (e.g., SDGs, United Nations Framework Convention on Climate Change (UNFCCC), CBD).

The above methodology ensured that the NEA was not only scientifically robust but also highly policy relevant. By involving stakeholders at every stage, integrating capacity building on contemporary approaches, and aligning with policy timelines, the NEA process in Thailand serves as a model for how NEAs can directly support and catalyse conservation and sustainable use policies, particularly in critical areas like marine and coastal ecosystems where timely action is needed.

In preparation of this NEA report, the NEA Project Steering Committee was set up by ONEP. The NEA PSC members comprises representatives from government agencies, academic institutions. NEA PSC is responsible for guiding the development of technical report, approving and submitting the final report to the National CBD Committee for information. The NEA PSC was chaired by ONEP Secretary General, and Director of the Office of Biodiversity Conservation of ONEP as a Member and Secretary. The list of NEA PSC members is in Appendix 1-1.

### 1.6.1 Overall key policy questions

A set of key policy questions was identified during the scoping phase to guide the NEA and ensure the assessment would be directly useful for decision-makers. These questions emerged from the gap analysis of past efforts (Section 1.5.5) and consultations with policymakers and experts. The seven primary policy questions are:

1. How can Thailand strengthen integration across ecosystem assessments to better link biodiversity, ecosystem services, and human well-being?
2. What mechanisms are needed to ensure that science-based assessments inform effective policy and implementation?
3. How can Thailand improve data systems and research to close critical knowledge gaps and guide informed decisions?
4. How can ILK be integrated into national assessment and decision-making processes in a respectful and effective way?
5. How can Thailand align its Blue Economy goals with ecosystem integrity and long-term sustainability?
6. What tools and approaches can help Thailand anticipate and manage risks and trade-offs in an uncertain future?
7. How can the NEA process support Thailand's global commitments and national policy coherence on biodiversity and climate?

Throughout the report, these seven questions are addressed in the analysis and conclusions of each chapter. Some recommendations in the report are organised directly in response to these questions. For instance, Chapter 6 (Policy Recommendations) will explicitly outline options to improve monitoring systems (answering question 1), opportunities for blue finance and private sector roles (question 3), mechanisms to integrate ILK (question 4), governance reforms (question 5), etc., often referencing the evidence provided in earlier chapters. By structuring around policy questions, the NEA maintains a solution-oriented focus, directly speaking to the concerns of policymakers rather than simply presenting data.

It should be noted that some recommendations were developed within the assessment chapters where data was readily available, whereas more complex or long-term recommendations (that require further deliberation) are summarised in the final chapter. This approach balances providing concrete guidance now with outlining a roadmap for future action and study.

## 1.6.2 Caveats

This assessment draws on a range of concepts and terminologies that are widely used in international biodiversity, sustainability, and ocean policy discourse. While efforts have been made to ensure consistency throughout the report, several terms—particularly Marine Biodiversity and Ecosystem Services (Marine BES), Blue Economy, and ILK—are inherently complex, context-dependent, and subject to varying interpretations. The following caveats clarify how these terms are applied in this assessment.

### Marine Biodiversity and Ecosystem Services (Marine BES)

The term "Biodiversity and Ecosystem Services (BES)" is used throughout this report in alignment with the conceptual framing of IPBES. It encompasses both the diversity of life (genes, species, and ecosystems) and the benefits that humans derive from ecosystems. In line with IPBES, this report also recognises the broader concept of "nature's contributions to people" (NCP), which extends beyond conventional ecosystem service classifications to include relational and cultural values. However, it should be noted that the boundaries between biodiversity, ecosystem functions, and ecosystem services are not always clearly defined in practice, and different disciplines may apply these concepts differently. As such, interpretations of Marine BES in this report should be understood as integrative and context-specific, rather than strictly bounded categories

### Blue Economy

The Thailand's NEA report use the World Bank's definition of "Blue Economy" which is as follows: The Blue Economy is the sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystems. This report adopts a sustainability-oriented interpretation, it also acknowledge emerging concepts such as "Sustainable Blue Economy" and "Regenerative Blue Economy" (used in developing scenarios in Chapter 8)

### Indigenous and Local Knowledge (ILK)

The term "Indigenous and local knowledge" or ILK is used here in line with the conceptual framework and methodological approaches of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), which guide the National Ecosystem Assessment. According to IPBES, ILK refers to "social and ecological knowledge practices and beliefs pertaining to the relationship of living beings, including people, with one another and with their environments", and such knowledge can provide information, methods, theory and practice for sustainable ecosystem management (IPBES, n.d., https://www.ipbes.net/ glossary/indigenous-local-knowledge-systems).

The Royal Thai Government's current position holds that all inhabitants are native to the land, in the context of the country's long history of shared co-existence; the Government therefore does not officially recognise the existence of "Indigenous Peoples" in Thailand. As used in this report, the term "indigenous and local knowledge" does not imply a determination of the indigeneity of any given population; rather, it emphasises the substance of knowledge that arises from close, sustained relationships between people and the natural environment and ecosystems of a given area. The term is therefore used here as a concept, or in reference to populations and cases from other countries, or as cited directly from original sources/documents.

With respect to promoting cultural diversity and recognising the rights of cultural groups, the Royal Thai Government enacted the Protection and Promotion of the Way of Life of Ethnic Groups Act, B.E. 2568 (2025), which came into force on 19 September 2025 and formally recognises and adopts the term "ethnic groups". The Act aims to establish a firm foundation for a multicultural society and to promote meaningful participation and engagement of ethnic groups in Thailand. Under the Act, "ethnic groups" are defined as "Thai people as a single or multiple groups who, originating and residing in Thailand, share a common identity and have accumulated a shared culture, language, way of life, wisdom, and beliefs based on traditions, or have a historical and cultural continuity related to Thai society".

### The Level of Confidence

Four specific confidence terms have been developed by IPBES (2018). For Thailand, the lead authors used these confidence terms to communicate how assured they were about their key findings:

- **Well established:** The highest level of confidence. Findings have significant, robust evidence with high levels of agreement.
- **Established but incomplete:** There is general agreement on the conclusions, but the available evidence is limited.
- **Unresolved:** There is a lot of evidence or data, but their conclusions do not agree and expert agreement remains low.
- **Inconclusive:** Limited or no evidence and very little agreement among available data.

### General interpretative caveat

Across all three terms, it is important to recognise that concepts are used as analytical tools to support understanding and policy dialogue, rather than as fixed or universally agreed definitions. Differences in interpretation across sectors, disciplines, and stakeholders are inevitable. The NEA therefore emphasises transparency in how these terms are applied and encourages their adaptive use in future policy and assessment processes.

## 1.6.3 Structure of the assessment report and linkages to subsequent chapters

The overarching objectives of Thailand's NEA (marine focus) set out in the Thailand NEA scooping stage (Thailand NEA 2024) are as follows:

- **Assess status and trends;**
- **Analyse Drivers and Pressures;**
- **Evaluate ecosystem services and contributions to well-being;**
- **Identify response options;**
- **Explore future scenarios;**
- **Strengthen the Science-Policy interface.**

Each subsequent chapter builds on the conceptual and methodological foundations laid out in this introductory chapter, offering deeper insights into the ecological, socio-economic, institutional, and spatial dynamics shaping Thailand's marine ecosystems.

- **Chapter 2** provides a detailed account of the current state and trends of marine and coastal biodiversity and ecosystem services. It evaluates the health of key ecosystems—including coral reefs, mangroves, seagrass beds, and estuarine systems—and documents observed changes, emerging stressors, and regional variations.

- **Chapter 3** explores the drivers and pressures affecting these ecosystems. It applies the DPSIR (Drivers-Pressures-State-Impacts-Responses) framework to identify the root causes of ecosystem degradation and quantify their impact across scales. It identifies natural, social and economic drivers such as economic development patterns, demographic changes, technological developments, government policy and strategies. Key pressures include human activities such as agriculture, fisheries and aquaculture, industry, tourism and transport. By doing so, the NEA lays the groundwork for pinpointing where interventions are needed.

- **Chapter 4** assesses the economic value of marine and coastal ecosystem services (provisioning, regulating, cultural, and supporting) and highlights the contribution of nature to national and local economies. It also reflects on the trade-offs and synergies between conservation goals and economic development, particularly within the context of the blue economy.

- **Chapter 5** highlights the importance of ILK in shaping sustainable ecosystem management. It examines the role of community experience, traditional ecological practices, and cultural values in enhancing resilience, particularly in vulnerable coastal areas.

- **Chapter 6** examines governance structures, institutional mechanisms, and regulatory frameworks relevant to Marine BES. It identifies fragmentation, overlaps, and gaps in policy implementation, and proposes pathways toward integrated and adaptive governance. It also identify and appraise current and potential response options ranging from policy measures, conservation and restoration initiatives, economic instruments, community-based actions, to capacity-building and research needs.

- **Chapter 7** focuses on Pilot Coastal Landscapes in Transition: Trat and Phuket. This chapter presents two grounded case studies that exemplify the socio-ecological complexity and governance challenges facing Thailand's coastal regions. Trat and Phuket offer contrasting yet complementary lessons on small-scale fisheries, tourism intensity, ecological resilience, and the role of local knowledge. These pilots operationalise the trialogue methodology introduced in Chapter 1 and serve as microcosms of the broader national assessment, providing place-based insights into future marine conservation strategies.

- **Chapter 8** outlines plausible future scenarios for Thailand's marine and coastal ecosystems under different policy, socio-economic, and environmental trajectories. It integrates stakeholder perspectives and scientific projections to explore risks, opportunities, and transformative pathways. By exploring scenarios, the NEA helps stakeholders envision the long-term outcomes of different choices and emphasises the importance of proactive planning. This objective ties into Thailand's forward-looking commitments and helps ensure resilience is built into marine and coastal management.

Collectively, these objectives ensure that the NEA serves as a bridge between knowledge and action–providing a state-of-the-art synthesis of what is happening in Thailand's marine and coastal realms, why it matters, and what can be done about it. Achieving these objectives will support Thailand in meeting its international commitments (like the CBD targets, UNFCCC and NDCs related to oceans), and more importantly, in safeguarding the natural marine heritage that underpins the well-being of current and future generations.

## 1.7 Conclusion and recommendations

### 1.7.1 Conclusion

Thailand's marine and coastal ecosystems are among the country's most valuable natural assets, underpinning biodiversity, economic development, and human well-being. This chapter has demonstrated that while Thailand has made significant progress in institutionalising ecosystem assessments—particularly through annual reporting by the DMCR—important gaps remain in terms of integration, coverage, and policy relevance. Past assessments have largely focused on key ecosystems such as mangroves, coral reefs, and seagrasses, often in isolation, with limited attention to ecosystem services, cross-ecosystem interactions, and socio-economic dimensions.

The Thailand NEA represents a critical step forward in addressing these limitations. By adopting the conceptual framework of the IPBES and integrating it with the DPSIR framework, the NEA provides a more holistic understanding of the relationships between biodiversity, ecosystem services, and human well-being. It also introduces a multi-evidence-based approach that brings together scientific knowledge, policy insights, and ILK, thereby strengthening the science–policy–society interface.

Importantly, the NEA is not only a technical assessment but also a policy-oriented process. Through stakeholder engagement, scenario development, and alignment with national policy processes such as the NBSAP and climate strategies, the NEA is designed to inform decision-making across sectors. It highlights that marine ecosystem degradation is driven by complex and interrelated factors—including economic development, governance fragmentation, and climate change—and that addressing these challenges requires integrated, cross-sectoral responses.
This chapter also underscores that concepts such as biodiversity and ecosystem services, Blue Economy, and ILK are not static or universally defined. Their application in Thailand requires contextual interpretation, careful consideration of national legal and institutional frameworks, and ongoing dialogue among stakeholders. Recognising these caveats is essential to ensure that the assessment remains both scientifically credible and socially relevant.

Overall, the NEA establishes a foundation for more integrated, inclusive, and policy-relevant ecosystem assessments in Thailand. It provides not only a synthesis of current knowledge but also a platform for future collaboration, learning, and adaptive management.

### 1.7.2 Overall key messages and recommendations

**Key Message 1: Thailand has established a strong foundation for marine ecosystem assessment, but current approaches remain fragmented and insufficiently integrated. *(Well established)***

While institutionalised assessments have improved data availability and consistency, they tend to focus on selected ecosystems and biophysical indicators, with limited integration of ecosystem services, socio-economic dimensions, and cross-ecosystem interactions.

**Recommendation:** Strengthen future assessments by adopting integrated, ecosystem-based approaches that link biodiversity, ecosystem services, and human well-being across spatial and sectoral scales.

**Key Message 2: Bridging the science-policy interface is essential to ensure that assessment findings translate into effective policy and action. *(Well established)***

Past assessments have often lacked clear pathways for policy uptake, resulting in a disconnect between knowledge generation and decision-making.

**Recommendation:** Institutionalise mechanisms—such as a National Biodiversity Platform—to facilitate continuous dialogue between scientists, policymakers, and stakeholders, and ensure that NEA findings are systematically integrated into national and subnational planning processes.

**Key Message 3: Addressing knowledge gaps requires strengthening monitoring systems, data integration, and interdisciplinary research. *(Well established)***

Significant gaps remain in temporal and spatial data, understanding of drivers and pressures, and valuation of ecosystem services, particularly for underrepresented ecosystems such as mudflats, sandy beaches, and offshore habitats.

**Recommendation:** Enhance national monitoring systems through coordinated data-sharing platforms, expanded coverage of ecosystems, and the use of innovative approaches such as remote sensing, citizen science, and ecosystem accounting.

**Key Message 4: Recognising and integrating ILK is critical for inclusive and effective ecosystem management. *(Well established)***

ILK provides valuable insights into ecological change, resource use, and sustainable practices, yet has been underrepresented in formal assessments.

**Recommendation:**

Develop participatory mechanisms to incorporate ILK into monitoring, assessment, and decision-making processes, while respecting the cultural, social, and institutional context of Thailand.

**Key Message 5: Transitioning towards a sustainable and inclusive Blue Economy requires aligning economic development with ecosystem integrity. *(Established but incomplete)***

Current development pathways place increasing pressure on marine ecosystems, threatening their ability to sustain long-term economic and social benefits.

**Recommendation:**

Promote a sustainability-oriented Blue Economy that integrates ecosystem service values into planning and investment decisions, encourages private sector engagement, and supports nature-positive pathways.

**Key Message 6: Future planning must consider uncertainty, trade-offs, and long-term scenarios to enhance resilience. *(Well established)***

Marine ecosystems are subject to multiple interacting pressures, including climate change, requiring forward-looking and adaptive approaches.

**Recommendation:**

Utilise scenario analysis and integrated planning tools—such as MSP and climate adaptation strategies—to guide decision-making under uncertainty and support resilient development pathways.

**Key Message 7: The NEA provides a critical opportunity to strengthen Thailand's contribution to global biodiversity and sustainability agendas. *(Well established)***

By aligning with the KMGBF, SDGs, and climate commitments, the NEA can serve as a key evidence base for national and international reporting.

**Recommendation:**

Ensure that NEA outputs—particularly the Summary for Policymakers—are actively used to inform NBSAP implementation, national reporting, and cross-sectoral policy coherence..

# 2 | Status and Trends of Marine Biodiversity and Ecosystem Services



## 2.1 Introduction

Here, we present the status and trends of Marine BES that underpin nature's benefits to people. Existing knowledge was systematically compiled, reviewed, and analysed to reflect both historical and current conditions of Marine BES, as well as their observed trends. Key gaps in knowledge and capacity-building needs for understanding and assessing nature's benefits to people were also identified. An integrated ecological assessment framework for marine biodiversity and ecosystem services is recommended, including standardised classifications and indicators of Marine BES, to strengthen resilient social-ecological systems and support the implementation of NbS. This chapter aims to address the following policy questions:

- **What are the status and trends of Marine BES, and how are they linked to ecosystem services and human well-being?**
- **What are the knowledge and management gaps, and how can these gaps be addressed to better understand nature's benefits to people, enhance resilient social-ecological systems, and enable NbS?**
- **How can Thailand improve its monitoring and assessment systems to address knowledge gaps in Marine BES?**

## 2.2 Status and trends of Marine BES

The aim of this section is to respond to the first question on the status and trends of Marine BES, describing the past and current status of three main ecosystems namely mangrove forests, coral reefs and seagrass beds. The last sub-section addresses other ecosystems. Information used in this assessment report was extracted from different sources including publications from relevant government agencies such as the ONEP and DMCR, and international and national research database studies. Based on the available information, the assessment covers a period of around 30 years depending on the availability of information. This section ends with an overview on the status of marine threatened species.

Overall, Thailand's marine biodiversity is among the richest in Southeast Asia, supported by a 3,148 km coastline along the GoT and the Andaman Sea and a marine area of approximately 320,000 km². The country encompasses a wide range of coastal and offshore ecosystems that sustain diverse marine life. These include at least 45 marine reptiles, such as sea turtles and sea snakes; more than 67 species of marine mammals, including whales, dolphins, dugongs, and mammals inhabiting mangroves; and around 280 species of marine birds. Reef-associated fish comprise between 241 and 983 species, while marine arthropods exceed 2,295 species across multiple classes. Marine molluscs are particularly diverse, with more than 3,222 species, dominated by gastropods, bivalves, and cephalopods. Coral diversity includes 320 species of scleractinian corals and 51 species of other coral groups. In addition, there are more than 375 echinoderm species, over 100 sponge species, more than 365 polychaete species, and over 150 marine fungi species. Marine flora includes at least 13 seagrass species, 96 mangrove species, and 330 species of marine algae.

## 2.2.1 Mangrove forests

Based on the latest satellite image analysis conducted in 2020, pristine mangrove forests cover about 2,780 km² along Thailand's coastline (DMCR, 2025). About 2,317 km² of this area is administered by DMCR, while the rest (463 km²) is in national parks and non-hunting areas, which are managed by the DNP. Phang Nga in the Andaman Sea has the largest pristine mangrove forests (461.5 km²), accounting for 17% of the total mangrove forests, followed by Satun (383.3 km²) (DMCR, 2025). There are 96 identified species of mangrove plants; including 41 true-mangrove forest species belonging to 22 genera in 14 families. Dominant species include those in the family Rhizophoraceae (*Rhizophora* spp., *Ceriops* spp., and *Bruguiera* spp.), family Sonneratiaceae (*Sonneratia* spp.) and family Avicenniaceae (*Avicennia* spp.) (DMCR, 2022). Phang-Nga had the highest species richness of mangrove plants (28 species), followed by Krabi (25 species), Ranong (23 species), Satun (22 species), Trang (21 species), Surat Thani (19 species) (DMCR, 2022; 2023). *Sonneratia griffithii Kurz* and *Heritiera fomes Buch.-Ham* have been assessed as Critically Endangered (CR) and Endangered (EN) plant species and at least four species of mangrove plants are Near Threatened (NT), according to IUCN Red List (IUCN, 2024).

Mangrove forests are home to various terrestrial and marine species. At least 66 species in 36 families of benthic organisms are found in mangrove forests. Several species of mangrove crabs are economically important in many areas. For example, local people in Trat Province catch mangrove crabs (*Family Sesarmidae*) for household consumption and/or to sell them to the markets, as this species is an important ingredient for cooking papaya salad which is a popular Thai dish. Local people perceive crab populations as an indicator of mangrove ecosystem health (Box 21). Mangrove forests are also important habitats for both resident and migratory birds. As many as 96 species of birds in 40 families inhabit mangrove forests. Some of them are Endangered and Near Threatened, according to IUCN, for instance, *Tringa guttifer, Limosa lapponica, Pelargopsis amauroptera and Anthreptes rhodolaemus* (IUCN, 2024).

Mangrove forests also play crucial roles in carbon sequestration and storage, making them significant for climate mitigation. Carbon stock assessments in mangrove forests of 18 coastal provinces were conducted by the DMCR from 2020 to 2024. Overall, the mean total carbon storage (above and below ground carbon storage) in mangrove forests was 9,472.30 tC/km². The highest estimated total carbon storage of mangrove forests was found in Krabi (15,356.88 tC/km²), followed by Phatthalung (15,181.25 tC/km²) and Nakhon Si Thammarat (14,612.50 tC/km²) (DMCR, 2021-2025).

## Box 2-1: Decline in mangrove crabs due to monoculture mangrove plantation

Mangrove crabs, particularly those belonging to the family Sesarmidae (suborder *Brachyura*), are commonly found in mangrove forests and play a crucial role in the biogeochemical processes and ecological dynamics of mangrove ecosystems (Gao& Lee, 2022). Various species of mangrove crabs occur in Thailand, including *Parasesarma eumolpe*, *Episesarma mederi*, *Episesarma versicolor*, *Metaplax dentipes*, and *Metaplax elegans* (Aiemsomboon et al., 2023). These crabs are predominantly associated with healthy mangrove habitats, which provide essential areas for breeding, foraging, and shelter. Mangrove crabs also serve as bioindicators of mangrove ecosystem health, as their abundance reflects stable, nutrient-rich environmental conditions required for successful reproduction and growth (Karniati et al., 2021).

Declines in mangrove crab populations are generally driven by overharvesting, mangrove degradation, and pollution. In many areas, intensive harvesting has resulted in population declines because mangrove crabs are a popular food source in many parts of the world, particularly in Asia, including Thailand. They are used in a variety of dishes and are also preserved as salted crabs for sale to restaurants nationwide. Although local regulations have been established to promote the sustainability of mangrove crab populations, enforcement remains challenging, especially due to extensive harvesting by fishers from outside local communities.

Mangrove vegetation composition can strongly influence crab populations through habitat modification. For example, dense mangrove root systems provide critical nursery habitats for juvenile crabs while facilitating bioturbation that enhances sediment aeration and nutrient cycling. Conversely, changes in mangrove composition—such as species loss or structural simplification caused by physical disturbances—can alter crab assemblages. Localised increases in crab abundance have been observed in areas with reduced physical complexity, which may negatively affect mangrove seedling recruitment (Skilleter&Warren, 2000). In Trat, local communities have reported that monoculture mangrove plantations have contributed to declines in mangrove crab populations due to changes in overall ecosystem structure. This highlights the potential negative consequences of inappropriate or poorly designed mangrove restoration efforts.



(Source: Marine Biodiversity Research Group, Ramkhamhaeng University)

Since 1961, approximately 3,679 km² of mangrove forests have been heavily encroached upon and converted for various purposes, such as shrimp farming, salt ponds, agriculture, residential areas, and coastal infrastructure, leaving 1,675.82 km² remaining by 1996 (Figure 2.1) (DMCR, 2025). Since then, the area of mangrove forests has increased to 2,779.23 km² in 2020. The increase in mangrove forests could be mainly attributed to interpretation methodology and the resolution of satellite images used, particularly when compared to the data from 2020, which used a 1:10,000 resolution map, whereas a 1:50,000 resolution map was applied in previous years. The establishment of conservation and protected areas as well as reforestation could also increase the mangrove area reported in 2020.

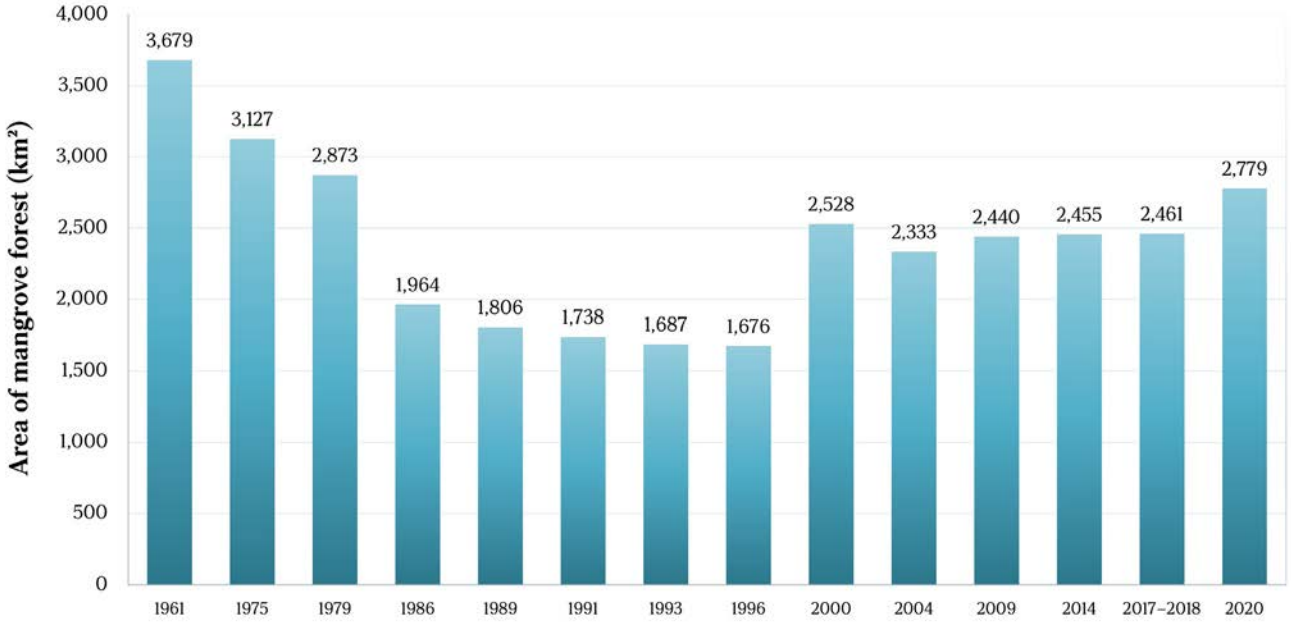



**Figure 2.1: Changes in areas of mangrove forests during 1961–2020 (Source: DMCR, 2024)**

Conservation measures have been taken to protect existing forests and to claim mangrove areas illegally encroached by people for shrimp farming and land conversion. Also, collaboration with local communities has been enhanced to conserve and monitor mangrove forests. Mangrove forest restoration has been conducted for different purposes, particularly habitat restoration and climate mitigation purposes (e.g., carbon stocks) (Janmaimool, 2016). Based on the trends from 1996–2020 along with current policies of DMCR's mangrove management and conservation, it is likely that the positive trends of increasing mangrove forest area will be observed in the future.

## 2.2.2 Coral reefs

A total coral reef area of about 238.7 km² is found across 17 coastal provinces in the GoT and the Andaman Sea. Surat Thani has the largest area of coral reefs (57.6 km², particularly Koh[1] Samui, Koh Pha Ngan, Koh Kraten, and Mu Koh Ang Thong), followed by Phang Nga (42.7 km²), and Trat (28.4 km²) (DMCR, 2024). Over 280 coral species (71 genera in 18 families) are found in Thai waters. *Porites* spp. and *Acropora* spp. are the dominant coral species.

[1] "Koh" is a Thai word meaning "island". When used as a prefix before a place name, for example Koh Pha Ngan, it means "Pha Ngan Island". Similarly, Koh Tao literally means "Tao Island".

The mean genus richness of corals in Thai waters ranged from 0.86-2.97. The coral reefs in Trang and Ranong had the highest mean genus richness, accounting for 2.59 and 2.47 respectively (DMCR, 2022). The surveys in 2024 revealed that the majority of the coral reefs are categorised as in healthy condition (51%) and in fair condition (29%), while 24% of them were in a damaged condition. The average live coral coverage was 48.51±18.80% (DMCR, 2025).

Coral reefs are the most biologically diverse marine ecosystem, providing critical habitats for diverse marine life. As many as 241 species and 983 species of reef fish were reported in the GoT and the Andaman Sea, respectively (Sataphumin, 2000; 2011). Based on the 2023 DMCR surveys, about 80% of reef fish were in the four main families: Pomacentridae, Gobiidae, Caesionidae, and Carangidae. Koh Dok Mai, Phang Nga, has the highest species richness (95 species). The highest average species richness was found in Phang Nga (56 species), followed by Phuket (53 ecologically important species), and Pattani (45 species). Overall, the species diversity index of reef fish ranged from 1.35 to 2.5 (DMCR, 2024). At least 173 species of reef-associated macrobenthic organisms are reported. Most of them (80%) are in 11 taxa including classes Gastropoda, Bivalvia, Echinoidea, Malacostraca, Holothuroidea, Demospongiae, Asteroidea, Anthozoa, Crinoidea, Polychaeta, and Anthozoa. The highest species richness of benthos is found at Koh Lon, Phuket (39 species). The species diversity index ranged from 0.48 to 1.8 (DMCR, 2024). Furthermore, other threatened marine species such as sea turtles and whale sharks, are also found in many areas attracting divers and tourists.

In Thai waters, there are still important ecosystems that have not yet been protected and managed, particularly underwater pinnacles, with some 200 estimated locations (Yeemin et al., 2021). Coral communities are usually found on underwater pinnacles with high biodiversity of macrobenthos and nekton, making them important dive sites and fishing grounds. Underwater pinnacles are also refugia against climate change; coral communities on underwater pinnacles tend to have fewer impacts of coral bleaching, compared to those located inshore. Based on recent surveys, about 60% of the observed underwater pinnacles are located outside MPAs and have not yet been properly managed (Yeemin et al., 2021). Examples of known underwater pinnacles include Hin Rab, Hin Bang Bao, Hin Luk Bat, and Hin Ao Chak in Trat and are marine biodiversity hotspots for corals, reef fish, and benthic communities as well as iconic species such as sea turtles and whale shark, that attract tourists and divers to visit.

Coral communities found in these underwater pinnacles are healthy with relatively high percentages of live coral cover compared to other underwater pinnacles in Trat, ranging from 58.75-65.65 %. The highest richness of corals is found at Hin Luk Bat. Coral communities at Hin Rab and Hin Bang Bao are mostly covered by stony corals (Porites lutea), while disc coral (Turbinaria mesenterina) is a dominant coral in Hin Luk Bat and Hin Ao Cha. Benthic species at the underwater pinnacles are highly diverse, dominated by several species such as Christmas tree worm (Spirobranchus giganteus), sponges (Neopetrosia spp.), sea whips (Junceella spp.), soft corals (Sarcophyton spp.), and sea anemones (Heteractis magnifica), with the average density ranges from 3.93–5.69 ind./$m^2$. As diverse as 27–50 species of reef fish in at least 10 families are found at the four underwater pinnacles, with an average density range of 1,016.67–4,310.28 ind./100 $m^2$. Hin Ao Chak has the highest species richness and abundance. Regal demoiselle *(Neopomacentrus cyanomos)* is found as a dominant fish at Hin Rab and Hin Luk Bat with an average density ranging from 1,592.01–1,849.88 ind./100 m2. However, the reef fish community at Hin Bang Bao and Hin Ao Chak, is dominated by silver demoiselle *(Neopomacentrus anabatoides)* with an average density range of 542.68–1,017.75 ind./100 $m^2$. Besides, there are many more species of reef fishes that have beautiful patterns and colors. These underwater pinnacles are also significant habitats for

several marine threatened species such as whale shark *(Rhincodon typus)*, sea turtle (mostly green turtle *(Chelonia mydas)*), Irrawaddy dolphin *(Orcaella brevirostris)*, and dugong *(Dugong dugon)*. Whale sharks can be regularly found near the underwater pinnacles. Dolphins and dugongs are frequently found along the mainland coasts but sometimes they can be found near Koh Kood, Hin Bang Bao and Hin Ao Chak. Sea turtles can also be found in these areas. These threaten marine species are considered iconic species that attract tourists and divers, supporting marine tourism sectors (Yeemin et al., 2021).

In terms of climate mitigation, in the interconnected seagrass, coral reefs, and sandy coastline ecosystems play significant roles in carbon sequestration and storage. The carbon stocks in seagrass, algal biomass, and sediment at Ao Phangka, Ao Thong Tanod of Koh Samui, Koh Tan, and Koh Mudsum, the Western GoT, were estimated, ranging from 1.58–19.10 tC/ha, 2.51–10.45 tC/ha, and 0.93–58.46 tC/ha, respectively (Yeemin et al., 2024).

Changes in coral reef area are difficult to assess due to the lack of long-term data. A total coral reef area of 238.32 km² was reported up to 2017; this figure was later revised to 238.69 km² following the discovery of additional coral communities on underwater pinnacles, and this estimate has been used to date. The long-term information on coral reef status[2] has been annually reported by the DMCR and suggests a positive trend from 2017-2023 (Figure 2.2). After the 2010 mass coral bleaching, the coral reefs gradually recovered. The proportion of healthy coral reefs increased from 6-12% during 2011 to 2017 to more than 50% during 2022 to 2024. The recovery was due to natural recovery and government measures such as temporary closure of dive sites, prohibition of wastewater discharge from boats and land-based activities. (DMCR, 2025; Yeemin et al., 2012). Due to the positive trend of coral status reported by DMCR, it is envisaged that without catastrophic event like seawater temperature rise, the overall coral status in Thailand should continue to improve in the future.

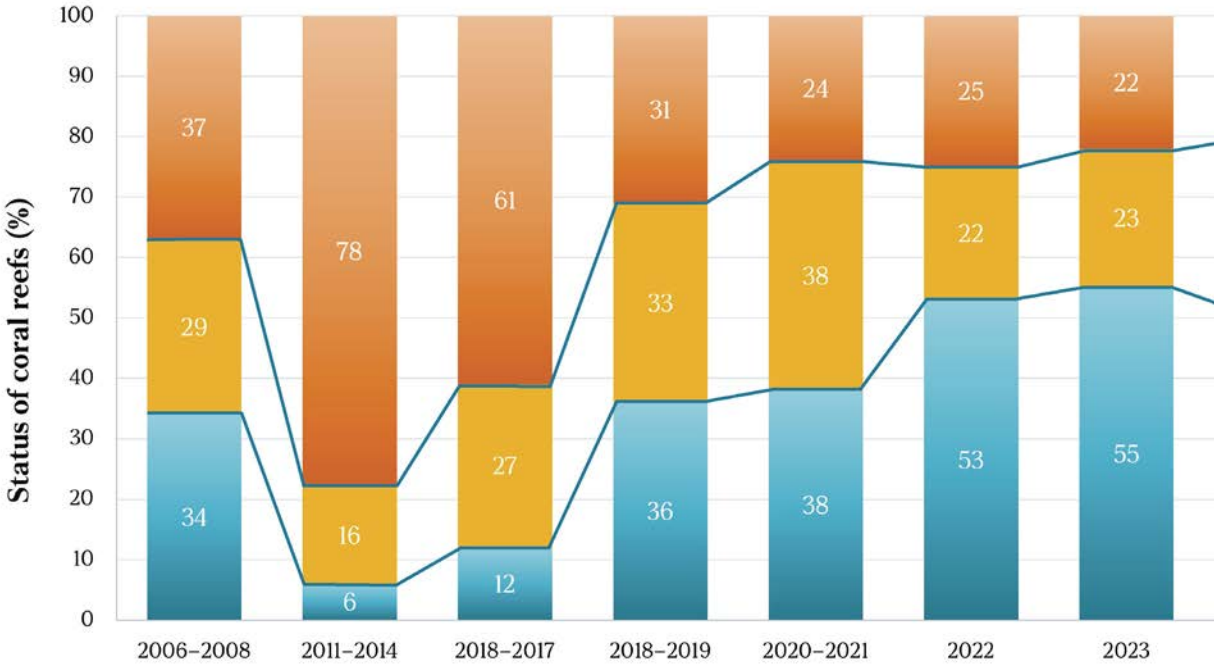



**Figure 2.2: Changes in the status of coral reefs during 2006–2024 (Source: DMCR, 2025)**

[2] According to DMCR, the status of coral reefs are assessed based on the proportion of live and dead corals. A live-to-dead coral ratio of >2:1 indicates a healthy reef condition; 1:1 indicates moderate; and 1:>2 indicate degraded.

Coral reefs in some areas are still facing local pressures, mainly caused by activities such as tourism, pollution (water pollution and marine debris), turbidity from speedboats, coastal development, coastal dredging, and mooring/anchoring. Some coral reefs are infected with diseases, which may be linked to land-based pollution. Coral bleaching events are mostly found in the hot season when the corals are exposed to elevated seawater temperatures. Bleaching can cause 100% coral mortality of some reefs, resulting in reef degradation. Promoting nature recovery alongside reducing local stressors and pressures is crucial in the era of climate change.

### 2.2.3 Seagrass beds

Seagrass beds are key habitats for various marine species, particularly dugongs, providing various ecosystem functions and services. According to DMCR's report, a total of 257 km² of potential areas[3] for seagrass beds were found in Thai waters, of which, about 71% was observed in the Andaman Sea (DMCR, 2024). Trang has the largest potential areas for seagrass beds of 55.8 km², followed by Krabi (54.7 km²), and Phang Nga (42.6 km²). The largest seagrass bed is at Koh Libong, Trang (43.9 km²), followed by Krabi (32.8 km²), and Phang Nga (28.6 km²). The condition of most seagrass beds (52%) was poor, followed by fair (31%) and in healthy condition (17%) (DMCR, 2025). The distribution of seagrasses is highly dynamic as the area and species composition of seagrass beds varies spatially and temporally due to environmental factors that control the structure and function of seagrass ecosystems, particularly substrate characteristics, waves, storms and water quality. There are 13 species of seagrasses in Thai waters: *Cymodocea rotundata, C. serrulata, Enhalus acoroides, Halophila beccarii, H. decipiens, H. major, H. minor, H. ovalis, Halodule pinifolia, H. uninervis, Ruppia maritima, Syringodium isoetifolium*, and *Thalassia hemprichii*.

As many as 127 species of fish are reported in the GoT and the Andaman Sea. About 75% of reef fish are in 12 main families: Siganidae, Leiognathidae, Gerreidae, Terapontidae, Lethrinidae, Ambassidae, Gobiidae, Lutjanidae, Atherinidae, Labridae, Monacanthidae, and Syngnathidae (DMCR 2024). Overall, the diversity index of fish ranged from 1.1-3.0—Phuket had the highest diversity index (3.0), followed by Phang Nga (2.9) and Chumphon (2.7) (DMCR, 2024). Furthermore, many juveniles of marine organisms are generally found in seagrass beds, reflecting the importance of seagrass beds as nursery grounds for various marine organisms (DMCR, 2021).

The role of seagrass beds in carbon capture and storage is large and important for climate mitigation. Some 134.20 tC/km² is stored in seagrass beds in Thailand; of which, about 97% is found in sediment (Stankovic et al., 2021). Seagrass beds are highly dynamic with high spatial and temporal variation. According to DMCR, the potential area for seagrass beds is 257 km². There has been a declining trend of healthy-good seagrass beds over time, reducing from 53% in 2012–2013 to 39% in 2016–2017, and to 17% in 2024 (Figure 2.3). Based on this time series, the decline in healthy seagrass beds will continue to occur in the future. Deterioration of seagrass beds is due to monsoons and storms which affect seagrass structure, deposition of sediments, and water quality (high turbidity). Several activities such as canal dredging, coastal development, port construction, and discharge of untreated wastewater from communities, aquaculture, and industries also degrade seagrass quality (DMCR, 2024).

[3] Potential areas for seagrass beds are defined as an area suitable for seagrass growth with either the present existence of seagrasses or the seagrasses in such area have been found in two survey cycles (within 8 years).

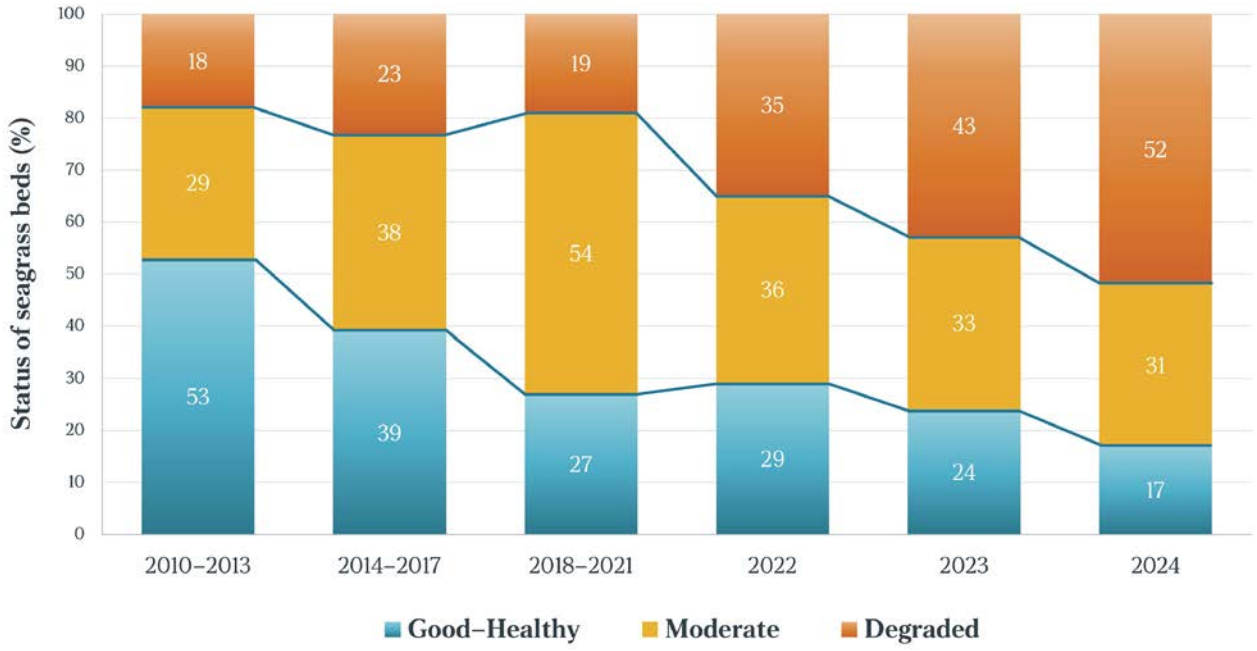



**Figure 2.3: Changes in the status of seagrass beds during 2012–2023 (Source: DMCR, 2024)**

## Box 22: Mass die-off of seagrass beds in Thailand

The largest seagrass bed is found in Trang with an approximate area of 55 km², providing various functions and ecosystem services, particularly crucial habitat for dugongs (DMCR, 2023). Since 2020, Thailand's Andaman Sea has experienced a widespread die-off of seagrass, especially in Trang and Krabi (at least 16 km²), resulting in starvation and migration of dugongs. Scientists link this decline to unusually low tides, elevated sea temperatures, and increased sedimentation, factors likely influenced by climate change and natural climate phenomena such as El Niño. Some studies identify that the cause of mass die-off of seagrass beds could be due to infectious diseases. The seagrass Enhalus acoroides is found to be infected by pathogenic protist Labyrinthula sp. (Wimanhaemin et al., 2025). However, the final conclusions of the mass die-off event have not yet made as studies and investigations are in progress.

The mass die-off of seagrass beds has led to several impacts, particularly dugong starvation. The widespread loss of seagrass, which serves as the main food source for dugongs, has caused a sharp decrease in their population and making them relocate to alternative feeding areas. The decline in seagrass also disrupts habitats for other marine organisms, including numerous fish species that depend on seagrass meadows as breeding and nursery grounds.

While initiatives to restore seagrass meadows and safeguard dugongs are underway, serious concerns persist regarding the long-term survival of these species and the overall health of the marine ecosystem.



(Source: Thai PBS and DMCR)

## 2.2.4 Other ecosystems

***a) Beach ecosystems (muddy, sandy, and rocky shores)***

Beach ecosystems in Thailand can be categorised into three main types: muddy, sandy, and rocky, with lengths of 1,020.62 km, 1,630.75 km, and 326.1 km, respectively (DMCR, 2025a). Muddy beaches are typically found near estuaries and mangrove areas where sediment accumulates, such as parts of the upper GoT. One of the largest tidal mudflats in Thailand is Don Hoi Lot, which is formed by sediment deposits from the Mae Klong River, located in Samut Songkhram, in the north-western part of the GoT. The mudflats are recognised as a Ramsar wetland site because of their ecological significance, serving as critical habitats for various species of marine life, shellfish particularly razor clams (*Solen regularis*) and migratory birds (Ramsar Sites Information Service, 2008).

Rocky beaches are found along the Thailand's coast with naturally hard substrates like rocky cliffs, platforms, rock pools and boulder/gravel fields. Various organisms are adapted to this habitat, particularly sessile species such as oysters, mussels, chitons, seaweeds, sponges, and sea anemones.

Sandy beaches provide many ecosystem services, including sediment storage and transport; wave dissipation and associated buffering against extreme weather events; dynamic response to sea level rise; breakdown of organic materials and pollutants; water filtration; nutrient mineralisation and recycling; storage of water in dune aquifers and groundwater discharge through beaches; maintenance of biodiversity and genetic resources; providing a nursery area for juvenile fishes; nesting sites or rookeries for turtles, shorebirds, and pinnipeds; prey for birds and other terrestrial wildlife; scenic vistas and recreational opportunities; and functional links between terrestrial and marine environments (Defeo et al., 2009). According to the DMCR database, 739 locations of sandy beaches are recorded (DMCR, 2025b); most of which are tourism sites. Some of them have unique environments and provide habitats for various marine species. For instance, Hat Pakmeng in Trang is important habitat for wedge clams (*Donax scortum*), which have a high economic value. Beach forests are usually found in the beach ecosystem, providing various contributions such as natural habitats, shoreline protection, carbon sequestration and storage. Beach forests are dominated by *Casuarina equisetifolia*, *Terminalia catappa*, *Calophyllum inophyllum*, *Hibiscus tiliaceus*, *Thespesia asiatica*, *Barringtonia asiatica* and *pandanus odorifer* and cover approximately 75.4 km² and are found in 18 coastal provinces in Thailand. Phang Nga has the largest area of beach forests (37.6 km²), followed by Krabi (7.1 km²) and Trang (5.9 km²) (DMCR, 2024). Coastal sand dunes, an important biodiversity hotspot, are also found at some beaches, for example, Nern Sai Ngam in Chumphon and Hat Taimuang, in Phang Nga (DMCR, 2024).

About 10% of Thailand's coastlines is rocky, providing a unique and rich ecological environment, characterised by significant biodiversity and complex intertidal habitats. Various sessile species such as the acorn barnacle (*Chthamalus malayensis*) and the rock oyster (*Saccostrea cuccullata*) are found on rocky shores, greatly contributing to the biomass and structural complexity of these shores, and acting as ecosystem engineers that maintain habitat diversity (Wangkulangkul et al., 2023).

It is difficult to observe change in beach areas as there is no continuously long-term monitoring data of change in the areas of the beaches in Thailand. The changes in the beach ecosystem are mainly influenced by coastal development, urbanisation, construction activities along the coasts, causing coastal erosion problems. Although, the area of beach forests increased from 37.8 km² in 2014 to 75.5 km² in 2020, this could be due to the interpretation and analysis of satellite images. Beach forests

in some areas have deteriorated due to coastal development, land encroachment for residential areas, and shrimp aquaculture as well as hard structures for coastal protection (DMCR, 2024).

***b) Coastal lagoon ecosystems***

A coastal lagoon is a shallow body of water along the coast, that is separated from the ocean but connected to it by one or more inlets. There are numerous coastal lagoons along the coast of Thailand. Examples of coastal lagoons in Thailand, such as Songkhla Lake in southern Thailand and Ao Kung Kraben in the Eastern GoT, are highlighted due to the availability of scientific information.

Songkhla Lake, a coastal lagoon in southern Thailand, is a natural brackish water lagoon with a complex cultural and ecological system. Although labelled a lake, it defies conventional definitions due to its geomorphological character. Situated on the Malay peninsula in the South of Thailand, this coastal lagoon is known for its distinctive physical appearance that consists of three connecting water bodies stretching from North to South, covering an area of 1,040 km² (DMCR, 2022). Thale Noi, a freshwater body, is in the northernmost part of Songkhla Lake, with an approximate area of 28 km² and being recognised as a Ramsar site. Thale Luang (Upper Lake) and Thale Sap (Middle Lake) cover the middle parts of the lagoon system with a total area of 818 km², where freshwater is seasonally mixed with seawater. The lagoon located southern-most is Thalesap Songkhla, connecting to the sea with its coverage of 182 km². Most of the area is dominated by saltwater, with brackish water present during rainy season. Songkhla Lake hosts diverse ecosystems, supporting rich biodiversity across freshwater, brackish, and marine habitats. Seagrass beds in the lower part of Songkhla Lake cover an area of 0.5 km². Only one species, *Halophila beccarii*, was found, with a low coverage of 10%. According to the DMCR surveys conducted in 2023, 10-14 Irrawaddy dolphins were found in Thale Luang; however, they are threatened by entanglement in fishing nets, pollution and construction activities in coastal and marine environments (DMCR, 2025). Songkhla Lake is a critical habitat for numerous species of aquatic life such as fish, crustaceans, and benthic organisms. At least 453 species of fish have been reported, consisting of 12 and 441 species of cartilaginous fish and bony fish, respectively (DOF, 2021). Furthermore, the presence of various fish species, particularly brackish and marine fishes such as barramundi *(Lates calcarifer)*, spotted scat *(Scatophagus argus)*, and brown-backed mullet *(Liza subviridis)*, spotted catfish *(Arius maculatus)*, underscores the lake's role as a significant fishery resource (Phaeviset et al., 2021). At least 27 families of juvenile fish were found with an average abundance of 5,608 ind./1000 m³ (DMCR, 2024).

Kung Krabaen Lagoon is a semi-enclosed coastal lagoon situated in the Eastern GoT, having an approximate area of 6.4 km². The lagoon has a maximum length of 3.5 km, oriented northwest to southeast, and a width of 2.3 km. The lagoon is shallow, with average depth of around 0.8 m, while the inlet of the lagoon is around 5 m deep. It has a wet area of approximately 6.7 km² during high tide. The lagoon is influenced by strong tidal currents and seasonal wind-driven circulation, with a significant connection to the sea (Pokavanich and Phattananuruch, 2022). The total area of mangrove forests is 5.1 km², consisting of key mangrove plants such as *Avicennia* sp., *Sonneratia* sp., *Rhizophora* spp., *Ceriops* sp. and *Lumnitzera* sp. (Jintana et al., 1995). The potential extent of seagrass beds is 4.25 km², with three species of seagrass in the lagoon, *Enhalus acoroides*, *Halodule pinifolia* , and *Halodule uninervis* . Surveys conducted by DMCR in 2021 reveal that the seagrass beds are in good condition with the coverage of 51-75% (DMCR, 2021). This lagoon serves as a habitat for various terrestrial and marine species. At least 17 species of marine crabs are found, particularly the blue swimming crab (*Portunus pelagicus*) and mud crabs (*Scylla* spp.) both economic species (Kunsook&Dumrongrojwatthana, 2017). The abundance of mud crab is higher in natural mangrove forest than in reforested mangrove forest (Kunsook et al., 2022). Twenty-nine species of shellfish in 17 families were found in mangrove forests and seagrass beds

(Kunsook et al., 2023). Tantichaiwanit et al. (2010) found that 40 groups of zooplankton from 15 phyla are playing important roles in supporting fishery resources, including economically important groups such as shrimp and crab larvae, which are essential for the growth and sustainability of at least 38 species of other fish. Moreover, seagrass beds in Kung Krabaen Lagoon harbour diverse species of benthos belonging to 27 families of polychaetes and 10 species of gastropods that were predominantly distributed in the seagrass beds (Satumanatpan et al., 2011), playing important roles in supporting ecological processes. The lagoon is an important blue carbon ecosystem. Two major species of seagrasses in the lagoon, *Enhalus acoroides* and *Halodule pinifolia* with a total areal coverage of 3.35 km² can store 330 tons of organic carbon (Kanmarangkool et al., 2022). The DMCR reported that mangrove forests in Chantaburi have the potential to store 8,637.5 t/km² (DMCR, 2021); thus, the estimated carbon storage in mangroves in Kung Krabaen Lagoon reached 44,051.25 tons of organic carbon.

Coastal lagoons in Thailand, such as Songkhla Lake, Kung Kraben Bay, and others along the coastline, face numerous pressures that threaten their ecological integrity and the services they provide. pollution, from agricultural runoff, aquaculture and urbanisation, seem to be the most significant pressures on the coastal lagoon ecosystem in Thailand. The expansion of rice paddy fields and shrimp farming has led to increased use of fertilisers and pesticides, which subsequently run off into the lagoons. Urbanisation generates solid waste and wastewater discharging into the lagoon. This influx of nutrients contributes to eutrophication, resulting in harmful algal blooms that deplete oxygen levels and disrupt aquatic ecosystems (Davidson et al., 2014). Sedimentation is another significant pressure, caused by land-use changes, deforestation in the watershed as well as coastal development and canal dredging. Fisheries are vital for local livelihoods, but overfishing has led to the depletion of fish stocks. Unsustainable fishing practices, such as the use of destructive fishing gear, cause habitat degradation, subsequently result in declining populations of key species, which can trigger trophic cascades within the ecosystem (Phaeviset et al., 2021). Climate change is also a threat that exacerbates various pressures on the lagoon such as sea level rise, rising temperatures, altered precipitation patterns, and increased frequency of extreme weather events can impact water levels, salinity, and the overall health of aquatic ecosystems (Wong et al., 2014; De Siqueira, 2011). As the population residing along the shorelines of the lagoon continues to rise, such impacts tend to increase if there are no mitigation measures taken.

***c) Offshore ecosystems***

Thai waters in the GoT and the Andaman Sea are nutrient-rich with high biological productivity, supporting fisheries resources (Jaroensuk et al., 2022; Nielsen et al., 2004). The surveys on fisheries resources conducted by the Southeast Asian Fisheries Development Center (SEAFDEC) and the DOF in the GoT showed that catch per unit effort (CPUE) was 43.29 kg/hr. The ratio of economic fish and trash fish in Thai and Cambodian waters were 51.55:48.45 and 78.79:21.21, respectively. In Thai waters, the composition of trash fish in the Eastern GoT, the Inner GoT, the Western GoT, the Lower GoT and the Central GoT accounted for 18.70%, 20.88%, 31.69%, 57.84% and 61.20% of the total catch respectively. As many as 299 aquatic species were found, consisting of 190 economic species and 109 low-market-value fish species. The analysis of species composition for economic fish revealed that demersal fish, pelagic fish, and cephalopod were the main composition (Kongpornprattana et al., 2020). Shelf break front is located between 9.68°N, 97.36°E and 6.08°N and 98.07°E, off the coast of Thailand at a depth of 100 to 200 m and covers 13,176 km² (Figure 2.4). This area has a unique hydrodynamic process generated by internal waves, playing an important role in transporting water that is rich in inorganic nutrients into the area. This process creates an area of elevated phytoplankton production related to fish larvae abundance due to the intrusion of deep water over the shelf. At the shelf front and its surrounding areas, phytoplankton biomass and production are three times greater than in shelf flat water, and fish larvae abundance is two

times greater (Nielsen et al., 2004; Janekarn et al., 2005). The high biological productivity of the shelf break front provides substantial spawning and feeding grounds, supporting, in particular, a potential fishing ground (Janekarn et al., 2005).

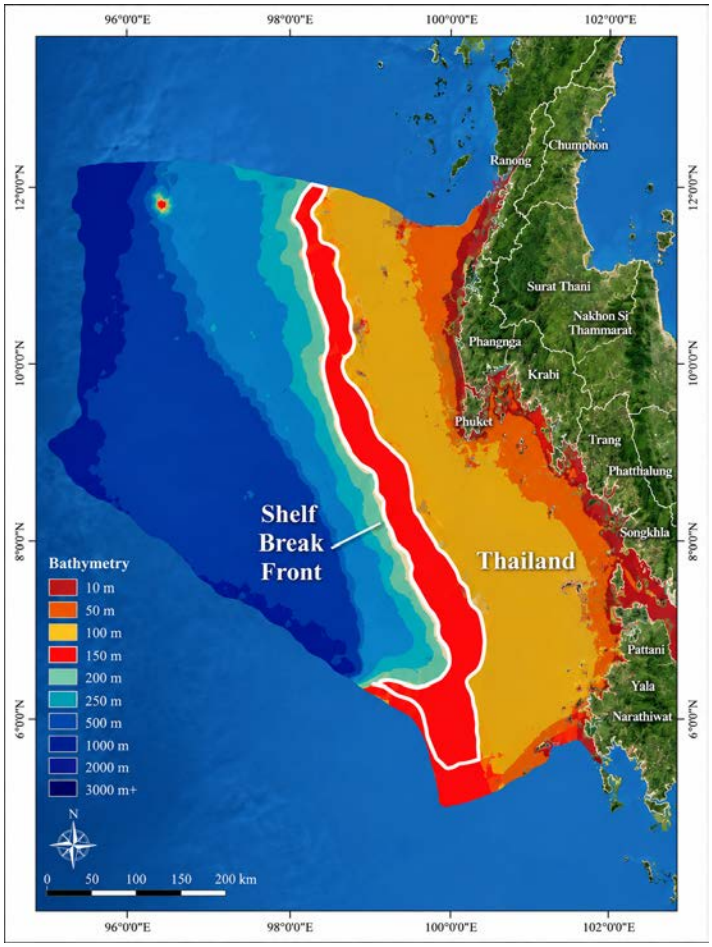



**Figure 2.4: Shelf break front in the Andaman Sea (Source: https://chm.cbd.int/database/)**

The Thai-Danish Deep Sea Research programme, which was carried out from 1996 to 2000, provides great information regarding the hydrography and biodiversity in this area (Bussarawit et al., 2005). The concentration of chlorophyll-a varied 10-40 mg/cm2, tending to be higher near the front and the overall primary productivity was highly observed ranging from 500–1500 mgC/$m^2$/day. The secondary productivity was relatively high in the shelf break front with more than 100 species of zooplankton, dominated by copepods. The copepod biomass ranged from 80–300 mgC/$m^2$. More than 109 families of fish larvae were found, and the diversity index values were relatively high at the stations near the shelf break front. Moreover, the shelf break front is also an important habitat for seabirds, whales and dolphins (Munk et al., 2015). Tuna fisheries (Skipjack tuna, *Katsuwonus pelamis*; Bigeye tuna, *Thunnus obesus*) are generally found in this area. The study of catches of long-line fisheries in the Andaman Sea during 2006–2010 revealed that as many as 36 species of fish were found, including tunas, billfishes, sharks, and other fishes. The average CPUEs for tuna, billfish and sharks in number were 0.50±0.14, 2.15±0.34 and 4.82±0.75 ind./1,000 hooks, and in wet weight were 14.30±4.25, 54.58±9.80 and 199.32±32.92 kg/1,000 hooks, respectively (Darumas& Chumchuen, 2019). The area might be targeted as a new fisheries site in the future; thus, further investigation and management should be conducted and a management plan prepared (Janekarn et al., 2005). The shelf break front is being proposed to be designated as an MPA by the DMCR, covering a total area of 6,750.39 $km^2$ and the DMCR finished preparing baseline information and conducting a public hearing for this proposal. It is now in preparation for

the draft ministerial notification and will be then proposed to the National Committee on Marine and Coastal Resources Management Policy and Planning (NCMCRM) (DMCR, 2025).

Biodiversity at oil rigs in Thailand presents a unique ecological scenario, where these artificial structures serve as novel habitats for various marine species. The presence of oil rigs in marine environments has been shown to enhance local biodiversity, acting as artificial reefs that support diverse marine communities (Macreadie et al., 2011). Various studies indicate that oil platforms can significantly increase local fish populations and species diversity as well as the fish sizes (Harvey et al., 2021; Sibley et al., 2023). For instance, studies have documented that fish assemblages around oil rigs often exhibit higher biomass and diversity than those found in nearby natural reefs (Torquato et al., 2017; Meyer-Gutbrod et al., 2020). The structural complexity of oil rigs creates microhabitats that are conducive to the growth of diverse marine life, thus enhancing local biodiversity (Elden et al., 2019). Harvey et al., (2021) observed the fish assemblage on the platforms and found that the fish assemblage was dominated by regal demoiselle *(Neopomacentrus cyanomos)*, accounting for 75% of all fish observed. Bigeye trevally *(Caranx sexfasciatus)* contributed 76.12% to the total observed fish biomass (3,933 kg). In Thailand, the ecological role of oil rigs is further emphasised by their potential to support economically important fish species. The "rigs-to-reefs" concept, which involves leaving decommissioned oil platforms in place to serve as artificial reefs, has been proposed as a strategy to enhance marine biodiversity and fisheries productivity. This approach has been successfully implemented in other regions, such as the Gulf of Mexico, where decommissioned platforms have been transformed into thriving marine ecosystems (Meyer-Gutbrod et al., 2020; Pradella et al., 2013). The potential for similar outcomes in Thailand could provide significant ecological and economic benefits, particularly for local fishing communities.

A trend cannot be analysed because there is no long-term data on oceanic productivity and biodiversity data at oil rigs.

## 2.2.5 Marine threatened services

According to DMCR, marine threatened species include four groups of marine animals, sea turtles, dugongs, dolphins and whales and cartilaginous fishes (whale shark and manta rays). Five species of sea turtles are found in Thai waters. Some sandy beaches in Thailand are nesting sites for sea turtles, particularly in Koh Kram (Chonburi), Koh Thalu (Prachuap Khiri Khan), Koh Kra (Nakhon Si Thammarat), and Mu Koh Similan (Phang Nga). In the year 2024, a total of 588 turtle nests were found, comprising 225 nests of the green turtle, 346 nests of hawksbill turtles, 16 nests of the leatherback turtle, and a nest of olive ridley sea turtle (DMCR, 2025).

Dugongs *(Dugong dugon)* are associated with seagrass beds and are found, mostly in the Andaman Sea with small groups in the GoT. Altogether there are about thirteen populations of dugongs, and these are found across coastal provinces in Thailand. DMCR (2024) reported that in 2024, the total population of dugongs was 267 individuals, consisting of 36 and 231 individuals in the GoT and the Andaman Sea, respectively. The largest dugong population in Thailand is at Koh Libong and Koh Muk, Trang.

Thai waters are home to 27 species of cetaceans (dolphins, porpoises, and whales), consisting of 9 coastal and 18 offshore species. The quantitative surveys conducted by the DMCR focus on five coastal species, in 2024 and counted 2,833 individuals. Most of them were finless porpoise *(Neophocoeno phocoenoides)* (50.5%), followed by Irrawaddy dolphin *(Orcaella brevirostris)* (25.7 %), Indo-Pacific humpback dolphin *(Sousa chinensis)* (13.4%), Indo-Pacific bottlenose dolphin *(Tursiops aduncus)* (7.7%), and Bryde's whale *(Balaenoptera edeni)* (2.6%). The majority of Bryde's whales are generally found in the Upper and Western GoT with a population size of 64 individuals (DMCR, 2025).

Two species of cartilaginous fishes are classified as endangered species in Thailand, the whale shark *(Rhincodon typus)* and manta rays (*Manta* spp., *Mobula* spp.). The quantification of their occurrence was conducted via field surveys, reports from divers, tourists, and information posted on social media. In 2024, about 73 whale sharks were found in Thai waters: 54 individuals were found in the GoT and 19 were found in the Andaman Sea (DMCR, 2024). Whale sharks are generally found in coastal waters in the GoT and the Andaman Sea, but are mostly seen at Hin Chumphon (Surat Thani), Koh Ngam Noi and Koh Ran ped Ran Kai (Chumphon), Hin Ploeng (Rayong ), HTMS Chang sunken ship (Trat), in the GoT, Hin Pad Mile (Satun), Hin Riserew (Phang Nga), Koh Tachai, Koh Ha, and Hin Bidah Nok (Krabi).

Manta rays are mostly seen in the Andaman Sea compared to the GoT. They were frequently seen at Koh Ta Chai, Hin Muang Dang, Koh Bon in the Andaman Sea, and Koh Tao and Koh Losin in the GoT. In 2021, 2022, and 2023, 18, 10, and 20 manta rays were found, respectively. All of them were in the Andaman Sea, mostly found at Christmas Point, Koh Bon, Phang Nga (DMCR, 2024).

The population size of marine threatened species (sea turtles, dolphins, whales, dugongs, whale sharks and manta rays) varies in space and time (Figure 2.5). An increasing number of green and hawksbill turtles nesting are now being recorded (DMCR, 2024). The trends of leatherback and olive ridley turtle nesting cannot be accurately assessed due to extreme variation in the number of nests found. For dugongs, an increasing trend is found from 2017-2023, with a total of 292 dugongs observed in 2023 (DMCR, 2024).

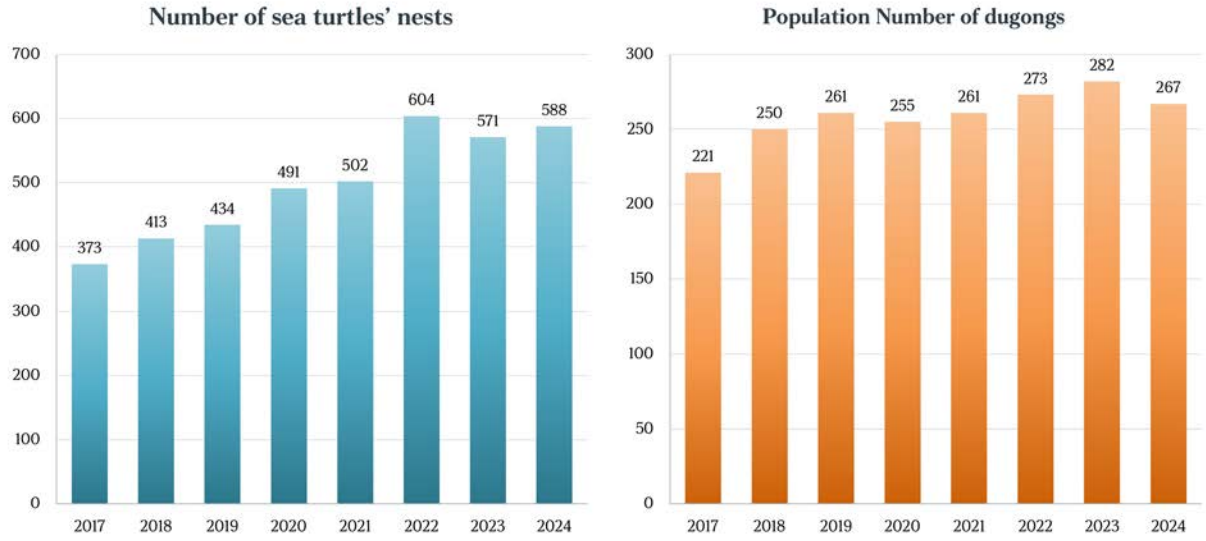



**Figure 2.5: Changes in the number of sea turtles' nests and dugongs during 2017–2024 (Source: DMCR, 2025)**

The population size of dolphins and Bryde's whales increased during 2017-2024 (Figure 2.6). All species of dolphins reveal a positive trend in their population size. For Bryde's whales, about 47 individuals were observed per year in 2017 to 74 individuals observed in 2024. The occurrence of cartilaginous fishes including whale sharks and manta rays fluctuates. For whale shark, a decreasing trend was found from 141 individuals in 2019 to 21 individuals in 2021 and slightly rebounded to 73 individuals in 2024 (DMCR, 2025)

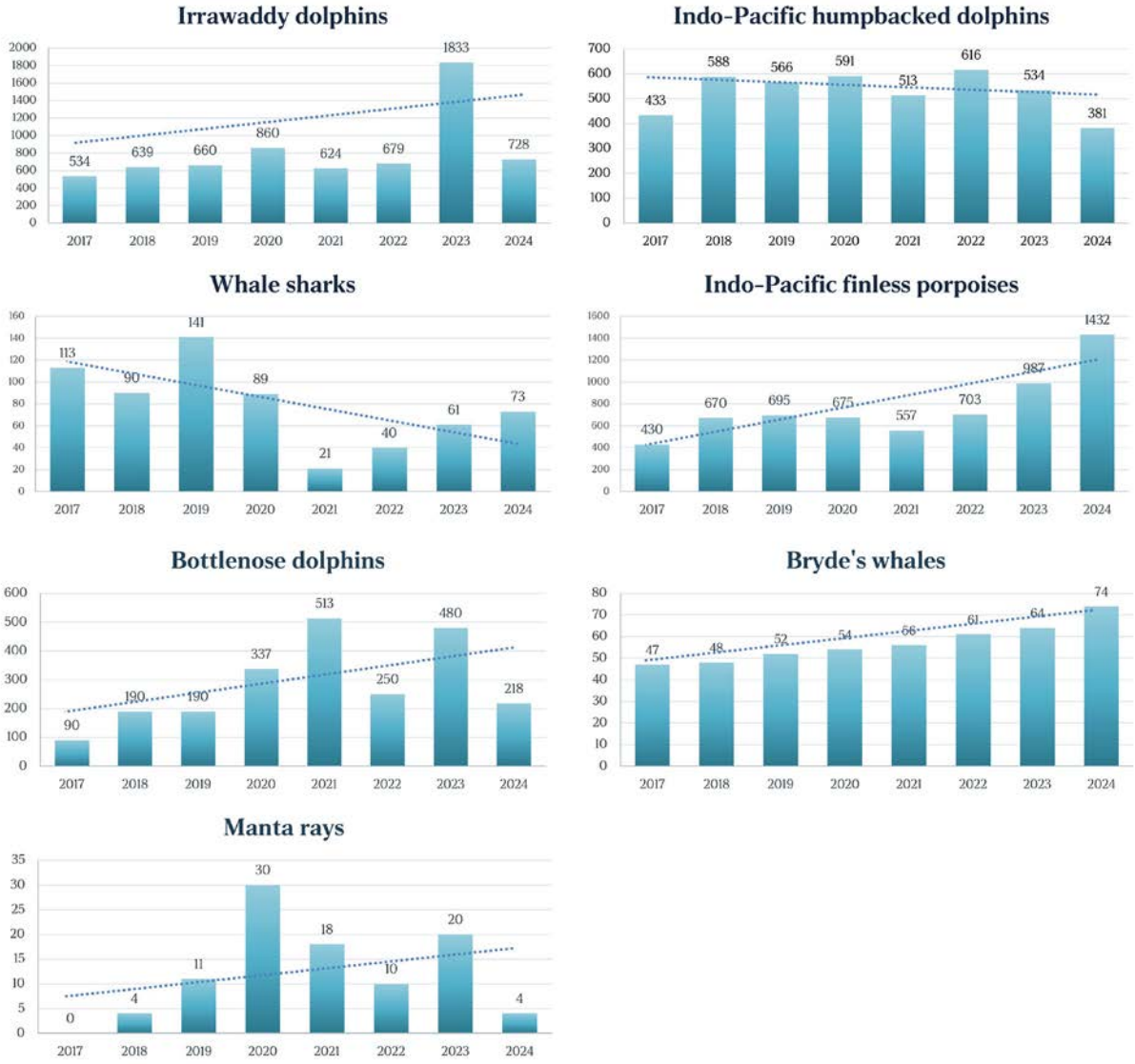



**Figure 2.6: Changes in the population number of dolphins and whales and some cartilaginous fishes during 2017–2024 (Source: DMCR, 2025)**

Despite increasing trends in most species, the overall number of strandings increased from 567 individuals in 2017 to 905 individuals in 2020, then declined slightly to 648 individuals in 2022 before rebounding to 963 individuals in 2024 (DMCR, 2025) (Figure 2.7). Human impacts are major threats to marine threatened species, especially the destruction and degradation of their habitats, food sources, and nesting grounds. The death of these species is also due to swallowing plastic waste, entanglement by fishing lines and nets, injuries from physical attack, and illness (DMCR, 2025). During the previous decade, the number of strandings of marine threatened species increased by an average of 9.49% per year. In 2024, stranded sea turtles exhibited the highest proportion (69%) compared to the number of stranded whales and dolphins (28%) and stranded dugongs (3%). Stranded dugongs, dolphins, and whales were mainly found dead (85–92% of total strandings), while the proportion was lower for stranded sea turtles (54%). The survival rates of live stranded species rescued and treated at the rehabilitation centers were 60% for sea turtles, 60% for dolphins and whales and 46% for dugongs (DMCR, 2025).

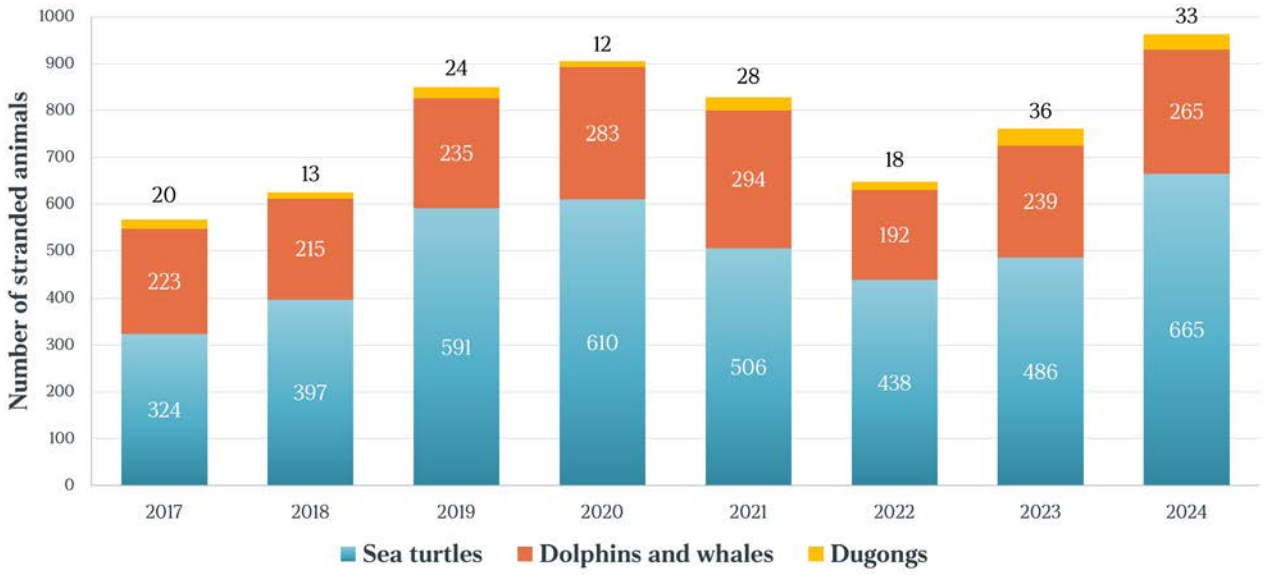



**Figure 2.7: Number of stranded marine animals during 2017–2024 (Source: DMCR, 2025)**

## 2.3 Linkage of marine ecosystems and ecosystem services

This section presents a detailed analysis of the current status and emerging trends of marine ecosystem services in Thailand and examines the extent of four categories of ecosystem services, provisioning, regulating, cultural and supporting (Table 2.1). In addition, this section introduces a proposed monitoring framework designed to systematically generate comprehensive, reliable, and up-to-date information on marine biodiversity and ecosystem services. This framework emphasises standardised data collection, integration of scientific and community-based monitoring, and the use of indicators to track changes over time. Ultimately, it provides the basis for informed decision-making, adaptive management, and policy development aimed at conserving and enhancing Thailand's marine ecosystems and the ecosystem services.

**Table 2.1: Classification of marine ecosystem service**

| Ecosystem Services | Intermediate Services | Final Services | Goods/Benefits |
|---|---|---|---|
| • **Provisioning** | • Similar to those listed in supporting services (e.g., primary production, larval & gamete supply, nutrient cycling, water cycling, and formation of habitats for species) | • Fisheries resources supply<br>• Algae & seaweed supply<br>• Ornamental materials<br>• Genetic resources supply<br>• Water supply | • Seafood (wild, farmed), e.g., animals and seaweed<br>• Fish feed from trash/bait fish<br>• Biofuels e.g. biodiesel from marine fungi<br>• Sea salt production<br>• Ornaments & aquaria<br>• Medicines & blue biotechnology e.g., bioactive compounds extracted from brown algae, microalgae, marine bacteria, ascidian, sea cucumber and sponge<br>• Genetic materials |
| • **Regulating** | • Biological control<br>• Natural hazard regulation<br>• Waste breakdown and detoxification<br>• Carbon sequestration | • Climate regulation<br>• Natural hazard protection<br>• Wastewater treatment & sedimentation control | • Healthy climate and clean water<br>• Prevention of coastal erosion<br>• Coastal protection by mangroves and beach forests<br>• Wave attenuation by coral reefs<br>• Waste burial / removal/ neutralisation in mangroves and seagrass beds |
| • **Cultural** | • Similar to those listed in supporting services, particularly formation of habitats for species and formation of seascape | • Seascapes and landscapes | • Tourism and recreation e.g., diving, sailing, beach recreation, whale/whale shark watching, bird watching, recreational fishing, walking along mangrove trail<br>• Spiritual and cultural well-being e.g., religious places or shrines that are respected by local people<br>• Education and research<br>• Local knowledge and experience<br>• Mental health benefits |
| • **Supporting** | • Primary production<br>• Larval & gamete supply<br>• Nutrient cycling<br>• Water cycling<br>• Formation of habitats for species: physical barriers; formation of seascape/ landscape<br>• Gene pool protection | • Similar to those listed in final services and goods / benefits of provisioning, regulating, and cultural services | |

(Modified from Turner et al., 2014; Hattam et al., 2015)

### *a) Provisioning services*

Provisioning services are derived from intermediate services[4] (generated through fisheries resources supply, algae and seaweed supply, ornamental materials, genetic resources, and water supply) which are transformed into final services[5] that support human needs. These include food from wild and farmed sources, fish feed, fertilisers and biofuels, ornaments for aquaria, and medicines derived from marine bioactive compounds. Marine fisheries are critical for food security. Studies indicate that global fisheries are under immense pressure from overfishing, impacting the sustainability of stock levels and, consequently, the availability of seafood (Bryhn et al., 2020). Overfishing and overharvesting are causing cascading ecological impacts in Thai waters due to the depletion of fish stocks and other collateral impacts such as bycatch and habitat damage (Christensen, 1998; Suebpala et al., 2018).

### *b) Regulating services*

Regulating services, such as climate moderation, nutrient cycling, and coastal protection, are equally critical. Marine ecosystems like seagrass beds, mangroves, and coral reefs, play a significant role in climate regulation as they can sequestrate atmospheric $CO_2$ through photosynthetic processes which are recognised for their ability to store carbon and mitigate climate change impacts (Nishijima&Belgrano, 2020; Gattuso et al., 2018). Intermediate processes like biological control, natural hazard regulation, waste detoxification, and carbon sequestration help ensure ecosystem stability. Additionally, these ecosystems regulate local climates and protect coastal communities from erosion and natural disasters, highlighting the essential services they provide (Nishijima& Belgrano, 2020; Tubío et al., 2021).

### *c) Cultural services*

Cultural services reflect the non-material benefits that ecosystems provide. Intermediate services such as beautiful seascapes and landscapes foster final services including tourism, recreation, cultural and spiritual enrichment, aesthetic enjoyment, education, research opportunities, contributing to human health and well-being. The degradation of these ecosystems can impede access to recreational areas, diminish aesthetic values, and reduce cultural heritage tied to marine communities (Nishijima&Belgrano, 2020; Tubío et al., 2021). Furthermore, effective MPAs and Other Effective Area-Based Conservation Measures (OECMs) can safeguard these diverse services while fostering community engagement and economic benefits through ecotourism and recreation (Fairbrass et al., 2025).

### *d) Supporting services*

Supporting services, including nutrient cycling and habitat formation, are foundational to sustaining marine life and the ecosystem services reliant upon them. Supporting services represent the fundamental ecological processes that sustain all other services. Primary production, larval and gamete supply, nutrient and water cycling, and habitat formation are crucial, supporting ecological processes that further support other services, for example, regulating services such as climate regulation, natural hazard protection, and the provision of clean water and sediment control. Coral reefs, for example, provide not only habitat for diverse marine species but also support other reefs as a source of coral larvae, nursery grounds for various species, associated fisheries and tourism, and so on (Woodhead et al., 2019; Liu et al., 2019). The loss of these ecosystems can have cascading effects on overall marine productivity and biodiversity, which, in turn, would diminish the yield of economic benefits derived from these systems (Duffy et al., 2016).

[4] Intermediate services refer to ecosystem function and processes supporting the production of final services, goods, and benefits. This service contributes to human well-being indirectly.

[5] Final services refer to those that contribute to human well-being directly.

The current status and trends of marine ecosystem services in Thailand cannot be fully assessed due to limited data availability, especially in relation to regulating and supporting services. While some research has been conducted on provisioning and cultural services, there remains a significant gap in understanding the ecological functions that underpin ecosystem resilience, such as carbon sequestration, coastal protection, nutrient cycling, and larval supply. The lack of systematic data collection and long-term monitoring makes it difficult to evaluate how these services are changing over time in response to human activities and climate change. Furthermore, the economic valuation of marine ecosystem goods and services is still limited. Existing studies have primarily focused on provisioning services, particularly fisheries and aquaculture, as well as on cultural services, such as tourism and recreation. However, very little information is available on the economic value of regulating services, like coastal hazard mitigation, or supporting services, such as biodiversity maintenance. This knowledge gap not only limits a comprehensive understanding of Thailand's marine ecosystems but also constrains effective policymaking, investment in conservation, and sustainable management of marine resources. Addressing this knowledge gap could support the improvement and development of assessment and monitoring frameworks with well-adapted indicators.

## 2.4 Status and trends of marine environmental quality

The status and trends of marine environmental quality reflect the overall condition of ocean health and its capacity to sustain biodiversity and human well-being. This section identifies direct and indirect threats to Marine BES and their associated impacts. Key issues include the spread of invasive species, water pollution, marine debris, coral bleaching, coastal erosion, oil spill, and eutrophication/red tide.

### 2.4.1 Invasive species

Marine invasive species pose significant threats to biodiversity, ecosystem stability, and human health in Thailand, particularly in marine environments. The introduction of non-native species through various pathways, including shipping, aquaculture and trading, has led to ecological imbalances and economic challenges. One of the primary causes for these invasions is the discharge of ballast water from ships, which is a significant area of concern for both the International Maritime Organization (IMO) and North American Regional Agreement (NORAD). Adopted in 2004, the IMO's International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention) aims to prevent the spread of harmful aquatic species through ballast water (IMO, 2014). This has been recognised as a critical factor in the introduction of invasive marine species in Thailand's waters such as black stripped mussel (*Mytilopsis adamsi*), golf ball sponge (*Tetilla japonica*), ascidian (*Esteinascidia thurstoni*) (ONEP, 2018; DOF, 2010). Blackchin tilapia (*Sarotherodon melanotheron*) has been identified as invasive in Thailand, disrupting local ecosystems and affecting native biodiversity (ONEP, 2018). Originally from West Africa, this species has been introduced globally for aquaculture purposes and has thrived in Thailand's brackish and freshwater ecosystems due to its high reproductive rates and adaptability (Chaianunporn, 2024). The ecological impacts of such invasions are profound, as invasive species can outcompete native species for resources, alter habitat structures, and disrupt food webs (Zalzabil, 2023). The diversity of marine sponges along the eastern coast of Thailand has also been impacted by invasive species. For instance, species such as *T. japonica*, which is non-indigenous to the region, have been documented, highlighting the ongoing changes in marine biodiversity

due to invasive species (Putchakarn, 2011). The presence of these non-native sponges can alter the ecological dynamics of coral reef systems, affecting both the physical structure of habitats and the biological interactions within these ecosystems. Invasive species not only threaten biodiversity but also pose risks to human health and economic activities, particularly in fisheries and tourism. The introduction of harmful algal blooms, often facilitated by invasive phytoplankton, can lead to toxic events that affect marine life and human consumers (Kajonwattanakul et al., 2020). Moreover, the economic implications of managing invasive species and restoring affected ecosystems can be substantial, necessitating coordinated efforts among stakeholders, including government agencies, researchers, and local communities.

### 2.4.2 Water pollution

Marine pollution in Thailand is a significant environmental concern due to its impact on biodiversity, economic activities, and public health. Various forms of pollution mainly generated by human activities including oil spills, microplastics, agricultural runoff and wastewater from aquaculture and mariculture, and community and industrial waste, degrade marine water quality in many areas, thus affecting the integrity of marine ecosystems and human well-being and livelihoods.

According to DMCR's MWQI[4] in 2024 at 330 monitoring stations, which were calculated based on eight parameters, including pH, dissolved oxygen, temperature, total suspended solid, ammonia, nitrate, and phosphate, 80% of the monitoring stations had good to very good conditions (MWQI>80), 18% reported moderate conditions (MWQI = 51-80), and 2% poor to very poor conditions (MWQI≤50). The water quality varies considerably across areas and seasons, depending on geographic location and intensity of human activities, as seen in the Upper GoT, large ports, and areas with intensive tourism such as Phuket (DMCR, 2025).

Recent research highlights that the upper GoT has experienced significant water quality decline due to the influence of massive discharge of four major rivers. This area is influenced by the discharge of untreated wastewater from communities, industries, agricultural and aquaculture activities. A study examining sediment quality revealed that various parameters, including organic matter content and salinity levels, did not meet the aquaculture standards (Srisunont&Srisunont, 2021). This degradation can be attributed to intensive shrimp farming practices, which have been linked to negative environmental impacts, including mangrove deforestation and nutrient pollution (Dierberg&Kiattisimkul, 1996; Szuster, 2006). Nutrient pollution is the main cause of eutrophication or red tide in coastal ecosystems, triggering ecological degradation, risk to aquatic species, due to oxygen depletion. Harmful algal blooms can also link to human health (see section 2.4.7). Moreover, human activities, particularly in regions with large ports such as Sriracha and Laem Chabang, have increased risks to ecosystem and local communities due to water pollution (Umprasoet et al., 2023), particularly eutrophication and oil pollution (see section 2.4.6). Water quality in Phuket, Thailand, is a significant concern due to increasing urbanisation and tourism contributing to water quality degradation. As a popular tourist destination, Phuket has experienced a considerable rise in population, particularly visitors, and corresponding increases in infrastructural development. This rapid growth, especially within coastal areas, has led to increased pressure on water quality (Reopanichkul, 2009).

[6] Marine Water Quality Index (MWQI) is calculated based on measurements of eight seawater quality parameters, including pH, dissolved oxygen, water temperature, total suspended solids, ammonia, nitrate, phosphate, and total coliform bacteria (TCB), classified into five conditions: very good (score 90-100), good (score 81-90), moderate (score 51-80), poor (score 26-50), very poor (score 0-25).

No significant change of MWQI was found during 2015–2021, but from 2022–2024, the MWQI tended to increase from 79–83, reflecting an improvement of overall water quality in Thailand (DMCR, 2025). However, the marine water quality in the areas with intensive human activities is still poor.

### 2.4.3 Marine debris

Marine debris in Thailand, particularly plastic waste, has become a critical environmental concern due to the country's significant contribution to global marine litter. Thailand's coastal regions and waterways are increasingly impacted by plastic pollution, adversely affecting marine ecosystems and public health (Horpet et al., 2020; Prampramote et al., 2022). Marine debris in Thailand originates from both land-based and marine sources. Estimates suggest that Thailand contributes approximately 150,000–410,000 tons of marine plastic litter annually, making as one of the top ten countries for mismanaged plastic waste entering the ocean (Jambeck et al., 2015). The influx of plastic waste primarily derives from urban activities, tourism, and ineffective waste management practices, with a notable prevalence of plastic items such as packaging, fishing gear, and personal care products amidst marine debris (Horpet et al., 2020; Prampramote et al., 2022). Microplastics are a concerning component of marine debris in Thailand. Recent studies have indicated that microplastics are frequently found in the gastrointestinal tracts of commercially important fish species. A key report by Srisiri (2024) found microplastic in almost 50% of 239 fish sampled from seven provinces in the upper GoT. Moreover, these microplastics pose serious ecological risks, as they can be ingested by marine organisms, potentially resulting in bioaccumulation up the food chain and impacting human health through seafood consumption (Srisiri, 2024; Azad et al., 2018). Various groups of zooplankton collected in the upper GoT have been contaminated with microplastics with a mean abundance of 0.402 particles per individual (Luankhamin et al., 2025). As zooplankton are lower tropic organisms, even small amounts of microplastics can be transferred and potentially magnified in consumers at higher trophic levels through biomagnification (Gao et al., 2024) and may also link to human health (Mercogliano et al., 2020). The environmental implications of marine debris are further exacerbated by the presence of derelict fishing gear, which can entangle and be ingested by marine megafauna and damage marine habitats (a phenomenon known as "ghost fishing"), such as coral reefs (Pengsakun et al. 2025; Wongnutpranont et al., 2021).

According to the DMCR on the quantity of floating debris collected at the mouths of five major rivers discharging into the Upper GoT, Bang Pakong River in Chachoengsao, Chao Phraya River in Samut Prakan, Tha Chin River in Samut Sakhon, Mae Klong River in Samut Songkhram, and Bang Tabun River in Phetchaburi from 2017 to 2024, a total of 65,560,273 pieces per year of floating debris (weighing 646 tons/year) were found. The greatest amount was from the Chao Phraya River (25,047,245 pieces/year, 130 tons/year), followed by the Bang Pakong River (15,884,545 pieces/year, 161 tons/year), the Mae Klong River (14,822,686 pieces/year, 208 tons/year), the Tha Chin River (7,604,276 pieces/year, 134 tons/year), and the Bang Tabun River (2,201,521 pieces/year, 13 tons/year). The activities contributing the largest proportion of waste were coastal and recreational activities (84.23%), followed by fishing and navigation activities (12.78%) as well as additional waste sources such as medical and health care activities and smoking-related waste. Based on the DMCR cleanup projects in 2024, a total of 327 tons of marine debris were collected from beaches, mangroves, coral reefs across 24 coastal provinces. Most of the marine debris collected from beaches were plastic (88%) such as food containers, drink bottles, and Styrofoam. One of the major concerns regarding marine debris relates to impacts on marine endangered species. In 2024, about 31.5% of stranded marine animals were due to the ingestion of and entanglement in marine debris. Dugongs (42.5%) showed the highest rate of impacts caused by marine debris, followed by sea turtles (37.3%) (Figure 2.8).

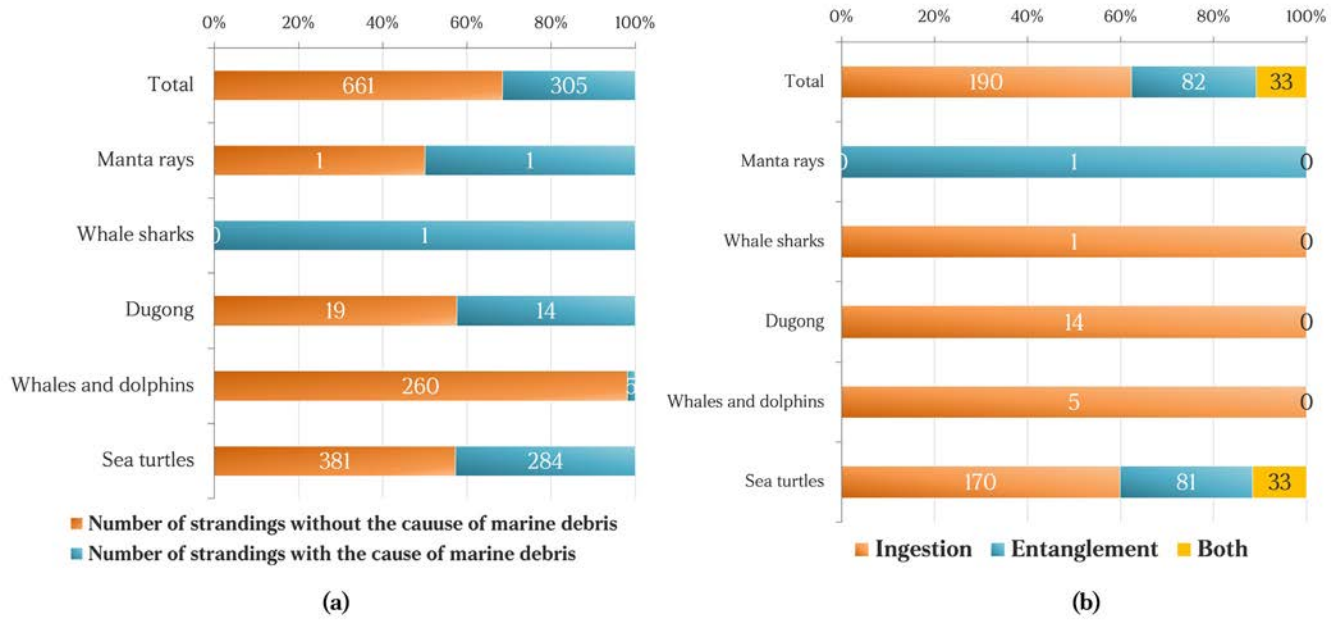



**Figure 2.8: Proportion and number of marine animals strandings caused by marine debris and by other causes (a) and the number of debris-related strandings by impact types (b) (Source: DMCR, 2025)**

From 2020 to 2024, the number of strandings of threatened marine animals related to marine debris has tended to increase for sea turtles and dugongs. The percentage of sea turtles impacted by marine debris rose from 21.6% in 2020 to 42.7% in 2024. Similarly, the percentage of dugongs impacted by marine debris also increased from 15.4% to 42.2%. In coral reefs, most marine debris originated from fishing activities including ropes, fishing nets, fishing lines (52%), followed by plastic packages and food containers (45%), metals, tires, and construction materials (3%) (DMCR, 2025).

## 2.4.4 Coral bleaching

Mass coral bleaching in Thailand was first recorded in 1991, and subsequently occurred in 1995, 1998, 2003, and 2010 (Phongsuwan and Chansang, 2012), These recurrent events represent a significant environmental concern and have gained increasing attention due to their profound impacts on Marine BES. The phenomenon occurs when corals expel the symbiotic algae known as zooxanthellae, leading to a loss of color and a decrease in the nutritional sources for coral. This phenomenon is predominantly driven by environmental stressors, particularly elevated sea surface temperatures associated with climate change (Yeemin et al., 2009; Sutthacheep et al., 2013). Thailand's coral reefs have experienced multiple bleaching events over the past few decades. Notably, 2010 mass bleaching event had a substantial impact on coral communities, decreasing live coral cover and reducing biodiversity, which itself jeopardises the resilience and recovery of coral ecosystems after bleaching events. Coral species such as *Acropora* spp., occupied around 5.5% of the total reef areas (Monchanin et al., 2025) (Box 2-3) have shown significant susceptibility to bleaching under extreme temperature conditions, and are at risk of long-term decline and local extinction (Yeemin et al., 2009; 2013).

In 2024, an anomalously elevated sea surface temperature was detected at 235 monitoring stations, revealing coral bleaching events in both the GoT and the Andaman Sea. In the GoT, the highest rate of coral bleaching occurred in May when 85% of observed coral reefs bleached and the mortality rate after bleaching ranged from 30–40%. In the Andaman Sea, the bleaching of 90% of observed coral reefs occurred in June although the mortality rate after bleaching (20–30%) was lower than in the GoT (DMCR, 2025).

### Box 2-3: Mass coral bleaching in Thailand: Experiences and responses

Coral bleaching is the most severe threat posed by climate change to coral reefs in Thailand. A severe mass coral bleaching event in 2010 occurred on most reef sites in Thailand. Bleaching in the Andaman Sea was more severe and extensive than in the GoT (Yeemin et al., 2010). It is predicted to increase in frequency and severity in this century (Hughes et al., 2003; Hoegh-Guldberg et al., 2007; Burke et al., 2011; Hoegh-Guldberg, 2011).

Prior to the 2010 mass coral bleaching event, Thailand had experienced a similar catastrophe in 1998. Both events caused drastic degradation of coral reef ecosystems throughout Thai waters and significant differences in the susceptibility of coral taxa to bleaching events between 1998 and 2010 were documented. Bleaching was significantly different between the most dominant corals. Species such as *Porites lutea* and *Diploastrea heliopora* were the most resistant to bleaching on both occasions; while some species showed more resistance to bleaching in 2010. Seven coral species, i.e. *Astreopora myriophthalma, Pachyseris rugosa, Turbinaria mesenterina, Goniastrea pectinata, Favia pallida, F. maritima, Favites halicora, Platygyra daedalea* and *Galaxea fascicularis*, were tolerant to the coral bleaching events (Sutthacheep et al., 2013).

To respond to the events, a list of recommendations for coral reef management in Thailand was provided, aiming to reduce local pressures and promote local recovery. The recommendations include preventing coral damage from snorkeling in the shallow reefs, sediment load from coastal development, wastewater discharge from boats and land-based activities into coral reefs, temporary closure of diving sites, establish new diving sites, conducting research and monitoring for coral conservation and restoration, informing people and tourists concerning the status of coral bleaching, providing sufficient man-power and budget to relevant government agencies, establishing effective networks of universities, government agencies, provincial offices, local administration offices, NGOs, private companies, and conservation groups (Yeemin et al., 2012).

## 2.4.5 Coastal erosion

Coastal erosion significantly impacts the extensive coastline along both the GoT and the Andaman Sea. This phenomenon is exacerbated by a combination of natural processes and anthropogenic factors, leading to the retreat of coastlines and the loss of valuable coastal resources such as mangrove forests and sandy beaches (Thepsiriamnuay&Pumijumnong, 2018; Langkulsen et al., 2022). The primary drivers of coastal erosion in Thailand include climate change, land subsidence, unsustainable coastal development, and altered sediment supply due to dam constructions (Saramul&Ezer, 2014; Thepsiriamnuay&Pumijumnong, 2018; Saengsupavanich et al., 2023). The ongoing loss of coastal land is significant, with reports indicating that Thailand loses approximately 30 $km^2$ of coastline annually due to erosion (Moses et al., 2022). The erosion processes in the Upper GoT have contributed to the coastline retreat by up to 1 km since the 1960s, mainly attributed to alterations in sediment dynamics and increased anthropogenic pressures (Uehara et al., 2010). Similarly, Thepsiriamnuay and Pumijumnong (2018) documented erosion rates of approximately 1.3–1.7 m/yr along beaches in southern Thailand, underscoring the urgency of implementing effective coastal management strategies. Human activities have also played a significant role in aggravating coastal erosion. Coastal developments, such as tourism infrastructures and urban settlements as well as structures for coastal protection disrupt natural processes and contribute to habitat destruction (Langkulsen et al., 2022). Climate change presents additional complexities to the erosion issue particularly accelerated by rising sea levels and storm surges (Sompratana et al., 2018). Thailand's coasts continue to erode as seen in the decline in the length of uneroded shorelines.

DMCR has been monitoring coastal erosion in Thailand, which can be used to determine a physical change in beach ecosystems. From 2017 to 2023, the proportion of shoreline experiencing mild erosion tended to decrease, while the proportion of shoreline showing moderate erosion appeared to increase, reflecting an increase in the magnitude of the impact (Figure 2.9). Meanwhile the length of coastlines without erosion problem and equilibrium shorelines[7] continuously decreased (Figure 2.10). This reveals that coastal erosion is still occurring despite implemented mitigation measures.

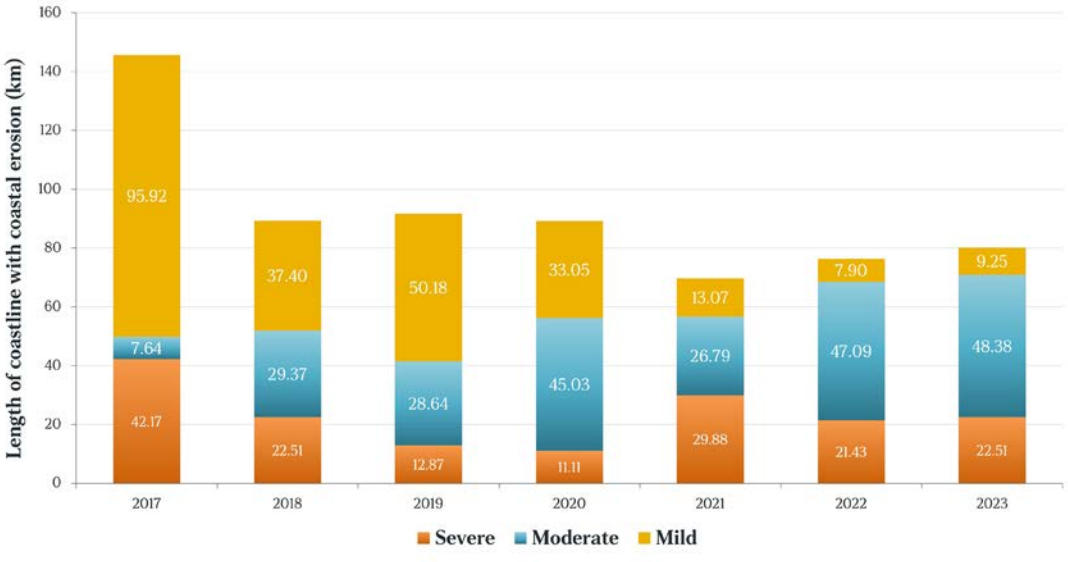



**Figure 2.9: Length of the shorelines at different levels of erosion with no coastal protection measures (Source: DMCR, 2024)**

[7] Equilibrium shoreline is a state of dynamic balance where the rate of erosion (sediment removal) equals the rate of deposition (sediment supply), resulting in no net change to the beach profile over time.

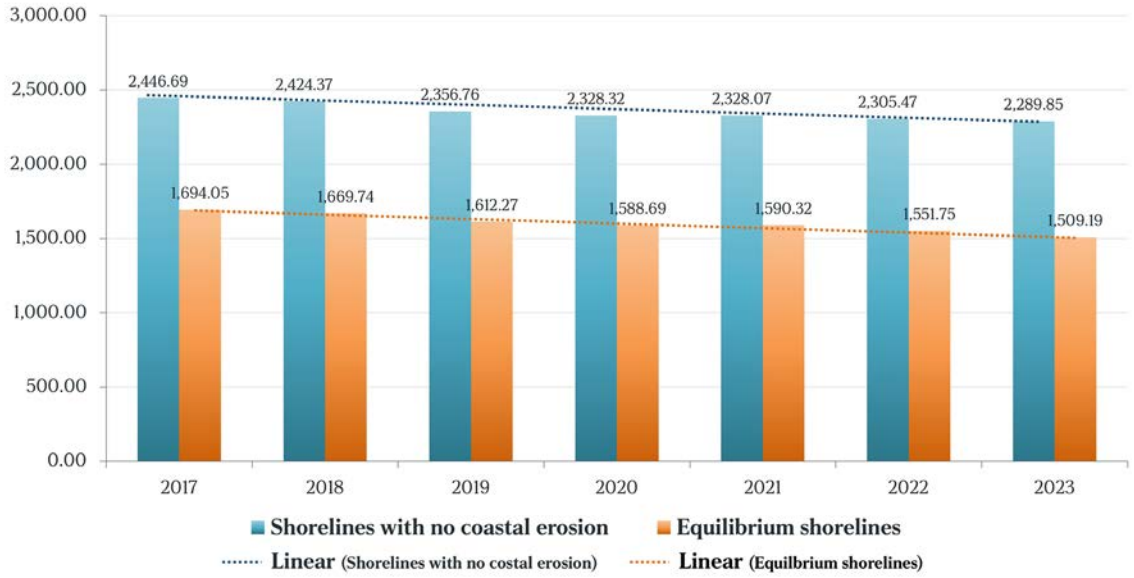



**Figure 2.10: Length of the shorelines without erosion problem and equilibrium shorelines (Source: DMCR, 2024)**

## 2.4.6 Oil spill

Oil spill pollution in Thailand is a pressing environmental issue that has garnered significant attention due to its detrimental effects on marine ecosystems, coastal economies, and public health. Oil spills in Thailand have resulted primarily from maritime accidents, industrial discharge, and operational mistakes in oil extraction and transport, leading to acute and long-term contamination of marine ecosystems and environment (Ellos & Bacosa, 2025). Historically, one of the notable incidents was the oil spill in Rayong in 2013, where an estimated 50,000 liters of oil were released into the GoT from a subsea pipeline (Pongpiachan et al., 2018). Such spills can have widespread and long-lasting effects on marine environments, including bioaccumulation of harmful hydrocarbons in marine organisms, which can affect both wildlife and human health through the food chain (Beyer et al., 2016). The ecological impacts typically manifest as degraded habitats for marine life, altered species compositions, and mortality of sensitive organisms, particularly in areas like coral reefs and mangrove forests that serve as vital ecological niches (Pongpiachan et al., 2018). In 2024, 24 oil spills and tar balls were reported. The most frequent incidents (15 cases) were reported in Chonburi, the GoT while only one incident was reported in Phang Nga on the Andaman Coast. Based on the monitoring, the concentration of petroleum hydrocarbons ranged from 0.07 µg/L in the Andaman Sea to 0.26 µg/L in the GoT, which was still within Thailand's Marine and Water Quality Standard (DMCR, 2025). An increasing trend of oil spills and tar balls incidents was found from 2 to 5 incidents in 2017–2019 to 28 incidents in 2023 with a slight decrease to 24 incidents in 2024 (Figure 2.11) (DMCR, 2025).

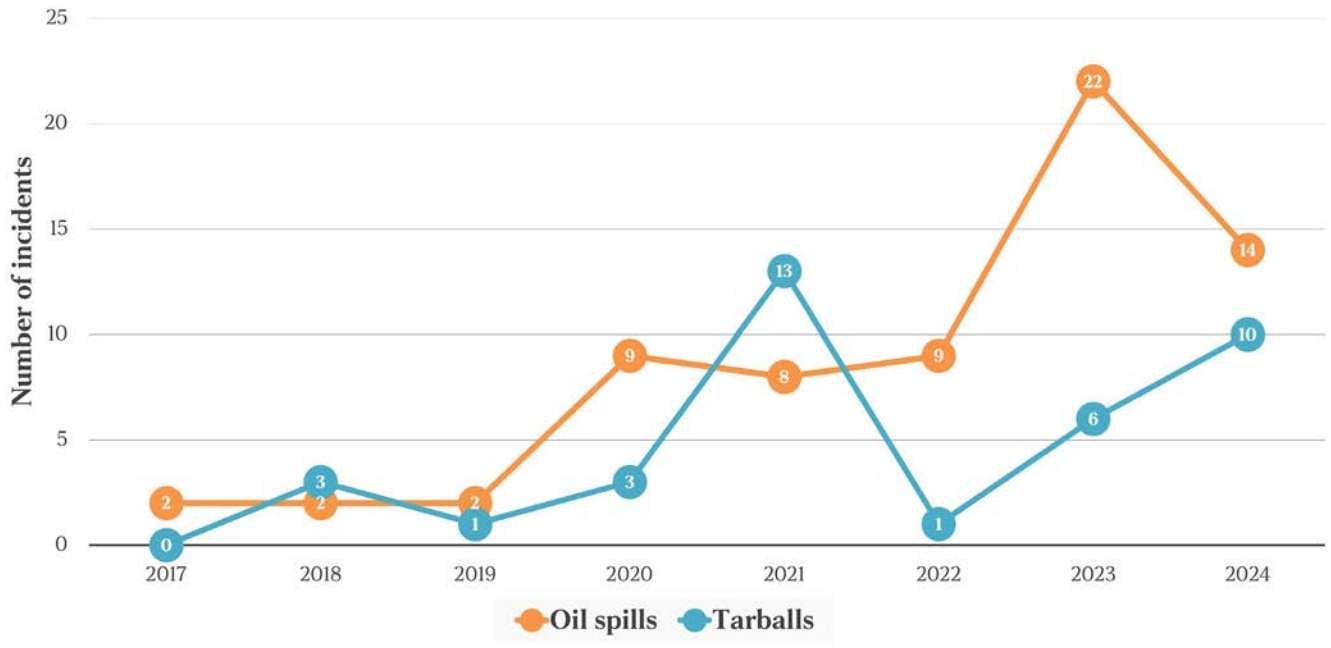



**Figure 2.11: Number of oil spill and tar ball incidents in Thailand (Source: DMCR, 2025)**

## 2.4.7 Eutrophication/red tide

Eutrophication has emerged as a significant environmental challenge in Thailand, driven largely by anthropogenic activities that contribute excess nutrients, particularly nitrogen and phosphorus, to aquatic ecosystems. This process leads to increased growth of algae and aquatic plants, which ultimately disrupts the ecological balance and degrades water quality. The major contributors to eutrophication in Thailand include agricultural runoff, urban wastewater, and industrial discharges, particularly in coastal and freshwater systems (Thitanuwat&Wongsoonthornchai, 2021). In various regions of Thailand, especially around the GoT, eutrophication has been exacerbated by intensive agricultural practices. The excessive use of fertilisers in crop production has established a direct pathway for nutrient runoff into rivers and coastal waters (Balasuriya et al., 2022). This nutrient influx can trigger harmful algal blooms (HABs), further impact local marine life and posing risks to human health through the consumption of contaminated seafood (Lan et al., 2024). The urbanisation and rapid expansion of tourism industries in Thailand also significantly contribute to eutrophication. Increased population density in coastal areas leads to greater wastewater generation, much of which is inadequately treated before being discharged into water bodies. This practice not only introduces nutrients but also pathogens and other pollutants that further deteriorate water quality and marine ecosystems (Micella et al., 2024). Research indicates that untreated sewage discharge is among the primary pollution problems affecting coastal areas, resulting in bacterial contamination and red tides, phenomena associated with eutrophication that can severely impact marine biodiversity (Stuhldreier et al., 2015). Furthermore, studies suggest that the impacts of eutrophication in Thailand are multifaceted. Coastal development, including jetty construction and land reclamation, has also contributed to declining water quality and eutrophication by disrupting natural water flows and habitats, linking to the occurrence of eutrophication and algal blooms (Stuhldreier et al., 2015).

In 2024, 49 events of red tides and algal blooms in Thai waters were reported, mainly caused by phytoplankton, dinoflagellate (*Noctiluca scintillans*). Most occurred in Chonburi (18), followed by Songkhla (5), the upper GoT and Phuket (4), in the Andaman Sea. In Chonburi, events of red tides and algal blooms generally occur in the rainy season and are caused by discharge of untreated wastewater and ocean circulation. Along the coasts of Songkhla, the occurrence was mainly due to the dinoflagellate (*Noctiluca scintillans*) and high concentration of phosphate. The occurrence in Phuket was caused by red algae (*Gracilaria sp.*) at Patong Beach, green algae (*Cladophora sp.*) at Tang Khen Beach and Nai Yang Beach, and Kamala Beach. According to the statistics from 2014-2027, an increasing trend of the occurrence was found although the number of occurrences was lower from 78 occurrences in 2023 to 54 occurrences in 2024 (DMCR, 2025).

### 2.4.8 Overfishing

Overfishing in Thailand is a critical issue that threatens both the marine environment and the livelihoods of communities dependent on fishing. The situation is dire, particularly concerning key fish species such as the short mackerel (*Rastrelliger brachysoma*), whose population has drastically declined due to excessive fishing practices driven by high consumer demand (Kongseng et al., 2021). The Thai fishery sector has faced significant challenges due to overexploitation, with estimates indicating that the annual marine catch has exceeded the maximum sustainable yield, leading to a stark reduction in fish stocks over recent decades (Teh et al., 2015). This overfishing has been attributed largely to industrial trawling methods, which have proliferated since the 1970s—open access to fishing grounds has exacerbated the situation, contributing to overcapitalization and resource depletion (Ahmed et al., 2007). Regulations aimed at curbing these practices have been introduced, following pressures by concern from local and international stakeholders about unsustainable and unethical fishing practices. For instance, the adoption of the European Union's illegal, unreported, and unregulated (IUU) fishing regulations has compelled Thai authorities to improve monitoring and compliance within the fishery sector (Wongrak et al., 2021; Kadfak&Antonova, 2021). These reforms are crucial not only for the sustainability of fish populations but also for addressing labor rights concerns, as many workers in the Thai fishing industry face issues such as labor exploitation (Kadfak et al., 2023).

Despite these reforms, significant challenges remain. The growth of aquaculture, while seen as a potential solution to diminishing wild fish stocks, raises concerns about environmental sustainability, given that aquaculture often relies heavily on wild fish as feed. This practice is exemplified by the concept of "fishing the feed", where wild fish populations are further depleted to support farmed species (Sampantamit et al., 2021). Furthermore, a decline in marine capture production from around 3.0 million tons in 1995 to approximately 1.5 million tons in 2015 illustrates the ongoing crisis facing Thai fisheries (Sampantamit et al., 2020). Recommendations for sustainable practices have suggested the need for integrated approaches to managing both wild fisheries and aquaculture, aiming for comprehensive strategies that address ecological impacts while meeting food security needs (Sampantamit et al., 2020).

## 2.5 ILK and ecosystems and environmental quality monitoring

At the international level, ecosystem assessments increasingly recognise the importance of ILK as a complementary source of understanding alongside scientific data. A significant milestone in this integration was the Global Assessment on Biodiversity and Ecosystem Services, conducted by IPBES in 2019, which was the first to systematically incorporate multiple knowledge systems, including ILK, into global evaluation processes (McElwee et al., 2020). In Thailand, ILK perspectives provide valuable insights into the status, trends, and changes of marine and coastal ecosystems. Local fishers particularly elders with long-term experience living and working in coastal areas, hold deep knowledge of past geographical conditions, biodiversity patterns, and ecological changes. Their observations not only reveal environmental transformations but also highlight the associated impacts on community livelihoods and well-being. Incorporating ILK into assessments therefore enhances understanding of ecological change, fosters more inclusive knowledge systems, and strengthens the relevance of conservation strategies at both local and national levels.

Interestingly, the Morgan community in Thai Mueang district, Phang Nga, perceives coastal ecosystems as interconnected systems, where peat swamp forests and mangroves function in harmony, sustained by tidal flows that generate a fertile environment. In the past, these ecosystems were vital subsistence zones, providing food and livelihoods. Elders from Thap Pla-Lam Pi village in Thai Mueang District, Phang Nga, emphasise that terrestrial forests, freshwater streams, peat swamps, brackish water, and mangroves are interconnected. Their ecological knowledge includes species like shortfin eel (*Anguilla bicolor*) or “Pla Tuhna” in Thai regarded locally as a freshwater fish but known to migrate between freshwater, brackish, and marine habitats for breeding. Observations from recent NEA community-based monitoring in 2024 confirmed the presence of shortfin eel in Ton Phrai Waterfall streams, which connect to brackish mangrove creeks. However, land-use changes, conversion of forests and streams into rubber, oil palm, and shrimp farms, have caused a decline in fish populations. Similarly, mangrove areas near shrimp ponds show reduced abundance and smaller sizes of mollusks, despite the community’s extensive knowledge of local shellfish species and harvesting techniques. These insights illustrate the significant ecological linkages recognised by the Morgan, while also highlighting the pressures of environmental change that threaten both biodiversity and traditional livelihoods.

Another interesting case is that the Urak Lawoi ethnic group in Ao Kung, Phuket, holds a vital role in mangrove conservation through their deep-rooted ecological knowledge and sustainable practices. Their long-term residence along the coast has enabled them to observe changes in mangrove ecosystems, understand tidal dynamics, and identify critical areas for restoration and protection. By integrating traditional harvesting methods with contemporary conservation approaches, the community actively contributes to maintaining mangrove health, supporting biodiversity, and safeguarding coastal resilience. Their engagement not only preserves important habitats but also reinforces cultural heritage and protects them from massive economic development, demonstrating how local stewardship can effectively complement scientific and governmental conservation initiatives. Detailed information on the roles of ILK on the status and trends of ecosystems and environmental quality is available in Chapter 5.

## 2.6 Conclusions and recommendations

### 2.6.1 Summary of key findings on status and trends

This section summarises the key findings on the status and trends of marine ecosystems, ecosystem services, and environmental quality. It highlights the condition of critical habitats such as mangrove forests, coral reefs, seagrass beds, and beach ecosystems, as well as the status of marine threatened species. In addition, it outlines major environmental challenges impacting marine ecosystems, including invasive species, water pollution, marine debris, coral bleaching, coastal erosion, oil spills, and eutrophication or red tides. Together, these findings provide essential insights into the state of marine biodiversity and the pressures influencing its sustainability.

***a) Status and trends of marine ecosystems and ecosystem services***

In 2020, about 2,780 km$^2$ of pristine mangrove forests were found along Thailand's coast (DMCR, 2025). From 1961 to 1996, mangrove forest areas declined by 50% from about 3,680 km$^2$ to 1668 km$^2$ due to mangrove (logging) concession and their conversion into shrimp ponds. However, within the last 20 years, this trend has reversed with an increase from 1,676 km$^2$ in 1996 to 2,780 km$^2$ in 2020. This increase could be mainly attributed to differences in methodology and the resolution of satellite images used to identify the expanse of these areas. However, it is also likely due to the implementation of DMCR policies on forest plantations and mangrove area reclamation as per DMCR's 20-year Action Plan.

A total coral reef area of about 238.7 km$^2$ is found across 17 coastal provinces in the GoT and the Andaman Sea. It is difficult to observe changes in coral reef extent for lack of long-term data. After the 2010 mass coral bleaching event, coral reefs recovered, increasing the proportion of healthy coral reefs from 6–12% in 2011–2017 to more than 50% in 2022–2024 due to natural recovery with some measures to reduce local pressures and to promote recovery such as temporary closure of dive sites, prohibition of wastewater discharge from boats and land-based activities. The continuity of this trend will depend on whether future mass bleaching events will occur due to global increases in sea water temperature. Coral reefs in some areas are also facing local pressures, mainly caused by anthropogenic activities, such as tourism activities and pollution.

According to the DMCR, a total of 257 km$^2$ of potential areas for seagrass beds have been found in Thai waters, of which about 71% are in the Andaman Sea. Seagrass beds are highly dynamic with high spatial and temporal variation. There has been a declining trend of healthy-good seagrass beds over time, from 53% in 2012–2013 to 39% in 2016–2017, down to 17% in 2024, due to a combination of natural and anthropogenic factors. Widespread seagrasses die-offs were reported in Trang in 2024 with causes still unknown.

Beach ecosystems in Thailand can be categorised into three main types: muddy, sandy, and rocky, covering 1,020.62 km$^2$, 1,630.75 km$^2$, and 326.1 km$^2$, respectively. Sandy and muddy beaches are threatened by coastal erosion, while coastal lagoons and estuaries are at risk from anthropogenic activities and their ecological impacts, namely water pollution, ecosystem degradation, overfishing, and coastal development.

Knowledge of offshore ecosystems remains limited, particularly biodiversity and the ecology of pelagic and benthic ecosystems, long-term monitoring, the status of resource use and threats,

in key biodiversity areas located beyond 12 nautical miles and within the EEZ (e.g., underwater pinnacles, oil rigs and shelf break front). These aspects require further research and exploration.

Four groups of threatened marine animals are of particular importance and concern: sea turtles, dugongs, dolphins and whales and cartilaginous fishes (whale sharks and manta rays). However, analysing population trends is challenging as standardised population data are limited, and there is high variability due to diverse factors.

Marine ecosystem conditions and the quality of ecosystem services are closely linked. Ecological structures and functions form the foundation of a cascade of ecosystem services, connecting intermediate and final services to the goods and benefits that sustain human well-being. The rich marine biodiversity and diverse ecosystems in Thai waters provides a wide range of ecosystem services. Provisioning services (e.g., seafood, raw materials, genetic resources and marine-derived medicines) and cultural services (e.g., tourism, recreation, education, and spiritual and cultural well-being) are widely recognised. However, regulating services (e.g., climate regulation, wastewater treatment, sediment control and natural hazard protection) and supporting services (e.g., primary production, larval dispersal, habitat formation and nutrient cycling) are often less recognised, as their benefits are delivered indirectly through ecological processes. This could be due to the limited number of economic valuation studies on regulating and supporting services making it difficult to raise public awareness and attention.

***b) Status and trends of marine environmental quality***

Invasive species identified in Thai waters include the black-striped mussel, golf ball sponge, tunicates, and blackchin tilapia, each causing significant ecological disruptions by outcompeting native species and altering habitats. However, no long-term studies on the impacts of such invasive species have yet been conducted.

Water quality monitoring stations across Thailand have recorded a range of conditions based on the MWQI with good to very good conditions. The variation in water quality is strongly influenced by geographic location and the intensity of human activity in the area. For instance, the upper GoT, a region with major shipping routes and urban development, frequently exhibits lower water quality due to the concentration of pollutants from port activities, industrial discharges, and urban runoff. Similarly, areas with intensive coastal tourism, such as Phuket and nearby islands, experience seasonal fluctuations in water quality due to increased waste generation, boat traffic, and infrastructure development during peak tourism periods.

Marine debris in Thailand, particularly plastic waste, has become a critical environmental concern due to the country's significant contribution to global marine debris. Plastic waste makes up the majority of debris found on beaches, including items like food containers, drink bottles, and Styrofoam. Debris in the marine environment mainly originates from fisheries, navigation, and tourism; posing serious threats to marine life. Notably, in 2024, 31.5% of stranded marine animals were affected by ingestion of or entanglement in debris. Dugongs (42.5%) had the highest rate of impact, followed by sea turtles (37.3%), highlighting the urgent need for targeted mitigation measures.

Coastal erosion significantly impacts coastlines along both the GoT and the Andaman Sea. Thailand's coasts continue to erode as seen in the decline in the length of uneroded shorelines (Figure 2.10). Climate change and some associated mitigation measures may exacerbate the erosion issue—particularly rising sea levels and storm surges.

Oil spills are the most frequent in provinces with high maritime traffic such as Chonburi while tar

balls incidents have been generally found on the coasts. However, the concentration of petroleum hydrocarbons remains within Thailand's Marine and Water Quality Standards.

Eutrophication in Thailand has become a major environmental issue, primarily driven by human activities causing agricultural runoff, urban wastewater, and industrial discharges. In 2024, 49 red tides were recorded, most notably in Chonburi, Songkhla, and Phuket. Coastal development and water quality further exacerbate eutrophication and its impacts.

Overfishing in Thailand poses severe threats to marine ecosystems and the livelihoods of fishing communities. Key species, such as short mackerel, have experienced dramatic population declines due to industrial trawling and open access to fishing grounds, exceeding the maximum sustainable yield. While aquaculture offers an alternative, it can further deplete wild fish stocks used as feed. The decline in marine capture production, from 3 million tons in 1995 to 1.5 million tons in 2015 as well as the decline in catch rate underscores the need for integrated management strategies that balance ecological sustainability and food security.

### 2.6.2 Summary of key findings on knowledge gaps

Our literature analysis identified several knowledge gaps which can pose issues for effective management and conservation strategies and planning. The following section highlights the major knowledge gaps that need to be addressed to improve conservation and management outcomes and support more comprehensive, informed, and adaptive approaches to ecosystem assessment. Major knowledge gaps are shown below:

***a) Lack of biodiversity information on marine ecosystems***

Thailand has significant gaps in biodiversity information related to its marine ecosystems. Critical data on undiscovered or poorly recorded species is much needed, limiting the country's understanding of its full biodiversity potential. This knowledge gap is compounded by the absence of comprehensive baseline data, which are essential for assessing ecological change, guiding conservation efforts, and evaluating the impacts of human activities and environmental pressures over time.

The availability and accuracy of data on the extent of marine ecosystems remain limited and inconsistent. In particular, there is a significant lack of comprehensive and up-to-date information on the distribution and coverage of coral reefs. Coral reef mapping is challenging due to their underwater location, variability in depth and clarity of water, and the limited spatial resolution of available satellite imagery. Similarly, data on seagrass meadows are often outdated and insufficient. Seagrasses are highly dynamic ecosystems that can change rapidly in response to environmental conditions such as water quality, sedimentation, and temperature. However, current monitoring programs are limited in scope and frequency, resulting in data that do not accurately reflect recent changes or the true extent of these habitats. Mangrove forest extent is relatively better documented compared to coral reefs and seagrasses, but the data still presents comparability issues. Variations in satellite image resolution, classification techniques, and interpretation methodologies across different studies and regions have led to inconsistent assessments. These discrepancies make it difficult to compare mangrove extent data across time periods or geographic areas with confidence.

Consistent monitoring programs have not been established or maintained in many areas to assess the condition of marine ecosystems, resulting in fragmented or short-term datasets

that are insufficient for robust scientific analysis or informed decision-making. The absence of long-term data limits the ability to assess the cumulative effects of stressors such as overfishing, coastal development, pollution, and climate change. It also hinders the capacity to evaluate the effectiveness of management interventions, such as MPAs or habitat restoration projects, over time. As a result, conservation strategies may lack the necessary evidence base to be adaptive, targeted, or measurable.

In addition, key habitat mapping on ecosystem connectivity is insufficiently developed. There is a lack of detailed and accurate spatial data on essential habitats such as coral reefs, seagrass meadows, mangrove forests, and spawning or nursery grounds. Without this information, it is difficult to assess how different ecosystems are interconnected, which is crucial for understanding ecological processes such as species migration, nutrient cycling, and ecosystem services.

Furthermore, the diversity information, particularly genetic diversity, functional roles, and ecological interactions between marine organisms are not well understood. This includes limited knowledge of keystone species, species-specific contributions to ecosystem functioning, and trophic dynamics. Understanding these roles is fundamental for ecosystem-based management and restoration planning. Another key gap lies in the understanding of ecosystem resilience and species vulnerability in the context of climate change. Limited research exists on how marine ecosystems, and the species within them, respond to climate-induced stressors such as ocean warming, acidification, sea-level rise, and extreme weather events. Without this information, Thailand is at a disadvantage in developing adaptive strategies to enhance ecosystem resilience and ensure long-term sustainability. Addressing these knowledge gaps requires strategic investment in marine biodiversity research, long-term ecological monitoring, and the integration of traditional ecological knowledge alongside modern scientific approaches. Enhanced collaboration among government agencies, academic institutions, and local communities is also essential to build a robust knowledge base for effective policymaking and conservation action.

***b) Socio-economic and ecosystem services***

Thailand currently lacks comprehensive data and analysis on the socio-economic dimensions and ecosystem services provided by its marine resources. While ecosystems, such as coral reefs, mangrove forests, seagrasses, and coastal wetlands, play a vital role in supporting local livelihoods, food security, tourism, and climate resilience. Their full economic and social value is often underappreciated or overlooked in national planning and decision-making. In particular, there is a significant gap in the valuation of ecosystem services, including provisioning services (e.g., fisheries and aquaculture), regulating services (e.g., coastal protection and carbon sequestration), supporting services (e.g., nutrient cycling), and cultural services (e.g., recreation, tourism, and spiritual values). Without robust valuation studies, these services are often treated as free goods, leading to underinvestment in conservation and overexploitation of natural resources. Furthermore, the critical link between human communities and the marine environment is not well understood or integrated into resource management strategies. Many coastal communities in Thailand are deeply dependent on healthy marine ecosystems for their economic well-being and cultural values. However, the social and economic impacts of environmental degradation, such as declining fish stocks, coral bleaching, or loss of mangrove forests, are rarely quantified or considered in policy development. Additionally, data management and the integration of biophysical and socio-economic information in accordance with international frameworks, for example the System of Environmental Economic Accounting (SEEA), Ocean Account (OA), remain limited. This weakens the ability of government and stakeholders to design effective, equitable, evidence-based, and community-based responses to environmental challenges. There is an urgent need for interdisciplinary research that combines ecological, economic, and social science

approaches to assess the full range of benefits provided by marine ecosystems. This knowledge base can help policymakers recognise the true value of these ecosystems, promote sustainable use, and enhance the resilience of both ecosystems and the communities that depend on them.

***c) Understanding on anthropogenic and natural impacts***

While individual threats like pollution, overfishing, and climate change are acknowledged, the cumulative and synergistic impacts of these multiple stressors on marine ecosystems are not fully understood. Habitat loss and degradation (e.g., mass die-offs of seagrass beds) resulting from the synergistic and cumulative impacts of human activities and climate change remain questionable. Despite efforts to address marine plastic debris, more detailed studies are needed to identify specific sources, pathways, and fates of various pollutants (plastics, microplastics, chemical contaminants, and nutrient runoff) throughout Thai coastal waters. Understanding land-sea interaction, for example, the impacts of land-based activities on coastal eutrophication is required for ICZM and MSP. While climate change impacts like coral bleaching and sea-level rise are observed, more localised and detailed assessments of climate change vulnerability for specific ecosystems and coastal communities are crucial for targeted adaptation strategies. This includes understanding the impact of altered monsoon patterns and ocean currents. While tourism is a major economic driver, detailed research on the long-term ecological impacts of various tourism activities (e.g., diving, boating, resort development, and pollution) and the effectiveness of current management measures is often limited.

***d) Ecosystem monitoring and restoration***

There is a significant lack of standardised methods and indicators for ecosystem monitoring and restoration, which hampers effective assessment and long-term management of marine ecosystems. Currently, various institutions and regions employ different methodologies for collecting data, analysing ecosystem health, and evaluating restoration outcomes. This inconsistency makes it difficult to compare results across locations or over time and prevents the establishment of a unified national or regional baseline. Without standardised indicators, such as those measuring biodiversity, habitat condition, or ecosystem services, it is challenging to track progress, assess the effectiveness of conservation actions, or make informed decisions.

In addition to methodological gaps, there is limited public participation in ecosystem monitoring and restoration efforts. Engaging local communities, stakeholders, and citizen scientists is crucial for the success and sustainability of these initiatives. Public involvement not only enhances data collection through community-based monitoring but also fosters a sense of ownership, awareness, and stewardship for marine ecosystems. The current lack of structured mechanisms to involve the public reduces opportunities for inclusive decision-making and undermines the social support needed for long-term conservation and restoration success. To address these challenges, it is essential to develop and adopt standardised, science-based monitoring protocols, while also creating inclusive platforms for public engagement and capacity building.

### 2.6.3 Key Messages and recommendations

**Key Message 1: Major marine ecosystems have degraded over the past decades. *(Well established)***

Thailand has various marine and coastal ecosystems including mangrove forests, seagrass beds, coral reefs, and other ecosystems such as beach ecosystems, coastal lagoons and offshore ecosystems, which play vital roles in maintaining marine biodiversity and providing essential ecosystem services. However, major marine and coastal ecosystems have experienced significant declines over recent decades due to anthropogenic activities and climate change (Figure 2.12).

# Status and trend of marine ecosystems

| Ecosystems | Current status | | Trends | | Major drivers |
|---|---|---|---|---|---|
| | Extent | Condition | Extent | Condition | |
| **Key marine ecosystems** | | | | | |
| Mangrove forests  | 2,780 km² of pristine mangroves (Year 2020) | NA No long-term monitoring and its impact data available | Increase in coverage of mangrove forests | NA No long-term monitoring and its impact data available | • Use satellite imagery of different resolutions, • restoration efforts, • climate change, • coastal development, • encroachment, • inappropriate restoration practices |
| Seagrass beds  | 257 km² of potential area for seagrass beds (Year 2020) | In 2024, only 17% of healthy seagrass beds was found. | NA No long-term change data of potential areas for seagrass beds available | Decrease in percentage of healthy seagrass beds since 2010 | • Sedimentation, • climate change, • dredging, pollution, • destructive fishing practices |
| Coral reefs  | 238.7 km² (Year 2018) | In 2024 51% was in healthy condition, 29% and 24% was in fair condition, and damaged condition, representatively. | NA No long-term change data of coral reef areas available | Increase in percentage of healthy reefs after the 2010 bleaching event | • Climate change, • unsustainable tourism, coastal development, • pollution, destructive fishing practices |
| **Other ecosystems** | | | | | |
| Beach ecosystems  | Length of muddy, sandy, and rocky, with lengths of 1,020.62 km, 1,630.75 km, and 326.1 km, respectively (Year 2024) | NA No long-term monitoring data available | Decrease in shorelines without coastal erosion and equilibrium shorelines | NA No long-term monitoring data available | • Climate change, • coastal erosion, • urbanization, coastal development, • pollution, • unsustainable tourism |
| Coastal lagoons  | NA No long-term monitoring data available | Habitat degradation, degradation in water quality | NA No long-term monitoring data available | Water quality and habitat quality | • Urbanization, coastal development, land-based pollution |

**Figure 2.12: Status and trends of marine biodiversity**

**Recommendations:**

**1.1. Promote the conservation and sustainable use of Marine BES** by establishing integrated MSP, strengthening area-based conservation measures (e.g., MPAs, OECMs, and Locally Managed Marine Areas (LMMAs)), and applying an Ecosystem-Based Fisheries Management (EBFM). These efforts should be aligned with tourism management based on ecological carrying capacity to maintain the integrity of ecosystem structures, functions, and services.

**1.2. Scale up and sustain ecosystem restoration efforts to reverse degradation of marine ecosystems and habitats.** Restoration initiatives should aim not only to recover ecosystem structure, but also to restore key ecological functions and the services they provide.

**1.3. Reduce land-based and sea-based pollution, particularly nutrient runoff, wastewater discharge, plastics, and marine debris,** to mitigate impacts on marine ecosystems. Climate mitigation and adaptation should also be integrated into marine policy, with a focus on protecting and restoring blue carbon ecosystems to enhance carbon sequestration and contribute to climate resilience.

**1.4. Strengthen monitoring and data systems to support adaptive management,** enabling policymakers to adjust strategies in response to emerging ecological trends, risks, and uncertainties in a timely manner.

**1.5. Enhance governance, coordination, and sustainable financing mechanisms** by strengthening inter-agency coordination, which is essential to align policies across sectors and levels of government. Also, innovative financial and economic instruments are needed to ensure the long-term sustainability of conservation efforts.

**Key Message 2: Declining marine and coastal biodiversity and increasing ecosystem degradation over the past decades have inevitably reduced ecosystem service quality. *(Established but incomplete)***

Marine ecosystems provide valuable and diverse types of goods and services to humans, categorised into provisioning, regulating, supporting, and cultural services, and these are directly linked to human well-being. Despite the significant contributions of marine ecosystem services, they remain insufficiently studied (Figure 2.13). Given the strong linkages between ecosystems and the quality of their services, declining marine biodiversity and ecosystem degradation over the past decades have inevitably reduced ecosystem service quality.

| Ecosystem Services | Intermediate Services | Final Services | Goods / Benefits |
|---|---|---|---|
| **Provisioning**  | Similar to those listed in supporting services e.g. primary production, larval & gamete supply, nutrient cycling, water cycling, formation of species–habitat | • Fisheries resources<br>• Algae & seaweed<br>• Ornamental materials<br>• Genetic resources<br>• Water supply | • Seafood (wild, farmed)<br>• Fish feed<br>• Biofuels<br>• Sea salt production<br>• Ornaments & aquaria<br>• Medicines & blue biotechnology<br>• Genetic materials |
| **Regulating**  | • Biological control<br>• Natural hazard regulation<br>• Waste breakdown and detoxification<br>• Carbon sequestration and storage | • Climate regulation<br>• Natural hazard protection<br>• Wastewater treatment & sedimentation control | • Healthy climate and clean water<br>• Prevention of coastal erosion<br>• Coastal protection<br>• Wave attenuation<br>• Waste burial/ removal/neutralisation |
| **Cultural**  | Similar to those listed in supporting services, particularly formation of habitats for species, seascape. | • Seascapes and landscapes | • Tourism and recreation<br>• Spiritual and cultural well-being<br>• Education and research<br>• Local knowledge<br>• Mental health benefits |
| **Supporting**  | • Primary production<br>• Larval & gamete supply<br>• Nutrient cycling<br>• Water cycling<br>• Formation of species–habitat; physical barriers; seascape<br>• Gene pool protection | Similar to those listed in final services and goods/benefits of provisioning, regulating, and cultural services. | Similar to those listed in final services and goods/benefits of provisioning, regulating, and cultural services. |

**Figure 2.13: Classification of marine ecosystem services quality**

**Recommendations:**

**2.1. Strengthen understanding and recognition of marine ecosystem services** by developing and applying ecosystem service valuation frameworks to quantify the economic, social, and ecological value of marine ecosystem services using recognised approaches (e.g., natural capital accounting, SEEA, and OA).

**2.2. Mainstream ecosystem services into national policy and planning to ensure long-term economic stability and the sustainability of ecosystem assets,** by integrating ecosystem service valuation into national accounting and Environmental Impact Assessments (EIAs) and policy making process, which allows policymakers to comprehend the true cost of environmental degradation.

**2.3. Protect and restore high-value ecosystem service areas as well as reduce threats** influencing the quality of ecosystem services.

**2.4. Mainstream NbS as cost-effective, resilient alternatives to hard infrastructure in climate adaptation and disaster risk reduction strategies,** delivering multiple co-benefits, including coastal protection, biodiversity conservation, carbon sequestration, and enhanced livelihoods.

**2.5. Strengthen monitoring of marine ecosystem services** by investing in long-term socio-ecological research to provide decision-makers with evidence needed for adaptive management, ensuring that policy remains responsive to environmental shifts.

**Key Message 3: Empirical evidence clearly indicates declining marine and coastal environmental quality. *(Well established)***

Available empirical evidence indicates that marine environmental quality in Thailand has deteriorated over recent decades. This decline is reflected in the increase frequency and severity of environmental pressures, including biological invasions, deteriorating water quality, marine debris, coral bleaching, coastal erosion, oil spills, eutrophication, and overfishing (Figure 2.14).

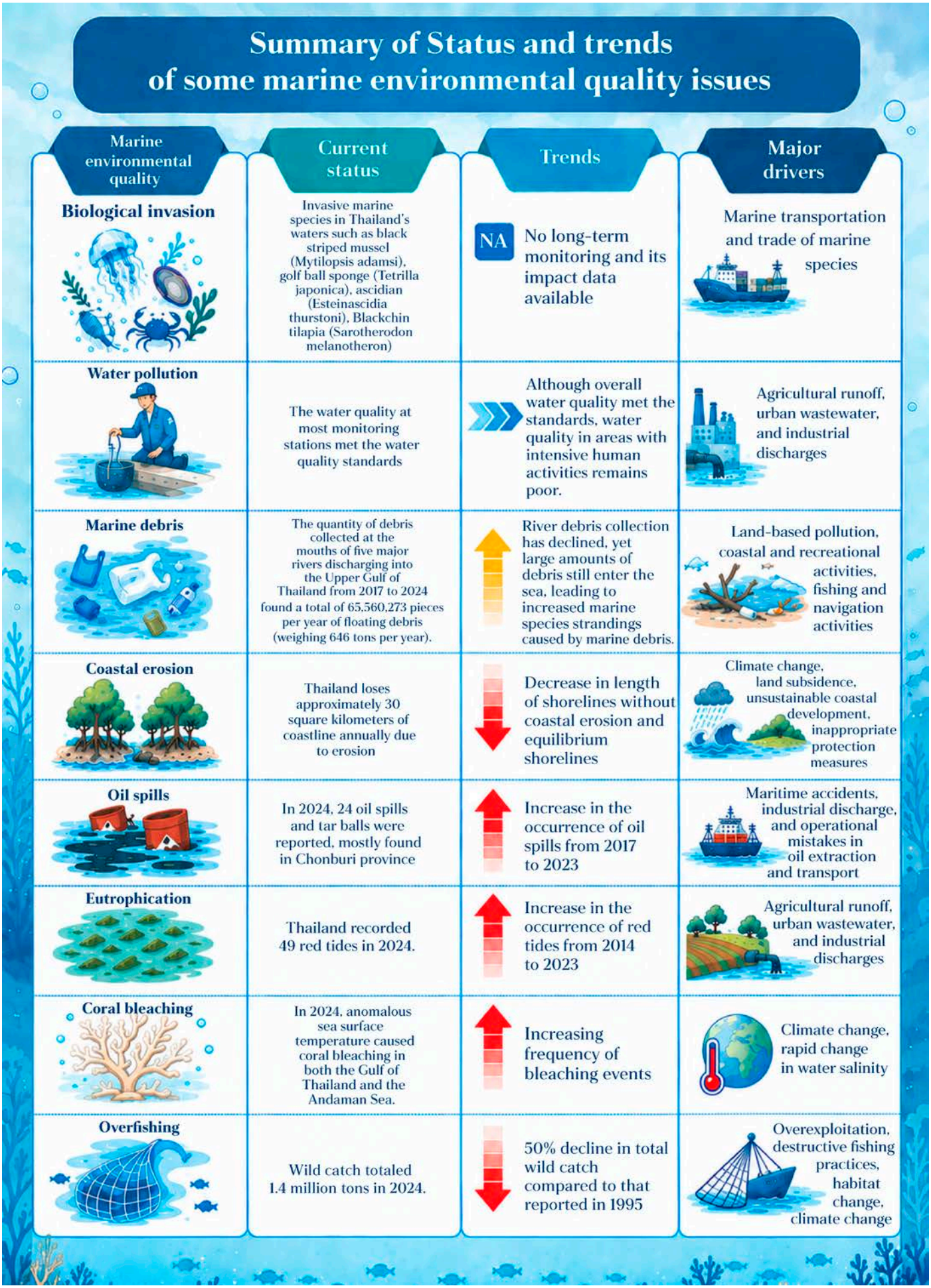



**Figure 2.14: Status and trend of some marine environmental quality issues**

**Recommendations:**

**3.1 Improve governance and policy coherence and strengthen cross-sector coordination** to address the cumulative and synergistic impacts by focusing integrated land-sea management approaches, including watershed, coastal, and marine environment to address upstream drivers such as nutrient runoff, sedimentation, and pollution.

**3.2 Enhance pollution management and enforcement particularly wastewater, solid waste, and marine debris** by implementing a combination of polluter pay principles, regulatory tools and economic incentives for circular economy and sustainable consumption.

**3.3 Apply EBFM to promote sustainable fisheries along with maintaining overall functional integrity of the marine environment and fisheries resources** such as eliminating IUU fishing, strengthening effective surveillance and enforcement while promoting co-management schemes.

**3.4 Promote sustainable marine tourism** by applying existing concepts such as sustainable tourism, regenerative tourism, and net-zero tourism, as a driver of conservation, less-impact generation, and fulfilling tourists' experiences,

**3.5 Restore degraded ecosystems and environment through passive and active restoration approaches** by removing local threats and stressors, and implementing active restoration activities such as mangrove plantation, seagrass transplantation, and coral reef restoration.

**3.6 Strengthen an integrated system that combines monitoring and citizen science to support effective emergency response and adaptive management.** This may include investing in real-time data systems, standardised indicators, and early warning tools for unprecedented events, while building local capacity in monitoring, compliance and local stewardship.

**Key Message 4: Despite progress made in research, monitoring and assessment, significant knowledge gaps remain to support evidence-based policymaking. *(Well established)***

Based on the assessment of existing knowledge on Thailand's Marine BES, four major gaps have been identified. These gaps limit effective conservation, sustainable management, and evidence-based decision-making as well as policy integration of marine resources.

Biodiversity information gaps: The availability and accuracy of data on the extent of marine ecosystems remain limited and inconsistent, for example, extent of coral reefs, actual extent of seagrass beds, key biodiversity areas located offshore. The lack of consistent, long-term monitoring restricts understanding of ecosystem health, cumulative impacts, and the effectiveness of conservation and restoration measures, making it difficult to establish effective ecosystem management. Thailand also lacks comprehensive baseline data on marine biodiversity, including unrecorded species, ecosystem connectivity, genetic diversity and ecological roles of species. In addition, data on trophic interactions, ecosystem resilience, and species vulnerability to climate change is limited, constraining the ability to assess ecological change, human impacts, and conservation effectiveness as well as climate change adaptive capacity.

Socio-economic and ecosystem services knowledge: Information on the socio-economic value as well as cultural values of marine ecosystems and their services is insufficient. Ecosystem services are rarely quantified or integrated into planning, leading to undervaluation and overexploitation. There is weak integration of ecological and socio-economic data, including limited use of international accounting frameworks. This limits the understanding of the linkages between ecosystems and human well-being, therefore leading to ineffective, non-evidence-based marine resource management.

Understanding on anthropogenic and natural impacts: The cumulative and synergistic effects of multiple stressors such as pollution, tourism and fishing practices, climate change, as well as land-sea interactions are not well understood. Gaps remain in identifying sources and pathways, types and magnitude of impacts, making it difficult to fully understand cumulative and synergistic impacts, localised climate change vulnerability, and long-term ecological impacts.

Ecosystem monitoring and restoration challenges: There is a significant lack of standardised methods and robust indicators for ecosystem monitoring and restoration, which affects effective assessment and long-term management of marine ecosystems. Currently, various institutions employ different methodologies for collecting data, analysing ecosystem health, and evaluating restoration outcomes. This inconsistency makes it difficult to compare results across locations or over time and prevents the establishment of a unified national or regional baseline. Public and community participation in monitoring and restoration is still limited. Stronger standardisation, coordinated protocols, and inclusive engagement mechanisms are needed to support effective marine conservation and restoration.

**Recommendations:**

**4.1 Promote and support research to close critical data gaps in biodiversity, ecosystems, and ecosystem services** as well as interdisciplinary approaches that link ecological conditions with socio-economic dimensions and integrate ILK.

**4.2 Advance understanding of cumulative and synergistic impacts by developing frameworks and models to assess the combined effects of multiple stressors**, including pollution, overfishing, tourism, and climate change. Strengthen land-sea integration to identify vulnerability hotspots and enable proactive management interventions.

**4.3 Establish a national long-term marine monitoring program and knowledge integration system with standardised indicators, methodologies, and advanced technologies** (e.g., eDNA, remote sensing, AI). This system should track ecological changes, distinguish natural variability from human impacts, assess restoration progress, and support adaptive management. It should also address data fragmentation by enabling cross-sector collaboration and data-sharing.

**4.4 Build institutional and technical capacity while promoting community and citizen science participation.** Provide adequate resources and training for central and local authorities, as well as stakeholders. Ensure sustained investment through national budgets and innovative financing mechanisms to support long-term monitoring and close knowledge gaps.

**4.5 Strengthen science-policy interfaces** by integrating biodiversity, ecosystem service values, and knowledge of cumulative and synergistic impacts, and ILK into economic and policy frameworks, thereby supporting evidence-based policy formulation and decision-making.

## Key Message 5: Improvement of monitoring and assessment is needed to close existing knowledge gaps. *(Well established)*

While the decline of Marine BES is well-documented, effective responses are often obstructed due to knowledge gap e.g., insufficient and fragmented data, inconsistent monitoring frameworks. Closing these knowledge gaps requires an improvement in monitoring frameworks towards a more robust, integrated approach to data collection that integrates diverse knowledge systems. This enhanced evidence-based approach which is critical for science-based policy making, ensures that conservation strategies are not only informed by the best available data but are also adaptive enough to support the long-term health of the ecosystem services.

**Recommendations:**

To strengthen marine biodiversity conservation and ensure effective management, a set of strategic recommendations is proposed. These recommendations aim to address existing knowledge gaps by enhancing monitoring frameworks, expanding research coverage, integrating multiple drivers of ecosystem change, and utilising innovative approaches. By aligning with international frameworks and incorporating both scientific and local knowledge, the recommendations provide a pathway for developing comprehensive and adaptive monitoring systems. They emphasise the importance of standardisation, inclusivity, and the use of cutting-edge technologies to generate reliable data and inform decision-making. Collectively, these strategies will support sustainable biodiversity management and strengthen national commitments to global conservation goals. Recommendations include:

**5.1 Development of National Biodiversity Monitoring protocols.** To enhance the effectiveness of environmental monitoring, it is essential to improve indicators to comprehensively capture biodiversity, including genetic diversity, ecosystem services, and socio-economic dimensions. This requires the standardisation of data collection methodologies to ensure consistency, continuity, and comparability across time and regions. Furthermore, monitoring protocols should align with internationally recognised frameworks such as the IPBES Conceptual Framework and the KMGBF Monitoring Framework, ensuring coherence with global conservation and sustainability goals. Given the knowledge gaps identified in the previous section, there is a critical need to improve selected indicators to strengthen the existing comprehensive ecological assessment of marine biodiversity and ecosystem services (See Appendix 6-2 table A6-2.2). Additionally, mechanisms supporting data management and the integration of biophysical and socio-economic information in line with international frameworks, particularly the SEEA and OA should be developed.

**5.2 Expanding assessments beyond coastal zones.** It is important to strengthen research on ecologically important offshore ecosystems, including underwater pinnacles, offshore platforms, and pelagic zones by promoting comprehensive research efforts in different aspects such as ecological dynamics, species interactions, ecological connectivity, and the impacts of human activities such as fishing, shipping, and resource extraction.

**5.3 Integrating anthropogenic and natural drivers and pressures.** To understand ecosystem change and support informed decision-making, biodiversity assessments should integrate both anthropogenic and natural drivers to provide a comprehensive understanding of their combined impacts on marine biodiversity and ecosystems. Effective biodiversity management requires a holistic and systematic approach that recognises land-sea interactions and ecological interconnectedness, particularly the influence of upstream land-use change, deforestation, agricultural runoff, and urban development on marine ecosystems and the delivery of ecosystem services. Assessments should also incorporate climate vulnerability and resilience metrics, including projections of climate-related phenomena such as sea-level rise, increasing sea surface temperatures, and ocean acidification, as well as their impacts on species, habitats, and coastal communities. By addressing cumulative pressures arising from both human activities and natural processes, such integrated assessments can better identify cross-sectoral and spatially coordinated solutions, ultimately strengthening policy formulation, management strategies, and conservation outcomes.

**5.4 Leverage cutting-edge technology and participatory monitoring approaches to enhance data collection and to support effective ecosystem monitoring systems.** Effective ecosystem monitoring requires the integration of innovative technologies, participatory approaches, and the inclusion of diverse knowledge systems. Innovative technologies such as remote sensing, Geographical Information System (GIS), and Artificial Intelligence (AI) technologies, offer powerful tools for assessing habitat changes and ecosystem health at various scales, enabling timely and data-driven decision-making. Molecular tools such as environmental DNA (eDNA) are also useful for detecting biodiversity, including marine threatened species, and stable isotope analysis can be also used to explore ecological interactions, species distributions, and overall ecosystem functioning. To strengthen monitoring efforts and foster stewardship, the inclusion of citizen science and community engagement is essential, promoting participatory monitoring and surveillance and enhancing local ownership and capacity as well as their environmental awareness. Additionally, integrating ILK with scientific data not only helps validate findings but also builds common understandings and more effective communication among stakeholders, ultimately leading to more inclusive and robust ecosystem management.

# 3 | Drivers, Pressures and Impacts



## 3.1 Introduction

This chapter will discuss the driving forces (Drivers) and Pressures that contribute to changes in marine biodiversity and ecosystem services, both positively and negatively, creating impacts on the environment and human well-being. The main driving forces, both at global and national level are population growth and economic development patterns. For Thailand, although population growth has been low during the last several decades, there has been a shift in demographic structure as the population ages. These driving forces have increased pressures on Marine BES. Such pressures, which are mainly anthropogenic activities, have been intensified by climate change. The state of marine and coastal resources in Chapter 2 demonstrates the increasing trend of marine resource degradation and negative impacts on marine resources and consequently impacts on human well-being (human security). Based on the state of Marine BES presented in Chapter 2, the following sections discuss detail of each element, drivers, pressures, and impacts, and the relationships among these elements (Figure 3.1)

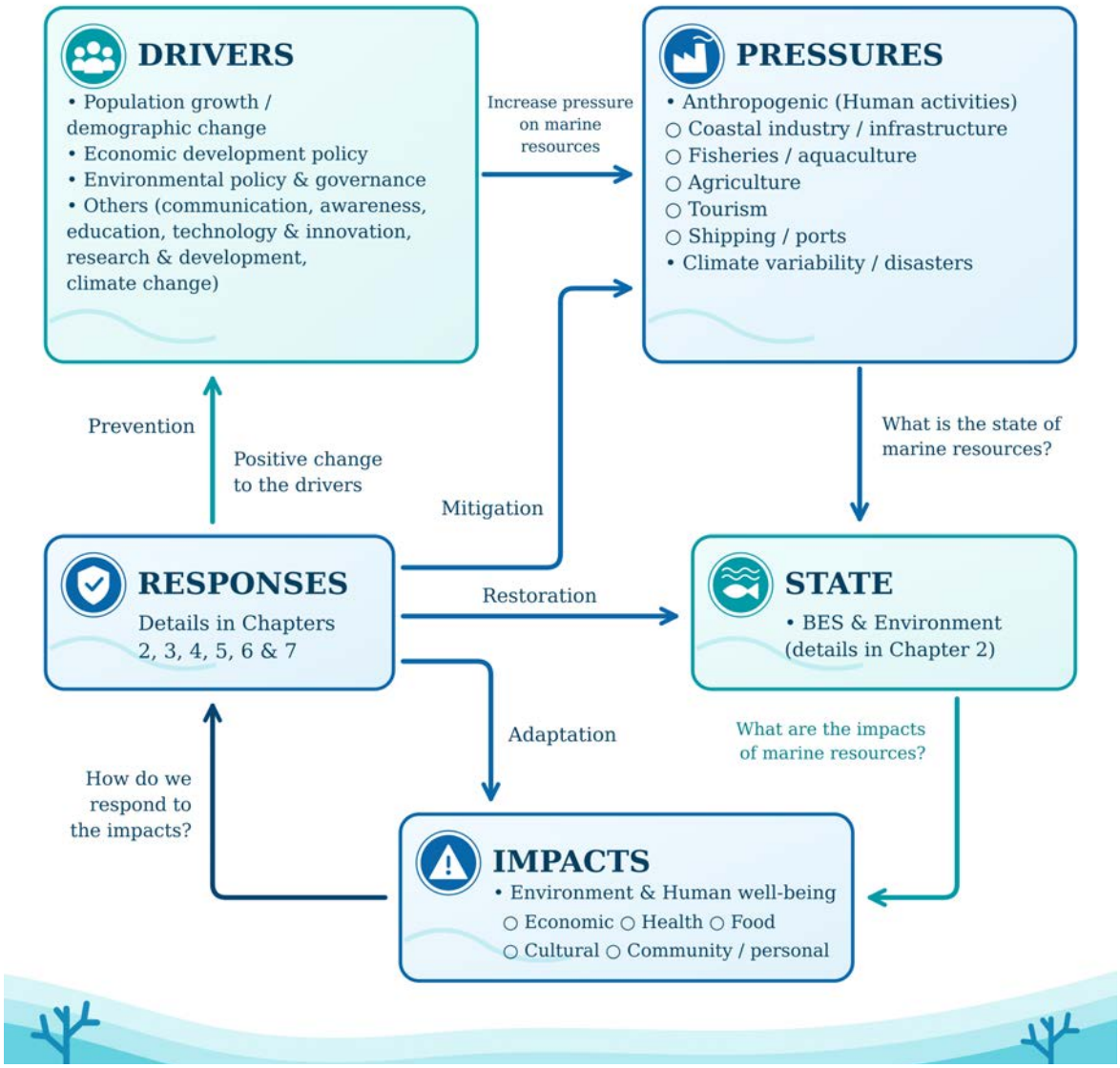



**Figure 3.1: Drivers Pressures and Impacts that contribute to change in Marine BES**

## 3.2 Drivers

Globally, the demand for marine and coastal resource utilisation is increasing due to the continuous growth of the world population. As of 14 January 2025, the global population stands at 8.19 billion people, marking a steady rise over time—an increase of 2 billion since 1998 and 1 billion since 2010. Projections indicate that by 2050, the population will reach 9.7 billion (Worldometer, 2025) and is expected to peak at approximately 10.4 billion in the mid-2080s. However, the current population growth rate is declining compared to past trends (Macrotrends, 2025). Factors contributing to global population growth include average fertility rate of 2.24 (Worldometer, 2025A), an average life expectancy of 73.49 years (Macrotrends, 2025), and migration.

The global coastal population continues to grow steadily. One study found that the highest concentration of the world's population, nearly 10%, lives within 5 km of the coast (Cosby&Lebakula, 2024). This trend is particularly evident in Asia, where countries such as China, India, Indonesia, and Pakistan account for 60% of the world's coastal population. The high population density in coastal areas has driven infrastructure development, playing a crucial role in both national and global economic growth.

In the context of Thailand, the principal drivers underlying changes in Marine BES are predominantly economic forces, arising from market mechanisms and government policy instruments. These economic drivers interact closely with demographic transitions, which reshape consumption patterns and subsequently emerge as significant social drivers. Collectively, these economic and social drivers influence the direction and intensity of human use of natural resources, resulting in both positive and negative impacts on Marine BES.

### 3.2.1 Demographic structure in Thailand

Over the past 16 years (Figure 3.2 left), the trend shows a continuous increase from 2008 to 2019. In 2019, the registered population reached its peak at 66,558,935 people. However, since 2020, the trend has reversed, with a gradual decline. By 2023, Thailand's registered population had decreased to 65,061,190 people, with a population density of 128.7 people/km² (DOPA, 2024). In the 23 coastal provinces, the population trend from 2008 to 2019 showed a continuous increase, similar to the overall national population trend. In 2019, the coastal population reached its peak at 15,900,440 people, accounting for 24% of the total national population. However, from 2020 to 2023, the population remained relatively stable with no significant changes. In 2023, the registered population in the coastal provinces was 15,859,572 people (DOPA, 2024). The coastal provinces with the highest population densities are Samut Prakan, Phuket and Samut Sakhon respectively. Despite the stable population, Thailand is now facing demographic shifts, characterised by a declining labor force and a transition into an aging society.

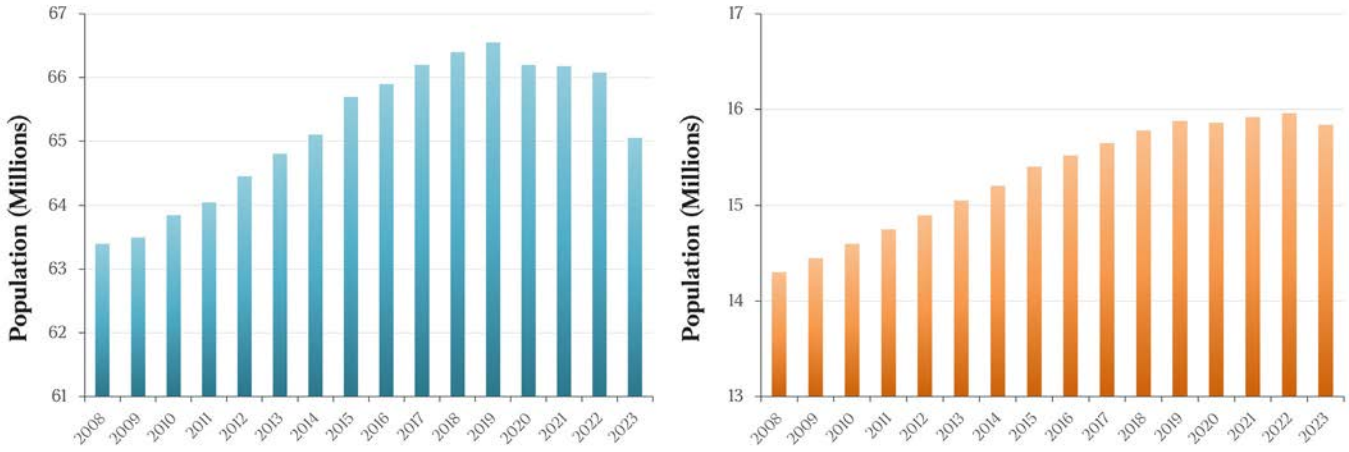



**Figure 3.2: The registered population from 2008-2023 in Thailand (left) and 23 coastal provinces (right) (Modified from: DOPA, 2024)**

The United Nations has identified key factors influencing population change, including fertility rates, life expectancy, and migration. In 2023, the Institute for Population and Social Research at Mahidol University (2024) reported that Thailand's fertility rate was 1.1, which is lower than the global average. The average life expectancy was 71.9 years for males and 79.9 years for females. These two factors hardly increase the overall population size of the country, but they create changes in population structure. Such changes include the declining proportion of the working-age population and the transition into an aging society.

**Migration:** Another factor influencing domestic population change is migration. According to Figure 3.3, the migration rate during 2011– 2024 decreased compared to the rate during 2011–2012. The highest migration occurred in 2012, with 935,338 people moving into rural areas and 526,710 people moving into urban areas (NSO, 2025). Since then, migration trends have shown a significant decline. Between 2011 and 2021, the number of people migrating to rural areas was higher than those moving to urban areas. This trend may be attributed to several factors, such as the larger population base in rural areas due to the fact that Thailand's primary occupations are agriculture and fishing. People's livelihoods depend on natural resources. Additionally, migration back to hometowns to care for family members or inherit property may also contribute to this trend. According to data from TDRI (2024), most migrants work in temporary jobs that lack stability and can be terminated at any time.

In 2022, 526,710 people migrated to urban areas, while 373,000 people moved to rural areas. By 2024, 443,300 people migrated to urban areas, and 355,400 people moved to rural areas (NSO, 2025). This indicates that from 2022–2024, migration to urban areas exceeded that to rural areas. A possible explanation for this shift is the post-COVID 19 economic recovery, which has led to increased employment opportunities in urban areas.

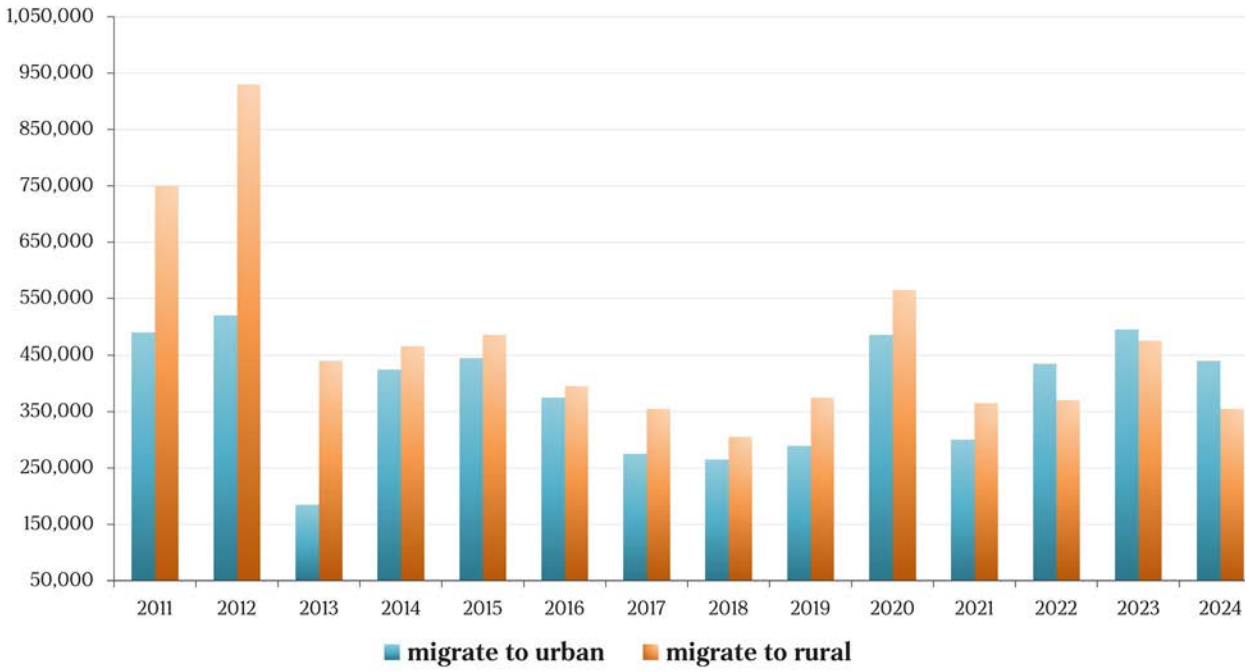



**Figure 3.3: Rural-Urban migration in Thailand during 2011–2024 (Modified from: NSO, 2025)**

**Latent population:** A survey latent population[8] is one of the databases for relevant agencies to use in planning and policy formulation for resource and public utility management. The change in latent population is related to three main groups; visitors, foreign laborers, and homeless people. This results in fluctuations in the population, especially in urban and coastal areas, affecting both local economies and social systems.

At the national level, the trend for the latent population is an increase (Figure 3.4). In 2018, the total latent population was 7,903,525 people, rising to 9,252,900 people in 2023. The latent population in the 23 coastal provinces (Figure 3.5) was 3,333,900 people in 2023, accounting for

an average of 36.03% of the total latent population nationwide. The top four provinces with the highest latent populations are Chonburi, Samut Prakan, Samut Sakhon, and Rayong (NSO, 2024).

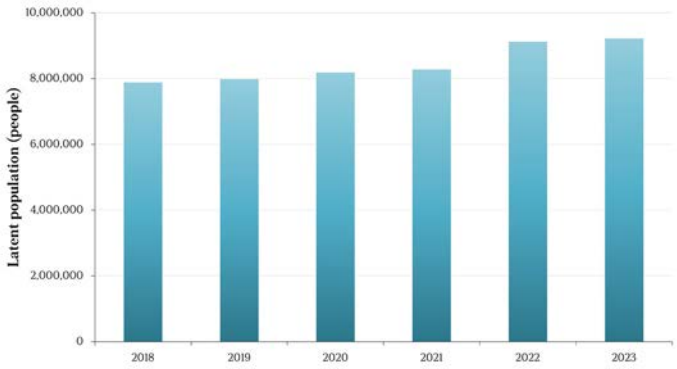



**Figure 3.4: The latent population in Thailand during 2018–2023 (Modified from: NSO, 2024)**

[8] The latent population refers to the population that resides, studies, or works in a province without officially changing their residence registration. It is divided into two types: commuter population and non-registered population

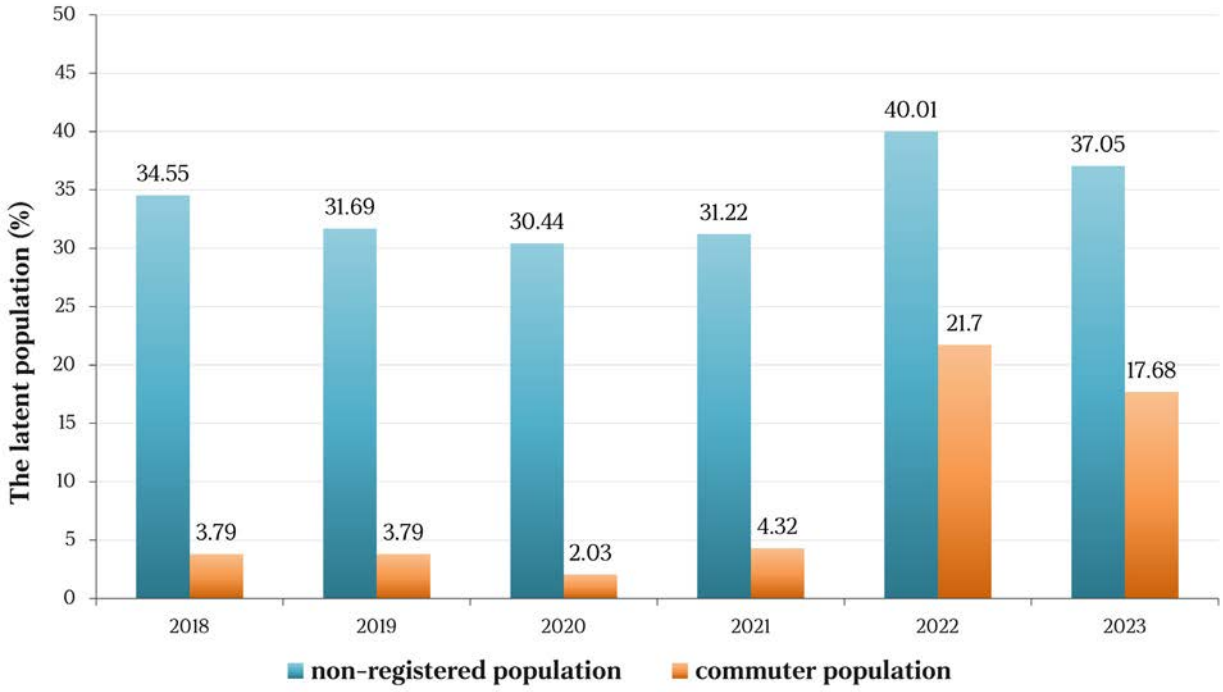



**Figure 3.5: The percentage of latent population in 23 coastal provinces during 2018–2023 (Modified from: NSO, 2024)**

In 2022, The highest percentage of non-registered population and commuter population in 23 coastal provinces was 40.01 and 21.70, respectively (NSO, 2024). Data from 2023 indicates that the non-registered population has decreased compared to 2022. However, when examining the overall trend over the past five years, both the non-registered population and the commuter population have increased.

A rise in the non-registered population can complicate management of resources. This group consists of individuals who reside in the area and utilise local resources without a clear intention to live in the area. As a result, local authorities face increased difficulty in planning and delivering essential services like healthcare, education, and infrastructure for these hidden populations.

**Foreign worker:** Over the past 10 years (2013–2023), as shown in Figure 3.6, the number of legally authorised foreign workers in Thailand has shown a continuous increase. The highest recorded number was 3,005,376 people in 2019. However, between 2020 and 2023, the numbers have fluctuated without a clear upward or downward trend. The proportion of foreign workers in the 23 coastal provinces has shown a steady decline. In 2013, they accounted for 58.85% of all migrant workers nationwide, while by 2023, the figure dropped to 44.07%, with a total of 2,613,373 legally authorised foreign workers (DOE, 2024). The top four coastal provinces with the highest number of foreign workers are Samut Sakhon, Samut Prakan, Chonburi, and Surat Thani.

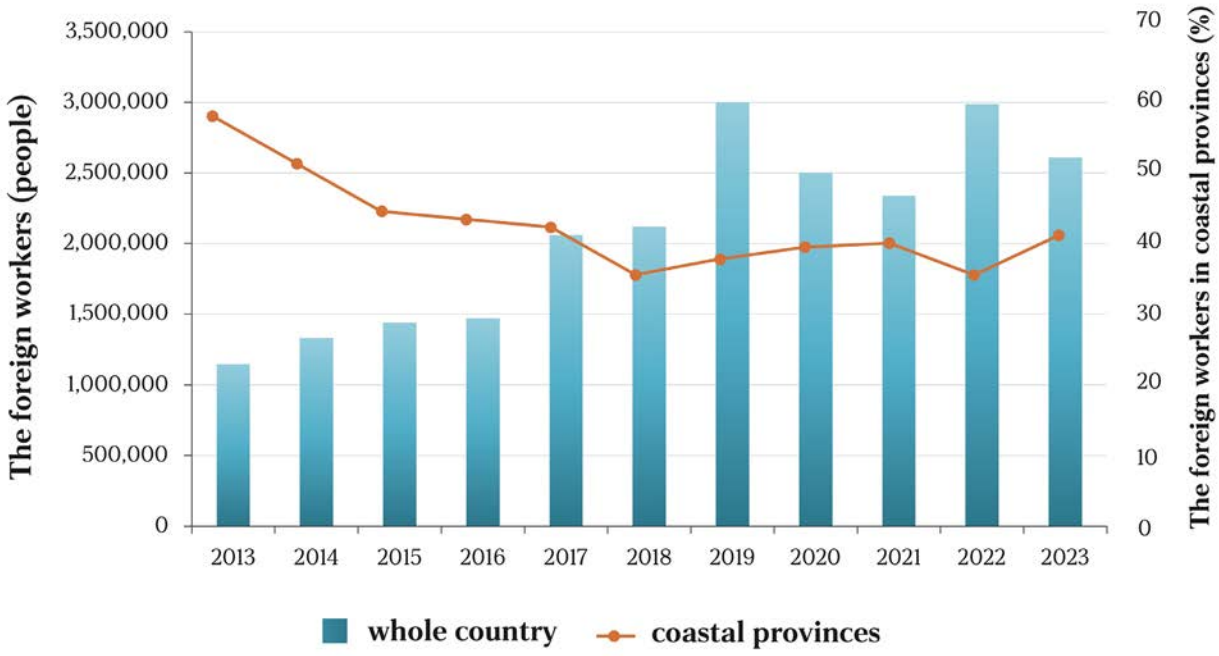



**Figure 3.6: The number of foreign workers in country and the percentage of foreign workers in 23 coastal provinces during 2013-2023 (Modified from: DOE, 2024)**

Although the proportion of foreign workers in coastal provinces has declined relative to the foreign workers as a whole, coastal provinces that function as key centers of economic activity and industrial development continue to host a high concentration of foreign workers. Notably, however, the majority of migrant workers remain geographically concentrated in non-coastal provinces.

**Ethnic groups:** There are approximately 60 ethnic groups spread across the country. Among these, 19 ethnic groups are found across 18 coastal provinces. Notably, there are 3 ethnic groups whose settlements and livelihoods are closely connected to the sea and coastal areas such as Urak Lawoi, Moklen, Moken (SAC, 2024).

In Thailand, shift in population structure—particularly the transition to an aging society at both the national level and across the 23 coastal provinces—have affected the labor system, resulting in a decline in the working-age population. This trend, together with shifts in consumption patterns and internal migration toward urban and coastal economic centers, has led to significant changes in coastal land use and an increased demand for public services. These dynamics are most pronounced in ethnically diverse coastal areas, leading to changes in traditional livelihoods, settlement patterns, and socio-cultural practices among long-established ethnic groups and local communities.

Furthermore, the presence and utilisation of latent populations have exerted increasing pressure on local resources and services, thereby imposing additional burdens on the management of resources and the provision of public services by local governments.

## 3.2.2 Economic development trend in Thailand

- **Socio-economic**

In 2022, Thailand's economic growth showed significant contributions from both national and regional outputs: The Gross National Product (GNP) THB 16.8 trillion (T) and Gross Domestic Product (GDP) THB 17.4 T. The Gross Provincial Product (GPP) of the 23 coastal provinces combined accounted for THB 5.62 T, representing approximately 32% of GDP (Figure 3.7) (NESDC, 2022). This indicates the substantial economic contribution of the coastal regions, driven primarily by industries related to marine resources, tourism, and logistics (i.e. the value of marine activities).

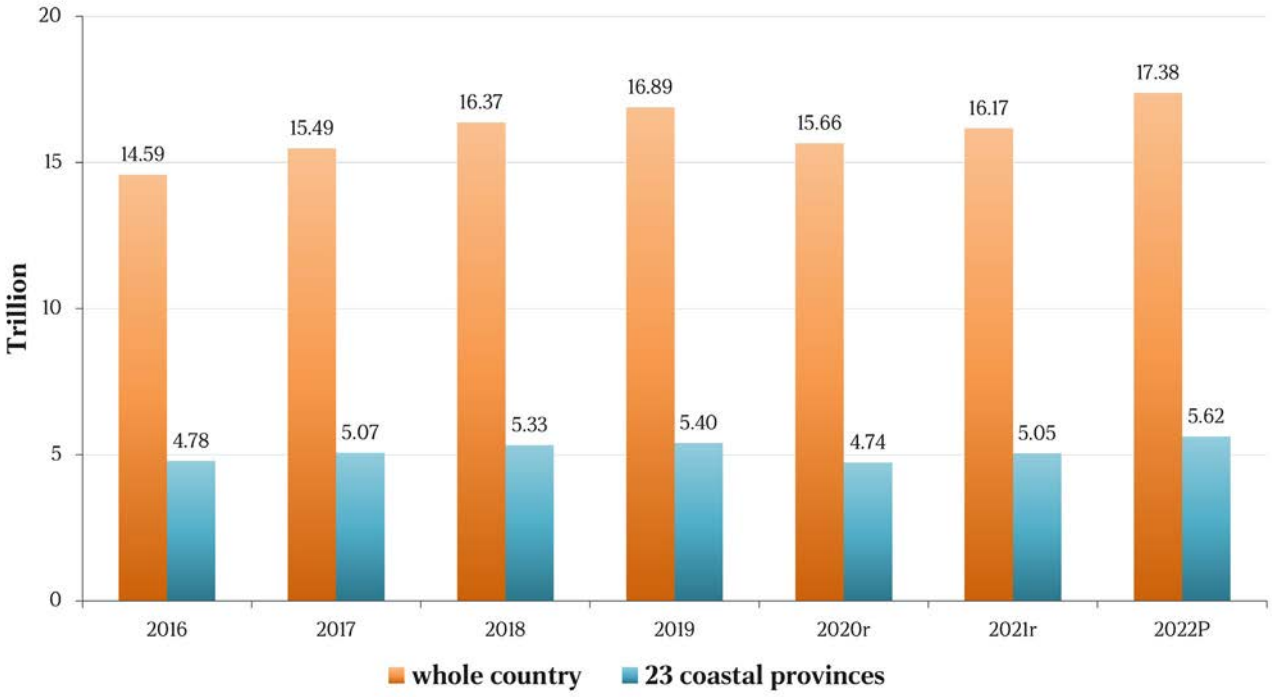



**Figure 3.7: GDP and GPP in 23 coastal provinces during 2016–2022 (Modified from: NESDC, 2022)**

Another indicator that Thailand uses to reflect the changing economic and social conditions is the poverty line and the headcount ratio[9]. According to Figure 3.8, the poverty line, which indicates the minimum standard expenditure necessary for an individual to sustain a living in society, has shown a continuous upward trend at the national level. In 2017, the basic expenditure was THB 2,689.5 per person per month, which increased to THB 3,043 per person per month in 2023. Meanwhile, the headcount ratio was 8.30% in 2018 and has shown a decreasing trend, with a proportion of 6.32% in 2023 (NESDC, 2024).

[9] headcount ratio is the percentage of the population living below the national poverty line. Thailand's NSO is used alongside the NESDC to track national socio-economic indicators (NSO, 2025).

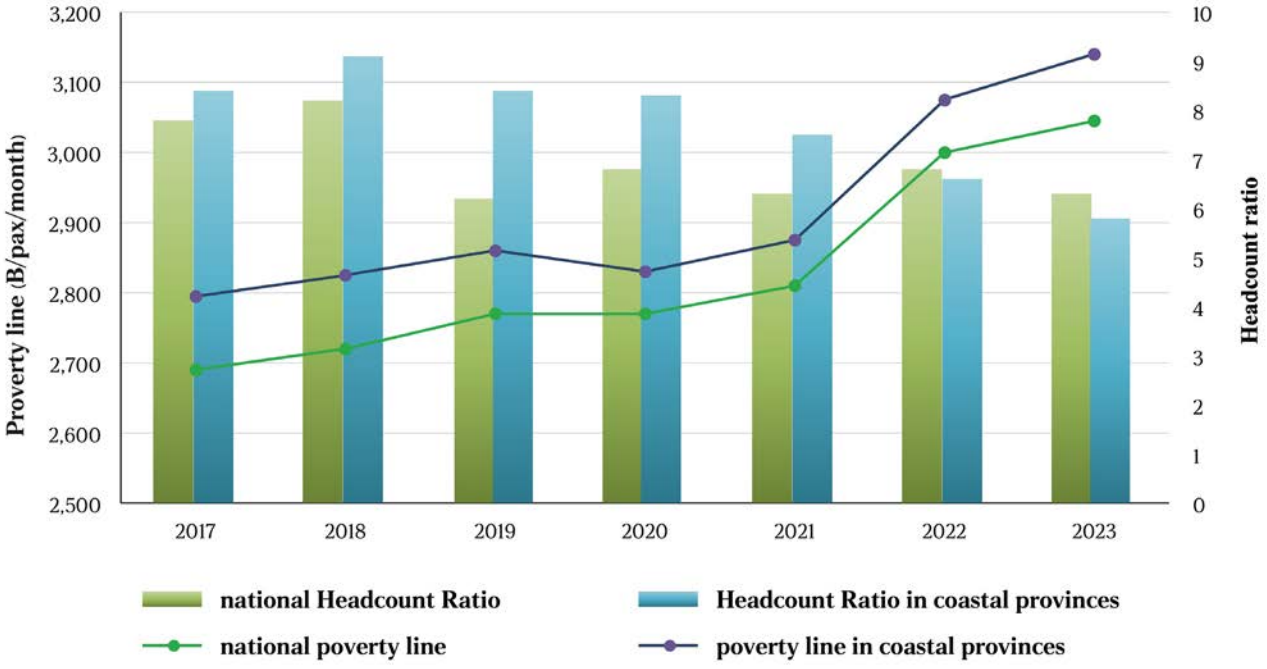



**Figure 3.8: The national headcount ratio and national poverty line in Thailand and 23 coastal provinces during 2017-2023 (Modified from: NESDC, 2024)**

For 23 coastal provinces, the poverty line has gradually increased. In 2017, the basic expenditure was THB 2,791 per person per month, which increased to THB 3,134 per person per month in 2023. The headcount ratio peaked at 9.10% in 2018 but has since declined, reaching 5.70% in 2023 (NESDC, 2024).

Based on the information above, the 23 coastal provinces account for nearly one-third of the country's GDP, highlighting their critical role in driving national economic growth. This figure indicates that local economies in these areas have shown signs of recovery and that the proportion of people living in poverty has declined. However, despite these positive trends, residents continue to face rising living costs.

The strong economic contribution of the 23 coastal provinces—accounting for nearly one-third of national GDP—indicates intensified economic activity concentrated along the coast. This recovery and reduction in poverty typically coincide with increased demand for employment, food, energy, transportation, housing, and tourism infrastructure. As many of these livelihoods and economic sectors depend directly on marine resources, the expansion of coastal and marine-based activities places additional pressure on Marine BES.

Rising living costs further reinforce this pressure by incentivising higher levels of resource exploitation. Coastal communities may increase fishing effort, aquaculture production, coastal development, or participation in tourism-related activities to maintain household incomes. At the same time, growing economic activity drives greater maritime transport, land-based pollution, and coastal industrial expansion. Together, these dynamics heighten pressures on Marine BES through overextraction of living resources, habitat degradation, pollution, and increased competition for space and ecosystem services, potentially undermining the long-term resilience and sustainability of marine ecosystems despite short-term economic gains.

### 3.2.3 Economic development and environmental policy in Thailand

At the national level, economic development in recent decades has been guided by the 20-Year National Strategy (2017-2036). The framework comprises six distinct strategies, each with varying degrees of relevance to maritime issues, for example: Strategy 1: Security & Sovereignty focuses on safeguarding national interests in both terrestrial and marine resources, with particular emphasis on coastal and oceanic assets; Strategy 2: Competitiveness Enhancement promotes the sustainable use of biodiversity to create added value and encourages research and innovation related to Marine BES; and Strategy 5: Environmentally Friendly Quality of Life aims for sustainable growth alongside biodiversity conservation and restoration. Based on this 20-year framework, 5-year National Economic and Social Development Plans are developed. Currently, we are implementing the 13$^{th}$ National Economic and Social Development Plan (NESDP: 2023-2027). The NESDPs are supplemented by regional development plans.

One of the marine-related government initiatives at the regional level is the Eastern Economic Corridor (EEC) aimed at achieving high-income status by 2036, as laid out in the 20-Year National Strategy. This "Thailand 4.0" strategy aims at transforming the country with innovative, value-based industries. The EEC initiative focuses on high-tech industries, smart ports, and logistics hubs as well as biofuel and biochemicals industries using the Bio-Circular-Green Economy (BCG) to promote economic development in the region. It aims at enhancing the existing development at Laem Chabang and Map Taput areas as well as expanding development activities into Chachengsao.

In the past most of the economic and social development plans focused mainly on economic benefits. Recently, Thailand has achieved considerable progress in mainstreaming environmental issues into the economic and social development plans. These include the National Environmental Quality Management Plan (2023–2027), the Climate Change Master Plan (2015–2050), NBSAP (2015–2021), and the Marine and Coastal Resources Management Plan. These plans have been developed as positive drivers for the environment including Marine BES. More detailed discussion is in Chapter 6.

### 3.2.4 Natural drivers

Thailand is among the countries most vulnerable to climate change. This means the country is highly exposed to extreme weather events such as floods, droughts, storms, and landslides. Rapid urban expansion and infrastructure development in coastal areas have further intensified these climate risks. Climate change has also put pressure on natural resources in coastal areas, increasing vulnerability of Marine BES that supports livelihoods, food security, and disaster risk reduction.

From 2000 to 2022, Thailand's greenhouse gas (GHG) emissions increased steadily, primarily in the energy and transport sectors (65.89% of total emissions), followed by agriculture (17.86%). In 2022, total emissions reached 385,941.14 kt$CO_2$eq, nearly 1% of global emissions (DCCE, 2024). Without effective mitigation, climate change will lead to sea-level rise, more frequent extreme weather, higher sea surface temperatures, and ocean acidification. These changes directly threaten Marine BES by accelerating coral bleaching, degrading coastal and marine ecosystems, and disrupting marine food webs that underpin fisheries and coastal livelihoods.

Climate change adversely affects human well-being, public health, food security, and the economy. Damage from storms and flooding affects coastal communities, while rising temperatures increase vector- transmitted and respiratory diseases. Degradation of Marine BES undermines fisheries

productivity and food security. It also weakens ecosystem services that support tourism, a key economic sector in Thailand that relies heavily on climate-sensitive marine ecosystems such as coral reefs. To address these risks and safeguard Marine BES, Thailand has set a national target to reduce greenhouse gas emissions by 40%, equivalent to 222 $mtCO_2eq$, as a critical step toward enhancing climate resilience and sustaining marine (DCCE, 2024).

### 3.2.5 Other drivers

According to Figure 3.1, other drivers may include communication, awareness, and education, science and technology development, financial resources, and implementation and law enforcement, which can all be positive and negative for the environment. These drivers can also be identified as responses, the detail of which is discussed in Chapter 6.

## 3.3 Pressure

Pressures refer to human activities that create impacts on the environment and human well-being. In the marine sector, major human activities are tourism, maritime transportation, fisheries and aquaculture, coastal industry and agriculture, and offshore oil and gas. These human activities have put a lot of pressures on the marine resource base; these activities are described in detail below.

### 3.3.1 Tourism

In 2023, the global tourism sector, particularly in terms of tourism revenue, began to recover to levels close to those of 2019, the year before the COVID-19 pandemic. However, this differs from Thailand's tourism sector, which, despite its continuous recovery, has not yet reached conditions similar to those of 2019. Nonetheless, the forecasted number of both international and domestic tourists in 2023 is expected to meet the target of approximately 25-27 million people, although tourism revenue remains slightly below the target.

According to data from the Ministry of Tourism and Sports (Figure 3.9), from 2015-2019, both domestic and international tourist numbers increased steadily, contributing to a consistent rise in total tourism revenue. The number of tourists and amount of revenue show the highest peak in 2019, then there was a significant decline in the number of tourists and income during the COVID-19 pandemic period from 2020 to 2022. Then, since 2022, as the severity of the COVID outbreak has decreased, the number of tourists and income has rapidly increased.

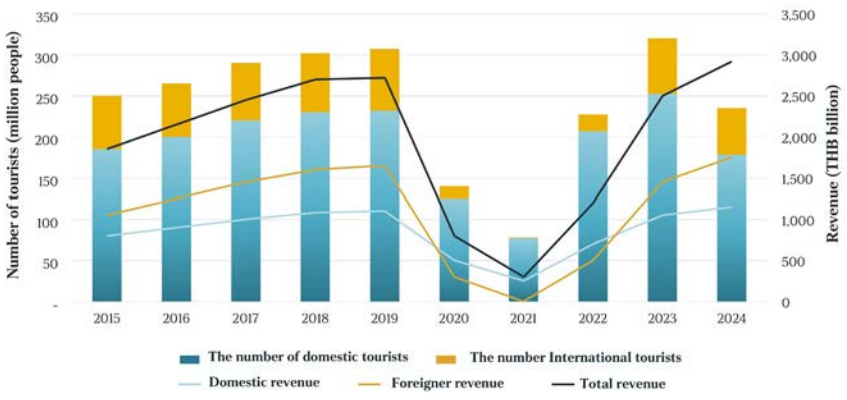



**Figure 3.9: The number of tourist arrival and revenue in Thailand during 2015–2023P (Modified from: MOTS, 2024)**

For coastal provinces (Figure 3.10), the number of tourists and revenue continuously increased from 2015-2019, a sharp decline in tourist numbers and revenue occurred during 2020-2021 because of COVID-19. However, after the pandemic domestic tourism increased significantly in 2022 and continued to increase in 2023 but dropped significantly dropped in 2024. On the other hand, after the pandemic foreign tourists slightly increased in 2022 and significantly in 2023. The rise in the number of domestic tourists was significantly higher than the international tourists during the recovery period (2022–2023). In terms of revenue, while there is an increasing trend in both domestic and international tourism, the revenue for international tourism is significantly higher, underscoring the importance of international tourism in driving the Thailand economy.

In 2024, the number of tourists in coastal provinces surged to 128 M, while tourist spending reached a total of THB 1,215,475 M. In 2022, the Gross Value Added (GVA) in the tourism industry was THB 1,119,025.71 M, with a growth rate of 39.81% compared to the previous year (MOTS, 2024). According to the National Accounts on Tourism for 2022, the Southern region had the highest GVA in domestic tourism, which is even much higher than the foreign tourism.

Cruise ships represent another important emerging sector of tourism. Thailand has become increasingly popular among international travelers as a key cruise ship destination. According to data from the Thai Maritime Enforcement Command Center (2024), the average annual expenditure generated by tourists from this activity amounted to THB 1.89 B. There were a total of 162 cruise calls in Thailand, bringing in about 379,036 tourists (Figure 3.10)

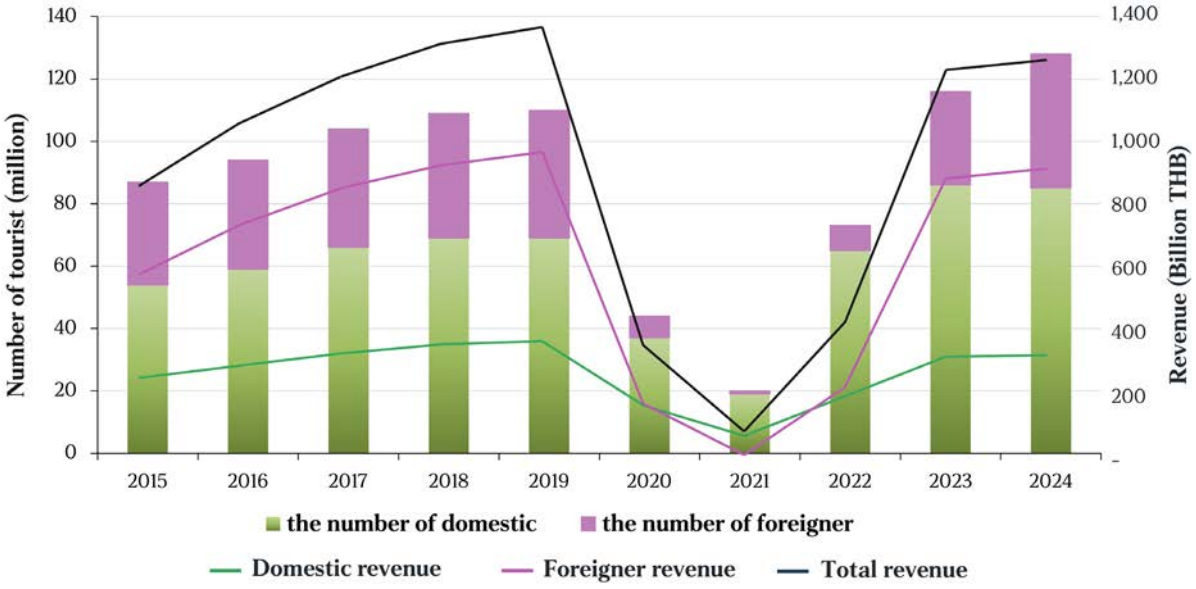



**Figure 3.10: The number of tourist arrival and revenue in 23 coastal provinces during 2015–2024 (Source: MOTS, 2024)**

Table 3.1 shows that the main cruise terminal on the Andaman coast is Ao Patong in Phuket, which recorded the highest number of arrivals with 63 cruise trips and 177,109 passengers. Meanwhile, on the GoT side, the main cruise terminal is Laem Chabang port in Chonburi, which also recorded 62 cruise calls with a total of 115,212 passengers.

**Table 3.1: Statistic data of cruise terminals in 2024**

| Cruise terminals | the number of cruise cal | the number of passengers |
|---|---|---|
| **Andaman coast** | | |
| Ao Patong, Phuket | 63 | 177,109 |
| Phuket deep sea port | 27 | 74,442 |
| **GoT** | | |
| Laem Chabang port, Chonburi | 62 | 115,212 |
| Koh Samui, Surat Thani | 50 | 94,681 |
| Sriracha habour, Chonburi | 3 | 5,727 |

(Modified from: Thai-MECC, 2024)
Note: One cruise trip may involve multiple port calls

Thailand is one of the world's leading tourism destinations, making tourism a major source of national income. However, the rapid increase in tourist numbers beyond the carrying capacity of many destinations has generated substantial pressure on marine ecosystems. Tourist activities exert multiple forms of impact on coastal environments, including trampling on beaches and coral reefs, increased marine debris and wastewater discharge, and the expansion of coastal resorts and infrastructure, which accelerates sediment runoff into the sea.

Ecologically fragile areas, particularly small islands, face heightened demand for energy and freshwater resources, placing additional stress on local ecosystems and disrupting the livelihoods of coastal communities. In the absence of effective management, resource use in tourism areas frequently exceeds ecosystem thresholds, undermining the resilience of marine systems. At the same time, the growing number of cruise ships imposes direct pressures on marine ecosystems through anchor damage to coral reefs, air and water pollution, underwater noise that disturbs marine fauna, and the introduction of invasive species via ballast water discharge. Collectively, these cumulative impacts accelerate the ongoing degradation of Marine BES, raising serious concerns about the long-term sustainability of Thailand's coastal and marine environments.

### 3.3.2 Maritime transportation

Shipping and ports are among the main contributors to the maritime economy for Thailand and include port activities, maritime transportation, shipbuilding and repair, as discussed below.

Major ports in Thailand include Bangkok Port, Laem Chabang Port, and Map Ta Phut Industrial port. These ports serve as critical hubs for Thailand's maritime trade and logistics network. The Port Authority of Thailand (PAT) which is a state enterprise under the jurisdiction of the Ministry of Transport is responsible for Bangkok Port and Laem Chabang Port, while the Industrial Estate

Authority of Thailand under the Ministry of Industry is responsible for Map Ta Phut Industrial Port. Si Racha Port is primarily operated by private port operators—led by Sriracha Harbour Public Company Limited—under regulatory oversight by Thailand's Marine Department (MD). (Sriracha Harbour, 2026)1

Bangkok Port is located near the urban center and mainly handles consumer goods, agricultural products, and light industrial cargo, with an emphasis on domestic distribution and smaller-scale container traffic. Laem Chabang Port, the largest deepsea port in Thailand, serves as the country's principal hub for containerized cargo, automobiles, machinery, and large-scale international trade. In contrast, Map Ta Phut Port is a specialised industrial port that primarily handles energy-related cargo, including petroleum, natural gas, and petrochemical products supporting heavy industry. Si Racha Port, part of the Eastern Seaboard industrial zone, functions as an important private deep-sea and industrial port, handling bulk cargo, break-bulk cargo, containers, and energy-related commodities, while supporting nearby industrial estates and complementing Laem Chabang's logistics operations. (Unisco, 2025)2

Table 3.2 shows port performance indicator such as ship calls, cargo and container throughput in two major ports, i.e. Bangkok Port and Laem Chabang Port in 2021-2023. The performance of Laem Chabang Port was better than Bangkok Port. The number of ship calls at Bangkok Port fluctuated; it decreased from 4,170 in 2021 to 3,937 in 2023 while the ship calls at Laem Chabang Port slightly rose from 11,041 in 2021 to 11,692 in 2023. Moreover, the volume of cargo and container throughput in 2023 at Laem Chabang Port reached 94.100 MT and 8.676 TEUs respectively, compared to the volumes at Bangkok Port which were 18.536 and 1.259 TEUs.

**Table 3.2: Port performance at Bangkok Port and Laem Chabang Port**

| indicators | Bangkok Port | | | Laem Chabang Port | | |
|---|---|---|---|---|---|---|
| | 2021 | 2022 | 2023 | 2021 | 2022 | 2023 |
| Ship call | 4,170 | 4,549 | 3,937 | 11,041 | 11,696 | 11,692 |
| Cargo throughput (MT) | 21.185 | 18.667 | 18.536 | 90.485 | 96.490 | 94.100 |
| Import | 13.275 | 12.077 | 11.415 | 38.919 | 39.568 | 40.590 |
| Export | 7.910 | 6.590 | 7.121 | 50.566 | 55.926 | 52.627 |
| Transhipment | NA | NA | NA | 1.000 | 0.996 | 0.883 |
| Container traffic (M TEU) | 1.438 | 1.277 | 1.259 | 8.419 | 8.730 | 8.676 |
| Import | 0.894 | 0.825 | 0.776 | 4.189 | 4.437 | 4.360 |
| Export | 0.544 | 0.452 | 0.483 | 4.147 | 4.293 | 4.316 |

(Modified from: PAT, 2024)

[10] https://srirachaport.com/en/services

[11] https://www.unisco.com/international-ports/sri-racha-thailand https://srirachaport.com/en/services

Map Ta Phut Industrial Port is located in the Map Ta Phut Industrial Estate on the eastern part of the GoT. It is one of Thailand's major deep-sea ports, particularly serving the petrochemical and energy industries. Map Ta Phut Industrial Port is managed by the Industrial Estate Authority of Thailand (IEAT) under the Ministry of Industry. It plays a critical role in handling energy-related cargo, petrochemicals, liquefied natural gas (LNG), and other industrial products.

In term of performance (Table 3.3), the number of ship calls at Map Ta Phut Industrial Port slowed down from 6,372 in 2022 to 6,102 in 2024. The volume of cargo slightly decreased from 53.75 MT in 2022 to 52.09 MT in 2024, while the cargo revenue has increased from THB 644.22 M in 2022 to THB 725.26 M in 2024.

**Table 3.3: Port performance at Map Ta Phut Industrial Port**

| indicators | 2022 | 2023 | 2024 |
|---|---|---|---|
| Ship call | 6,372 | 6,299 | 6,102 |
| Cargo throughput (MT) | 53.75 | 52.118 | 52.09 |
| Import | 39.472 | 38.874 | 37.906 |
| Export | 12.615 | 11.323 | 12.519 |
| Cargo Revenue (M THB ) | 644.22 | 635.25 | 725.26 |

(Modified from: IEAT, 2024)

Although vessel traffic and cargo throughput at Map Ta Phut Port have shown a declining trend from 2022 to 2024, revenues from cargo handling have continued to increase. Although overall volumes have declined, the higher unit value of cargoes and the port's ability to adjust service charges and tariffs have been the key factors enabling Map Ta Phut Port to maintain profitability and achieve sustained revenue growth.

Marine transportation and commerce are critical coastal activities that play an increasingly key role in the country's development. These activities include maritime navigation, the construction of coastal ports—such as shipping ports, fishing ports, and passenger ports—and related operations extending to communities and land transportation. Based on data from the MD, Table 3.4 shows the number of shipping ports along Thailand's coastline; in 2022, there were 147 ports, and the largest number of port constructions were recorded in Samut Prakan, followed by Chonburi and Surat Thani, respectively

**Table 3.4: Number of shipping ports categorised by province in 2022**

| Provinces | 2022 |
|---|---|
| 1. Chachoengsao | 9 |
| 2. Chanthaburi | - |
| 3. Trat | 1 |
| 4. Rayong | 12 |
| 5. Chon Buri | 17 |
| 6. Bangkok | 11 |
| 7. Samut Prakan | 47 |
| 8. Samut Sakorn | 2 |
| 9. Samut Songkhram | 3 |
| 10. Phetchaburi | 2 |
| 11. Prachuap Khiri Khan | 1 |
| 12. Chumphon | 2 |
| 13. Surat Thani | 16 |
| 14. Nakhon Si Thammarat | 5 |
| 15. Songkhla | 8 |
| 16. Pattani | - |
| 17. Narathiwat | - |
| 18. Ranong | 2 |
| 19. Phang Nga | - |
| 20. Phuket | 3 |
| 21. Krabi | 5 |
| 22. Trang | 1 |
| 23. Satun | - |
| **Total** | **147** |

(Source: MD, 2022)

In 2022, data on waterborne cargo transportation collected from 20 coastal customs checkpoints revealed a total of 77,880 ship calls. These included 36,626 ship calls by international trading vessels and 41,254 ship calls by coastal trading vessels. The total volume of goods transported was 438.483 M tons, with approximately 370.052 M tons handled by international trading vessels and 68.431 M tons by coastal trading vessels (Figure 3.11).

This data highlights the significant role that both international and coastal shipping play in the movement of goods, contributing greatly to Thailand's maritime economy.

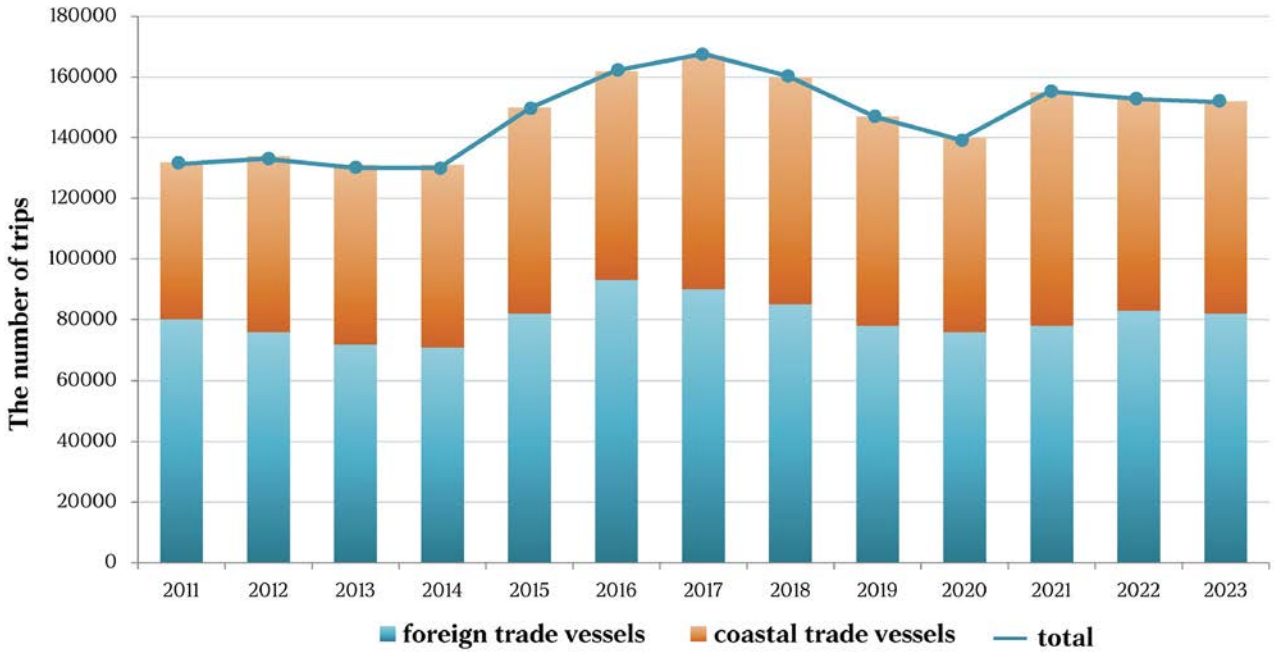



**Figure 3.11: The total number of arriving and departing vessels of foreign trade ships and coastal trade ships at the coastal areas during 2011–2023 (Source: DMCR, 2024; MD, 2023)**

The continued expansion of maritime transport activities has generated multidimensional environmental pressures. Infrastructure expansion associated with port development has contributed to coastal erosion, sediment redistribution in adjacent areas, and the loss of natural habitats. Within the port area, the intensive movement of container trucks and the operation of heavy machinery have resulted in elevated air pollution, greenhouse gas emissions, and noise pollution. Shipping activities further introduce marine litter, sewage, and oil residues into the marine environment. Additionally, the risk of chemical spills poses a serious threat to local and surrounding ecosystems, with toxic contamination potentially accumulating in marine organisms and ultimately affecting human health through the consumption of contaminated seafood.

## 3.3.3 Marine Fisheries

Thailand ranks among the top 10 countries globally in terms of fishery production and leading exporter of fishery products since 1992. The diversity of marine life in Thailand has enabled the use of a wide range of fishing gear, from highly efficient tools that require large fishing vessels, such as push nets and trawl nets, to lower-efficiency fishing tools used with smaller vessels, commonly employed by small-scale fishers. The DOF has collected data, which can be summarised as follows:

### *a) Number of fishing boat*

In 2021, the total number of fishing vessels was 61,832 vessels, with 51,237 small-scale fishing vessels[12] and 10,595 commercial fishing vessels. In 2024, the total number of fishing vessels decreased to 55,501 vessels, with 45,799 small-scale fishing vessels and 9,702 of commercial fishing vessels. Figure 3.12 shows a continuous decline in the number of small-scale fishing vessels, while the number of commercial fishing vessels has slightly decreased.

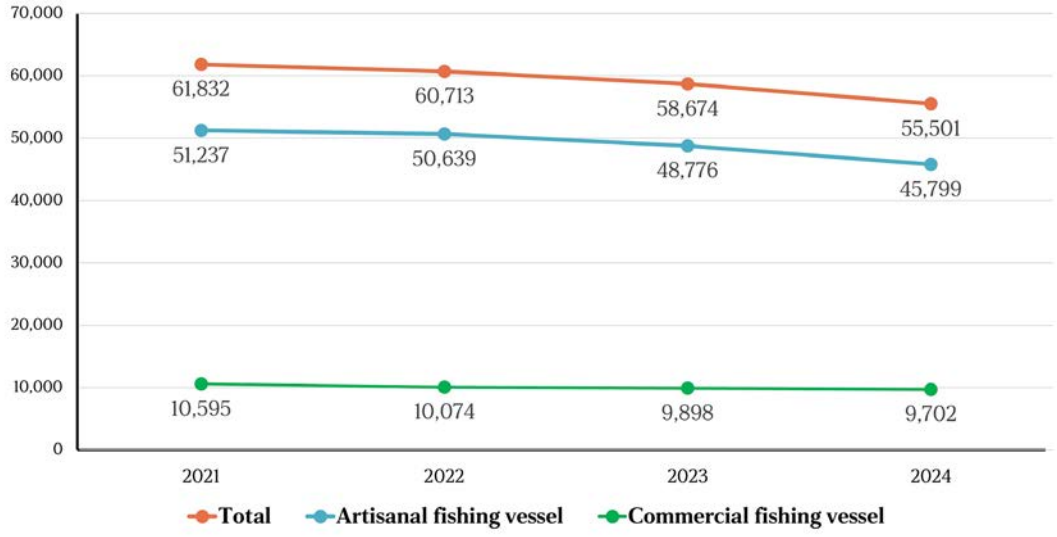



**Figure 3.12: The number of fishing vessel in Thailand during 2021–2024 (Modified from: DOF, 2024b)**

### *b) Fishery production*

Marine fisheries in Thailand, including both wild capture and coastal aquaculture, are a major activity that has a direct impact on the Marine BES. The Fisheries Statistics Group, DOF, has reported that the production from marine capture and aquaculture have decreased during 2003-2023, but the value of these fisheries' production has continued to increase as shown in Figure 3.13

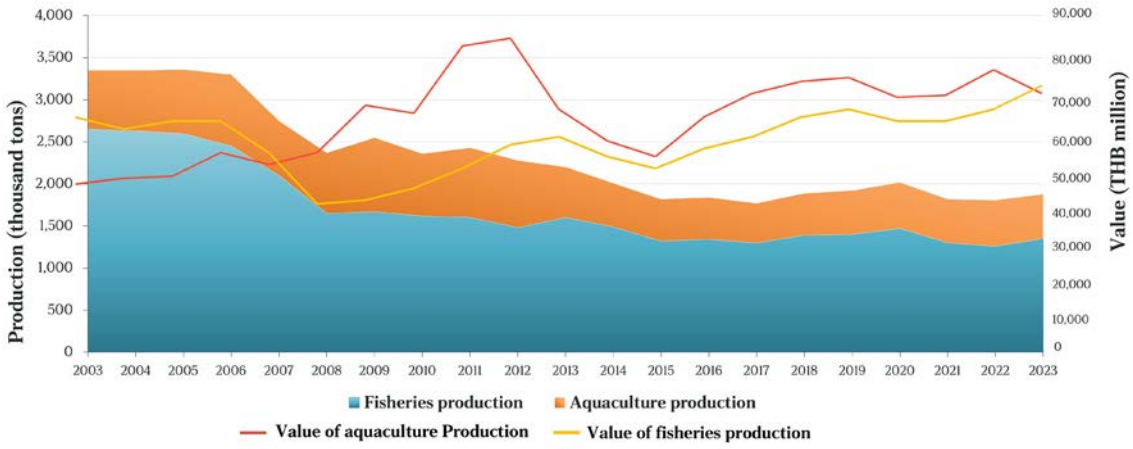



**Figure 3.13: Fisheries production and value from marine capture and aquaculture during 2003–2023 (Modified from: DMCR 2024, DOF 2023a)**

[12] Small-scale coastal fisheries refer to fishers operating vessels of less than 10 gross tons, equipped with engines not exceeding 350 horsepower.

This trend emphasises the increasing importance of coastal aquaculture, which has played a critical role in reducing pressure on wild stocks and sustaining seafood supply. However, aquaculture has also introduced several challenges, including pollution from farming activities, coastal land-use changes, and the introduction of invasive species that threaten local biodiversity. These issues highlight the need for effective management and regulatory measures to ensure that aquaculture develops in a sustainable manner while supporting marine ecosystems and coastal livelihoods.

In addition, the DOF (2023) conducted a survey on the volume of marine capture harvested by small-scale and commercial fishing vessels. Figure 3.14 shows the volume of marine capture harvested by commercial fishing[13] vessels recorded a decline from 1,177,368 tons in 2016 to 1,029,061 tons in 2021, followed by a slight decrease to 1,071,506 tons in 2023. In contrast, small-scale fisheries[14] showed an increasing trend, rising from 65,915 tons in 2016 to as high as 280,011 tons in 2023.

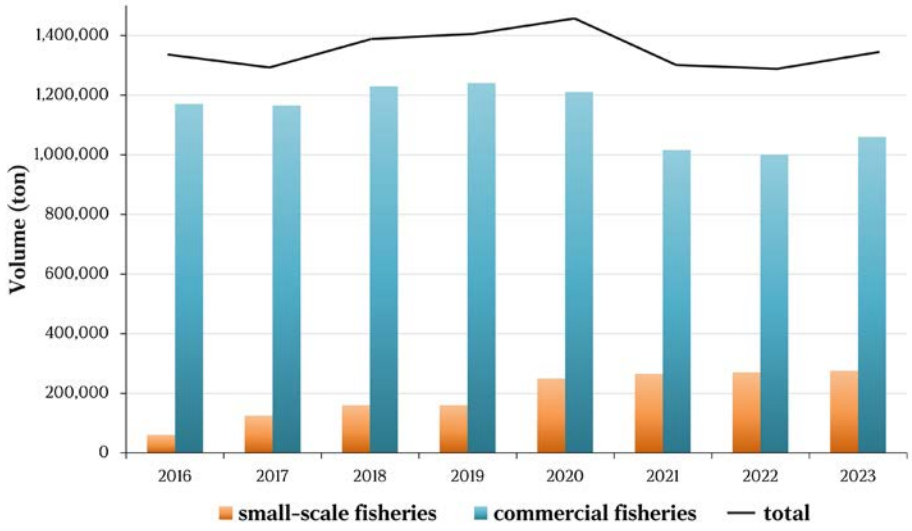



**Figure 3.14: Amount of fishery production by commercial fisheries vessels and small-scaled fisheries (Modified from: DMCR 2024, DOF 2023a)**

This trend may be explained by several factors, including stricter enforcement of regulations on commercial fishing vessels, as well as limitations in data collection methodologies for both commercial and small-scale fisheries, which may result in underestimation of actual production.

### *c) Fishery composition*

The composition of production from marine capture in 2023 (Figure 3.15) included food fish, trash fish, shrimp, crab, squid, shellfish, and others. By weight, food fish accounted for the largest proportion, comprising 40% pelagic fish, 7% demersal fish, and 10% other fish species. This was followed by trash fish (27%), shrimp and crab (7%), squid and shellfish (8%), and other species such as jellyfish (1%).

[13]"Commercial fishing" means fishing operations carried out by using a fishing vessel of ten gross tons or more, or a vessel equipped with an engine of horsepower as provided in section 5 of the Royal Ordinance on Fisheries B.E. 2558 (2015), and the Royal Ordinance on Fisheries (Amendment No. 2) B.E. 2560 (2017).
[14]"Small-scale fisheries" is defined as fishing activities conducted within coastal marine areas, whether by using fishing vessels or by operating fishing gear without vessels, provided that such activities do not fall under the category of commercial fisheries (DOF, 2023A).

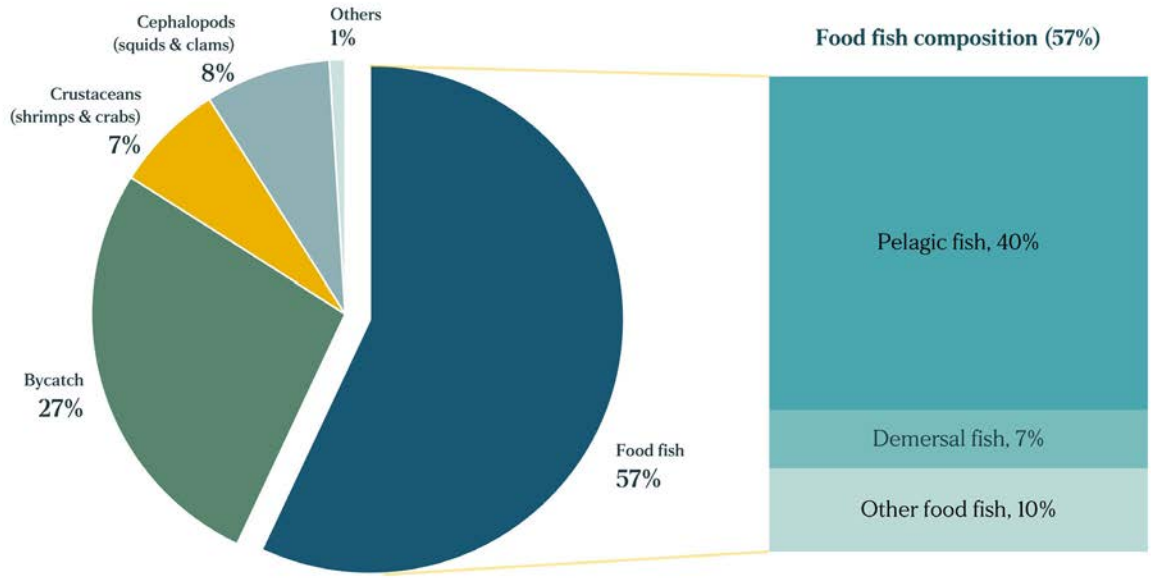



**Figure 3.15: Production from marine capture by groups of species in 2023 (Modified from: DOF, 2023a)**

Coastal aquaculture has continuously increased, due to the decline in natural aquatic resources, and from 1977 – 1986, the DOF implemented a policy to increase the volume of aquatic animals produced through aquaculture. Currently, it is estimated that coastal areas with potential for aquaculture cover over 9600 $km^2$ (DMCR, 2024). According to Marine shrimp aquaculture accounts for the largest share of land use in 24 coastal provinces (include Bangkok), covering 216.92 m2 with a total of 27,633 farms (Table 3.5). This is followed by sea crab aquaculture, which occupies 70.05 m2 with 5,176 farms, and then shellfish and marine fish farming.

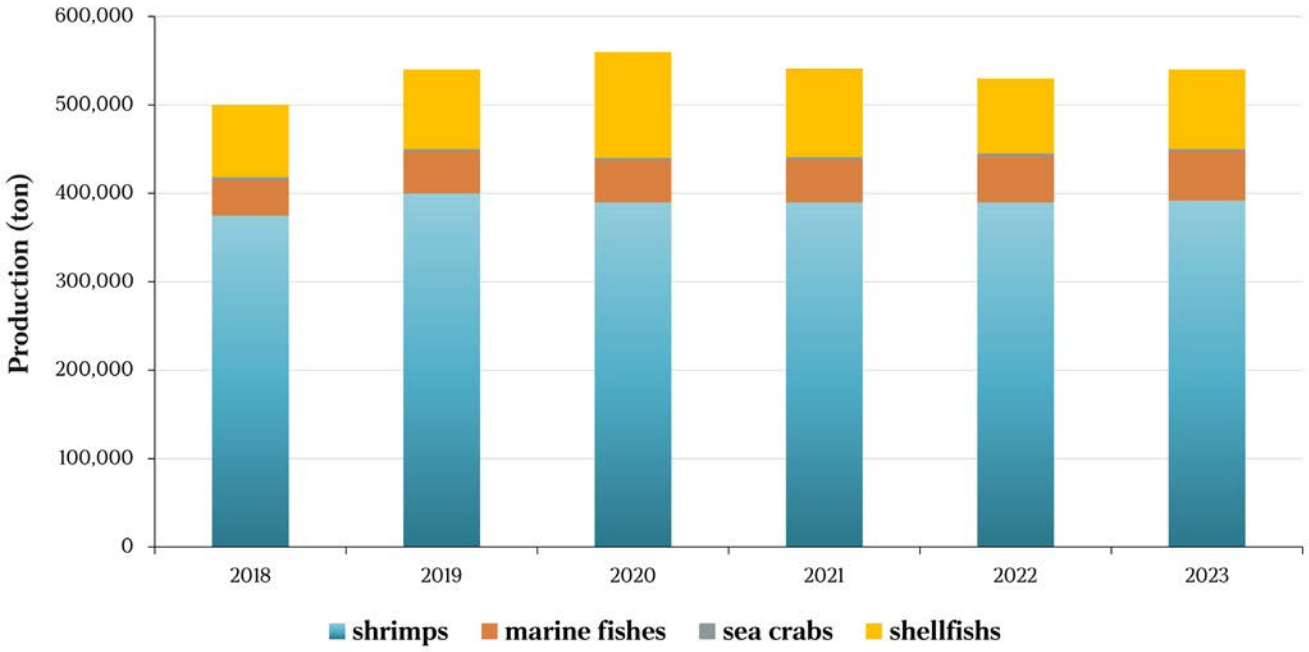
**Table 3.5: Number of farms, area, production and value of coastal aquaculture in 2023**

| groups | species | number of farms | Area (Rai) | yield (ton) | Value (unit: THB B) |
|---|---|---|---|---|---|
| shrimp | Banana shrimp, Black tiger shrimp, White leg shrimp, Jinga shrimp, Other shrimp, Fish | 27,633 | 347,069 | 392,544 | 57.44 |
| marine fish | sea bass, grouper, milkfish, cobia and others | 7,038 | 29,127 | 55,734 | 5.74 |
| shellfish | Blood cockle, Green mussel, Oyster | 5,554 | 90,070 | 89,425 | 4.80 |
| sea crabs | | 5,176 | 112,074 | 3,536 | 1.26 |

(Source: DOF, 2023a)

When considering coastal aquaculture production (Figure 3.16), it was found that during 2018–2023, marine shrimp accounted for the largest share of total output, followed by shellfish, marine fish, and sea crabs. In 2023, the key cultured species included white leg shrimp, with a recorded production volume of 370,260 tons, valued at THB 52.2 B, followed by Black tiger shrimp with 21,933 tons (THB 5.2 B), seabass with 54,760 tons (THB 5.5 B), green mussel with 49,000 tons (THB 0.52 B), blood cockle with 30,189 tons (THB 3.71 B), and sea crab with 3,536 tons (THB 1.26 B). These data highlight the dominant role of shrimp aquaculture in both production and

economic contribution, while shellfish, marine fish, and sea crabs provide additional diversity and value to the sector.




**3.16: Production of marine animals from coastal aquaculture during 2018–2023 (Source: DOF, 2023a)**

The value of both marine capture and aquaculture is increasing in response to demand for domestic consumption. Additionally, there are risks from climate variability that impact aquaculture, which may encourage farmers to continue farming and release several batches of juveniles. However, production may not increase significantly due to high production costs, including feed and energy expenses. It is projected that by 2025, the volume of aquatic animals from coastal aquaculture will reach 602,566 tons, with an estimated value of THB 82,678 M (DOF, 2023a).

## 3.3.4 Coastal industry

In 2023, the Industrial Estate Authority of Thailand (IEAT) operated a total of 67 industrial estates across 16 provinces nationwide. The total area of these industrial estates covers 291.6 km$^2$, with a total investment of THB 5.59 T, generating employment for 926,262 people.

There are 55 industrial estates in 10 coastal provinces namely Chachoengsao, Chonburi, Rayong, Samut Sakhon, Samut Prakan, Bangkok, Phetchaburi, Prachuap Khiri Khan, Songkhla and Pattani, most of them located in the eastern part.

According to data from the Department of Industrial Works from 2022-2024, the number of factories licensed to operate under the Factory Act B.E. 2535 (1992) and the Factory Act (No. 2) B.E. 2562 (2019) in the 23 coastal provinces has shown an increasing trend. The number of factories increased from 31,838 in 2022 to 32,538 in 2024, corresponding with a rising trend in investment value, which grew from THB 4.4 T in 2022 to THB 5.06 T in 2024.

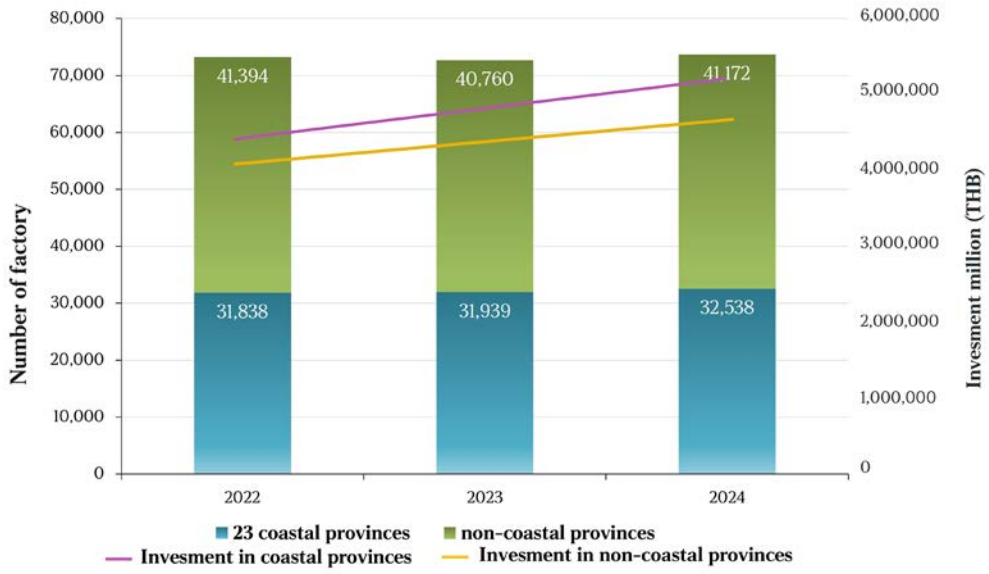



**Figure 3.17: Number of factories and investment value in 23 coastal provinces and non-coastal provinces (Modified from: DIW, 2024)**

Table 3.6 shows the three-year average (2022–2024) for coastal province, Coastal provinces have higher average numbers of factories, higher average investment value, and higher number of workers than those of the rest of the country. The provinces with the highest number of factories are Samut Prakan, Samut Sakhon, Chonburi, Rayong, and Chachoengsao. In terms of investment, Rayong and Chonburi have the highest value.

**Table 3.6: The three-year average (2022–2024) of the number of factories, investment value, and number of workers in coastal provinces.**

| Average per province | No. of factories | Investment (THB M) | No. Of Worker (pax) |
|---|---|---|---|
| Coastal provinces | 1,396 | 205,531 | 79,514 |
| Whole country | 951 | 117,137 | 51,202 |

(Modified from: DIW, 2024)\

## 3.3.5 Coastal agriculture

Thailand is an agricultural country; therefore, agriculture constitutes a major part of land use. In the coastal areas, agricultural land is dominated by rice paddies, fruit orchards and rubber plantations. Other types of land use include aquaculture (mainly shrimp farming) and salt ponds. Some types of agriculture such as rice paddies and shrimp farming have been the main cause of mangrove deforestation.

In addition to agriculture, land use along the coasts of Thailand is driven by the need of coastal development for tourism and urbanisation. Urbanisation occurs in many areas, particularly touristic areas where tourism facilities have been developed to support a growing demand from tourists. Basic infrastructure construction has also been expanded in correspondence to the growth of tourists, local and latent population, as well as migrant workers. Coastal development has been accelerating by construction of tourist facilities such as hotels and restaurants and resorts. Other coastal infrastructure includes ports and hard structures for coastal protection (e.g., seawalls, groynes, breakwaters/artificial headlands) leading to the degradation of natural coastal ecosystems.

### *a) Agricultural area*

shows land use change during 2007 to 2021, with agricultural land accounting for the largest proportion of land use across all coastal provincial groups. This includes rice fields, field crops, perennial trees, fruit orchards, and vegetable gardens, highlighting Thailand's identity as an agricultural country. However, some provincial groups, such as the Inner GoT and the Western GoT, show a declining trend in agricultural land (DMCR, 2024).

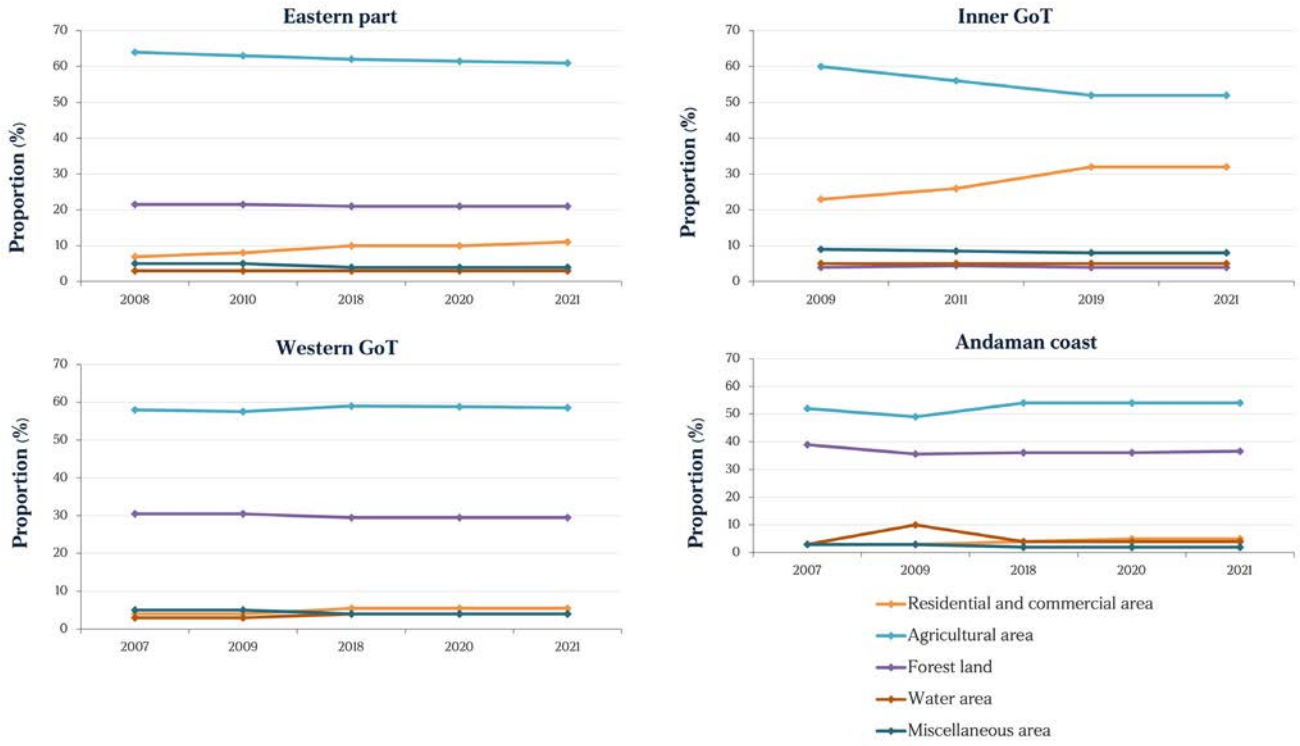



**Figure 3.18: Land use changes in Thailand's 23 coastal provinces during 2007–2021 (Source: DMCR, 2024; LDD, 2020)**

This is further reflected in field-level data from a pilot survey in Trat, which raised concerns about the expansion of durian orchards along coastal areas. Durian cultivation requires large amounts of freshwater and chemical inputs, some of which may flow into the sea. This runoff can degrade water quality and lead to chemical contamination in marine life in the surrounding area.

### *b) Sea salt farming*

In the 2023/24 production year, Thailand's sea salt production covered approximately 71.6 km², distributed across seven provinces: Phetchaburi (41.8%), Samut Sakhon (42.0%), Samut Songkhram (13.0%), Chachoengsao (1.0%), Pattani (1.0%), Chonburi (0.7%), and Chanthaburi (0.5%). Although the total production area has shown a declining trend, yield has increased (Figure 3.19). Compared to 2019, when production was 5,000 tons, production rose to 6,000 tons in 2023, indicating improved production efficiency. This improvement can be attributed to the adoption of new technologies in several production areas (DOAE, 2024).

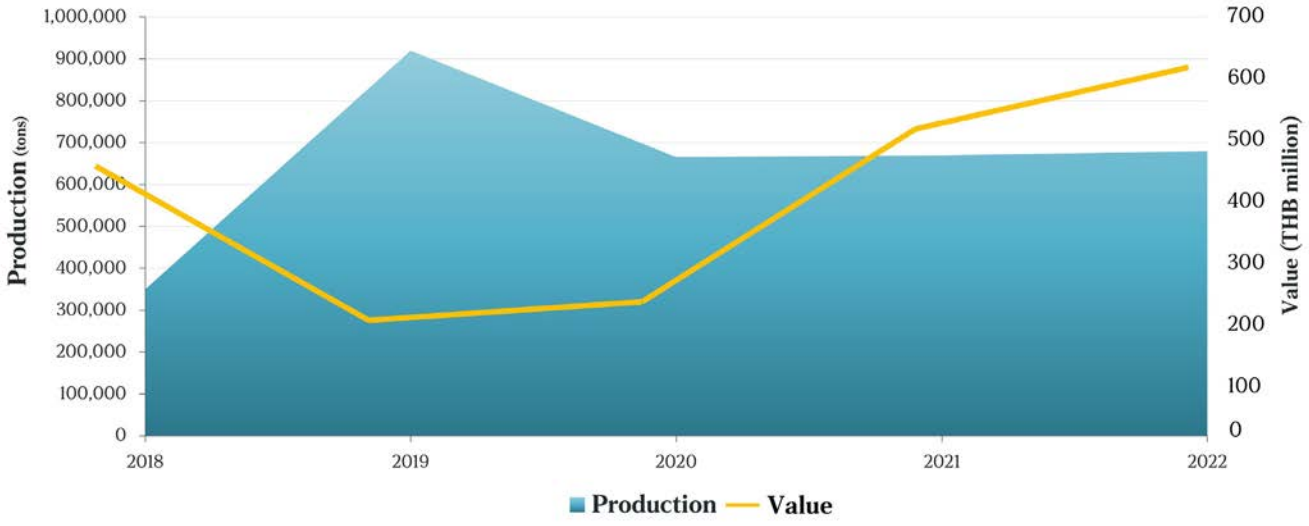



**Figure 3.19: Salt pans production and value, 2018-2022 (Modified from: DIT, 2024: DOAE, 2024)**

For production value, during 2019–2020 the value of sea salt production declined due to surplus stock. As a result, in 2021 the government introduced measures to support farmers. Since then, in 2021-2023, both production volume and value have shown an upward trend. However, in 2024, reports indicated that production costs per km² had risen (THB 8.9 M), while compensation per km² had decreased (THB 8.2 M). This reflects the increasing burden of production and labor costs on sea salt producers (DIT, 2023).

### *c) Offshore oil and gas*

All petroleum concessions in Thailand's maritime areas are located in the GoT, primarily within the EEZ as shown in Figure 3.20.

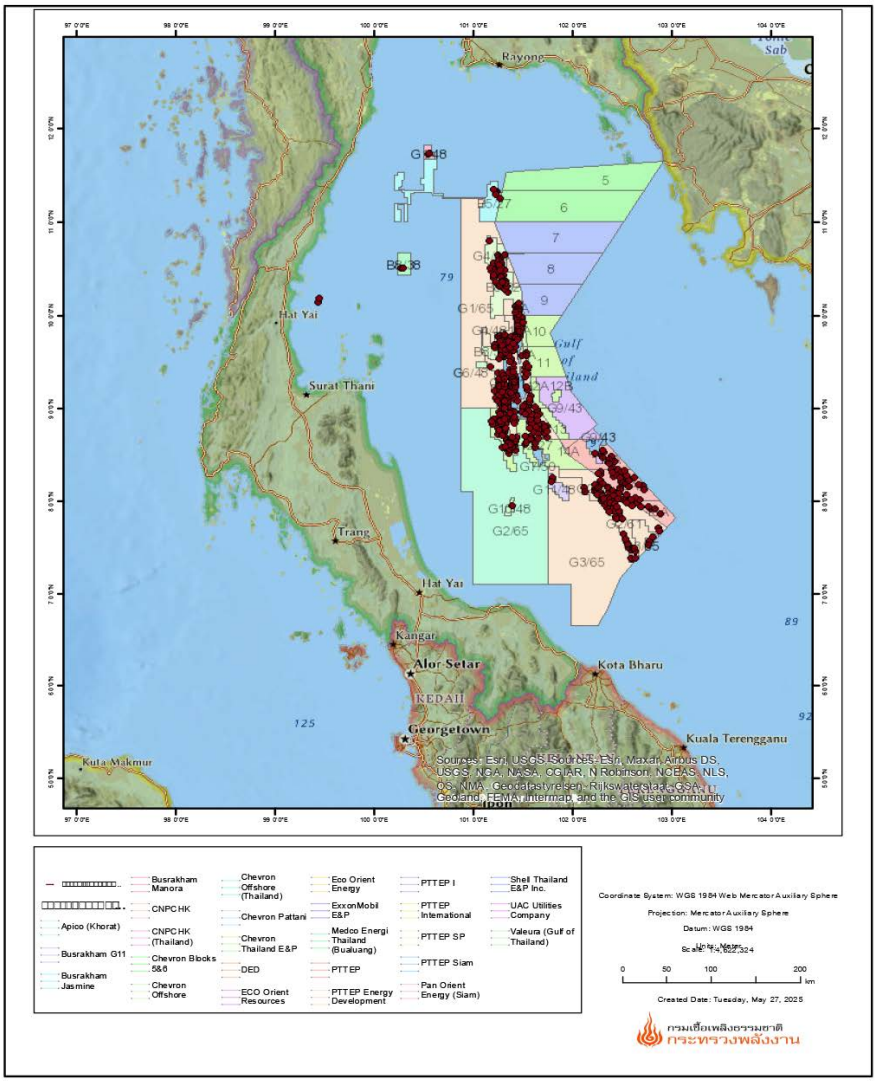



**Figure 3.20 : Concession area in GoT (Source: DMF, 2024)**

According to the Department of Mineral Fuels, Ministry of Energy (2022), the production of liquefied natural gas (LNG) was 23,045,434 barrels, and crude oil production was 17,771,706 barrels. The largest crude oil production came from the Tantawan and Benjamart fields, with a production of 4,340,292 barrels, followed by the Jasmine and Banyen, and Nongyao fields, producing 3,642,815 and 3,371,583 barrels, respectively (Table 3.7).

**Table 3.7: Thailand offshore petroleum production data, 2022**

| Company | Block | Concession area | Petroleum Production | | |
|---|---|---|---|---|---|
| | | | Gas (MMscf) | Condensate (bbl) | Oil (bbl) |
| CTEP | 10-13 10A 11A | Erawan field | 56,435.91 | CTEP | 10-13 10A 11A |
| PTTEP | B15-16 | Bongkot field | 135,180.45 | PTTEP | B15-16 |
| PTTEP | B14A-16A | Arthit | 118,219.60 | PTTEP | B14A-16A |
| PTTEP | B16-17 | South Bongkot | 147,625.07 | PTTEP | B16-17 |
| PTTEP | G12/48 | G12/48 | 5,258.81 | PTTEP | G12/48 |
| CTEP | B 12/27 | Pailin and Morakot | 158,631.66 | CTEP | B 12/27 |
| COTL | B 8/32 | Tantawan and Benjamart fields | 19,823.94 | COTL | B 8/32 |
| COTL | G4/43 | Lanta and Surin | 1,650.45 | COTL | G4/43 |
| C P | G4/48 | Yungthong | 333.29 | C P | G4/48 |
| MP B5 | B 5/27 | Jasmine and Banyen field | 2,042.38 | MP B5 | B 5/27 |
| MP G1 | G 1/48 | Manora | 206.99 | MP G1 | G 1/48 |
| MP G11 | G 11/48 | Nongyao | 1,139.53 | MP G11 | G 11/48 |
| Medco | B 8/38 | Bualuang | 8.84 | Medco | B 8/38 |
| PTTEP ED | G1/61 | Erawan field | 57,446.79 | PTTEP ED | G1/61 |
| PTTEP ED | G2/61 | Bongkot field | 51,520.68 | PTTEP ED | G2/61 |
| **Total** | | | **755,524.40** | **23,045,434** | **17,771,706** |

As of November 2022, the Department of Mineral Fuels reported a total of 416 active production installations and equipment (Table 3.8) and there are 58 in-active offshore installations. Government revenue from the Malaysia-Thailand Joint Development Area (MTJDA). Figure 3.21 shows revenue peaked around 2013 and gradually declined in the following years. The Petroleum Income Tax component showed the most significant drop after 2014, while Royalty and Special Remuneratory Benefits (SR) remained relatively consistent. Revenue from The Malaysia-Thailand Joint Development Area (JDA) contributed a smaller portion throughout the period.

**Table 3.8: Number of production facilities and offshore production/storage vessels in GoT (data as of February 2024)**

| Types | Number |
|---|---|
| Wellhead Platform | 355 |
| Processing Platform | 20 |
| Living Quarter Platform | 11 |
| Compression Platform, Riser Platform, Flare Platform, Mobile Production Unit | 21 |
| Floating Production Storage and Offloading | 1 |
| Floating Storage and Offloading | 8 |
| **Total** | **416** |

(Source: DOF, 2024)

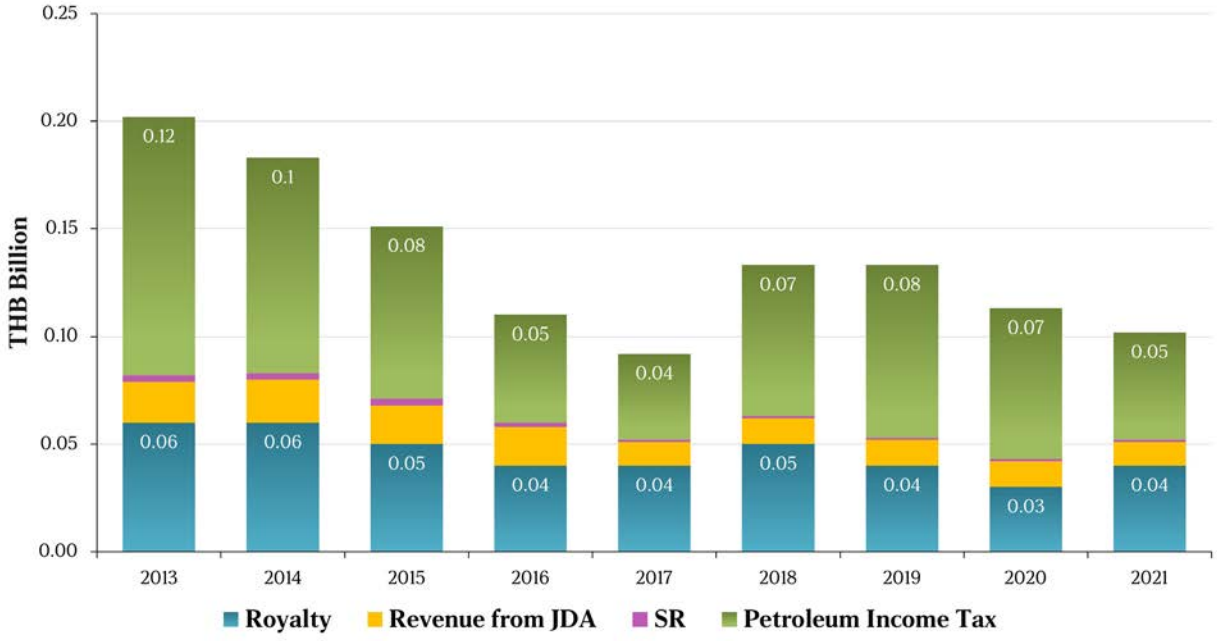



**Figure 3.21: State revenue from petroleum business (Modified from: DMF, 2022)**

Although these installations are subject to various safety and environmental protection measures, they continue to pose risks of oil spills arising from multiple causes—ranging from drilling operations and oil transfer procedures to wastewater discharge from vessels or deliberate illegal discharge into the marine environment. Such incidents can significantly impact marine ecosystems, including deterioration of water quality, contamination of marine organisms with petroleum residues, and oxygen depletion in the water column.

Furthermore, as reported in 2024, there are 58 offshore petroleum installations that are no longer in use and are scheduled for decommissioning. This presents a major challenge for Thailand, as many of these structures have been in place for more than ten years and have developed into novel ecosystems supporting diverse marine life. Thus, leaving certain installations in place may be considered as an alternative option for conserving offshore habitats, although such an approach would require appropriate long-term management and monitoring measures.

Decommissioning activities themselves also impose environmental pressures. The removal process can generate suspended sediments, leading to changes in seabed conditions and negatively affecting benthic organisms. Additional impacts include underwater noise pollution, the release of greenhouse gases, and potential leakage of hazardous substances. These factors highlight the need for careful planning and environmentally responsible practices throughout the decommissioning process to minimise ecological disruption in both the immediate and surrounding marine environments.

## 3.3.7 Emerging activities

### *a) Desalination*

Reverse Osmosis (RO) technology is used for desalination in Thailand, with installations across various sectors including hotels, manufacturing plants, and businesses for their own internal water use.

In the water supply field, Seawater Desalination plants in Thailand are operated by Universal Utilities Co., Ltd. (UU), a subsidiary under East Water group, which is recognised as the country's first and largest provider in this field. The company employs Reverse Osmosis (RO) technology and currently operates production facilities on Koh Samui (Surat Thani), Koh Larn, and Koh Si Chang (Chonburi), with a combined desalination capacity of approximately 10,000–20,000 cubic meters per day. The company plans to expand its investment into other major tourist destinations and is conducting feasibility studies for new desalination projects in four additional locations: Koh Phi Phi (Krabi), Koh Tao (Surat Thani), Koh Samet (Rayong) and Koh Chang (Trat) (DMCR, 2024).

In addition, the Office of National Water Resources (ONWR) has introduced initiatives to promote seawater desalination in the EEC, particularly in key economic zones located in Chonburi and Rayong, including the Map Ta Phut Industrial Estate and Pattaya City. These studies aim to address the growing demand for water in the industrial, agricultural, and service sectors. The project also involves assessing the current and future environmental impacts in the targeted areas to ensure that the development will not adversely affect local communities or natural resources.

### *b) Renewable energy*

According to the AEDP 2018 plan, Thailand has set a target to increase the share of renewable and alternative energy in final energy consumption to 30% by 2037. Alternative energy sources include solar, wind, small and large hydropower, biomass, biogas, and biofuels such as ethanol and biodiesel. Figure 3. 22 shows a steadily increasing trend in wind power generation capacity. In 2015, wind energy contributed 233.9 MW (2.94%) to electricity generation, and by 2024, it had significantly increased to 1,543.56 MW (12.10%). The major coastal wind farm in Thailand is at Nakhon Si Thammarat (DEDE, 2024).

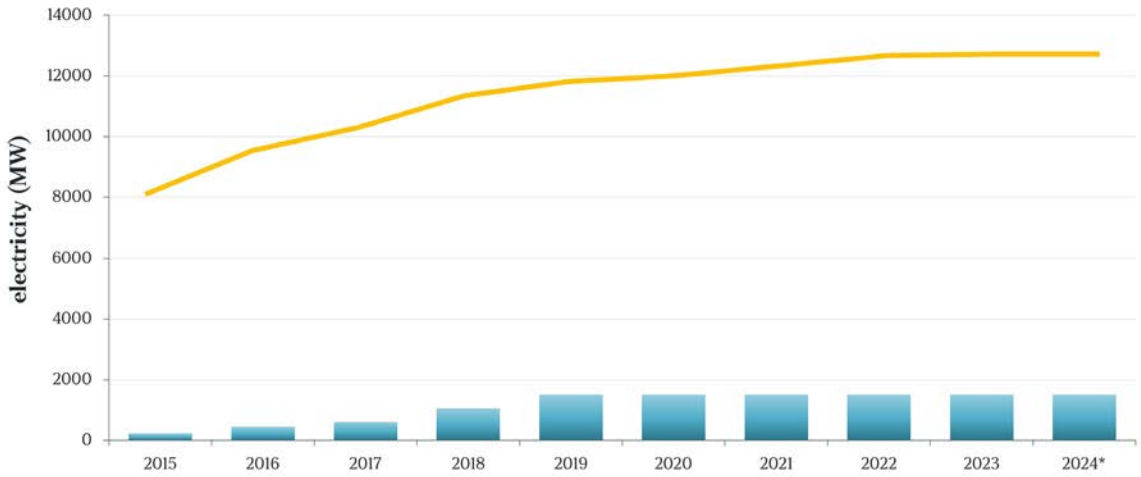



**Figure 3.22: Installed capacity of wind power in Thailand during 2015–2024 (Source: DEDE, 2024)**

## 3.4 Impacts

This analysis underscores the urgent need for integrated and sustainable marine resource management policies that address both ecological integrity and human well-being. Strategic interventions should prioritise inclusive governance, ecosystem restoration, climate resilience, and sustainable economic development to mitigate these impacts and support long-term human security. In the DPSIR framework, 'Impact' refers to the consequences arising from changes or degradation in the state of Marine BES, affecting ecosystem functions, ecosystem services, and ultimately human and societal well-being.

Table 3.9 illustrates the multidimensional impacts of Marine BES degradation on human security. These impacts are categorised across four types of ecosystem services Provisioning, Regulating, Cultural, and Supporting, and span seven key dimensions of human security: health, environment, economy, food, social/cultural, personal safety, and rights/participation (Sahwatdi, 2022).

**Table 3.9: Impacts of marine security biodiversity and ecosystem services degradation on human**

| Marine ES /Human security | Provisioning Services e.g. Marine food production (Fisheries) | Regulating Services e.g. Climate regulation (Carbon sequestration) | Cultural Services e.g. Marine recreation/tourism | Supporting Services e.g. Coastal protection (Mangroves/Coral reefs) |
|---|---|---|---|---|
| Health | Toxins in seafood such as mercury affect consumer health | Climate change affects health, e.g., heat-related illnesses | Pollution from tourism activities affects health | Waste accumulation affects coastal health |
| Environment | Overfishing reduces biodiversity | Coral bleaching due to rising sea temperatures | Resource degradation from overuse, e.g., coral trampling | Coastal erosion due to mangrove loss |
| Economy | Decline in local fisheries income affects coastal economies | Decline in ecotourism affects income | Tourism income declines with resource degradation | Increased costs for coastal protection infrastructure |
| Food | Reduced fish stocks lead to food insecurity | Ecosystem changes affect marine food sources | Contaminated seafood poses food safety risks | Loss of breeding grounds reduces seafood production |
| Social/Cultural | Loss of traditional livelihood such as artisanal fishing | Loss of cultural site in coastal areas | Loss of local identity such as traditional performances | Loss of community cultural spaces |
| Safety (personal) | Conflicts over resources may lead to community insecurity | Sea level rise causes coastal flooding | Tourist decline affects local business security | Damage to homes and infrastructure from waves |
| Rights/ Participation | Communities lack participation in resource management policies | Lack of data and participation in climate solutions | Non-transparent management, e.g., concessions without community input | Communities lack access and participation in restoration |

(Modified from: Thamasak, Wichin, and Orapan)

In terms of health, the presence of toxins such as mercury in seafood poses direct risks to consumers (Tremlova et al., 2017), while climate change contributes to heat-related illnesses and other risks. Pollution from tourism and waste accumulation in coastal areas further deteriorate public health conditions (Jotaworn&Nitivattananon, 2021).

From an environmental perspective, overfishing leads to biodiversity loss, coral bleaching results from rising sea temperatures, and excessive use of natural resources such as coral trampling accelerates ecosystem degradation. The loss of mangroves also contributes to coastal erosion, reducing natural resilience to storms and sea-level rise.

The economic consequences are evident in declining income from fisheries and ecotourism, as well as reduced tourism revenue due to degraded natural attractions. Additionally, governments and communities face rising costs for coastal protection infrastructure.

Regarding food security, reduced fish stocks and the loss of breeding grounds threaten the availability and safety of marine food sources, increasing vulnerability among coastal populations.

In the social and cultural domain, the degradation of marine ecosystems undermines traditional livelihoods such as artisanal fishing, erodes cultural heritage sites, and diminishes local identity and community spaces. Personal safety is also affected, as resource conflicts may arise, coastal flooding becomes more frequent due to sea-level rise, and infrastructure damage from wave action threatens homes and businesses.

Finally, the dimension of rights and participation highlights governance challenges. Communities often lack meaningful involvement in resource management, climate adaptation, and restoration efforts, leading to non-transparent decision-making and limited access to benefits.

This analysis underscores the urgent need for integrated and sustainable marine resource management policies that address both ecological integrity and human well-being. Strategic interventions should prioritise inclusive governance, ecosystem restoration, climate resilience, and sustainable economic development to mitigate these impacts and support long-term human security.

## 3.5 Conclusion and recommendation

This section provides key findings and recommendations based on the policy questions which were been developed and discussed among lead authors and presented in the NEA Scoping Report (2024). These policy questions have been revisited and revised in finalising this report, and are as follows:

### 3.5.1 Key Findings

***a) There are 3 key drivers which affect Marine BES***

- **Population growth and shifts in consumption patterns;** the Thailand population growth rate has remained relatively stable over the past decade; however the population structure has changed, and the country has become an aging society. Influencing patterns of economic activities. Urban migration has driven significant changes in coastal land use, resulting in the unsustainable exploitation of marine resources and subsequent negative impacts on Marine BES. At the same time, the decline in the working-age population—particularly in the fisheries and service sectors—has accelerated the migration of both Thai and foreign workers into coastal areas. This increase in population, together with shifts in consumption patterns, has intensified demand for natural resources. Unsustainable resource use, compounded by inadequate centralized waste treatment systems, has led to land-use change, resource degradation, and elevated pollution levels, ultimately posing significant threats to Marine BES. Overall, the combined effects of demographic transitions and the presence of latent populations have placed substantial pressure on Marine BES.

- **Economic development trends;** The expansion of tourism, fisheries and aquaculture, coastal industries and urbanisation have been evident in Thailand's 23 coastal provinces. The contribution of Coastal Economy from coastal provinces constitutes up to one-third of the national GDP (approximately 30%) (NESDC, 2022), reflecting a high concentration of economic activities along the coastline. Economic recovery and a decline in poverty levels have generally been accompanied by rising demand for employment, food, energy, transportation, housing, and tourism-related infrastructure. At the same time, increasing living costs compel coastal communities to maintain household incomes, leading to intensified fishing efforts, expansion of aquaculture, and further coastal development to generate additional income. Collectively, these factors have increased pressures on marine biological and ecosystem services through overexploitation of living resources, habitat degradation, pollution, and intensified competition for marine space and ecosystem services.

- **Government social and economic development policies and plans;** The 2017 Constitution calls for a 20-year national strategy which guides the development path for this period. In addition, the government has been establishing 5-year development plans since 1961. At present, Thailand is implementing the 20-Year National Strategy (2017-2036) and the 13$^{th}$ NESDP. The 20-year Strategy and recent development plans have already integrated environmental considerations into the development process. Thailand has also developed various environmental policies and plans such as the National Environmental Quality Management Plan, the Climate Change Master Plan, and the Marine and Coastal Resources Management Plan, all of which support sustainable development. At regional level, the EEC has been developed to promote high-tech industries through the BCG model, an example of integrating environmental concerns into regional economic development initiatives. The

government has made significant progress in addressing the problems of Marine BES. These government policies and plans will contribute to improving conservation of Marine BES in the country.

### *b)Increasing human activities cause pressures on marine ecosystems*

**Pressures**

Human activities significantly affect both the environment and human well-being. There are diverse human activities that involve intensive use of marine resources. Key activities include tourism, fisheries and aquaculture, shipping, and offshore oil and gas production.

Tourism is the economic sector that contributes the most to GDP and marine tourism constitutes nearly half of the tourism revenue. Cruise tourism has also shown continuous growth. The growing number of tourists exceeds the carrying capacity of many destinations has placed mounting pressure on marine ecosystems. These impacts include trampling of beaches and coral reefs, increases in marine debris and wastewater, sedimentation from coastal land development, and rising demand for energy and freshwater. Moreover, the increasing number of cruise ships, lacking effective regulatory controls, has intensified a range of ecological pressures. This includes air pollution, underwater acoustic disruption, and the heightened risk of introducing invasive alien species—all of which accelerate the degradation of marine ecosystems.

Fisheries and coastal aquaculture, despite a decline in production of volume, have seen an increase in their economic value, especially production white-leg shrimp farming. The composition of production from marine capture in 2023 shows that food fish accounted for the largest proportion (57%) and the second followed by (27%).

Non target fisheries essential for the maintenance of marine ecosystems These data highlights the need the increased coastal aquaculture in supplementing seafood supply and reducing fishing pressure on wild stocks. However, its expansion has also generated key environmental concerns, including pollution from farming operations, coastal land-use changes, and the introduction of invasive alien species that threaten native biodiversity. These emerging challenges underscore the need for stronger management frameworks and regulatory measures to ensure that aquaculture develops sustainably while safeguarding marine ecosystems and supporting coastal communities.

Maritime transport and port operations play a vital role in national trade and the economy, with major ports such as Bangkok Port, Laem Chabang Port, and Map Ta Phut Port, each handling different types of cargo based on their specific roles and geographic locations. However, Si Racha Port is another key port that plays an important role in supporting the country's transportation and logistics system, particularly within the Eastern Seaboard industrial region. The continued expansion of maritime transport activities has generated multidimensional environmental pressures. Infrastructure expansion associated with port development has contributed to coastal erosion, sediment redistribution in adjacent areas, and the loss of natural habitats. Within the port area, the intensive movement of container trucks and the operation of heavy machinery have resulted in elevated air pollution, greenhouse gas emissions, and noise pollution. Shipping activities further introduce marine litter, sewage, and oil residues into the marine environment. Additionally, the risk of chemical spills poses a serious threat to local and surrounding ecosystems, with toxic contamination potentially accumulating in marine organisms and ultimately affecting human health through the consumption of contaminated seafood.

Coastal industries have expanded with rising investment and factory numbers. In coastal agricultural areas, dominant land uses traditionally include rice farming, fruit cultivation, and forestry; however, growing concern has arisen over the rapid expansion of durian plantations, which demand substantial freshwater and agrochemical inputs and may pose increasing risks to coastal water quality. Sea salt production, although covering less area, but its production process has efficiently been improved. Collectively, these changes exert cumulative pressure on Marine BES by degrading water quality, disrupting nutrient balances, and altering coastal habitats, which in turn can reduce fisheries productivity, weaken coastal protection functions, and undermine the long-term ecological sustainability of coastal and marine systems.

Offshore oil and gas production remain a major activity in the GoT, with over 416 petroleum installations currently in operation and 58 decommissioned installations (DMF, 2024). Although existing offshore installations are subject to strict environmental controls, incidents of oil spills reported in recent years demonstrate that risks from operational activities remain, with impacts including water quality degradation, contamination of marine organisms, and oxygen depletion. At the same time, offshore structures scheduled for decommissioning present new management challenges, as many have existed long enough to develop into artificial or novel ecosystems that support marine biodiversity. While retaining certain structures may offer conservation benefits, decommissioning processes themselves generate ecological pressures, such as seabed and sediment disturbance affecting benthic habitats, underwater noise pollution, and greenhouse gas emissions. Collectively, both active operations and decommissioning activities exert significant pressures on Marine BES, highlighting the need for carefully planned and sustainable management of offshore infrastructure throughout its entire life cycle.

Additionally, emerging activities such as desalination and renewable energy provide the opportunity for future development. Wind energy production in coastal areas has potential to grow as alternative sources of energy to help Thailand meets its climate commitments. These developments underscore the need for sustainable management to safeguard marine BES and ensure long-term human well-being.

***c)The degradation of marine BES significantly impacts human well-being across multiple dimensions.***

The impacts discussed in this study are defined as the consequences that arise when the status of Marine BES deteriorates. The degradation of Marine BES significantly impacts globally and nationally significant biodiversity as well as human well-being across multiple dimensions. If marine ecosystems such as mangroves, coral reefs, and seagrasses deteriorate, the essential services they provide (such as food production, climate regulation, coastal protection, and cultural value) are diminished or lost. This leads to serious consequences including health risks from contaminated seafood, increased vulnerability to climate-related hazards, reduced income from fisheries and tourism, food insecurity, and the loss of traditional coastal livelihoods and cultural identity. Furthermore, communities have limited participation in resource management and restoration efforts, which can increase social inequality and weaken long-term sustainability. Therefore, restoring and conserving Marine BES is crucial to support human well-being and ensuring resilience for future generations.

### 3.5.2 Key messages and recommendations

Based on the findings, recommendations are provided on how to improve the assessment process focusing on drivers and pressures to create positive impacts to Marine BES.

Marine ecosystem assessments in Thailand have traditionally focused on evaluating the status of marine and coastal resources, such as mangrove forests, coral reefs, and seagrass beds. These assessments tend to emphasise outcomes or symptoms of degradation, rather than identifying and addressing the drivers (underlying causes) and pressures (direct impacts) that lead to environmental change. This outcome-based approach is largely due to several key limitations such as insufficient and inconsistent data. Our data and information systems on economic and social factors are not designed for identifying drivers and pressures in the marine sector. The national system does not separate inland and marine activities, therefore making it difficult to reflect the real economic contribution of marine activities to the overall economy of the country as well as its impact on the Marine BES. Recommendations to address the information and knowledge gaps on drivers, pressures and impacts are as follows:

Policy Question 1:

What are the drivers and pressures which affect Marine BES?

**Key message 1: A combination of both government and market-driven forces are key drivers of change affecting marine biodiversity and ecosystem services. *(Established but incomplete)***

**Recommendations:**

**1.1 Promote use of the DPSIR Framework**. Encourage economic agencies, including NESDC, to adopt the DPSIR framework to effectively identify key drivers, address the root causes of Marine BES-related problems, and formulate appropriate policy responses.

**1.2 NESDC should develop more indicators** that effectively monitor and evaluate drivers and pressures in order to support the development of policy responses for the sustainable uses of marine resources and conservation of Marine BES.

**Key message 2: Pressures on Marine BES come from economic sectors that generate the major share of national revenue, particularly coastal land-use changes driven by tourism, fisheries, shipping, and coastal industries. *(Established but incomplete)***

**Recommendations:**

**2.1 Encourage government agencies to use the "Blue Economy" Approach** for national and regional economic development plans/projects in the ocean sector in order to reduce pressures to Marine BES.

**2.2 Mainstreaming Marine BES** into the 14th NESDP (2027-2032) and its sectoral development plan/ projects as well as develops direct policy responses to mitigate pressures affecting Marine BES.

**2.3 Promote community and local participation** as a mechanism for promoting "Blue Economy" at local level.

**2.4 Support the Subcommittee on Marine Spatial Zoning under the National Maritime Interests Protection Policy Committee (MIP)** for the establishment of Marine Zones for development, conservation and buffer zones to enable sustainable use of marine areas for both current and future needs.

Policy question 2:

What are the impacts on the environment and human well-being?

## Key message 3: Resource depletion, ecosystem degradation and decline of environmental quality ultimately affect human well-being. *(Unresolved)*

**Recommendations:**

**3.1 Improve laws and regulations related to EIA, SEA and EHIA** to effectively address the impacts caused by development projects and activities both by the government and the private sector.

**3.2 Improve the monitoring process** conducted by relevant authorities to ensure the implementation of EIA measures.

Policy question 3:

How can marine ecosystem assessments in Thailand be reoriented to better identify and address drivers and pressures, rather than focusing primarily on environmental outcomes?

## Key message 4: Shifting marine ecosystem assessments from an outcome-based approach to one that systematically identifies and addresses drivers and pressures is essential for tackling root causes of degradation and achieving effective, long-term improvements in Marine BES. *(Unresolved)*

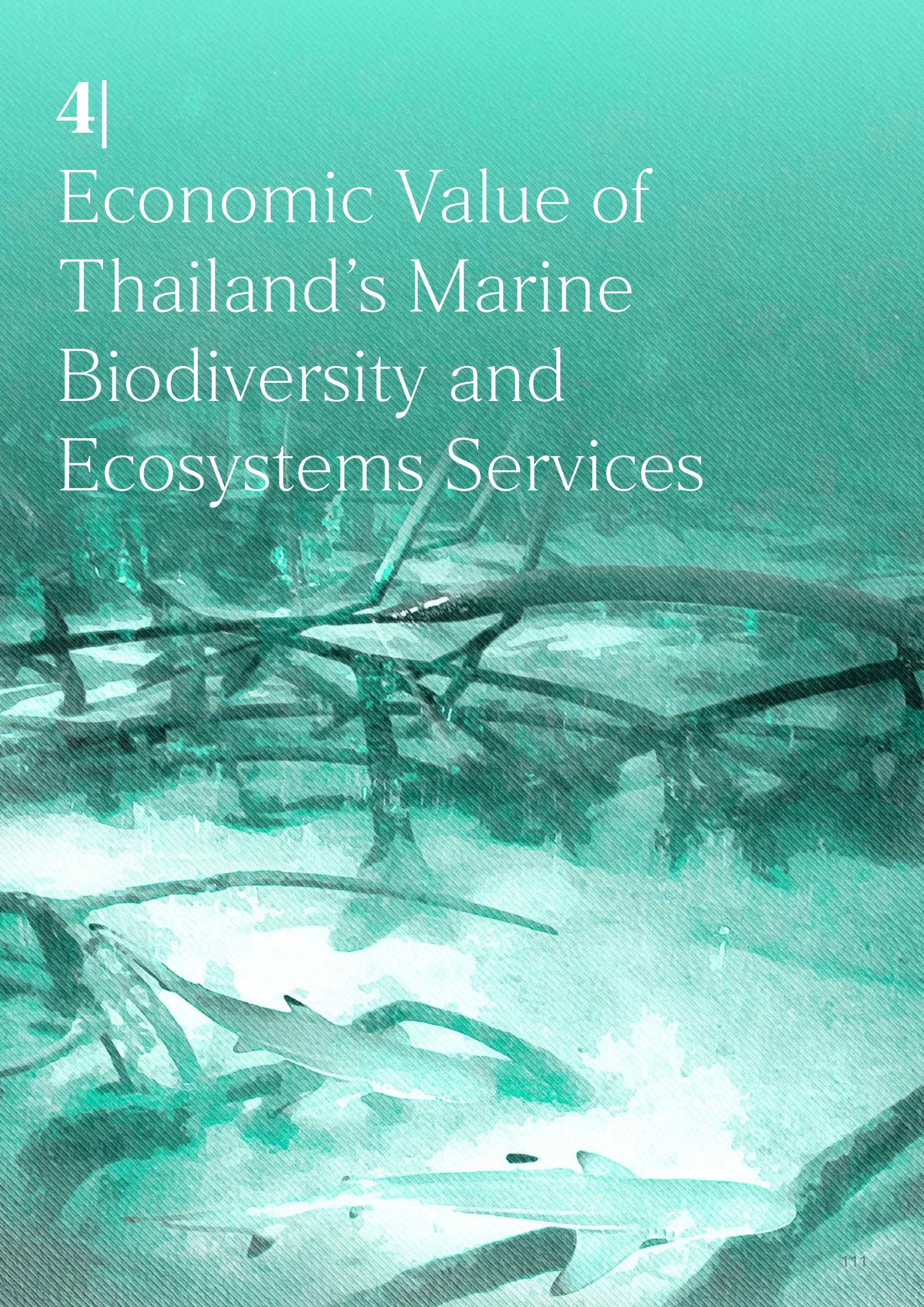
**Recommendations:**

**4.1 Develop marine-specific socio-economic information systems and indicators** to accurately evaluate the impacts of drivers and pressures on Marine BES and consequently on human well-being.

**4.2 Encourage government agencies** such as the Ministry of Social Development and Human Security (MSDHS), the Ministry of Public Health, NESDC, DOF, and the Department of Disaster Prevention and Mitigation (DDPM) to collect and compile quantitative data on the impacts of ecosystem services on all dimensions of human well-being.

**4.3 Promote community and local participation** in collecting community-based data and incorporate local knowledge into assessments of the impacts on human well-being, including engagement of local community and ethnic groups.

# 4| Economic Value of Thailand's Marine Biodiversity and Ecosystems Services



## 4.1 Introduction

The purpose of this Chapter is to discuss the economic dimensions of marine resources. The information and discussions presented in this chapter will address three fundamental policy questions:

- **How do marine ecosystems and their ecosystem services contribute to the national economy and human well-being in Thailand?**
- **What are the investment gaps, and how can the private sector engage meaningfully in supporting Thailand's NEA, conservation, sustainable use, and restoration efforts? and**
- **How can existing public investments minimise negative impacts while at the same time being "nature-positive"?**

In Section 4.2 we consider available knowledge on Thailand's ocean economy and highlight the potential misrepresentation of the benefits it derives from marine ecosystems as the values presented do not account for the economic value of negative externalities. For example, the tourism sector is an important source of revenue but also one of the major causes of damage to the natural assets that generate this revenue. In Section 4.3, we present the concept of economically valuing biodiversity and ecosystem services and how this can help us understand the existence of market failures and the policies which underlie the unsustainable use of coastal natural resources. Section 4.4 further discusses the conditions and prerequisites to transition into a Blue Economy. The discussion highlights the gaps in addressing both market and policy failures under the Blue Economy transition plan. We argue in Section 4.5 that one of the preconditions for reversing market and policy failures is a good understanding of the true economic value of marine resources, and we highlight the knowledge gaps for Thailand coastal resource managers. The lack of financial resources to support total economic valuation and the key challenges it poses to Thailand's efforts are discussed in the final section.

## 4.2 Thailand's ocean economy: Why business as usual is not sustainable?

This section reviews existing studies that estimate the economic value of marine and coastal ecosystem services in Thailand in order to highlight both what is currently known and, importantly, what remains uncertain or unaccounted for. While these studies provide useful insights into the contribution of marine ecosystems to the economy, they also reveal significant limitations, particularly in understanding how changes in ecosystem services result from changes in the conditions of the marine and coastal resources both human-induced or due to natural processes. These knowledge gaps pose challenges for informed decision-making and are therefore central to the policy discussion that follows. The foundation of economic growth is fueled by the ways in which we utilise natural resources either directly or indirectly to produce goods and services. The manner in which we access and utilise resources has evolved in ways that leads to underpricing and overutilising natural resources. This is somewhat aggravated by the 'public goods' nature of natural resources, the goods and services that are not "traded" in the markets and the absence of 'market' values.

Similar comparisons have been made by Barbier (1994) highlighting significant increases in foreign exchange earnings from export of shrimps from Thailand on the one hand and the steady trend in the reduction of the country's mangroves on the other (Barbier, 1994). Caution is thus important when celebrating economic sectors such as tourism, fisheries and maritime navigation that rely on marine resources. Measures to mitigate harm directly or indirectly inflicted on these resources by those economic sectors must be put in place.

While Barbier's studies have demonstrated one dimension of the relationship between the direct and indirect impacts of human use of Thailand's natural capital, similar trends are seen in the country's use of marine and coastal resource (Barbier, E. B., 2007a ;2007b; Barbier&Cox, 2003; Barbier et al., 2008; Barbier, E. B., 2014). At present, there is insufficient information on the trajectory of economic growth (indicated by the level of produced capital vis a vis the reduction in natural capital (Figure 4.1) for Thailand. While it is possible to collect information on changes in the stock and quality of marine resources, it is challenging to estimate the contribution of natural resources to economic growth and vice versa.

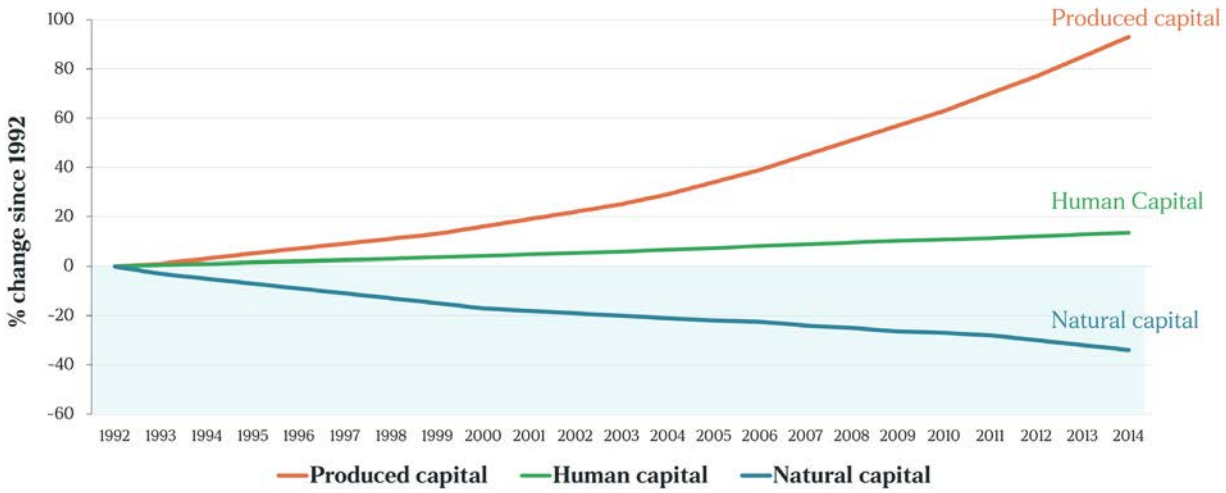



**Figure 4.1: Trends of produced capital, human capital and natural capital (Source: Dasgupta, 2021)**

This relationship underpins the value of the Blue Economy. The key word in the World Bank's Blue Economy is sustainability (World Bank, 2017). Sustainable utilisation of marine resources requires better management practices, which rely on clear understanding of the net contribution of Thailand's marine natural capital. The true cost of economic growth requires an acknowledgment of both the revenue these ecosystems generate and the value of the damage they suffer.

Previous studies have attempted to consolidate existing evidence on the economic contributions of marine and coastal resources to Thailand's economy. An early study by Jarayabhand *et al.* (2007) estimated that the total benefits of Thailand's marine resources amounted to THB 7,442,817.17 M at that time. Over 80% of these revenues are generated by maritime navigation, particularly exports and imports. The value share of downstream industries was just under 5% while tourism share was under 3%. Two estimates were provided for the external impacts—coastal erosion and oil spills—which

only represented a small share of the total damages reported, though this likely reflects a significant underestimation of true external costs.

A BIOTECH's 2018 study on the Development of the SEEA for Thailand Blue Economy estimated the economic value of the Blue Economy for selected economic sectors (Meelord, W., 2018). This study adopted the SEEA developed by the United Nations Statistical Division (UNSD). Reference was made to the OECD (2016) to determine the scope of the study covering marine fisheries, aquaculture, seafood processing, maritime navigation, ship construction and repair, oil and gas extraction, marine and coastal tourism, marine insurance and research. The study covered Thailand's environmental assets in both physical and monetary terms. Information used for the analysis included the physical stock of mangroves, beach forest, coral reefs, seagrass and marine icon species at the beginning of the year and at the end of the year. The economic value of mangroves was estimated by using both the value of carbon stock and replacement cost. Loss of coral reefs was monetized by using replacement cost. Environmental costs were estimated using a number of methods. The cost to protect marine and coastal resources was the actual budget allocated to the 4 key agencies with mandates to protect coastal and marine resources, namely DNP, DMCR, DOF and the MD. Costs associated with coastal erosion were estimated using replacement cost. The impact of the Blue Economy sector was calculated by estimating the Global Warming Potential (GWP) calculated from GHG emission from use of energy, electricity, waste and wastewater. The study estimated that in 2015, the total value of the Blue Economy—which includes sectors such as marine fisheries, coastal aquaculture, offshore energy, maritime transport, and especially coastal and marine tourism—was assessed at between THB 0.95 and 1.18. The environmental and resource damage was estimated to be between THB 17.99–22.21 B, which reduce the net value of the Blue Economy. The study did not take into consideration, the health impact, ecological impact, and changing cost of the natural resources and acknowledged that the net value of Thailand's Blue Economy would be lower than the figures cited.

A follow-up study by UN-ESCAP (2019), Thailand Ocean Accounts Pilot: Case Study on Sustainable Tourism, the Environment and the Ocean, estimated the total economic value of Thailand's coastal and marine resources at approximately USD 27.67 billion. The study found that almost 37% of this value was derived from indirect use and non-use values associated with ecosystems and selected endangered species, including the role of mangrove forests in carbon sequestration, coastal protection, and as fish breeding and nursery grounds. Marine fisheries and aquaculture, coastal tourism, and marine transportation were identified as the principal economic activities associated with Thailand's coastal and marine resources. The study also reported that the tourism sector contributed 7.68% of Thailand's GDP in 2016. Within the tourism sector, the Andaman Cluster (Phuket, Krabi, Phang Nga, Trang, and Satun) accounted for the largest share of tourism value added, contributing approximately 37% of the national total, with tourism income estimated at USD 16.15 billion in 2016.

A study by Yeemin et al. (2023) focused on two types of services, provisioning and regulating services. When analysing provisioning services, this study considered the value of fishing and fish culture in the three provinces of Phang Nga, Krabi and Phuket. The estimation of direct impacts involved identifying the percentage contribution of ocean-related industries to each provincial economy and using this percentage to allocate the Gross Provincial Product (GPP) across the three provinces. Employment benefits were estimated using employment data from the NSO and a revenue-based allocation ratio for the ocean sector to estimate the number of people employed in ocean-related activities.

Indirect impacts were estimated by using the national Input–Output table to trace how spending in ocean-related industries leads to additional economic activities in other sectors. In simple terms, the

method shows how demand from ocean industries creates further production, purchases, and income throughout the wider economy. In 2017, direct value added from the ocean sector was THB 214.4 B, amounting to 57.34% of the GPP of Phang Nga, Krabi and Phuket. The value added to related economic sectors was estimated to be THB 209.9 B, amounting to 56.14% of the GPP of Phang Nga, Krabi and Phuket in the same year. Employment within the ocean sector and related industries included 178,911 people, equivalent to 26.60% of the total number of people employed in these three provinces.

A more recent study was conducted by Seenprachawong (2020) to construct Thailand's Ocean Satellite Account for 2018 by employing the Leontief Model. The ocean account contained 12 sectors namely i) capture fisheries, ii) seafood processing, iii) shipping, iv) seaports, v) marine and seabed mining, vi) shipbuilding and repair, vii) offshore oil and gas, viii) marine manufacturing and construction, ix) marine and coastal tourism, x) marine business services, xi) marine R&D education and xii) dredging. The study covered all of Thailand's 23 coastal provinces. The study concluded that the ocean economy represented 27 % of the country's GDP in 2018. The major economic sectors which accounted for 75 % of the ocean economy included marine and coastal tourism, offshore oil and gas, marine R&D education, and marine manufacturing and construction. The ocean economic multiplier of 2.6 indicates that if final demand spending on a particular ocean sector increases by THB 1 M, then the GDP will be increased by THB 2.6 M The study further specified that each sector has a different economic multiplier so the magnitudes of income will depend on the sector.

All of the above studies provide fragments of information which help us begin to understand the contribution of marine resources to the country's economy, although it must be noted that the values provided depend on the methodologies chosen and could be further refined. For example, replacement cost is practical but might only reflect the lower bound value of ecosystem services. This value is influenced by the choice of parameters that can be used as proxies of negative (or positive) externalities, by the selection of what constitutes human induced externalities that should be included and by the choice of nature driven disasters outside of human control which should be excluded. Some of the findings generated by these studies can be plugged into the structure of the Blue Economy put together by PEMSEA in its 2019 report on the National State of Oceans and Coasts 2018: Blue Economy Growth of Thailand (PEMSEA, 2019). According to this structure, the ocean economy consists of 12 economic sectors. Substantial efforts will need to be made to fill in the blanks of Table 4.1 as well as update the available data it is based on. On the positive side some of this information exists but may not necessarily be in a form that can be readily accessed. For example, tourism revenue for the coastal provinces will need to be disaggregated to isolate the revenue that is related to the marine sector. Agencies such as the NESDB and the NSO, those responsible for environmental protection and conservation, and the economic sectors that utilise marine resources will need to collaborate to clearly identify the service sectors benefitting directly and indirectly from marine ecosystem services as well as forward and backward linkages.

**Table 4.1: Ocean Economy: the information gap**

| Ocean economic sector | value | Source |
|---|---|---|
| 1. Fishery and aquaculture | THB 63,569.8 M<br>USD 4,438.59 M | DOF (2013) |
| 2. Off-shore oil and gas<br>(natural gas+ Condensate and crude oil) | THB 91,096 M (2023) | DMF annual 2023 |
| 3. Mining | Information not available | |
| 4. Energy/electricity (ocean energy; offshore wind, renewables) | Information not available | |
| 5. seawater utilisation and desalinisation | Information not available | |
| 6. Manufacturing<br>(seafood processing+ shipbuilding and repair +marine transport equipment+ marine biotechnology, pharmaceuticals, chemicals) | Information not available | |
| 7. Marine construction | Information not available | |
| 8. Shipping and ports<br>(Transportation, Ports, storage and warehouses) | Information not available | |
| 9. Marine tourism and recreation | THB 991,494 M<br>USD 12,679.07 M<br>USD 5.69 M | MOTS (January – September 2013)<br>DNP (2013) |
| 10. Defence/government (navy, coastguards etc.) | Information not available | |
| 11. Marine research and education | Information not available | |
| 12. Marine services (mapping managing consulting Maritime insurance) | Information not available | |

Once completed, Table 4.1 will be valuable to understand the revenue generated by the 12 economic sectors but the Blue Economy picture will still be incomplete. Understanding how both extractive and non-extractive economic activities can have direct and indirect impacts on coastal resources is needed so that these costs to society can be valued and deducted from the value of the gross output shown in Table 4.1 (in addition to the financial costs of the economic agents). For example, land-use change and infrastructure development can directly alter the extent and condition of mangroves, beach forests and seagrass beds. Shrimp farming and other forms of coastal aquaculture can also degrade coastal water quality, creating risks to marine habitats that are not yet fully understood. Other profitable sectors, such as maritime transport, also contribute to marine pollution, while offshore oil and natural gas extraction poses risks of physical disturbance, habitat degradation and contamination to vulnerable marine ecosystems.

## 4.3 Why economic valuation is important?

### 4.3.1 The concept of economic value of biodiversity and ecosystem services

A key challenge and precondition for any meaningful economic valuation is the development of a robust understanding of how ecosystem services contribute to the various economic sectors dependent on marine and coastal resources, as well as how anthropogenic stressors affect the stocks and flows of these ecosystem services. The values that nature provides can be broadly classified into two categories: use values and non-use values. Combined, nature's total worth to human beings is titled the total economic value (TEV) of nature. Use values can be further classified into i) direct use and ii) indirect use values, which can be consumptive and extractive by nature or non-consumptive and non-extractive. Consumptive use values include the benefits that human beings obtain from extracting resources and utilising them for consumption or as material inputs for the production of goods and services which are consumed. The very act of extraction as the term implies means that whatever is extracted is no longer available in its habitat. The non-consumptive direct use value is less damaging to the natural resources base and refers to ways in which utility can be generated merely by being able to observe or be close to nature, such as nature-based recreational activities. Indirect use values are less understood as they refer to the multiple life supporting services provided by ecosystems such as water provision, carbon sequestration, coastal protection, production of oxygen, habitat-production linkages, etc. Non-use values are considered even more abstract as they encompass the value that humans attach to a particular resource that is not related to any perceived current or future benefits (i.e. existence value) as well as the 'bequest value' as well as desire to know that the natural resources continue to 'exist' for the benefit of future generations.

In the context of marine ecosystems, Contreras del Valle and Starnfeld (2016) used the information from Dunn et al. (2011), Santora et al. (2021) and Amstrong (2012) to organise the types of services provided by marine and coastal ecosystems which fall under provisioning, regulating, cultural, and supporting services. The key point is that different categories of ecosystem services tend to correspond to different types of economic values. Provisioning services are most closely associated with direct consumptive use values, while cultural services are typically reflected in non-consumptive use values. Regulating services, by contrast, underpin indirect use values, and a sound understanding of their biophysical functions is therefore a prerequisite for robust economic valuation. While economics can contribute to a better understanding of the importance of the stock of natural capital and the flows of goods and services, not everything has to be monetized. Economic analysis is by nature, anthropocentric. The values estimated will depend on the ways humans benefit from ecosystem services. It will also depend on the potential uses of the estimated values as well as the availability of the scientific knowledge on the biophysical processes of the ecosystem on which solid economic valuation work relies. As discussed in Chapter 2, scientific understanding of the biophysical conditions of Thailand's marine ecosystems is generally well established, except for the deep-sea and pelagic zones.

The ecosystem service categories presented in Table 4.2 provide the basis for identifying economic values: provisioning services correspond to direct use values, regulating services largely underpin indirect use values, cultural services reflect non-consumptive use values, while non-use values (such as existence and bequest values) are not ecosystem services per se and are therefore not explicitly represented in the table.

**Table 4.2: Marine ecosystems and the types of ecosystems services**

| ECOSYSTEM | PROVISIONING ES | REGULATING ES | CULTURAL ES | SUPPORTING ES |
|---|---|---|---|---|
| **Coastal** | | | | |
| **Mangrove forests** | Commercial fish species, medicinal products, honey, forest products | Water filtration, climate regulation, flood control, water retention, carbon sequestration | Recreational, spiritual | Habitat for species (including those of commercial interest), primary production |
| **Seagrass beds** | Fertilisers, medicinal products | Erosion control, nutrient retention, coastal protection, water purification | Recreational | Habitat for species (including those of commercial interest), production of oxygen |
| **Coral reefs** | Commercial fish species, raw materials, medicinal products | Coastal protection, nutrient cycling | Recreational | Habitat and maintenance of species (including those of commercial interest) |
| **Dunes** | Raw materials, water retention and purification | Coastal protection, erosion control, prevention of saltwater intrusion | Recreational, spiritual | Habitat and maintenance of species |
| **Marine** | | | | |
| **Deep sea and pelagic zone** | Commercial fish species, medicinal products, raw materials | Carbon sequestration and storage, climate regulation, nutrient cycling, water filtration, bioremediation | Recreational | Production of oxygen, habitat and maintenance of species, genetic diversity |

(Source: Contreras del Valle and Starnfeld, 2016)

Thailand's NBSAP recognises "multiple values" of biodiversity resources that support economic activities, food production, security and health. The NBSAP also mentions the significance of biodiversity in terms of cultural, spiritual and intrinsic values acknowledging that some of these values can be monetized and others not (NBSAP. Section 5.3.1 target 8).

A clear message put forward by the Dasgupta Review (2021) is that acknowledging that nature supports our survival both directly and indirectly alone could be a powerful message that we need to protect nature to ensure our own survival. Correct economic reasoning requires that we recognise that we are "embedded" and "not separated" from Nature. The tools we have for the analysis of "values" are based on the fundamental concept that we are not external to nature. Beyond the economic value of ecosystem services, the existence of nature's intrinsic value—which cannot be monetised—is well acknowledged across environmental economics, ecological economics, and biodiversity policy frameworks, and provides even stronger reasons for protection and conservation. Different approaches to analysing values do not have to overrule each other but are complementary. Although economic valuation does not capture the full range of biodiversity values, it remains essential for mainstreaming biodiversity issues into decision-making, as called for under the Aichi Biodiversity Targets. In Thailand, current levels of public awareness and engagement on biodiversity fall short of the KMGBF Target 16[15], which requires, by 2030, that people understand the value of biodiversity and adopt behaviours that support its conservation and sustainable use. In national strategies and plans, links have been made on the interconnectedness between the state of natural and biodiversity resources, how this is instrumental for local development and poverty reduction. But the values of natural and biodiversity resources, their contribution to the economy and the values of the impacts (externalities) have yet to be better understood. To refer back to the terminology used in the Dasgupta Report, our economy is embedded in nature, the more we extract, and the more waste we dump back will have consequences that affect us because we are part of it. A clearer picture of the Blue Economy can only be developed if we understand both the value of nature's contribution and the costs we impose on nature to sustain life and our level of well-being.

[15] KMGBF Target 16: Enable sustainable consumption choices to reduce waste and overconsumption:

### 4.3.2 Market failure and policy failure

Well-functioning markets are normally efficient and have mechanisms to allocate resources among competing users. In the Thai marine context, a number of conditions for markets to function well appears to be absent. Property rights for instance tends to be ill-defined or not existent. The absence of clear property rights is primarily due to the fact that most marine resources are public goods leading to a situation where the goods and services are not priced properly or not priced at all. When this happens, we find ourselves in a situation where there is a discrepancy between the values that producers or consumers place on resources and the values that society place on those same resources, where market prices do not reflect all costs and benefits of a good or service nor the scarcity of resources. Often times, market failure is aggravated by policy failure. Government intervention, for all its good intentions, can end up distorting well-functioning markets or intensifying existing market failure. Rather than correcting existing market failures, government policies may sometimes compound them. Poorly designed taxes and subsidies can create perverse incentives, while public projects with low or negative economic returns can further contribute to the inefficient allocation of resources. Distortions through taxes, and subsidies for example can create distortions as can public projects with a low or negative economic return, etc. Policy failures can also be a result of incomplete assessment of the costs and benefits of public investments. In the Thai marine context for example, the policy bias towards investment in hard infrastructures to prevent coastal erosion, the MDs' investment in beach nourishment for Chalatad beach in Songkhla and various perverse incentives in the fishery sector which have the propensity to lead to overfishing and the use of destructive fishing gears; are all relevant examples.

## 4.4 Moving towards a Blue Economy

The definition of the Blue Economy, as discussed during the East Asian Seas (EAS) Congress 2012, refers to a sustainable ocean-based economic model. In a Blue Economy, environmentally sound and innovative infrastructure, technologies, and practices are employed with institutional and financing arrangements to achieve:

1. **sustainable and inclusive development;**
2. **protecting our coasts and oceans, and reducing environmental risks and ecological scarcities, addressing water, energy, and food security;**
3. **protecting the health, livelihoods, and welfare of the people in the coastal zone; and**
4. **fostering ecosystem-based climate change mitigation and adaptation measures.**

Translating the above principles into practice would entail substantial work on implementation details, including policy design, institutional arrangements, and cost–benefit trade-offs. Sustainability of marine resources could imply reduction of use as well as reduction of waste flow both of which implies higher prices and/or lower profit. On fostering ecosystem-based climate change mitigation and adaptation measures, there could be many options. Each option would differ on the costs and benefits. Welfare of the people would also be affected given the variation in the distribution of costs and benefits.

Economic valuation of marine and coastal resources can contribute to identification of some but not all of the answers needed by disaggregating the biophysical components into types of ecosystems services

that affect the welfare of different groups of people in society and translating them into monetary values using suitable valuation method or combination of efforts. Instrumental to the materialisation of the Blue Economy is the application of user charges and pollution charge is to ensure that they can reduce the discrepancies between social and private benefits as well as social costs and private costs. While both user charges and pollution charges already exist in some form, they will need to be overhauled so that they can indeed ensure that users and polluters absorb the external costs and ultimately narrow the aforementioned discrepancies. Understanding the true economic value of marine resources could generate information on what those charges should be. Likewise, analysing external costs would provide a clearer and more accurate picture of the ocean economy's net contribution to the national economy. Although the existing evidence remains limited, economic valuation can help governments establish more appropriate user fees and pollution charges so that environmental costs are better reflected in economic decision-making. In practical terms, economic valuation helps governments set more appropriate user fees and pollution charges so that environmental costs are better reflected in economic decision-making.

Transitioning towards the Blue Economy is not necessarily all about compromises but there are also the economic benefits from the potential to create additional and new employment opportunities within the economic sectors. The transition could well take advantage of a range of potential investment opportunities. A potential area that has yet to explored is renewable energy. In one aspect, switching to renewable energy can have significant contribution to the reduction on GHGs for the maritime sector thus being of great relevance to the climate change landscape. Subject to cost-effectiveness of the switch, renewable energy could offer a win-win solution to the maritime economic sector and the environment. renewable energy could offer potential co-benefits for the maritime economic sector and the environment, subject to careful design and management. On the other hand, marine renewable energy such as offshore wind, and wave energy could offer new investment opportunities. Nonetheless, ensuring that these emerging activities generate net benefits for society without compromising marine sustainability requires a stronger scientific, technical and economic foundation. Renewable energy is presented here as one illustrative opportunity rather than an exhaustive pathway, and any such investments would need to carefully consider ecological, social, and economic trade-offs.

## 4.5 Economic values of Thailand's marine resources: What we know?

Among the coastal marine ecosystems, few economic studies have been conducted compared to the biophysical studies. In this Section, we review the different types of ecosystems services, take stock of the recent economic valuation studies and identify the knowledge gap that can be used as pointers of where more concerted efforts will be needed to fill in these gaps.

We use as the starting point, the framework provided by UNEP on the four types of ecosystem services, namely Provisioning, Regulating, Cultural and Supporting. UNEP (2006) report marine ecosystems provide three types of provisioning services. Currently, the most important of these is food provision from capture fisheries. Given the mismatch in the rate of harvest compared to the rate at which nature can replace which contributed to the decline in stock, over the years, aquaculture is recognised

as a type of provisioning services. Also included in this category is the benefit from bioprospecting. Coral reefs for example are recognised to be reservoirs of natural bioactive products. Testimony to this is the pharmaceutical industry's discovery of potentially useful substances for anti-cancer drugs among sponges, sea mosses, jellyfish and starfish. Others such as cone shells are also. Highly prized for conotoxins which can be used to develop medicines for pain control and cancer treatment, and microsurgery. In mangroves, in addition to fish and building materials, local communities have also benefited from medicinal plants.

Regulating services refer to the benefits people obtain from the regulation of ecosystem processes, including air quality maintenance, climate regulation, erosion control, regulation of human diseases, and water purification. One of the ecological functions of coral reefs is buffering land from waves and storms and prevent beach erosion and in so doing stabilise the shoreline. The same function is performed by seagrass and stabilising sediments. Mangroves can absorb heavy metals filtering water of pollutants and other toxic substances in effluents and similar functions is performed by seagrass in filtering water pollutants. One important ecological function of marine plants (phytoplankton) in coastal ecosystems is as a carbon sink and hence any changes in marine ecosystems will have far reaching consequences.

Cultural and recreational services are more tangible and more easily understood but the same cannot be said on supporting services such as provision of habitats, primary productivity, nutrient cycling, and soil formation Table 4.3 below is from the same report summarising the ecosystem services for mangroves, coral reefs and seagrass. Note that in this Table, we highlight only 3 of the 6 coastal and marine ecosystems mentioned in chapter 2 of this report. What is not represented are types of ecosystem services for beach ecosystems, coastal lagoons and offshore ecosystems. While there are a few studies on beach and coastal lagoons ecosystems services, to the best of our knowledge, there are only 2 studies touching on economic aspects of offshore ecosystems and these are primarily related to the "novel ecosystems" created by submerged jackets of offshore drilling platforms.

**Table 4.3: Ecosystems services of key marine ecosystem**

| Ecosystems services | Mangroves | | Coral reefs | | Seagrass | |
|---|---|---|---|---|---|---|
| | ES | ES studied | ES | ES studied | ES | ES studied |
| Provisioning | | | | | | |
| Food | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Fibre, timber, fuel | ✓ | ✓ | | | | |
| Medicines and other resources | ✓ | ✓ | ✓ | | | |
| Regulating | | | | | | |
| Climate regulation | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Human disease control | ✓ | ✓ | ✓ | | ✓ | |
| Waste processing | ✓ | ✓ | ✓ | | ✓ | |
| Flood and storm protection | ✓ | ✓ | ✓ | | ✓ | |
| Erosion control | ✓ | ✓ | ✓ | | ✓ | |
| Cultural | | ✓ | | | | |
| Spiritual benefit | ✓ | ✓ | ✓ | | | |
| Recreational | ✓ | ✓ | ✓ | ✓ | | |
| Aesthetic | ✓ | | ✓ | | | |
| Education and research | ✓ | ✓ | ✓ | | | |
| Supporting services | | ✓ | | | | |
| Biochemical | ✓ | | | | | |
| Nutrient cycling | ✓ | | ✓ | | | |

Source: (UNEP, 2006)
Note: 1. yellow shaded cells in are ecosystem services where economic studies have been undertaken
2. blue shaded cells in are ecosystem services where there are studies have been undertaken focusing on social aspects

While there is broad recognition of the multiple services provided by mangroves, seagrasses, and coral reefs, the monetisation of these benefits is not always straightforward. Proper valuation requires an understanding of ecosystem condition, the relevant biophysical processes, and the mechanisms through which people extract, use, or degrade ecosystem resources. It also requires understanding how waste from production and consumption affects ecosystem stocks, quality, and the flow of services that ultimately shape human well-being.

On provisioning services, the blue-shaded cells in the table indicate areas where some valuation studies already exist and may serve as reference points. For provisioning services, studies estimating the contribution of coastal ecosystems to food supply are available for all three ecosystems. Details of these studies are provided in Table 4.3, and although the estimated values are location-specific, they can still provide useful benchmarks for other sites along both the Andaman Coast and the GoT. In addition, a broad body of literature documents how local communities rely on mangroves for fibre, fuelwood, non-timber forest products, and medicinal plants (yellow-shaded cells). Many of these benefits support household subsistence rather than market transactions; thus, imputing the market value of substitute goods can illustrate their economic significance and strengthen the case for mangrove conservation.

On regulating services, research on regulating services has largely concentrated on carbon sequestration for both mangroves and seagrasses, with values estimated using a range of price references. However, carbon sequestration represents only one component of a wider suite of regulating services. As indicated by the many unshaded boxes containing ✓, substantial knowledge gaps remain across other key functions, including disease control, waste processing, erosion control, and storm protection. Addressing these gaps will require coordinated effort to build stronger biophysical–economic linkages before meaningful valuation can be undertaken.

On cultural services, numerous social and anthropological studies have examined how communities interact with mangroves. However, very few provide monetary estimates of cultural values. In contrast, coral reefs have a much larger body of recreational valuation studies, including travel cost and willingness-to-pay assessments. This imbalance highlights the limited quantitative evidence available for mangroves and seagrasses in the cultural domain.

On supporting services, supporting services are conceptually distinct from cultural services and present a separate challenge. Although ecological studies have documented the supporting roles of mangroves, seagrasses, and coral reefs—such as nutrient cycling, habitat provision, and primary productivity—these functions are rarely translated into parameters usable for economic analysis. Under SEEA-EA and standard valuation frameworks, supporting services are not valued directly, which partly explains the absence of such studies in Thailand.

Among the three ecosystems, valuation studies for seagrass habitats are the most limited. Despite clear ecological functions—fish nursery grounds, spawning habitat, nutrient cycling, pollutant filtering, and water purification—there is a paucity of valuation work. Some non-use values have been inferred indirectly through studies focused on the existence of dugongs, but direct valuation of seagrass functions remains largely unexplored.

## 4.5.1 Provisioning services

Marine and coastal ecosystems contribute to human welfare and economic activity through a range of provisioning services, including food provision, livelihoods, and raw materials. Across ecosystems such as mangroves, coral reefs, seagrass meadows, fisheries, and marine and coastal tourism systems, existing valuation studies consistently indicate that these contributions can be economically significant. However, the magnitude and scope of estimated values vary widely across ecosystems and locations, reflecting differences in ecological conditions, data availability, and valuation methods. In many cases, regulating services that underpin provisioning benefits—such as habitat support, coastal protection, and ecosystem resilience—are only partially captured or remain underrepresented in monetary terms. The following subsections summarise selected evidence from the literature to illustrate the range of provisioning values identified for different marine and coastal ecosystems, rather than to provide an exhaustive or fully comparable assessment of economic values.

***a) Mangroves***

Fishery income: A 2019 study (Nabangchang and Vincent, 2019) estimated the economic values of ecosystems services provided by mangroves in order to clearly demonstrate the economics losses if mangrove areas are converted to alternative uses as well as the benefits from investments in mangrove conservation. Three types of economic values were estimated, the use value from fisheries, indirect use value for carbon sequestration function and non-use values. The study also analysed the economic feasibility of investment in mangrove conservation for the potential benefit of generating revenue from blue carbon. Furthermore, the study looked into how the status of mangroves in certain protected areas such as National Parks, may result in reducing the rate of loss or conversion for alternative uses.

On the use value from fisheries, the major findings are that over 90% of the species caught depended on the mangroves in some part of their life cycle. This finding confirms the benefit of mangroves as spawning, nursery and feeding habitat for marine species and the assumption that the deterioration of mangroves and the reduction of mangrove areas will have direct impacts on small-scale fisheries and related downstream economic activities. Net fishing income per year averaged THB 85,669.7 per household. For fishermen who only fish in the mangroves, net income per year averaged THB 46,493.3 per household. For fishermen who only fish in the open seas, net income per year averaged THB 110,239.4 per household.

***b) Coral Reefs***

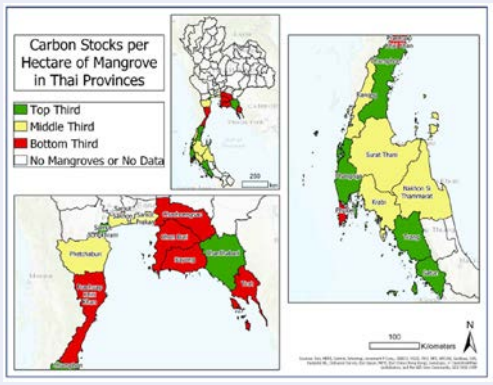
For Thailand, the most recent study undertaken was the 2021 study supported by the Thailand Research Fund. Revenue forgone for reef-related coastal fisheries was estimated using net factor income approach. The data used for the analysis was from interviews of 248 small-scale coastal fishers comprising 118 fishermen from Koh[16] Phang Ngan and Koh Tao and 130 fishermen from the coastal districts of Satun. Average annual costs were THB 102,703 per fishermen per year for Phang Ngan and slightly lower at THB 71,572 per fishermen per year for Satun. Average annual net revenue for the small-scale fishermen in the two provinces was THB 181,383 and 145,995 per fishermen per year respectively.

## 4.5.2 Regulating services

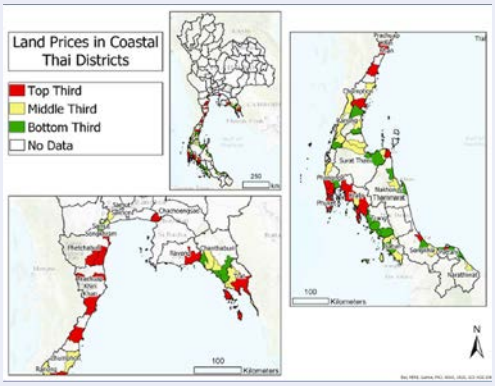
With the sole exception of carbon sequestration, the economic value of most regulating services remains largely unstudied. In Box 4-1, by linking detailed bio-physical assessments with opportunity-cost and valuation estimates, the study offers a more robust justification for safeguarding existing mangrove areas.

**Box 4-1: Mangroves and contribution of economic analysis to support protection and conservation**

To validate the claim that mangroves ecological services is a spawning grounds, nursery and feeding habitat for marine life, face-to-face interviews were conducted with 778 small-scale fishermen in 42 villages in 5 provinces both in the GoT and along the Andaman coast. Altogether 90 marine species were caught either in the mangroves, mud flats or the open seas. Regardless of where they were caught, over 90% of the species caught depended on the mangroves either all through their life span or in some part of their life cycle. Net income per year averaged THB 85,669.7 per household. For fishermen who only fish in the mangroves, net income per year averaged THB 46,493.3 per household. For fishermen who only fish in the open seas, net income per year averaged THB 110,239.4 per household. This finding confirms this aspect of mangroves' ecological functions as well as provide a strong justification for protection and conservation to avoid the direct impacts on small-scale fisheries and related downstream economic activities.




With attention being targeted at blue carbon and carbon credits as a "low hanging fruit" the research question posed was, what would be the opportunity cost of keeping land under mangrove cover. To answer this, the study adopted as a proxy of the opportunity cost of land parcels located along the two coastlines. Information on carbon stock obtained from the DMCR was used to classify the coastal provinces into three categories. Green refer to the provinces with the highest carbon stock per hectare of mangroves, yellow are the provinces with lower carbon stock per hectare whereas red are the provinces with the lowest carbon stock by comparison.




To analyse the opportunity of maintaining the existing mangroves, prices of land parcels along the coast were obtained from the Treasury Department. The map shows that red are the provinces with the highest land price; yellow are the provinces with middle range land prices and green are the provinces where prices of land located on the coast is lowest. The land prices were compared with the 'potential' value of carbon credits using both the EU-ETS price of carbon credits and the social cost of carbon. Results show that if the EU-ETS price were used, the protection of mangroves for purpose of generating carbon credits would be feasible in 12 districts out of the total of 59 districts. If, however, the social cost of carbon were used, the number of feasible districts would increase to 16. The clear message from this analysis is that expectation of benefits from blue carbon should be weighed against the cost. The picture is not all dismal, and mangroves are much more than just the carbon. Factoring in all other ecological benefits could increase the number of districts where the benefits exceed the opportunity costs. Economic approach which seeks to combine the biophysical with the economics can be an entry point to start communicating with decision-makers. While the tools cannot represent all the values, they do generate numbers to start the negotiation process.

### 4.5.3 Cultural/recreational services

Economic studies on coral reefs have mostly been on recreational values or are studies that focused on iconic marine species that depend on coral reefs as habitats and feeding grounds. Among these is the study by Nabangchang (2021) which estimated the use value of reef-based tourism. The consumer surplus estimated as THB 6,223 per person per trip. Based on this value and the reported number of 500,000 tourists visiting Koh Tao in 2018, the total use value from tourism can be estimated at THB 3,115 M per year.

### 4.5.4 Supporting services

The most cited economic valuations are by Barbier which originated from the EEPSEA funded study on 'Economic valuation of mangroves and the roles of local communities in the conservation of natural resources' (Sathirathai, 1998). This was more or less a spring board which preceded other studies and publications by Barbier and colleagues over the years including: Valuing the environment as input: Review of application to mangrove-fishery linkages (Barbier, 2000), Habitat-fishery linkages and mangrove loss in Thailand (Barbier, 2003), Shrimp farming and mangrove loss in Thailand (Barbier&Sathirathai, 2004) Mangrove conservation vs. shrimp farming in Thailand (Corps, 2007).

The supporting services of mangroves were also captured as part of the non-use values estimated by Nabangchang and Vincent (2019). Using CVM, respondents were informed of the mangroves ecological functions, i.e., apart from provisioning services, mangroves are spawning grounds, nursery, and feeding habitat for marine species, birds and some mammals; provide a storm protection function and sequester carbon. Respondents were asked if they were willing to pay for 5 proposed measures that will help to protect and restore degraded mangroves to ensure that those ecological functions can be sustained. MWTP for Bangkok and for the rest of the country was respectively THB 385 /household and 206 /household. Multiplying the MWTP with the number of households in Bangkok and in the rest of the country gave a total non-use value of THB 4,895.76 M. Dividing this value by 1,530,000 (the mangrove areas in rai at the time of the study) gives a non-use value of THB 1.99 M/km$^2$

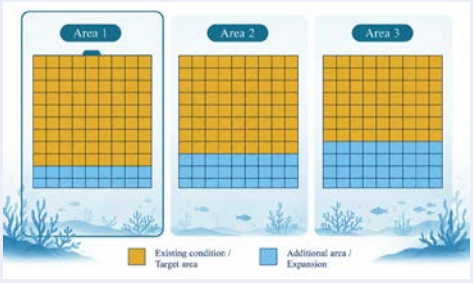
Indirect use values of coral reefs were captured by using stated preference method by Nabangchang (2021) The non-use value was estimated by using a Choice Experiment. The hypothetical goods posed to ask respondent's willingness to pay were, i) measures to treat a percentage of wastewater prior to being discharged into the sea, ii) imposing no dive zones for some dive sites which were observed to be more ecologically sensitive and iii) replanting corals in designated sites around the island. A total of 576 respondents were interviewed. The orthogonal design included four attributes, each with three levels of improvement. The first attribute related to wastewater quality, where treatment increased from 10% in Level 1 to 20% in Level 2 and up to 30% in Level 3; infographics were used to ensure respondents understood that even at the highest level a considerable volume of wastewater would still remain untreated. The second attribute concerned the designation of restricted-access zones, with higher levels of restriction giving natural reefs greater opportunity to recover. The third attribute focused on coral reef restoration, defined as the replanting of 1 coral branch per m2, implemented in one area at Level 1, two areas at Level 2, and three areas at the highest level. For the households interviewed in Bangkok, the combined willingness to pay to move from the status quo to Level 1 was THB 848 M. The willingness to pay for further improvements—from Level 1 to Level 2, and from Level 2 to Level 3—was THB 1,697 M and THB 2,545 M, respectively. For international tourists, WTP to move from the status quo to level 1 was THB 830.6 M. WTP to move from level 1 to level 2 and level 2 to level 3 were respectively THB

1,661 M and THB 2,491 M respectively (Box 4-2).

Two studies have been conducted which captured the indirect use values of seagrass. (Nabangchang, 2012 and Nabangchang, 2023). Both used Stated Preference Method, the earlier study used Choice Experiment; the latter used CVM. While both studies focused on the dugongs, the survival of the dugong was tied up with the ability to maintain the seagrass beds. In the latter study the CV scenario describes the water filtering, nutrient recycling, and oxygen production functions as well as providing habitat for dugongs, marine turtles and dolphins. Findings and application of findings are discussed and illustrated in (Box 4-2).

## Box 4-2: Coral reefs: The economic life line of Koh Tao (Nabangchang, 2021a)

Koh Tao is a small island in the GoT, some 115 km from Ban Don Bay Surat Thani and over 70 km off the coast of Chumphon. It is one of the major island destinations of Thailand and within the top ten ranking of the world ranking of sites for scuba diving training. The entire economy of the island is linked to the coral reefs around the island which offer around 44 dive sites. During the pre-covid era, the island recorded around 500,000 visitors annually. The covid 19 period, revenue of the island plummeted to almost zero but post-covid tourist numbers rapidly climbed ing back up to the pre-covid period numbers.Recreational Value was estimated by the same author using Travel Cost Method in two time periods, i.e., in 2010 and 2021. In nominal terms, the consumer surplus of THB 6,223 per person per trip for 2021 was lower than the estimation for 2010 which was 6,638. In real terms, it must be acknowledged that consumer surplus has reduced over an interval of around 10 years. Undoubtedly, the natural assets,-the conditions of the reefs,- have declined over this interval and some of the 44 dive sites were new sites which were promoted for the purpose of reducing the pressures on the natural reefs. Most popular among these is the sunken warship Sattagud submerged in 2011 with the collaboration between the Royal Thai Navy, the DMCR, and the PTTEP.







More recently in September 2023, with the success of Sattagud has been the motivation for submerging two additional warships, Su-Pairin and Han Hak Satttru. It is the expectation that these two sunken warships will become as popular as Sattagud and the DMCR is now putting together a team of in-house researchers to estimate the recreational value of these two new dive sites as well as monitor changes in marine life diversity and abundance. Non-Use Value: Apart from the recreational use value, the coral reefs also have indirect use values, providing ecosystems services which are not traded but nevertheless are valuable even to those who have never been nor intend to travel to Koh Tao. The estimation was done using choice experiment. The orthogonal design included 4 attributes and 3 levels. The first attribute was improvement of wastewater quality from 10% to 20% and the highest level 30%. Infographics were used to ensure that respondents understood that even at the highest level, there was still a large proportion of wastewater that would be discharged untreated.

The second attribute was designating restricted access zones. The greater the restrictions, the more chance that natural reefs in those areas would have to recover. For the 3rd attribute, the restoration of coral reefs was the replanting of coral branches (1branch/m2). In level 1, coral restoration would occur in one designated area, increasing to 2 areas in level 2 and at most 3 areas in the highest level.

Each choice set contained 4 alternatives. The first is the situation as is (no additional measures and nothing to pay). Alternatives 2 to 4 propose different levels of undertaking for each of the attribute and the associated sum that respondents would be asked to pay. From the 288 respondents interviewed in Bangkok, households were willing to pay THB 848 M to move from the status quo to Level 1. For increasing the scale of conservation to level 2, Bangkok respondents were willing to pay THB 1,697 M. For the most intensive conservation measures in level 3, willingness to pay increased to 2,545 THB

Note: Choice Experiment (CE) is a stated preference method in which respondents are asked to choose among hypothetical alternatives with different environmental attributes and costs. The choices are used to estimate willingness to pay for environmental improvements and non-market ecosystem services.

## Box 4-3: The Dugongs as the personal touch to Trang coastline MPA: Taking non-market valuation to action (Nabangchang, O., 2023)

Between 2023 and 2024, the DMCR reported a total of 70 dugong deaths—a devastating loss given that the estimated population along the Andaman coast has fallen to a critically low level of approximately 250 individuals. The number of deaths may continue to increase with the observed degradation of seagrass beds from rising coastal water temperature intensified by the accumulation of sediments from dredging activities.

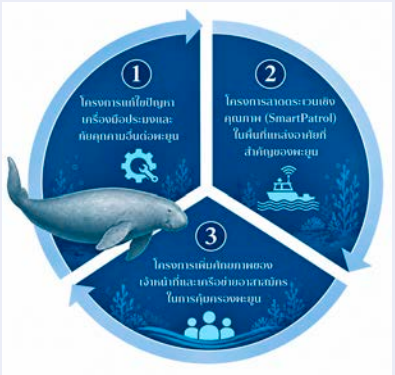
One of the largest dugong habitats along the Andaman coast is  in Trang. The seagrass beds of this province expand over an area of 4,123 hectares hence being the home and major feeding and breeding ground of 70% of the country's dugong population.  Apart from dugongs, the coastal area of Trang is also the habitat of the bottle nose and the Indo-Pacific humpbacked, striped and Risso's Dolphin.  These areas are also habitat and feeding grounds for the green and Olive ridley turtles.

In 2022 , the coastline of Trang was officially declared as a MPAs,  one of the largest along the Andaman Coast (DMCR, 2021).  By virtue of these sites being declared as MPAs, it is assumed that more resources would be allocated to step up the level of 'protection' in conjunction with more concerted efforts to execute the resource restoration measures. Since the market for wildlife viewing and scuba diving is somewhat limited among the Thai general population, the research design is focused on capturing the non-use value of these iconic marine species to reflect the benefits of the habitats that these MPAs provide that contribute to their improved environment and reduction of human-induced pressure.  The attraction of MPAs it was assumed, would be more appealing to the general public and in many respects, give the MPAs with iconic marine species the 'personalised' front needed.  It is easier after all to recognise the coastline of Trang as being an important habitat for dugongs than to try communicating the importance of the ecological functions of seagrass. In the case of Trang, the province is already known to be the home of the largest percentage of dugongs in the country, and the coastal areas' elevated status as a MPAs in principle promises more concerted efforts to protect this habitat.

Non-use value of dugongs was estimated by Contingent Valuation Method and face-to-face interviews of 258 respondents in Bangkok.  The hypothetical goods for which respondents in each group were asked to pay for was a conservation package which contained measures to protect and conserve the natural resources

MWTP to support dugong conservation in the Trang MPA was USD 2.5 /household.  Not all the households in Bangkok would be willing to pay USD 2.5 /household.  In the surveyed sample, 26% of the respondents were willing to pay up to USD 3 /household.

The non-use value estimated was multiplied with the same percentage of households in Bangkok in 2021 with the estimated MWTP  In 2021, 26% of the number of households in Bangkok was equivalent to 818,280 households.  The non-use values estimated of THB 188 M could potentially be mobilised from the general households clearly indicating that there is demand for conservation measures Two major challenges remain.  One was how to create funds mobilisation mechanisms to capture such values. The findings could be used to justify investment in iconic marine species conservation or as empirical evidence to formulate investment portfolios to mobilise funds to actually finance the conservation measures in those plans at the scale and speed that could reverse the existing trends towards extinction.




Over a period of 20 years for protection and conservation of marine mammals, the shared cost for Trang alone would be THB 40.6 M. Adding this to estimated cost of implementing  dugong conservation  over a 20-year period which amounted to THB 66.5 M , the total cost over a period of 20 years would be approximately THB 122.8 M.  If the THB 188 M in principle is the benefit households perceive in making contributions to preventing the likelihood of extinction of dugongs, then the benefits of perceived by the residents of Bangkok alone exceeds the cost of bringing the dugong and the marine mammal conservation plan into action.  The second challenge surprisingly is how to ensure that the institutional mechanisms are flexible enough to accept the contributions mobilised and earmark this specifically for the use of dugongs conservation.

[17] Information is reflected in internal budget estimations for the establishment of MPA.

Filling the knowledge gaps on the economic values of BES as shown in Table 4.4 is a key precondition for achieving sustainable use within the broader Blue Economy framework. However, far less work has been done on analysing external costs, even though such analysis would provide a clearer and more accurate picture of the ocean economy's contribution to the national economy. In the last two decades, those in the judiciary system has shown interests in the approaches that environmental economists take in assessing the external costs (Nabangchang, O., 2009). In 2011 the DMCR commissioned a study on the Economic Valuation of Marine and Coastal Resources: Application to the Judiciary Processes, the objective being to review experiences and valuation approaches in assessing the economic value of marine and coastal ecosystem services (Nabangchang, O., 2011). With the increasing number of cases involving damages to natural resources, in 2018 the TSRI supported a study on Estimating the Economic Values of Coral Reef Damages to Support Thailand's Judiciary Processes(Nabangchang, O., 2018) which preceded the study focusing on only the direct use values of small-scale fishers in Phuket by DMCR which was to serve as a baseline for determining the value of economic losses to small-scale fishers should some human-induced damages be inflicted on the natural reefs of this province (Nabangchang, O., 2021). All these efforts culminated in a standard formular to estimate the value of the natural resources damages which was presented an approved by the NCMCRM in 2021. Beyond having this formula institutionalised however, the challenge that remains is the groundwork on estimating the values that should ideally be area specific.

**Table 4.4: Summary of economic values for selected ecosystem services.**

| ES/Ecosystems | Type of economic value | Value estimated | Source |
|---|---|---|---|
| **Provisioning** | | | |
| **Mangroves** | Use value: Fish | For fishermen who only fish in the mangroves, net income per year averages THB 46,493.3 /household.<br>For fishermen who only fish in the open seas, net income per year averages THB 110,239.4 / household. MWTP for Bangkok was THB 385 / household.<br>For the rest of the country was THB 206 / household. | Nabangchang and Vincent, 2019. |
| **Corals** | Use value: Fish | Phang Ngan: THB 181,383 / household /year (2020 prices)<br>Satun: 145,995 THB/ household /year (2020 prices) | Nabangchang, 2021 |
| **Coastal lagoons** | Use value: Fish | Upper Songkhla Lake: Average net income of THB 221,501 /year | Nabangchang, 2021b |
| **Offshore** | Use value: Fish | The study sites were the seven jackets which were towed some 133 - 205 km to a reefing site near Koh Phangan in 2020 to create a reef approximately 500 meters long. The total biomass was estimated to be 2,927 kg of fish on the platforms with a mean economic value of THB 175,500 /platform. | Harvey et.al., 2021 |
| **Regulating** | | | |
| **Mangroves** | carbon sequestration | Study compared data on carbon stock/rai for all coastal areas with the land price/rai to derive at opportunity cost per rai to maintain area as mangrove. Then compared opportunity cost/rai with the price of carbon credits. See Box Study estimated the benefits of restoring a total area of 4.8 M km2 of mangroves over a period of 50 years at THB 504 M in current prices which is then discounted. | Nabangchang & Vincent, 2019.<br>Nabangchang, 2023a |
| **Seagrass** | carbon sequestration | Study estimated the difference in the value carbon in seagrass beds without and with Trang MPA over a period of 20 years at THB 727.2 M | Nabangchang, 2023c |
| **Cultural** | | | |
| **Corals** | Recreational | 2021: In nominal terms, the consumer surplus of THB 6,223 /person /trip<br>2009 which was THB 6,638 /person/trip | Nabangchang, 2021a<br>Nabangchang, 2009a |
| **Beach ecosystem** | Recreational | 2010: In nominal willingness to pay for conservation of Saengchan beach Mae Rampueng beach of THB 837.17 M and 169.995 M | Nabangchang, 2010b |
| **Supporting** | | | |
| **Mangroves** | Indirect use value: ecological functions of mangroves was described in the CV scenario as the hypothetical goods which respondents were being asked to pay for.<br><br>The non-use values of mangroves were estimated by using Choice Experiment Method. | total non-use value of THB 4,895.76 M (THB 1.99 M/km2). | Nabangchang & Vincent, 2019. |
| **Corals** | Habitat and maintenance of species: marine turtles, manta rays, whale sharks | marine turtles: USD 1.41 / household for a period of 5 years. (estimated in 2007) | Jin et al., 2010a |
| **Seagrass** | Habitat for species: dugongs | Non-use: Trang : USD 127 / household<br>Bangkok: USD 66 / household | Nabangchang, 2012 |
| **Marine icon species** | | | |
| | Non-use value: Irrawaddy dolphins | USD 16 / household (estimated in 2009) | Nabangchang et. al., 2008 |
| | Non-use value | Non-use value: International tourists<br>Whalesharks: USD 47 / household<br>Manta Rays: USD 51/ household<br>Thais:<br>Whalesharks: USD 11 / household<br>Manta Rays: USD 10 / household | Nabangchang, 2011b |
| | Bryde whales. Department of Coastal and Marine Resources. (2019) | Recreational value: TCM (471 respondents) Consumer surplus 111 USD/trip<br>Non-use: CVM (661 respondents) | |
| | Non-use value (MPA+whale sharks) | Study estimated the non-use value of whale sharks as the flagship species of Losin MPA = THB 120 /household | Nabangchang, 2023a |
| | Non-use value (MPA+group of dolphins) | Study estimated the non-use value of group of dolphins as the flagship species of Trad Bay MPA = 303 THB/household | Nabangchang, 2023a |
| | Non-use value (MPA+dugongs) | Study estimated the non-use value of dugongs as the flagship specie of Trang MPA = 261 THB/household | Nabangchang, 2023c |
| | Non-use value: Irrawaddy dolphins | Study estimated the non-use value of Irrawaddy Dolphin was between THB 219 /household and 279 /household | Nabangchang, 2021b |

[18] The results of the other study conducted as part of the Chulalongkorn University eDNA Research Project Year 3 was inconclusive due to lack of primary data to estimate the fish biomass around the PTTEP sites in the GoT.

Assessment of the economic values of these damages would require some basic understanding of the bio-physical changes that result and how such changes in turn affect the flow of ecosystem services. In Table 4.5, direct and indirect impacts from the various economic sectors are presented. The last column of this Table is an indication of the knowledge gap which is essential for the analysis of the Blue Economy as pointed out earlier.

**Table 4.5: Missing values that need to be generated to complete the picture of the Blue Economy**

| | Economic sectors | Nature of benefit/types of economic value | Direct impact | Indirect impact | Existence of knowledge/studies on the economic value of the impacts |
|---|---|---|---|---|---|
| **Economic sectors which rely on coastal and marine natural capital as source of revenue** | Tourism | non-consumptive uses of coastal and marine resources | Wastewater | | None |
| | | | Marine debris | | None |
| | | | Anchoring | | None |
| | Fishery | Consumptive use of marine resources | If over utilisation will result in decline of population stock | | Production function analysis (Barbier and Sathirathai, 2024). Only assumptions on changes in productivity for purpose of cost benefit analysis (Nabangchang O., 2023). |
| | | | Fishing practices could result in damages to the habitat | | None |
| | Aquaculture | non-consumptive uses | coastal water quality>impact on natural population | | None |
| **Economic sectors which are sources of water pollution** | Maritime navigation | non-consumptive uses of coastal and marine surface area | Oil spill | Dredging | Studies have been commisioned by the DMCR 3/ |
| | | | Ship's ballast water | Demand for expansion of port facilities and supporting utilities | None |
| **Economic sectors which are sources of land-based water pollution and water pollution** | Agriculture | | Leachates from use of organic and chemical pesticides and fertiliser | | None |
| | Infrastructure development, eg. Seaports | | Potential loss of mangroves, seagrass beds, beach forests | reduction of coverage of natural habitat and deterioration of condition of habitat | None |
| | | | Sedimentation | | |

## 4.6 Financing protection, restoration and conservation of marine resources

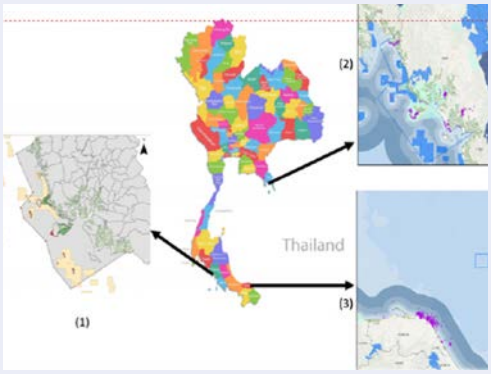
### 4.6.1 Lack of financial resources

Maintaining the stock of marine resources requires investments. To quote the Dasgupta Review, we need '*large chunks of investment*' to '*depart from the current paradigm that coastal ecosystems are worth more dead than alive*' (Dasgupta, 2021). In a study of worldwide costs of MPAs, Balmford et al. (2004) has estimated that to achieve the target of conserving 20–30% of the world's seas by 2030 would require between USD 5–19 B annually. In this study, Balmford et al. (2004) compared the management costs of 83 MPAs worldwide and found that around 50% of these MPAs had average costs of approximately USD 775 per km², expressed in constant 2000 prices. The range however is great and can be from 0 to as high as USD 28,000 / km². The study also concluded that there is an economy of scale in investments, i.e., that the larger the size of the MPA, the lower the unit cost. Apart from size, other factors influencing cost included the location of the MPA and whether or not the location is an extended part or connected to existing MPA. If the new MPA is located in a site with no connectivity with the existing MPAs, the cost could be USD 12.5 B /year for a 20% coverage and USD 18.8 B /year for a 30% coverage. At the other end of the spectrum, the model that assumes the highest percentage of connectivity, the costs could be lowered down to only USD 5.4 B and 6.9 B /year for a 20% coverage and 30% coverage respectively.

Addressing the goal to increase coverage of protected areas to 30% of the world's land and sea surface area Waldon et al (2020) estimated that the investment cost would range from USD 103–178 B. These estimates however cover investment costs of both terrestrial and MPAs and there is no disaggregated information on investment requirements specific to MPAs. The authors also pointed out that the cost estimates did not include the expenses for effectively managing existing protected areas which was estimated to be about USD 68 B of which only USD 24.3 B or around 36% of what is required was actually funded. Most of the funding needs would be for resource-rich low income and middle-income countries. For Thailand, expediting the process of expanding MPAs to reach that 30% target must be matched with ability to finance their operations. In the 2023 study, Nabangchang, (2023a) estimated the establishment and operational costs for three MPAs over a period of 20 years, even if no additional investments are made to step up conservation measures, will cost around USD 19.7 M. Even this baseline cost will be a challenge to finance. Even more far-fetched will be the additional investments to make MPAs work such as compensating fishers for restricted access, restoring the degraded mangroves, seagrass beds and coral reefs and stepping up measures to protect iconic marine species (Box 4-4).

## Box 4-4: MPAs: Making a case for investment (Nabangchang, 2023a)

Similar to other countries, Thailand is attempting to expand the coverage of MPAs by 10% as part of the process towards achieving the more ambitious goal of 30% area coverage by 2030. As part of the road map, the DMCR has identified 33 sites along the GoT and the Andaman coastlines as the designated MPAs purely on the criteria of abundance and fragility of natural resources. However, in addition to the designated prevalent human-induced pressures and demand for economic uses, there is also the financial issues, a basic question of the cost to establish and manage the MPAs. Without an analysis of the costs and the benefits, it is most likely that the few MPAs already established and the ones to be established even to reach the less ambitious 10% target coverage will join the ranks of the already existing stockpile of 'paper' parks. To prove the economic feasibility of investment, a study was conducted in 2022 focusing on 3 MPAs recently established in Thailand, the near-shore Trad Bay and offshore Losin island MPAs in the GoT and the Trang coastal areas MPA located on the Andaman coast.




These areas have been selected to represent fragile ecosystems in the various regions of Thailand. All 3 MPA study sites are habitats of 3 of Thailand's iconic marine species, namely dolphins, whale sharks and dugongs

In the base model, costs were divided into 2 components, the establishment and the operational costs over a period of 20 years. Establishment costs and annual operating expenses were actual cost data obtained from the DMCR. One of the key cost items included in the CBA is the expenses required to compensate losses of revenue should restrictions of access within MPAs be imposed. In addition to the establishment and annual operating expenses, the CBA analysis also include scenarios where additional investments are made for protection and conservation of iconic marine species as well as costs to restore mangroves and seagrass beds. Three types of benefits were included in this analysis, i) benefits from greater productivity of fishes, ii) value of carbon credit assumed to be generated from the additional investments in restoring degraded mangroves and seagrass beds within the three study sites and iii) the non-use value of the marine icon species of the 3 MPAs given the higher level of protection and reduced risks of harm from human induced activities.

After adjusting the median estimate reported by Balmford et al. (2004) to 2022 prices (USD 1,317/km$^2$), the estimated cost of managing the Trat MPA (USD 11,208/km$^2$) is approximately 8.5 times higher. However, it still falls well within the global cost range reported by Balmford et al. (USD 0–28,000 /km$^2$). The costs for the Trang MPA (USD 6,366 / km$^2$) and the Losin MPA (USD 2,391 /km$^2$) are also above the adjusted global median but remain comfortably within Balmford's observed range.

The B/C ratio calculated also supports the feasibility of investment of some of the investment options discussed above. Whereas the Brander et al. study (2020) concluded that depending on the location of the MPAs, investments could generate returns between 1.4 times to 2.7 times the value of investments, the B/C ratio for the Trang MPA even using the highest discount rate of 12% is 5 for the Base case scenario where only the basic investments are made for establishment and management and slightly lower at 4.48 with additional cost of imposing the additional no-take zones. For Trad MPA without and with no-take zones and using the highest discount rate the B/C ratio is still high at 13 and 5 respectively. This is also the case for the Losin MPA where without and with no-take zones and using 12% discount rate, the B/C ratio is still high at 10 and 6 respectively.

This study has demonstrated which investment options would give society higher returns and thus for a start can serve as investment guidelines and concrete evidence which can potentially be packaged to mobilise funds without which, given the rigidity of the country's budgetary system, the executing agencies will be not be able execute or expedite protection conservation measures which constitute the fundamental objective which the MPAs have been established in the first place.

### 4.6.2 The role of financial instruments

This section reviews a range of financial instruments that can support marine and coastal conservation in Thailand, recognising that their feasibility and effectiveness vary across contexts. Among the economic instruments reviewed, particular attention is given to mechanisms that directly link beneficiaries to conservation outcomes, such as Payment for Ecosystem Services (PES), which offer clear relevance for Thailand's institutional and policy setting. The discussion that follows is therefore intended to illustrate options rather than rank or prescribe specific instruments.

Financing nature conservation measures is not only about mobilising additional funds; it also involves creating positive incentives and eliminating incentives that are harmful to biodiversity. This challenge is reflected in Aichi Target 3, which calls for the reform or elimination of subsidies and incentives that are harmful to biodiversity, alongside the development of positive incentives for conservation and sustainable use. A similar objective is articulated in SDG Target 14.6, which calls for the elimination of subsidies that contribute to overfishing. This is mirrored in the SDG Target 14.6 that calls for an end to subsidies that contribute to overfishing.

To complement the legal command and control measures, the aim of introducing economic instruments is to create incentives for actions that will generate positive externalities and to create disincentives to reduce and eliminate negative externalities. In so doing economic instruments in theory will reverse market and policy failures reducing the discrepancies between private costs and benefits and social costs and benefits.

Adequate finance will feature among the prerequisite as discussed above.

On the demand side, we need to create markets for the non-tradable services provided by the coastal and marine ecosystems. A range of financing mechanisms are available but Thailand needs to be strategic in our choices because not all them can be readily implemented. All entail costs and benefits, lag time to invest, and further lag times before results can be discerned, measurable and quantifiable. Some finance tools already exist but can be revamped and revitalised to increase both the volume and the nature in which they are used because not all of them can be readily implemented. These include i) Donations/philanthropy, ii) Entrance and access fees, iii) Taxes and levies and iv) Conservation trust funds.

The supply side refers to the variety of conservation measures which must be executed to preserve the condition of the natural capital stock of marine and coastal resources and the flow of services. These are the key areas in which investment is needed, as illustrated in Figure 4.2. Figure 4.3 is an illustration of the situation as is. On the left side of the cliff are all the sources of revenues currently available. On the right side are the list of measures which require financing. The gap denotes the missing link between the sources of funding and what funding should be used for. Entrance fees for MNPs for example are primarily used for improvement of tourist amenities in the park and not specifically earmarked for the maintenance and restoration of the natural resources within the park. Donations on the other hand, tend to be one-time and issue specific with no guaranteed continuity. Figure 4.3 illustrates a mismatch between sources of revenue and the investment need areas. Simply put, it is a situation where money is not being channeled to where it is most needed.

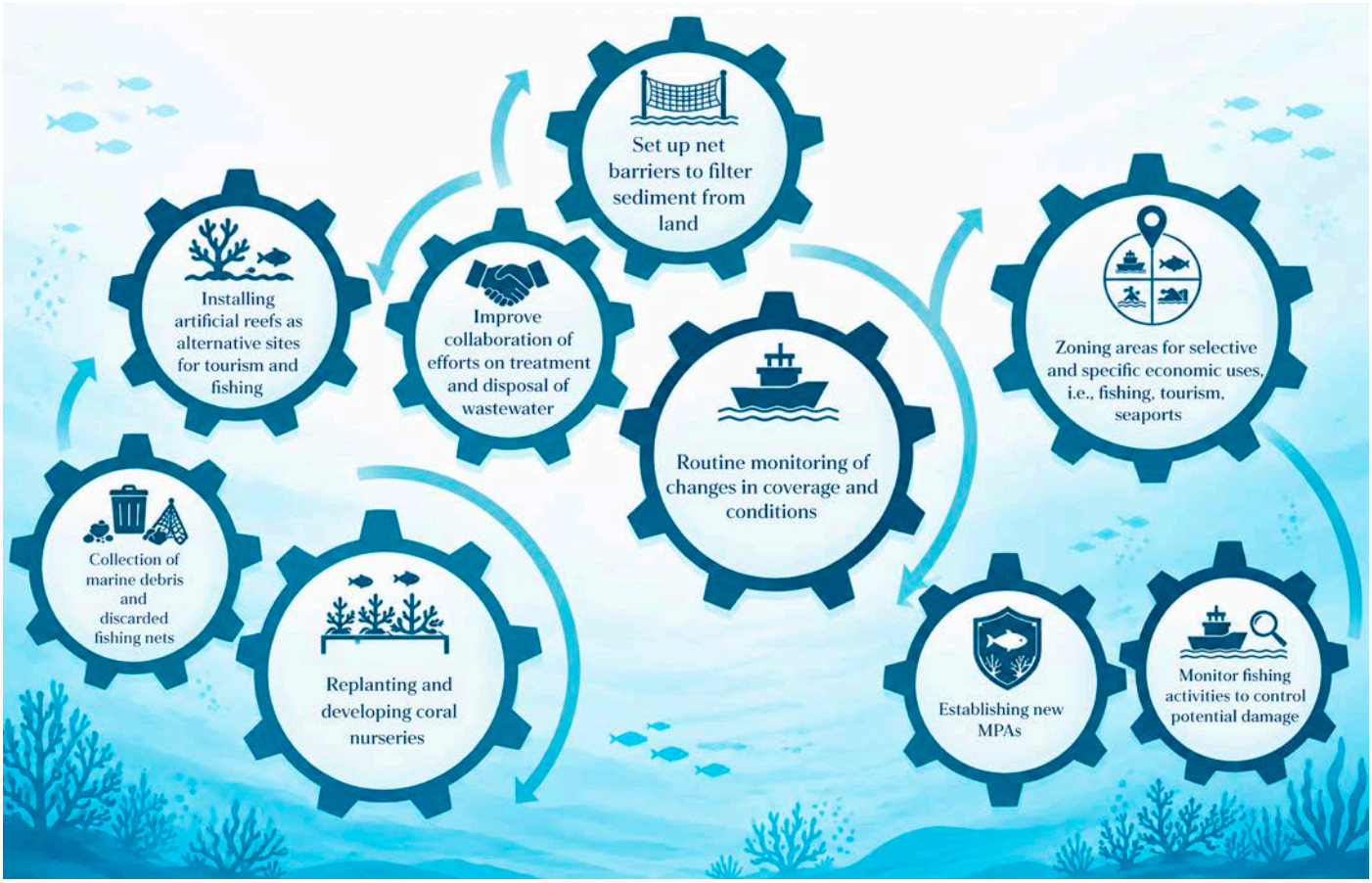



**Figure 4.2: Areas where investments are needed**

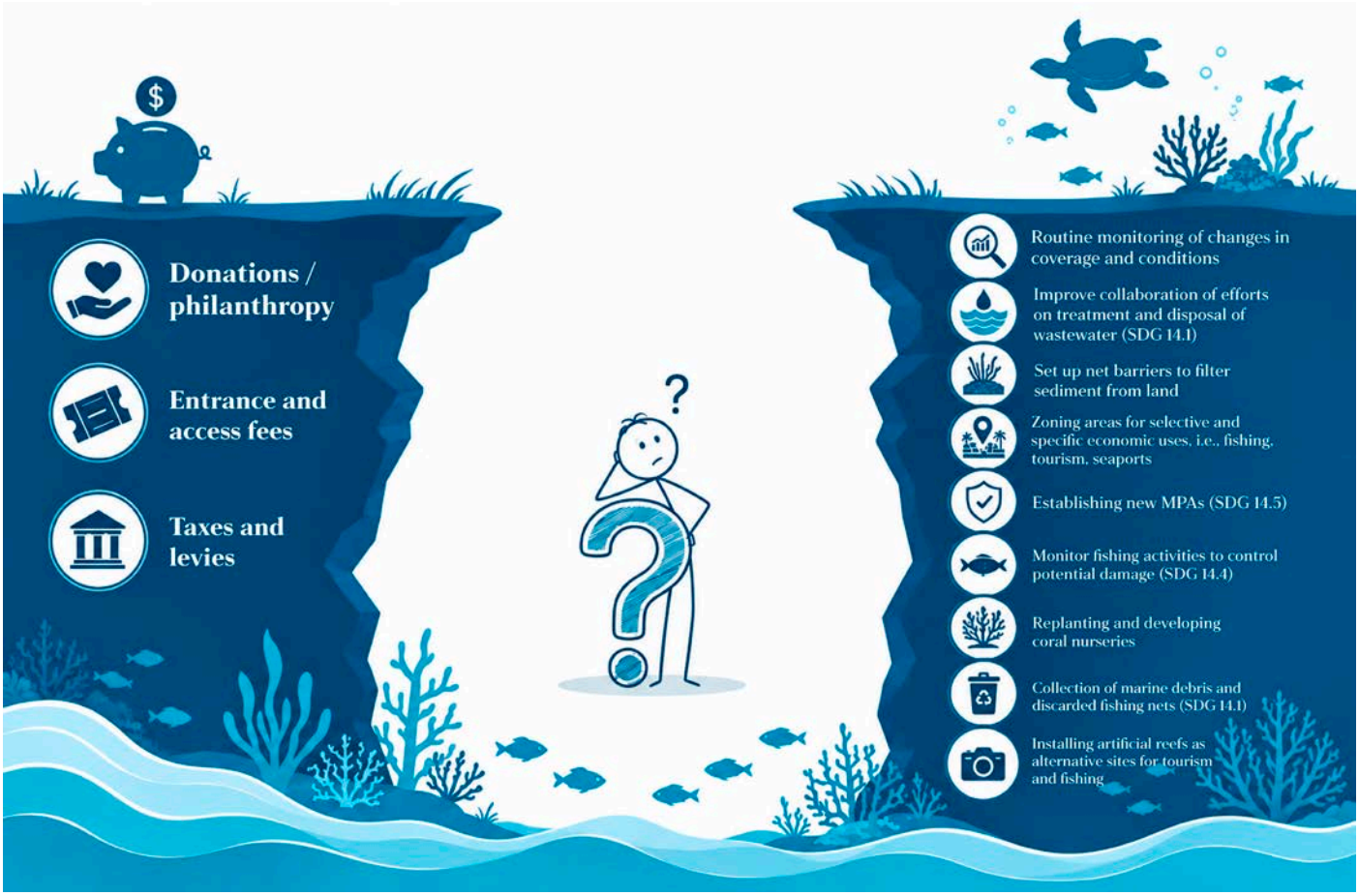



**Figure 4.3: Existing sources of revenue and the missing link with the investment need areas**

Other than the existing sources of revenue, Figure 4.4 shows potential financing mechanisms such as blue bonds, performance bonds, and biodiversity offsets. At present, much attention is being given to the blue bond. In principle, a blue bond is issued to support investment in healthy oceans and blue economies. Investors lend money to bond issuers which could be governments, banks or companies who is obligated to pay interest every year during the lending period which the bond covers plus capital at the date when the bond expires. Issuing bonds is not something new to the Thai government. What is new is that the concept has never been applied to the blue sector. Types of projects typically funded by blue bonds that could potentially be the source of finance for the coastal and marine sector include sustainable fisheries, ecosystems management and restoration, and coastal and marine tourism. Blue bonds could potentially to be instrumental to mobilise funds to implement a national scale mangroves, coral reefs and seagrass restoration effort with clarity that the proceeds from the bonds should be tied to concrete conservation measures that produces, measurable and tangible outcomes.




**Figure 4.4: Financing mechanisms that create and mobilise demand for conservation**

With all the investments in the coastal and offshore areas, a mechanism that is long called for is Performance bonds. Performance bonds are essentially money paid as a deposit against possible environmental damages or provisions for sustainable use which may arise in the course of carrying out an economic activity, such as construction, tourism or the extraction of offshore gas or minerals. These are usually refundable on the completion of economic activities, if no damage or non-compliance has been demonstrated to have taken place. There is as yet no experience in issuing performance bonds in Thailand, but many large-scale infrastructure and coastal development projects including offshore gas and oil exploration pose risks to the fragile coastal and marine ecosystem. Beyond conducting the EIAs, a mechanism needs to be put in place to ensure that all possible liabilities will be covered. The requirement that investors purchase "performance

bonds" would not only create incentives for compliance with environmental regulations and standards as well as incentives for reducing externalities but would also motivate investors/developers to take the necessary precautionary measures and in so far as possible avoid any adverse environmental impacts that are likely to occur. Moreover, the existence of this financial mechanism will ensure that sufficient funds are available to mitigate or remediate the effects of any environmental damage that does occur.

A mechanism that could also ensure no net-harm to coastal and marine resources is Biodiversity offsets, a regulatory instrument for assigning financial liability for environmental damage to developers and having significant potential to generate revenue for marine conservation (Bos et al., 2014; Walsh, 2017). Many investment projects, more specifically coastal infrastructure investment projects as well as offshore oil and gas exploration and extraction create damages for which the investors are seldom held fully responsible for the cost of damages incurred. This is a financial instrument which will require companies to firstly recognise and take measures to prevent, reduce and mitigate their impacts from a planned development, and where mitigation measures are insufficient to eliminate all impacts, to then pay to offset the residual impacts. This could be a tool to ensure that such investments will at least create no net loss and at best create a net gain of benefits to society by ensuring that approval of investment projects become contingent on the investors accepting full responsibilities for the damages. As a precautionary step to adopting this mechanism, it is necessary to be aware of the controversies. Some of the counter arguments see biodiversity offsets as a "license to pollute", that the option of being able to offset the adverse environmental impact will provide incentives for investors to embark on projects that they would otherwise not contemplate. As Iyer et al. (2018) observed, any decision to adopt this mechanism, for all its promises, will take more time and upfront resources to put in place.

Though these three financing mechanisms (new to Thailand) are needed, they will require considerable upfront preparation work beyond the economic rationale for adopting them, to ensure that they are not misused and or used to 'blue wash' the responsibilities of businesses that utilise coastal and marine resources. These three financing instruments, in addition to the ones already existing can be said to represent the demand side for conservation. The challenge remains how to link the demand and the supply side, how to match the flows of revenue to the conservation measures that need financing.

The answer lies in financial instruments such as Payment for Ecosystems Services and Impact Investment. PES is a system within which the beneficiaries of ecosystems services pay the service providers for the services rendered in looking after, protecting and/or restoring the natural resources which generate the ecosystem service benefits. Beneficiaries can range from individuals, communities, business sectors that use natural resources for the production of goods and services or even the public sector. In general, the incentives for the beneficiaries relate to cost savings considerations or assurance of continued supplies of goods or flows of services from the ecosystems they benefit from. There are opportunities for adopting PES as a financial mechanism for management of Thailand's coastal and marine resources. All of the coastal and marine ecosystems provide all the four types of services classified by the MDG, namely provisioning, regulating, cultural and spiritual. Without PES, beneficiaries may be paying for only the tradeable parts of the goods and services. The non-tradable dimensions of services in effect become missing markets and the root cause of market failure and environmental problems. PES can be applied in all cases involving restoring, rehabilitating and protecting marine and coastal ecosystems, specifically mangroves, seagrass, and coral reefs. For PES to work however, there must be "actions" that can be undertaken to reduce or eliminate ongoing degradation, and/or to restore the degraded or damaged conditions of the natural resources base. The results of

these actions must be quantifiable and measurable to justify payment so long as the beneficiaries continue to rely on the flow of the ecosystems services.

Linked to the concept of PES are mitigation banks. A mitigation bank is a wetland that has been restored, established, enhanced, or preserved for the purpose of providing compensation for unavoidable impacts to aquatic resources. In the Thai context, all categories of MPAs that are under the jurisdiction of the DMCR and DNP could potentially be developed as sources of mitigation credits that are of economic value. This fits into the PES framework as by elevating the level or protection, and/or by focusing on restoration of coastal and marine resources, it can be said that these agencies are providing "ecosystem services", albeit from the supply side of conservation. In addition, mangroves and seagrass meadows are increasingly recognised as Blue Carbon ecosystems, providing climate regulation services that could further strengthen the case for applying PES and related financial instruments.

To complement PES, Impact Investment can be a modality to package the planned conservation measures in ways that are more attractive potential investors in the private sectors and the financial sectors. Impact investing is an investment strategy that seeks to generate financial returns while also creating a positive social or environmental impact. Financial mechanisms such as Impact Investments could be a possible solution into making sure that there are adequate financial resources to implement many existing plans as well as the measures listed on the right side of the cliff in Figure 4.5.

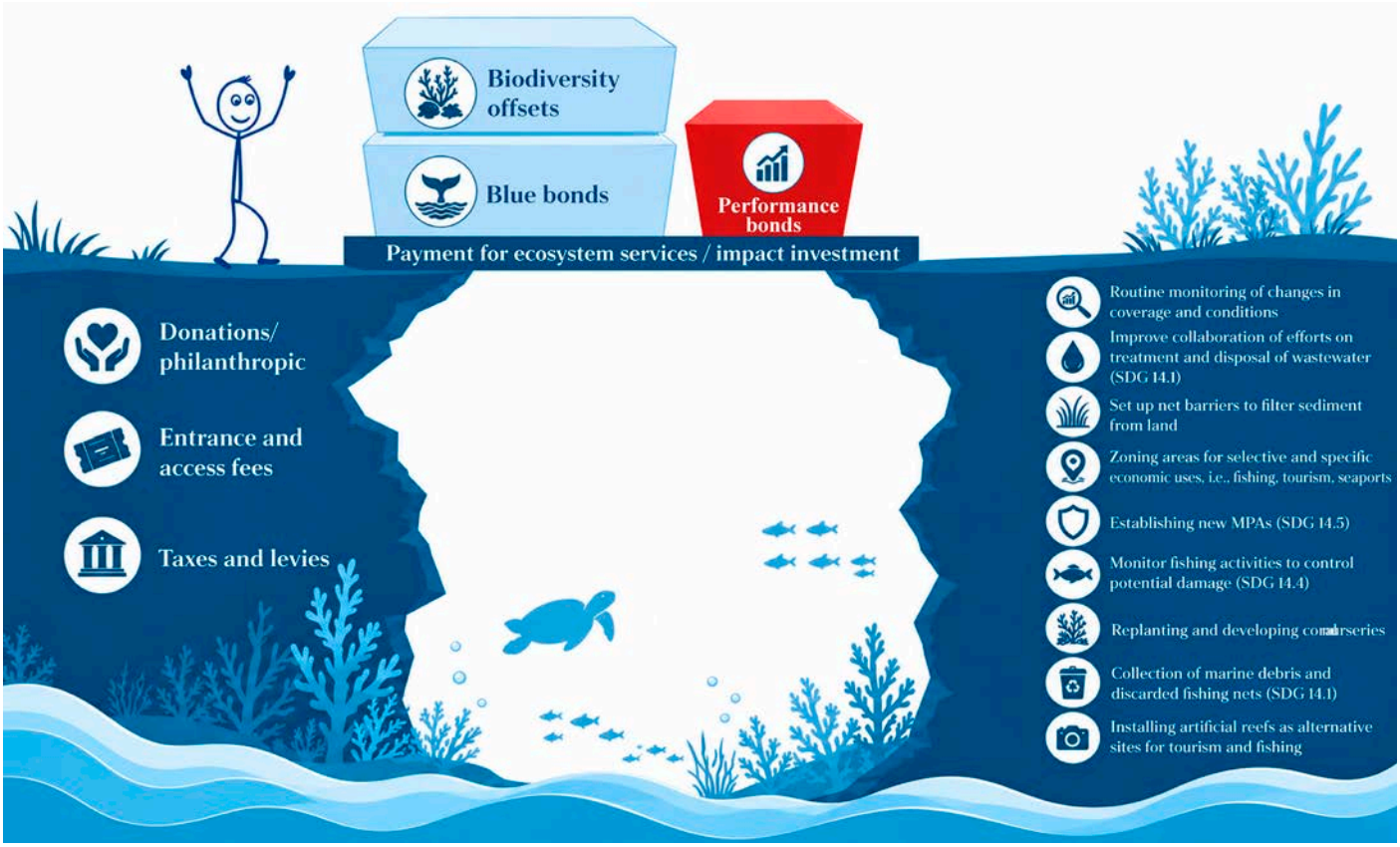



**Figure 4.5: Linking demand and supply for protection and conservation of coastal and marine resources**

In restoring and rehabilitating coastal and marine habitats, those who are involved are in fact services providers in the PES scheme or using the Impact Investment terminology, they are outcome payers.

## 4.7 Conclusion and recommendations

### 4.7.1 Conclusion

This chapter has highlighted significant gaps in knowledge on the economic value of marine and coastal resources in Thailand, particularly regarding ecosystem service flows and the costs associated with degradation and damage. Without addressing these gaps, it remains difficult to fully understand the true contribution of marine resources to the economy or to design effective policy interventions. Thailand therefore does not yet have a sufficient understanding of the value of its marine and coastal resources, nor of the extent to which environmental degradation reduces long-term economic benefits.

The analysis also underscores that stronger collaboration between natural scientists and environmental economists is essential. Meaningful economic valuation depends on sound understanding of ecosystem conditions, ecological processes, and the impacts of anthropogenic pressures on the stocks and flows of ecosystem services. At present, economic analysis is often undertaken only after policies have been enacted or damages have occurred, and is therefore constrained by limited data and the need for simplifying assumptions.

The chapter further shows that conservation and restoration of marine and coastal resources will require financing that exceeds existing public budgetary resources. Although a range of financing tools already exist—including donations, access fees, taxes, levies, and trust funds—these mechanisms remain underutilised or insufficiently developed. Mobilising additional resources from the private sector, philanthropic organisations, financial institutions, and the public will therefore be necessary.

The case examples presented throughout this chapter reinforce these broader conclusions. They demonstrate that investments in MPAs can generate economic as well as ecological benefits; that blue carbon opportunities must be assessed alongside financial, logistical, and opportunity costs; that tourism-based economies depend fundamentally on maintaining ecosystem quality; and that there is public willingness to contribute financially to visible and credible conservation initiatives. At the same time, the examples confirm that effective implementation depends not only on sound economics, but also on supportive institutional and legal frameworks.

Overall, the central message of this chapter is that economic valuation is not an end in itself. Rather, it is a practical tool to help reveal hidden benefits, identify trade-offs, improve policy design, guide investment decisions, and support a development pathway in which marine ecosystems continue to sustain both nature and human well-being.

### 4.7.2 Key messages and recommendations

**Key Message 1: Marine ecosystem and their services play a critical role in Thailand's national economy and human well-being. *(Well established)***

Understanding economic value is fundamental to policy decisions on the sustainable use of marine and coastal ecosystems. These ecosystems generate benefits that extend far beyond market transactions, including fisheries, tourism, coastal protection, climate regulation, water purification, and cultural identity. Many of these services, particularly regulating and cultural services, do not have market prices and are therefore often overlooked in policymaking.

Because ecosystem services are not priced, their degradation is often perceived as costless. In reality, the loss of services from mangroves, coral reefs, or seagrass creates substantial long-term costs for communities, businesses, households, and the public sector. Economic valuation helps reveal these hidden benefits and costs, improves trade-off analysis, and supports better policy and investment decisions.

Thailand already possesses substantial valuation evidence for mangroves, coral reefs, and seagrass ecosystems. Existing studies show that these ecosystems generate significant benefits through fisheries, tourism, carbon storage, coastal protection, and biodiversity conservation. However, important gaps remain for beaches, dunes, offshore ecosystems, pollution costs, and cumulative impacts. These gaps limit Thailand's ability to fully integrate ecosystem values into planning and nature-positive development strategies.

Failure to account for ecosystem values can make development decisions appear economically efficient in the short term while generating long-term economic losses, environmental degradation and insufficient investment in conservation and restoration.

Credible valuation depends on strong biophysical evidence, reliable socio-economic data, institutional capacity, standardised methodologies, and clear policy purpose. Without these conditions, valuation is unlikely to influence policy in a meaningful way.

**Recommendations:**

**1.1 Integrate economic valuation into decision-making frameworks by embedding it in policy appraisal,** cost-benefit analysis, investment screening, EIAs, and major infrastructure approvals, while ensuring ecosystem service losses are reflected in public investment decisions.

**1.2 Recognise the full value of ecosystem services in development choices by systematically accounting for non-market benefits** such as coastal protection, carbon sequestration, and cultural values, using valuation evidence to assess trade-offs, and promoting NbS where they deliver stronger long-term returns.

**1.3 Strengthen the valuation evidence base and methodological consistency by consolidating existing studies into a national reference database,** prioritising under-assessed ecosystems, expanding valuation of regulating services, improving research on pollution and cumulative impacts, and developing standardised national guidelines.

**1.4 Enhance safeguards, accountability, and precaution in development planning** by enforcing mitigation and compensation measures based on credible valuation, reviewing past investments to identify hidden environmental costs, and applying precautionary approaches in ecologically sensitive coastal areas.

**1.5 Build enabling systems, institutions, and governance capacity through systematic biophysical monitoring,** stronger data integration across agencies, technical training, inter-agency coordination, clear policy objectives for valuation exercises, and stronger legal and judicial mechanisms for ecological damage assessment and compensation.

## Key Message 2: Closing investment gaps requires strategic mobilisation of the private and financial sectors. *(Established but incomplete)*

Thailand's marine and coastal ecosystems generate substantial economic benefits, yet investment in their protection and restoration remains below what is required. Public budgets alone are insufficient to meet the scale and urgency of conservation needs.

Existing financing tools such as donations, entrance and access fees, environmental taxes and levies, and conservation trust funds provide a foundation but require revitalization and better coordination. Transparent and well-governed financing mechanisms can build confidence among donors, philanthropic organizations, and private actors, ensuring sustained and predictable funding flows. Corporate Social Responsibility (CSR) contributions should be strategically aligned with national conservation priorities, moving from ad hoc support toward structured investment roadmaps.

A key priority is the development of bankable conservation and restoration projects that demonstrate economic feasibility, expected benefits, and manageable financial risks. This can help attract commercial banks, impact investors, and institutional investors.

The financial sector should also be encouraged to integrate environmental considerations into lending and investment decisions through incentives, disclosure requirements, and risk-sharing arrangements. Together, these measures can help Thailand move toward a more diversified and resilient conservation financing model.

**Recommendations:**

2.1 Strengthen governance and transparency of conservation financing mechanisms.

2.2 Encourage financial institutions to integrate environmental risk into lending criteria.

2.3 Promote innovative instruments (blue bonds, blended finance, carbon finance).

2.4 Align CSR investments with national conservation priorities.

## Key Message 3: Public investment must avoid causing environmental harm and actively contribute to Nature-Positive development. *(Established but incomplete)*

A recurring challenge in Thailand's development pathway is that the economic value of ecosystem degradation is rarely fully incorporated into public investment decisions. While EIAs are required, the broader economic consequences of lost ecosystem services are often not systematically quantified.

Moving toward nature-positive development requires integrating ecosystem valuation directly into planning, budgeting, and regulatory processes. Estimating the economic value of potential environmental damage should become a standard component of decision-making for both public and private investments.

Where adverse impacts cannot be avoided, they should be minimised, with any remaining losses adequately compensated on the basis of credible economic valuation and due recognition of non-economic loss and damage. Applying "no net loss" principles across sectors can strengthen accountability and reinforce the recognition of natural capital as an economic asset.

Nature-positive public investment does not impede development; rather, it aligns economic growth and infrastructure expansion with long-term sustainability.

**Recommendations:**

- 3.1 Apply "no net loss" or "net gain" principles across sectors.
- 3.2 Prioritize NbS in coastal infrastructure.
- 3.3 Ensure full compensation for unavoidable ecosystem damage.

## Key Message 4: Thailand's future sustainable pathway depends on systematically incorporating the value of coastal and marine natural capital into policymaking and investment decisions. *(Established but incomplete)*

Incorporating ecosystem values into Thailand's development pathway requires a shift in how marine and coastal ecosystems are understood and managed. Evidence from valuation studies shows that restoration and conservation investments can generate substantial economic returns through enhanced fisheries productivity, coastal protection, tourism benefits, biodiversity conservation, and carbon sequestration.
Embedding ecosystem values into EIAs, cost-benefit analysis, infrastructure planning, MSP, and public budgeting can help minimise ecological harm, improve investment choices, and promote NbS.

Incorporating natural capital into national development and climate strategies can strengthen resilience, mobilise finance, prioritise high-value ecosystems, and align economic growth with ecological integrity. In doing so, it supports long-term well-being for present and future generations.

**Recommendations:**

4.1 Integrate coastal and marine natural capital into national development and climate strategies.

4.2 Incorporate ecosystem values into MSP and coastal zone management.

4.3 Develop natural capital accounting systems for marine ecosystems.

4.4 Scale up restoration where economic returns are demonstrably high.

4.5 Mobilise long-term financing mechanisms to sustain conservation outcome.



# 5 | Indigenous and Local Knowledge and Marine Biodiversity and Ecosystem Services

## 5.1 Introduction

In Thailand, the NEA has conventionally been the work of scientist experts equipped with technical tools and complex measurement processes for analysis. ILK has not played a significant role in these assessments, or as it has only been a small part of the data collected from local community members, without reference or involvement of these knowledgeable individuals in defining the issues, objectives, approaches, and processes of the ecological assessments.

International academic and practical work has demonstrated that ILK plays a crucial role in assessing ecosystems and biodiversity. It contributes additional perspectives and dimensions to understanding changes in ecosystems more deeply and profoundly, including aspects of values, worldviews, and ways of life that differ from mainstream society.

The IPBES supports the adoption of a multiple evidence base approach in ecological assessments, combining scientific evidence and ILK systems. Scientific knowledge typically emphasises quantitative data and statistical analysis, whereas ILK focuses on qualitative insights drawn from close observation of nature, long-term community lived experiences, and culturally embedded practices and relationships with local ecosystems. Although much ILK remains unrecorded and has not been systematically tested in laboratory settings (based on scientific worldview), for many communities, nature itself serves as a natural laboratory, where sustained observation and real-life experience and interaction with nature generate evidence of ecological changes. Consequently, even without formal experimentation, ILK is dynamic, adaptive and grounded in extensive real-life experience and long-term ecological observation (IPBES, 2019; IPBES, 2022a).

Globally the way of life of Indigenous Peoples and local communities who live closely with nature reflects their dependence and bond with both nature and within their own communities. This has led to customary traditions related to natural resources and the establishment of sustainable use and management practices. Several IPBES assessments have clearly demonstrated this (IPBES, 2019; IPBES, 2022).

Chapter 4 of the Thailand NEA demonstrates the valuation of ecosystems in terms of economic value, which is based on mainstream worldviews and thinking that emphasise judgment or weighting and monetising of ecosystem services through quantitative criteria. However, this valuation of ecosystems is considered relatively new, as it represents a paradigm shift from viewing natural resources as free or available for human use to seeing natural resources and ecosystems as providing services that can be valued. Adding an economic dimension to the assessment makes the importance of ecosystems clearer, and having monetary values helps policymakers weigh decisions that impact ecosystems and biodiversity more effectively.

However, ecosystem assessments need to allow space for multiple forms of valuations beyond economic value. Local villagers often view the value of ecosystems differently from scientists, economists, and policymakers. Across the globe, many Indigenous Peoples and local communities see nature as having a value that cannot be quantified in numerical or monetary terms. These values arise from the long-standing bond, cultural identity, spirituality, reciprocity, and gratitude toward nature.

The IPBES assessment on the diverse values and valuation of nature underscores this plurality of values, highlighting that relational, cultural, and intrinsic values are central to how Indigenous Peoples

and local communities interact with and care for nature. It revealed that many Indigenous Peoples and local communities understand themselves as *part of nature, living in nature* or *living as nature*, reflecting deeply embedded worldviews that shape environmental stewardship principles, practices, and decision-making (IPBES, 2022b).

In Thailand, many coastal communities refer to the sea as "life" "the land of ancestors" or as a domain protected by the "the lord of the sea". These expressions carry meaningful relationships and create emotional bonds that foster a shared responsibility to protect natural resources—resources that are both an important food source and a source of spiritual and community security. Therefore, incorporating ILK into the assessment of the ecosystem adds dimensions of community and even humanity. Caring for nature does not arise from assigned value or price, but from the view that nature and humans are inseparable parts. This reflects diverse worldviews that aim for the sustainability of nature and people together.

Incorporating ILK into ecosystem assessments does not mean extracting knowledge from people and communities and merely appending it to scientific data to enhance its accuracy and completeness. Rather, it refers to the co-production of knowledge among diverse knowledge holders, including ILK holders, scientists, practitioners, and various sectors involved in ecosystem conservation. This process must be grounded on a multiple evidence base (MEB) approach, based on mutual respect and understanding that ILK holders are not merely sources of information (data providers), but custodians who have coexisted with nature for a long time and possess worldviews that may differ from scientific perspectives. They also have traditional knowledge and management systems and practices that support sustainability, which may differ from the formal conservation regulations.

This Chapter explains the role of ILK in the assessment and conservation of ecosystems and biodiversity. It introduces concepts and meanings of ILK and addresses why ILK is important for assessment of ecosystems and biodiversity. The Chapter then focuses on coastal groups or communities in Thailand, specifically the "Chao Lay" sea nomadic groups whose ways of knowing and ILK have been neglected in marine and coastal conservation policies. Small-scale local fishing communities are also included in this Chapter, but with less emphasis as there have been more studies and more targeted policies on these groups. The Chapter also outlines the methodology and processes for participatory ILK data collection and analysis, and discusses the value of ILK in terms of familiarity and connection with nature, the value of care and ethics in conservation, and its contributions to monitoring and assessing environmental changes. The concluding section of the chapter examines the status and trends of ILK, threats to communities and pressures on ILK, responses and restoration efforts while exploring best practices. Finally, it assesses policies, knowledge gaps that need further research, awareness and capacity-building needs to ensure that ILK remains relevant and effectively utilised for sustainable ecosystem and biodiversity use and conservation.

## 5.2 ILK: Concepts and meanings

### 5.2.1 Concepts and meanings of ILK

ILK is a holistic concept encompassing philosophies, worldviews, knowledge, understandings, traditional practices, value systems, and skills accumulated by Indigenous Peoples and local communities. It develops as an intricate system of relationships between people and "nature" (the latter referred to in scientific terms as "ecosystems and biodiversity"). Rooted in specific territories or lands, including coastal areas and seas, ILK is transmitted through generations via

observation and experience. This accumulated experience evolves into concepts and practices related to natural resource management, thus constituting a significant cultural heritage (IPBES, 2017; UNESCO, 2017; McElwee et al., 2020).

While some local communities may lack written languages and do not record their experiences and knowledge as "explicit knowledge," their experiential knowledge—knowledge embedded in the experiences and expertise of people (tacit knowledge)—enables communities and groups to survive and thrive amidst various risks and coexist with nature over extended periods. Indeed, IPBES (2019) global assessment confirmed that about a quarter of global land area is traditionally owned, managed, controlled, used or occupied by Indigenous Peoples, which largely coincide with formally protected areas and landscapes with low human interventions, underscoring their environmental stewardship.

Early studies of ILK were primarily confined to the social sciences (Gadgil et al., 1993). However, as environmental crises intensified, and as Indigenous Peoples and local communities increasingly found themselves at the forefront of these crises due to their close reliance on natural ecosystems, scientists and conservation organisations began to pay greater attention to community experiences that reflect observed changes in nature and community adaptation strategies.

International processes and organisations have also played a pivotal role in amplifying ILK by elevating its recognition, legitimacy, and influence across global environmental governance. Through complementary mandates, platforms such as IPBES, the CBD, and UNESCO have helped shift ILK of biodiversity from being treated as supplementary knowledge to being recognised as a distinct and equally valid knowledge system alongside science. The KMGBF reinforces these principles by explicitly recognising the rights, knowledge systems, and customary governance of Indigenous Peoples and local communities, and by calling for their full and effective participation in biodiversity planning, implementation, and monitoring.

IPBES in particular has operationalised this recognition through its conceptual framework and assessment processes, promoting multiple knowledge systems, the multiple evidence base approach, value pluralism, and knowledge co-production, while creating formal spaces for Indigenous Peoples and local communities to participate meaningfully as contributors to assessments, policy development, and implementation.

Together with UNESCO's Local and Indigenous Knowledge Systems (LINKS) Programme, these international frameworks have strengthened the embedding of IPBES and national assessment assessments, ensuring that community-based knowledge systems and worldviews contribute substantively to ecological assessment, biodiversity conservation, sustainable use, and long-term ecosystem resilience.

The Thailand NEA embraced and adopted a similar approach based on the tailored IPBES conceptual framework by embedding ILK in the entire assessment process in alignment with national practices and international principles.

## 5.2.2 Multiple knowledge systems

As the scientific knowledge system becomes more established and mainstreamed, other knowledge systems became more marginalised. For example, Native people in Alaska, USA, have noticed signs of environmental change since the 1950s, but scholars have disregarded personal observations in their search for statistically accurate data, ignoring this "indirect" evidence. In fact, these people are observing climate change and its impact on plants and animals, especially those who spend a lot of time hunting and fishing. Therefore, focusing on knowledge from stories and observations can help to understand changes in ecosystems (Leonard et al., 2022).

Multiple knowledge systems refer to the recognition that there are many systems of knowledge beyond mainstream scientific knowledge. There are now international norms, protocols and platforms advancing diverse knowledge systems. For instance, Article 8(j) of the CBD promotes the recognition, safeguarding, and effective use of traditional knowledge for biodiversity conservation, while ensuring the rights and active participation of the knowledge holders. The KMGBF further affirms the importance of this knowledge in conservation and sustainable use of biodiversity and outlines the multiple evidence base approach as one the key enabler principles in the implementation of KMGBF targets. Similarly, recognition of multiple knowledge systems is also central to the work of IPBES, which supports ILK in ecosystem and biodiversity assessment including policy decisions on biodiversity (Tengö et al., 2017). Furthermore, collaboration across multiple knowledge systems is a pathway to more inclusive and equitable ecosystem governance in the Anthropocene, amidst a growing awareness of planetary boundaries (Diaz et al., 2017).

There are various examples of knowledge systems collaboration and co-production of knowledge between scientists and Indigenous Peoples and Local Communities in terms of assessing and monitoring the status of forests, wildlife, marine ecosystems, and agricultural biodiversity. A key finding is that biodiversity monitoring designed with science and ILK can promote the conservation of culturally important species, and that such inclusion can lead to better adaptation to highly changing social and ecological conditions (Reyes-Garcia&Benyei, 2019).

The difficulty of working to bridge different knowledge systems stems from an encounter of different worldviews, identities, practices and ethical systems; and what is even more difficult is that these encounters often occur in the context of an imbalance of power and rights. Many scholars working on this issue emphasise that global environmental governance must understand this imbalance of power in order to accommodate multiple knowledge systems (Reyes-García&Benyei, 2019; Tengö et al., 2017). One approach is to study ILK systems where knowledge holders are actually engaged and not treated as just participants or informants (Diaz et al., 2015; Whyte et al., 2015). In many countries that focus on ILK, scholars have drawn on local or Indigenous community philosophies to guide their work, such as the "two-eyed seeing" concept of Mi'kmaq elders, an Indigenous People living in Canada and the northern United States. This concept suggests that the braiding of scientific knowledge systems and diverse ILK methods can promote the sustainability of the seas and oceans. This emphasises the importance of diverse knowledge and thought systems in order to understand and help sustain nature (Leonard et al., 2022).

## 5.2.3 Multiple evidence-based approach

A multiple evidence-base (MEB) approach posits that knowledge of ecosystems and biodiversity should be grounded in empirical data and evidence that illustrates and clarifies key issues. This involves reviewing, researching, analysing, interpreting, monitoring, and evaluating the confidence level of data and its applications.

ILK constitutes a valuable source of empirical evidence, accumulated, passed down, tested, and refined across generations. ILK is derived from long-term observations and real-life experiences, often spanning centuries. While largely undocumented, ILK is transmitted through cultural practices and traditions.

Figure 5.1 shows diverse knowledge systems that are analogous to colored strands or strings of rope that may be interwoven or braided together to create a more complete picture.

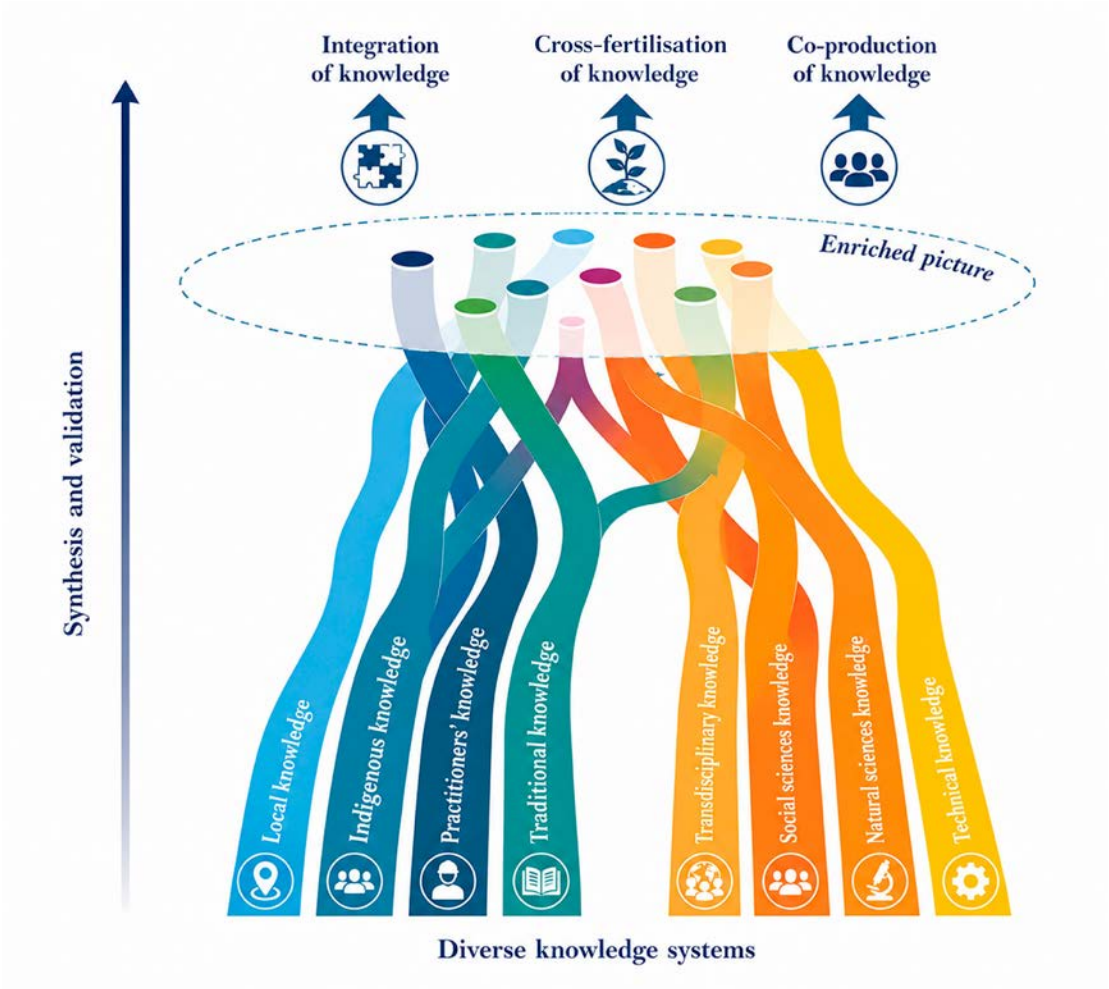



Figure 5.1: Diagram showing diverse knowledge systems
(Source: Tengö et al., 2019)

Including ILK into ecosystem and biodiversity assessments acknowledges the importance of diverse evidence, ensuring decisions and actions are informed on the best available evidence. This involves sharing and exchanging various sets of empirical data. Academic/scientific knowledge, primarily rooted in Western traditions, is typically explicit, documented, and formally taught in educational

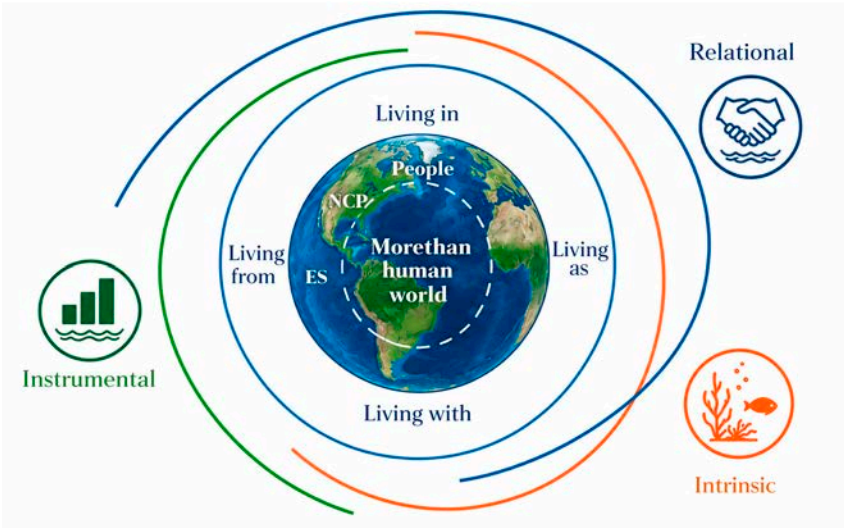
institutions. It often seeks to establish universal laws and theoretical and statistical frameworks to explain natural phenomena. However, ILK is context- and location-specific, characterised by holistic worldviews that integrate knowledge with social and community relationships, discouraging exclusion, monopolisation, or irresponsible use. Understanding ILK requires incorporating cultural practices, community structures, social institutions, biomimicry, social learning, transmission, and governance of this knowledge (Malmer et al., 2019; Tengö et al. 2017).

A critical consideration when studying ILK is avoiding the imposition of "scientific" standards as the sole determinant of empirical validity. Different knowledge systems are based on distinct ontologies and worldviews, leading to variations in meaning-making, interpreting natural conditions, and establishing causality. Therefore, IPBES emphasises that criteria for judging accuracy may not be universally fixed. Empirical testing, argumentation, and validation processes may differ across contexts. The principle of co-production of knowledge promotes collaborative learning between knowledge systems, avoiding cross-system comparisons and verifications. This approach reduces power and rights imbalances and empowers groups or communities with data sovereignty, including ownership and intellectual property rights (Malmer et al., 2019; Tengö et al., 2017).

### 5.2.4 Multiple value systems or value pluralism

Multiple value systems here refer to the diversity of worldviews and value systems related to nature. As exemplified earlier, Indigenous Peoples and local communities may view nature as "life," whereas scientists may perceive it analytically as a diverse ecosystem, valuing its capacity to generate ecosystem services for humans (IPBES, 2022b).

IPBES emphasises multiple value systems and endeavors to understand different dimensions of value despite the inherent difficulty in classifying such abstract concepts. Nevertheless, the values that different groups attribute to nature significantly influence ideas, policies, practices, and behaviors that impact nature. Therefore, understanding values is not solely the concern of philosophers but should be of interest to all stakeholders in order to connect with sustainability issues (Blake, 1999; IPBES, 2022b; Pascual et al., 2023; Vilkka, 2021). Figure 5.2 from O'Connor and Kenter (2019) illustrates four different value perceptions of people living in, from, with, and as nature, which deepens understanding of diverse ways that human relates to nature.




The four Life Frames of Values and their relation to the IPBES (2016) categories of intrinsic, instrumental and relational values. ES ecosystem services, NCP nature's contributions to people.

**Figure 5.2: Four life frames of values (Source: O'Connor&Kenter, 2019)**

In the Figure 5.3 IPBES (2022b) assessment categorises value dimensions into four levels: (a) *worldviews* which form the basis for perspectives and actions; (b) *knowledge systems*, encompassing knowledge, beliefs, and practices; (c) *broad values*, which give rise to life principles and goals; and, (d) *specific values*, which involve judgments or valuations. Specific values are further divided into three countries: intrinsic, instrumental, and relational values.

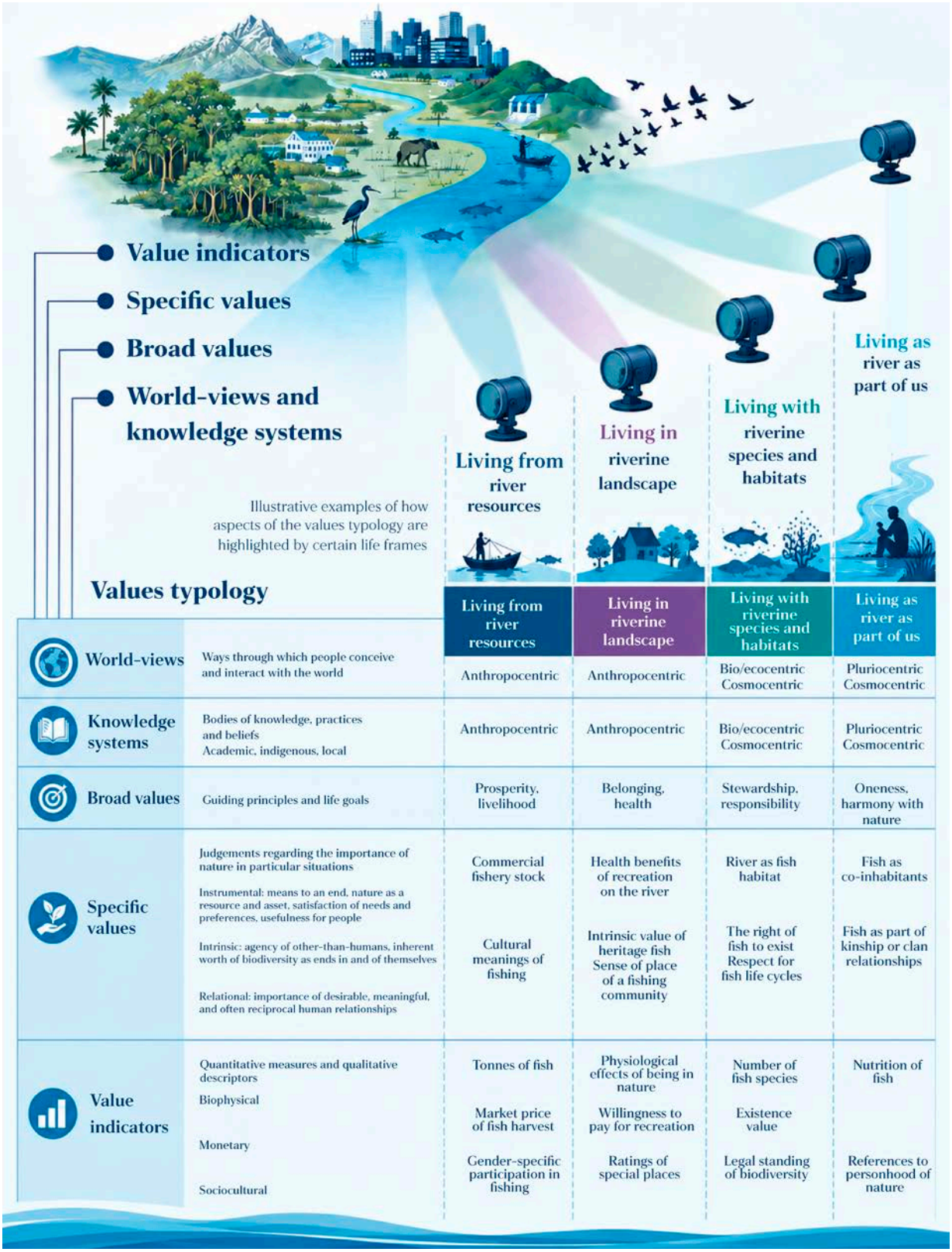



**Figure 5.3: Values assessment typology (Source: IPBES, 2022b)**

The framework illustrates these concepts using the example of a river. It presents at least four potential worldviews, knowledge systems, and value systems:

- **The river as a resource (Living from the river—an anthropocentric worldview).**
- **The river as a source of livelihood and habitat (Living in the river—also an anthropocentric worldview).**
- **The river as a source of livelihood and habitat for all living things (Living with the river and all living things—a biocentric/ecocentric worldview).**
- **The river as a part of us (and we are a part of the river) (Being a part of each other—a multi-centric worldview).**

These four perspectives are not mutually exclusive, and an individual or group may hold multiple perspectives. Each perspective places different emphasis on values and indicators of value.

Most Indigenous Peoples and local communities view humans as an integral part of nature, inseparable from it. This embodies a relational value grounded in "connection-gratitude-kinship," which motivates respect and stewardship, preventing degradation or destruction of nature. Such values and meanings are linked to cultural identity, customs, traditions, cultural heritage, and intergenerational ties to elements of nature. This is often reflected in personified or metaphorical language, referring to nature as a relative, such as Mother River, Mother Earth, and the Rice Goddess (IPBES, 2022b).

Why should we care about multiple value systems? Since the Industrial Revolution, humans have largely viewed nature as a "resource" to promote human well-being. Valuing nature has thus been primarily about instrumental value, treating it as a factor of production, a commodity, or a concession area. Subsequently, extractivism has negatively impacted ecosystems and biodiversity.

This has led to a shift in how nature is valued. The need to conserve nature has prompted conservationists to advocate for its preservation, while environmental economists have developed concepts for assessing the economic value of "ecosystem services" including calculating the costs (in quantitative terms) of biodiversity loss. The goal is to highlight the importance of often-overlooked values, "nature is a 'blind spot' in economics" or "economic invisibility of nature" (Dasgupta, 2021) to policymakers and to encourage policies that balance utilisation and conservation.

A key feature of IPBES's framework for valuing nature is the inclusion of cultural and ethical values, reflecting the importance of nature beyond economic or utilitarian considerations. IPBES therefore supports incorporating ILK in NEAs to promote comprehensiveness and fairness.

### 5.2.5 Customary governance of ecosystems

Discussions about local communities and nature typically fall into two main camps: those who believe natural resources are gradually exploited to meet community needs, leading to environmental degradation, and those who believe communities depend on the environment and therefore protect and conserve it for long-term use.

The first view, which sees local communities as contributing to resource destruction, leads to strict resource use regulation, protection or restriction by the state agencies and often conservation structures that disregard local cultural practices and governance structures that help conserve ecosystems and biodiversity.

The second view posits that ILK contains fundamental principles for ecosystem stewardship through customary management practices, promoting "sustainability" based on that knowledge and beliefs. The production, accumulation, learning (biomimicry), and transmission of knowledge are linked to communal relations, which are collective in nature. This leads to the development and refinement of customs and traditions as shared rules or agreements, including those related to the use and care of nature (Gadgil et al., 1993; Tengö et al., 2017).

Past nature conservation efforts that adopted the first view, which separates nature from people or communities, as a universal model for protected areas and national parks. This model, derived from Western scholarship that believes in a single truth (i.e., one effective way to manage conservation), reduces the complexity of issues and problems (Chatty & Colchester, 2002). However, this perspective has gradually shifted, with increasing interest in customary governance of ecosystems and a more spiritual view of ecology, such as the concept of "sacred ecology" (Berkes 1999).

The core idea of "sacred ecology" emphasises the overlap and integration of a "knowledge-practice-belief complex" Berkes (1999) explains that traditional knowledge has four interconnected parts:

- **Knowledge of nature,** such as specific species.
- **Resource management** systems that integrate local knowledge with practice.
- **Social** institutions that create rules and codes of behavior.
- **Worldviews** reflected through religion, ethics, and broadly defined belief systems.

In the context of coastal marine ecosystems, community members possess knowledge of natural resources but are also governed by traditional concepts and practices that regulate utilisation through specific times, seasons, areas, etc. This custom is locally accepted, benefiting conservation (Ruddle, 1998; Johannes, 2002; Cinner & Aswani, 2007). However, state management often overlooks the importance of customs, prioritising state regulations, rules, and laws.

Research on coral reef ecosystems has found that customary management strategies align with many aspects of Western or modern resource management (Cinner and Aswani, 2007). Several countries are beginning to recognise local customs and community by laws as rules that promote sustainable use and are integrating them into formal protected area management. Furthermore, studies have found that emphasising ILK and values in management enhances conservation effectiveness, as seen in over 3,000 protected areas worldwide (Chaplin-Kramer et al., 2023).

Currently, internal pressures (such as significant population growth) and external pressures (such as resources becoming increasingly commodified) are forcing ILK to be used for short-term gain, no longer governed by custom (Cinner & Aswani, 2007). This challenge of declining customs and community rules leads to ILK being seen as destructive.

To clarify this issue, the Table 5.1 illustrates the holistic nature of ILK, which should contain four components. Using knowledge solely for resource extraction is just one aspect (first row). If the use of that knowledge lacks the other three components—rules and customs (management system), enforcement and management of violations (social institutions), and the relationship with nature (worldviews)—then knowledge can be used in negative ways or misused by external actors.

**Table 5.1: Summary of the differences between ILK systems in a form of "sacred ecology" and modern knowledge and management systems**

| Component | ILK | Scientific/Ecological & Biodiversity Knowledge |
|---|---|---|
| **Body of Knowledge** | Knowledge of all things, including learning (biomimicry), transmission, training, and experimentation within families, kin groups, and communities. Primarily experience-based and hands-on; tacit knowledge embedded in individuals/community, often undocumented. | Scientific/ecological and biodiversity knowledge, management/conservation knowledge is systematic and mainstreamed; it is formally transmitted, emphasising explicit knowledge through documents and texts. |
| **Resource Management Systems** | Management based on beliefs/culture, unwritten customs and regulations, through traditions and rituals, grounded in the worldviews that humans are part of nature, coexisting, caring for, and benefiting from it. | Management through bureaucratic systems, organising missions, tasks, duties, and responsibilities that divide nature into parts for ease of management. |
| **Social Institutions** | Governance/management structures within the community, through social institutions. Emphasis on community rules and regulations through traditions, rituals, elder groups that assist in decision-making and mediation, etc. | Legal structures with formal, written rules, promulgated and enforced, with a justice system and defined penalties. |
| **Worldviews** | Humans are merely a part of nature, emphasising the intrinsic value of nature and the relational value between humans, nature, and the supernatural, or the sacredness of nature. | Nature has physical and biological dimensions that can be classified, analysed, and understood by science. Humans manage nature by utilising and benefiting from ecosystem services, including conservation and preservation, and attempting to gain control. |

(Source: based on Berkes' (1999) four components of knowledge (Analysed by the NEA ILK authors)

In summary, ILK cannot be separated from management systems, social institutions, and worldviews, because social institutions and worldviews are the foundation that cultivates and sustains customary systems. If we focus on the "body of knowledge" and search, record, and analyse only that part (e.g., what fishing gear is used, where and when), we will overlook the critical foundation that leads to sustainability.

These conclusions have implications for the methodology of collecting and analysing data on ILK. There are several caveats to collecting and interpreting ILK by outsiders, including reducing knowledge to "mere factual data" without considering the context of that knowledge (decontextualisation) and compartmentalising it, cutting it off from the community's system of values, social institutions, and holistic worldview. There are also concerns about truncating or segmenting knowledge for ease of integration with bureaucratic management (Alexander et al., 2019) or for use as supplements or additions to scientific work (Berkes, 1999; Whyte, 2017).

The issue of current pressures and challenges that have a severe impact (on worldviews, social institutions, and management systems) is important if we are to move forward to consider the future and policy recommendations. The end of this chapter will discuss proposals to promote customary governance of ecosystems and hybrid management strategies (Cinner & Aswani, 2007).

## 5.3 The importance of ILK in NEA in Thailand

Current global ecosystem assessment and NEAs, supported through IPBES and Biodiversity and Ecosystem Services Network (BES-Net), respectively, are giving increasing importance to ILK. The first global work to widely use multiple knowledge systems in the assessment was the IPBES Global Assessment Report on Biodiversity and Ecosystem Services in 2019 (McElwee et al., 2020). IPBES assessments have further advanced ILK consideration and inclusion, including on the sustainable use of wild species (IPBES, 2022a), diverse values and valuation of nature (IPBES, 2022b), invasive alien species (IPBES, 2023), among others. Figure 5.4 illustrates how ILK should be promoted and supported in order to enhance sustainable use of wild species.

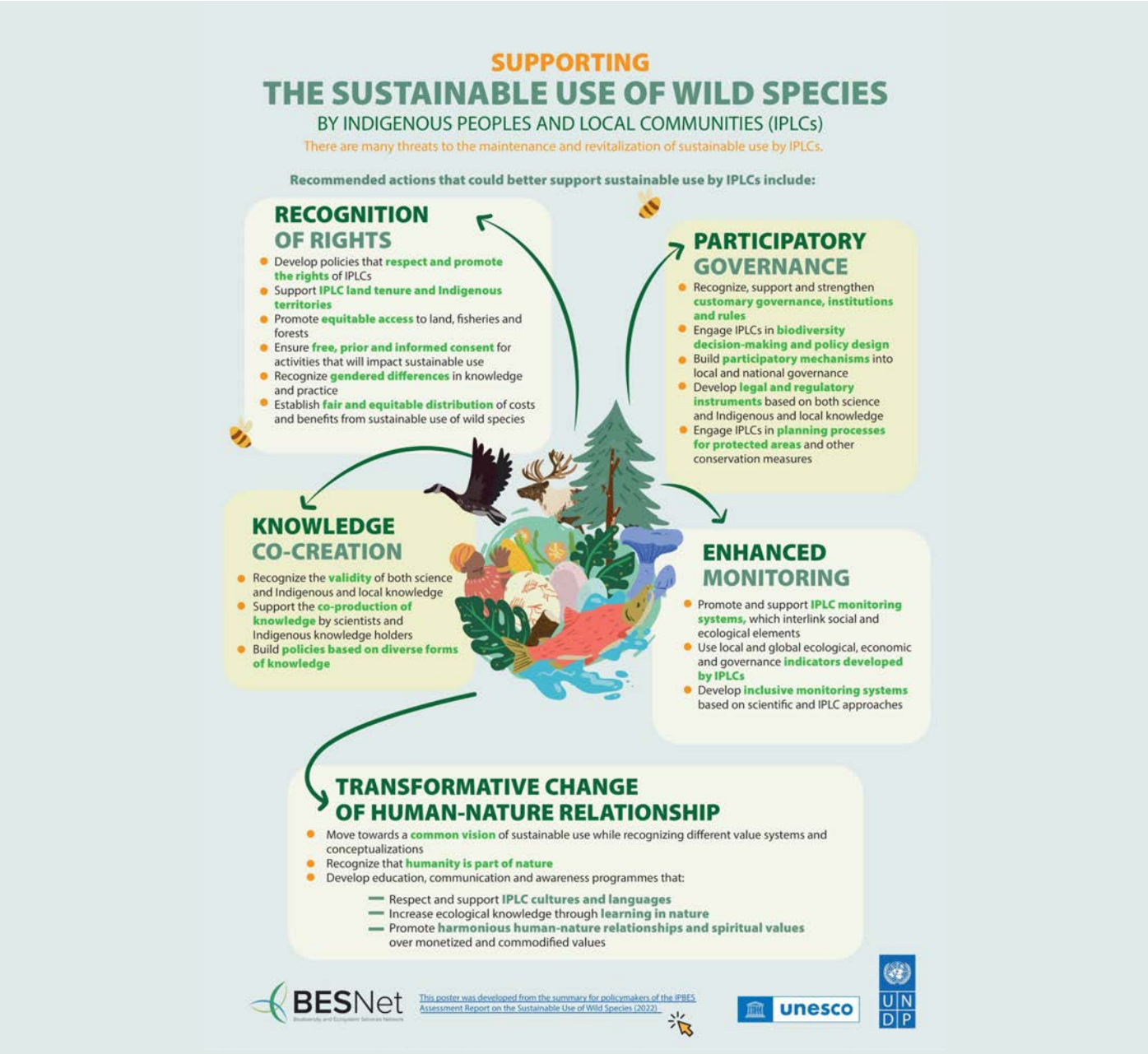



**Figure 5.4: Infographic from the assessment report on the sustainable use of wild species (Source: IPBES, 2022a)**

The IPBES Assessment Report on Invasive Alien Species (IPBES, 2023) found out that there are fewer alien species in the territories of Indigenous Peoples and local communities compared to other areas. Many communities are knowledgeable about the causes and impacts of alien species, and many communities manage these species successfully. Local communities often have names that clearly distinguish alien species from local species or have knowledge about alien species embedded in stories, poems, and songs.

Apart from IPBES assessments, there are many studies of ILK related to ecosystem assessment, including the monitoring of changes. Community knowledge provides insights into population trends of certain species. For example, an assessment of the abundance, size, and distribution of abalone (*Haliotis kamtschatkana*) used Indigenous observations in British Columbia, Canada (Lee et al., 2018). Similarly, ancestral Māori sayings describes understanding the interactions between species that generate ecosystem services, such as the role of native parrots (*Nestor meridionalis*) in the pollination of New Zealand flax (*Phormium tenax*) that help conservationists target the restoration of both species (Wehi, 2009).

Using multiple knowledge systems in the assessment leads to the co-production of knowledge, thus fosters a sense of shared ownership of knowledge, empowering and building confidence in communities that inhabit, utilise, and care for nature (stewardship), which sustains biodiversity and reinforces and transmits the ethics embedded in lifestyles and customs.

## 5.4 ILK in Thailand NEA

### 5.4.1 ILK in Thailand context

In Thailand, ILK began to receive serious attention around the late 1980s, even though this knowledge has always been an important part of the livelihoods of ethnic and local communities. The story of ILK began to be disseminated in the book "Returning to Roots: Alternatives and Criticisms on Folk Wisdom" (Phongpit, 1986), and after that, there were more research studies on these knowledges in various aspects during the 1990s (Vaddhanaphuti&Banpasirichote, 1997). After Thailand 1997 Constitution mentioned community rights and the participation of traditional local communities, government agencies gave more recognition and promoted community participation in natural resources management.

The gradually expanding study of ILK is the "Thai Baan Research" series, starting with "Mae Moon: The Return of the Fishers" in 2000, which originated from a group of villagers themselves becoming interested in exploring, reviewing, and recording folk knowledge in cooperation with academics. The research questions and joint learning of dozens of villagers along both sides of the Mun River were: "*What was lost after the construction of the Pak Mun Dam?*" and "*What was gained when the dam was opened?*" Dozens of villagers who were experts in fish species reflected and analysed data on the Mun River ecosystem, fish migration, fishing gear, the use of herbal plants, and agriculture along the Mun River (Setthachua, 2002). The Thai Baan Research series is a review of folk knowledge that shows that villagers have knowledge that the authorities do not recognise or honor as a type of science or valid evidence.

Subsequently, "*Tai Baan Research*," "*Chao Baan Research*," "*Pagaka'nyaw Research*," etc., became terms for research studies and data collection undertaken by local communities. This way of working and using methodology has been developed and expanded to various areas in the Mekong and Salween basins and later expanded to neighboring countries, such as the Sala

Phoum Research in the Stung Treng wetland in Cambodia (Setthachua, 2016). Tai Baan Research is a restoration of folk knowledge to collect data on the status and monitor changing natural conditions. Moreover, this process also helps strengthen communities, especially in participating in monitoring, inspecting, and making decisions in development projects that will affect nature. Tai Baan Research also produces maps, posters, and other resources to publicise the work and to build more awareness and confidence on local knowledge (Figure 5.5 and Figure 5.6).




**Figure 5.5: Drawing of Mun River ecosystem (Source: Mekong Community Institute Association, n.d.)**




Fish species from Mun River (2013)

Aquatic species from Upper Mae Jaem River Basin, Chao Baan Research

**Figure 5.6: Local knowledge on fish species (Source: Living River Siam Association, n.d.)**

The first attempt to introduce the term "participatory ecosystem monitoring" in the country was at the seminar on "Participatory Ecosystem Monitoring: Current Lessons for Future Directions" (May 2005). The experiences and lessons learned from 10 ecosystem status monitoring case studies were presented and discussed, and two case studies were coastal marine ecosystems (mangrove forests): the Pred Nai community in Trat and the Ban Khlong Lidi community in Satun. For the Pred Nai community, ILK was used to assess the drastic decline in fiddler crabs and to develop sustainable utilisation management approaches from community participation (Thaworn, 2006).

During that period, there were studies of communities to link ILK, livelihoods, and resource management to promote the protection of community livelihoods. The studies also questioned large-scale development projects, including management by government agencies that focused on conservation without community participation. Examples of these studies and projects are the team of Srisak Vallibhotama (Lek-Prapai Viriyapan Foundation) that conducted research on local cultural ecology (Figure 5.8-Left), the team of Somporn Pengkam of the National Health Commission Office (NHCO) that worked on community health by linking it to the ecosystem and ILK (Figure 5.8-Right).




**Figure 5.8: Studies on fishing communities: Left: The book "Echo from fisheries community in Pattani Bay" (Source: Lek-Prapai Viriyaphan Foundation, 2007) and Right: A map showing ecosystems and local livelihoods of Tha Sala District, Nakhon Si Thammarat (Source: Phatkaew, 2012)**

Another set of publications that collected and analysed data on the livelihoods, ILK, and resource management of various Chao Lay communities, as shown in Figure 5.7, are the outcomes of the Andaman Pilot Project conducted by the Social Research Institute, Chulalongkorn University.




**Figure 5.7: Three books that mention about ILK from the Andaman Pilot Project (Source: Chulalongkorn University Social Research Institute)**

Later, collaborative ecosystem assessments began to be conducted by interdisciplinary research teams. For example, in 2007, there was a research on "*Assessing the Stability of the Estuarine Ecosystem Flowing into the Sea (Estuary), Pak Phanang Bay, Nakhon Si Thammarat Province*" (Mangrove Forest Resource Research and Development Group, 2008), which had a team of 27 researchers in the fields of marine ecology, community and marine resource management, forestry, and physical oceanography. The 622-page report had a chapter on community, population structure, economy, society, and participation. In terms of ecosystem assessment, in addition to collecting samples with fishing gear, there was also a survey of changes by using interviews with fishermen in the area.

In 1996, the study of ILK linking with ecosystems, biodiversity, and natural resource management was promoted and expanded widely when the Community Research Division was established under the Thailand Science Research and Innovation (TSRI, formerly known as Thailand Research Fund or TRF), as there was generous funding to support communities to work with academic researchers (Buasai, 2004). There are many research projects in the TSRI Local series that are related to communities and the management of coastal natural resources.

## 5.4.2 Knowledge holders: Chao Lay and small-scale fishers

This section of the ILK chapter focuses on the knowledge systems of the Chao Lay and small-scale fisherfolk. However, the emphasis is primarily on Chao Lay knowledge due to their distinct language and culture compared to the larger society. Access to and understanding of Chao Lay knowledge systems remain limited relative to small-scale fisherfolk, who have been the subject of more extensive research and have greater engagement with NGOs and government agencies.

The background information on the Chao Lay and small-scale fishers is as follows:

1) Chao Lay, widely known as sea gypsies or sea nomads, are ethnic groups that reside, derive their livelihoods, and maintain cultural practices deeply intertwined with marine, coastal, and island environments. In Thailand, there are three subgroups: the Moken, Moklen, and Urak Lawoi.

While these groups exhibit variations in language, historical background, and customs, they share cultural traits as members of the Austronesian language family and a way of life dependent on and connected to the marine environment. Traditional marine livelihoods center on subsistence, characterised by familiarity with diverse coastal ecosystems, seasonal and tidal-dependent resource utilisation, and the use of simple, species-specific, and diverse tools.

In terms of population size and distribution (Figure 5.9), the Chao Lay inhabit coastal or island communities across five provinces along the Andaman Sea: Ranong, Phang Nga, Phuket, Krabi, and Satun, with an estimated total population of 14,000 individuals in 46 communities (Arunotai, 2023; Andaman Pilot Project survey, 2025).

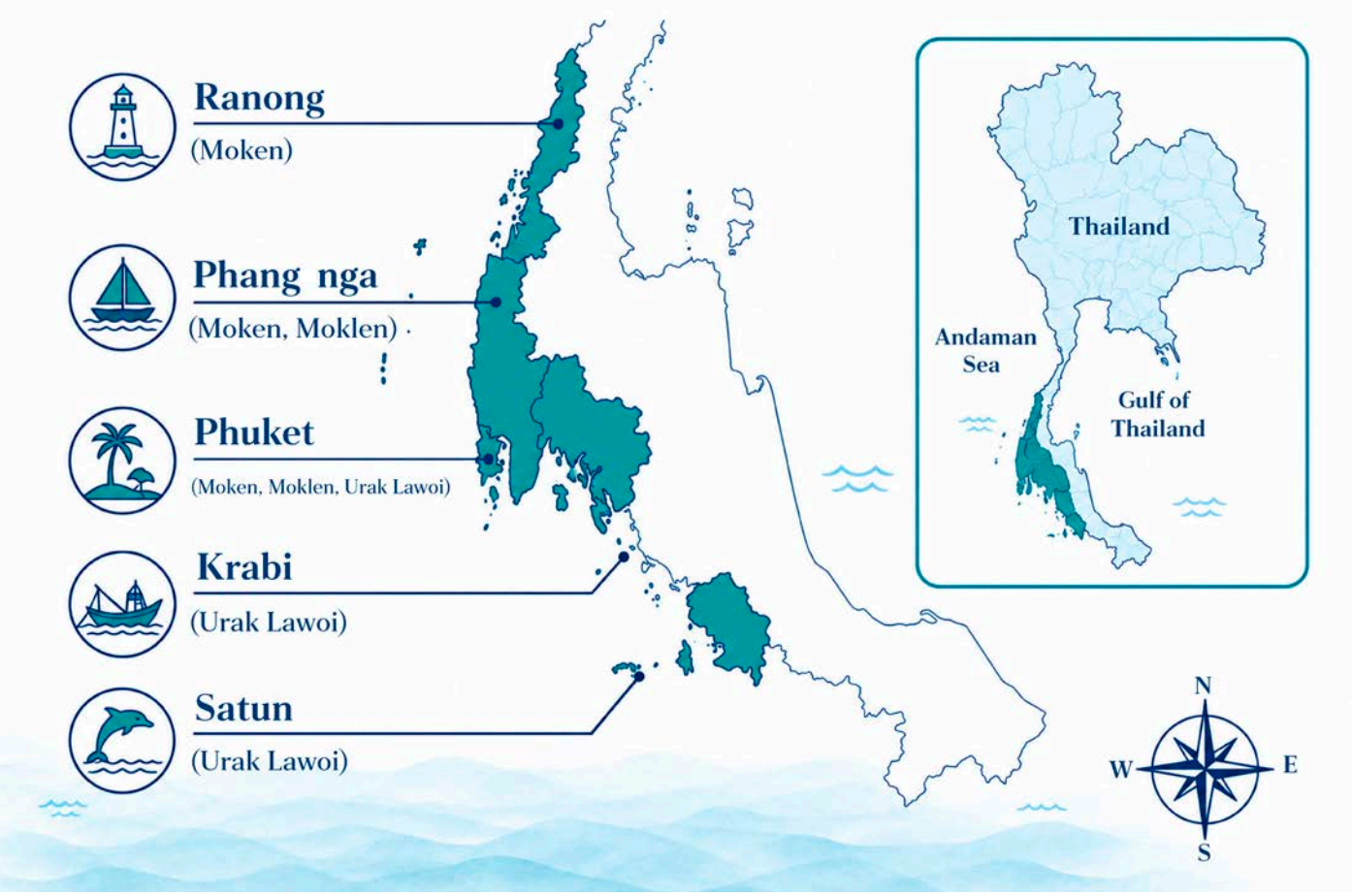



**Figure 5.9: Map showing Thailand southwestern provinces that are home to the three groups of Chao Lay (Source: Arunotai, 2023; Andaman Pilot Project survey, 2025)**

The Chao Lay have been the original inhabitants of coastal areas and islands in Thailand for at least 200 years. In the past, the Chao Lay hardly modified the local environment for habitation and livelihood, apart from cutting wood, bamboo, and natural materials to build huts, boats, and gather for subsistence and barter or trade. Currently, many areas where the Chao Lay used to live, make a living, and fish have been designated national conservation areas in the form of national parks and environmental protection zones, etc., which means that the condition of those ecosystems is still good even though they used to be living and fishing areas of the Chao Lay (Arunotai, 2006a). At the same time, the semi-nomadic lifestyle makes it easy for their traditional living and foraging areas to be occupied, and many areas have been transformed to the point where there is no trace of the original ecosystem.

2) Small-scale fishers, according to Thailand's Royal Ordinance on Fisheries B.E. 2558 (2015), the official definition of "small-scale fishing" or "artisanal fishing" is, "fishing operations in coastal seas in which a fishing vessel is used or in which a fishing gear is used without a fishing vessel, but in any case does not include commercial fishing".

In this report, the term "small-scale fisheries" or "artisanal fisheries" refers to small-scale coastal fishing in near-shore waters or around islands, using small boats or no boats at all. It relies on sophisticated knowledge but simple tools, requiring minimal investment compared to commercial fishing, to catch coastal and marine life. Small-scale fisheries select seasonal fish and aquatic animals, and the work is often carried out by family or kin members, from making and maintaining fishing gear to fishing, sorting, and processing/selling. Most of the produce is for household or local consumption and/or sold without maximising profits. Small-scale fishing communities often possess knowledge, navigation skills, traditions and customary management that promote sustainable resource utilisation.



A Moken man with dugout boat, Surin Islands, Phang Nga



Small-scale local fisher at Tha Sala, Nakhon Si Thammarat

**Figure 5.10: Way of living of Chao Lay and small-scale fishers**

In the past, both the Chao Lay and small-scale fisherfolk possessed an understanding of coastal and marine environment passed down through generations, solidifying into resource management practices embedded within their community cultures. For example, seasonal fishing cycles aligned with breeding patterns, helping maintain ecological balance. Harvesting practices involved hand-gathering or deploying traditional fishing gear, adapting it to modern needs without degrading natural resources.

The Chao Lay and small-scale fisherfolk engaged in diverse gathering and fishing activities, utilising a variety of tools across coastal environments ranging from sandy or muddy beaches and rocky shores to coral reefs, mangrove forests, mangrove canals, and the open sea. These communities often have their own categorisation of marine zones, reflecting their perception and multi-faceted use of ecological areas. Despite using only small boats and simple tools, their extensive knowledge of and expertise in marine areas give them confidence and security (Figure 5.10).

Expanding Thai Baan Research into other regions included work in Krabi, where data collection efforts on coastal marine species identified 191 fish species, 86 shellfish species, 28 crab species, 7 squid species, and 22 shrimp species used as both household food sources and for market sale (Setthachua, 2016). Local fishers recognised 26 species as conservation animals, and this is in accordance with the government's designation. In addition, villagers also identified specific species, such as sea snails, as indicators of marine ecosystem health (Setthachua, 2016).

While both the Chao Lay and small-scale fisherfolk generally inhabited and drew their livelihoods from coastal and marine areas, the Chao Lay maintained a more mobile lifestyle (Arunotai, 2023). Consequently, boats formed the core of their existence. All three Chao Lay groups historically possessed ILK related to boat construction, particularly the Moken. Figure 5.11 shows Moken's traditional boat building. The traditional "Kabang"—a dugout boat reinforced with Zalacca wood—was lightweight, "unsinkable",and represented a complex symbolic system reflecting the group's mobile maritime culture (Ivanoff, 1999; Na Pombejra et al., 2006).




**Figure 5.11: Traditional "Kabang" a dugout boat building by Moken (Source: Ivanoff, 1999; Na Pombejra et al., 2006)**

In comparing the marine livelihoods of the Chao Lay and small-scale fisherfolk, the Chao Lay's livelihoods have maintained greater diversity in terms of fishing methods, foraging grounds, harvested marine life, labor practices, duration, and markets or sales outlets, as shown in the Table 5.2 (Arunotai et al., 2007).

**Table 5.2: Diversity of fishing activities of the Chao Lay (A case study of the Urak Lawoi in Phuket)**

| Aspect of Fishing/Livelihood | | Diversity Observed |
|---|---|---|
| **Methods** | | Hand-gathering.<br>Using simple tools, e.g., spears, fishing rods, homemade spear guns from umbrella spokes.<br>Using more sophisticated equipment requiring greater investment: fish traps, various types of nets (e.g., shrimp nets or trammel nets), air compressors for diving. |
| **Targeted Marine Life** | | Various types of fish.<br>Various types of shellfish, e.g., turban snails, giant clam (Tridacna gigas), snail (Turbo argyrostomus), venus shell, cockle.<br>Other marine life e.g., shrimp, mantis shrimp, crabs, sea cucumbers, bait, etc. |
| **Foraging Grounds** | Ecosystems | Coral reefs, underwater rock formations, sandbars, mangrove forests, sandy beaches, mudflats. |
| | Coverage | On land, in terrestrial forests, beach forests, etc.<br>Shallow coastal waters.<br>Deeper water of approximately 20 meters (free diving). |
| | Area | Around the community.<br>Coasts and islands throughout the Andaman Sea.<br>Myanmar waters and the GoT (historically). |
| | | Often with temporary campsites (bagad) for shelter and stopovers during extended sea voyages. |
| **Labor** | Family-Community Relations & Age | Family members, relatives, and friends.<br>Children, adults, and the elderly (children as young as 10-12 years old can go out to sea with their father, older brother, or other relatives, helping with simple tasks such as reeling or collecting lines, adding diesel to the engine, holding the engine, pulling the anchor, and helping to collect shellfish or fish; the elderly still fish near shore). |
| | Gender | In the past, both women and men went out to sea together, traveling as families and kinship groups. In more recent times, if using fish traps and nets, men typically fished together in groups using long-tail boats. |
| | Number | 1- 15 people. |
| **Duration** | | Two to three hours<br>Round trip within a single day<br>One week or longer. |
| **Markets/Sales Outlets** | | Direct sales<br>Consignment sales through relatives<br>Sales to local and international wholesalers. |

(Modified from: Arunotai et al., 2007b)

For small-scale fisherfolk, those who still harvest marine life by hand and practice natural freediving have greatly diminished in number. Those who maintain traditional practices do so out of preference. Furthermore, cost savings are a factor, as traditional fishing methods using hands or simple equipment require minimal investment and eliminate the need for equipment maintenance and repair. Indeed, the simpler the tools and equipment, the greater the reliance on ILK and skills, reducing dependence on technology and equipment performance, maintenance and repair.

The Chao Lay and small-scale fisherfolk who rely on hand-gathering and simple fishing gear are more likely to observe and experience natural changes than those who use sophisticated tools and large fishing vessels equipped with engines and sonar/sounder devices (Figure 5.12). The Chao Lay who continue to make a living by diving to collect marine life (both through freediving and using air compressors) have a direct exposure to temperature variations, currents, underwater marine life, and the overall conditions of the underwater environment.



**Figure 5.12: Chao Lay and small-scale fishers collecting fish-nets, mangrove leaves, and mushrooms in coastal areas (Photos by: Narumon Arunotai & Suwan Sae-Ton)**

The Chao Lay and small-scale fisherfolk maintained livelihoods directly linked to the sea. However, both groups also utilised terrestrial natural resources. Historically, the Chao Lay had numerous sources of food and raw materials obtained from the land. Chao Lay men typically gathered wild fruits or harvested leaves from tall trees, requiring skillful climbing. During the honey-collecting season, men ventured into the forest to harvest honey, again demanding expertise in locating beehives and climbing trees. They also collected resin oil to apply to their boats. Chao Lay women excelled at finding and digging up yams and collecting pandanus leaves. Children accompanied their parents into the forest.

An ethnobotanical study of the Moken on the Mu Koh Surin in Phang Nga documented 159 plant species from 57 families utilised by the Moken, along with an additional 24 unidentified species. The research categorised these plants into four types: food plants, medicinal plants, wood for housing construction and tools/utensils, and 54 species with other uses (Thaewchatturat, 2000). According to Figure 5.13, knowledge of these plant and animal resources has been incorporated into the nature-culture trail guide "Chok Madah," a trail that Elder Madah used for hiking in the forest and mooring his boat in a small bay on the western side of Mu Koh Surin.

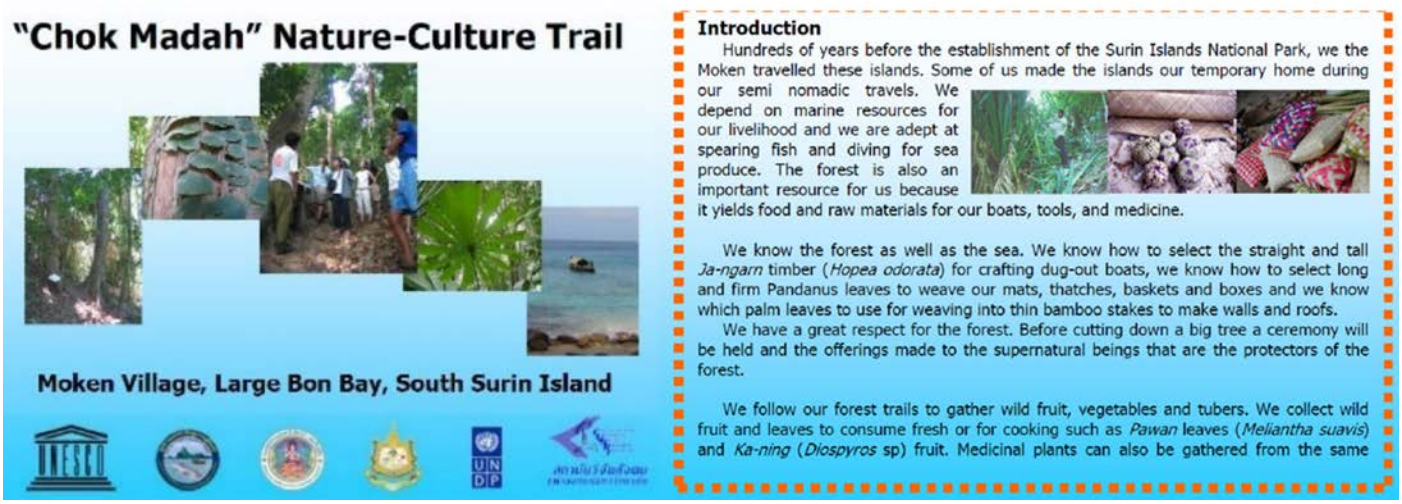



Figure 5.13**: Chok Madah trail guide booklet, developed from Moken's forest foraging trail (Source: Arunotai et al., 2009)**

In addition to the research cited above, there are several other studies on Chao Lay knowledge, such as: The World of the Moken: A view from Indigenous Knowledge about the sea and coastal areas (Na Pombejra, 2003); Local Wisdom and Community-Based Resource Management: development impacts on the transmission of local ecological knowledge of the Urak Lawoi, Phuket (Kreua-in, 2010); The Urak Lawoi and The Complexity of Sustainable Resource Use: the political ecology of change in the Adang Archipelago, Andaman Sea, Thailand (Wongbusarakum, 2002); Ikat Lawo'i (Soo-amphan & Atsilarat, 2009), etc. A prominent work on the knowledge of small-scale fisherfolk in the GoT is Khon Mae Klong (Chirawet, 2005).

## 5.4.3 Participatory methods

When working with Indigenous Peoples and local communities, IPBES, BES-Net and the NEA Initiative have established methodological guidelines for exchanging knowledge based on equality and mutual respect, collaborating with knowledge holders, and supporting community participation in various stages of ecosystem assessment, including the use of Free, Prior, and Informed Consent (FPIC) in accessing communities, collecting, analysing, disseminating, communicating, and applying data.

Regarding approaches to connecting ILK and scientific knowledge, Alexander et al. (2019) reviewed research articles from various journals. These studies sought to link Indigenous and scientific knowledge to assess coastal marine ecosystems in Canada: the Arctic, Pacific, and Atlantic. They found several methods used to collect ILK, such as interviews, workshops, participatory mapping, document reviews, surveys, participatory observation, focus groups, and oral histories. There were also many methods for collecting scientific data, such as document reviews, quantitative inventories, sampling of both living and non-living things, dissection for study, mapping, population assessments using mark-recapture studies, modeling, surveys, natural historical observations, interviews, remote sensing, and expert consultations. The majority of the research articles reviewed in Alexander et al. (2019) focused on species-level studies, with fewer studies on ecosystems and the fewest on ecological communities.

During data collection on ILK for this ecosystem assessment, the team employed all the methods listed in Alexander et al. (2019), including interviews, workshops, participatory mapping, document review, surveys, participatory observation, focus groups, and oral history (Figure 5.14).

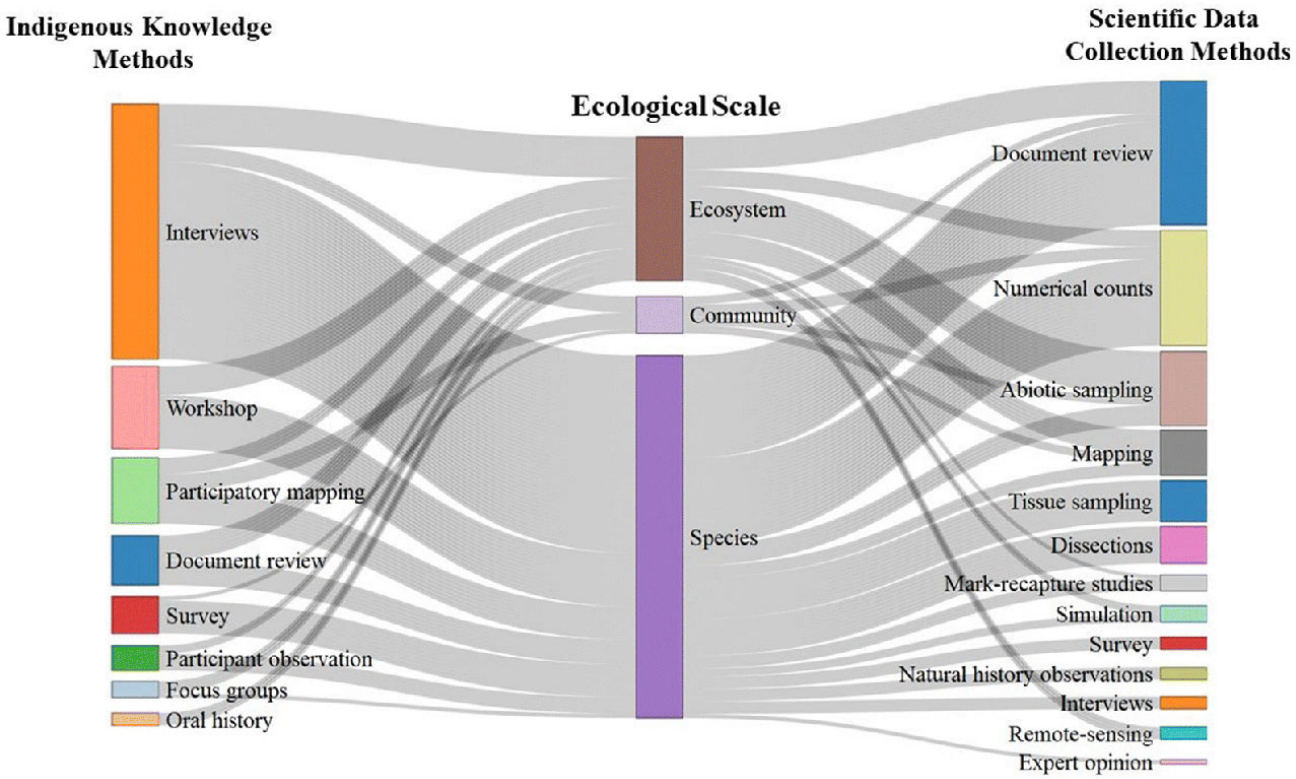



**Figure 5.14: Diagram showing the indigenous knowledge methods and scientific data collection methods in terms of ecological scale (Source: Alexander et al., 2019)**

The steps in collecting, gathering, and analysing data on ILK in Thailand NEA are as follows:

***a)Documentary review:***

Selecting documents, reports, articles, news, etc., related to the concepts of ILK from various countries to understand concepts and methods, as well as reviewing documents on ILK of marine and coastal ecosystems in Thailand, focusing on Chao Lay communities/traditional coastal communities/small-scale fishing communities. The majority of documents/reports on this knowledge focus on the connection of knowledge to natural resource management, ILK disconnect with policies and operations, community rights, etc. However, there are relatively few documents on the role of knowledge in ecosystem and biodiversity assessment.

***b)Field survey:***

Field survey on the status of marine and coastal ecosystems and changes from the perspective of ILK: focusing on Chao Lay communities and small-scale fishing communities in the GoT and the Andaman Sea. Two surveys were conducted:

- Survey of selected communities to understand the coastal situation and the status of ILK: communities in Nakhon Si Thammarat and Phuket.
- Workshops to collect preliminary data on the history-development-condition of the community

and its relationship with the sea/coast, participatory mapping to understand marine wisdom and the changes in nature-ecosystems (divided into subgroups according to gender, age, and occupation), analysis of the current situation, stakeholders, policies, and related projects, identification of knowledge gaps, and formulation of policy questions related to issues of community interest/concern (Figure 5.15).



**Figure 5.15: Workshop activities (including the use of Google Map in understanding and pinpointing ecosystems and places) (Photo by: Narumon Arunotai)**

***c)Data collection using the "Field School" process:***

The team worked with communities in the pilot areas, namely the Ban Thap Pla Moklen community in Phang Nga and Koh Jum and Koh Lanta Urak Lawoi communities in Krabi, to collect and analyse data on ILK. The tools used included participatory mapping to understand the worldview and knowledge of the community regarding coastal areas, islands, and the sea, and questionnaires/forms on plants, animals, and biodiversity. The field schoolwork (nature acting as a classroom) helped build familiarity and relationships between the ILK team and the local communities,

fostering equitable relationships that emphasised collaborative learning rather than one-way data collection and communication. Figure 5.16 illustrates field school activities with various age groups in the communities, in the form of children's camps, intergeneration camps, workshops, field visits, GIS skills training, participatory data collection and documentation.



**Figure 5.16: Field School activities with various age groups in the communities (Photos by: Narumon Arunotai)**

***d)Data collection in case study areas***

Data collection in case study areas in Collaboration with the NEA Core Team, with Phuket and Trat as sample areas. For Phuket, the selected small-scale fishing community was Ao Kung community in Pa Khlok Subdistrict, Thalang District. For Trat, the selected small-scale fishing communities were Pred Nai community in Huai Nam Khao Subdistrict, Mueang District, and Ban Yai Mom community in Ban Yai Mom subdistrict, Laem Ngop district.

***e)Organising data sharing sessions***

Organising data sharing sessions to present the findings and analysis, soliciting feedback and suggestions from community representatives for improvement and additions to make the report more complete.

***f)Organising small group discussions for envisioning futures***

Organising small group discussions for envisioning futures in order to understand how the elders and middle-aged Chao Lay think about the future, and their expectations regarding the livelihoods of future generations including the future of ILK.

Lessons from the "Field School" project implemented by the Princess Maha Chakri Sirindhorn Anthropology Centre (SAC), the Andaman Pilot Project of the Social Research Institute of Chulalongkorn University (CUSRI), and UNESCO Bangkok concluded that participatory mapping is particularly effective for learning about ILK. This is because hand-drawn maps serve as tools or media for compiling data, images, records, and other information in one place.

While participatory mapping methods with communities have been widely popular for a long time, there is very little experience in creating marine or underwater maps that reflect ILK. As mentioned earlier, the Chao Lay and small-scale artisanal fishers possess deep knowledge about the sea, but this knowledge has not yet been reflected in concrete maps. Therefore, collecting data that delves into the knowledge and observations of the Chao Lay and artisanal fisherfolk will be an important part of developing ILK maps that enhance a deeper and broader ecosystems assessment.

After the field survey and participatory mapping workshops, the team synthesised the data and designed two-way communication methods to provide opportunities for community members to learn about the information presented in the article on ILK in the NEA, and to gather additional information, opinions, and policy recommendations.

## 5.5 ILK and values for Marine BES

From an ecosystem services perspective, local communities derive direct benefits from nature. In terms of provisioning services, nature provides food and essential resources for their livelihoods. Regarding cultural services, it offers spiritual and belief-based values, expressed through nature-related rituals. It also fosters knowledge, learning, and strong relationships within the community, connecting people to each other, to the natural world, and from the local perspective to the supernatural.

Regarding the community's benefits as a "source of production", the Chao Lay and small-scale fisherfolk often say, "the sea is life", "the sea is our rice pot", and "land dwellers have fields and gardens, but for us, the sea is our field". They also express the idea that "the Chao Lay's bank is in the sea; catching fish is like making a withdrawal, but we are careful to ensure regeneration and recovery keep pace with our use". In this context, key ecosystem service values for the Chao Lay and small-scale fisherfolk include the value of familiarity and connection with nature, the value of stewardship and conservation ethics, and the value of ILK in monitoring and assessing environmental change.

In Chapter 4, calculating the monetary value of ecosystem services in the "provisioning" dimension is more straightforward than in other dimensions (i.e. regulating, cultural, and supporting). The calculated monetary value of such services, though stressing more on instrumental value rather than relational or intrinsic values; but the number can provide a quantitative picture of the impact of natural resources on the livelihoods of various communities.

### 5.5.1 *Values of intimacy with nature*

Living in close proximity to the sea has allowed the Chao Lay and small-scale fisherfolk to develop extensive knowledge of the coastal marine environment. This includes physical aspects, such as weather patterns and tides; and biological aspects, like the species, behaviors, and life cycles of marine animals (Figure 5.17 and Figure 5.18). This deep understanding informs community practices and adaptations aligned with natural cycles. Thus, ILK embodies values of relationship and interconnectedness with the environment.

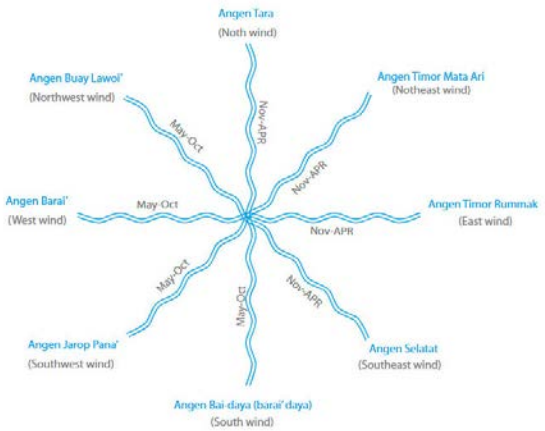



**Figure 5.17: The drawing showing eight-direction wind of Urak Lawoi of Koh Lipe, Satun (Source: Arunotai et al., 2007)**

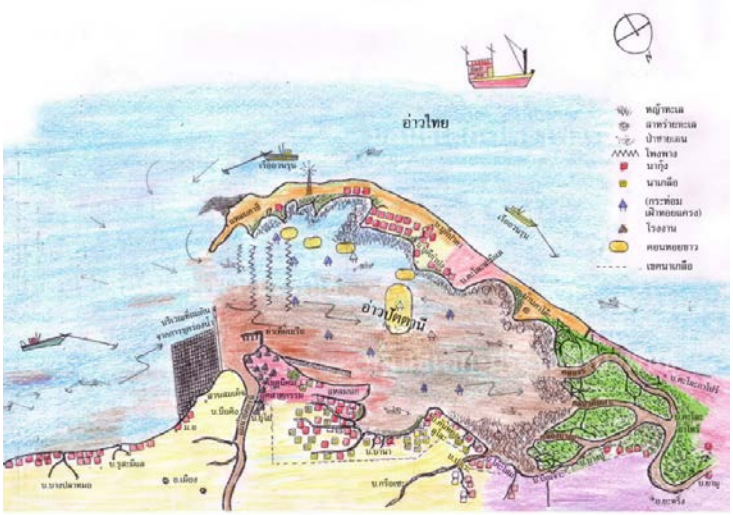



**Figure 5.18: Drawing of fishing area and currents from the Book "Reading the water, remember the wind, reading the sky, remember the stars" (Source: Kreua-in, 2015)**

The underwater landscape is an integral part of the livelihoods that the Chao Lay and small-scale fisherfolk recognise and experience. However, this knowledge is often overlooked in policymaking, planning, and management. The oil spill in Rayong in January 2022 clearly illustrates this fact, as management decisions did not acknowledge the role of small-scale fisherfolk in providing insights into the environment of the affected fishing grounds (Pongpipatwattana, 2022).

While small-scale fisherfolk may not be experts in oil spill removal techniques, they can observe the dispersal patterns of the oil. Based on their experiences following a previous oil spill in Rayong (in 2013), fisherfolk observed that the use of oil dispersants contributed to long-term impacts on marine life inhabiting the seabed. One fisherman mentioned specific spots on the seabed (spawning grounds, fish aggregation areas, etc.) that could be affected by similar dispersal methods in 2022 (Pongpipatwattana, 2022).

Furthermore, research conducted with local communities in Pattani Bay (Srisakra Vallibhotama et al., 2007) demonstrated how ILK can help monitor terrestrial changes linked to mangrove forests and the sea. The map below (Figure 5.19) illustrates the underwater landscape, including seagrass beds, seaweed, and currents.




แผนที่ตำบลแหลมโพธิ์และอ่าวปัตตานี
แผนที่แสดงการไหลเวียนของกระแสน้ำขึ้น-น้ำลงในปัจจุบัน

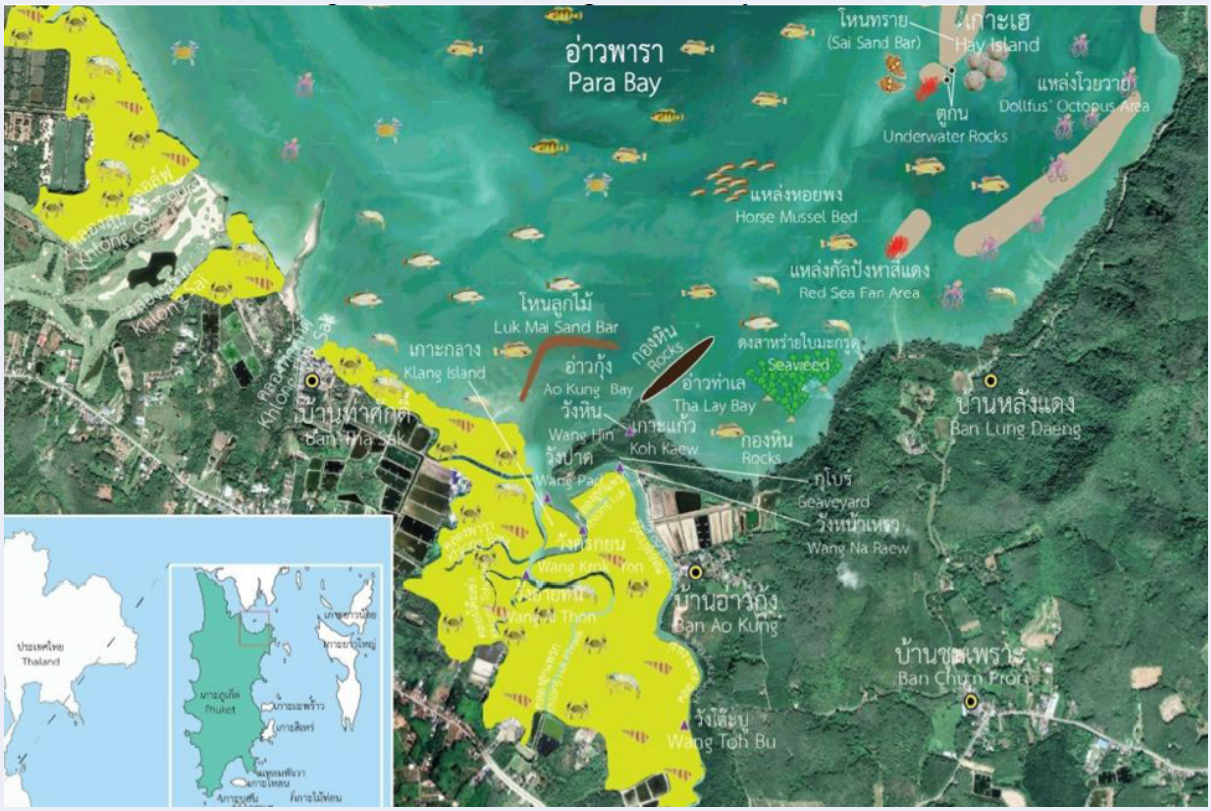
**Figure 5.19: Hand-drawn map by the local communities in Pattani Bay (Source: Songsiri, 2016)**

## Box 5-1: Toponyms of coastal and underwater landscape of Ao Kung small-scale fishing community, Phuket

During the collection of toponyms or place names with the Ao Kung fishing community, a participatory mapping process was used, employing satellite imagery as a basemap. The results revealed the coastal marine landscape, including underwater areas not visible or appearing on the satellite imagery.

After recording data using adhesive paper with place names written on it and affixed to the map, the team designed a map showing the location of these points, as well as the community's resource areas and foraging/fishing grounds. The map, therefore, reflects the overlapping areas of ecosystems, biodiversity, and the livelihoods of the Ao Kung villagers.

An important observation is that the community's naming of geographical features both resembles and differs from the classifications of marine scientists. Cross-disciplinary learning can broaden perspectives and enhance understanding of often-overlooked ecosystems, such as "Wang" (a deeper part of the water or waterway) in mangrove canals, seaweed beds, sandbars, underwater rock formations, and red gorgonian coral reefs, etc. Place names and geographical names provide a different perspective on the "services" of the ecosystem and will help assess changes in the marine and coastal ecosystems by paying attention to small details that are neglected in large-scale ecosystem assessments.




ILK is also embedded in language, geographical vocabulary, and place names (toponyms, hydronyms, or oceanic place names). The Chao Lay have been the early inhabitants of coastal areas and islands in Thailand for at least 600 years (Arporn, 2011), thus possessing a collective socio-cultural memory of the land and sea passed down in the form of place names, tales, songs, and even personal stories from real experiences. This ILK also takes the form of language, particularly toponyms or place names. For example, the aforementioned "Chok Madah" is the name of a small bay on North Koh Surin, named after a Moken elder who enjoyed foraging in the forest, mooring his boat, and fishing in that area. This name not only denotes the "physical location" of the bay, clearly distinguishing it from other areas, but also carries social and emotional weight for the descendants and relatives of that Moken elder, along with other community members.

Geographers distinguish between two terms to convey different characteristics or dimensions of "area": "space", referring to a "location" or "physical area", and "place" referring to a physical area imbued with meaning, specificity, and a unique identity that sets it apart from other locations. Place names reflect people's perceptions, relationships, and familiarity with the environment. Thus, place names are "cultural artifacts" arising from the complex interaction between the mind, culture, and the environment (Taylor, 2016).

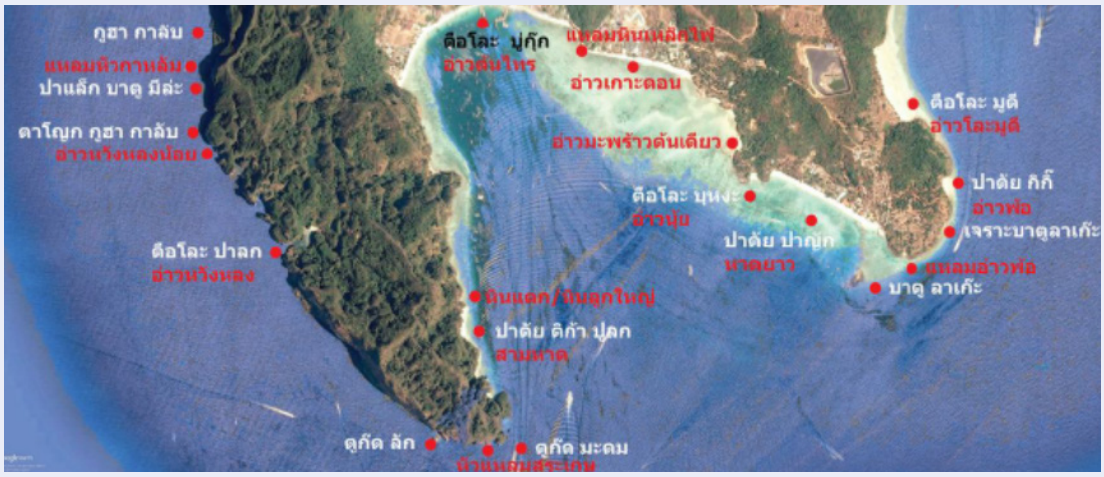
Local place names reflect information about the geomorphological characteristics of an area, its history, its ecosystems, important or prominent animals and plants in the vicinity, or connections to certain people or events. Because place names often provide information about natural and cultural conditions at the time those names were established, they are part of the memory of places and are important in terms of language and local history. Place names are therefore considered a form of cultural heritage (Lauder&Lauder, 2015), and the relationship between humans and space (relational value) also creates a sense of place. Map in Figure 5.20 shows place names in the Pattani Bay area, derived from ILK which is gradually fading away.




**Figure 5.20: Map showing place names in the Pattani Bay area, derived from ILK (Source: Songsiri, 2016)**

## Box 5-2: Urak Lawoi place names on Phi Phi Don Island, Krabi

The map below illustrates Urak Lawoi/Malay place names in the southern part of Phi Phi Don Island, Krabi Province. A preliminary survey identified over 50 Urak Lawoi place names around the island (see the map below). The Urak Lawoi can recount the history of settlement, livelihoods, and the names of capes, bays, beaches, and even underwater rocks around the island. Thus, place names reflect an important connection between the community and the physical space, including the spiritual dimension of the place (Arunotai, 2023). In contrast, most Thai names have been newly established after the growth of tourism, and are often named after hotels, resorts, or restaurants.




| Urak Lawoi Name | Thai Name | Details/Description |
|---|---|---|
| Batu La Gae  | Hin Phae (Raft Rock) | Snorkeling/diving spot. Sharks are often found swimming around this area because it is a no-fishing zone. When nature is undisturbed, it is abundant with food sources, resulting in a large number of fish and aquatic animals. |
| Patai Panjak  | Hat Yao (Long Beach) | Physical characteristic of the beach, which stretches in a long, straight, continuous line. |
| Teulo Bunga  | Ao Nui (Nui Bay) | The Urak Lawoi name translates to "Bay of Flowers," but in Thai, it is called Ao Nui, named after the small size of the bay. |
| Teulo Buku  | Ao Ton Sai (Ton Sai Bay) | A deeply recessed bay, making it ideal for anchoring boats to shelter from the wind, especially during the monsoon season. When both the southwest and east monsoons blow, most boats dock at Ton Sai Bay. Suitable for docking large vessels, or some go to Lo Lana Bay, with the mountain range on the eastern side helping to block the wind |

### 5.5.2 Values of custodianship and conservation ethics

While the concept of ecosystem services originates from natural sciences, local communities, particularly ethnic groups or fisherfolk with long-standing ties to a region, do not view the benefits they receive solely as "services" or mere "benefits". Instead, they emphasise the value of interconnected relationships. This manifests as gratitude or appreciation, expressed through offerings, rituals, or oral traditions. These relationships evolve into bonds, leading to stewardship and conservation ethics.

Community traditions establish customs that transform into regulatory systems for conservation. Rituals and beliefs play a central role in the lives of the Chao Lay and fisherfolk. The Chao Lay believe in spirits that protect the sea and nature, and they respect and make apologies to the sea, mountains, and forests. Rituals honoring ancestral spirits and spirits in nature, such as the sea worship tradition (Puya Lawoi) or the boat-floating ceremony (Plajak) of the Urak Lawoi, foster attachment and respect for the water and the marine environment. These rituals reinforce and regulate the use of natural resources, even without codified prohibitions.

Modern knowledge systems, developed from Western sciences, have led to written laws and regulations governing the use of natural resources. Consequently, ILK with its customary resource management practices, has been neglected. However, conservation approaches that establish rules solely based on external knowledge and prioritise "fortress protectionism" by government agencies are increasingly criticised. The limitations of these conventional models, emphasising government regulations, are evident in their failure to reverse environmental degradation (Parsons et al., 2021).

Conversely, there are examples of responsible resource management utilising community knowledge. The concept of co-management has gained wider acceptance. In Thailand, successful examples include small-scale fishing communities collaborating with the Andaman Foundation, an NGO in Trang, to establish four village-based juvenile aquatic animal conservation zones, drawing upon community relationships and knowledge to promote conservation (Thongyoi, 2016).

Even though the Chao Lay communities have customs and prohibitions, such as restrictions on fishing certain species in specific areas and during certain seasons, observations suggest that the key factors contributing to their sustainable resource use in the past were simple tools and technology, diverse use of natural resources, cyclical utilisation of multiple areas, and community relationships that fostered sharing, discouraged monopolisation, and limited extravagant or wasteful use of resources (Arunotai, 2006; Wongbusarakum, 2002). Therefore, pressures that drive the Chao Lay to adopt more complex and expensive tools, exploit resources in the same areas repeatedly, and experience shifts in community relationships toward individualism, all negatively impact stewardship and conservation ethics.

The data in Table 5.1 which shows the holistic nature of ILK systems, can help explain this phenomenon. Because "knowledge" for sustainable use does not mean only the skill of catching marine animals but must also encompass management systems and social institutions based on the shared values and worldview of the community. If pressure causes this knowledge system to deteriorate to the point where customary management and social institutions are weakened and meaningless to the community, then these marine skills may create an impact on nature. As mentioned, ILK cannot be separated from customary systems, social institutions, and worldview. The topic of weakening ILK will be discussed in more detail in section 5.6.2.

ILK reveals that ecosystems also possess intangible value, and paying attention to ILK is a crucial factor in making the assessment of social and spiritual benefits more comprehensive and accurate. This is because ecosystems contribute to the development of culture, knowledge systems, resource management systems, and related social institutions, further increasing the economic value of the ecosystem. These variables have not yet been factored into economic assessments in Thailand. At the same time, it may be argued that quantifying cultural and spiritual dimensions diminishes their value, transforming them into tradable assets within a monetary system.

Nevertheless, this may be a starting point for understanding diverse aspects of ecosystem services and their values. Moreover, there are significant policy implications that ILK plays a vital role in protecting and conserving ecosystem services. Conversely, protecting ecosystems and biodiversity also means protecting local communities and their sustainable livelihoods.

Chapter 5 illustrates ILK's intrinsic and relational values, which remain largely absent from economic analysis. Environmental economists could theoretically measure the benefits of ILK—such as sustainable marine resource management practices rooted in customary knowledge—yet such valuations are still limited in practice. Therefore, ILK offers significant potential for bridging different academic disciplines. Environmental scientists, anthropologists, economists, geographers, marine biologists, and policy experts each bring unique perspectives to understanding how communities sustainably use and protect natural resources. By bringing these disciplines together around ILK, we can develop more comprehensive approaches to conservation and resource management. ILK thus becomes not just a "subject", but a catalyst for genuine interdisciplinary collaboration—connecting traditional ecological wisdom with modern scientific methods, economic analysis, and policy implementation.

### 5.5.3 ILK and the assessment of marine and coastal change

As previously mentioned, current global international ecosystem assessments emphasise the importance of ILK. However, in Thailand, assessments tend to prioritise scientific methodologies that utilise academic datasets. ILK perspectives can significantly contribute to understanding the status, trends, and changes in coastal marine environments. In particular, the Chao Lay and small-scale artisanal fishers possess intimate familiarity with coastal and marine areas. They provide observations and perceptions of natural changes, including tidal currents, temperatures, water clarity, seasonal patterns, rainfall, and marine animal movements.

A research project titled "Risk and Adaptation to Climate Change of Indigenous Communities in Forest and Marine Contexts" (2011-2012) revealed that the Chao Lay elders and middle-aged men in the Rawai community, who practice fish trapping (requiring diving to retrieve fish from traps), have observed unusual changes in natural phenomena (Arunotai et al., 2015). These include water temperature fluctuations, with the water becoming colder or warmer than usual at certain times, leading to altered behavior in marine animals. For instance, lobsters and certain fish species migrate to deeper waters to escape warmer temperatures, or conversely, move to shallower waters to avoid colder temperatures. Furthermore, observations include the disappearance of some fish species, an increase in box jellyfish sightings, and coral bleaching expansion around Koh Racha, Koh Mai Thon, Koh Khai, and Mu Koh Phi Phi in 2010. The southwest monsoon season also appears to be arriving earlier. Additionally, wind patterns have become more erratic, making it difficult to predict direction or prepare for events in a timely manner. These changes necessitate increased caution, constant monitoring of news, weather forecasts, and warnings before going out to sea.

As an ethnic community with a long and continuous history in the area, elders possess memories of the past geography, ecology, and biodiversity of the region, and provide observations on changes and impacts on both the natural environment and the community's quality of life.

The Moklen in Phang Nga have long inhabited and utilised the coastal area, and over the past two to three generations have observed land-use changes from terrestrial forests, peat swamp forests, and beach forests to mines, rubber plantations, palm plantations, shrimp farms, and tourist destinations. This has resulted in ecosystem transformation and reduced biodiversity. The map below illustrates canals in Thai Mueang sub-district, Thai Mueang District, Phang Nga, that flow from the mountains through forests, replenishing peat swamp forests, meandering along mangrove forests as brackish-saltwater canals before reaching the sea. The Moklen are familiar with these canals from their headwaters, including stream areas in the forests that were once sources of fish, bamboo shoots, mushrooms, and other forest products. Consequently, Moklen elders possess clear memories of the area's original condition and can recount the history of its transformation. Satellite images in Figure 5.21 and Figure 5.22 reveal the historical landscape as recalled by Moklen elders, where swamp forests once consisted of interconnected pools and waterways. Currently, these areas have been transformed into rubber plantations, oil palm plantations, and shrimp aquaculture farms

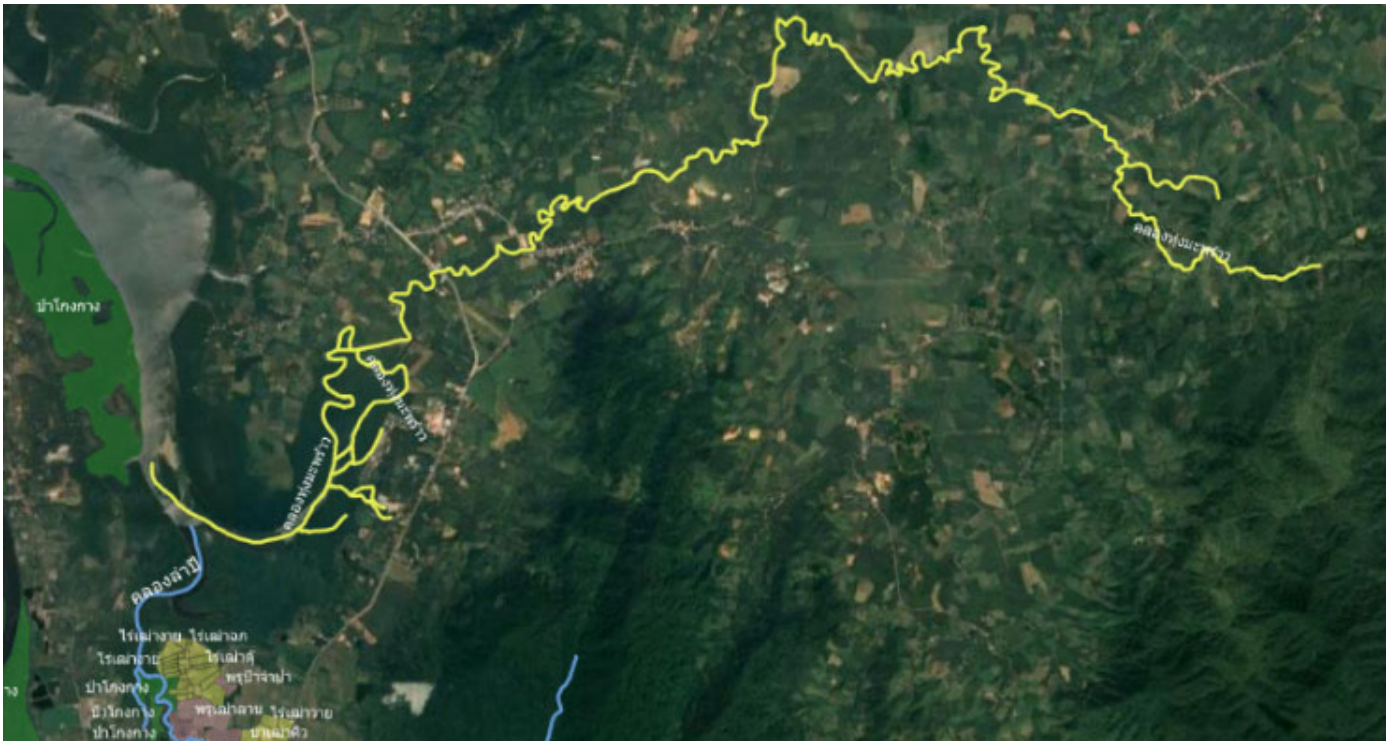


**Figure 5.21: Satellite imagery from Google Map showing Thung Maphrao Canal (yellow line) and the Lampi Canal (blue line), flowing from terrestrial forest zones into mangrove ecosystems and ultimately the sea at the mouth of the Thap Lamu Canal (Source: Field School Project Map)**




**Figure 5.22: Satellite images revealing the historical landscape as recalled by Moklen elders (Source: Field School Project Map)**

## Box 5-3: Local knowledge emphasises the interconnectedness of ecosystems spanning terrestrial forests, peat swamp forests, and mangrove forests

The Moklen conceptualize the coastal marine ecosystem as an integrated network of terrestrial forests, peat swamp forests, and mangrove forests. The area's topographic gradient, the convergence of stream flows, the seasonal rains that cause inundation and expansion of peat swamp forests, variations in water depth influencing temperature, and the tidal dynamics of the sea are all viewed as natural mechanisms that contribute to the ecological richness of the Thap Pla-Lampi area in Thai Mueang District, Phang Nga Province. The streams, peat swamp forests, and mangrove canals serve as habitats for diverse aquatic fauna.

Historically, peat swamp forests, mangrove forests, and coastal zones were crucial foraging grounds for the Moklen. Their traditional livelihoods encompassed upland rice cultivation, paddy fields, vegetable gardens, and the harvesting of fish and various aquatic organisms. In the perspective of Moklen elders, the terrestrial forest ecosystem, including streams and freshwater channels, is inseparable from the peat swamp, brackish water, and mangrove ecosystems.

The mangrove forests near the community remain vital food sources, with the community possessing specialized knowledge of shellfish habitats and harvesting techniques for species such as horn shell, clam, turban shell, cowry, top shell, mud whelk, cockles, etc. Notably, shellfish populations have diminished, and individuals have gotten smaller in areas adjacent to shrimp farms.

Local knowledge often adopts a holistic perspective, emphasising the interconnectedness of ecosystems spanning terrestrial forests, peat swamp forests, and mangrove forests. The Moklen recount the life cycle of eels (Anguillidae), which, from the community's perspective, are freshwater fish that migrate to brackish and marine waters to reproduce, laying their eggs near the mouths of mangrove-lined canals. The larvae thus develop in brackish-marine environments but, upon maturation, migrate upstream to freshwater canals or streams near waterfalls.

During the "Water Detective" activity of the Field School Project, a component of the NEA initiative with local communities in early 2024, eels were observed in the Ton Phrai Waterfall canal, which flows into the Pa-te Canal (freshwater canal) and converges with the Hin Lad Canal (mangrove canal) in Phang Nga Province (see the picture below). However, this region has undergone extensive transformation, with forests and streams being converted into rubber plantations, palm plantations, and shrimp farms, resulting in a decline in eel populations.



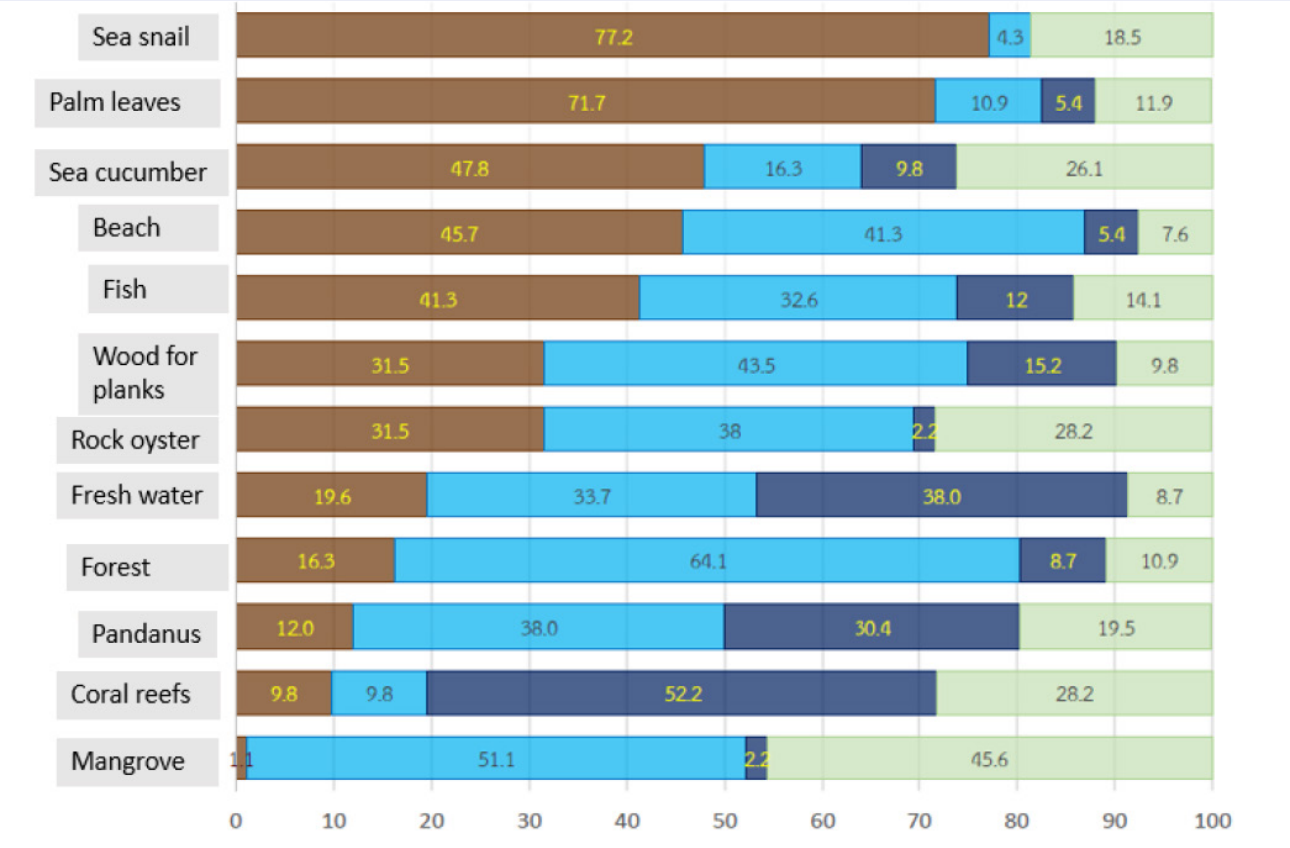
**An eel found in the stream**



**A part of the stream that retains its natural state as it flows through the temple**

## Box 5-4: Observations of changes in nature: Areas and species

Concerning island ecosystems and species situated offshore, traditional communities such as the Moken of the Surin Islands in Phang Nga Province have observed changes in the natural environment, particularly in areas and plant and animal species that the community regularly utilises as sources of sustenance and resources for essential livelihood needs. Data collected through household questionnaires by Social Research Institute in April 2022 yielded the following chart regarding the percentage changes in areas and species.



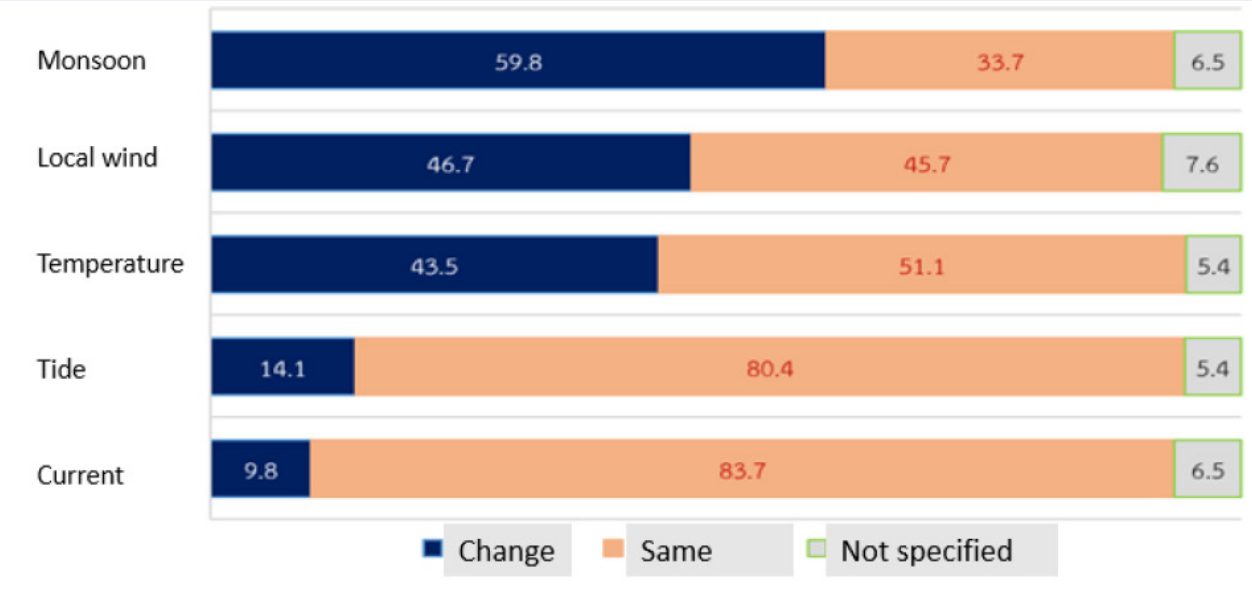

(Source: Social Research Institute, 2022)

Moken respondents indicated that natural resources have changed, with beaches becoming narrower, steeper, and more littered with waste. Overall, coral reefs are in better condition compared to the recent past, exhibiting increased recovery and new growth. Mangrove forests are scarce in the Surin Islands and are located far from the community, resulting in limited utilisation compared to other resources.

In terms of specific resources, respondents reported that wood for house posts/walls and palm leaves for roofing are increasingly difficult to obtain due to the growing number of houses on the Surin Islands. This increased demand coincides with stricter enforcement by the National Park prohibiting logging. The number of fish available for consumption has decreased, and fish do not have sufficient time to mature ("grow in time") due to increased fishing (using rods) and illegal encroachment by external vessels using fish traps/trawling nets.

## Box 5-5: Observations of changes in nature: Meteorological and oceanographic factors

In addition to areas and species, the Moken of the Mu Koh Surin have observed changes in monsoon winds, local winds, sea temperature, tides, and currents. Monsoon winds have exhibited the most significant alterations, particularly during transitional periods. Typically, the southwest monsoon arrives around mid-May, but in the past decade, its onset has occurred earlier in some years, making it less predictable than before. Furthermore, wind intensity has increased, leading to heavier rainfall. Changes in local winds, which persist for extended durations, are also notable. Sea temperatures have risen in some periods. Tides and currents exhibit the least amount of change, although annual peak tides have been observed to be higher than in the past, and water turbidity has increased during certain periods.




In addition to facilitating the monitoring and assessment of changes in the natural environment, ILK derived from observing subtle cues in nature, combined with intuition and rapid responsiveness to danger, promotes vigilance and risk awareness. Furthermore, experiences in confronting various dangers are distilled into lessons and incorporated into narratives to caution future generations about these hazards. An example is the 2004 tsunami event, from which the Chao Lay escaped due to their ancestral knowledge preserved in the "Seven-Wave" narrative. Despite the absence of a written language among the three Chao Lay groups, the receding sea level in the absence of wind and waves served as a warning sign, prompting community members to flee to higher ground (Arunotai, 2006).

Ancestors of the Chao Lay who had experienced past tsunamis "managed" their experiences and knowledge of these massive waves, integrating them with imagination and weaving them into narratives. These narratives represent "hidden knowledge" conveyed through social processes and socialisation within the community. The presence of the term "laboon" in the Moken language, which translates to "giant wave" without borrowing from other languages, indicates that past experiences have undergone a process of knowledge creation, involving the creation and selection of a term to represent this phenomenon (Arunotai, 2009).

## 5.6 Status and Trend of ILK

### 5.6.1 *Pressures on community knowledge and threats to knowledge-holder communities*

Although the Chao Lay and small-scale fishers possess ILK that enable them to coexist with nature, rapid changes associated with "development" and "conservation" have profoundly impacted the livelihoods, ways of life, and quality of life of these communities. Consequently, this knowledge is gradually being lost, confined primarily to the elderly and middle-aged individuals still engaged in marine-related livelihoods.

The primary pressures can be categorised into three interconnected areas: a) increasingly limited access to natural resources; b) degradation of ecosystems and biodiversity; and c) attitudes, policies, and laws that are unfavorable to the marine-based livelihoods of the Chao Lay and small-scale fishers.

***a) Significantly limited access to natural resources***

Ethnic and local communities that traditionally reside in and derive their livelihoods from natural resources increasingly find their access restricted due to various prohibitions. Historically, the Chao Lay and small-scale fishers could navigate freely, traveling among islands and anchoring for rest without regulations or restrictions. However, as areas have been privatised, developed for tourism, or designated as government conservation zones, their access to resources has been significantly curtailed.

Furthermore, increased government surveillance and enforcement have led to the confiscation of fishing equipment, fines, imprisonment, and court appearances. Following the 2004 Indian Ocean tsunami, alternative occupations were promoted as options for fishing communities. However, the Chao Lay expressed that "there is no need to promote alternative occupations. If they want us to live well, they should support traditional fishing and reduce restrictive measures because people born and raised with the sea must make their living from the sea" (Arunotai et al., 2007).

The Chao Lay and small-scale fishers also face numerous challenges in accessing resources and other rights. The Chao Lay community serves as a clear example of those negatively impacted by development, particularly coastal development in southern Thailand. Over the past decades, many areas along the Andaman coast have been designated as concessions for mangrove logging to produce charcoal, followed by of mineral extraction, large-scale commercial fishing, and the current boom in trade and services. The latter involves the construction of hotels and resorts to accommodate the expansion of the tourism industry and foreign investment. These developments are based on a value system that views nature as an instrument for generating income (instrumental value), disregarding the interconnectedness of social and environmental responsibilities. Consequently, the security of housing, access to resources for livelihoods, ILK, and the sustainability of ethnic communities are not primary considerations. The Moken community on Mu Koh Surin, Phang Nga, has become a place where tourists can freely enter and exit (Figure 5.23). The Laem Tukkae community on Koh Sireh, Phuket, is squeezed into a limited area, where the Chao Lay do not yet have land title deeds.



**Figure 5.23: Impact of the development on the Moken Community on Mu Koh Surin and the Laem Tukkae community on Koh Sireh (Photos by Narumon Arunotai)**

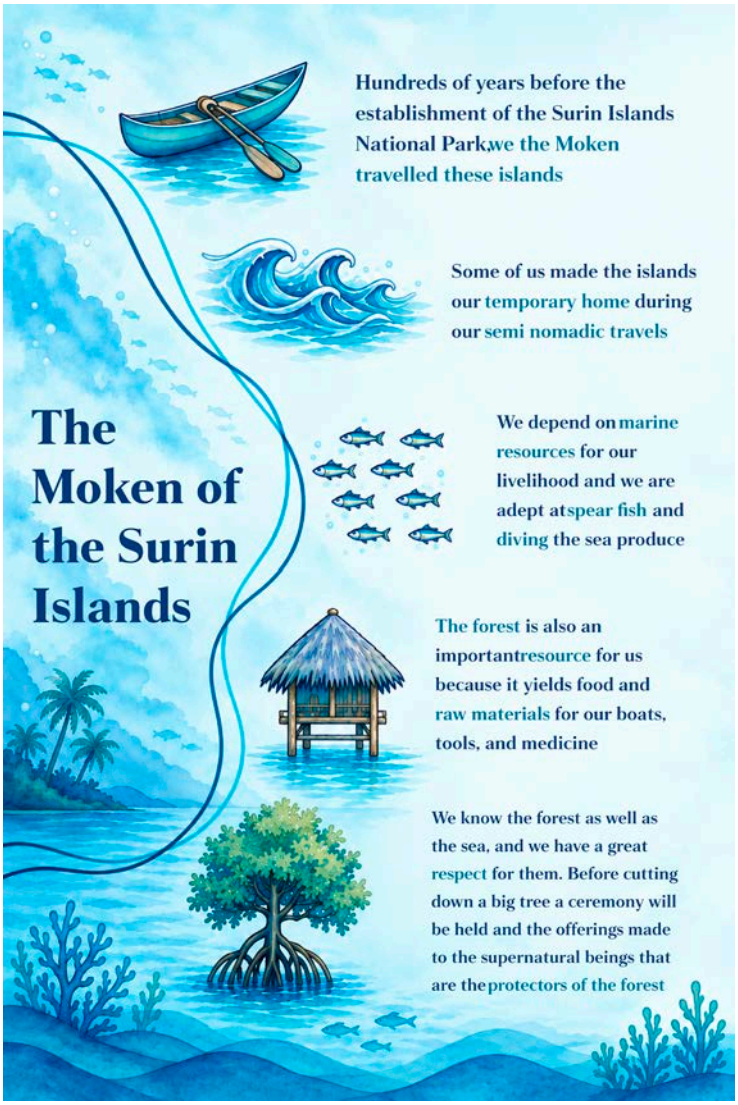



**Figure 5.24: Infographic captures the Moken's way of thinking on Mu Koh Surin in Phangnga (Source: UNESCO, 2024)**

The adverse impacts of development not only cause the Chao Lay to lose security in their livelihoods but also undermine their spiritual well-being. Many Chao Lay communities have been deprived of sacred spaces used for spiritual ceremonies, such as cemeteries and shrines.

The lack of housing security or land rights among the Chao Lay, despite their long-standing residence and livelihoods in these areas without formal land titles or ownership, stems from their traditional belief that resources—land, coastal areas, beaches, and marine resources—are collectively owned, and everyone has equal access and rights to these resources (Arunotai et al., 2015). Figure 5.24 illustrates the Moken's ways on the Mu Koh Surin which have been declared a National Park in 1984.

Furthermore, prejudice from some external parties and a general apprehension of strangers, especially government officials, have led to the neglect of the Chao Lay by external entities and government agencies. This has resulted in a lack of support for protecting the rights of the Chao Lay, particularly their land and housing rights. Additionally, the oral tradition of the Chao Lay community and the lack of literacy and legal knowledge among older generations make them vulnerable to deception and exploitation by outsiders seeking personal gain. In some cases, even when the Chao Lay possess land titles, they may sell their land due to economic necessity, deception, or coercion, ultimately leading to the loss of their ancestral lands.

***b) Degradation of Marine BES***

Based on the experiences of the Chao Lay and small-scale fishers, the overall condition of natural resources and the environment in coastal ecosystems has deteriorated. Marine life populations have declined, individual sizes have decreased, and water quality has deteriorated. The Chao Lay and small-scale fishers attribute this degradation to several factors, including large-scale commercial fishing vessels that harvest vast quantities of marine life, water pollution from land-based sources, shrimp farms, oil spills, and the reduction of habitats and nursery grounds for marine animals.

Historically, the Chao Lay and small-scale fishers required minimal capital, equipment, and time to sustain their livelihoods from the sea. However, as marine life populations have declined, fishing costs have increased. This has necessitated larger boats, engines, more efficient fishing gear, and longer and deeper fishing expeditions. The use of boat engines requires diesel fuel, which is increasingly expensive. While the Chao Lay traditionally used simple, self-made tools, access to forests and natural resources for harvesting wood and bamboo to construct fish traps and other equipment is now restricted, further increasing costs. The Chao Lay and small-scale artisanal fishers burdened with debt and dependence on patrons (towkays) find themselves in increasingly vulnerable positions.

Some Urak Lawoi practice deep-sea diving using air compressors, exposing them to risks from marine predators and decompression sickness, which occurs when divers ascend to the surface too quickly from deep depths. Many Chao Lay men have died or become paralysed from this condition, becoming dependent on their families due to their inability to continue fishing.

Small-scale fishers have greater opportunities than the Chao Lay to adapt to new occupations due to their greater access to education and familiarity with mainstream society, including language skills. When faced with declining fish catches and unprofitable returns, they may transition to wage labor, agriculture, or other jobs. Research in fishing communities near Pak Phanang has found that many communities have experienced the loss of their working-age population, who are both producers and contributors to community development, leading to "skip-generation households" composed primarily of elderly individuals and children, thus diminishing family stability and overall

well-being. The degradation of ecosystems and biodiversity, therefore, contribute to both the erosion of ILK and the destabilisation of families and communities (Siriboon et al., 2008).

Furthermore, the degradation of ecosystems and biodiversity increases the need for establishing additional conservation areas, which exacerbates the issue of community access to natural resources, as noted previously.

***c) Attitudes, policies, and legal measures not supporting small-scale marine livelihoods***

Past government policies have provided limited support for the marine-based livelihoods of the Chao Lay and small-scale fishers, while failing to fully acknowledge and enhance the role of traditional coastal communities. The government has historically supported the growth of commercial fisheries and the fishing industry to increase fish production and export value. However, the production of marine resources from traditional fisheries is considered to be small and primarily for household consumption. "Traditional fishers" began to appear in government policy documents around 1979-1980, where they were defined as a poor population group that required infrastructure development and aquaculture promotion (Banduwong, 2000). Moreover, the overall attitude toward traditional fishing occupations tends to be negative. Most fishers do not encourage their children to pursue fishing, considering it a risky, dangerous, arduous, and unreliable occupation (Siriboon et al., 2008).

Policies and laws have become significant "pressures" on the traditional way of life of coastal communities, much like those who lived in the forests long before the laws were enacted. Cultural rights to reside and make a living in their ancestral lands are not guaranteed, and some are forced to relocate against their will. The broader society only began to familiarise itself with the Chao Lay after the 2004 tsunami, and even then, attention focused primarily on issues concerning land security, livelihoods, and spiritual space. Consequently, unfair legal aspects should be considered as root causes of human rights problems, in line with international standards, such as the human rights-based approach.

In terms of the image of the Chao Lay, some are perceived as engaging in illegal fishing, using methods such as explosives and poison. The fish traps they set in various areas are opened by divers and tourists, or sometimes the wire mesh is cut, rendering the traps unusable.

Urak Lawoi women who go out to sea to collect shellfish in various areas are excluded from the areas where their ancestors have long earned their living, which have now been transformed into hotels, resorts, and restaurants. Chao Lay are portrayed as offenders, but if we consider the Driver-Pressure-State-Impact-Response (DPSIR) framework, these problems are the downstream state. We must consider the root causes- the driving forces behind various development policies and the lack of measures to protect those who will be affected or have been affected.

The threats facing the Chao Lay and small-scale fishing communities primarily stem from the cognitive systems, legal frameworks, and management practices created by our society. A progressive and holistic policy regarding the Chao Lay is the Cabinet Resolution on the Revitalisation of the Chao Lay Ways of Life (2010), which includes key measures for developing special cultural zones as an alternative development pathway to create security for these communities, as discussed further in the section on revitalising ILK.

## 5.6.2 Weakening ILK and its impact on social equity and marine and coastal sustainability

The status and strength of the ILK of the Chao Lay and small-scale artisanal fishers depend on two components: a) the perpetuation and continuity of coastal livelihoods and cultures, and b) social institutions or socio-cultural mechanisms that govern sustainable resource utilisation through customary traditions. The decline of these traditions has implications for both sustainability and social equity.

***a) Continuity and succession of coastal livelihoods and cultures***

ILK is inherently linked to place, experience, and practical application. The absence of "sensing", direct experience, and practical application diminishes this knowledge. For example, Moken of Mu Koh Surin traditionally free-dived to collect marine life. This activity allowed them to observe and sense the underwater environment, water temperature, currents, the condition of coral reefs and rock formations, and various marine species. As the harvesting of marine life has been restricted, younger Moken increasingly rely on line fishing from boats, reducing their understanding and awareness of the natural underwater environment. Similarly, Urak Lawoi in Phuket, facing declining marine life populations, stated that, "If shellfish disappear in the future, we will probably work as construction laborers, and future generations will not know anything about the sea."

The inability of ethnic communities to access areas and resources also puts ILK at risk of being lost. In many cases, restricted access stems from well-intentioned policies aimed at conserving biodiversity and ecosystem services (Bates&Trakarnsupakorn, 2021). When communities are separated or estranged from these areas, their knowledge, attachment, and ability to observe and assess changes in the environment gradually fade. The subsequent inability to access resources often leads to the weakening of individuals, families, and communities as they struggle to find alternative livelihoods that do not rely on their traditional skills and expertise, primarily becoming low-wage laborers in construction, manufacturing, or service industries. This is due to the limited education and qualifications of many the Chao Lay and some small-scale fishers, which restricts their employment options.

The example of the Urak Lawoi place-name map of Koh Phi Phi Don illustrates the rich history, knowledge of nature, and cultural memory embedded within these names. As Koh Phi Phi Don has embraced tourism as its primary economic driver without valuing ILK and traditional place names, these names are gradually being forgotten and abandoned, replaced by newly established Thai and foreign names or the names of hotels and other businesses located in the area. This further diminishes the community's ability to benefit from the locations as well as reducing knowledge of geography, ethnobotany, and understanding of changes in the local ecosystems and biodiversity.

For the Moken, the areas available for travel, shelter, and community establishment are limited due to private land ownership and government designation as conservation areas. Additionally, policies promoting permanent settlement limit the nomadic lifestyle of the Moken, restricting their resource harvesting to confined areas, and gradually eroding their eco-cultural knowledge.

***b) Social institutions or socio-cultural mechanisms that regulate resource utilisation***

ILK is linked to place, experience, and also to community solidarity. Thus, the meaning of local knowledge encompasses the existence of social institutions or socio-cultural mechanisms that ensure that marine knowledge and skills are governed by principles of sustainable utilisation, as discussed above in the section on "Traditional Ecological Governance". If these institutions or

mechanisms decline, the traditional resource management system becomes ineffective (excluding the gray area of "unknowingness" or "lack of awareness" regarding potential impacts, please also see Dearden (2018).

Social institutions or socio-cultural mechanisms are key factors in building and maintaining the power of local communities. A review and analysis of over 20 years of research by the Community Research Division of the Thailand Research Fund (TRF) found that the foundation of local power consists of four interconnected pillars: 1) resource base; 2) social networks; 3) knowledge systems; and 4) culture and beliefs. External development that impacts any of these pillars will have repercussions for the others (Buasai, 2004).
One mechanism that fosters mutual support and promotes generosity and sharing within the community is the moral economy. The livelihoods of both the Chao Lay and small-scale fishers involve subsistence activities, surplus sales, and sharing and exchange. This system ensures food security within and among communities and promotes sustainable resource utilisation, as it does not solely prioritise maximising profits or accumulating wealth for economic or commercial purposes (Setthachua, 2016).

The decline of social institutions or socio-cultural mechanisms that govern sustainable utilisation and promote generosity and sharing leads to the erosion of ILK. Traditional communities become increasingly individualised, and the elder and knowledgeable individuals pass away. Community data collected in 2005 on the Moken of Mu Koh Surin revealed the existence of dozens of knowledgeable individuals with expertise in various fields, such as traditional boat building, traditional medicine, music and oral literature, crafts, etc., which are related to nature, ecosystems, and biodiversity (Arunotai et al., 2007a). Currently (2025), only three individuals with expertise in these areas remain (from Andaman pilot project field visit in 2025).

### 5.6.3 Future perspectives and community-based scenarios

This section serves as a foundation for Chapter 7 on "Scenarios for Thailand's Marine Ecosystems and their Biodiversity Ecosystem Services" by situating ILK within community-based future thinking and illustrating how local perspectives, values, and lived experiences inform scenario development. Envisioning futures and scenario development have traditionally relied on the perspectives of academic experts, often focusing on macro-level or broad-scale overviews. The primary goal of such approaches has been to present various potential future pathways for policymakers to make informed decisions, emphasising empirical evidence derived from scientific insights. While this approach to scenario development has merit, it frequently overlooks the nuanced knowledge and unique perspectives of small local communities, particularly those with deep connections to specific ecosystems and biodiversity.  Envisioning futures through the worldviews and experiences of these coastal communities broadens the range of future possibilities and strengthens scenario development by incorporating participatory and equity dimensions.

In line with the priorities of the Thailand NEA, scenarios explored in this section are retrospective and exploratory in nature.

***a)Retrospective scenarios***
Retrospective scenarios are essential for ethnic and local communities as they help reflect on past changes and inform future decisions. The "Retrospective policy evaluation scenario" involves looking back at the impacts of community livelihoods and the state of ecosystems and biodiversity (IPBES 2025). In this chapter, scenarios serve as a tool to encourage community members to reflect

on the past and trace significant changes that have affected nature and livelihoods, while linking these changes to relevant policies or driving forces. This work does not assess whether policies achieved their explicitly stated objectives. Rather, its aim is to show how changes—including the problems and hardships communities have faced at different times—were influenced by direct and indirect drivers, to retrospectively question policies that produce mixed positive and negative impacts.

In development project evaluation, positive results/outcomes are often highlighted to demonstrate economic growth and progress, while impacts on nature and people cannot be easily and quickly quantified. These positive results create an illusion that encourages us to "see" only what is measurable and tangible, while negative impacts, especially on small and marginalised populations, are only recognised when their voices are intentionally heard. Retrospectives scenarios are therefore important for policymakers in formulating future development agendas by drawing on lessons from the past as examples for (re)consideration.

Retrospective policy evaluation scenarios involve assessing past policies or development initiatives to examine their intended results as well as unintended impacts. In this case, the analysis focuses on changes from the perspectives of Chao Lay and small-scale fishers, tracing back to the driving forces—some of which originate from state policies that promote the extraction and utilisation of natural resources. These policies are grounded in instrumental values and an anthropocentric worldview, which contrast sharply with the values and worldview of communities that view nature holistically, positioning humans as interconnected with nature and all entities in the world as an integrated whole. Figure 5.26 reflects that retrospective policy evaluation and waves of change from these development policies do not necessarily lead to community well-being nor benefit traditional community's ways of life. This framework synthesizes the IPBES retrospective policy evaluation approach (IPBES, 2016) with findings from envisioning futures workshops, as adapted and developed by the authors.

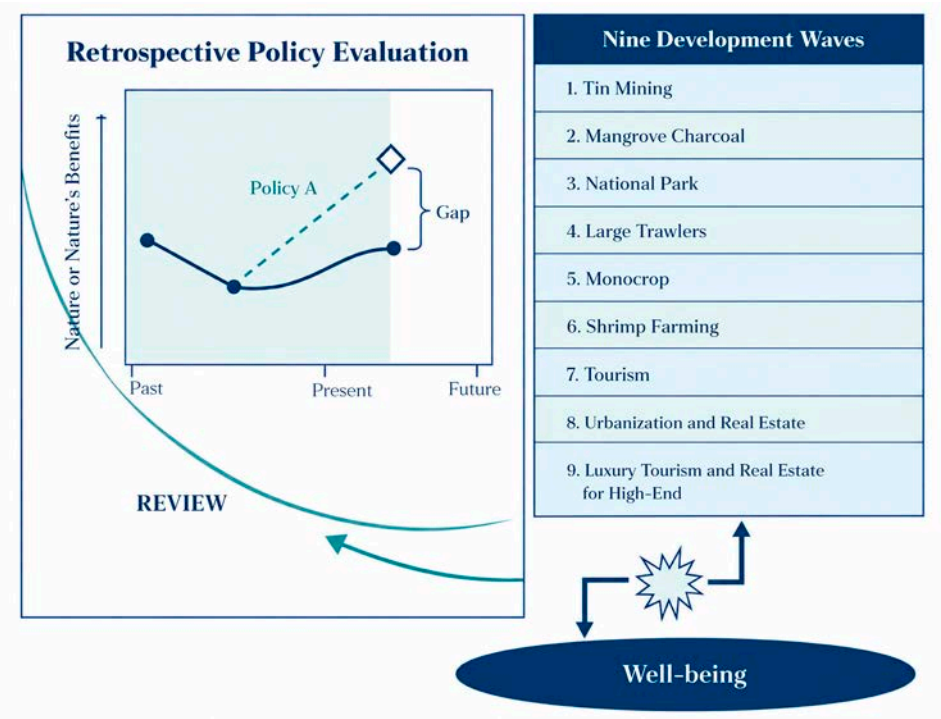



**Figure 5.25: Diagram illustrates an upward economic trajectory and downward nature and social/community trajectories (Source: Diagram by authors)**

Analysing scenarios in this manner constitutes learning from real-world experiences, yielding important lessons and feedback for current and future policy decisions. A key finding from this analysis is the focus on short-term economic benefits without comprehensive consideration of potential impacts (or impacts that have already occurred in the past) and the lack of preparatory policies to address those impacts—reflecting a policy blind spot. This has resulted in long-term degradation to ecosystems and social systems (Figure 5.25).

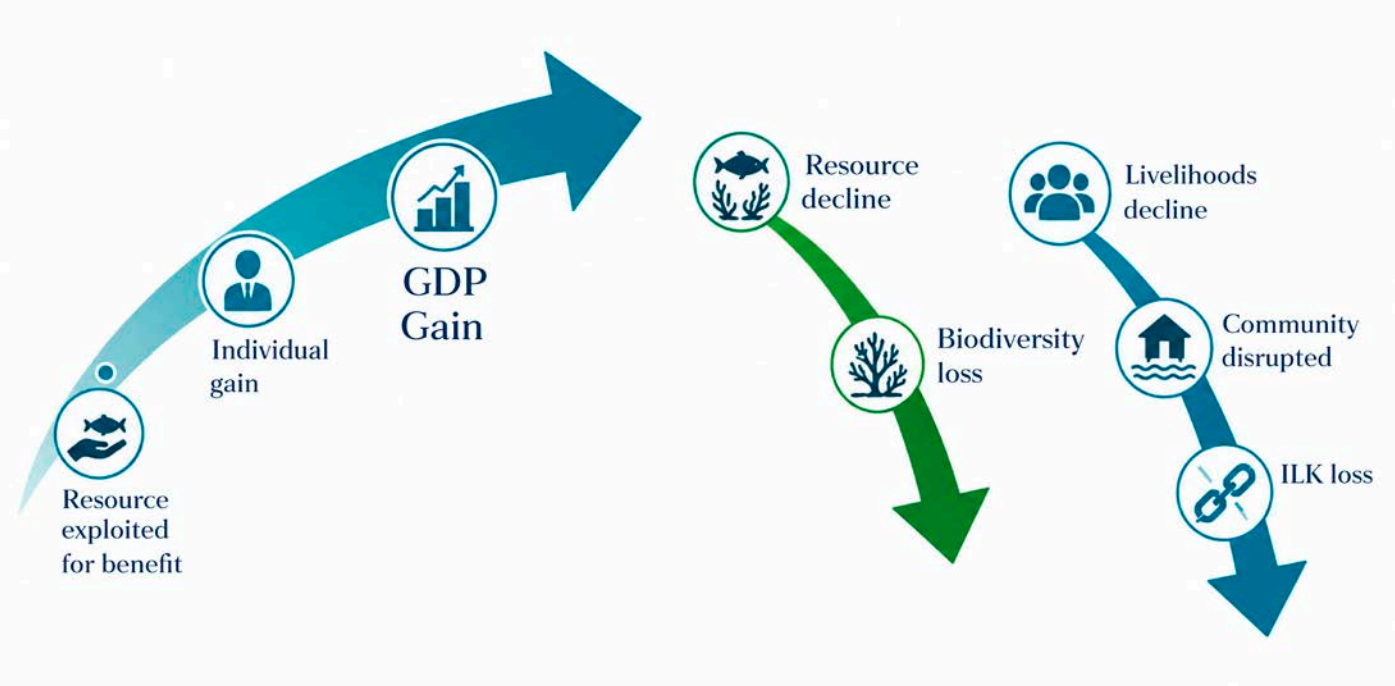



**Figure 5.26: The "waves" of development on traditional communities as reflected from retrospective policy evaluation (Source: IPBES, 2016)**

In Thailand's NEA Report, Chapter 4 on resource economics presents tools to calculate the value of ecosystem resources and quantify these losses. However, from a socio-cultural perspective—such as community cohesion and peace, and the intergenerational transmission of ILK that enables humans to live in harmony with nature—these dimensions have not yet received policy attention. Reviewing and presenting concepts and experiences from abroad, such as the Cultural Health Index (Tipa&Tierney, 2003), may foster understanding and encourage policymakers to adopt new assessment tools in Thailand.

Another important issue is tracing indirect drivers, which reveals the broad-scale complexity that conditions and propels direct drivers. These forces encompass new technologies and industries, lifestyles and consumption patterns exceeding basic necessities, demands from groups with superior economic and political power, and so on. National-level policies alone are insufficient to manage or control these indirect driving forces.

Exploratory scenarios

"Exploratory scenarios"(or Descriptive scenarios) look forward to multiple plausible future pathways based on trends in driving factors such as social, political, economic, and technological factors, as well as natural factors like habitat change and climate change. These scenarios describe the future according to past processes of change or forecast trends from historical patterns, resulting in multiple possible future pathways or options. In this type of scenario, there is typically a baseline

or "BAU" scenario, which represents a future with no changes or new policy interventions that would create shifts in paradigm or practice.

Data from small group meetings (2025) and workshop meetings (2022) consistently indicated that for Chao Lay, having a life of sufficiency in coastal and island areas, surrounded by warm families, along with shared cultural practices and mutual support within the community, represents a goal of a happy and quality life. Research on "good living" (Yeesakul, 2023) concluded that Chao Lay (case study of Ban Sangka-u, Krabi) value "abundant nature," "social relationships," and "freedom in life."

Regarding hopes for the future, both small-scale fishers and Chao Lay wish for the sea to retain its abundance and for coastal small-scale fishing and cultural livelihoods to continue. Comparing small-scale fishers and Chao Lay, the former demonstrates higher adaptive capacity (Bennett et al., 2014), and tends to plan more clearly for the future, emphasising their children's education as an alternative to narrowing fishing opportunities. In contrast, elder and middle-aged Chao Lay tend to live more in the present than think about the future, viewing it as something for younger generations to manage and decide on their own, since elders cannot keep up with new developments. Chao Lay thus have a more accepting orientation than other groups and do not believe they can significantly resist or change what is happening.

Several small-scale fishing communities are strong and well-organised in conserving nature and maintaining sustainable cultural practices (Dearden et al., 2017). For example, the Ao Kung community has the men advocating for participatory management, while the women want the community to create their own alternative development path, such as applying the philosophy of sufficiency economy through frugal savings. As a Muslim community, the women also emphasise that outsiders and tourists must respect local practices, particularly those related to Islamic beliefs and prohibitions, such as modest dress and abstinence from alcoholic drinks.

In fact, Indigenous Peoples and local communities worldwide hold philosophies that demonstrate the interconnectedness of all things, which gives rise to ethical principles of respect, care, and mutual support, rather than emphasising humans as the center of all things or economic wealth as the center of happiness and quality of life. This philosophy reveals profound relationships among humans themselves and between humans and nature and the supernatural (Berkes, 1999; Nakashima et al., 2018).

The Government of Thailand has previously promoted the philosophy of Sufficiency Economy, based on the concepts of King Rama IX, which emphasises self-reliance and living with dignity, freedom to determine one's own destiny, moderation, reasonableness, and resilience in responding to impacts, various changes and uncertainty. The conditions for practicing Sufficiency Economy require both knowledge and morality. However, a key challenge in practical implementation is the diversity and inconsistency in the interpretations of Sufficiency Economy. In most cases, the philosophy has been co-opted to serve dominant capitalist power structures, contributing to economic, social, and cultural inequalities rather than alleviating them (Jirasatthumb, 2017).

Based on data from retrospective policy evaluation scenarios and data on Chao Lay and small-scale fishers perspectives on happiness, quality of life, and the future, the team proposed exploratory scenarios into five futures for Thailand's development; 1) Rich-Big-Fast Future, 2) Conservation-Rush Future, 3) BAU Future, 4) Sustainable Future, and 5) Sufficiency-Coexistence-Sharing Future.

**Table 5.3: Showing five scenarios categorised by development characteristics and the primary forces driving development**

| Future Scenario | Characteristics of Development | Primary Forces Driving Development |
|---|---|---|
| **Scenario 1:** Rich-Big-Fast<br><br>Exploitative capitalism prioritises profit over people and nature | Heavy extraction of natural resources. Opening of areas for drilling and extracting additional resources. Large-scale projects to inject economic growth | Large businesses, multinational corporations seeking profits and constantly seeking new opportunities. Emphasis on competition and modern technology, without considering social and environmental impacts. Local communities are marginalised, displaced, or exploited |
| **Scenario 2:** Conservation-Rush<br>Conservation without community excludes those dependent on nature | Intensive conservation. Expanding protected areas for ecosystem and biodiversity preservation. Increasing strict regulations | The state is the primary driver for issuing conservation regulations, thus limiting and strictly controlling resource use by local communities. Communities may be relocated or displaced to create conservation areas |
| **Scenario 3:** BAU<br>Status quo perpetuates existing inequalities and degradation | Heavy use of natural resources. Pursuing economic growth. Using conventional indicators such as GDP to measure progress | State and business continue operations as before. No structural changes occur. Communities remain marginalised and struggle as they always have |
| **Scenario 4:** Sustainable Development<br>Sustainability discourse while maintaining inequality and unsustainable systems | Sustainability becomes new discourse. Problem-solving at symptoms level, improving social and environmental conditions somewhat. However, there is no change in values, so production and consumption remain unsustainable, and inequality persists | State, business, and civil society work together more, but there remain value and ideological conflicts depending on who gains power in each period. Communities have more voice and increased power somewhat, but do not play a leading role. Community knowledge and values do not drive transformation toward a better world |
| **Scenario 5:** Sufficiency-Coexistence-Sharing<br>Transformative fundamentally reorients toward community-led development based on interconnectedness and sufficiency | Fundamental transformation based on coastal community worldviews. Reducing excessive production and consumption for economic-social status. Emphasising relationships, mutual support and sharing | Local communities lead development through their worldviews integrating harmony among humans-nature-the spiritual in coexistence. Reducing desires to a level of sufficiency. Not emphasising competition but emphasising sharing and creating equality. Humans thus live well again with nature |

Source: Social Research Institute, Chulalongkorn University (2025)

Typically, the "BAU" future scenario represents a baseline showing no policy changes for society or the environment. However, for Chao Lay and small-scale fishers, there are futures even worse than "BAU"—namely the "Rich-Big-Fast" future, which emphasises economic growth through extracting natural resources and marginalising vulnerable groups, and the "Conservation-Rush" future, which prioritises nature conservation by excluding people directly dependent on nature. "Sustainable Development", meanwhile, is seen as a discourse constructed to create the impression that some policy changes and minor problem-solving are occurring, yet it still does not lead to a world that genuinely preserves biodiversity and cultural diversity. Future perspectives and community-based scenarios reflect the need for value transformation in order to reorient humanity's

relationship with nature and with human fellows.
Over 40 years ago, Club of Rome's Limits to Growth (Meadows et al., 1972) proposed computer models that predicate societal collapse if there is no radical shift of value from growth-obsessed to quality development. Along similar lines, IPBES works put the emphasis on the values that will facilitate transformative changes. The Transformative Change Assessment Report (IPBES, 2024) identifies that the pressures causing biodiversity loss are habitat loss, pollution, overexploitation of resources, invasive alien species, and climate change. The root causes of these pressures stem from an economic system that prioritises short-term profits, unsustainable consumption, concentration of wealth and power, and disconnection from nature.
As such, transformative change or fundamental paradigm shift is needed, and it requires systemic transformation, including value change. Reconsidering the values, worldviews, knowledge, and cultural ways of life of local communities, while strengthening community capacity and creating equitable participation, will recalibrate our values in our relationship with nature. This involves shifting from domination, control, and exploitation of benefits toward stewardship and appropriate, moderate resource use. This represents a challenge that will require policymakers to avoid the dangers of Scenarios 1, 2, and 3, and ultimately drive development toward Scenarios 4 and eventually 5.

## 5.7 Responses and revitalisation

### 5.7.1 ILK: responses and revitalisation

Following the broader recognition of the Chao Lay after the 2004 tsunami disaster, combined with increased interactions between the Chao Lay and various other groups, there has been growing recognition of the importance of their culture and ILK. This has led to increased interest in learning about, understanding, and passing down their own cultural heritage–a stark contrast to the past when the Chao Lay culture was suppressed, as mainstream society viewed this group as poor and uneducated. Many communities have collaborated with external agencies and organisations to establish public spaces within communities in various forms, such as cultural centers, ethnic museums, exhibition huts, and similar facilities (Arunotai et al., 2008). After the Chao Lay network was established in 2008, support began for data collection using tools such as community histories, community hand-drawn maps, and seasonal calendars, with assistance from the SAC. Additionally, responses to and revitalisation of ILK have taken the form of research studies involving community participation as researchers, resulting in reports, documents, and maps that record and analyse ILK, as discussed above. This type of work has enabled knowledge that was previously conveyed through oral storytelling to be recorded in written form and can now be learned and transmitted more widely.

Beyond revitalising local knowledge through the collection and documentation of information, there has also been application of knowledge in various ways, such as teaching language to children through local folktales and stories, developing local curricula, and so forth (Figure 5.27).




**Figure 5.27: Children learning through the Chao Lay cultural identity curriculum at Ban Koh Adang School, Koh Lipe, Satun (Source: Active Learning Television or ALTV)**

Revitalising ILK and culture can be made in conjunction with tourism, creating community-led tourism initiatives where the community plans and organises programs and schedules, encouraging various groups within the community to participate as hosts, while tourists learn about the local culture and knowledge. Figure 5.28 shows examples of community-led tourism organised by various Chao Lay communities in Phang Nga and Krabi.

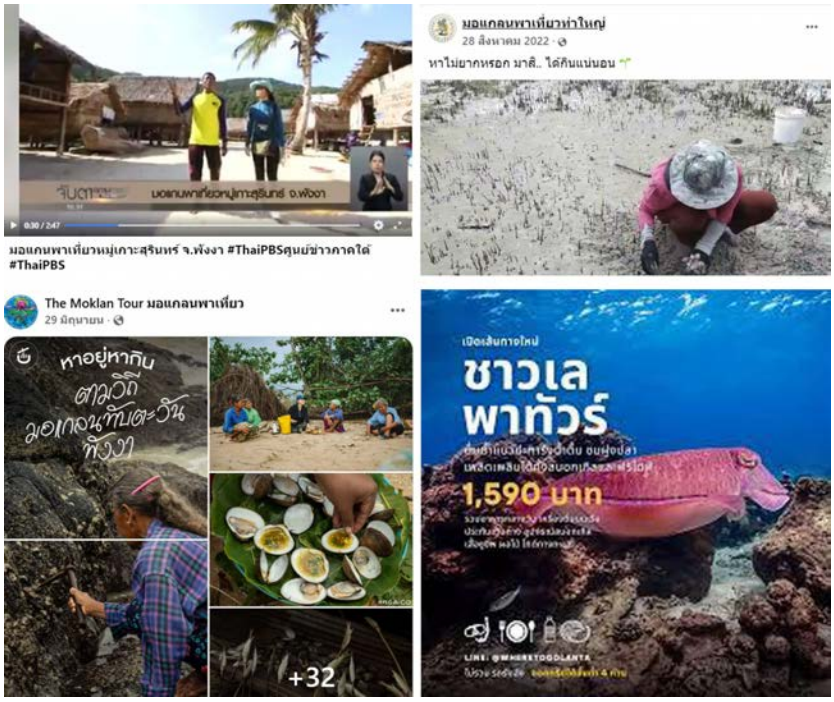



**Figure 5.28: Examples of community-led tourism organised by various Chao Lay communities (Source: ThaiPBS, Moklen Pha Thieaw Tha Yai (Phang Nga); Facebook page, Moklen Pha Thieaw (Thap Tawan, Phang Nga); and Facebook page, Touring with Chao Lay (Koh Lanta, Krabi))**

ILK is also being applied in order to adopt traditional form of fishing tools that do not harm the coastal environment. Figure 5.29 below illustrates the revival of bamboo fish traps by the Chao Lay of Koh Jum in Krabi, as the community has begun to recognise the environmental impacts of traps made with nylon netting and wire, which are not biodegradable like bamboo. Additionally, bamboo traps are lightweight, making them easy to transport on motorcycles with sidecars.

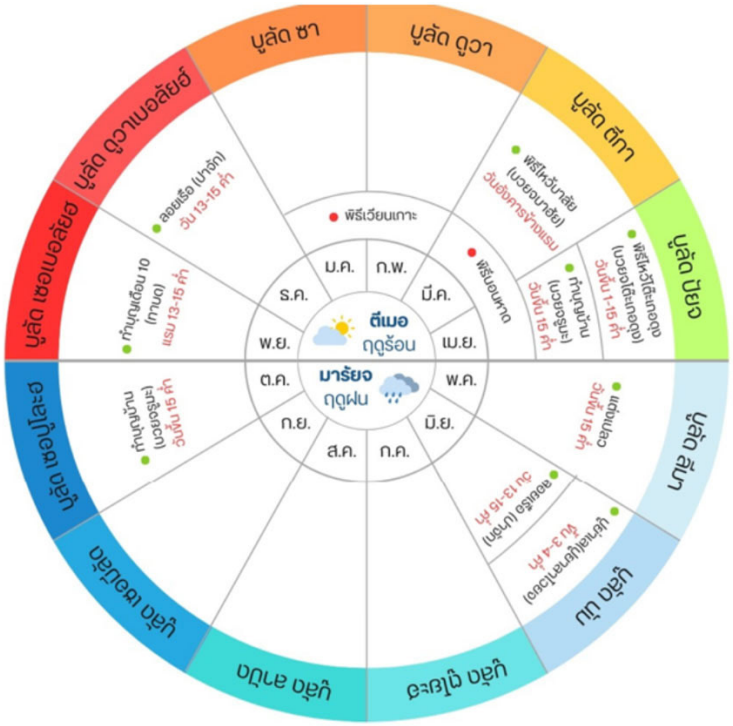


**Figure 5.29: Bamboo fish traps used by the Urak Lawoi Community on Koh Jum, Krabi (Photos by Naree Wongsachon)**

For the Chao Lay communities, a tangible form of revitalising ILK and values is the "Special Cultural Zone" outlined in the Cabinet Resolution on the Revitalisation of the Chao Lay Ways of Life (June 2010). The Special Cultural Zone is defined as "an area where communities can sustain their way of life based on culture, knowledge, wisdom, language, customs, traditions, and customary rules under the principle of sustainable coexistence between humans and nature. The aim is to promote cultural practices while promoting the existence of nature and biodiversity" (Arunotai et al., 2015; Princess Maha Chakri Sirindhorn Anthropology Centre, 2024).

The concept and practice of Special Cultural Zones have evolved since 2010. The Special Cultural Zone has been renamed "Ethnic Group Way of Life Protection Area". However, the declaration of such areas is initiated by the community, although government agencies may participate, and some areas may have joint agreements. Yet, the protection of these areas has not been formally recognised, and government agencies do not have consistent long-term budgets and plans to support them. Figure 5.30 shows supporting documents for the declaration of Ethnic Group Way of Life Cultural Protection Area, seasonal calendar, community map, and fishing practices of the Toh Balew community, Koh Lanta, Krabi.









บูบู อีกัด (ไซปลา) ถือเป็นภูมิปัญญาและสัญลักษณ์ของชุมชนชาวเล

**Figure 5.30: Documents showing protection area, seasonal calendar, community map, and fishing practices by local communities (Source: Toh Balew Community, 2024)**

Regarding small-scale fisheries, ILK is being revitalised in projects by NGOs working to link local knowledge with community ways of life. The focus is on creating sustainable coastal resource management models. Table 5.4 listed important organisations working on small-scale fisheries and coastal communities:

**Table 5.4: Projects/organisations supporting artisanal fisheries in resource management, ecosystem and biodiversity restoration, and community quality of life improvement**

| Year | Project/Organisation |
|---|---|
| 1981 | Small-Scale Fishing Community Development Project in Songkhla (later registered as the Rak Talea Thai in 2007) |
| 1981 | Andaman Coastal Community Rehabilitation Cooperation Network in Trang (later registered as the Save Andaman Network Foundation in 2009) |
| 1985 | Yad Fon Association in Trang |
| 1990 | Environmental Conservation Club (Phuket) (later expanded into the Andaman Project for Participatory Restoration of Natural Resources or ARR) |
| 1991 | Sustainable Development Foundation (SDF) |
| 1993 | Confederation of Thai Fisherfolk, which is an organisation of small-scale fishers themselves (currently registered as an association under the name Confederation of Thai Fisherfolk Association) |

The establishment of groups and organisations has strengthened communities and provided opportunities for exchanging and learning about applying ILK combined with modern knowledge in coastal rehabilitation and ecosystem and biodiversity conservation. Examples include observing fishing moratoriums during spawning seasons, using selective fishing tools, establishing fish sanctuaries, developing eco-tourism, developing community economies, etc. Additionally, many communities have leaders who have stood up to fight against large trawlers encroaching on coastal fishing areas, cases of dredging that impact coastal resources, and mangrove forest encroachment, among others. Many communities have received awards for resource conservation and protection (Bandhuwong, 2014; Emphandhu & Dearden, 2021).

However, pressures on the way of life of small-scale fishing communities continue persistently, such as illegal and destructive fishing supported by influential local figures, pollution, chemicals, waste, and sediment runoff from inland areas flowing into the sea, construction encroaching into the sea including concrete structures in the form of wave barriers and sand traps as well as climate change affecting coastal resources.

## 5.7.2 Good practices

Revitalising local knowledge is the first step towards enabling communities to restore and maintain their harmony with nature. Extending such revitalisation in a tangible form of Cultural Protected Area for Ethnic Groups or Community-led MPAs will lead to co-management, as will be discussed further in Chapter 6.

Challenging the state's monopoly on natural resource management and decision-making has become more prevalent since the late 1980s, particularly after Elinor Ostrom's (1990) concept of "common resources" gained wider recognition, coupled with research on community management systems in various parts of the world supporting this concept. Examples of good practices based on the concepts and philosophy of stewardship and careful utilisation through customary mechanisms that are practiced and enforced through local social institutions (e.g., the Ethnic Group Way of Life Cultural Protection Area) demonstrate the success of participatory management, where local stakeholders participate in policy formulation, access control, utilisation, and resource maintenance.

Ostrom's work does not directly address the right to use resources but rather discusses the right to organise collectively in order to manage resources (collective rights to manage) and proposes eight design principles, namely: 1) focusing on clear boundaries, 2) locally adapted rules, 3) participatory decision-making, 4) effective monitoring, 5) graduated sanctions, 6) accessible conflict resolution, 7) respect for self-governance, and 8) nested, layered governance for larger system. These principles are derived from research findings and thus represent empirical evidence demonstrating that groups or communities can effectively maintain and protect common-pool resources. The content in principles 1, 2, and 3 reflect the necessity of recognising community rights (human rights-based approach), particularly the recognition of customary systems that enable sustainable resource use.

Marine and coastal resource management policies in many countries are shifting to emphasise local participation and promote the revitalisation of customary governance systems (Cordell, 1989; Johannes, 1993; Jentoft&Chuenpagdee, 2015; Chuenpagdee&Jentoft, 2018). Concurrently, social movements of communities have emerged, particularly regarding community rights and the use of their knowledge, customs, and capacity to manage and conserve their own resources.

**Box 5-6: How do the values and customary systems of Chao Lay and small-scale fishers relate to conservation management?**

Chao Lay and small-scale fishing communities possess values deeply embedded in customs and traditions that govern activities related to coasts and the sea. Therefore, the subconscious understanding of "conservation" of coastal resources is fundamentally a matter of way of life and relational values, which encompass relationships between humans and nature, the supernatural, and among humans themselves (including future generations who should also be able to live from/with/as the sea). This differs from policymakers and conservationists who base their approaches on ecosystem integrity and formal, concrete conservation measures.

In many cases, Chao Lay and other small-scale fishing communities may disagree with strict measures that emphasise written regulations and formal structures, and may be in conflict with regulations that make their livelihoods and living spaces increasingly constrained and difficult. Policymakers should therefore prioritise the customs and values of local people that already align with and promote conservation, rather than imposing new regulations that appear to view Chao Lay and small-scale fishing communities as resource users and even destroyers. Moreover, culturally sensitive communication about the spirit of shared coastal resources, combined with strengthening social norms regarding conservation, can help enhance the effectiveness and sustainability of community participation.

From empirical evidence, this proposal aligns with the common resource management principles proposed by Elinor Ostrom, particularly the principle of clearly defining boundaries and user groups, and the principle of using rules and norms that conform to local context (Ostrom, 1990, Satumanatpan&Kanongdate, 2025). Therefore, understanding, acknowledging the values, and recognising the conservation approaches embedded in the knowledge and customs of Chao Lay and small-scale fishers is essential for policymakers in designing effective coastal management strategies, which will connect to issues of governance or management discussed in Chapter 6.

Regarding the Thai government's support on revitalising ILK and promoting participation in the management, utilisation, and maintenance of nature; there are tangible examples in the form of "community forests" in both terrestrial and mangrove areas. However, community forests primarily focus on the management and utilisation regulations and do not emphasise the revitalisation of cultural practices, traditional customary rules, worldviews, and values that emphasise being part of nature. Furthermore, an area eligible for designation as a community forest must be outside of state-protected areas. Even if the original local community may have previously inhabited or utilised the area, they are not entitled to declare it a community forest.
In Thailand, participatory governance policies are particularly important at this time because the

physical, social, and spiritual space of the Chao Lay and small-scale fishers is rapidly diminishing due to policies that promote economic growth, particularly tourism, which encourages speculation, real estate investment, the reservation of private areas for the benefit of tourism businesses and tourists, and marine activities that further narrow the space for local communities. The state has become a promoter of development and, indirectly, a guardian of business interests, facilitating trade and investment, or, in other words, "ocean grabbing" away from people who have continuously resided in and made their living from the coast and sea (Bennett et al., 2015).

In terms of policies concerning coastal communities and resources, some promotion of participation has begun, such as the Act on the Promotion of Marine and Coastal Resources Management (2015), which has a chapter (Chapter 2) on coastal communities that explicitly states "promoting participation and supporting coastal communities in the management, planting, maintenance, conservation, restoration, and utilisation of marine and coastal resources". The appointment of the Provincial Marine and Coastal Resources Committee (Section 12) specifies the inclusion of "representatives of the public or coastal communities who have demonstrable knowledge and experience". However, there is no support for including representatives of traditional local communities or for considering ILK as a criterion for selection.

In terms of practice, government agencies have begun promoting participatory management. In particular, the DMCR has officially recognised community-led marine and coastal resource protection areas, such as the "Khet Lay Se Ban" (meaning "Four Villages Sea Area"), where four coastal villages in Trang were developed into "a juvenile marine life conservation area" in 2007. This was done in collaboration with government agencies, NGOs, academic institutions, and local administrative organisations, who jointly drafted local ordinances. The focus was on adopting sustainable fishing gear, establishing blue crab banks, and conservation mechanisms using local methods and agreements (Thongyoi, 2016). Subsequently, this management approach was successful and expanded to cover nine villages (December 2024) and later to ten villages (August 2025), proving that collaborative management leads to sustainable conservation, restoration, and utilisation of marine and coastal resources.

## 5.8 Conclusion and recommendations

### 5.8.1 Summary of findings

ILK held by Chao Lay communities and small-scale fishers represents an invaluable, evidence-based system for understanding and managing Thailand's coastal and marine ecosystems. This knowledge—accumulated over centuries of direct observation and adaptive management—must be formally recognised and woven into national policy frameworks to achieve sustainable resource management, social equity, and ecosystem resilience.

Following from the point on revitalising ILK, and lessons from good practice, Thailand needs policies to promote ILK in order to maintain sustainable use of coastal and marine natural resources and to effectively understand, monitor, and assess changes in ecosystems. Policy proposals begin with a solid foundation of awareness and formal recognition of the value of ILK, which will have consequential effects on the development of policies that are conducive to the livelihoods of Chao Lay communities and small-scale fisheries as well as the promotion of quality of life based on knowledge that coexists with nature.

## 5.8.2 Key messages and recommendations

This chapter translates the following policy questions into clear key messages and recommendations for future actions to enhance ILK in Thailand:

- **What is Indigenous and local knowledge and who are the knowledge holders? How does Indigenous and local knowledge contribute to the sustainable use and conservation of coastal and marine resources?**
- **How does Indigenous and local knowledge play a role in understanding the status and trends/changes of biodiversity and coastal and marine ecosystems?**
- **What is the current status of Indigenous and local knowledge? What driving factors and pressures affect it? If it deteriorates, how would it impact coastal and marine resources?**
- **How can policies that promote Indigenous and local knowledge help strengthen the sustainable management and conservation of resources at the national level while also enhancing quality of life?**

**Key Message 1: ILK held by Chao Lay and small-scale fishing communities in Thailand reflects relational understandings of human–nature relationships and contributes to the sustainable use of marine biodiversity and ecosystem services. (*Well established*)**

ILK represents a holistic compilation of philosophical principles, worldviews, traditional and adaptive practices, value systems, and skills developed by Indigenous Peoples and local communities. It embodies a profound relationship system between humans and "nature". ILK offers a nuanced understanding of human-nature interconnectedness. Traditional local coastal communities perceive humans as an integral, inseparable part of the natural world, emphasising a deep symbiotic relationship with the environment.

Important global regulations all point to this knowledge, whether it be the Paris Agreement under the UNFCCC and the KMGBF under CBD. For KMGBF, targets have been set for the conservation of biological diversity by 2030 and have created important mechanisms to link biodiversity and culture, which demonstrates recognition of the critical role of local knowledge and the promotion of such knowledge sets as empirical evidence for improved policy decision-making, and the promotion of fair benefit-sharing with meaningful community participation. This includes emphasis on the principle of FPIC for access to communities and knowledge, respecting diverse worldviews.

In Thailand, as noted in this chapter, ILK knowledge has been greatly neglected and undervalued. During the National Trialogue meeting (2025), convened to provide comments and build consensus on key findings of the first order draft of Thailand NEA report, concerns emerged regarding verification of ILK by "evaluation standards". These concerns focused on the lack of uniformity across different areas, as well as questions on verification of ILK's accuracy and relevance to sustainability. Such views reflect the continued perception that such knowledge does not meet scientific standards and therefore

requires validation/verification through scientific criteria, rather than being recognised as a legitimate and valid knowledge system in its own right.

These concerns necessitate more intensive work on local knowledge to build awareness and appreciation of its value, as well as to seek clearer epistemological explanations regarding the relationship between knowledge systems. If ILK or other knowledge systems are entirely absorbed into the scientific knowledge system or are converted to "serve" certain objectives that do not align with the values or principles of that knowledge or are "judged" by the standards of another knowledge system, the integrity of knowledge may be lost. As mentioned throughout this chapter, local knowledge systems are often linked to relationships and meanings in the moral and collective responsibility sense, rather than being viewed solely in terms of utilisation value. As shown in Figure 5.31, the two knowledge systems are linked but not merged into one single system.




**Figure 5.31: Diagram showing linkage between scientific knowledge and ILK (Source: UNESCO LINKS, 2025)**

There are examples of how to connect and weave ILK and scientific knowledge together without merging into a single system as espoused by the multiple evidence base approach. In Canada, this can be accomplished through principles grounded in Indigenous community culture, such as "Two-eyed Seeing" (or using the Indigenous language term Etuaptmumk) (Bartlett, et al., 2012), to bring together the strengths of each system to find common solutions through collaborative research design, respect for cultural practices, recognition of the holistic nature of ILK, and inclusion of ILK into management. This is considered "braiding diverse knowledge systems" rather than consolidating knowledge into a single system. Every knowledge system has its own strengths and limitations, but when the strengths of each system are combined, it provides a broader and more comprehensive perspective. It also creates a stronger sense of unity and shared purpose. Economics can collaborate and leverage both ILK and science in assessing the value and importance of coastal and marine resources as habitats and sources of livelihoods (with humans as the center), as sources of livelihood for both humans and all beings (with bio-ecosystems-cosmos as the center), and as part of one another that cannot be separated from each other (everything is important and interconnected; there is no single center).

When local knowledge is recognised and acknowledged, this knowledge becomes crucial in properly assessing ecosystems. As explained in this chapter, Chao Lay and small-scale fishing communities are

users and stewards of resources and are among the first groups to experience and observe changes in ecosystems and the impacts that occur. Many groups have developed "indicators" that help monitor or watch for changes and enhance the existing knowledge base. Community-based monitoring systems can develop indicators that link social, health, and ecological aspects. For example, in New Zealand, a Cultural Health Index for Maori regarding freshwater ecosystems has been developed (Ministry for the Environment New Zealand, 2006). In Canada (Clair et al., 2025), risk assessment for endangered species has been conducted by creating two sets of assessment criteria—one set based on Indigenous knowledge systems and another set based on scientific criteria—to create an assessment process that can be meaningfully analysed from both knowledge systems. In the coastal zone in Canada the performance and effectiveness of MPAs has been evaluated from the perspectives of local communities using their own knowledge systems (e.g., Heck et al., 2011a; 2011b) as well as government agencies. In some cases, traditional resource management practices have been re-introduced into marine conservation areas, even where they may formally contradict government policies (Augustine and Dearden 2014) suggesting a change in paradigm for conservation agencies where culturally related management practices may be seen as of greater importance than existing policy.

**Recommendations:**

**1.1 Formally recognise and support Chao Lay and small-scale fishers as stewards and primary observers of marine ecosystem change in all policy sectors.** As mentioned, the overall public and policy attitude toward Chao Lay and small-scale fishers tends to focus on poverty, precarity and "low" education attainment. This stereotype persists, so their in-depth knowledge about marine environment has often been neglected. The first step, then, is to push for a knowledge turn by recognising and explicitly acknowledging these people as "knowledge holders". This should be the priority in policy, planning, and implementation of marine ecosystems and biodiversity management. The Protection and Promotion of the Ways of Life of Ethnic Groups Act B.E. 2568 (2025) provides a legal infrastructure for the formal recognition and support of ILK.

**1.2 Mainstream ILK into national policy frameworks across all sectors, aligned with the KMGBF, CBD Article 8(j) on traditional knowledge, and NBSAP.** International frameworks on biodiversity and ILK serve as a guideline for developing national policies. Thailand's 5th NBSAP (2023-2027) has progressive language that aligns with KMGBF in the protection of traditional knowledge held by ethnic groups, including their sustainable use of biodiversity resources. National policy frameworks, especially the 14th NESDP that is now in the drafting stage, have to mainstream ILK to ensure "quality growth" along with the meaningful engagement and roles of ILK in decision-making spaces, and in participating in national biodiversity initiatives.

**1.3 Mandatory implementation of ethical principles in ILK engagement** Ethical principles of working with ILK ensure that it is valued, appreciated and respected. Government agencies and stakeholders engaged with ILK must adopt established principles, including but not limited to FPIC, equitable benefit-sharing, and community-centered governance frameworks. ILK represents far more than utilitarian resources, it embodies intrinsic values rooted in relational contexts, moral frameworks, and collective stewardship responsibilities. If ILK is converted to serve certain objectives that do not align with the values or principles of the communities, the integrity of knowledge may be lost. Adopting and ensuring such principles will guarantee a transparent, accountable process, enhancing social equity, and in turn, strengthen the capacity of ILK communities to engage meaningfully.

## Key Message 2: Chao Lay and small-scale fishing communities often practice environmental stewardship rooted in reciprocity with nature, which has historically functioned as effective community based marine management through customary rules and self-regulation. ***(Well established)***

Importantly, Chao Lay and small-scale fishing communities do not view ecosystem benefits as mere "services." Instead, they practice stewardship rooted in reciprocal relationships— expressed through rituals, offerings and oral traditions—that translate into effective conservation ethics and self-regulation. Historically, their customs created de facto marine and coastal management systems: seasonal fishing restrictions, species-specific prohibitions, diversifying fishing grounds, cyclical resource rotation that prevented overexploitation, etc.

**Recommendations:**

**2.1 Promote local customary marine governance and develop formal recognition and support.** The policy framework should promote ILK and customary management, including supporting local administrative units to develop statutory mechanisms for communities to affirm and enforce customary rules while aligning them with national biodiversity conservation objectives. Government resources are needed to facilitate joint work between government agencies, local administrative units and community organisation. Improved compliance through culturally embedded governance will eventually reduce enforcement costs from the government in the long run.

**2.2 Provide social and economic/financial support for customary stewardship practices.** Marine stewardship rooted in relational values suggests that Chao Lay and small-scale fishers value ecological balance as an intrinsic good. There should be social and economic/financial support to reward stewardship and conservation practices. This can be done by creating PES schemes for community marine conservation outcomes (e.g., habitat protection) in order to further support locally-driven development and conservation initiatives. Preferential market access for sustainable catch should also be promoted along with sustainable community enterprises that generate income while reinforcing conservation worldviews and norms.

**2.3 Establish networks among Chao Lay and small-scale fishing communities.** Chao Lay and small-scale fishing communities possess valuable ILK and customary governance practices, and by creating networks of communities-of-practice, these communities can share diverse experiences and lessons learned in integrating customary governance with contemporary biodiversity management approaches, strengthen collective management capacity and build resilience through knowledge exchange. The policy framework needs to provide resources and institutional support for these initiatives, including coordination mechanisms and platforms for sharing experiences.

## Key message 3: ILK contributes to the assessment of marine and coastal change through a multiple evidence-based approach. ***(Established but incomplete)***

As long-term inhabitants with generational memory embedded in place names, geographical vocabulary, oral history, and keen seasonal observations, these communities detect subtle environmental shifts that large-scale assessments miss. This represents a critical advantage for monitoring biodiversity loss, ecosystem transformation, and environmental impacts. ILK is also important as an early warning system, as in the case of the tale of the seven giant waves which helped the Chao Lay survive by fleeing to higher ground during the Indian Ocean Tsunami of 2004. Despite its great potential for the assessment of unusual coastal change and for early warning systems, ILK has been marginalised, typically included as minimal, unsourced supplementary information to scientific data. Historically, most research on coastal communities—such as Chao Lay and small-scale fishing communities—has focused primarily on natural resource management, policy conflicts, and community rights. Consequently, numerous knowledge gaps remain that could be filled or deepened through the lens of ILK.

Countries with progressive policies on communities and ILK generally emphasise multi-sectoral collaboration in ecosystem research, monitoring, and biodiversity assessment particularly when research is conducted in community territories, allowing local communities to participate in decision-making, research design, and methodology. This is considered an ethical commitment (Alexander et al., 2019) and represents a form of knowledge weaving that prioritises local needs and practical applications.

Developing interdisciplinary research questions and employing integrated conceptual frameworks, such as the biocultural approach, helps explain how human societies have developed unique ways of interacting with, caring for, and utilising nature. Research from a biocultural perspective reveals the relationships between human societies and nature, providing empirical evidence for policy decisions regarding the management and conservation of both social and ecological systems (Maffi, 2005; Otamendi-Urroz et al., 2025). Connecting different knowledge systems and incorporating worldviews and methodologies from ILK may yield fresh perspectives and new insights. For example:

### *I) New knowledge from different thinking systems and methodologies*

Previous ecosystem assessments have relied on scientific frameworks using specific indicators based on measurable physical characteristics, dominant organisms, or ecosystem components (producers, consumers, decomposers). In contrast, ILK emphasises interconnected relationships, where humans are part of the ecosystem rather than external observers. ILK prioritises place-based understanding through toponymy (place names). Ecosystems may be classified by geography, administrative boundaries, legal jurisdictions, or according to local classification systems distinct from science. Studying these different classification systems, categories, and criteria—or adding new dimensions to existing ones—can generate novel insights and discoveries.

### *II) Valuing small, overlooked but critical details*

National-level ecosystem assessments require broad overviews that often miss small-scale elements of high importance and value. Additionally, community-defined "values" differ from scientific or economic values. Top-down criteria and indicators may overlook alternative possibilities. ILK supports data collection, community-based research, and mapping ecosystems from local perspectives, ensuring small-scale features are recorded and become important databases for detailed comparative analysis across space and time.

### *III) ILK generates new research questions for science*

Local perspectives can challenge scientific assumptions and prompt knowledge review. For example, regarding mangrove restoration through clear-cutting and replanting: residents of Koh Siboya in Krabi see this as destructive rather than restorative (Bandhuwong, 2001). Inhabitants of Koh Phra Thong in Phang Nga note that clearing allows direct sunlight to reach the mangrove floor, reducing fish and marine fauna numbers and diversity. Residents of Pred Nai Community in Trat observed that mangroves historically contained diverse plant species, but government monoculture plantations hardened soil, reduced monitor lizard populations, and decreased mud crabs since the decomposing leaves that feed them diminished (as noted by participants from the NEA National Trialogue held in 2024).

Research that helps developing shared questions—whether using joint or different methodologies—generates knowledge that may reflect different values. For instance, clear-cutting and replanting may facilitate faster tree growth and increased carbon absorption, while natural recovery or

supplementary planting in unaltered areas may better conserve biodiversity. Such data carries policy implications, clarifying trade-offs in decision-making.

***IV) ILK illuminates contemporary global challenges***

Local perspectives can help analyse emerging problems, such as invasive species. Thailand has faced outbreaks of Blackchin Tilapia (*Sarotherodon melanotheron*) from Africa, introduced by private companies. These fish escaped into natural waters, reproduced rapidly, and spread widely. Though typically freshwater fish, they tolerate brackish and saltwater environments and prey on fish and other aquatic life, particularly shrimp—an important economic species. Local fishers, citizen journalists, and environmental workers first raised awareness, though problem-solving remains incomplete. ILK regarding monitoring and mitigation through local fisheries expertise has not yet been systematically studied.

***V) Develop Research Questions on Science-ILK Nexus that Support Local Livelihoods***

An example of a research question on the science-ILK nexus that supports local livelihoods is how to determine sustainable catch quotas within ecosystem carrying capacity? As mentioned above, ILK can be sustained through the continuity of coastal livelihoods and cultures and through social institutions or socio-cultural mechanisms that govern sustainable utilisation through customary traditions. However, amidst mounting pressures that are undermining both factors, there must be support systems, such as a special permit or quota system for Chao Lay's sea cucumber catch and for small-scale fishing in certain protected areas, yet clear guidance remains absent due to insufficient "scientific" support.

Along the same lines, there should be interdisciplinary research to assess the outcome of "Cultural Protected Area" as endorsed by the Act on Protection and Promotion of Ethnic Groups' Ways of Life, B.E. 2568 (2025), and LMMAs like the "Aquatic Larvae Conservation Area in Four Villages" in Trang. Empirical data and indicators proving these communities' positive contributions are crucial. Documenting evidence of positive change should be linked to quantitative ecosystem service changes, connecting ILK with natural science, and economics. Research findings will help strengthen Chao Lay and small-scale fishing communities' sustainable practices and cultural resilience. To reiterate respect for different worldviews and methodologies, policies should promote collaborative approaches rather than making science the standard for evaluating ILK. There are several best practices on building frameworks that analyse ILK within its own context, as exemplified in Canada's endangered species risk assessment (Clair et al., 2025).

Capacity-building efforts need not focus solely on local communities. ILK itself can raise awareness and generate questions challenging other knowledge systems, thus building more capacity in science, economics and other disciplines. Furthermore, using ILK's relational values and collective responsibility principle can help build ethical capacity within academia, government, and policymaking sectors as well.

**Recommendations:**

**3.1 Weave ILK into ecosystem assessments, biodiversity monitoring, and climate adaptation strategies.** The policy framework should encourage weaving of ILK into ecosystem assessments, biodiversity monitoring protocols, and climate adaptation strategies. ILK shall be recognised as a co-equal knowledge system with scientific approaches, not as supplementary or secondary data sources. Chao Lay and small-scale fishing communities possess intergenerational observational capacity and adaptive knowledge systems that enable them to detect natural changes and have systematised their observations into indicators which can serve as monitoring tools. Thailand NEA has already illustrated the potential of ILK in ecosystem assessments.

**3.2 Mandate collaborative research protocols that include community engagement in design, approach and methodology, and decision-making on ecosystem studies conducted in their territories.** Thailand's national research framework must assert requirements for community acknowledgement and collaboration in ecosystem studies, development and conservation initiatives, and environmental research conducted within local communities and territories/marine areas. This includes community recognition as co-researchers, community agreement regarding data dissemination and application. Such protocols are essential to maintain the integrity of ILK and to prevent knowledge misappropriation. In addition, the protocols will fulfill Thailand's international obligations under the CBD and Nagoya Protocol.

**3.3 Support co-production of knowledge, bridging Ethnic and Local Knowledge and scientific approaches to generate novel insights on conservation, invasive species management, climate adaptation, etc.** The policy framework must support co-production of knowledge, because connecting different knowledge systems and incorporating worldviews and methodologies from ILK will yield fresh perspectives and new insights.

## Key message 4: ILK is declining primarily as intergenerational transmission to younger generations weakens. (***Well established***)

ILK is gradually disappearing. It is held primarily by aging elders, while younger generations face limited opportunities for transmission due to limited/restricted access to training grounds (territories) and are pushed into low-wage labor. When communities lose place-based access, their capacity to observe, learn, and transmit knowledge erodes. When social institutions governing sustainable practices weaken, conservation ethics dissolve. Without intervention, Thailand risks losing centuries of empirical expertise.

Local knowledge management flourished significantly in Thailand during the period when there was a "Research for Local Communities" program supported by the Thailand Research Fund (TRF), which emphasised action research to answer questions, problems, or address issues that community members viewed as important and wanted to solve together. The program emphasised process and networks (communities, academics, policymakers, developers, and other stakeholders) rather than creating new knowledge. In later years, when organisational changes occurred, this work gradually lost importance.

For local communities, in terms of building capacity regarding knowledge about ecosystems and biodiversity, an example from the "Field School Project" (2566-2568) demonstrates the promotion of ethnic community capacity to collect, record, and manage biodiversity and cultural data, and the integration of new knowledge and tools, such as geographic information systems to promote the protection of "cultural capital" existing alongside "natural capital." Such work can be expanded into joint research between diverse knowledge systems, toward the development and piloting of local curricula, and toward the development of community management plans that integrate and harmonise customary systems and ecosystem stewardship with local regulations. Moreover, many local communities that serve as learning centers for ecosystem knowledge work in collaboration with external groups and connect with citizen science for public learning and to emphasise diverse values in different knowledge systems.

Policy promotion should therefore focus on plans and budgets to develop the skills of community members to become "community researchers" who collect, record, compile, and analyse and connect data regarding the relationships between biodiversity and cultural diversity, while observing Indigenous data sovereignty. From the lessons of the "Field School Project", "community researchers" have learned tools for surveying and collecting data on biodiversity and cultural diversity both from community elders and external sources, learned methods of managing and communicating data through various methods, including modern technology, and learned how to use data to jointly develop community plans to improve quality of life, manage resources in a balanced and sustainable manner, and increase economic value. Additionally, it has promoted youth learning and intergenerational relationships, as well as created collaborative networks for shared learning, enabling knowledge and skill sharing across communities, and supporting the development of protected areas for ethnic lifestyle that will be recognised through the Protection and Promotion of Ethnic Groups' Ways of Life (SAC, 2025).

Once knowledge has been recorded and compiled, promotion in terms of database development becomes necessary, and this database will contain both spatial and temporal data useful for monitoring and assessing changes and will serve as a repository for restoring and transmitting ILK. Under the preparation of this assessment report on Thailand's ecosystems, the Geo-Informatics and Space Technology Development Agency (GISTDA) participated in surveying a local fishing community and collecting coordinate data of the physical and cultural areas of communities in order to develop a geographic information database in the Marine GI Portal. However, an important issue for all types of databases concerning local communities is that, in addition to being careful about personal information20,

consideration must be given to recognising data sovereignty, which means the right to own and make decisions regarding the storage, access, control, and use of this data. This will help prevent sensitive data from being disclosed, misinterpreted, distorted, and exploited or used in ways inconsistent with the values, consent and worldview of the data owners.

Another important issue is the use of citizen science in monitoring and assessing ecosystems and biodiversity, which requires understanding the differences between ILK and citizen science. Fundamentally, local knowledge is a knowledge system that embodies the values, worldviews, practices, and social institutions of communities for accumulating, transmitting, and applying knowledge. Therefore, it is connected to identity and culture and is often culturally specific. ILK aims at living together with nature and humans in harmony. Citizen science, on the other hand, focuses on techniques and practices defined and guided by scientific experts, enabling ordinary individuals to participate in observation, recording, and data interpretation. The objective of citizen science is to feed data or measurable results into the scientific knowledge system in order to obtain large datasets, expand knowledge, and create opportunities for generating new knowledge, emphasising universal values (Tengö et al., 2021).

**Recommendations:**

**4.1 Fund and support community-led documentation initiatives where local members serve as "community researchers" and (co-)authors.** The Policy framework should focus on participatory planning and budget allocation to develop the skills of community members to become "community researchers" who collect, record, compile, analyse and connect ILK data regarding the relationships between biodiversity and cultural diversity. "Community researchers" should be equipped with tools for data collection and management and learn how to use data to jointly develop community plans to improve quality of life and continue to manage resources in a balanced and sustainable way. Such initiatives need to promote youth learning and intergenerational relationships, as well as create collaborative networks for shared learning, enabling knowledge and skill sharing across communities, and supporting the development of culturally protected areas. The support on lifeways and historic data is indicated in Chapter 4 of the Protection and Promotion of the Ways of Life of Ethnic Groups Act B.E. 2568 (2025), thus the infrastructure for funding and supporting is already in place.

[20] The results of the other study conducted as part of the Chulalongkorn University eDNA Research Project Year 3 was inconclusive due to lack of primary data to estimate the fish biomass around the PTTEP sites in the GoT.

**4.2 Establish secure, locally controlled databases integrating spatial, temporal, and cultural data for ecosystem monitoring and knowledge revitalisation.** Once ILK has been recorded and compiled, database development becomes necessary, and this database will contain both spatial and temporal data useful for monitoring and assessing changes and will serve as a repository for restoring and transmitting ILK. The GISTDA created and updates a Marine GI Portal which will be a geoinformatics knowledge platform that facilitates weaving together systems of knowledge while prioritising local needs and practical applications. Thailand's NBSAP recognises the importance of community databases (Target 5 of KMGBF) and establishing robust policies that guarantee long-term funding and technical capacity critical for weaving ILK into these systems and ensuring its practical use in biodiversity conservation efforts.

**4.3 Protect community data sovereignty and ensure communities' right to control data ownership, access, use, and ensure equitable benefit sharing arising from the use of their data and knowledge, in line with the Nagoya Protocol on Access and Benefit Sharing (ABS), national ABS legislation, and other locally established/ agreed community biocultural protocols.** Consideration must be given to recognising data sovereignty, which means the right to own and make decisions regarding the storage, access, control, and use of this data. This will help prevent sensitive data from being disclosed, misinterpreted, distorted, and exploited or used in ways inconsistent with the values and worldview of the data owners. Thailand must establish mechanisms to protect community data sovereignty, ensuring communities retain ownership and control over their biodiversity data and ILK. By establishing clear legal protections and accountability mechanisms, communities will be empowered and counted as genuine partners in biodiversity conservation while ensuring they benefit equitably from knowledge use.

## Key Message 5: Weakening ILK causes cascading effects across the three domains of community viability, ecosystem integrity, and policy effectiveness. (***Established but incomplete***)

As mentioned above, both society and the policy sector do not yet understand the maritime semi-nomadic living of Chao Lay communities, which frequently involves mobility, as well as their worldviews that do not claim exclusive ownership or assert individual property rights over areas. These worldviews, ways of knowing, and ways of living have resulted in nearly half of all Chao Lay currently facing housing security issues, because there are no policies to protect and safeguard the collective rights of communities, including the right to temporary settlement areas for mobility in accordance with marine animal migration and the seasonal patterns of monsoons and storms. When communities face various risks and pressures, their way of life gradually changes, leading to a decline in knowledge, which in turn impacts community security, quality of life, and the integrity of the ecosystem and biodiversity that Chao Lay communities depend upon.

Therefore, ILK decline directly undermines social equity, ecosystem integrity, and conservation policy effectiveness as described below.

### *I) Community viability*

When communities lose secure access to coastal resources and the social institutions that govern sustainable use, the implications extend far beyond livelihood loss. These communities become economically vulnerable as individuals, families, and households struggle to find alternative livelihoods that do not rely on their traditional skills and expertise. Many are pushed into precarious low-wage labor in construction and service industries—eroding household resilience and community cohesion. More critically, when place-based access is severed, the intergenerational transmission of knowledge fails as younger generations have no opportunity to learn from elders or practice marine skills. The cultural and ethnic integrity of these communities is threatened as customary knowledge-sharing mechanisms—central to social bonding—progressively dissolve as communities become individualised and fragmented.

### *II) Ecosystem integrity*

ILK has been marginalised in national ecosystem and biodiversity assessments, typically relegated to minimal, unsourced supplementary information. This represents a critical gap in evidence-based policymaking. Communities with centuries of continuous presence and observation possess irreplaceable knowledge of historical ecology, past land-use changes, and gradual ecosystem transformations that scientific monitoring alone cannot capture. Their detailed observations of subtle environmental cues—informed by intuition and rapid risk responsiveness—contribute to vigilance and early warning capacity. When these communities are estranged from their territories through restricted access, their knowledge and capacity to observe and assess environmental change gradually fades. Without this embedded knowledge system, national assessments remain incomplete, monitoring becomes less effective, and adaptive management capacity is diminished.

### *III) Conservation effectiveness*

The decline of ILK, together with policies that overlook or neglect such knowledge, and the enforcement of conservation measures without regard to the cultural practices and traditions, often undermine the effectiveness and efficiency of conservation and can even generate resistance among local communities (see Bennett&Dearden, 2014 for a Thai example). Chao Lay and small-

scale fishers have deeply ingrained values rooted in customary traditions that govern coastal and marine activities. Therefore, the subconscious awareness of "conserving" coastal resources is a matter of cultural and relational values, distinct from policymakers and conservationists who base their focus on ecosystem integrity and formal, concrete conservation measures. In many cases, Chao Lay and small-scale fishers may disagree with rigid, written, and formally structured measures. Conversely, incorporating customary traditions into conservation fosters voluntary cooperation and reinforces the importance of knowledge as a key factor in successful conservation efforts. Lunn&Dearden (2006) provide an example of how the design of MPAs can be adjusted to accommodate the needs of local fishers on Koh Chang.

Without supporting policies and implementation, Thailand faces a triple loss: erosion of community viability and cultural continuity, degradation of ecosystem assessment capacity, and reduced effectiveness of conservation efforts. Recognising and supporting ILK offers a path toward inclusive approaches where conservation goals, community wellbeing, and evidence-based assessment reinforce one another.

The enactment of the Protection and Promotion of Ethnic Groups' Ways of Life, B.E. 2568 (enforced on September 18, 2025) represents an important legal structural step that will create policy space to address existing problems. In particular, it will create a new form of "conservation" that protects ways of life, ILK, and marine ecosystems simultaneously. However, laws and policies on "protecting and promoting ways of life" may be viewed as matters of people, society, and culture, falling under the responsibility of the social and cultural ministries only. In reality, however, issues concerning communities whose lifestyle is intertwined with nature also fall under the responsibility of agencies that protect and conserve natural resources and the environment. Therefore, the proposal to "formally recognise and endorse the value of ILK across all policy sectors" means integrating the conservation of "biocultural" diversity into these state agencies (mainstreaming biocultural diversity in nature conservation).

Regarding small-scale fishing communities, although there is more data, documentation, reports from state agencies, educational and research institutions, NGOs, as well as fishing associations and groups compared to those of Chao Lay communities, progressive policies that support the livelihoods of these communities remain scarce. Existing policies emphasise small-scale fishing as an economic occupation with low returns, and the perspective on women in fishing communities considers their roles as housewives, seafood processing workers, small-scale market sellers, and so forth. These policies do not yet value ILK and cultural-spiritual aspects of small-scale fishing, particularly the roles of women in these communities. Many studies elsewhere have documented the important roles that women play in small scale fisheries (e.g., Hauzer et al., 2013) but there is little work in Thailand on this important topic.

Promoting ILK of small-scale fishing communities must include definitions and conceptualisations that emphasise the value of both Chao Lay and fishers in terms of ways of life, culture, ILK. This encompasses community relationships and sharing of work within extended families, from boat and fishing gear maintenance, fishing practices, sorting, distribution, processing, preservation traditions, etc. to defining vessel types and sizes, defining and delineating fishing grounds, categorising sustainable fishing gear types through seasonal selection of fish and aquatic species, supporting the rights of small-scale fishers to use resources and fishing grounds for subsistence, promoting conservation approaches and ecosystem restoration according to local ILK and practices (Sustainable Development Foundation, 2024; Homthip, 2024).

Furthermore, exceptions should be considered for certain groups, such as the hundreds of Moken who are not recognised as Thai nationals despite being born and residing in Thailand for generations. This lack of recognition hinders them from registering their boats and deprives them of multiple rights.

When recognising the need to develop policies that support the lifestyle of sea-faring peoples and small-scale traditional fishers, it is equally necessary to consider and address policies that exert pressure on these communities and produce negative impacts. One potential mechanism to mitigate such impacts is the EIAs. However, to date, EIAs have rarely reflected and considered ILK, socio-cultural safeguards and values of people directly affected by large-scale projects. This is largely because projects typically rely on frameworks that treat nature as a resource for exploitation (an instrumental value) aimed at supporting dominant, economic growth-focused, extractivist development paradigm (Pascual, 2022). Such approaches frequently overlook consideration of social justice, equity, and ecological limits.

Although Thailand has made efforts to expand EIAs to include social impact assessments and health impact assessments, there are still no standardised guidelines for collecting, in-depth analysis, and continuous participatory monitoring data throughout project implementation. Furthermore, although the CBD provides various tools, including voluntary guidelines called the "Akwe: Kon Voluntary Guidelines"[21], which are designed to promote the participation of Indigenous Peoples and local communities in assessing cultural, social, and environmental impacts from development projects, these processes have yet to be implemented effectively and meaningfully in Thailand.

Debates surrounding infrastructure mega-projects in Thailand, such as the Landbridge Project, have highlighted how ILK that provides detailed/critical insights is often overlooked in impact assessments. This excludes for instance detailed observations of underwater topography, currents, and water flow patterns that could be altered by the construction of large ports and various structures, potentially affecting key biodiversity and local fishing grounds[22] (Thanasomboon, 2568).

When discussing policy, it is necessary to understand the characteristics and limitations of this political sector. The dynamic, politically driven policy sector often overlooks long-term ecosystem sustainability and local quality of life by favoring short-term interests. Since most policy sectors are dynamic due to politics and short-term interests, it tends to overlook long-term issues regarding ecosystem sustainability and the quality of life of small groups of people. Despite having adequate policies and tools, these tools are not utilised to their full potential. Additionally, the policy and political sectors rely on a bureaucratic system that still favors centralised and top-down management, with performance indicators tied to hierarchy and supervision, preventing genuine changes or reforms that would address ecosystem restoration and the quality of life of marginalised people in society. These limitations should be raised as important issues in system and structural reform.

[21] This term originates from a word in the Mohawk indigenous American language, which means "everything in the universe." This voluntary guideline was established to ensure that EIAs of various projects incorporate cultural and social dimensions, emphasising a holistic perspective of interconnectedness, particularly regarding sacred areas and indigenous community territories. In Finland, this approach is used in national and regional planning (such as management plans for protected areas, forest areas, and nature reserves, particularly in the indigenous Sápmi/Lapland territories), with consideration given to emphasising local knowledge in the planning process (Harkoma, 2018).

[22] According to the explanation of local fishermen, "The reason why the Don Ta Paeo area has abundant aquatic life is partly because of its underwater topographical characteristics—the undersea hills or ridges help resist the strong currents of the Ranong Sea. Marine animals can forage easily without having to chase or struggle against strong water currents compared to other areas, and it serves as an excellent habitat for juveniles. Combined with the fact that Ranong has extensive mangrove forests, this further promotes the abundance of aquatic life."

**Recommendations:**

**5.1 Support access rights for subsistence-based livelihoods and knowledge transmission in the community traditionally used and conserved areas.** Policy frameworks must protect the right of ILK communities to access and sustainably use biodiversity resources for subsistence-based livelihoods within their traditionally used and conserved territories. This access is fundamental to intergenerational knowledge transmission and conservation effectiveness. These policy frameworks should guarantee communities' customary and sustainable use rights for subsistence purposes within traditional territories, explicitly protect knowledge transmission activities (ceremonial practices, traditional teachings, seasonal harvesting, etc.), and recognise culturally protected areas, LMMAs and other community protected area as legitimate conservation mechanisms. Chao Lay have foraging strand areas, fishing grounds, and temporary shelters (or "ba-khad" in Urak Lawoi language, sometimes referred to as "rotating sea"). These should be recognised and supported through agreements within the community itself, between communities, and between communities and state agencies.

**5.2 Develop policies that protect ILK communities from the negative impact of development or conservation.** Thailand must establish mandatory, comprehensive impact assessment frameworks that integrate ILK along with scientific analysis to identify and mitigate development and conservation project harms. While Thailand has expanded environmental, social and health impact assessments, critical gaps remain. Protocols integrating ILK analysis alongside scientific assessment should be mandatory, CBD's Akwé: Kon Voluntary Guidelines should become a binding national standard for development and conservation projects affecting community territories. In addition, ILK should be considered an essential part of in-depth data collection and monitoring throughout project implementation. Other policy recommendations are to establish community grievance mechanisms and remedy processes. By centering ILK in impact assessment and ensuring communities are seriously engaged with monitoring and remediation processes, Thailand may help protect communities from harm while simultaneously strengthening conservation and development decision-making through integrated knowledge systems.

**5.3 Redefine and legally protect small-scale fishing as a cultural meaningful and sustainable livelihood** Existing policies reduce small-scale fishing to an economic occupation with minimal returns, portraying women in fishing communities narrowly as housewives, seafood processors, and market vendors, roles that obscure the deeper dimensions of their lives and work. These frameworks fail to recognise ILK and the cultural-spiritual significance embedded in small-scale fishing practices. Promoting ILK requires fundamentally reconceptualising small-scale fishing and fisher identities—including those of the Chao Lay—as expressions of distinctive ways of life rooted in culture, traditional knowledge, and familial relationships. To operationalise this broader vision, policy must mandate comprehensive data collection on the socio-cultural dimensions of fishing livelihoods and ensure that policy and planning decisions reflect the full complexity and value of small-scale fishing as a cultural and knowledge system, not merely an economic activity.

Under the section "Good Practices," there is discussion of the traditions and values of Chao Lay and small-scale fisheries related to conservation management, including the emphasis by state agencies on community involvement and co-management in various forms and methods. This serves to strengthen traditions while simultaneously developing local regulatory mechanisms, such as local ordinances drafted by local administrative organisations, to ensure formal enforcement and alignment.

Chao Lay have designated foraging strand areas, fishing grounds, and temporary shelters. These should be formally recognised and supported through agreements within the community itself, between communities, and between communities and state agencies. Mechanisms are needed to ensure resource use remains within customary regulatory frameworks and can be monitored and controlled without exploitation or manipulation of the support system established. The concept of "cultural protected areas for the livelihoods of ethnic groups" addresses this issue, with each area requiring rules, regulations, and implementation plans to maintain ecosystems and biodiversity integrity while simultaneously improving the quality of life.

The characteristics of cultural protected areas for ethnic group ways of life are similar to the model of "Territories and areas conserved by Indigenous Peoples and local communities", (ICCAs)[23], which are territories or areas maintained by Indigenous or local communities through traditions that preserve important biodiversity values and ecosystem services. Communities managing these territories play a role in both monitoring and data collection, submitting progress reports on management to the ICCAs Registry website with support from UNEP-WCMC. Beyond promoting conservation, this also enhances the capacity of local communities in data collection and raises management standards through the power of networks. However, Thailand has not yet actively promoted participation in such networks.

In addition to ICCAs, Thailand is advancing a newer conservation framework through OECMs (ONEP, 2025). Five areas have been formally designated as OECMs, each managed by a private company. The OECM approach offers significant potential as a collaborative platform that brings diverse stakeholders together, facilitating community participation in management and creating pathways towards formalised co-management structures.

[23] See <https://www.iccaconsortium.org/discover/>

**Key Message 6: Policies that promote ILK will lead to participatory and sustainable management and conservation of ecosystems and biodiversity based on worldviews and in-depth understanding of nature of the local communities, and their quality of life will be enhanced because of national recognition to land and resources rights. *(Established but incomplete)***

**Recommendations:**

**6.1 Implement co-management strategies built on existing customary conservation practices rather than imposing external regulations.** Policymakers need to understand, acknowledge, and recognise conservation values and approaches already embedded in ILK. Policy frameworks must leverage existing customary practices through meaningful community involvement. By supporting various forms and methods of community-based co-management, government agencies can simultaneously strengthen cultural traditions and facilitate the development of community-led regulatory mechanisms that resonate with community values and practices. This collaborative framework not only enhances the legitimacy and effectiveness of conservation efforts but also ensures that management strategies are culturally appropriate.

**6.2 Establish multi-sectoral governance mechanisms that center community voice in ecosystem management decisions, including ecosystem restoration through ILK and practices.** Multi-sectoral governance mechanisms must be established to support community voice in ecosystem management decisions, particularly through weaving in ILK and customary governance practices. Such mechanisms should incorporate formal regulatory frameworks, including local ordinances drafted collaboratively by local administrative organisations and community stakeholders. This multi-sectoral governance mechanisms ensure alignment across governance levels, together with alignment of dual purposes of maintaining ecosystems and biodiversity integrity while simultaneously enhancing the quality of life for local communities.

**6.3 Transition from top-down conservation to locally-driven stewardship.** Policy frameworks need a fundamental reorientation of ecosystem management—from a centralised regulatory exercise into genuinely collaborative process where communities are recognised as primary stewards. Management systems must be designed to respect ILK, strengthen local actors, and ensure that conservation outcomes are both equitable and sustainable. Thailand's advancement of the LMMAs and OECMs framework exemplifies this transition. By enabling communities to assume stewardship roles, this decentralised model simultaneously relieves government burden, enhances effectiveness and accountability. Locally-driven stewardship is less costly and more sustainable, but policy support is needed in terms of appropriate institutional frameworks and resources.

To successfully implement these six policy recommendations, governments must demonstrate unwavering political commitment and decisive action. This is particularly crucial for government agencies tasked with ecosystem and biodiversity conservation, which must balance their environmental mandates with genuine respect for the rights and knowledge of ethnic and local communities. As shown in Figure 5.32, rather than operating in isolation, each recommendation builds upon the others, creating a comprehensive and integrated framework that yields significantly more substantial and enduring results than piecemeal efforts.

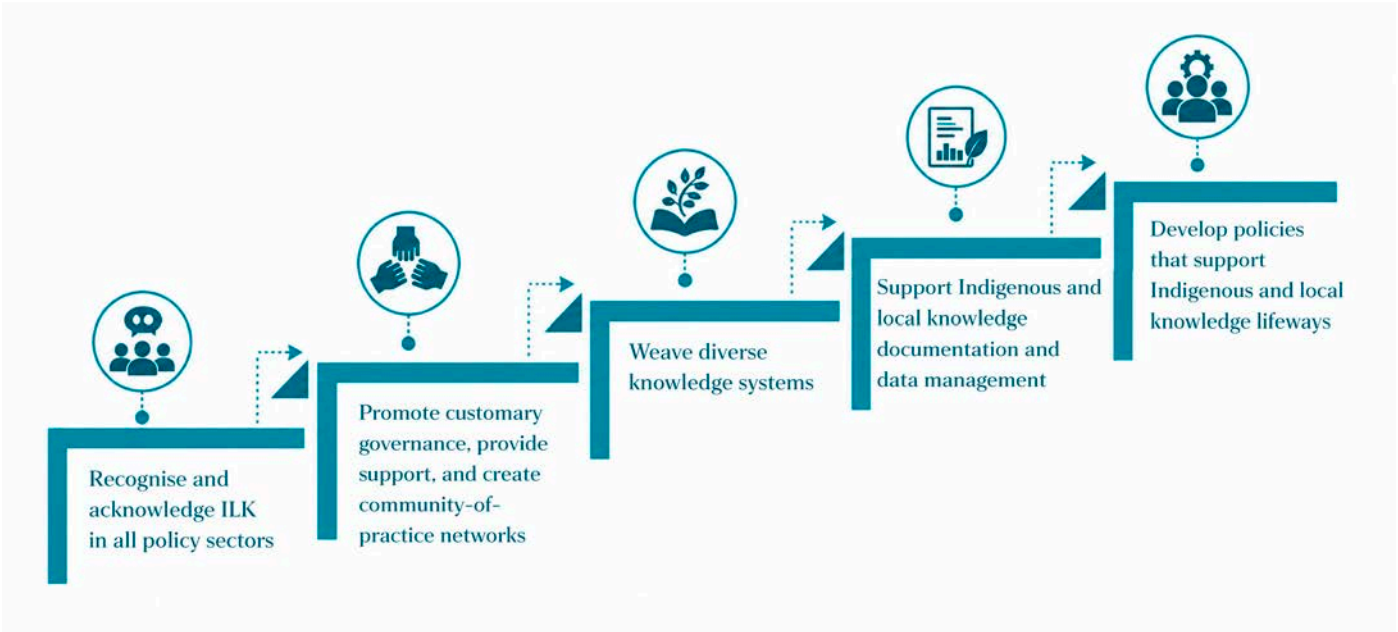



**Figure 5.32: Diagram showing policy recommendations to support ILK**

The foundation of this success lies in ensuring the meaningful and sustained participation of communities throughout the process. This participatory approach becomes essential for six interconnected processes: first, recognising and formally acknowledging ILK as a legitimate knowledge system; second, promoting customary governance, provide support and create community-of-practice networks; third, weaving together diverse knowledge systems; fourth, supporting robust ILK documentation and establishing effective data management systems; fifth, developing forward-thinking policies that actively support and protect ILK-based lifeways and practices; and finally, implementing truly collaborative management strategies that honor community expertise alongside government oversight. Together, these elements form an approach that not only benefits ecosystems and biodiversity but also upholds the dignity, rights, and agency of the communities. Weaving ILK into sustainable use and conservation of marine ecosystem are not discretionary recommendations; it is operational necessity. Every year of inaction accelerates knowledge loss that cannot be recovered.

## 5.9 Glossary and remarks on the use of terms relating to ILK in Thailand NEA report

### Ethnic community or ethnic group

Ethnic community or ethnic group are people who have collective identity and shared culture, language, way of life, wisdom, and beliefs. In the case of coastal communities, the distinctive ethnic community covered in this report is "Chao Lay" (widely known as sea nomads or sea gypsies) with the three subgroups of Moken, Moklen and Urak Lawoi.

**Remark:** The Thailand Constitution (2017) specifies the right of different "Thai" ethnic groups in Section 70, but does not provide the definition of "ethnic group". The Act on Protection and Promotion of the Way of Life of Ethnic Groups (2025) provides the definition of ethnic groups as, "*Thai people living as one or multiple groups, originated and settled in Thailand, or have historical and cultural continuity that is connected with Thai society. Ethnic group possessing distinctive identities and have accumulated shared culture, language, way of life, knowledge, and belief according to common tradition.*" This report, however, uses the definition that is broader and more comprehensive than that specified Act that delimit the ethnic groups as "*Thai*" or "*have historical and cultural continuity that is connected with Thai society*".

## Indigenous Peoples

Indigenous Peoples mean groups of people descended from original inhabitants with a strong sense of collective identity, maintaining distinct social, cultural, economic, and political traits from dominant societies. Indigenous Peoples often have deep social and spiritual ties to territories and aquatic/marine spaces and often applying knowledge systems for sustainability through customary systems.

**Remark:** "Indigenous Peoples" is the term used in this report to refer to groups of people that maintain distinct socio-cultural systems over time and share deep connections with their natural environment. The Thai Government's current stance considers all inhabitants as native to the land within the country's historical and socio-cultural context of prolonged shared co-existence; therefore, the Government does not officially recognise that there are "Indigenous Peoples" in Thailand. The term, however, is used in this report to refer to general concepts, populations, or cases from other countries, or citations from the original sources/documents. It is important to acknowledge the unique connotations the term "Indigenous Peoples" carries related to rights and claims of various kinds, as stipulated by the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), which was adopted by the United Nations General Assembly in 2007, in which Thailand voted in favor, but unlike many other countries has not formally adopted.

## Indigenous Peoples and local communities (IP and LCs)

Indigenous Peoples and local communities are diverse groups of people with deep, intergenerational ties to territories and aquatic/marine spaces, maintaining unique ecological knowledge crucial for biodiversity conservation.

**Remark:** According to IPBES' Report on Sustainable Use of Wild Species, the term "Indigenous Peoples and local communities" and its acronym "IPLC" are widely used by international organisations and conventions to refer to individuals and groups who self-identify as indigenous or as members of distinct local communities" (IPBES, 2022). This term, again, has the word "Indigenous Peoples" or groups that deemed non-existence in Thailand, so the use has a limited reference for general concepts, populations, or cases from other countries, or citations from the original sources/documents.

## Indigenous and local knowledge (ILK)

ILK is a holistic concept and practice encompassing philosophies, worldviews, understandings, knowledge and skills accumulated and passed down by indigenous peoples and local communities. It represents an intricate system of relationships between people and nature.

**Remark:** the term is used in line with the IPBES which provides a universal guiding framework for the NEA. ILK as a term used in this report does not specify the indigeneity of the people but emphasises the essence of the knowledge that arises and culminates from the close relationships with nature and the ecosystems of the areas.

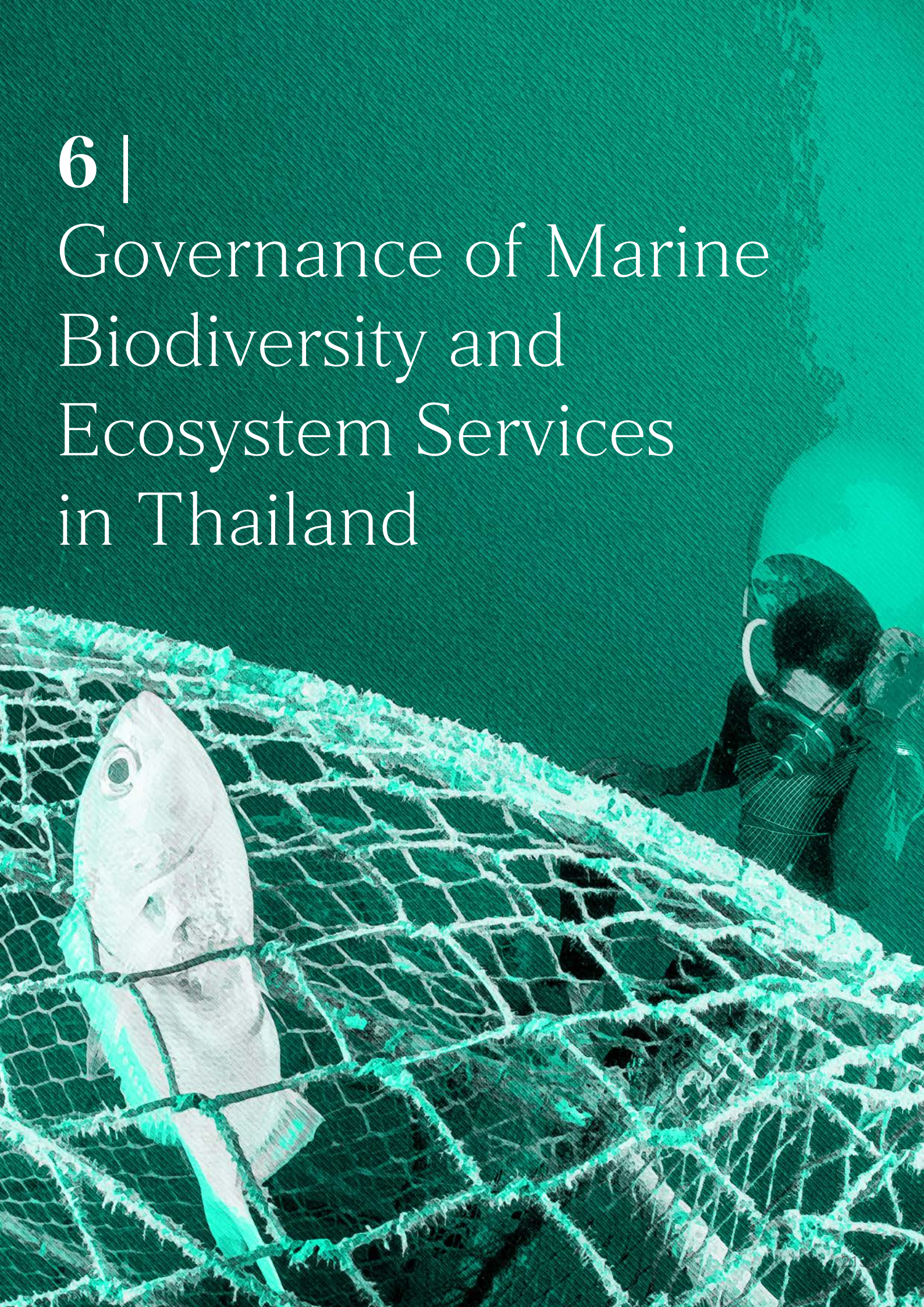
## Local community (or local communities)

Local community (or local communities) is a term used in this report to refer to local small-scale fishing and other coastal communities that do not share descent/ethnicity with the Chao Lay.

## Small-scale fisheries

Small-scale fisheries or artisanal fisheries refer to small-scale coastal fishing in near-shore waters or around islands, using small boats or no boats at all. It relies on sophisticated knowledge but simple tools, requiring minimal investment compared to commercial fishing, to catch coastal and marine life. Small-scale fisheries select seasonal fish and aquatic animals, and the work is often carried out by family or kin members, from making and maintaining fishing gear to fishing, sorting, and processing/selling. Most of the produce is for household or local consumption and/or sold without maximizing profits. Small-scale fishing communities often possess knowledge, traditions and customary management that promote sustainable resource utilisation.

# 6 | Governance of Marine Biodiversity and Ecosystem Services in Thailand



## 6.1 Introduction

Marine resources are fundamental to Thailand's economy, food security, and social well-being, forming a core pillar of the country's Blue Economy. Fisheries and aquaculture remain critical livelihood sectors for coastal communities and important contributors to national income and exports. The agriculture, forestry, and fisheries sector together contribute a substantial share to national GDP, while seafood exports consistently rank among Thailand's major foreign exchange earners. Millions of people depend directly or indirectly on marine and coastal ecosystems for employment, nutrition, and income, underscoring the significance of effective marine biodiversity and ecosystem service governance not only for environmental sustainability, but also for economic and social resilience.

This chapter provides a national level assessment of marine and coastal governance in Thailand, with a specific focus on how existing governance arrangements support the conservation of biodiversity and the provision of BES. Governance is treated as a critical indirect driver of biodiversity change in the IPBES conceptual framework, shaping how societies interact with nature through institutions, policies, and decision-making processes. Policies and laws, administrative structures, customary practices, and informal social norms—determine access to resources, distribution of benefits, accountability, and the exercise of power across scales.

Previous national governance assessments in Thailand, including reviews conducted under the Mangroves for the Future initiative (TEI, 2008) and subsequent academic studies (Satumanatpan, 2015; Satumanatpan et al., 2017), have demonstrated that while Thailand possesses an extensive institutional and legal architecture for marine and coastal management, implementation effectiveness remains uneven. Persistent challenges include fragmented institutional mandates, limited enforcement capacity, financial constraints, and variable levels of public participation. These challenges have, in many cases, constrained the ability of governance systems to respond effectively to accelerating coastal development pressures, climate change impacts, and biodiversity loss.

The analytical purpose of this chapter is therefore not only to describe Thailand's marine governance architecture, but also to assess how well existing policies, institutions, and governance mechanisms function in practice to support biodiversity conservation and ecosystem service provision. The chapter focuses primarily on the policy and institutional dimensions of governance, rather than on ecological conditions or biophysical trends, which are addressed in other chapters of the NEA. It evaluates the structure, coherence, and implementation capacity of governance arrangements, while recognising that governance effectiveness is shaped by interactions between national policy frameworks, sectoral agencies, and local-level institutions.

Specifically, this chapter examines: (i) the alignment between global commitments and national policy frameworks; (ii) the coherence and coordination of institutional mandates; and (iii) the role of participatory and area-based governance tools in supporting marine biodiversity and ecosystem services. By linking national governance structures with the social-ecological context of coastal Thailand, the assessment aims to identify both systemic strengths and persistent structural constraints that influence Marine BES outcomes.

Accordingly, this chapter addresses the following policy questions:

1. **What existing policies and institutional frameworks are relevant to Marine BES?**

2. **What are the roles and contributions of state and non-state actors—including government agencies, local communities, and civil society organizations—in the governance, integration, and mainstreaming of Marine BES across national and sub-national levels?**

3. **Given the current state of marine and coastal governance in Thailand, what governance processes, institutional arrangements, and enabling conditions could be strengthened to enhance the effective, inclusive, and sustainable management of Marine BES?**

By clearly defining the analytical scope and situating governance within Thailand's socio-economic dependence on marine resources, this chapter provides the foundation for subsequent assessments of policies, legal frameworks, institutions, and governance mechanisms presented in Sections 6.2–6.6.

## 6.2 Assessment approach

This governance assessment examines the extent to which Thailand's existing policy, legal, and institutional frameworks support the conservation and sustainable management of Marine BES. The analysis focuses on governance structures, policy coherence, institutional coordination, and key implementation mechanisms that enable or constrain effective Marine BES management.

The assessment adopts a qualitative, document-based review approach, complemented by selected empirical cases drawn from peer-reviewed studies and official government records. Rather than evaluating biophysical outcomes directly, the chapter assesses the governance conditions and institutional capacities that shape marine biodiversity and ecosystem service outcomes.

### 6.2.1 Scope of the assessment

The scope of the assessment covers three interrelated governance dimensions:

1. Policy and strategic directions supporting marine and coastal BES at global, regional, and national levels (Section 6.3);
2. Legal and institutional frameworks governing marine and coastal systems, including regulatory instruments, responsible agencies, and inter-agency coordination mechanisms (Section 6.4); and
3. Key governance mechanisms that operationalise BES management in practice, with a focus on participation, co-management, and area-based conservation tools, including MPAs, OECMs, and LMMAs (Section 6.5).

This assessment does not attempt to quantify ecological change or biodiversity trends directly. Instead, it evaluates whether existing governance arrangements create enabling or constraining conditions for effective Marine BES management across national and sub-national levels.

### 6.2.2 *Data sources and review process*

The assessment is based primarily on a systematic desk review of national policies and development plans, legal and regulatory instruments, government reports, and peer-reviewed academic literature.

At the global and regional levels, key frameworks reviewed include:

- **The 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs);**
- **The Convention on Biological Diversity (CBD);**
- **The Kunming–Montreal Global Biodiversity Framework (KMGBF);**
- **The Ramsar Convention on Wetlands; and**
- **The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).**

At the national level, the review covers Thailand's major development, environmental, and biodiversity strategies, including: Thailand's 2030 Agenda and Sufficiency Economy Philosophy (SEP); the 20-Year National Strategy (2017–2036); the 13th NESDP (2023–2027); the National Environmental Quality Management Plan (2023–2027); the Climate Change Master Plan (2015–2050); the National Adaptation Plan (NAP); the NBSAP (2023–2027); and the NCMCRM (2023–2027).

The legal review focuses on core environmental and sectoral laws governing marine and coastal resources, including the National Environmental Quality Act, the Promotion of Marine and Coastal Resources Management Act (PMCRM Act), the Royal Ordinance on Fisheries, the National Park Act, the Maritime Interest Protection Act, and relevant draft legislation, including the Biodiversity Act and Climate Change Act.

### 6.2.3 Analytical framework

The assessment applies a governance-oriented analytical lens, drawing on the IPBES conceptual framework and interactive and multi-level governance perspectives. Governance is examined through five core analytical dimensions:

- **Institutional arrangements and mandates;**
- **Policy coherence and alignment across sectors;**
- **Coordination mechanisms and data-sharing systems;**
- **Participation, inclusion, and co-management structures; and**
- **Implementation capacity, enforcement, and monitoring conditions.**

Rather than measuring conservation outcomes directly, the governance assessment evaluates whether existing policies, institutions, and mechanisms enable or constrain effective Marine BES governance in Thailand's marine and coastal ecosystems.

## 6.3 Policy and strategic direction supporting Marine BES

This section examines the policy and strategic context shaping the governance of marine and coastal BES in Thailand. It situates Thailand's marine governance within the broader landscape of international

and national policy commitments and assesses how these commitments are translated into domestic strategies, plans, and implementation frameworks.

Rather than providing a descriptive inventory of policy instruments, the analysis focuses on the directional influence, policy coherence, and implementation implications of key global and national frameworks. Particular attention is given to how international biodiversity and sustainability agendas are reflected in national policy architecture, and where gaps emerge between strategic intent and operational delivery.

The section is structured in three parts. Section 6.3.1 outlines the global and regional policy directions that shape Thailand's marine BES governance and identifies their key implications at the national level. Section 6.3.2 reviews Thailand's national policy architecture for biodiversity and ecosystem services, highlighting areas of strong formal alignment with global commitments. Section 6.3.3 critically assesses policy coherence and implementation challenges, with a specific focus on the NBSAP, MSP, and Thailand's commitment to the KMGBF Target 3.

Together, these subsections provide the policy foundation for the subsequent analysis of legal frameworks, institutional arrangements, and governance mechanisms presented in Sections 6.4 and 6.5.

### 6.3.1 *Global and regional policy directions: Implications for Thailand's Marine BES governance*

Global biodiversity and sustainability frameworks provide the overarching policy and strategic direction for Thailand's marine and coastal governance. Key instruments—including the SDGs, CBD, and the KMGBF establish international goals and expectations for ecosystem conservation, sustainable use, climate resilience, and area-based protection (Appendix 6-1).

For Thailand, these frameworks function not merely as aspirational references but as direct drivers of national policy reform, particularly in relation to (i) integrating BES into development planning, (ii) expanding marine and coastal area-based conservation toward the KMGBF target 30×30, and (iii) mainstreaming ecosystem services into climate, fisheries, and Blue Economy strategies. Engagement with supplementary instruments, such as the Ramsar Convention, CITES, and the World Heritage Convention, further generates monitoring, reporting, and compliance obligations that place increasing demands on national coordination, standardised indicators, and integrated data systems.

While global frameworks provide strong normative alignment, their effective translation into national outcomes depends critically on institutional capacity, inter-agency coordination, legal coherence, and monitoring systems—conditions that remain uneven across sectors and spatial scales in Thailand.

### 6.3.2 National policy architecture for Marine BES

Thailand has developed a comprehensive national policy architecture to operationalise its global biodiversity commitments. Core instruments include the 20-Year National Strategy, the 13th NESDP, the National Environmental Quality Management Plan, the Climate Change Master Plan and National Adaptation Plan (NAP), the NBSAP (2023–2027), and the NMCRC (2023–2027) (Appendix 6-2).

Collectively, these instruments embed BES within Thailand's sustainable development, climate resilience, and Blue Economy agendas, promote ecosystem-based management and participatory governance, and explicitly align national targets with SDG 14 and the KMGBF target 3 (CBD, 2022) and its 30×30 commitment. The NBSAP 2023–2027 serve as the principal biodiversity mainstreaming instrument, linking spatial conservation, sustainable use, access and benefit-sharing, financing mechanisms, and cross-sectoral integration. In parallel, the National Marine and Coastal Resources Management Policy and Plan (NMCRMP) provides sector-specific operational guidance for marine ecosystems, with emphasis on restoration, fisheries sustainability, climate adaptation, and spatial management.

At the policy design level, Thailand demonstrates a high degree of formal alignment with global biodiversity and sustainability agendas. Biodiversity is no longer treated solely as an environmental concern, but is increasingly integrated into national economic, climate, tourism, and spatial planning frameworks.

### 6.3.3 Policy gaps and implementation challenges in relation to NBSAP, MSP, and the KMGBF Target 3

Despite strong strategic alignment at the policy level, persistent implementation gaps remain evident in the operationalization of Thailand's global commitments, particularly in relation to NBSAP implementation, MSP, and the 30×30 target.

Despite strong strategic alignment, persistent implementation gaps remain evident in the operationalisation of Thailand's biodiversity commitments, particularly with respect to the NBSAP implementation, the MSP, and the 30×30 target.

Three interlinked structural gaps are most evident:

***a) Policy-practice gap in biodiversity mainstreaming***
While the NBSAP and marine policies articulate ambitious biodiversity objectives, their translation into binding sectoral regulations, budgetary priorities, and performance-based accountability mechanisms remain uneven. Biodiversity mainstreaming across fisheries, tourism, energy, and coastal infrastructure continues to rely largely on project-based initiatives rather than institutionalised mandates.

***b) MSP as a weakly institutionalised integration tool***
MSP is widely recognised as the primary mechanism for integrating MPAs, OECMs, fisheries, shipping, tourism, and climate adaptation. However, MSP remains weakly institutionalised, with limited statutory authority, fragmented data systems, and uneven uptake across provinces. This constrains its ability to function as the operational backbone for ecosystem-based governance and the delivery of the 30×30 target.

***c) The 30×30 target implementation and OECM readiness***
Although Thailand has committed to conserving 30 % of marine and coastal areas by 2030, reliance on MPAs alone is insufficient. OECMs and LMMAs are increasingly promoted as complementary tools, yet national legal recognition, standardised monitoring frameworks, and long-term financing mechanisms remain underdeveloped. Without these enabling conditions, the credibility and durability of the 30×30 target implementation and reporting remain at risk.

Overall, Thailand's challenge is no longer the absence of a strategic vision, but the effective institutional and operational integration of existing commitments across agencies, spatial scales, and governance instruments. Strengthening MSP, formalising OECM governance frameworks, and reinforcing NBSAP implementation mechanisms, therefore, represent the critical levers for closing the policy–implementation gap in Marine BES governance.

**Summary – Section 6.3** Thailand demonstrates strong formal alignment between global biodiversity commitments and national policy frameworks, particularly through the NBSAP, the NMCRMP, and climate strategies. These instruments explicitly support ecosystem-based management, area-based conservation, and the 30×30 target. However, implementation remains uneven due to weak institutionalisation of Marine MSP, incomplete legal and financial frameworks for OECMs, and fragmented cross-sectoral mainstreaming. Strengthening MSP, formalising OECM governance, and reinforcing NBSAP implementation are therefore critical to translating policy ambition into effective marine and coastal BES outcomes.

## 6.4 The national legal and regulatory framework

### 6.4.1 Core legal and regulatory foundations for marine and coastal governance

Thailand's marine and coastal governance is underpinned by an extensive body of legislation that establishes regulatory authority, allocates mandates, and provides enforcement mechanisms for the protection of Marine BES (Appendix 6-2).

The Prime Minister's Office Regulation on the Conservation and Utilisation of Biodiversity (2020) remains the only regulation dedicated exclusively to biodiversity governance. It sets national policy directions on biodiversity conservation, sustainable use, access and benefit-sharing (ABS), and biosecurity.

Thailand is currently drafting a comprehensive Biodiversity Act, intended to become the principal legal instrument for biodiversity governance. The draft Act incorporates key international principles, including the polluter-pays principle, public participation, sustainable development, the precautionary principle, and accountability for biodiversity damage. However, progress has been slow due to multi-agency mandate harmonisation, ABS negotiations under the Nagoya Protocol, and extended inter-ministerial consultations on regulatory authority and enforcement responsibilities. Political transitions have further delayed parliamentary progression, reflecting broader institutional bottlenecks in environmental law-making.

In addition, marine and coastal biodiversity governance is supported by sectoral laws, most notably:

- Promotion of Marine and Coastal Resources Management Act, B.E. 2558 (2015)
- Royal Ordinance on Fisheries, B.E. 2558 (2015)
- National Park Act, B.E. 2559 (2019)
- Marine Interest Protection Act, B.E. 2559 (2019
- ECNEQ Act, B.E. 2535 (1982 and 2018 amendment)
- Protection and Promotion of Ethnic Groups' Way of Life Act, B.E. 2568 (2025)

Together, these laws provide a comprehensive regulatory framework for marine management. However, their effectiveness ultimately depends on enforcement capacity, institutional coordination, and monitoring systems.

### 6.4.2 Enforcement and monitoring capacity

Despite the breadth of Thailand's legal framework, enforcement capacity remains uneven across agencies and geographic areas. Key constraints include limited field personnel, insufficient operational budgets, overlapping enforcement authorities, and inconsistent monitoring protocols among line agencies and local administrations.

Standardised compliance indicators and centralised reporting systems remain weak, making it difficult to assess regulatory performance systematically. Evidence from Environmental Protected Areas (EPAs), Provincial Fisheries Committees, and other governance mechanisms presented in this chapter demonstrate that weak enforcement, fragmented inspections, and inconsistent follow-up frequently undermine regulatory effectiveness.

Strengthening enforcement coordination, developing standardised national compliance indicators, and investing in digital reporting and inspection systems, therefore, remain core institutional priorities for improving the effectiveness of Thailand's legal framework.

### 6.4.3 Institutional architecture and coordination mechanisms

Thailand's marine and coastal governance responsibilities are distributed across multiple ministries and departments. Since administrative decentralisation in 1999, day-to-day coastal management has been delegated to local authorities.

The establishment of the MNRE in 2003 consolidated national environmental governance. Under MONRE, the DMCR serves as the lead technical agency for marine ecosystems, including mangroves, coral reefs, seagrass beds, and endangered marine species.

However, key responsibilities are shared with several other agencies, including:

- Department of National Parks, Wildlife and Plant Conservation (DNP)
- Office of Natural Resources and Environmental Policy and Planning (ONEP)
- Department of Fisheries (DOF)
- Marine Department (MD)
- Department of Public Works and Town Planning (DPT)
- Department of Tourism (DoT)
- Department of Mineral Fuels (DMF)
- Department of Social Development and Welfare (DSDW)

To support inter-agency coordination, several national committees operate as formal governance platforms, including:

- **National Biodiversity Committee (NBC)**
- **National Marine and Coastal Resources Committee (NMCRC)**
- **National Marine Interest Protection Committee (MIP)**
- **Thai Maritime Enforcement Command Center (Thai-MECC)**

These bodies offer important institutional coordination spaces. However, their operational effectiveness varies considerably depending on leadership continuity, technical capacity, budgetary support, and the strength of inter-agency mandates.

### 6.4.4 Role of civil society, NGOs, academia, and the private sector in marine governance

Civil society organisations (CSOs), NGOs, academic institutions, and the private sector play an important complementary role in Thailand's marine and coastal governance system. While statutory authority remains concentrated within government agencies, these non-state actors contribute significantly to policy implementation, community-based conservation, scientific research, public awareness, and capacity-building. Their engagement strengthens local stewardship, supports co-management arrangements, and enhances governance integration and resilience across coastal areas.

Thailand hosts a diverse network of national NGOs, community organisations, and academic institutions active in marine conservation and sustainable development, including the Marine Science Association of Thailand, the Seub Nakhasathien Foundation, the Environmental Litigation and Advocacy for the Wants (EnLAW) Foundation, the Sustainable Development Foundation (SDF), and the Raks Thai Foundation. Major universities—such as Prince of Songkhla University, Mahidol University, Kasetsart University, Ramkhamhaeng University, and Burapha University—contribute with scientific research, monitoring, and policy-relevant knowledge that informs national and sub-national governance processes.

Together, these actors form an essential bridge between national policy frameworks and local-level implementation, reinforcing multi-actor governance and supporting the mainstreaming of Marine BES across sectors.

### 6.4.5 Coordination effectiveness

Institutional coordination remains uneven across marine governance agencies. Overlapping mandates and parallel approval processes delay decision-making and weaken policy coherence. While inter-agency committees provide important coordination forums, their effectiveness is highly dependent on leadership continuity, technical capacity, and budgetary support. As a result, coordination performance varies widely across provinces and thematic policy areas.

### 6.4.6 Data-sharing and reporting fragmentation

Marine and coastal data systems remain largely siloed, with agencies operating independent monitoring platforms, indicators, and reporting cycles. The absence of interoperability constrains cumulative impact assessment, ecosystem-based planning, and evidence-informed enforcement. Although national committees promote information exchange, limited digital integration and inconsistent reporting frameworks prevent the development of a unified national evidence base. A unified national marine data platform therefore remains a critical institutional gap.

### 6.4.7 Institutional fragmentation and governance outcomes

Fragmented mandates reduce administrative efficiency, weaken accountability, and limit strategic policy alignment. Sector-driven priorities frequently override integrated ecosystem objectives, constraining Thailand's capacity to operationalise ecosystem-based management in practice. These structural conditions contribute directly to delayed approvals, overlapping enforcement, and inconsistency between national policy intent and local implementation.

**Summary 6.4** Thailand has established a comprehensive legal and institutional framework for marine and coastal governance, supported by extensive environmental and sectoral legislation and multiple national coordination platforms. However, governance effectiveness remains constrained by uneven enforcement capacity, fragmented data systems, overlapping institutional mandates, and variable coordination performance across agencies and provinces. While civil society, academia, and the private sector play growing complementary roles, stronger institutional integration and unified monitoring systems remain critical for translating legal foundations into effective BES outcomes.

## 6.5 Importance of governance mechanisms that support Marine BES

Within Thailand's existing coastal governance architecture, two governance mechanisms play a particularly critical role in enabling the effective conservation and sustainable management of Marine BES:

(i) participatory and co-management arrangements that integrate communities into decision-making processes (Section 6.5.1), and

(ii) area-based governance instruments, with particular emphasis on MPAs and related spatial conservation tools (Section 6.5.2).

Together, these mechanisms translate formal policy and legal mandates into operational governance practices, at both national and local levels.

## 6.5.1 Community Participation and Co-Management in Marine Governance

Community participation constitutes a central pillar of Thailand's marine and coastal governance system and represents a key enabling mechanism for BES. Adaptive and inclusive governance arrangements that integrate local users into decision-making are widely recognised as essential for sustainable resource management. In Thailand, legal and policy frameworks increasingly embed participatory governance, reflecting the understanding that coastal communities are both primary resource users and long-term stewards of marine ecosystems.

***a) Legal Basis and Institutionalisation of Participation***

Thailand's legal framework provides a strong formal foundation for public participation in marine and coastal governance. Key instruments include the Official Information Act (1997), which guarantees public access to state information; the ECNEQ Act, B.E. 2535 (1982 and 2018 amendment), which mandates public participation in EIAs processes; the PMCRM Act, B.E. 2558 (2015); and the Royal Ordinance on Fisheries, B.E. 2558 (2015).

Under the PMCRM Act, B.E. 2558 (2015), the DMCR is mandated to promote participation and to support coastal communities and local administrative organisations in marine and coastal management. Section 16 allows coastal community organisations to register formally and nominate representatives to Provincial and National Marine and Coastal Resources Committees. As of 2021, 504 registered coastal community organisations had been formally recognised, comprising 13,590 members and 21,434 marine protection volunteers. Despite this extensive institutional platform, participation remains constrained by uneven local capacity, limited operational budgets, and dependence on project-based funding.

***b) Participation and degree of influence in decision-making***

Although the number of formally registered community organisations is substantial, their substantive influence in governance processes remains uneven. In many cases, community representatives function primarily in advisory or consultative roles, with limited authority over final decisions. Committee structures continue to be dominated by technical agencies and administrative officials, and community inputs are not always systematically incorporated into planning and regulatory outcomes. As a result, participation is often procedurally recognised but substantively weak. Strengthening feedback mechanisms, decision-making authority, and long-term institutional support is therefore essential for transforming participation from symbolic consultation into meaningful co-governance.

***c) Gender equity and social inclusion***

Gender equity and social inclusion remain insufficiently institutionalised within participatory governance mechanisms. Women play critical roles in fisheries livelihoods, post-harvest activities, household food security, and knowledge transmission, yet their representation in formal governance bodies remains limited. Structural barriers include entrenched social norms, meeting schedules that conflict with care responsibilities, limited recognition of informal labour, and restricted access to leadership pathways. Mainstreaming gender-responsive participation—through inclusive nomination processes, targeted leadership training, and formal recognition of differentiated resource use—would enhance both equity and governance effectiveness. These actions are also aligned with Thailand's commitments under the SDGs and the KMGBF.

### *d) ILK*

ILK systems play a vital role in ecosystem monitoring, fisheries management, and place-based stewardship. However, ILK is not yet systematically integrated into formal planning and regulatory processes. Scientific assessments continue to dominate official decision-making, while community knowledge is frequently treated as supplementary rather than coequal. Strengthening ILK integration through participatory mapping, co-production of knowledge, and community-based monitoring would improve ecological relevance, institutional legitimacy, and local ownership of governance decisions.

### *e) Co-Management effectiveness and structural constraints*

Co-management arrangements have expanded in Thailand, particularly in small-scale fisheries and mangrove rehabilitation. These arrangements demonstrate strong potential for strengthening stewardship, compliance, and local legitimacy. Nevertheless, their effectiveness is constrained by uneven delegation of authority, short-term project financing, variable political support, and limited integration with state regulatory systems. Many co-management initiatives remain dependent on NGOs and donor support, resulting in inconsistent long-term continuity. Strengthening legal recognition, mandate-sharing, and predictable financing mechanisms would substantially improve co-management performance.

### *f) Participatory provincial committees as a governance mechanism.*

The Royal Ordinance on Fisheries (2015) and the PMCRM Act B.E. 2558 (2015) establish formal participatory mechanisms through the Provincial Fisheries Committees (PFCs) and Provincial Marine and Coastal Resources Committees. These bodies are intended to provide deliberative spaces for stakeholder participation in fisheries and coastal governance. However, their effectiveness in practice remains uneven. Key structural constraints include imbalanced representation, irregular meeting cycles, limited operational resources, weak data support, and non-binding decision authority. In several provinces, committee composition is dominated by administrative officials, reducing the substantive influence of small-scale fishers, women, and marginalised groups (Box 61). As a result, many committee resolutions function primarily as recommendations and may be overridden at higher administrative levels, constraining local governance autonomy (Satumanatpan et al., 2024). Studies further indicate that provincial coastal committees also experience weak sectoral integration, reactive agendas, and limited cross-agency coordination, reflecting broader institutional fragmentation in sub-national marine governance (Satumanatpan et al., 2018).

### *g) Illustrative case of participatory governance*

The Trat Province case illustrates the potential of participatory co-creation of fisheries regulations. Under the 2015 Royal Ordinance on Fisheries, structured community consultations enabled small-scale fishers to directly contribute to the designation of aquatic sanctuaries and the formulation of locally adapted fishing gear and spatial restrictions. This participatory process enhanced regulatory compliance, ecological relevance, and livelihood security by ensuring that management measures reflected both scientific guidance and local ecological knowledge. The case demonstrates that when the decision-making authority is meaningfully shared between state agencies and resource users, participatory governance can generate tangible conservation and social outcomes (Box 62).

### *h) Role of CSOs, NGOs, and academia*

CSOs, NGOs, and academic institutions play a critical intermediary role in translating national policies into local action. They provide technical support for community-based conservation, facilitate participatory processes, strengthen co-management arrangements, and enhance local capacity for monitoring and enforcement. NGOs also contribute to legal advocacy, policy dialogue, and

environmental education, thereby promoting accountability and social learning within governance systems. Through partnerships with government agencies, universities, and local communities, CSOs and NGOs promote shared responsibility and collaborative governance, particularly in small-scale fisheries management, mangrove rehabilitation, and community-based MPAs.

***i) Private sector and CSR in participatory governance***

Beyond government and civil society, the private sector and CSR initiatives increasingly influence Marine BES governance. While CSR can mobilise financial resources and technical support for conservation, poorly designed interventions—such as mono-species mangrove rehabilitation and narrowly framed Blue Economy projects—may inadvertently reduce biodiversity and weaken ecosystem resilience. CSR initiatives should therefore be guided by scientific evidence, ILK, national conservation standards to ensure ecological integrity, social legitimacy, and long-term sustainability.

## Box 6-1: Challenges in representation and functionality of the Provincial Fisheries Committee

The Royal Ordinance on Fisheries promotes small-scale fishers' participation in fisheries governance, particularly through Sections 25–27. The DOF is mandated to support this involvement by disseminating knowledge, facilitating participation in conservation and management efforts, and encouraging the formation of registered community-based fishing organisations. These organisations can nominate representatives to serve on the PFCs, which includes 13 appointed members from various stakeholder groups. Registered community members may also assist fisheries officers and propose development plans or legal measures, such as gear restrictions and seasonal closures. As of 2018, 1,499 local fishing organisations had been registered nationwide (DOF, 2018).




However, structural and operational challenges persist. Small-scale fishers have expressed concerns about imbalanced representation, as PFCs in some provinces are dominated by district chiefs or government officials—reducing the influence of fishers and civil society voices in decision-making. This unequal composition can skew policy outcomes toward administrative interests rather than community needs. Additionally, the work of the PFCs is often inconsistent and irregular, with meetings convened sporadically and lacking continuity, which hampers the development of long-term, strategic fisheries management plans. Furthermore, PFCs decisions are not binding; they serve only as recommendations to the National Fisheries Committee, which retains final authority and can overturn local decisions—further limiting the effectiveness of participatory governance in practice.

## Box 6-2: Co-creation of fisheries regulations through participatory governance in Trat

Trat Province on Thailand's eastern coast provides an illustrative example of how participatory governance can operate effectively when decision-making authority is meaningfully shared between state agencies and resource users. Following the enactment of the 2015 Royal Ordinance on Fisheries, extensive community consultations were conducted with small-scale fishers to jointly design locally appropriate regulatory measures. This participatory process resulted in the formal designation of aquatic animal sanctuaries and the adoption of locally adapted fishing gear, methods, and spatial restrictions.

The Trat case demonstrates that inclusive governance arrangements can enhance regulatory compliance, strengthen the ecological relevance of management measures, and improve livelihood security when local knowledge is incorporated into formal regulatory frameworks. It further illustrates the potential of co-governance mechanisms to translate national fisheries policy into context-specific, socially legitimate, and ecologically responsive management outcomes.

**Summary - section 6.5.1** Community participation is legally well established in Thailand's marine governance, supported by over 500 registered coastal community organisations and active roles of CSOs, NGOs, academia, and the private sector. However, participation remains largely consultative, with limited decision-making power and continued dominance by administrative agencies. Gender equity, social inclusion, and ILK are weakly institutionalised in practice. Co-management shows strong potential but remains constrained by unclear mandates, short-term financing, and weak integration with governmental regulatory systems.

## 6.5.2 MPAs, OECMs and LMMAs

Area-based management tools are a central pillar of Thailand's marine biodiversity governance. These include MPAs, EPAs, Aquatic Animal Sanctuaries, and the emerging use of OECMs and LMMAs. Together, they constitute the spatial foundation through which Thailand operationalises its biodiversity commitments—particularly the 30×30 target.

Importantly, these instruments link national policy intent with local-level implementation, making them essential bridging mechanisms between formal regulation, ecosystem stewardship, and community participation.

***a) Legal and institutional basis for MPAs***

Thailand's MPA system is governed by multiple sector-specific laws, reflecting a multi-agency institutional architecture. Key legal instruments include:

- **The National Park Act (2019) – Marine National Parks (DNP)**
- **The Wild Animal Reservation and Protection Act (amendment 1992) – Non-Hunting Areas (DNP)**
- **The National Environmental Quality Act (1992) – EPAs (ONEP/PCD)**
- **The PMCRM Act B.E. 2558 (2015) – Marine and Coastal Protected Areas (DMCR)**
- **The Royal Ordinance on Fisheries (2015) – Aquatic Animal Sanctuaries (DOF)**
- **This multi-agency framework results in a legally comprehensive but institutionally fragmented governance system, requiring strong coordination to maintain coherent spatial management.**

***b) Governance effectiveness and institutional challenges***

Although Thailand's MPAs are supported by strong legal mandates, their management effectiveness varies significantly. Key governance constraints include:

- **Overlapping institutional mandates across agencies;**
- **Variable enforcement capacity at the site level;**
- **Inconsistent monitoring and evaluation systems; and**
- **Limited integration of MPAs into broader MSP frameworks.**

Many MPAs lack sufficient human and financial resources to fully implement management plans. Coordination between national agencies, provincial offices, and local communities also varies significantly across sites. These constraints directly affect ecological outcomes and long-term conservation effectiveness (Box 63).

***c) National and global conservation targets***

Thailand has endorsed Aichi Target 11, committing to protect at least 10% of marine areas. As of 2025, approximately 5.2% of Thailand's marine waters are under formal protection, comprising:

- **23 Marine National Parks**
- **3 Coastal Non-Hunting Areas**
- **56 Aquatic Animal Sanctuaries**
- **6 EPAs**
- **4 Marine and Coastal Protected Areas**

Under the KMGBF (Target 3: 30x30), Thailand has also committed to expanding protection to 30% of marine areas by 2030, with a growing role for OECMs alongside MPAs.

***d) OECMs***

OECMs offer a flexible pathway for broadening conservation coverage beyond traditional protected areas, especially in multi-use landscapes. ONEP's National OECM Working Group (2024) is developing:

- **Legislative and policy frameworks;**
- **Monitoring and reporting systems;**
- **Ecological and governance criteria, and**
- **Financing mechanisms.**

Key unresolved issues include determining whether seasonal closures, community conservation zones, and fisheries co-management areas meet OECM requirements. Their inclusion will depend on demonstrated long-term positive biodiversity outcomes.

Because formal MPAs alone cannot meet the 30×30 target, OECMs represent a critical lever for expanding conservation coverage rapidly while supporting inclusive governance and multi-sector engagement.

***e) LMMAs***

LMMAs, supported primarily by DMCR, provide a community-led governance model that enhances stewardship, compliance, and place-based management. They may also qualify as OECMs if they meet international criteria.

- **However, their long-term contribution depends on:**
- **Formal legal recognition**
- **Stable financing mechanisms**
- **Integration with provincial and national planning systems**

LMMAs create a natural governance interface between state institutions and local communities—therefore becoming a practical steppingstone toward operationalising both OECMs and 30×30 target at the local scale.

***f)Integration with MSP***

MSP is increasingly recognised as the unifying framework for aligning MPAs, OECMs, LMMAs, fisheries zones, navigation routes, and coastal development. Integrating Marine BES into MSP enables:

- Identification of cumulative ecological pressures;
- Spatial alignment of conservation and economic uses;
- Enhancement of NbS for climate adaptation; and
- Improved cross-sectoral coordination.

**MSP therefore, becomes the operational backbone for Thailand's 30×30 target commitment,** ensuring that area-based tools function synergistically rather than as isolated interventions.

**Box 6-3: Challenges in cross-sectoral integration within EPAs governance framework**

A. Koh Tao located in Surat Thani, was designated as an EPAs in 2014, with a multi-stakeholder Committee for Controlling and Monitoring the Environment (CCME) of 18 members appointed by the Surat Thani Governor. The CCME is authorized to make decisions on marine and coastal resource management and must report biannually to the provincial committee. While the EPA notification prohibits certain activities, the CCME may approve exceptions for projects that serve the public interest.

Despite this mandate, the CCME has demonstrated weak cross-sectoral integration. A study by Satumanatpan et al. (2017) found that members lacked clarity on their roles and had limited understanding of the EPA framework and coastal environmental issues. The committee rarely convened and showed little capacity to coordinate inputs from different agencies, hindering its ability to address complex, multi-dimensional challenges. Nevertheless, in one politically sensitive case, the CCME acted effectively by rejecting a proposed development following a public consultation, citing ecological harm and insufficient public benefit. This instance illustrates the committee's potential, though its broader performance remains constrained by institutional fragmentation and limited collaboration across sectors.

B. Phetchaburi and Prachuap Khiri Khan, located along the GoT, face mounting coastal pressures from unregulated tourism, destructive fishing, and mangrove conversion. In response, MONRE established an EPAs in 2004, with a CCME tasked with overseeing environmental management. However, the first-phase evaluation (2004–2009) revealed continued degradation and institutional weaknesses. Despite updated notifications in 2010 and 2018, the CCME's performance remained suboptimal due to unclear planning processes, low leadership engagement, weak coordination, and budget constraints (Satumanatpan& Chuenpagdee, 2015). Governance remains fragmented, limiting the CCME's capacity to drive effective cross-sectoral environmental protection.

**Summary – Section 6.5.2: Area-Based Governance Mechanisms** Area-based governance tools—particularly MPAs, OECMs, and LMMAs—form the spatial foundation of Thailand's marine biodiversity governance and are central to achieving the 30×30 target. While Thailand's MPA system is legally comprehensive, governance effectiveness is constrained by fragmented institutional mandates, uneven enforcement, and weak integration with spatial planning. OECMs and LMMAs offer critical opportunities to expand conservation coverage beyond formal protected areas, but require clearer legal recognition, monitoring standards, and sustainable financing. Strengthening MSP as the operational backbone is essential to integrate area-based tools and translate policy commitments into effective, coherent biodiversity outcomes.

## 6.6 Conclusion and recommendations

### 6.6.1 Conclusion

This chapter has examined Thailand's marine and coastal governance system through an integrated assessment of policy directions (Section 6.3), legal and institutional frameworks (Section 6.4), and key governance mechanisms that operationalise Marine BES management (Section 6.5). Together, these components illustrate that Thailand has established a robust formal governance architecture for marine and coastal biodiversity conservation, underpinned by strong international alignment, comprehensive legislation, and multiple institutional platforms.

At the policy level, Thailand demonstrates high formal coherence with global biodiversity and sustainability commitments, particularly through the NBSAP, the NMCRC, and climate-related strategies aligned with the KMGBF and the 30×30 target. Biodiversity and ecosystem services are increasingly mainstreamed across development, climate, and Blue Economy agendas.

However, this strategic alignment has not yet been fully translated into binding legal mandates or consistently effective governance outcomes. As discussed in Section 6.4, the absence of a comprehensive Biodiversity Act, fragmented statutory mandates across agencies, uneven enforcement capacity, and weak data interoperability continue to constrain implementation. Despite the breadth of Thailand's legal architecture, governance effectiveness remains limited by coordination gaps, overlapping authorities, and inconsistent monitoring and reporting systems, which collectively hinder the operationalisation of Marine BES objectives on the ground.

Section 6.5 demonstrates that governance mechanisms—particularly participatory and co-management arrangements and area-based conservation tools—play a critical role in bridging policy intent and on-the-ground implementation. Community participation is procedurally well established through multiple legal instruments and institutional platforms, supported by CSOs, NGOs, academia, and private-sector engagement. Yet participation remains largely consultative, with limited decision-making authority, weak institutionalisation of gender equity and ILK, and reliance on short-term, project-based support. Similarly, while MPAs form the backbone of Thailand's spatial conservation system, their effectiveness is constrained by institutional fragmentation, variable enforcement, and limited integration into MSP.

The analysis further underscores that achieving Thailand's 30×30 target commitment will not be possible through MPAs alone. The OECMs, LMMAs, and a fully institutionalised MSP framework represent critical levers for expanding conservation coverage in an inclusive, ecologically credible, and socially legitimate manner. MSP, in particular, emerges as the operational backbone required to integrate MPAs, OECMs, fisheries management, coastal development, and climate adaptation into a coherent spatial governance system.

Overall, Thailand's central governance challenge is no longer the absence of policy ambition, but the need to strengthen institutional integration, legal operationalisation, and governance mechanisms that enable effective, inclusive, and adaptive BES management. Addressing these challenges will be essential for translating strong policy commitments into durable biodiversity and ecosystem service outcomes across marine and coastal systems.

### 6.6.2 Key Messages and recommendations

Based on key findings of this chapter, the following key messages and recommendations are proposed:

**Key message 1: Thailand demonstrates strong alignment between national policy frameworks and global biodiversity commitments for Marine BES, but implementation remains uneven across sectors and spatial scales. *(Well established)***

**Recommendations:**

**1.1 Institutionalise MSP through the development of a national marine spatial plan led by DMCR,** with formal integration into sectoral plans (fisheries, tourism, transport)

**1.2 Operationalise NBSAP targets** by linking them to sector-specific regulations, budget allocations, and performance indicators, coordinated by ONEP

**1.3 Establish a national monitoring framework for Marine BES,** aligned with NBSAP indicators and implemented jointly by ONEP and relevant line agencies

**1.4 Develop a national OECM framework, including criteria, registry, and monitoring system,** led by ONEP in collaboration with DNP and DMCR

**1.5 Strengthen inter-agency coordination mechanisms** under the National Biodiversity Committee to ensure cross-sectoral implementation

Key message 2: Thailand has developed a comprehensive and relatively mature legal framework for marine biodiversity governance; however, coherence across legal mandates and implementation effectiveness remain uneven. ***(Established but incomplete)***

**Recommendations:**

**2.1 Accelerate enactment of the Biodiversity Act and Climate Change Act,** led by ONEP, to strengthen integrated governance;

**2.2 Harmonise mandates across marine and coastal legislation,** through a formal legal review coordinated by ONEP;

**2.3 Develop national compliance and enforcement indicators,** aligned with NBSAP monitoring frameworks;

**2.4 Strengthen inter-agency enforcement coordination,** particularly between DMCR, DOF, and DNP, through joint inspection protocols;

**2.5 Enhance legal recognition of OECMs and integrated**

## Key Message 3: Thailand's multi-actor governance system provides a strong institutional foundation for Marine BES management, but institutional fragmentation and uneven coordination continue to constrain governance effectiveness. (***Established but incomplete)***

**Recommendations:**

**3.1 Strengthen national coordination mechanisms,** particularly the National Biodiversity Committee and Marine and Coastal Resources Committee, with clear mandates and performance monitoring frameworks (ONEP-led);

**3.2 Develop an integrated national marine data platform,** led by DMCR, with formal data-sharing protocols across agencies;

**3.3 Clarify roles and responsibilities across governance levels,** through a national coordination framework endorsed by ONEP;

**3.4 Strengthen sub-national implementation capacity,** including DMCR regional offices and provincial committees, through targeted technical and budget support;

**3.5 Streamline approval processes across agencies,** to reduce duplication and delays in marine governance decisions.

Key Message 4: Participatory mechanisms are well established in Thailand's marine governance framework, but stakeholder influence on decision-making remains limited, with participation largely consultative rather than substantive. ***(Established but incomplete)***

**Recommendations:**

**4.1 Mandate stakeholder representation in decision-making bodies,** including provincial marine and fisheries committees, to enable shared decision-making;

**4.2 Institutionalise gender-responsive governance,** including consideration of representation targets or quotas where appropriate;

**4.3 Integrate ILK into formal planning and monitoring frameworks,** coordinated by ONEP and academic partners;

**4.4 Establish long-term financing mechanisms for co-management,** including dedicated budget lines and funding windows;

**4.5 Strengthen intermediary roles of NGOs and academic institutions** to support community engagement and capacity-building.

## Key Message 5: Thailand has established a comprehensive system of area-based conservation instruments for marine biodiversity; however, fragmented governance and incomplete spatial integration limit their overall effectiveness. ***(Established but incomplete)***

**Recommendations:**

**5.1 Institutionalise MSP as a legally supported cross-sectoral framework,** through a national marine spatial plan led by DMCR;

**5.2 Develop national criteria, registry, and monitoring systems** for OECMs and LMMAs, coordinated by ONEP and DNP;

**5.3 Standardise management effectiveness assessments across MPAs,** including adoption of tools such as METT, led by DNP and DMCR;

**5.4 Strengthen cross-agency coordination** for marine zoning and spatial planning, through joint planning platforms;

**5.5 Develop a national sustainable financing roadmap** for area-based conservation, including public funding, trust funds, and private sector contributions.



# 7 | Pilot Coastal Landscapes in Transition: Trat and Phuket

# 7.1 Introduction

The Thailand NEA is designed not only as an assessment of ecosystem status and trends, but as a process for bridging knowledge systems and decision-making domains. Central to this approach is the use of trialogue techniques which integrate scientific knowledge, policy and institutional perspectives, and ILK through structured and iterative engagement (BES-NET 2026, IPBES 2022). This approach recognises that biodiversity loss is shaped by interactions among ecological change, governance arrangements, and societal values, and therefore cannot be adequately understood through a single knowledge system alone.

As part of the Thailand NEA, the two provinces of Trat and Phuket were selected as pilot coastal landscapes to illustrate contrasting, but nationally significant trajectories of socio-ecological change. Together, the two sites capture a broad spectrum of Thailand's marine biodiversity and ecosystem services, from small-scale fisheries–dominated provinces undergoing rapid transition to international tourism hubs confronting the limits of growth. The pilot assessments were designed to ground the NEA in lived experiences, local knowledge systems, and real governance challenges, while informing national-level conclusions.

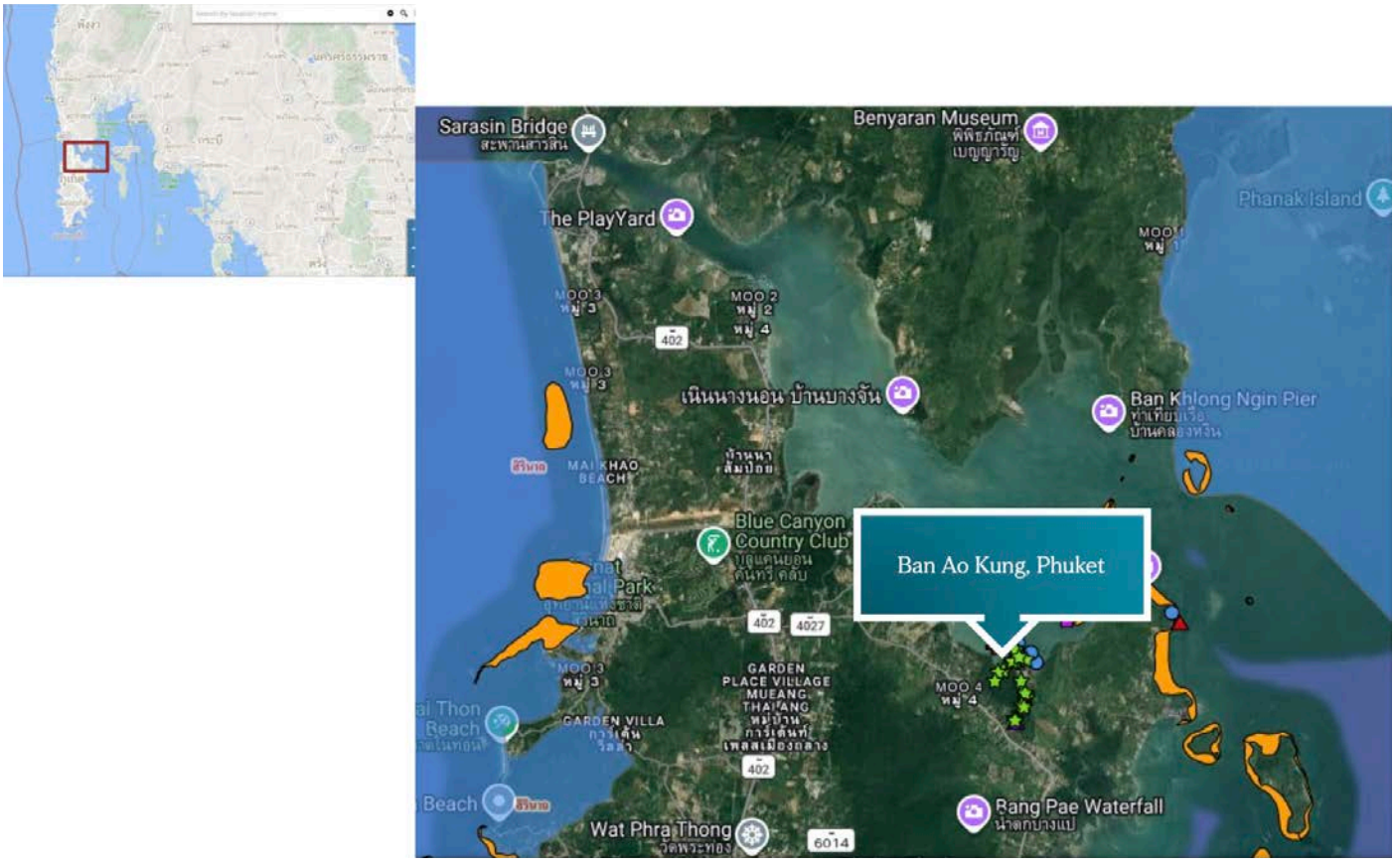



**Figure 7.1: Pilot site at Ban Ao Kung, Phuket (Modified by: Th-NEA and GISTDA)**

For Phuket, the first field visit to Ban Ao Kung (Figure 7.1), a community in the northeast of the island, was conducted back to back with a "mini trialogue" held in Phuket town, during 16–19 January 2024. There were 66 participants from: (1) government agencies: DMCR, Phuket Provincial Fisheries Office, Phuket Provincial Thai-MECC and Phuket Provincial Statistics Office; (2) Private sector: Phuket Hotels Association and Phuket Chamber of Commerce; (3) Academic sector: Prince of Songkhla University (Phuket Campus) and Phuket Rajabhat University; and (4) Civil society: Ao Kung community, Andaman Food Security Association.

The second visit to Ban Ao Kung took place from 26–28 April 2025, focusing on mapping marine and coastal resources. The event was led by GISTDA and Phuket Rajabhat University and involved 35 participants from the Ao Kung community. The primary aim was to support the local community in developing an ecosystem database to contribute to future NEAs.

Similarly, a mini-trialogue and study visit were organised in Trat from 21–23 August 2024. The main objective was to provide a forum for stakeholders to exchange views and experiences on ecosystem assessment and resource management. Participants included representatives from: (1) government agencies, Marine and Coastal Resources Regional Office 1, Trat Provincial Fisheries Office, Maritime Security Coordination Center, and Trat Provincial Statistics Office; (2) private sector, Trat Tourism Business Association and Trat Chamber of Commerce; (3) academic sector, Burapha University (Chanthaburi Campus); and (4) civil society, the Pred Nai and Yai Mom communities. Following the trialogue, a study visits to Ban Pred Nai and Ban Yai Mom was conducted to gather local insights on ecosystem changes, with a particular focus on mangrove systems.

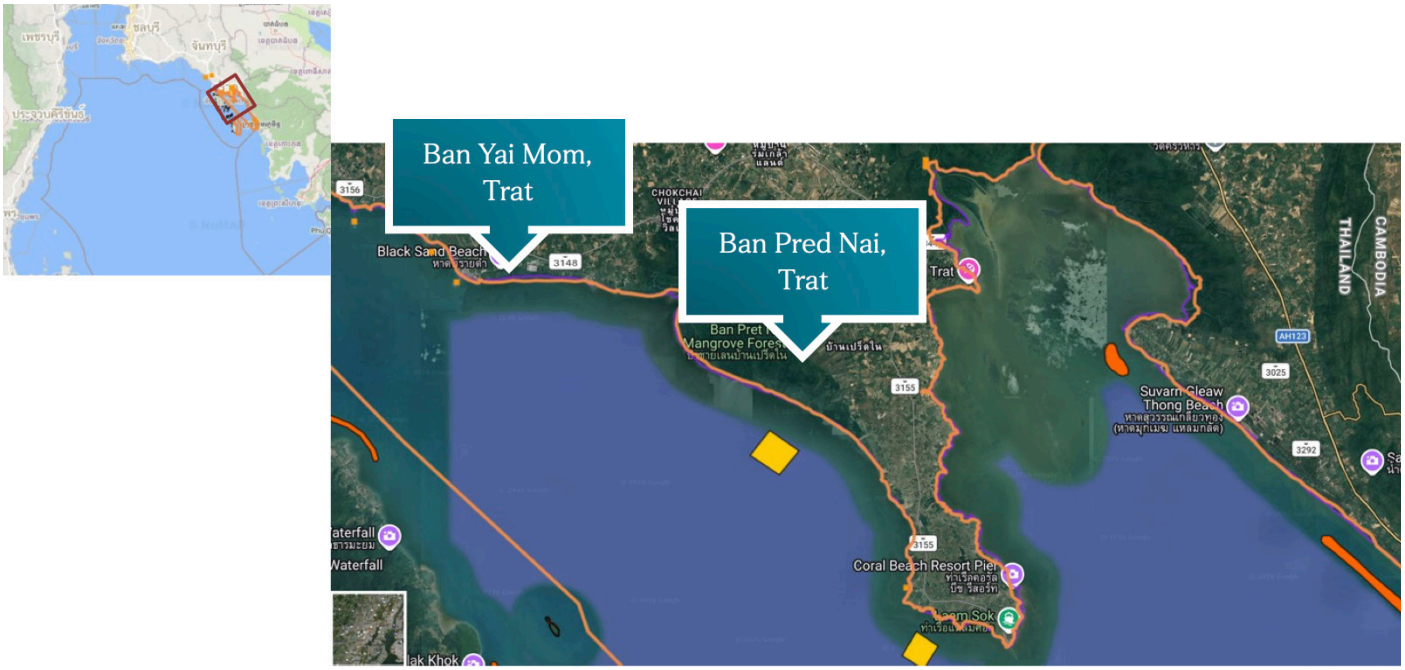



**Figure 7.2: Pilot site at Ban Pred Nai and Ban Yai Mom, Trat**

The pilot assessments in Trat and Phuket demonstrate how this trialogue approach can be applied in contrasting coastal contexts. While the two provinces differ substantially in their development pathways, both illustrate how coastal ecosystems are embedded within complex social–ecological systems, where

livelihoods, economic change, cultural identity, and governance are closely interlinked. The following information and insights are based on the trialogues and field visits.

## 7.2 Trat: Small-scale fisheries in a rapidly changing coastal landscape

Trat Province represents a coastal system where small-scale fisheries remain central to livelihoods, food security, and cultural identity. Mangroves, seagrass meadows, tidal flats, and nearshore fishing grounds continue to form the ecological foundation of coastal communities, supported by long-standing local knowledge derived from daily interaction with the marine environment.

The expansion of coastal and island tourism, combined with rapid agricultural intensification inland, has altered land-sea interactions and increased pressure on coastal ecosystems. These changes are cumulative and interconnected, affecting water quality, sedimentation patterns, access to fishing grounds, and the functioning of nearshore habitats.

Ecologically, Trat retains high natural capital value, but signs of stress are increasingly evident. Nearshore fisheries are characterised by declining productivity and greater variability, seagrass habitats show degradation in several areas e.g. Koh Kradad and Koh Chang (DMCR 2024a), and mangrove systems—despite recovery in total area in some locations—are becoming more fragmented. Many of these changes are more clearly articulated through community observations than through formal monitoring systems, highlighting the importance of local knowledge for understanding ecosystem dynamics.

The trialogue process revealed that local ecological knowledge in Trat remains extensive. Intergenerational transmission is weakening as younger community members move away from fisheries-based livelihoods, and as formal governance and education systems give limited recognition to place-based knowledge. This erosion reduces adaptive capacity at the local level and weakens feedback between ecosystem change and management responses.

From an institutional perspective, government agencies recognise the importance of marine ecosystems to provincial development. However, the assessment identified persistent challenges related to **fragmented governance**, including overlapping mandates, sector-based rather than integrated planning, and inconsistent enforcement. Community participation mechanisms exist, but are often perceived as consultative rather than enabling meaningful influence over decisions that directly affect livelihoods, resource access and the environment.

From the dialogues with coastal communities, a consistent concern related to data governance emerged. Communities expressed that information is frequently collected without being returned in accessible or actionable forms, undermining trust and limiting the perceived relevance of assessments. In this context, the NEA's emphasis on knowledge co-production and feedback is critical for strengthening legitimacy and shared stewardship.

Trat Province therefore illustrates a broader national issue: how to manage coastal development pathways where small-scale fisheries remain socially and culturally significant, but economic pressures are shifting rapidly. Without integrated land–sea governance and explicit recognition of ILK, ecological decline and social vulnerability risk reinforcing one another.

## 7.3 Phuket: Tourism intensity and ecological constraints

Phuket presents a contrasting but equally instructive case. As one of Thailand's most intensively developed tourism destinations, the province has undergone long-term economic transformation driven by coastal and marine tourism. This has generated substantial economic benefits, but has also reshaped relationships between communities and coastal ecosystems.

The pilot assessment shows that Phuket's coastal ecosystems continue to provide essential services, including shoreline protection, fisheries support, and tourism value. At the same time, they are subject to chronic and cumulative pressures (DMCR, 2024b). Coral reefs are affected by intense tourism, sedimentation, and climate change-related bleaching. Mangroves and seagrass habitats have been reduced or fragmented by coastal development, while nearshore fisheries have become increasingly marginalised in both ecological and governance terms.

Governance challenges in Phuket are primarily associated with trade-offs among competing objectives, rather than regulatory absence. Spatial plans, environmental regulations, and conservation initiatives exist, but their effectiveness is constrained by economic incentives, political pressures, and uneven enforcement. Environmental management efforts tend to focus on immediate and visible impacts, such as waste management or erosion control, rather than addressing underlying drivers such as development intensity, spatial allocation, and ecological carrying capacity.

Community dialogues revealed a widespread perception of reduced agency among long-established coastal communities. Loss of access to traditional fishing grounds, rising living costs, and limited influence over tourism-driven decision-making were frequently raised concerns. At the same time, communities largely recognise tourism as a structural feature of Phuket's economy and do not seek to reverse development, but rather to rebalance it toward more sustainable and inclusive models

The trialogue approach facilitated exchanges among local authorities, tourism operators, scientists, and community representatives, enabling shared reflection on the long-term sustainability of current trajectories. These discussions highlighted growing interest in community-based conservation and nature-positive tourism initiatives, alongside recognition of the institutional barriers that limit their scaling and long-term viability.

Phuket thus illustrates the ecological and social risks associated with tourism-led growth that is insufficiently integrated with biodiversity considerations. It demonstrates that economic success does not eliminate vulnerability, and that failure to recognise ecological limits can undermine long-term resilience.

## 7.4 Cross-cutting insights and national relevance

Despite their contrasting development pathways, Trat and Phuket reveal common patterns that are relevant across Thailand's coastal regions. In both sites, biodiversity change is closely linked to livelihood security, governance arrangements, and social equity. Ecosystem degradation is experienced directly by communities, affecting food systems, cultural continuity, and resilience to environmental change.

Both pilots also highlight the decline of ILK systems, occurring alongside ecological degradation and institutional fragmentation. This loss reduces adaptive capacity and weakens the ability of governance systems to respond to complex and uncertain change.

Importantly, the pilot studies demonstrate the added value of the NEA's trialogue approach. By integrating scientific analysis, policy perspectives, and local knowledge, the assessment was able to identify feedbacks, trade-offs, and governance gaps that would not be apparent through single-sector or single-knowledge assessments. Across both sites, communities emphasised the importance of data transparency, feedback, and policy relevance as conditions for trust and engagement.

## 7.5 Contribution to the NEA

The pilot assessments in Trat and Phuket provided a vital bridge between national-level findings and place-based realities, contributing both substantively and methodologically to Thailand's NEA. By embedding the trialogue approach within these two distinct coastal contexts, the pilots operationalised the NEA's commitment to integrating multiple knowledge systems—scientific, policy, and ILK—into a cohesive assessment process.

These case studies offered grounded insights into how biodiversity challenges and ecosystem transitions unfold differently across Thailand's diverse coastal zones. In Trat, the erosion of traditional small-scale fisheries in the face of tourism and agro-industrial expansion underscored the tensions between ecological integrity and rural development. In contrast, Phuket illustrated the governance and ecological pressures of tourism-driven growth in a more urbanised and economically advanced setting. These local dynamics enriched the national narrative, adding nuance to the broader findings on drivers of change, institutional fragmentation, and social vulnerability.

From a process perspective, the pilots exemplified the NEA's inclusive and participatory methods. Trialogue activities brought together stakeholders from government agencies, civil society, academic institutions, and the private sector. This created opportunities for co-producing knowledge, identifying data gaps, and debating priorities in a transparent and iterative manner. As such, they provided a proof-of-concept for what inclusive science-policy engagement can look like in practice—strengthening both the legitimacy and relevance of assessment outputs.

Several specific contributions of the pilot assessments to the NEA include:

- **Ground-truthing national trends:** Observations and testimonies from local communities validated and expanded upon national datasets, particularly regarding ecological degradation, governance gaps, and the erosion of ILK systems.
- **Highlighting governance feedbacks:** The pilots illustrated how institutional fragmentation, data asymmetries, and limited community agency affect conservation outcomes. These insights helped shape recommendations in Chapters 6 (Governance) and 7 (Future Scenarios).
- **Advancing methodological innovation:** The use of trialogue methodology and participatory mapping served as a practical testbed for future assessments and laid the foundation for more robust national frameworks in knowledge co-production.

- **Informing scenario building and policy options:** Place-based insights from Trat and Phuket were integrated into the scenario narratives developed in Chapter 7. These scenarios now better reflect the complexity of coastal realities and the pathways toward resilience and equity.

## 7.6 Conclusion and recommendations

In summary, the Trat and Phuket pilots affirmed the NEA's premise that ecosystem assessments must be both scientifically credible and socially inclusive. Their integration into the NEA ensured that technical analysis was grounded in lived experience, and that policy recommendations were informed by the realities of implementation.

At the same time, the NEA provides a strategic evidence base that can directly inform decision-making in these pilot landscapes. In Trat, NEA findings can support the revision and strengthening of provincial coastal zone planning and fisheries management frameworks, including zoning of nearshore fishing grounds, mangrove and seagrass conservation priorities, and improved integration of land-sea interactions in watershed and agricultural planning. These insights are particularly relevant for guiding future provincial development plans and coastal resource management strategies, where trade-offs between tourism expansion, agriculture, and small-scale fisheries are becoming more pronounced.

In Phuket, the NEA can inform ongoing and future spatial planning and coastal development decisions, including the evaluation of large-scale infrastructure proposals such as marina developments. By providing evidence on ecological carrying capacity, ecosystem service values, and community dependencies (e.g., in Ao Kung), the NEA can help ensure that coastal zoning, tourism planning, and EIAs better reflect ecological limits and social equity considerations. It also offers a basis for advancing nature-positive tourism models and locally led conservation initiatives, which are increasingly being explored in the province.

More broadly, the NEA can support both provinces in aligning local planning processes with national priorities, including the NBSAP, MSP initiatives, and emerging area-based conservation approaches such as LMMAs and OECMs.

Moving forward, these pilot sites can serve not only as innovation hubs for ecosystem governance, monitoring, and community engagement, but also as priority landscapes for translating NEA findings into action, demonstrating how integrated, evidence-based approaches can inform real-world decisions and contribute to a transition toward nature-positive coastal development in Thailand.

### 7.6.1 *Conclusion*

The pilot assessments in Trat and Phuket demonstrate that Thailand's coastal systems are undergoing profound transitions driven by the interaction of economic development, environmental change, and governance dynamics. While the two provinces reflect different development pathways—Trat characterized by small-scale fisheries under increasing pressure, and Phuket by tourism-driven growth approaching ecological limits—both reveal converging risks of ecosystem degradation, declining livelihoods, and reduced resilience.

A central finding of this chapter is that ecosystem change, human well-being, and governance are deeply interconnected. Degradation of coral reefs, seagrass beds, mangroves, and nearshore fisheries

directly affects income, food security, and cultural identity, particularly for coastal communities. At the same time, fragmented governance systems, limited coordination across sectors, and unequal power dynamics constrain the effectiveness of policy responses and limit community agency in shaping development pathways.

The pilots also highlight the critical but under-recognised role of ILK. In Trat, ILK continues to support adaptive fisheries and mangrove management but is gradually eroding. In Phuket, communities such as Ao Kung retain strong ecological knowledge and stewardship practices, yet face increasing pressure from external development interests, including proposed marina developments that may alter ecosystems and restrict traditional resource use.

Importantly, the trialogue approach used in the NEA demonstrates that integrating scientific knowledge, policy perspectives, and ILK can reveal system dynamics, trade-offs, and governance gaps that are not captured through conventional approaches. This strengthens both the credibility and relevance of ecosystem assessments.

The NEA not only benefits from these pilot landscapes but also provides a strategic evidence base for informing decision-making at the provincial level. In Trat, NEA findings can guide coastal zoning, fisheries management, and the integration of land–sea interactions in provincial planning. In Phuket, the NEA can inform spatial planning, tourism development, and EIAs, particularly in evaluating large-scale infrastructure proposals and ensuring that ecological limits and community perspectives are incorporated.

Overall, the pilots demonstrate that achieving sustainable coastal futures in Thailand requires a transition from fragmented, sector-driven approaches toward integrated, inclusive, and nature-positive governance systems, where ecological integrity, economic development, and community well-being are addressed together.

### 7.6.2 Key Messages and Recommendations

This section presents key findings and actionable recommendations to address the following policy questions:

- **How can Thailand manage coastal development pathways to balance economic growth, ecosystem integrity, and community well-being?**
- **How can land–sea interactions and cumulative impacts be more effectively managed?**
- **How can ILK be strengthened and integrated into coastal governance?**
- **How can governance systems address fragmentation, power imbalances, and limited community agency?**
- **How can pilot landscapes support the implementation of NEA findings and inform real-world decision-making?**

## Key Message 1: Coastal development pathways must align with ecological limits and community resilience

Coastal systems in Trat and Phuket are undergoing rapid transitions, with increasing pressures from tourism, infrastructure, and land-based activities. Current development pathways often fail to account for ecological carrying capacity and long-term sustainability, leading to cumulative impacts on ecosystems and livelihoods.

**Recommendations:**

**Trat:** Strengthen zoning and management of nearshore fishing grounds and critical habitats (mangroves and seagrass), while managing land-based pressures from agriculture and development.

**Phuket:** Integrate ecological carrying capacity into tourism and coastal development planning, including stricter regulation of infrastructure such as marina developments.

**National level:** Embed nature-positive and ecosystem-based approaches into coastal development policies.

## Key Message 2: Land-sea interactions and cumulative impacts require integrated governance approaches

Ecosystem degradation is driven by interconnected pressures across sectors, including tourism, agriculture, and coastal development. Fragmented governance systems limit the ability to address these cumulative impacts effectively.

**Recommendations:**

Strengthen integrated land-sea planning linking watershed, coastal, and marine systems.

Enhance cross-sector coordination among relevant agencies (e.g., fisheries, environment, tourism, agriculture).

Incorporate cumulative impact assessment into spatial planning and EIAs processes.

## Key Message 3: ILK is essential but increasingly under pressure

ILK provides critical insights into ecosystem dynamics and supports sustainable resource management. However, it is declining due to socio-economic changes and is often not adequately recognised in formal governance systems. In Phuket, communities such as Ao Kung face increasing pressure from development, highlighting the need to safeguard both knowledge and resource access.

**Recommendations:**

- Recognise and integrate ILK into policy, planning, and monitoring systems.
- Support intergenerational knowledge transfer and community-based management.
- Ensure meaningful participation of communities in decision-making processes, particularly for development projects affecting coastal ecosystems.

## Key Message 4: Governance fragmentation and power imbalances limit effective and equitable outcomes

Overlapping mandates, weak enforcement, and limited coordination reduce the effectiveness of coastal management. Communities often have limited influence over decisions, particularly in areas experiencing rapid economic development.

**Recommendations:**

- Strengthen governance coordination and clarify institutional roles and responsibilities.
- Enhance enforcement capacity and accountability mechanisms.
- Promote inclusive governance approaches, including co-management and LMMAs/ OECMs.

## Key Message 5: Pilot landscapes provide a pathway for translating NEA findings into action

The Trat and Phuket pilots demonstrate how integrated assessments can inform real-world decisions, including zoning, tourism management, fisheries governance, and ecosystem restoration. They provide a platform for testing and scaling nature-positive solutions.

**Recommendations:**

- Use pilot sites as implementation hubs for NEA recommendations.
- Align provincial planning processes (e.g., spatial plans, tourism strategies, EIAs) with NEA findings.
- Strengthen data systems, monitoring, and participatory platforms (e.g., trialogues) to support continuous learning and adaptive management.

The experiences from Trat and Phuket show that the transition toward sustainable coastal development in Thailand is not only a technical challenge but also a governance and societal one. By integrating science, policy, and local knowledge, and by aligning development with ecological limits, Thailand has the opportunity to move toward a nature-positive and resilient coastal future.



# 8 | Scenarios for Thailand's Marine Ecosystems and Biodiversity Ecosystem Services

This chapter synthesizes scientific evidence and ILK to co-produce a set of plausible futures for Thailand's coastal and marine ecosystems. It integrates insights from previous chapters and stakeholder perspectives to evaluate alternative pathways, identify leverage points for policy and governance, and derive actionable recommendations. The chapter also presents a consolidated Summary for Policy Makers (SPM) with key messages derived from the scenario exercise.

The scenario analysis focuses on Marine BES. It draws on Chapters 1-6 to examine how different policy and management pathways could shape Thailand's marine biodiversity by 2050. The approach combines exploratory scenarios, intervention-oriented policy scenarios, and participatory narrative development.

## 8.1 Scenario development approach and methodology

The scenarios were developed through a participatory NEA process, using a methodological framework informed by the IPBES methodological assessment on scenarios and models of biodiversity and ecosystem services. The approach combines exploratory scenarios, intervention-oriented policy scenarios, and a participatory qualitative process adapted to Thailand's marine context. The key elements are:

- Exploratory Scenarios: examining a range of plausible futures under varying socio-economic and environmental conditions (e.g., from BAU to transformative changes).

- Intervention (Policy) Scenarios: exploring the outcomes of selected policies or management strategies (e.g., expanding MPAs or adopting a national "Blue Economy" strategy).

- Participatory, Expert-Driven Process: emphasising that scenario development is grounded in stakeholder and expert input rather than computational modeling. Multi-stakeholder workshops (marine scientists, policymakers, local communities, and Indigenous knowledge holders) were used to co-create and validate the scenario narratives (UNEP-WCMC, 2023)

This methodological framework distinguishes clearly between conceptual foundations (scenario logic, drivers, uncertainties) and practical implementation (stakeholder co-production, validation steps), as recommended. The scenario process therefore unfolded in two phases. First, stakeholders co-created a set of exploratory scenario archetypes during national stakeholder participatory workshops, capturing distinct combinations of growth, equity and stewardship. Second, during NEA expert review, these scenarios archetypes were synthesised into final set of archetypes that was used for integrated analysis, monitoring and policy alignment in the later sections of this chapter.

Throughout, the approach and methodology used in the study demonstrated that a robust qualitative approach—informed by data from Chapters 1-6 and stakeholder knowledge—is sufficient to produce credible, policy-relevant marine scenarios. The key focus is qualitative evidence-based scenarios, not quantitative modeling. This approach demonstrates that the scenarios are grounded in participatory storytelling, supported by evidence from Chapters 1-6 and structured around international best practice. Each chapter contributes specific insights, data, or framing elements critical for scenario construction—from the ecological baseline and drivers of change to governance and economic considerations. Table 8.1 below summarises how each chapter supports specific components of the scenario-building process.

**Table 8.1: Contributions of NEA chapters 1-6 to chapter 8 scenarios development**

| Scenario Development Element | Chapter 1: Overview | Chapter 2: Status & Trends | Chapter 3: Drivers & Pressures | Chapter 4: Economic Value | Chapter 5: ILK | Chapter 6: Governance & Institutions |
|---|---|---|---|---|---|---|
| **1. Baseline Scenario Context (BAU)** | Describes current policy environment, national drivers, and ecosystem-service dependence | Provides status of key habitats and trends in species/populations | Establishes DPSIR framework and pressure linkages | Identifies undervaluation in planning | Shows how ILK is marginalised | Describes fragmented governance structure |
| **2. Drivers of change** | Introduces macro-level drivers | Illustrates impact patterns | Prioritises direct/indirect drivers | Economic underpricing as systemic driver | Erosion of traditional practices | Legal overlaps and enforcement weaknesses |
| **3. Scenario typologies framing** | Supports selection of scenario archetypes | Offers real-world examples of degradation/recovery | Defines structural divergence logic | Supports trade-off exploration | Enables ILK-integrated narratives | Enables governance-oriented futures |
| **4. Key variables & indicators** | Provides contextual metrics | Ecological metrics (e.g., coral, mangroves) | Pressure indicators | Economic and valuation indicators | Socio-cultural indicators | Governance effectiveness indicators |
| **5. Stakeholder roles in scenarios** | Frames multi-level stakeholder importance | Emphasises regional actors | Links drivers to stakeholder behavior | Private sector's role in valuation | Community & ethnic perspectives | Governance participation mechanisms |
| **6. Intervention leverage points** | Outlines national commitments | Demonstrates reversible degradation | Maps policy levers (e.g., enforcement) | Advocates for natural capital accounting | Suggests ILK-based co-management | Supports MSP, co-management, biodiversity finance |
| **7. Scenario monitoring & validation inputs** | Aligns with policy targets | Provides biodiversity baselines | Long-term pressure pathways | Links valuation to outcomes | Community-based monitoring insights | Institutional M&E readiness |

This integrated matrix in Table 8.1clarifies how each preceding chapter contributes evidence, logic, or variables essential for robust scenario-building. It also ensures that scenario narratives are grounded in both current ecological realities and practical governance contexts, while allowing space for transformative futures aligned with national goals and the KMGBF.

## 8.2 Baseline context: Current status and trends of Marine BES

The current state of Thailand's marine ecosystems and services provides the baseline for all scenarios and serves as the BAU starting point. The baseline draws on Chapters 1 and 2, with supporting evidence from Chapter 4, to summarise current ecosystem conditions, recent trends, and the socio-economic importance of Marine BES.

Key findings from earlier chapters establish the ecological and socio-economic importance of coastal ecosystems and Thailand's commitments to global frameworks, including the KMGBF. Chapter 2 provides evidence on the condition of mangroves, coral reefs, seagrass beds, fisheries, and other marine ecosystems, including documented pressures from pollution, overfishing, habitat loss, and climate change. Chapter 4 highlights the economic importance of these services and the risks of undervaluing them in development planning.

This baseline defines the BAU assumptions and identifies the key concerns that the alternative scenarios address differently. By clearly articulating "where we are now" and "how we got here", this baseline enables to project forward in a grounded way. The BAU scenario is essentially extrapolated from this baseline–so the baseline context effectively defines the BAU scenario assumptions. It also flags the key concerns that scenarios will address differently. In short, it is to ensure that each scenario's narrative has a solid factual foundation rooted in Thailand's coastal and marine reality as established in Chapters 1.

## 8.3 Key drivers of change and uncertainties for marine futures

Major drivers and uncertainties shaping Thailand's marine futures were identified from Chapter 3, with relevant institutional drivers drawn from Chapter 6. These drivers explain why different assumptions about governance, development pressure, climate risk, resource use, and social response lead to different scenario outcomes.

Using Chapter 3's findings, the direct drivers affecting coastal and marine biodiversity include coastal development and land-use change destroying habitats, marine pollution including plastics and industrial runoff, overfishing and destructive fishing practices, climate change impacts like sea level rise and coral bleaching. Port, and river stream dredging, and at-sea disposal of dredged materials are also pressures, particularly in shipping lanes, industrial coastal zones, and estuarine areas, which contribute to turbidity, resuspension of contaminated sediments, and local habitat disturbance. Drivers include economic growth patterns, population increase in coastal areas, tourism demand, governance effectiveness, technology, and broader socio-political factors. Each driver is described along with its current trend and uncertainty.

These drivers form the basis for scenario divergence. For example, different assumptions about overfishing, tourism pressure, coastal development, pollution control, climate adaptation, and governance effectiveness lead to different outcomes under BAU, Blue Economy, and Nature-Positive pathways.

## 8.4 Inclusion of ILK and stakeholder perspectives

ILK and community perspectives were incorporated into the scenario narratives through the participatory process. Insights from Chapter 5 informed how the scenarios treated customary management, cultural ecosystem services, community stewardship, and the risks associated with weakening traditional knowledge systems.

Chapter 5 highlighted the traditional knowledge and practices of coastal communities, the cultural importance of marine ecosystems, threats to ILK transmission, and the value of community-led conservation. These insights were reflected in the scenario narratives through ILK-based management approaches, cultural ecosystem service values, and differentiated outcomes for ILK. Under BAU, traditional practices are likely to erode further, whereas under conservation-oriented and Nature-Positive pathways, ILK is strengthened and incorporated into resource management.

Formalising the inclusion of ILK ensures that the scenarios are locally grounded and inclusive. It broadens the knowledge base beyond scientific data incorporating how coastal communities perceive changes and what future they desire. This is crucial for coastal/marine scenarios, as many resource-use decisions are made at the community level and ILK can offer sustainable solutions (as noted in Chapter 5). Including ILK improves the relevance and legitimacy of the scenarios: stakeholders are more likely to see themselves in the narratives and support outcomes that resonate with their knowledge. This influence makes scenario narratives more realistic to acknowledge customary tenure or community-managed fishing zones in the storyline and highlight the human dimension of ecosystem change. The inclusion of ILK strengthens the legitimacy, realism, and social relevance of the scenarios by grounding them in community experience and multiple knowledge systems.

## 8.5 Governance and policy framework as a scenario context

Current governance structures, institutions, and policy frameworks from Chapter 6 were incorporated into the scenario foundation. Governance quality, institutional coordination, enforcement capacity, and policy coherence are treated as critical determinants of scenario outcomes. Chapter 6 identified fragmented MSP, overlapping mandates, and enforcement weaknesses as key constraints on effective ecosystem management. It also assessed how Thailand's policies align with, or fall short of, international commitments such as the CBD targets and the KMGBF.

Governance assumptions differentiate the scenarios. One pathway assumes improved and proactive governance, while another assumes continuation of the status quo or ad hoc governance. Current policy initiatives relevant to coastal and marine ecosystems are treated as starting points that could either scale up or stagnate depending on political commitment, institutional capacity, and stakeholder participation.

## 8.6 Scenario framework and typologies for futures

Scenario typologies were developed to represent distinct but plausible coastal and marine futures for Thailand. For the participatory phase, five workshop scenario archetypes were used to explore stakeholder priorities and trade-offs. For final NEA reporting, these were consolidated into three core scenarios: Business-as-Usual (BAU), Blue Economy, and Nature-Positive (Blue Economy Plus).

- **Business-as-Usual (BAU):** A future in which current trends, policies, and practices continue their present course. This scenario assumes no major shifts in policy or behavior beyond what is already underway. For coastal ecosystems, BAU might mean gradual degradation continues (e.g., incremental mangrove loss, slow decline of fish stocks) despite existing conservation efforts, as economic development and population pressures persist at historical rates. BAU serves as the baseline to contrast other scenarios against.

- **Blue Economy Scenario:** A future where Thailand strategically pursues a World Bank-framed Blue Economy pathway, expanding ocean-based economic opportunities while ensuring that marine resource use remains sustainable, socially inclusive, and within ecological limits. In this scenario, economic growth in marine sectors is achieved in tandem with strong environmental safeguards. Policies emphasise innovation, integrated ocean planning, and investment in restoration.The Blue Economy scenario envisions robust public-private partnerships and regional cooperation in alignment with frameworks such as the ASEAN Blue Economy principles (ASEAN, 2021) to ensure that exploitation of marine resources remains within ecological limits. Essentially, it's the scenario balancing economic and conservation goals, assuming moderate improvements in governance and technology to enable sustainable use. The term Blue Economy follows the World Bank and UN DESA (2017) framing, which understands the Blue Economy as the range of ocean-related economic sectors and policies that together determine whether the use of ocean resources is sustainable. It is therefore not used to mean ocean-sector growth alone, but a development pathway that promotes economic opportunities, social inclusion, livelihood improvement, and environmental sustainability, while decoupling ocean-based development from marine and coastal ecosystem degradation.

During the Trialogue Workshop (November 2025), experts emphasised the need to clarify the distinction between "Blue Economy" and the emerging concept of "Regenerative Blue Economy". While the Blue Economy scenario described in this chapter reflects a sustainable and well-regulated ocean-based economic model, workshop participants noted that international discourse is rapidly shifting toward a more ambitious framework.

Within the World Bank-framed Blue Economy used in this chapter, marine sectors such as fisheries, aquaculture, tourism, ports, shipping, renewable energy, and marine biotechnology are expected to operate within ecological limits, minimize environmental harm, adopt cleaner technologies, and be supported by integrated marine planning and safeguards. A Regenerative Blue Economy is treated here as a higher-ambition extension of this pathway, where sustainable use progresses further toward active ecosystem restoration, net-positive biodiversity outcomes, circular marine value chains, blue-carbon enhancement, and stronger community benefit-sharing.

Stakeholders stressed that Thailand's Blue Economy scenario can therefore be understood as a transitional step, with some provinces or sectors potentially advancing toward a Regenerative Blue Economy by 2050. This evolution aligns closely with global biodiversity goals, climate resilience priorities, and community empowerment principles identified in Chapters 5 and 6.

This clarification is not intended to introduce a separate scenario but rather to highlight that the Blue Economy scenario contains an internal trajectory—from sustainable use toward regenerative practices—depending on governance ambition and policy uptake.

- **Conservation-Focused Scenario** (which later informs the Nature-Positive): A future where ecosystem protection and restoration are the top priority. In this scenario, Thailand significantly strengthens marine conservation measures—expanding MPAs, strictly enforcing no-take zones, curbing coastal development in sensitive areas, and investing heavily in ecosystem restoration. Economic growth is deliberately guided by sustainability principles; some short-term economic opportunities are forgone or regulated heavily in favor of long-term ecosystem health. This scenario might also involve high community engagement and Indigenous/local stewardship of resources, aligning development with conservation. It represents an optimistic pathway where global biodiversity commitments are met or exceeded by 2050, leading to stabilizing or improving trends in biodiversity.

- **Sustainable Balanced Development:** This scenario envisions a future where economic growth, environmental stewardship, and social equity are pursued in a balanced manner. Decision-making integrates national strategies and local knowledge; innovation supports green infrastructure and sustainable aquaculture; community enterprises are supported alongside MSP and strong environmental regulations. This path reflects inclusive, multi-actor collaboration to maintain ecosystem services while ensuring prosperity and resilience.

- **Local Resilience and Community Empowerment:** During the group discussions at the 1st scenarios participatory workshop, some stakeholders raised interest in a future that is more community-driven and equity-oriented than what is reflected in the current four scenarios. While the "Sustainable Balanced" scenario integrates national planning with local empowerment, and the "Conservation-focused" scenario emphasises centralized stewardship, these stakeholders proposed an alternative vision prioritising local rights, decentralised decision-making, ecosystem justice, and indigenous or traditional governance models. This could reflect and embody a high degree of equity-oriented development and bottom-up ecosystem stewardship.

For each scenario typology, the section explains why it is relevant to coastal/marine issues and how it reflects different combinations of drivers and policies identified earlier. BAU reflects a continuation of current driver trends, the Blue Economy scenario addresses economic drivers with sustainable tech and moderate governance improvement, and the Conservation scenario addresses environmental drivers with strong governance changes. These scenarios are chosen to bracket a range of plausible futures: from minimal intervention (BAU) to moderate intervention (sustainable development focus) to maximum intervention (conservation priority). Any scenario archetypes unrelated to marine systems (such as ones focused on agricultural or forest futures) have been omitted or re-scoped to keep the spotlight on coastal/marine dynamics.

These scenario typologies guided the participatory scenario-development process by clarifying the assumptions, values, and policy orientations represented by each storyline. They also ensured that the scenarios remained coastal and marine-specific and reflected Thailand's policy discourse, including Blue Economy development, biodiversity conservation, local resilience, and community empowerment.

For the participatory phase, these five scenarios' archetypes provided sufficient diversity to explore stakeholder priorities and trade-offs. For the final NEA synthesis, the NEA lead authors consolidated them into three reporting archetypes: (i) BAU as a risk baseline; (ii) a Blue Economy (Blue Growth)

scenario, combining elements of the original Blue Economy and Balanced Sustainable Development scenarios; and (iii) a Nature-Positive scenario, combining the Conservation-Focused and Local Resilience & Community Empowerment narratives and aligning with KMGBF targets. This consolidation allows clearer communication of policy choices while preserving the original workshop insights.

### 8.7 Participatory scenario development process

The participatory process for developing scenario narratives was implemented across four steps. The process combined expert judgement, stakeholder input, ILK, and iterative review to ensure that the storylines were evidence-informed, internally consistent, and policy-led.

- **Step 1:** Co-creation Workshops: Participatory scenario workshops were convened, bringing together marine experts, government officials, local community representatives, NGOs stakeholders, and ILK holders. In these workshops, participants discussed drivers and trends (from Section 7.4) and collectively brainstormed elements of each scenario. The discussions incorporated data from Chapters 1-6 and ILK perspectives.
- **Step 2:** Drafting Storylines: Using input from the workshops, the scenario team drafted qualitative narratives for each scenario. This involved writing out how the future might unfold from the present to 2050 under BAU, Blue Economy, and Conservation pathways, including key events, policy decisions, socio-economic changes, and environmental responses. Each storyline was internally consistent with its theme, and the narratives explicitly incorporated elements identified by stakeholders.
- **Step 3:** Validation and Iteration: The draft narratives were then presented, shared, and circulated for feedback. Additional expert consultations and the second workshop were used to verify plausibility and ensure that no critical factor had been overlooked. At this stage, available quantitative information was lightly overlaid to check consistency. The emphasis remained on expert judgment and stakeholder consensus in refining the storylines.
- **Step 4:** Finalization: Feedback was incorporated to finalize the scenario narratives. Each scenario was then structured in a comparable way, covering drivers, policies, and outcomes for biodiversity and ecosystem services. This stage locked in the narratives later presented in Section 7.9.

The participatory process increased transparency and traceability by showing how the scenarios emerged from stakeholder dialogue and evidence from Chapters 1-6. It also strengthened legitimacy by incorporating ILK, expert judgement, and multi-stakeholder validation. The process served as the bridge between the assessment evidence base and the scenario narratives presented in Section 7.9.

## 8.8 Scenario narratives and storylines for futures

The scenario narratives describe distinct future pathways for Thailand's coastal and marine ecosystems in 2050 under each scenario archetype. Each narrative presents key developments, policy choices, socio-economic changes, ecological outcomes, and implications for biodiversity and ecosystem services over time.

- **BAU 2050:** Describes a future in which no major new initiatives are taken beyond those already in place. By the 2030s, coastal urban development continues to sprawl with limited zoning enforcement, leading to the loss of Thailand's remaining mangroves. Coral reefs suffer annual bleaching events; despite some local reef restoration projects, overall coral cover declines and fisheries yields fall, hitting small-scale fishers' livelihoods. Tourism infrastructure expands in coastal areas, but water pollution and eroding beaches begin to deter ecotourists. The government's efforts remain fragmented, and weak enforcement means illegal fishing and pollution persist. By 2050, Thailand's coastal and marine biodiversity is in a fragile state. Iconic species are rare outside protected areas, and while the Blue Economy was hoped to grow, unsustainable use has led to diminishing returns in fisheries and reef tourism. This BAU storyline integrates actual trend data from the baseline, essentially painting a future if those trends continue unaltered (Figure 8.1).



**Figure 8.1: BAU Scenario (2050) of Thailand Marine Ecosystems**

- **Blue Economy 2050:** Describes a more optimistic, sustainability-driven growth future. In the 2020s, Thailand pivots to a Blue Economy model – establishing a national mechanism to coordinate policy. By 2030, MSP is in place: shipping lanes, fishing zones, tourism areas, and strict conservation zones are allocated based on scientific and local input. Investments in green technology flourish. Traditional fishing fleets are upgraded with bycatch-reducing gear and monitoring systems. Potentially, several alternative renewable power sources developed. The increase of wind and solar energy in coastal zone is proportionate to providing jobs and clean energy. Coastal communities (including ILK) are partners in conservation–community-managed marine areas receive government support, blending

ILK with modern science. Throughout 2030–2040s, these measures payoff: fish stocks stabilise then increase as habitat is protected and sustainable aquaculture fills demand. Coral reefs start recovering in well-managed tourism zones. By 2050, Thailand's maritime sectors are booming economically and operating within ecological limits. The country has a model for how economic development can coexist with healthy coastal and marine resources, having met international biodiversity targets as a byproduct of pursuing inclusive, long-term growth. This narrative highlights specific policy interventions and innovations and their positive outcomes, showing a plausible route to synergistic goals (Figure 8.2).



**Figure 8.2: Blue Economy scenario (2050) of Thailand marine ecosystems**

- **Conservation-focused 2050** (as a workshop-stage scenario): Describes a future of ecosystem-first decisions. Facing escalating environmental crises, Thailand makes bold moves in the late 2020s: it declares larger coastal and MPAs and OECMs by 2035, with an increase of no-take zones. A moratorium on coastal wetland conversion is enacted, and massive mangrove replanting programs restore buffers against storms. Many large-scale developments are re-evaluated or halted in sensitive coastal zones; instead, livelihood programs help coastal communities pivot to sustainable enterprises like ecotourism, artisanal fisheries, and marine product crafts. Enforcement is strict: a dedicated Marine Rangers unit, including local youth trained in conservation, curbs illegal fishing and pollution with near-zero tolerance. By 2050, the fruits are evident–fish populations have rebounded significantly inside no-take zones and are replenishing adjacent fishing areas. Coral reefs, while still under climate stress, are far more resilient thanks to reduced local pressures and active restoration. The health of ecosystems enhances food security and coastal protection, and community co-management agreements ensure that ILK (such as Chao Lay Sea tenure traditions)

guides day-to-day stewardship. Thailand meets global biodiversity benchmarks early, and while economic growth in conventional terms was slower in the 2030s, by 2050 the quality of growth is high: fisheries and tourism are sustainable, and the nation avoids costly losses from environmental collapse. This narrative emphasises strong governance changes and trade-offs accepted in favor of long-term sustainability, illustrating the potential gains in biodiversity and ecosystem services when nature is prioritised (Figure 8.3).




**Figure 8.3: Conservation-focused scenario (2050) of Thailand Marine ecosystems**

- **Balanced Sustainable Development 2050** (as a workshop-stage scenario): From the 2020s onward, Thailand progressively integrates environmental sustainability into coastal development planning, expanding MSP from pilot provinces into a national framework, linking fisheries, tourism, and conservation policy, and embedding regular stakeholder consultations into permitting processes. By the 2030s, certified sustainable seafood and eco-tourism increase their share of coastal GDP, while restoration targets for mangroves, seagrass, and coral reefs are met in many provinces. In the 2040s, ICZM becomes standard, delivering healthier ecosystems and equitable benefit-sharing, and by 2050, the country achieves a resilient balance between ecological integrity, economic prosperity, and social well-being—sustained by adaptive governance that responds to ecological trends and market changes (Figure 8.4).




**Figure 8.4: Balanced Sustainable Development Scenario (2050) of Thailand Marine Ecosystems**

- **Local Resilience and Community Empowerment 2050** (as a workshop-stage scenario): Beginning in the 2020s with legal recognition of community-managed marine areas and customary fishing rights, Thailand steadily scales up bottom-up governance and integrates ILK into provincial MSP and restoration programs. Through the 2030s, government and donor budgets flow directly to community-led conservation, and blue carbon and biodiversity credit schemes begin generating tangible local income. By the 2040s, recovery of fish stocks, mangrove cover, and coral health is evident in stewardship zones, demonstrating high adaptive capacity to climate change. In 2050, empowered coastal communities manage healthy, productive ecosystems, sustain cultural traditions, and deliver equitable benefits—signaling that strong local leadership can achieve national biodiversity and climate goals while fostering enduring social cohesion and resilience.

Each scenario narrative draws on the baseline, drivers, ILK, governance conditions, and stakeholder inputs presented earlier in the chapter. The narratives translate technical evidence into plausible future pathways that can be compared, discussed, and used to identify policy implications. In the final NEA synthesis, elements from the earlier workshop scenarios were consolidated into the final reporting scenarios of Blue Economy and Nature-Positive (Blue Economy Plus), while BAU was retained as a risk baseline.

In the final NEA synthesis, the narrative elements from the earlier workshop scenarios were consolidated into the final reporting scenarios of Blue Economy and Nature-Positive (Blue Economy Plus), while BAU was retained as a risk baseline.

## 8.9 Comparison of Thailand's NEA scenarios on the matrix mapping

The five scenario archetypes were compared across growth orientation, equity orientation, and ecosystem stewardship. It maps them onto a two-axis matrix: Growth vs. Equity on the horizontal axis, and Reactive vs. Proactive Stewardship on the vertical axis. This approach highlights how each scenario combines socio-economic and environmental priorities, and where trade-offs emerge.

**Box 8-1: Working definitions used in scenario comparison**

- **Growth:** expansion of economic activities linked to marine sectors while considering ecological constraints.
- **Equity:** fair distribution of benefits, rights, and decision-making power among coastal communities, including small-scale fishers and Indigenous groups.
- **Stewardship:** long-term care and responsible governance of marine ecosystems involving state, private sector, and local communities.

The BAU scenario sits in the growth-oriented / reactive stewardship quadrant, reflecting continued economic development under current policy trends, with limited capacity to anticipate or prevent environmental degradation. The Blue Economy scenario moves upward into growth-oriented / proactive stewardship, combining economic expansion in marine sectors with stronger environmental safeguards and technological innovation. The Conservation-Focused scenario occupies the equity-oriented / proactive stewardship quadrant, prioritising biodiversity protection, ecosystem restoration, and inclusive governance over short-term economic gain. Balanced Sustainable Development straddles the center, leaning toward equity orientation but with moderate proactive measures, aiming to harmonize environmental, economic, and social goals incrementally. The Local Resilience and Community Empowerment scenario (Scenario 5) also lies in the equity-oriented / proactive stewardship quadrant but distinguishes itself from the Conservation-Focused model by placing community rights, ILK and local benefit-sharing at the center of governance and management. While it shares ecological ambition with Conservation-Focused, its pathways are rooted in bottom-up governance, small-scale livelihoods, and cultural heritage preservation. This delivers strong social cohesion and adaptive capacity but entails trade-offs such as slower national-scale economic growth, reliance on external capacity building, and variability in performance between communities.

Mapping these scenarios on the Growth–Equity vs Reactive–Proactive matrix illuminates the strengths and trade-offs inherent in each future. Stakeholders can visually grasp, for example, that BAU clusters heavy economic focus with weak environmental action, whereas the Conservation-Focused scenario does the opposite, and Blue Economy and Balanced scenarios occupy the intermediate spaces. This configuration helps prompt discussion on what kind of future Thailand wants: How much priority should be given to economic growth versus equitable, inclusive development and to what extent should be invested early in ecosystem stewardship versus risk reactive, crisis-driven management? By examining each quadrant, workshop participants debated which trade-offs are acceptable or how to combine elements of scenarios. The 2×2 chart thus serves as a communication tool, making abstract scenario concepts tangible and highlighting that moving toward the upper-right (Equity-Oriented and Proactive) generally improves sustainability at the cost of short-term conveniences–a critical insight

for policy planning and collaborative decision-making. Ultimately, this matrix encourages a nuanced conversation about Thailand's future, helping stakeholders explore where on these axes they envision the country's coastal development and ecosystem management heading, and what actions today could make the desired scenario a reality. Key scenario descriptions are based on scenarios narratives. The matrix framework was used to interpret how each narrative emphasises different development values and stewardship strategies, facilitating a comparative evaluation of outcomes.

Figure 8.5: Synthesises the overall scenario space. The text below provides only a concise interpretation to help readers navigate the distinctions shown in the figure. Axes correspond to the definitions provided in Section 8.10.

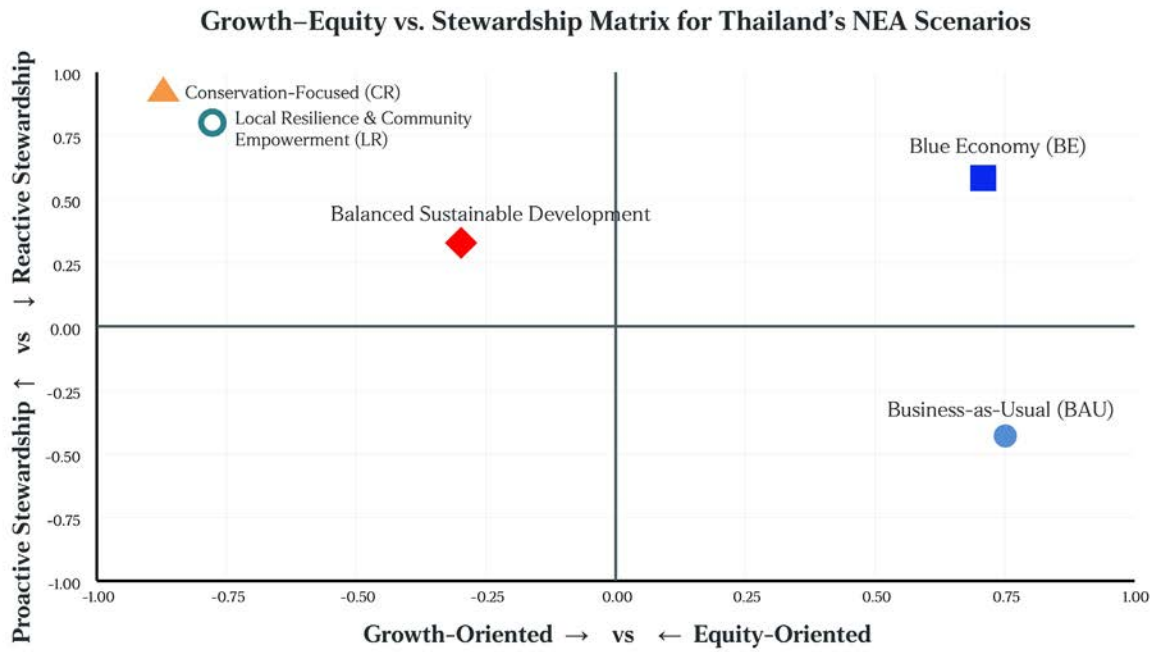



**Figure 8.5: Growth-Equity vs. Stewardship Matrix for Thailand's NEA Scenarios**

**Legend:**

- = Business-as-Usual (BAU)
- = Conservation-Focused (CR)
- = Blue Economy (BE)
- = Balanced Sustainable Development
- = Local Resilience & Community Empowerment (LR)

Later after the Trialogue Workshop (November 2025), the NEA team finalised to consolidate the 3 core scenarios. So, the 2x2 matrix mapping is described for final three scenarios (Figure 8.6).

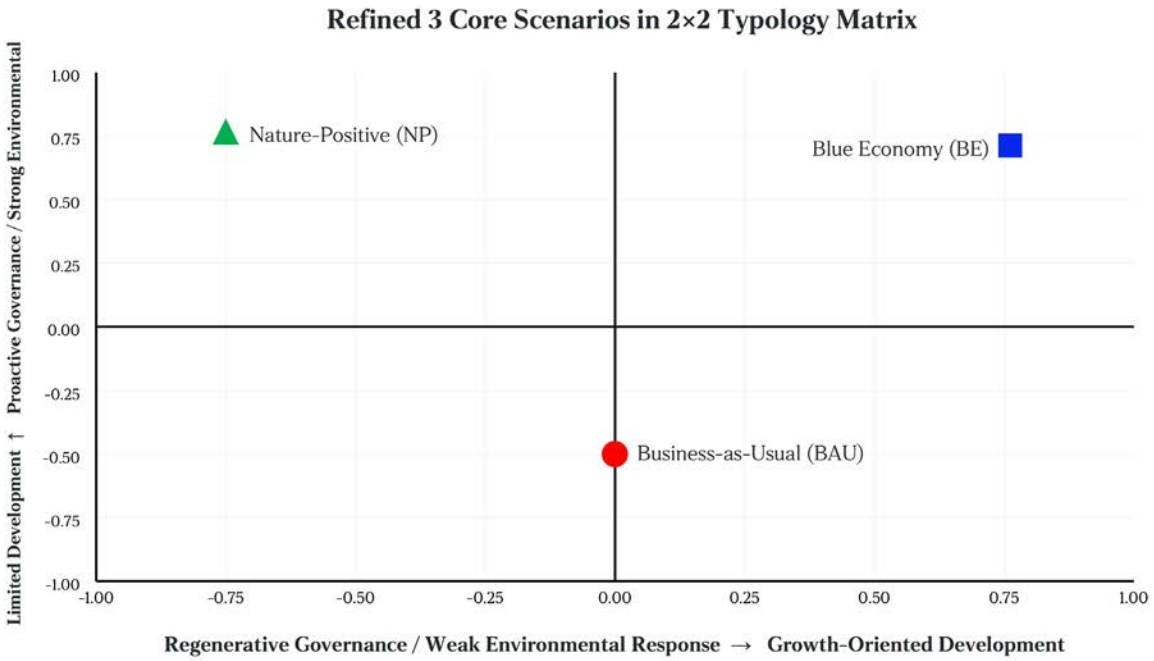



**Figure 8.6: 2x2 Matrix to visualise the refined 3 scenarios orientation in terms of level of development approach and governance**

**Legend:**

= Business-as-Usual (BAU)

= Nature-Positive (NP)

= Blue Economy (BE)

- **BAU–Reactive + Growth-Oriented** BAU sits in the lower-left quadrant because it continues current trends: fragmented governance, short-term growth priorities, and weak enforcement. The economy grows in the short run, but environmental declines accelerate, leaving ecosystems and communities more vulnerable.

- **Blue Economy–Growth+Equity, Proactive** Blue Economy occupies the upper middle, straddling both growth and equity orientations. This is because it combines sustainable ocean industries (like aquaculture, eco-tourism, marine renewables) with inclusive participation of communities. It is proactive in governance, using MSP, green financing, and regulations to ensure that economic growth does not undermine ecosystems. The essence is that sustainability is achieved at all levels–from national-scale investments to local community enterprises.

- **Nature-Positive (Blue Economy Plus)–Proactive+Equity-Oriented** Nature-Positive is in the upper-left quadrant. It represents a future where Thailand acts early and decisively to protect ecosystems, restore degraded habitats, and empower local communities. Here, ILK and co-management are central, and equity ensures benefits are shared fairly. The emphasis is on ecological health first as the foundation for sustainable livelihoods.

The 2x2 Matrix helps policymakers to visualise and position where different choices about how Thailand develops and governs.

- BAU shows what happens if we continue with today's reactive, growth-first mindset.
- Blue Economy shows how growth and equity can be combined under proactive governance.
- Nature-Positive shows what happens if we prioritise ecosystems and communities.

Together, the three refined scenarios highlight the trade-offs, risks, and opportunities Thailand faces. They show that sustainability can be pursued through different pathways, but that proactive governance and community empowerment are essential in all cases.

## 8.10 Orientation and features of all scenarios

### 8.10.1 BAU: Growth-oriented & reactive

In the BAU scenario, Thailand's coastal development continues its current trajectory with no major policy shifts. Economic growth remains a primary goal, following conventional patterns of development. Ecosystem stewardship under BAU is largely reactive– environmental issues are addressed piecemeal or only after they become acute, rather than through upfront planning. Governance stays fragmented and enforcement weak, resulting in incremental degradation of ecosystems despite some existing conservation efforts. BAU essentially makes the baseline for comparison.

- **Strengths:** Maintains economic growth along familiar lines, providing short-term development gains and continuity in industries and livelihoods. This scenario is easiest politically since it requires no drastic changes–it reflects BAU comfort and stable institutions.

- **Trade-offs:** Environmental decline continues largely unchecked, leading to loss of biodiversity and ecosystem services. Benefits of growth are uneven and long-term sustainability is undermined. Reactive management means higher risk of ecological crises and costly damage control in the future, potentially eroding economic gains.

### 8.10.2 Blue Economy: Growth-oriented & proactive

The Blue Economy scenario pursues an aggressive "sustainable growth" path in maritime sectors. It remains growth-oriented, seeking to expand industries like fisheries, aquaculture, tourism, and offshore energy, but does so by investing in sustainability. Economic development is achieved in tandem with strong environmental safeguards. Governance improves moderately, enabling proactive ecosystem stewardship: policies anticipate and prevent environmental problems so that marine resource use stays within ecological limits. This is essentially a "win-win" scenario, attempting to balance economic and conservation goals via innovation and public–private partnerships.

- **Strengths:** Achieves synergies between economy and environment – continued economic growth with enhanced sustainability. Natural assets are seen as valuable infrastructure, so ecosystems get proactive protection and restoration while industries profit. This scenario improves long-term resource security and can meet international sustainability principles,

demonstrating that development and conservation can go hand-in-hand.

- **Trade-offs:** Requires significant investment, technology, and governance capacity – if these falls short, gains may not fully materialise. The focus on market and tech solutions may overlook social equity; benefits might skew toward larger enterprises or well-equipped communities, risking that small fisher or marginalised groups get left behind. Also, a "win-win" may involve compromises: environmental standards are improved, but not to the strictest level. In short, the Blue Economy assumes moderate reforms – if economic growth pressures outpace those reforms, there's a risk of backsliding into unsustainable exploitation.

### 8.10.3 Conservation-focused: Equity-oriented & proactive

The Conservation-Focused scenario makes ecosystem health the top priority. It is equity-oriented in that it emphasises community stewardship and long-term common benefits from nature. Thailand undertakes strong proactive measures to protect and restore ecosystems–for example, vastly expanding MPAs, strictly enforcing no-take zones, curbing harmful coastal development, and investing heavily in restoration of habitats like coral reefs and mangroves. Economic growth is deliberately guided by sustainability principles, with some short-term development opportunities forgone or tightly regulated in favor of long-term ecosystem health. This scenario also features high community engagement, coastal communities and Indigenous groups co-manage resources, ensuring development aligns with conservation and local well-being. The stewardship approach is highly proactive, aiming to prevent environmental harm before it occurs and to exceed global biodiversity targets by 2050.

- **Strengths:** Dramatic environmental gains – biodiversity loss is halted or reversed and Thailand meets or exceeds global conservation targets. Healthy ecosystems secure fisheries, coastal protection, and carbon storage, which in turn safeguard food security and livelihoods. Community co-management and inclusive decision-making strengthen social equity, as local people benefit from conservation and traditional knowledge is respected. By prioritising nature, this scenario avoids the catastrophic costs of ecosystem collapse, and by 2050 even the "quality of growth" improves.

- **Trade-offs:** Economic growth is slower especially in the near term – certain large-scale projects or intensive uses are curtailed, which can mean foregone revenue and jobs in unsustainable industries. This requires strong governance and public support to enforce tough measures and manage the transition for affected sectors. There may be short-term socio-economic pain in exchange for long-term gains. Politically, prioritising the environment and equity over immediate growth can be challenging, and success hinges on maintaining commitment despite pressures. In sum, the conservation-first approach demands significant upfront sacrifice and political will, trading some short-run development gains for far greater sustainability and resilience in the future.

### 8.10.4 Balanced sustainable development: Equity-oriented & reactive

The Balanced Sustainable Development scenario attempts to balance social, economic, and environmental objectives, inspired by the idea of sustainable development "for all." It leans toward equity-oriented development, emphasising inclusive growth, poverty reduction, and broad well-being over maximising GDP. Policies in this scenario focus on social investments and fair distribution reflecting Thailand's vision of balanced and sustainable development for all. However,

this future takes a more reactive approach. Environmental stewardship is not as systematically integrated upfront; the government addresses ecosystem issues as they emerge rather than through comprehensive preventive strategies. There is some progress on sustainability, but it tends to come as incremental fixes or add-on measures to development programs, rather than bold ecosystem-focused initiatives.

- **Strengths:** Makes inclusive development a priority – economic gains are more evenly shared, and development is moderated by social and environmental awareness aligning with the national "sufficiency economy" ethos of moderation and resilience. This scenario likely improves human well-being and community resilience: by elevating education, local livelihoods, and social welfare, it builds capacity to cope with environmental changes. It may also be politically palatable, as it promises tangible improvements in people's daily lives and pursues sustainability in a gradual, consensus-driven way.

- **Trade-offs:** Lacking a fully proactive green strategy, this scenario risks continued ecosystem degradation in subtle ways–environmental improvements often lag development. Reactive stewardship means some problems are only addressed after they cause damage. Consequently, biodiversity and ecosystem services could still decline, which in turn can undermine the very development gains the scenario aims for. Additionally, by not aggressively pursuing either high growth or maximal conservation, the Balanced approach may yield "middling" outcomes–steady but unspectacular economic performance, and only partial sustainability gains. It's a compromise path that avoids extreme trade-offs but also fails to fully capitalise on win-win potentials.

### 8.10.5 Local resilience and community empowerment: Equity-oriented & proactive

This scenario envisions a future in which Thailand's marine ecosystems are stewarded primarily through the leadership, knowledge, and rights of local communities and Indigenous peoples. Governance is bottom-up, with national policy frameworks enabling and resourcing community-based management systems. Marine tenure and resource rights are formally recognised for Indigenous and local fishing communities, ensuring long-term stewardship incentives. ILK is integrated with scientific approaches to create adaptive management plans. Economic activities are small-scale to medium-scale, rooted in local benefit-sharing: eco-tourism managed by community cooperatives, low-impact artisanal fisheries, seaweed farming, and mangrove-friendly aquaculture. Blue carbon and biodiversity credit schemes channel finance directly to communities maintaining healthy ecosystems. Education and youth engagement are central—reviving traditional ecological knowledge and linking it with modern sustainability skills. The scenario assumes strong social cohesion and cultural continuity, with communities having high adaptive capacity to climate change through diversified livelihoods and resilient ecosystems. Nationally, this scenario contributes to achieving biodiversity targets through decentralised governance and equitable benefit sharing. It also delivers high cultural ecosystem service values, strengthens place-based identity, and reduces conflict over marine resources.

- **Strengths:** The Local Resilience and Community Empowerment scenario offers a strongly equity-oriented pathway by formally recognising the rights of local and Indigenous communities to manage and benefit from marine resources. It integrates ILK with scientific approaches, creating adaptive management systems that respond effectively to environmental change. This blend of knowledge systems enhances ecological outcomes while reinforcing cultural heritage and community identity. Economic activities are rooted in diversified, low-impact

livelihoods such as community-managed eco-tourism, artisanal fisheries, seaweed cultivation, and mangrove-friendly aquaculture, which generate income while sustaining ecosystem health. By ensuring that benefits from emerging mechanisms directly to communities, this scenario strengthens social cohesion, builds resilience to climate change, and reduces vulnerability to global market fluctuations.

- **Trade-offs:** While this scenario provides strong local benefits, it delivers slower large-scale economic growth than industrialised Blue Economy models. The decentralised governance structure requires sustained external support in capacity building, financing, and technical assistance to ensure long-term effectiveness. Shifting authority from central agencies to communities may face resistance from industrial sectors and policy actors who favor more centralized control. The small-scale nature of production can limit opportunities for national-level exports and reduce economies of scale. Moreover, variability in capacity and governance across communities can lead to uneven management outcomes. The model's success also depends heavily on maintaining social cohesion; demographic changes, out-migration, or local conflicts could undermine the stability and effectiveness of community governance over time.

At the later period of the study, the NEA expert team grouped the five workshop scenarios into three final scenario archetypes for reporting and monitoring purposes:

- **BAU–corresponds directly to the original BAU scenario.**
- **Blue Economy–combines the original Blue Economy scenario with the development-oriented elements of the Balanced Sustainable Development scenario.**
- **Nature-Positive–combines the Conservation-Focused and Local Resilience & Community Empowerment scenarios, emphasising net gains for biodiversity, ecosystem restoration, and community rights consistent with the KMGBF. The resulting Nature-Positive (Blue Economy Plus) scenario is described in Section 8.11.6.**

## 8.10.6 Nature-Positive (Blue Economy Plus) Scenario

The Nature-Positive (Blue Economy Plus) scenario represents a nature first transformation pathway in which halting and reversing biodiversity loss is the primary objective, and economic activities are redesigned to follow—rather than drive—ecosystem recovery. The Nature-Positive (Blue Economy Plus) scenario represents a nature-first transformation pathway in which halting and reversing biodiversity loss is the primary objective, and economic activities are redesigned to follow—rather than drive—ecosystem recovery. The defining feature of this scenario is that ecological integrity, ecosystem functionality, and community stewardship form the foundation of development, with economic benefits emerging only where they reinforce net-positive outcomes for nature. The Trialogue workshop (November 2025) discussion on Blue Economy evolution also has implications for scenario comparison. Participants noted that if governance ambition, investment, and community participation strengthen significantly, the Blue Economy pathway could shift into a Regenerative mode by 2050—achieving net-positive ecosystem outcomes rather than neutrality or minimal-impact performance.

Under the Nature-Positive pathway, Thailand commits to achieving net gains in ecosystem extent, condition, and resilience across marine systems. This includes expanding and effectively managing protected and conserved areas (including OECMs), restoring degraded ecosystems such as mangroves, seagrasses, coral reefs, and coastal wetlands at scale, and embedding biodiversity recovery targets into MSP, fisheries management, and coastal development controls. Ecological recovery is treated

as a non-negotiable prerequisite for long-term development and climate resilience.

The Blue Economy Plus element of the Nature-Positive scenario reflects a regenerative economic model that emerges from ecosystem recovery, rather than a growth strategy constrained by environmental safeguards. Economic benefits materialise progressively through improved fisheries productivity, enhanced coastal protection, blue-carbon sequestration, nature-based tourism, and large-scale restoration employment. While short-term expansion in extractive or infrastructure-intensive activities may be moderated or re-sequenced, the long-term returns include reduced disaster risks, sustained livelihoods, and strengthened cultural and relational values associated with healthy seas and coasts.

Governance in the Nature-Positive (Blue Economy Plus) scenario places ILK, community rights, and co-management at the center of decision-making. Coastal communities are recognised not only as beneficiaries but as stewards of ecosystem recovery, with equitable benefit-sharing mechanisms ensuring that gains from conservation, restoration, and blue-carbon finance accrue locally. Strong state leadership, coherent institutions, and adaptive governance are essential to support this transition and to manage political-economy challenges arising from the phase-out of harmful practices.

Overall, this scenario demonstrates that nature recovery is the enabling condition for long-term economic security, showing how Thailand can secure biodiversity, climate resilience, and human well-being simultaneously by redefining the Blue Economy as an outcome of living, functioning ecosystems rather than a pressure upon them.

On the comparative matrix, this trajectory would place regenerative Blue-Economy outcomes associated with the Nature-Positive scenario at a higher level of ecological restoration, blue-carbon performance, and community empowerment than the Blue Economy described in the scenario narratives. This reinforces that scenario outcomes exist along a continuum of ambition and that Thailand's pathway could evolve toward regenerative practices under favorable governance and financial conditions.

## 8.11 Scenarios impacts over different period (2025–2050) and coastal regions

The overall sequencing logic and the progression across the three scenarios are summarised in , which provides a consolidated overview supporting the narrative description below. Stakeholder consultations and expert deliberations confirmed that no single scenario can adequately address Thailand's diverse coastal and marine contexts. Instead, a phased and regionally differentiated combination of scenarios provides the most realistic and adaptive pathway toward 2050. This approach recognises that ecological degradation, governance capacities, and socio-economic priorities vary significantly across Thailand's five coastal zones, and that national policy must remain flexible and iterative. The refined process consolidates the earlier five archetypes into three final scenarios/archetypes:

- **Scenario 1:** BAU – retained as a reference baseline of current trends, fragmented governance and systemic risks.

- **Scenario 2:** Blue Economy – a sustainability-aware pathway that expands ocean-based economic opportunities in fisheries, aquaculture, tourism, ports, shipping, marine energy, and related sectors within ecological limits, while promoting social inclusion, livelihood improvement, improved regulation, MSP, innovation, circular economy approaches, and safeguards against ecosystem degradation.

- **Scenario 3:** Nature-Positive (Blue Economy Plus) – a conservation- and community-centered pathway that aims to halt and reverse biodiversity loss, expand and effectively manage protected and conserved areas, restore degraded ecosystems, and secure community rights and benefits, consistent with KMGBF targets. This scenario integrates ecological recovery, community stewardship, and regenerative blue-economy outcomes within a single pathway.

**Table 8.2: Comparison of three scenarios impacts over year periods (2025-2050)**

| Year | BAU | Blue Economy | Nature-Positive (Blue Economy Plus) |
|---|---|---|---|
| 2025 | Fragmented governance, weak enforcement, short-term GDP focus; degradation continues (coral, mangroves, fisheries) | Policy push for sustainable ocean industries (aquaculture, eco-tourism, renewables); MSP pilots; community enterprises supported | Thailand adopts a Nature-Positive commitment, tightening controls on destructive practices and expanding protected and conserved areas (including OECMs). Co-management rights are strengthened and ILK is integrated into restoration pilots |
| 2030 | Urban/industrial expansion in Eastern Seaboard; Upper Gulf pollution worsens; overfishing deepens livelihood insecurity | Certified fisheries, eco-tourism, biodiversity credits expand; inclusive PPPs integrate communities; ecosystems moderately improve | Restoration (mangroves, seagrasses, reefs) is scaled nationally with biodiversity/blue-carbon finance, and community fisheries/LMMAs expand. Thailand reaches ≥30% effectively conserved and well-managed marine/coastal areas, with early recovery signals in priority sites |
| 2040 | Tourism & fisheries revenues decline due to ecosystem loss; disaster risks rise; inequities widen | Thailand leads region in sustainable ocean industries; local co-ownership of enterprises; blue carbon mainstreamed | Recovery becomes widespread and measurable, strengthening coastal protection, fish productivity and climate resilience. ILK–science integration and adaptive co-governance are institutionalised; Blue Economy Plus benefits grow (restoration jobs, blue carbon, nature-based tourism) within ecological limits |
| 2050 | Systemic ecological & social decline; biodiversity collapse, food security compromised, reliance on imports grows | Blue Economy evolves into whole-of-society SD pathway; growth decoupled from ecosystem decline; resilience & inclusivity achieved | Marine ecosystems show substantial net gains in extent/condition, underpinning long-term human security and adaptation. Blue Economy Plus is established as an outcome of healthy ecosystems, with equitable benefit-sharing secured through strong institutions and community stewardship |

### 8.11.1 Scenarios impacts over the year periods (2025–2050)

#### *a) Scenario 1: Business-as-Usual (BAU)*

- **2025**: Policy and governance remain fragmented. Development priorities focus on short-term GDP growth, with weak enforcement of coastal zoning and fisheries regulations. Ecosystem degradation continues in sensitive areas (coral bleaching, mangrove clearing, overfishing).

- **2030:** Urbanisation and industrial expansion on the Eastern Seaboard accelerate. Pollution in the Upper Gulf worsens. Fisheries are increasingly overexploited, forcing small-scale fishers into debt and livelihood insecurity. Limited MSP is introduced but poorly enforced.

- **2040:** Degraded ecosystems undermine tourism and fisheries revenues. Coastal communities face higher disaster risks due to loss of mangroves and coral reefs. Social inequities widen as large-scale operators continue benefiting while small communities struggle.

- **2050:** BAU leads to systemic decline. Coastal ecosystems lose resilience, biodiversity continues to collapse, and ecosystem services (food security, storm protection) are severely diminished. Economic reliance shifts toward imports, with high social and ecological costs.

BAU serves only as a cautionary counterfactual, underscoring the costs of inaction.

#### *b)Scenario 2: Blue Economy*

- **2025:** Policy frameworks emphasise investment in sustainable ocean industries, with pilot projects in aquaculture, ecotourism, and renewable marine energy. Community-level enterprises (eco-seaweed farms, artisanal aquaculture, homestay tourism) are supported as part of the Blue Economy. Early MSP is rolled out in high-pressure provinces.

- **2030:** Blue Economy expands with stronger regulatory safeguards. Certified fisheries, green shipping, and biodiversity credit schemes begin generating revenue. Communities are integrated into public–private partnerships, ensuring inclusive participation. Ecosystem health improves moderately due to environmental safeguards, though pressures from investment remain high. At least 10% of the marine area is under effective conservation and sustainable use arrangements, underpinning growth in certified sustainable fisheries, eco-tourism and low-carbon marine sectors.

- **2040:** Thailand positions itself as a regional leader in sustainable ocean industries. Marine biotech, eco-tourism, and renewable energy thrive, generating jobs across scales. Importantly, local communities co-own enterprises, ensuring benefits reach households as well as corporations. Blue carbon and biodiversity finance flows are mainstreamed into national accounts.

- **2050:** The Blue Economy evolves into a whole-of-society sustainable development pathway. Ecosystem services are stabilised through regulation and community stewardship, while economic growth is decoupled from ecological decline. Thailand's coastal regions demonstrate resilience and inclusivity, achieving sustainable development across macro, meso, and local levels.

The scenario pathway of Blue Economy will support to revive a decline of past and negative conditions of coastal and marine ecosystems over the period of 2025-2050 (Figure 8.7).

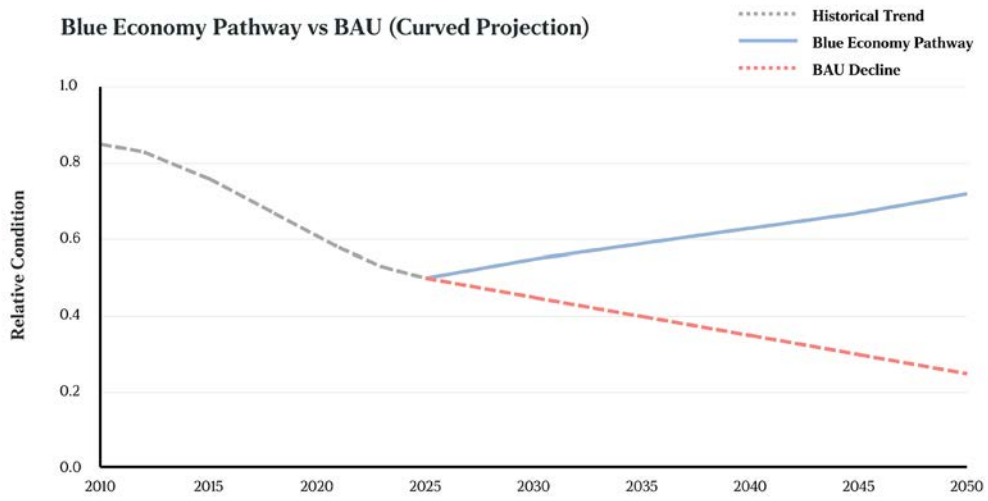



**Figure 8.7: Thailand's coastal and marine ecosystems scenario pathway with historical baseline (2010-2050): BAU VS Blue Economy**

The Blue Economy provides a vehicle for inclusive growth, provided safeguards and equity mechanisms are enforced.

### *c) Scenario 3: Nature-Positive (Blue Economy Plus)*

- **2025:** This period is to lay the ecological foundations. In the Nature-Positive (Blue Economy Plus) scenario, ecological recovery precedes and enables economic outcomes, rather than being pursued alongside or subordinate to growth objectives. Thailand makes an explicit national commitment to a Nature-Positive pathway, prioritising the halting of biodiversity loss in marine ecosystems. Legal and policy frameworks are strengthened to restrict destructive activities, expand protected and conserved areas (including OECMs), and embed biodiversity recovery objectives into MSP and coastal development controls. Formal recognition of community co-management rights in coastal zones is expanded, and ILK is systematically integrated into the design of early restoration pilots. At this stage, economic expansion is deliberately secondary to establishing ecological baselines, governance coherence and social legitimacy.

- **2030:** It is to scale restoration and to secure net-positive trajectories. Large-scale restoration of mangroves, seagrasses, coral reefs and coastal wetlands is underway in priority degraded areas, supported by public investment and emerging biodiversity and blue-carbon finance. Community-based fisheries management and LMMAs are scaled up, with early signs of ecological recovery evident in improved fish biomass and stabilising reef conditions in well-managed sites. By 2030, Thailand is on track to achieve at least 30% effectively conserved and well-managed marine and coastal areas, with restoration embedded as a national policy instrument. Economic benefits begin to emerge indirectly through improved food security, reduced disaster risks and small-scale nature-based livelihoods, but growth remains intentionally measured.

- **2040:** It will recover to translate into resilience and livelihoods. Ecosystem recovery becomes more widespread and ecologically meaningful, with restored habitats providing tangible coastal protection, fisheries productivity and climate resilience benefits. Governance systems mature, institutionalising ILK–science integration, adaptive management and cross-sector coordination. Communities are firmly positioned as stewards and decision-makers rather than beneficiaries alone. As ecosystem functions recover, a Blue Economy Plus begins to materialise restoration-linked employment, resilient small-scale fisheries, blue-carbon revenues and nature-based tourism expand, explicitly grounded in ecological thresholds and equity safeguards.

- **2050:** Nature-Positive outcomes underpin long-term prosperity. By mid-century, Thailand's marine ecosystems have achieved substantial recovery in extent, condition and functionality, forming the backbone of national climate adaptation and human security strategies. Economic activities associated with the Blue Economy Plus are well established but remain conditional on maintaining net-positive biodiversity outcomes. Strong institutions, empowered communities and long-term financing mechanisms ensure equitable benefit-sharing and sustained stewardship. Conservation is no longer treated as a sectoral objective, but as a structural foundation for resilient, inclusive and sustainable national development.

The scenario pathway of Nature-Positive will significantly bend the decline of past and negative conditions of coastal and marine ecosystems over the period of 2025-2050 (Figure 8.8). Towards Nature-Positive is indispensable to halt ecological decline and restore resilience.

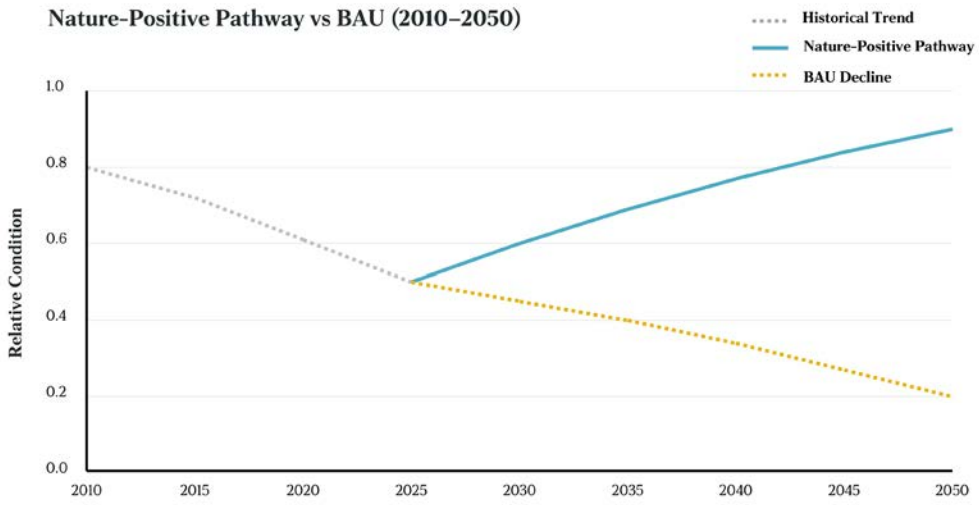



**Figure 8.8: Thailand's coastal and marine ecosystems scenario pathway flow diagram with historical baseline (2010-2050): BAU VS Nature-Positive (Blue Economy Plus)**

During the Trialogue Workshop (November 2025), participants raised an important clarification regarding the sequencing of Thailand's future pathways. Several stakeholders emphasised that the transition from the present to 2050 should not be interpreted as a fixed or linear sequence. Instead, pathways represent plausible and equally legitimate trajectories depending on governance readiness, ecological conditions, and political priorities. Some participants argued for a direct transition from today's BAU trajectory to a Blue Economy model, noting that economic incentives, technological innovation, and rapid policy reform could enable Thailand to adopt sustainable

ocean-based industries without necessarily undertaking a conservation approach. Others stressed that a 'Conservation First' sequence is essential, arguing that ecological recovery and rebuilding natural capital are necessary foundations for sustaining long-term blue-economy benefits—particularly in degraded coastal zones where ecosystem function must improve before productivity can be increased.

**Box 8-2: Criteria for applying scenario pathways in marine areas**

1. **Ecological significance**–presence of critical habitats, biodiversity hotspots (e.g., mangroves, coral reefs, KBAs/IBAs), blue carbon ecosystems, and areas under high restoration priority.
2. **Socio-economic vulnerability or opportunity**–dependence on fisheries or tourism, poverty/vulnerability levels, coastal livelihood diversity, anticipated growth pressures, and local economic opportunities.
3. **Governance readiness and institutional capacity**–effectiveness of local institutions, existence of co-management arrangements, MSP/ICZM readiness, enforcement capability, and cross-sector coordination.
4. **Feasibility and financing potential**– availability of public or private investment, suitability for NbS, restoration feasibility, blue/green finance access, and project pipeline maturity.
5. **Equity and inclusion considerations**– presence of ILK holders, small-scale fishers, women-led enterprises, and communities requiring stronger benefit-sharing mechanisms.

The NEA therefore recognises multiple plausible entry points and sequences toward Thailand's desired 2050 future. The sequence will depend on how governance, finance, ecosystem health, and stakeholder engagement evolve over time. By 2050, integration of both pathways (Blue Economy and Nature-Positive) offers the most plausible and desirable national future: resilient ecosystems underpinning a thriving, inclusive ocean economy. This clarification reinforces that scenario pathways should be interpreted as alternative strategic options—not prescriptions—allowing policy makers to adopt whichever transition becomes feasible under future political, economic, or ecological conditions.

## 8.11.2 Scenarios impacts over different coastal and marine regions (of Thailand)

Different scenarios might be suited to different coastal regions of Thailand. This is due to their context, baseline, level, risks and opportunities in respect to economic, social and environmental development, management and conservation. At the 2nd Scenarios Workshop (October 2025), stakeholders preliminarily considered addressing the following:

- Eastern Seaboard: Blue Economy priorities dominate (ports, aquaculture, shipping), but under strict safeguards.
- Andaman Coast and Islands: Nature-Positive scenario (Conservation-first) is emphasised, with MPA, ILK stewardship, and eco-tourism central to livelihoods.
- Some Southern Provinces (Trang, Satun): Hybrid approaches, where community resilience supports both Nature-Positive and small-scale Blue Economy ventures.
- Upper Gulf & Bangkok Metro Coastal areas: Initially BAU-like pressures dominate (pollution, urban expansion), but transition is required toward regulated Blue Economy to avoid collapse.
- Songkhla Lake Basin: Balanced approach integrating wetland conservation with community fisheries and local development enterprises.

To guide practical application of the scenarios in different coastal regions, a set of high-level criteria for selecting or combining scenario pathways is provided in Box 82 The principle of sequencing and spatial tailoring highlights that policymakers should avoid framing scenarios as mutually exclusive choices. Instead, the NEA presents a portfolio of pathways that evolve over time and across regions. The key insight is that Nature-Positive provides the ecological base, Blue Economy provides long-term inclusive growth, and BAU serves as a baseline warning. Adaptive governance is essential to guide the transition across these phases and contexts.

## 8.11.3 Scenarios impacts to biodiversity ecosystem services of Thailand

The three scenarios will impact in a change and resilience of key coastal, and marine ecosystems, habitats, species and their biodiversity ecosystem services at varying degrees of impacts. Scenarios impact on ecosystems and their services is compared in Table 8.3 and Figure 8.9. In more details of scenarios impacts on biodiversity ecosystem services (provisioning/regulating/cultural/supporting services), it is assessed and presented in Table 8.4. In addition, scenarios features and dimensions also are compared to view their impacts in Table.

**Table 8.3: Comparative impacts and outlooks of BAU, Blue Economy and Nature-Positive scenarios toward sustainable development**

| Ecosystem / Service | BAU | Blue Economy | Nature-Positive (Blue Economy Plus) |
|---|---|---|---|
| Coral Reefs | Ongoing decline from bleaching, overfishing, and pollution; live coral cover drops below critical thresholds | MSP regulates coastal development; eco-tourism and reef-friendly industries create incentives; moderate recovery, but hotspots still stressed by climate change | Strict no-take protection and restoration, with co-management |
| Beaches & Coastal Dunes | Continued erosion due to sand mining, unregulated tourism, and coastal infrastructure | Green infrastructure (eco-resorts, managed tourism) and integrated coastal planning stabilise beaches while sustaining tourism | Enforced coastal setbacks and dune/vegetation rehabilitation, supported by community stewardship, reduce erosion and improve buffer function |
| Mangroves | Conversion for aquaculture, ports, and settlements persists; fragmentation undermines carbon storage and nursery functions | Blue carbon finance drives large-scale mangrove planting and sustainable use; mixed outcomes depending on governance quality, but net positive cover gains | Protected area expansion plus large-scale rehabilitation increases connectivity and nursery/carbon functions, with community co-management strengthening tenure and compliance |
| Seagrass Beds | Declines due to sedimentation, eutrophication, and boat traffic; dugong and seahorse populations threatened | Zoning of seagrass meadows into MSP ensures protection alongside aquaculture/tourism; eco-certification schemes incentivise sustainable use | Priority meadow protection and targeted restoration reduce physical damage and improve water quality, enabling recovery of associated species (e.g., dugong habitats) |
| Estuaries & Coastal Wetlands | Pollution, reclamation, and hydrological disruption reduce productivity and biodiversity | Sustainable aquaculture and wastewater treatment integrated into estuarine zones; balance between use and ecological health | Integrated watershed–coastal management and wetland protection restore hydrology and water quality, improving productivity and nursery functions |
| Open Sea / Pelagic Ecosystems | Overfishing and bycatch persist; declining pelagic fish stocks, plastic pollution accumulates | Regional collaboration on sustainable fisheries and green shipping; aquaculture reduces pressure on wild stocks; moderate improvement | Stronger fisheries controls (quotas, bycatch reduction, enforcement) and reduced pollution pressures support rebuilding of pelagic stocks |
| Small Islands & Associated Ecosystems | Over-tourism, waste, and freshwater scarcity degrade fragile ecosystems | Eco-tourism and renewable island energy projects diversify income; ecosystem safeguards partially offset pressures of continued visitation | Visitor management, waste/water controls, and community/ILK-led stewardship reduce chronic pressures and strengthen storm resilience |
| Provisioning Services (Food, Livelihoods) | Declining fisheries and aquaculture unsustainably exploit ecosystems; local food insecurity rises | Certified sustainable aquaculture and fisheries supply both domestic and export markets; communities benefit through inclusive PPPs | More secure food and livelihoods arise from recovering ecosystems via community-based fisheries and sustainable small-scale enterprises |
| Regulating Services (Coastal Protection, Climate Regulation, Water Quality) | Loss of mangroves, reefs, and seagrass weakens coastal defenses and carbon sinks | Ecosystem-based solutions embedded in MSP and infrastructure planning; resilience improves if governance enforces safeguards. | Restored reefs–mangroves–seagrass strengthen coastal protection, blue-carbon storage and water purification at landscape scale. |
| Cultural & Supporting Services | Loss of ILK, cultural landscapes, and eco-tourism appeal. | Community enterprises (seaweed farms, eco-homestays, cultural tourism) thrive under Blue Economy; local values integrated into industry | ILK and cultural identity are reinforced through stewardship, with eco-cultural tourism growing as an outcome of healthier ecosystems. |
| Overall Outlook (2050) | Systemic decline; biodiversity collapse undermines livelihoods, equity, and resilience. | Balanced sustainable growth, ecosystems stabilised, inclusive benefits across scales; Thailand becomes regional leader in sustainable ocean economy. | Net gains for ecosystems and resilience, with Blue Economy Plus benefits accruing from sustained nature recovery and equitable governance. |

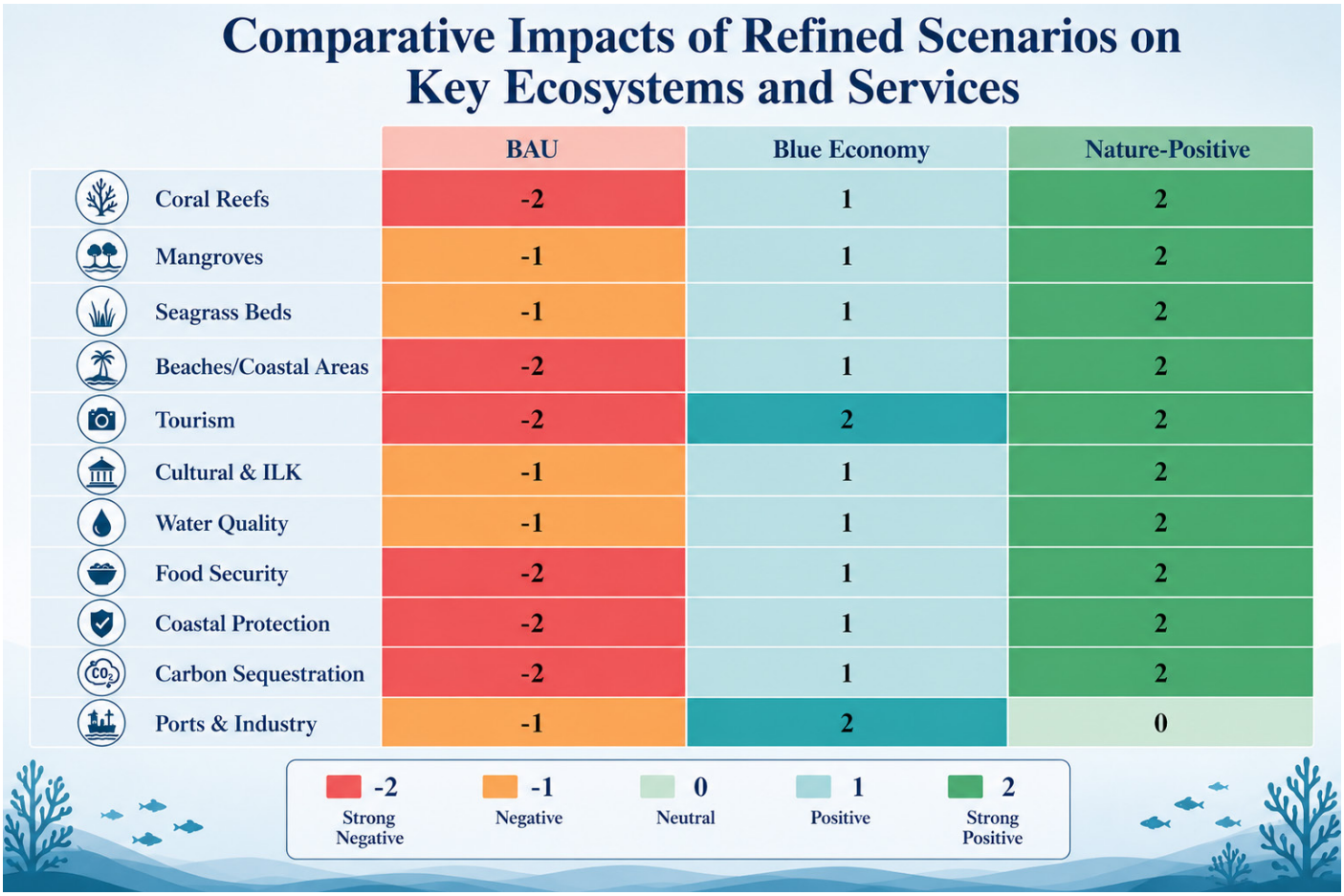



**Figure 8.9: Comparative impacts of 3 scenarios to coastal and marine biodiversity and ecosystem services of Thailand**

Figure 8.9 is the heatmap which explains comparative impacts of three scenarios on Marine BES. Scoring from -2 (strongest negative impacts) to +2 (strongest positive impacts). Orange to red, Blue, and Green colour shades for BAU, Blue Economy and Nature-Positive Scenarios respectively. The heatmap illustrates how the three refined scenarios would affect major coastal and marine ecosystems and services of Thailand. BAU (red cells) shows systemic decline across most dimensions, underscoring its role as a baseline risk pathway. The Nature-Positive scenario (dark green) generates the strongest ecological and social gains, though with limited expansion in ports and industry. The Blue Economy scenario (light to dark green) delivers moderate ecological improvements alongside stronger economic and governance outcomes. Together, these visual contrasts highlight why sequencing and integration of Nature-Positive and Blue Economy pathways offer the most desirable future.

**Table 8.4: Distinctive features regarding ecosystem services of the three scenarios (2025–2050)**

| Ecosystem Service | BAU | Nature-Positive | Blue Economy |
|---|---|---|---|
| Provisioning (Food, Livelihoods, Raw Materials, Bioprospecting) | Overfishing reduces fish stocks; aquaculture unsustainable; local food insecurity grows | Community fisheries & ILK secure sustainable catches; small-scale aquaculture; new livelihood diversity | Certified fisheries, sustainable aquaculture, marine biotech & biodiversity credits; inclusive PPPs provide income at local & national scales |
| Regulating (Coastal Protection, Carbon Sequestration, Water Purification, Climate Regulation) | Loss of reefs, mangroves, seagrass; declining coastal defenses; rising disaster risks | Restored ecosystems enhance storm protection, blue carbon sequestration, and water quality regulation | Ecosystem-based solutions mainstreamed in MSP & infrastructure; blue carbon finance integrated; partial but significant recovery |
| Cultural (Tourism, Recreation, Spiritual & Heritage Values, ILK) | Tourism appeal declines with degraded ecosystems; ILK practices erode | ILK revitalised; eco-cultural tourism expands; community identity and stewardship strengthen | Eco-tourism, seaweed farms, community homestays thrive; cultural values integrated into sustainable industries |
| Supporting (Nutrient Cycling, Primary Productivity, Habitats for Biodiversity) | Severe disruption: nutrient cycling weakened; habitat loss leads to biodiversity decline | Ecosystem recovery restores habitats; biodiversity rebounds; supporting services secured | MSP balances development with habitat protection; supporting services moderately improve; innovation offsets some pressures |
| Overall 2050 Outlook | Systemic decline of Marine BES undermines human well-being and national economy | Strong recovery of Marine BES secures ecological resilience, food security, and cultural identity | Marine BES stabilised through governance & green growth; sustainable development achieved at all scales |

## 8.11.4 Scenario Impacts on Features and Dimensions related to marine ecosystems of Thailand

In addition, scenarios' impacts are featured and determined in a varied way. The comparison of scenarios impacts differentiates what, and how they will lead to different ways to reach out the coastal and marine futures (Table 8.5).

**Table 8.5: Comparative different features and dimensions of three scenarios**

| Features/Dimension | BAU | Nature-Positive | Blue Economy |
|---|---|---|---|
| 1. Primary Orientation | Short-term economic growth; reactive problem-solving. | Ecosystem health and biodiversity protection as first priority. | Balanced pursuit of sustainable growth, integrating economy & ecology |
| 2. Environmental Governance Mode | Fragmented, weak enforcement; sectoral planning. | Strong state-led conservation, community co-management, expansion of MPAs. | Integrated MSP (MSP), multi-level governance, PPPs. |
| 3. Economic Impact & Changes | Continued GDP gains but with resource depletion; risk of collapse in fisheries/tourism | Initial economic slowdown (restrictions) but long-term resilience from ecosystem recovery | Sustained, diversified growth via eco-tourism, aquaculture, renewables, marine biotech |
| 4. Social & Equity Improvement | Benefits skewed toward large-scale/industrial sectors; equity gaps persist | High emphasis on community rights, ILK, equity, food security, and social resilience | Shared benefits across levels (macro + local); emphasis on inclusive business models |
| 5. Role of Technology & Innovation | Incremental, driven by industry; limited green adoption | Supportive tools for monitoring, restoration, enforcement; less tech-intensive | Central driver: green tech, renewable energy, marine biotech, digital MSP tools |
| 6. Governance Approach | Centralised, sectoral, reactive | State regulation + decentralised co-management with local/ethnic communities. | Networked governance: PPP, state facilitation, private sector leadership, local empowerment. |
| 7. Main Benefits | Short-term income, infrastructure expansion, urban/port growth | Recovery of coral, mangroves, seagrass; biodiversity rebound; food security; cultural continuity | Steady growth with sustainable marine sectors; carbon credits; jobs in green economy |
| 8. Key Risks | Ecosystem collapse, overfishing, coral bleaching, social inequity, climate vulnerability | Economic opportunity costs; conflict with business interests; enforcement burden. | Greenwashing; unequal benefit sharing; dependence on tech/finance; policy capture risk |
| 9. Tools Acquired/Used | Conventional EIA, fragmented policies | MPAs, OECMs, LMMAs, ILK-based practices, PES, strict enforcement | MSP, blue carbon markets, biodiversity credits, eco-certification, advanced monitoring |
| 10. Typical Sequencing Role (2025–2050) | Baseline path; continuation if no reform | Early-stage 2025–2030 to stabilise ecosystems and empower local resilience | Scaling up 2030–2050 for green industries and integration into national strategy |
| 11. Role of Local Communities & ILK | Marginalised; ILK eroded | Central actors in co-management, restoration, and resilience building | Partners in eco-business, community tourism, and blue economy co-benefits |

Figure 8.10 helps visualize scenario impacts across four dimensions—ecological, economic, social & cultural, and governance—under the three refined scenarios: BAU, Blue Economy, and Nature-Positive (Blue Economy Plus). Impact scores range from –2 (strong decline) to +2 (strong improvement/recovery), shown as a heatmap with scenario-specific colour families (red/orange for BAU, blue for Blue Economy, and green for Nature-Positive)

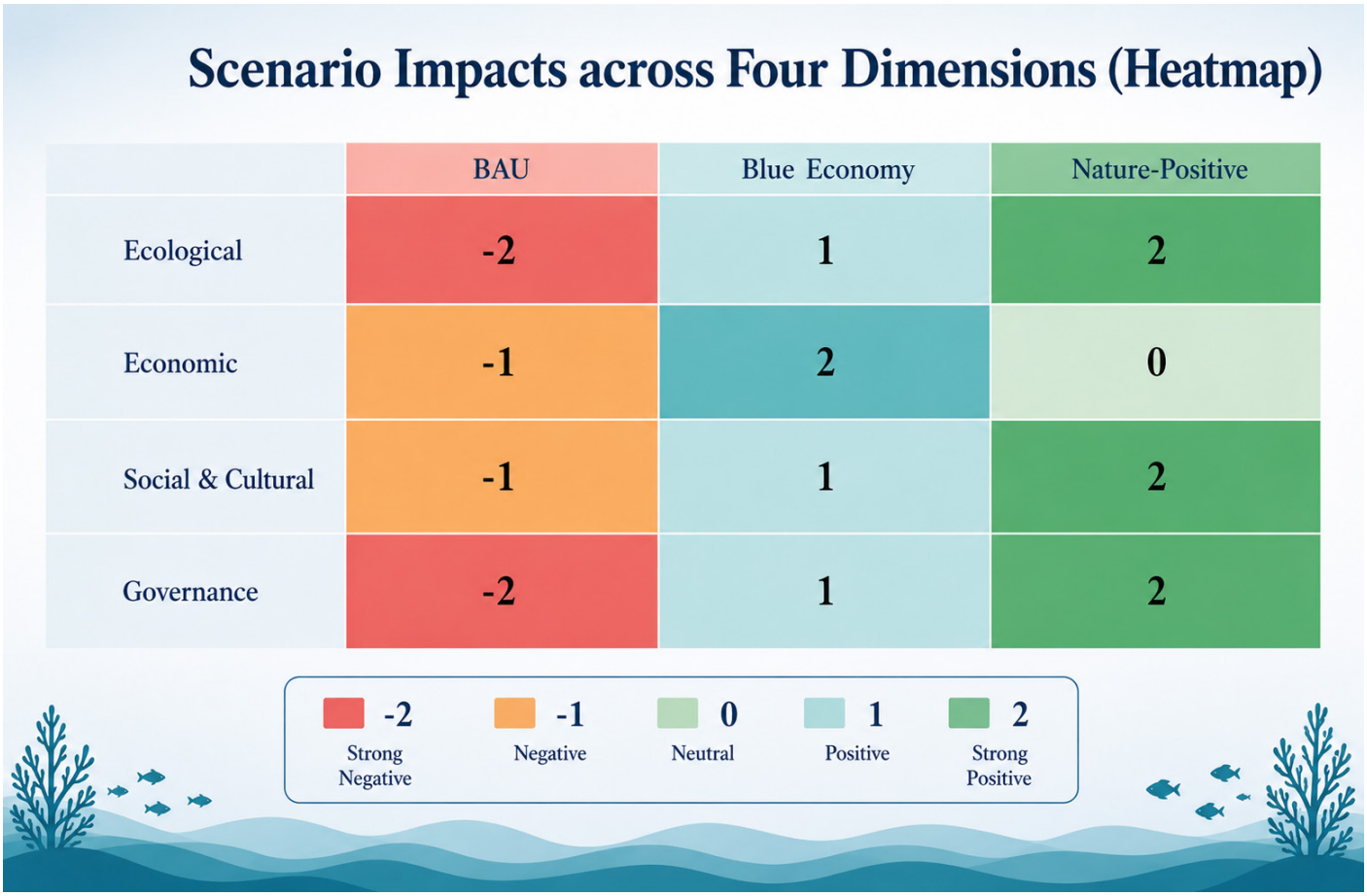



**Figure 8.10: Scenario impacts across four dimensions – ecological, economic, social & cultural, and governance**

## 8.12 Scenarios monitoring

The scenarios monitoring is necessary to track scenario impacts. It should be designed as an unified system. A common set of indicators is applied across all scenarios, supported by a smaller set of scenario-specific signposts that track divergence points relevant for adaptive management. The framework therefore supports a single national monitoring structure, while still enabling early detection of shifts that may require different policy responses.

The monitoring of scenarios serves two main purposes:

1. To track the evolution of each scenario pathway (individual monitoring), ensuring that intended ecological, social, and economic outcomes are realized.

2. To evaluate the integrated pathway of combined and sequenced scenarios across time and space, recognising that "no single scenario fits all contexts" in Thailand's diverse marine ecosystems.

The framework reflects the consolidation of scenarios into three core archetypes:

- **Scenario 1: BAU**
- **Scenario 2: Blue Economy**
- **Scenario 3: Nature-Positive**

The scenarios monitoring framework should be designed as an unified set of indicators. Scenario-specific differences are captured through divergence signals (signposts), rather than by creating separate indicator lists for each scenario. Scenario signposts or divergence signals are qualitative patterns or thresholds in the core indicators that indicate whether Thailand is moving closer to, or further away from, scenario logics (e.g. Nature-Positive, Blue Economy, or BAU). They can be positive signals of progress or early warnings of undesirable drift.

## 8.13 Policy implications/insights and actions required by scenarios

The three scenarios for Thailand's coastal and marine ecosystems offer distinct pathways toward 2050. Each presents a set of outcomes and trade-offs and requires policymakers to adopt tailored strategies to either support, manage, or avoid those futures. For each scenario, likely outcomes and corresponding policy actions are identified to support, manage, or avoid the pathway.

- **Scenario 1: BAU** If Thailand continues along the BAU trajectory, the current fragmented governance and short-term growth priorities will dominate. Coastal and marine ecosystems will continue to degrade, with coral reefs and seagrass beds reaching critical thresholds of collapse, mangrove losses accelerating in unprotected areas, and fisheries increasingly overexploited. As a result, ecosystem services such as food provision, coastal protection, and tourism revenues will decline. Social inequities will deepen as coastal communities lose livelihoods, while large-scale operators benefit in the short term. Policymakers must recognise BAU as a risk scenario rather than a desirable option. If this path persists, governments will need to strengthen disaster response budgets, social protection mechanisms, and food imports to mitigate worsening crises. BAU illustrates the high costs of inaction and reinforces the urgency of proactive alternatives.

- **Scenario 2: Blue Economy** The Blue Economy pathway offers a balanced, proactive future in which Thailand expands ocean-based economic opportunities while operating within ecological limits. In this scenario, growth in sectors such as sustainable fisheries, aquaculture, eco-tourism, ports and shipping, and offshore renewable energy is guided by MSP, ICZM and robust environmental safeguards. Ecosystem conditions improve in key use areas compared to BAU but may not recover as fully or as quickly as under the Nature-Positive scenario, especially in highly pressured seascapes. Distributional outcomes depend heavily on whether local communities and small-scale operators can participate in and benefit from new blue-economy investments.

  For policymakers, the Blue Economy scenario implies a shift from fragmented, sector-by-sector decision-making to integrated ocean governance and economic planning. It seeks to align investment, innovation and trade with environmental objectives, rather than treating them as separate agendas. However, without strong institutions, transparency and accountability, there is a risk of "blue-washing" – where activities are labelled as sustainable or green but continue to degrade ecosystems and concentrate benefits among powerful actors.

  To enable a credible and equitable Blue Economy pathway, governments and partners must:

  - Institutionalise MSP and ICZM as legal and practical frameworks that guide where and how marine activities can expand, ensuring compatibility with conservation and climate resilience objectives.
  - Mobilise sustainable blue finance – including blue bonds, blended finance, biodiversity credits and carbon markets – linked to clear environmental and social performance criteria.
  - Set and enforce sustainability standards and certification for key sectors (fisheries, aquaculture, tourism, ports, marine energy), to prevent over-exploitation and pollution and to maintain Thailand's competitiveness in global markets.
  - Design inclusive Public–Private–Community Partnerships (PPCPs) that enable local communities, small-scale fishers and SMEs to access capital, technology and markets, rather than being displaced by large operators.
  - Support innovation and knowledge hubs in marine biotechnology, low-impact aquaculture, renewable energy, coastal protection and circular bio-economy solutions, linked to universities and local enterprises.
  - Strengthen monitoring, transparency and accountability through open data, independent audits and participation of civil society and communities, to reduce greenwashing and elite capture.

  This scenario shows how Thailand can pursue sustainable blue growth that contributes to jobs, income and fiscal revenue, while maintaining ecosystem integrity and strengthening local resilience–provided that governance reforms, equity safeguards and genuine environmental standards are in place.

- **Scenario 3: Nature-Positive (Blue Economy Plus)** A conservation- and community-centered pathway that aims to halt and reverse biodiversity loss, achieve net gains in ecosystem extent and condition, and deliver a regenerative "blue economy plus" model in which economic activities are redesigned around ecosystem recovery, climate resilience and equitable benefit-sharing. A Nature-Positive pathway would prioritise ecological recovery and community resilience as the foundation of marine development. In this scenario, Thailand commits to halting and reversing biodiversity loss, expanding and effectively managing protected and conserved areas (including OECMs), and restoring degraded ecosystems such as mangroves, seagrasses and coral reefs at scale. Short-term growth in some extractive and infrastructure-intensive sectors may be moderated, but long-term gains in climate resilience, fisheries productivity, coastal protection and cultural values are substantial. The scenario also assumes that ILK, community rights and co-management are central to governance, so that benefits from conservation and restoration are shared fairly.

  For policymakers, the Nature-Positive (Blue Economy Plus) scenario implies a deliberate rebalancing of priorities: from maximizing near-term sectoral GDP to safeguarding the natural capital that underpins long-term well-being and risk reduction. It requires confronting political economy challenges – including resistance from vested interests and the need to compensate or support groups that may face opportunity costs when harmful activities are phased out. At the same time, it opens space for new green and blue livelihood opportunities (restoration jobs, eco-tourism, sustainable fisheries, blue carbon projects) that can benefit coastal communities if designed with equity in mind.

  To make a Nature-Positive pathway viable, governments and partners must:

  - Secure rights and roles of local communities and small-scale fishers in marine resource governance, through legal recognition of tenure, co-management arrangements and inclusive decision-making.

  - Strengthen and expand area-based conservation and restoration, including MPAs and OECMs, backed by long-term finance, effective enforcement and clear social safeguards.

  - Provide fiscal and market incentives for nature-positive practices, such as reforming harmful subsidies, adopting PES schemes, and using tax and fee structures that reward conservation outcomes.

  - Invest in community-based enterprises and diversified livelihoods (e.g., eco-tourism, sustainable aquaculture, value-added processing, blue carbon projects) to offset opportunity costs and share benefits from conservation.

  - Institutionalise ILK and community monitoring in planning and evaluation, for example through community-based monitoring (CBM) systems that inform national indicators and adaptive management.

  - Ensure social protection and just transition measures for workers and communities affected by the phase-out of destructive practices, so that conservation is associated with fairness rather than loss.

Under this scenario, Thailand demonstrates that strong state commitment, robust institutions and empowered communities can deliver net gains for nature while enhancing long-term human security and coastal resilience.

There are cross-cutting policy insights from the three scenarios.

**BAU is a risk baseline, not a viable option.**

The BAU scenario is useful as a reference to visualize the cumulative costs of fragmented governance, delayed reforms and continued ecosystem degradation, but it clearly demonstrates that "no major change" is inconsistent with Thailand's climate, biodiversity and sustainable development commitments.

**Nature-Positive is essential to secure ecological foundations and resilience.**

The Nature-Positive scenario shows that halting and reversing biodiversity loss, scaling up protection and restoration, and recognising ILK and community rights are not optional add-ons, but pre-conditions for safeguarding coastal protection, food security, cultural values and long-term risk reduction.

**A credible Blue Economy depends on Nature-Positive outcomes.**

The Blue Economy scenario illustrates that sustainable blue growth can generate jobs, revenues and innovation, but only if it is grounded in clear ecological limits, effective safeguards and genuine improvements in ecosystem condition. Without those Nature-Positive elements, "blue growth" risks becoming blue-washing and locking in new pressures.

**Integrated policy packages are needed, combining Nature-Positive and Blue Economy instruments.**

In practice, Thailand's policy mix will need to draw on both Nature-Positive and Blue Economy levers: regulatory reforms, area-based conservation and restoration, community-based governance and social protection on the one hand, and blue finance, MSP/ICZM, standards and innovation on the other. The scenarios suggest that combining these tools is more effective than pursuing any single "pure" pathway.

**Equity, participation and institutional capacity are decisive enablers in all futures.**

Across all three scenarios, the distribution of benefits and risks – between regions, sectors and social groups – is shaped by who participates in decision-making, how rights are recognised and enforced, and whether institutions have the capacity and integrity to implement agreed policies. Strengthening these enabling conditions is therefore a common policy priority, whatever pathway Thailand chooses.

## 8.14 Policy alignment of scenarios with NBSAP, KMGBF, and SDGs

The refined NEA scenarios are not only tools to envision possible futures for Thailand's marine ecosystems but also instruments to guide the country toward achieving its national and international biodiversity commitments. By explicitly linking scenario outcomes to Thailand's 5th NBSAP (2023–2030), the KMGBF, and the 2030 Agenda for Sustainable Development (SDGs), the NEA demonstrates its relevance for policy implementation at multiple levels (Table 8.5).

**Table 8.6: Comparative alignment of Thailand's NEA scenarios with policy frameworks (2025-2050)**

| NEA Scenario | 5th NBSAP (2023–2030) | KMGBF Targets (2030) | SDGs | Thailand's BCG Economy Policy & Blue Economy Strategy |
|---|---|---|---|---|
| **BAU** | Risks undermining most targets, esp. T1–T4 (conservation), T5–T7 (sustainable use), T8–T12 (mainstreaming, finance, capacity) | Fails KMGBF T1–T3 (area-based), T7 (pollution), T8 (climate), T10 (fisheries); undermines T14–23 on mainstreaming and participation | Negative impacts on SDG 14, 15, 13, and equity-focused SDGs (1, 10) | Threatens biodiversity capital, weakens food, health, and tourism sectors under BCG; undermines sustainability of marine industries under Blue Economy |
| **Blue Economy** | Advances Strategy 2 targets: T5–T7 (bio-based livelihoods, sustainable aquaculture/fisheries/tourism, ABS)<br>Supports Strategy 3: T8–T12 (mainstreaming, finance, capacity, legal tools) | Advances T9–T13 (sustainable use, fisheries, tourism), T14–T15 (mainstreaming, business disclosure), T18–T19 (finance), T20–T23 (capacity, knowledge, gender). | Aligns with SDG 14.7, 8.2, 9.4, 12.6/12.7, 13.2. | Directly operationalises BCG (bio-based industries, sustainable tourism, health innovation, bioenergy) and Blue Economy (green ports, MSP, eco-certification, blue bonds)<br>Comparable caution notes for distributional risks and implementation costs |
| **Nature-Positive (Blue Economy Plus)** | Strongly supports Strategy 1 targets: T1–T4 (protected areas, restoration, resilience, IAS control)<br>Also contributes to Strategy 3 (mainstreaming, capacity) | Advances T1–T3 (30×30, restoration), T7–T8 (pollution/climate), T11 (nature's contributions), T21–T22 (ILK, participation) | Aligns with SDG 14.2, 14.5, 15.1, 15.5, 13.1<br>May involve short-term trade-offs with growth and employment objectives unless paired with livelihood diversification, compensation, and just-transition support | Safeguards biodiversity base of BCG sectors (food, health, tourism); anchors Blue Economy strategy with healthy ecosystems and community stewardship |
| **Integrated Sequenced Pathway (→ Blue Economy → Nature-Positive →Integration by 2050)** | Provides holistic alignment across all 12 NBSAP targets by sequencing early conservation with later sustainable growth<br>Can be aligned with Thailand's near-term biodiversity priorities and longer-term sustainable development goals | Delivers a comprehensive contribution across KMGBF Targets 1–23 | Supports SDG 13, 14, 15 directly; spillovers to SDG 8, 9, 12 | Offers the most realistic strategy to deliver both BCG transformation and Blue Economy scaling while safeguarding biodiversity |

### 8.14.1 Alignment with the 5th NBSAP (2023–2030)

- The Nature-Positive scenario directly supports Strategy 1 of the NBSAP (conserve, restore, and eliminate threats to biodiversity), especially Targets 1–4 on halting biodiversity loss, expanding protected areas and OECMs, restoring ecosystems, and strengthening resilience to climate change and pollution.
- The Blue Economy scenario contributes to Strategy 2 (promote bio-based economy and sustainable use), particularly Targets 5–7 on fostering bioeconomy benefits, mainstreaming sustainable production and services, and advancing access and benefit-sharing (ABS).
- Both alternative scenarios also underpin Strategy 3 (enhancing capacity and participation), aligning with Targets 8–12 on mainstreaming biodiversity across sectors, mobilising finance, building capacity and knowledge systems, and improving legal frameworks.
- In contrast, the BAU scenario risks undermining most NBSAP targets by continuing degradation, thereby serving as a cautionary baseline against which progress is measured.

### 8.14.2 Alignment with the KMGBF

- The Nature-Positive scenario strongly advances KMGBF Targets 1–8, especially expanding effective area-based conservation (Target 3), ecosystem restoration (Target 2), and reducing pollution and climate threats (Targets 7–8).
- The Blue Economy scenario operationalises Targets 9–13, emphasising sustainable use of marine resources, sustainable fisheries and aquaculture, green tourism, and fair and equitable benefit-sharing.
- Both scenarios support Targets 14–23 on mainstreaming biodiversity into policies, strengthening finance and business accountability, and fostering participation of all stakeholders, including women, youth, and Indigenous peoples.
- Together, the Conservation and Blue Economy pathways provide a sequenced and complementary strategy to advance Thailand toward the KMGBF 2050 vision of “living in harmony with nature”

### 8.14.3 Alignment with the SDGs

- Scenario outcomes cut across multiple SDGs:
- SDG 14 (Life Below Water): through sustainable fisheries, coastal protection, and marine pollution reduction.
- SDG 15 (Life on Land): by addressing habitat restoration, reducing invasive species, and improving ecosystem connectivity.
- SDG 13 (Climate Action): via NbS and blue carbon initiatives.
- SDG 12 (Sustainable Consumption and Production) and SDG 8 (Decent Work and Economic Growth): through sustainable tourism, aquaculture, and bio-based value chains.
- SDG 1 (No Poverty) and SDG 10 (Reduced Inequalities): by ensuring that local communities benefit equitably from biodiversity conservation and bio-economy opportunities.

The NEA scenarios therefore provide a strategic bridge: they translate scientific evidence and participatory visions into policy pathways that directly support Thailand's NBSAP delivery, fulfill KMGBF global targets, and contribute to SDG progress. The adaptive sequencing of scenarios—moving from conservation-led recovery (2025–2030) to scaling a sustainable blue economy (2030–2040) and consolidating integrated resilience thereafter—mirrors Thailand's own stepwise commitments under the NBSAP and KMGBF. This ensures that the NEA is not an abstract foresight exercise but a practical policy instrument to monitor, guide, and accelerate national implementation toward 2030 and 2050 biodiversity milestones.

## 8.14.4 Alignment with Thailand's BCG Policy and Blue Economy Strategy

In addition to biodiversity and global frameworks, Thailand has adopted national economic strategies that place biodiversity at the heart of development. Two key frameworks are the BCG Policy and the emerging National Blue Economy Strategy. The NEA scenarios provide pathways to support and strengthen both agendas.

### *1)Alignment with BCG Policy*

The BCG policy, endorsed as a national agenda since 2021, seeks to transform Thailand's economy by leveraging biodiversity, renewable resources, and innovation. It emphasises four priority sectors: food & agriculture, bioenergy & biomaterials, health & medicine, and tourism & services.

- The Nature-Positive scenario supports the BCG agenda by safeguarding the biodiversity capital on which these sectors depend, ensuring the ecological foundation for bio-innovation and sustainable value chains.
- The Blue Economy scenario aligns with BCG goals by expanding sustainable aquaculture, eco-tourism, marine biotechnology, blue carbon, and renewable marine energy, while embedding equity and local resilience.
- Both scenarios highlight the risks of BAU, where degradation of biodiversity undermines Thailand's bio-based industries and threatens the competitiveness of BCG sectors.

### *2)Alignment with Blue Economy Strategy*

Thailand is also formulating a National Blue Economy Strategy to promote sustainable growth from ocean and coastal resources. This strategy emphasises MSP, sustainable fisheries and aquaculture, marine transport and ports, eco-tourism, and ocean-based renewable energy.The

- Nature-Positive scenario provides ecological safeguards and local empowerment necessary to maintain healthy marine ecosystems and fisheries that underpin the Blue Economy.
- The Blue Economy scenario operationalises the strategy's goals by scaling sustainable marine industries with safeguards, financing, and innovation.
- The integrated pathway—sequencing conservation first, followed by sustainable Blue Economy scaling—offers the most realistic national approach, balancing economic growth with biodiversity protection and climate resilience.

The NEA scenarios thus act as a strategic bridge between biodiversity commitments (NBSAP/KMGBF/SDGs) and Thailand's economic transformation policies (BCG and Blue Economy). By embedding biodiversity as natural capital within economic planning, the scenarios provide decision-makers with foresight to ensure that Thailand's economic strategies enhance, rather than erode, the ecosystems that sustain long-term prosperity and resilience.

## 8.15 Conclusion and recommendations

This chapter has explored five plausible future scenarios for Thailand's Marine BES, grounded in the evidence and trends presented in Chapters 1–6. The scenarios reflect a spectrum of choices in development orientation, governance, and stewardship.

The scenario development process for Thailand's marine ecosystems has been both exploratory and participatory, reflecting the inputs of scientific assessments, ILK, and multi-stakeholder dialogue. The scenarios provide not only plausible futures but also structured ways of thinking about trade-offs, risks, and opportunities in relation to biodiversity and ecosystem services.

Through two national stakeholder participatory workshops and subsequent Trialogue workshop, and expert deliberation, stakeholders confirmed that scenarios are valuable tools for visualizing alternative futures and testing policy options. They help policymakers understand the long-term implications of different governance modes, development orientations, and social choices.

- **Refinement to three core scenarios** As a result of the iterative process, the initial five archetypes were refined into three core scenarios: (i) BAU, (ii) Nature-Positive and (iii) Blue Economy. This refinement provides clarity while retaining analytical richness. BAU remains as a baseline warning of risks, while Nature-Positive and Blue Economy together illustrate alternative pathways toward resilience and sustainability.

- **Sequencing and spatial differentiation** A critical insight of the process is that no single scenario fits all Thai marine contexts. Instead, the most realistic and desirable outcomes emerge from sequencing different scenarios over time (2025–2050) and applying them selectively across regions. Conservation is prioritised in the near term to halt degradation and restore ecological foundations. Blue Economy strategies expand in the medium term, diversifying livelihoods and industries under safeguards. By 2050, integration of both pathways enables a resilient, inclusive, and sustainable marine future. Spatial differentiation also matters: some regions lean more toward Conservation (e.g., Andaman coasts), others toward Blue Economy (e.g., Eastern Seaboard), while hybrid approaches evolve elsewhere.

  Across all futures, common enablers are essential: governance reforms to reduce fragmentation, recognition of ILK and community rights, innovative financing (e.g., blue carbon, biodiversity credits), and strong institutional capacity for adaptive management. These cross-cutting measures underpin success in both Conservation and Blue Economy pathways and safeguard against the risks inherent in BAU.

  In conclusion, the scenarios developed under the NEA provide not fixed predictions but policy-relevant pathways. They illustrate that choices made in the next decade will determine whether Thailand experiences ecological decline, ecological recovery, or balanced sustainable development. By embracing adaptive sequencing, spatial tailoring, and cross-cutting enablers, policymakers can ensure that Thailand's marine ecosystems remain a foundation for resilience, prosperity, and well-being toward 2050. The scenario discussions (during Trialogue Workshop, November, 2025) also highlight an opportunity for Thailand to position itself as a leader in emerging regenerative ocean economy models. Strengthening governance, blue finance, innovation, and community empowerment can allow Thailand's Blue Economy development to evolve toward a Regenerative Blue Economy (Blue Economy Plus or Nature-Positive) that delivers net-positive ecosystem and livelihood outcomes by 2050.

## 8.15.1 Key Findings

The scenario development process for Thailand's coastal and marine ecosystems has yielded several key findings that are highly relevant for both the NEA assessment and national policy dialogue.

***1)Participatory and co-produced knowledge***
The process was participatory, drawing on insights from a series of national stakeholder workshops, scientific assessments, ILK, and policy dialogue. This co-production of knowledge helped ensure that the scenarios reflect multiple perspectives and foster ownership among stakeholders.

***2)Refinement to three core scenarios***
Through iterative engagement and expert deliberation, the initial five archetypes were consolidated into three core scenarios/archetypes:

- BAU: a baseline reference that extrapolates current governance and development patterns, highlighting systemic risks and the cost of inaction.
- Blue Economy: a pathway that expands sustainable ocean-based economic opportunities, underpinned by regulation, MSP, innovation, circular resource use and
- Nature-Positive (Blue Economy Plus): a pathway that prioritises ecosystem recovery, biodiversity protection, large-scale restoration and community stewardship, with explicit alignment to KMGBF targets and recognition of ILK.

***3)No single scenario fits all contexts***
A central conclusion is that no single scenario adequately fits Thailand's diverse marine contexts. Stakeholders emphasised the need for adaptive sequencing over time and spatial tailoring across regions. Nature-Positive (Blue Economy Plus) measures must be prioritised in the short term to halt degradation and restore ecosystems, while Blue Economy opportunities should expand in the medium term under safeguards. By 2050, these two scenarios converge into an integrated sustainability pathway. The integration of Nature-Positive and Blue Economy pathways provides the most plausible and desirable future: Nature-Positive secures ecological foundations and resilience in the short term, while Blue Economy expands inclusive opportunities in the medium to long term, converging into integrated sustainability by 2050.

***4)BAU as a risk baseline***
BAU remains valuable only as a counterfactual reference. It illustrates the risks of continued fragmentation and short-term, including accelerating ecosystem collapse, declining ecosystem services, and deepening social inequities. This scenario underscores why inaction is not an option.

***5)Complementary strengths of Nature-Positive and Blue Economy***
The participatory process highlighted that the Nature-Positive and Blue Economy scenarios are not mutually exclusive, but rather complementary. Conservation secures the ecological foundation and enhances resilience, while Blue Economy provides diversified livelihoods, innovation, and financing opportunities. Together, they form the basis of an integrated, whole-of-society pathway toward resilient and inclusive sustainable development.

***6)Cross-cutting enablers***
Across all scenarios, several enabling conditions are critical: governance reform to reduce fragmentation, recognition of ILK and community rights, capacity-building, sustainable financing (e.g., blue carbon, biodiversity credits, blue bonds), and regional cooperation. These enablers

determine whether Thailand can successfully implement the sequencing and integration of Conservation and Blue Economy strategies.

***7)Monitoring, data, and adaptive management***

Effective implementation of the sequenced and spatially tailored pathway requires a continuous learning system built on robust monitoring, transparent data, and adaptive management. Monitoring and adaptive management are indispensable to make sequencing work overtime and across regions; without them, both conservation gains and blue-economy benefits risk reversal.

***8)Alignment with national and global policy frameworks***

The NEA scenarios do not stand alone as foresight tools; they provide a strategic bridge between Thailand's biodiversity commitments and its economic transformation strategies. By linking scenario outcomes to the 5$^{th}$ NBSAP (2023-2030), the KMGBF Targets, the SDGs, and Thailand's BCG Economy Policy and Blue Economy Strategy, the scenarios demonstrate their practical policy relevance. The scenarios demonstrate that Thailand's coastal and marine future is shaped by choices made in the next decade. The process reinforces the value of scenarios not as predictions, but as tools to explore risks, opportunities, and adaptive pathways for policy and governance.

## 8.15.2 Key messages and recommendations

Scenarios are tools which have been used in this NEA to explore plausible futures for Marine BES of Thailand under various conditions, helping stakeholders visualize the potential outcomes of different decisions. They are built directly on NEA findings by using the status and trends of marine ecosystems and identifying key drivers as a starting baseline. The approach combines exploratory scenarios, intervention (policy) scenarios, and a participatory, qualitative process. The scenarios towards 2050 are thus rooted in the past trends and current challenges of Thailand's Marine BES. The scenarios reflect a spectrum of choices in development orientation, governance, and stewardship. They help policymakers understand the long-term implications of different governance modes, development orientations, and social choices.

The scenarios were co-produced through a participatory process combining scientific evidence, ILK, expert review, and multi-stakeholder dialogue. This strengthens their credibility, relevance and legitimacy for policy use.

Insights and findings have been generated throughout the scenario's development process, with inclusive stakeholder participation and inclusion of stakeholder inputs in the study. This has led to the following key messages with recommendations responding to the policy questions set out by the NEA for policymakers and also for practitioners, regulators, researchers, agencies and institutions, to support coastal and marine sustainability in Thailand.

Policy Question 1:

**What alternative futures for Thailand's coastal and marine ecosystems are plausible by 2050, and what trade-offs do they entail?**

## Key Message 1: There are three contrasting but plausible coastal and marine futures by 2050—BAU, Blue Economy, and Nature-Positive—each involving different trade-offs across biodiversity, ecosystem services, livelihoods, equity, and climate resilience. ***(Well established)***

Chapter 8 presents three contrasting but plausible futures for Thailand's coastal and marine ecosystems to 2050:

- **BAU:** A continuation of current trends with incremental improvements, where governance remains fragmented, pressures from coastal development, fisheries, tourism and infrastructure persist, and many ecosystems continue to degrade despite local successes. This scenario highlights the systemic risks of inaction, including rising vulnerability of coastal communities to climate and disaster risks, livelihoods under uncertainty and climate change, and increasing fiscal and social costs over time.
- **Blue Economy:** A pathway where Thailand expands ocean-based economic activities (such as sustainable fisheries and aquaculture, tourism, ports and shipping, and offshore energy) within clearer environmental safeguards, MSP and integrated coastal management. Ecosystem condition stabilises or improves in some areas compared to BAU, and new jobs and income are created, but full recovery in heavily pressured seascapes remains uncertain and equity concerns may persist if benefits are not widely or equitably shared.
- **Nature-Positive (Blue Economy Plus):** A more ambitious pathway that explicitly aims to halt and reverse biodiversity loss, restore key ecosystems (mangroves, seagrasses, coral reefs and other coastal habitats), and strengthen resilience and equity. It combines carefully governed blue-economy growth with large-scale restoration, expanded protected and conserved areas (including OECMs), recognition of community rights and ILK, and sustained investment in ecosystem health. This scenario delivers the greatest long-term co-benefits for biodiversity, climate resilience, livelihoods and risk reduction, but requires stronger governance, political commitment and financing.

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| | |
|---|---|
| **Recommendation:** | Use the three scenarios as a policy stress-test framework for major coastal and marine decisions. Treat BAU as risk reference and require major plans and investments to make explicit their expected trade-offs between short-term growth, long-term ecosystem integrity, social equity, and climate and disaster resilience. |

## Policy Question 2:

**Which development pathways best safeguard biodiversity, ecosystem services and coastal livelihoods under conditions of uncertainty and climate change?**

### Key Message 2: Different policy choices, governance reforms and investment decisions can lead to markedly different ecological, social and economic outcomes for Thailand's coastal and marine future. ***(Established but incomplete)***

Taken together, the three scenarios demonstrate that Thailand's coastal and marine future is not pre-determined: different policy choices, governance reforms and investment decisions can lead to markedly different ecological, social and economic outcomes.

**Table 8.7: Comparison aspects of three scenarios of Marine BES of Thailand towards 2050**

| Aspect | BAU | Blue Economy | Nature-Positive (Blue Economy Plus) |
|---|---|---|---|
| **Short description** | Continuation of current trends with only incremental improvements and fragmented governance | Expansion of ocean-based economic activities under clearer environmental safeguards, MSP and ICZM | Ambitious pathway aiming to halt and reverse biodiversity loss while strengthening resilience and equity |
| **Ecosystem condition** | Ongoing degradation of coral reefs, seagrasses, mangroves and other habitats in many areas; local successes remain isolated | Ecosystem condition stabilizes or improves in some use areas compared to BAU, but full recovery in heavily pressured seascapes is uncertain | Net gains in extent and condition of key ecosystems through large-scale restoration and expanded protected and conserved areas (including OECMs) |
| **Livelihoods and economy** | Increasing vulnerability of coastal communities and small-scale fishers to job and income; higher long-term fiscal and social costs | New jobs and income from fisheries, aquaculture, tourism, ports, shipping and offshore energy; benefits may be unevenly shared | More resilient and diversified livelihoods based on healthy ecosystems; long-term economic benefits from risk reduction and ecosystem services |
| **Equity and communities** | Benefits largely captured by powerful actors; growing inequalities and conflict risks | Equity outcomes depend on safeguards; without them, there is risk of "blue-washing" and exclusion of small-scale users | Strong emphasis on community rights, ILK, co-management and fair benefit sharing; social inclusion is a core objective |
| **Climate and disaster risk** | Rising exposure and vulnerability to storms, erosion and flooding as natural buffers are degraded | Some reduction in risk where safeguards and restoration accompany development, but residual risks remain | Significant reduction of climate change and disaster risks through restored natural buffers and resilient coastal landscapes and seascapes |
| **Governance and finance** | Fragmented mandates, weak enforcement and limited use of integrated planning; underinvestment in ecosystem health | Stronger standards, MSP/ICZM and environmental safeguards are required; growing role for blue finance if well governed | Requires strong, coherent governance, long-term policy commitment and scaled, aligned blue–green finance (e.g. blue bonds, biodiversity and blue carbon finance) |
| **Overall policy signal** | A risk scenario to be actively avoided, not a neutral reference pathway | A transition pathway that can deliver better outcomes than BAU if standards and equity safeguards are robust | A strategic national direction for a regenerative, resilient and equitable marine future, with the highest long-term co-benefits |

**Recommendation:** The impacts of different scenarios would aspire policymakers on cautious decision-making to opt for specific context. Prioritise a Nature-Positive pathway where ecological degradation and climate risk are already high, because it provides the strongest safeguard for biodiversity, ecosystem services, and long-term resilience. Use a well-governed Blue Economy pathway as a transitional or complementary route where strong safeguards, transparency, MSP/ICZM, and equitable benefit-sharing can be ensured. BAU should not be pursued as a development option.

Policy Question 3:

**Which "no-regret" actions are robust across all scenarios and can be implemented immediately?**

## Key Messages 3: Regardless of preferred scenarios, Thailand should implement robust and cross-cutting actions which are beneficial under any plausible future. ***(Well established)***

Despite their differences, the scenarios reveal a set of common and immediate policy implications and actions that are robust across futures:

- **Integrated marine and coastal governance is essential.** Fragmented mandates and uncoordinated sectoral decisions are a key driver of risk in all scenarios. Strengthening ICZM, MSP and cross-agency coordination is a no-regret priority.
- **Community rights, ILK and co-management underpin resilience.** All desirable futures rely on empowered coastal communities, secure and equitable access to resources, and the active use of ILK alongside other kinds of scientific information in decision-making.
- **Blue and green finance need to be scaled and better aligned.** Achieving either a strong Blue Economy or a Nature-Positive outcome requires sustained investment from public budgets and private finance, guided by clear environmental and social safeguards to avoid "blue-washing".
- **Data, monitoring and "signposts" are needed to steer adaptive pathways.** Regularly tracking key indicators of ecosystem health, livelihoods, equity and risk– and linking them to scenario "signposts"– can help Thailand adjust policies and investments over time to stay on a desired pathway.
- **Regional differentiation and sequencing are important.** Different coastal regions, sectors and communities may need different transition routes and speeds, provided that they remain within a coherent national framework that keeps Thailand on track to reach its biodiversity, climate change, and sustainable development goals.

| | |
|---|---|
| **Recommendation:** | Begin immediate no-regret action through four entry points: **(1) ONEP / MNRE, DMCR, DOF and MD** should establish a standing cross-agency mechanism to align ICZM, MSP and coastal sector planning; **(2) DMCR, provincial authorities and coastal community networks** should strengthen co-management, community rights and ILK inclusion in monitoring and local planning; **(3) NESDC, MOF, BEDO and financial actors** should develop safeguarded blue-green finance pipelines for restoration, community livelihoods and resilient marine industries; **(4) DMCR with national data platforms and research institutions** should establish a scenario signpost and monitoring system, reviewed every 3-5 years |

Policy Question 4:

**How can insights from the scenarios guide and stress-test policies and investments linked to Thailand's NBSAP, the KMGBF, the SDGs, the BCG and emerging Blue Economy strategies?**

## Key Message 4: Insights from the scenarios provide a strategic bridge for translating scientific evidences and stakeholder views into Thailand's national and global policy pathways. ***(Well established)***

The scenarios are not only tools to envision possible futures for Thailand's Marine BES but also **instruments to guide the country toward achieving its national and international biodiversity and sustainable development commitments.** By explicitly linking scenario outcomes to Thailand's 5th NBSAP (2023-2030), the KMGBF, and the 2030 Agenda for Sustainable Development (i.e., the SDGs), the scenarios demonstrate its relevance for policy implementation at multiple levels.

The scenarios therefore provide a strategic bridge: they translate scientific evidence and participatory visions into policy pathways that directly support Thailand's NBSAP delivery, fulfill KMGBF global targets, and contribute to SDG progress. The adaptive sequencing of scenarios—moving from conservation-led recovery (2025–2030) to scaling a sustainable blue economy (2030–2040) and consolidating integrated resilience thereafter—mirrors Thailand's own stepwise commitments under the NBSAP and KMGBF. This ensures that the NEA is not an abstract foresight exercise but a practical policy instrument to monitor, guide, and accelerate national implementation toward 2030 and 2050 biodiversity milestones.

Confidence levels for the Chapter 8 key messages were assessed using the IPBES qualitative four-box model. Because the scenario assessment is based mainly on qualitative scenario analysis, expert judgement, stakeholder deliberation, ILK, and synthesis of evidence from Chapters 1–6, likelihood terms were not applied. The confidence terms reflect the level of agreement among evidence sources and the quality, quantity, consistency, and traceability of supporting evidence. Overall, the Chapter 8 key messages are assessed as either Well established or Established but incomplete; none are assessed as Inconclusive or Unresolved. (Table 8.8)

**Table 8.8: Evident judgement and rationale to support confident levels of Chapter 8 key messages**

| SPM key messages | Recommended confidence term | Evidence judgement | Rationale |
|---|---|---|---|
| **Key Message 1.** Thailand faces three contrasting but plausible coastal and marine futures by 2050—BAU, Blue Economy, and Nature-Positive—each involving different trade-offs. | Well established | High agreement; multiple evidence streams | The message is strongly supported by the scenario methodology, the use of Chapters 1–6 as baseline evidence, stakeholder workshops, expert review, and the final consolidation into three archetypes. The Chapter explicitly states that scenarios were grounded in Chapters 1–6, stakeholder knowledge, and a participatory qualitative process. The SPM itself clearly presents the three scenarios and their trade-offs. |
| **Key Message 2.** Different policy choices, governance reforms and investment decisions can lead to markedly different ecological, social and economic outcomes. | Established but incomplete | High agreement; evidence is consistent but mainly qualitative | The direction of difference among BAU, Blue Economy, and Nature-Positive is strongly supported by Chapter 8 comparative tables, pathway narratives, impact heatmaps, and policy analysis. However, the magnitude, timing, and certainty of 2050 outcomes depend on future implementation, climate change, finance, enforcement, and social acceptance. Because the finding is not backed by quantitative modelling or probabilistic estimation, it should be rated Established but incomplete, not "Well established". |
| **Key Message 3.** Regardless of preferred scenarios, Thailand should implement robust and cross-cutting "no-regret" actions beneficial under any plausible future. | Well established | High agreement; evidence repeated across scenarios | This message is strongly supported because the same enabling actions recur across all scenario pathways: integrated governance, MSP/ICZM, community rights, ILK, co-management, blue-green finance, data systems, and monitoring signposts. Chapter 8 explicitly identifies cross-cutting policy insights and common priorities across all futures. The SPM also lists the no-regret actions directly. |
| **Key Message 4.** Insights from the scenarios provide a strategic bridge for translating scientific evidence and stakeholder views into Thailand's national and global policy pathways. | Well established | High agreement; strong policy traceability | The finding is well supported because Chapter 8 contains a dedicated policy-alignment section linking scenarios to the 5th NBSAP, KMGBF, SDGs, BCG economy, and Blue Economy strategy. It also explains that the scenarios are practical policy instruments for monitoring, guiding, and accelerating implementation. The SPM's policy-alignment table reinforces this linkage. |

**Recommendations:**

4.1. Policymakers should benefit from NEA scenarios exercise as one of policy instruments in practice to escalate preferred plausible marine futures of Thailand to achieve national and international biodiversity targets and sustainable goals. Also, scenarios can help policy decision-making to monitor, guide and accelerate Thailand's progress of implementation on marine biodiversity actions.

4.2 Embed scenario-based stress-testing into the next review cycles of Thailand's NBSAP, marine and coastal resource planning, BCG implementation, Blue Economy strategy development, and provincial coastal plans. ONEP and NESDC should lead the policy integration, while sector agencies use the three scenarios to test whether proposed investments reinforce BAU risks, support safeguarded blue growth, or move Thailand toward a nature-positive transition

## 8.15.3 General recommendation

Insights and findings have been learned; throughout the scenario's development process and outcomes with inclusive stakeholder participation and inputs in the study, lead to the following recommendations to policymakers on coastal and marine ecosystems for economic and social development and conservation in Thailand. Additionally, some recommendations are also for practitioners; regulators, researchers and agencies and institutions, to support coastal and marine operations and development.

1. Adopt an adaptive, mixed-scenario approach–Policymakers should avoid rigid adherence to a single scenario and instead adopt a phased or blended approach that evolves with ecological, economic, and governance realities.
2. Institutionalise scenario use in planning–Integrate scenario-based planning into national and provincial marine and coastal policy cycles, ensuring that decisions consider alternative futures and their trade-offs.
3. Enhance ILK inclusion–Recognise and embed ILK in marine governance frameworks, ensuring local stewardship is a pillar of coastal management.
4. Strengthen enabling conditions–Prioritise governance reforms, capacity-building, and financing mechanisms (e.g., blue bonds, biodiversity funds) that are essential preconditions for the preferred scenarios.
5. Develop a monitoring system–Establish indicators to track early signals of scenario trajectories, enabling timely policy adjustments.

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## Chapter 1


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## Chapter 3

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# Appendix 1-1

## PSC Member

1. Secretary General, ONEP (Chairman)
2. Representative from UNEP-WCMC (Committee)
3. Representative from DMCR (Committee)
4. Representative from DNP (Committee)
5. Representative from DOF (Committee)
6. Representative from NESDC (Committee)
7. Representative from Office of the National Security Council (NSC) (Committee)
8. Representative from Department of Tourism (DOT) (Committee)
9. Representative from Thailand Science Research and Innovation (TSRI) (Committee)
10. Representative from Thailand Institute of Scientific and Technological Research (TISTR) (Committee)
11. Representative from Geo-Informatics and Space Technology Development Agency (Public Organisation) (GISTDA) (Committee)
12. Representative from Center of Excellence on Biodiversity (BDC) (Committee)
13. Mr. Anuwat Nateewattana (Committee)
14. Director of Biodiversity Management Division, Office of Natural Resources and Environmental Policy and Planning (ONEP) (Committee and Secretary)
15. Biodiversity Management Division Officer, Office of Natural Resources and Environmental Policy and Planning (ONEP) (Secretary Assistant)

# Appendix 2-1

## Recommended indicators of marine biodiversity and ecosystem services

Marine ecosystem components, processes, and the ecosystem services they provide are inherently complex, shaped by dynamic interactions among biological, physical, and human systems. This complexity can be effectively addressed through a framework for ecosystem assessment, consisting of well-defined indicators that capture the condition, functioning, and benefits of marine ecosystems. Indicators serve as practical tools for translating scientific knowledge into measurable and policy-relevant information, enabling systematic assessment of ecosystem status, trends, and responses to natural and anthropogenic pressures. To be effective, indicators of marine biodiversity and ecosystem services should align with the KMGBF, ensuring consistency, comparability, and relevance across national, regional, and global scales, while also supporting reporting against international commitments.

Such indicators should not only describe the current state of marine ecosystems, but also track temporal trends and identify key drivers of change, including overexploitation, habitat degradation, pollution, and climate-related stressors. Importantly, they should reflect nature's contributions to people by linking ecological conditions to ecosystem services that underpin livelihoods, food security, coastal protection, and cultural values. This integrated approach supports adaptive, ecosystem-based management by providing evidence to guide conservation actions, evaluate policy effectiveness, and prioritise interventions under changing environmental and socio-economic conditions.

Here, we propose a set of example indicators designed to improve marine monitoring and ecosystem assessment in Thailand. These indicators are organised across three complementary dimensions: (a) biodiversity, encompassing ecosystem extent and condition, species diversity, abundance, and ecological integrity; (b) ecosystem services, capturing provisioning, regulating, and cultural benefits derived from marine and coastal ecosystems; and (c) socio-economic dimensions, reflecting human dependence on marine resources, governance, equity, and resilience of coastal communities. Together, these indicators provide a holistic and policy-relevant framework to support integrated marine management, strengthen national biodiversity assessments, and enhance alignment with the Global Biodiversity Framework.

**Table A2-1.1: The indicators system for key marine biodiversity and habitats**

| Key ecosystems | Example indicators |
|---|---|
| Mangrove forests | Trends in mangrove forest fragmentation, trends in mangrove extent and condition, tree cover loss, vegetation index, Mangrove Ecosystem Health Index (MEHI), mangrove density, canopy cover/height, species composition, diversity and composition of fish, benthos, mammal, reptile, bird, quality of water and sediment. |
| Seagrass beds | Change in seagrass extent, species diversity and composition of seagrasses, condition of seagrass beds (% coverage), species dominance index, leaf length, leaf width, fish abundance and biomass, diversity and composition of benthos, quality of water and sediment, nutrient content. |
| Coral reefs | Change in coral reef extent, condition (proportion of life-dead coral coverage), composition of reefs, fish abundance and biomass, diversity and composition of benthos, index of coastal eutrophication, percent coral reefs effectively protected, fleshy algae cover, quality of water and sediment. |
| Offshore ecosystem | Productivity, abundance and diversity of phytoplankton, abundance and diversity of zooplankton, zooplankton/phytoplankton ratios, demersal and pelagic fish biomass, occurrence and abundance of marine mammals and sea birds, benthic invertebrate diversity, quality of water and sediment. |

(Modified from Global Ocean Accounts Partnership 2021)

**Table A2-1.2: The indicators system for assessing marine ecosystem services**

| Services | Sub-services | Criteria layer | Example of indicators |
|---|---|---|---|
| Provisioning services | Seafood provision | Seafood products | Fishery yield/ biomass of nekton/edible algae |
| | Vegetable from mangroves | Vegetable products | Amount of edible vegetables |
| | Timber from mangroves | Timber products | Amount of timber products |
| | Genetic materials and bioactive compounds | Genetic materials | Amount of genetic materials utilised |
| | | Bioactive compounds | Amount of bioactive compounds utilised |
| Supporting services | Biodiversity maintenance | Nekton biodiversity | Species diversity-composition |
| | | | Density/Abundance |
| | | | Biomass |
| | | | Mean trophic level |
| | | Phytoplankton biodiversity | Species diversity-composition |
| | | Zooplankton biodiversity | Species diversity-composition |
| | | Benthos biodiversity | Species diversity-composition |
| | | | Density/ Abundance |
| | | | Biomass |
| | | Indicator/flagship/threaten species | Abundance/occurrence |
| | | | species diversity-composition |
| | Habitat provisioning | Sea water quality | Basic water quality parameters e.g., dissolved oxygen, temperature, pH, turbidity, total dissolved solids (TDS) |
| | | | Nutrients e.g., nitrate-nitrogen, nitrite-nitrogen, ammonia, total nitrogen, total phosphorus |
| | | Aquatic habitat | The area of water in the bay |
| | | Important and specific habitat | The area of important and specific habitat, e.g., shellfish areas, areas for resident and migratory birds |
| Regulating services | Biological control | Control of ecological disasters | The frequency of ecological disasters, occurrence of diseases, pest control (including invasive species) |
| | Water purification | Physical self-purification | The tidal prism |
| | | | The Bay Openness Index |
| | | Coastal wetland purification | The area of coastal wetland |
| | | Clean water | The area of clean water, water quality that meets water quality standards |
| | Coastal protection | Coastal protection | The length of shoreline naturally protected by mangroves and coral reefs |
| | Pollination | Gamete dispersal in marine environment | Importance level of larval sources |
| | Climate mitigation | Carbon sequestration and storage | Carbon sequestration and storage |
| Cultural services | Tourism and leisure | Natural destinations | The length of natural shoreline designated as tourist destinations, number of dive sites/tourist destinations, number of tourists/visitors, destination quality |
| | Scientific research and education | Landscape naturalness | The area proportion of natural landscape,number of scientific research and education |

(Modified from Yu et al., 2022; Global Ocean Accounts Partnership 2021)

**Table A2-1.3: The indicators system for assessing socio-economic aspects of marine ecosystem services**

| Aspects | Example indicators |
|---|---|
| Resource use | Extraction activities, rights of resource use |
| Stakeholder characteristics | Boundary of community, number of inhabitants or households, number of ethnic groups |
| Gender issues | Number of women in decision making bodies, organisations |
| Stakeholder perception | Resource dependency level, perception on area-based conservation, level of environmental awareness |
| Organisation and resources governance | Governance types, regulations, number of bodies/forums involved in resources governance |
| Traditional knowledge | Variations in local knowledge, trends of use of local knowledge in resource management |
| Socio-economic, cultural aspects and well-being | Revenue/income, employment, health status, resilience level, change in population and population structure, percentage of population with access to basic infrastructure (e.g., clean water, wastewater treatment, healthcare), change in cultural values, sense of place, local environmental quality |

(Modified from Bunce et al. 2000)

Overall, the use of a comprehensive indicator system is essential for understanding the condition, functioning, and societal value of marine and coastal ecosystems in terms of ecosystem services. By integrating ecological, ecosystem service, and socio-economic indicators, assessments can capture not only the status of key habitats and biodiversity but also the benefits they provide and the human dimensions that influence their management. Although it is impossible to monitor every aspect of these complex systems, prioritising indicators that clearly link ecosystem condition with service provision enables more effective tracking of change and supports evidence-based decision-making. In the context of Thailand, the combined use of biophysical and socio-economic indicators offers a practical framework for improving NEAs, strengthening monitoring efforts, and guiding sustainable management of marine and coastal resources.

# Appendix 6-1

## Global and Regional Development Policies and Directions

**a) The 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs)The 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs) establish five goals with explicit biodiversity targets:**

- SDG 2: Zero Hunger – Maintain the genetic diversity of seeds, cultivated plants, farmed and domesticated animals, and their related wild species through well-managed and diversified seed and plant banks at the national, regional, and international levels. Promote fair and equitable access to genetic resources and associated traditional knowledge, as internationally agreed.
- SDG 6: Clean Water and Sanitation–Protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes.
- SDG 12: Responsible Consumption and Production–Achieve the sustainable management and efficient use of natural resources, and ensure that people everywhere have access to information for sustainable development and lifestyles in harmony with nature.
- SDG 13: Climate Action – Strengthen resilience to climate-related hazards and integrate climate measures into national policies, given that climate change increasingly threatens marine and coastal ecosystem health and services.
- SDG 14: Life Below Water – Sustainably manage and protect marine and coastal ecosystems, strengthen their resilience, and take action for their restoration to achieve healthy and productive oceans.
- SDG 15: Life on Land – Ensure the conservation, restoration, and sustainable use of terrestrial ecosystems and their services, combat desertification, restore degraded land and soil, and halt biodiversity loss by 2020.

In particular, SDG 14: Life Below Water highlights four critical targets directly related to marine biodiversity management:

- Target 14.2: Sustainably manage and protect marine and coastal ecosystems, strengthen resilience, and take action for their restoration.
- Target 14.4: Regulate harvesting practices and end overfishing, illegal, unreported, and unregulated fishing, implementing science-based management plans to restore fish stocks.
- Target 14.5: Conserve at least 10% of coastal and marine areas, consistent with national and international law and scientific evidence.
- Target 14.6: Prohibit certain forms of fisheries subsidies that contribute to overcapacity, overfishing, and illegal, unreported, and unregulated fishing.

These targets form the basis for Thailand's efforts to align national marine and coastal resource management policies with global commitments.

In addition to the SDGs, several key international agreements and conventions further guide global biodiversity management:

### b) The Convention on Biological Diversity (CBD)

Adopted in 1992, the CBD is a landmark international agreement committed to promoting development that integrates environmental conservation. It outlines three main objectives:

- The conservation of biological diversity
- The sustainable use of its components
- The fair and equitable sharing of benefits arising from the use of genetic resources

### c) The Kunming-Montreal Global Biodiversity Framework (KMGBF)

Adopted during the 15th Conference of the Parties (COP15) to the CBD, the KMGBF establishes a comprehensive global plan to achieve biodiversity goals. Building on the Strategic Plan for Biodiversity 2011–2020 and the Aichi Targets, the GBF supports the achievement of the SDGs and sets a vision for humanity to live in harmony with nature by 2050. It contains:

- 23 action-oriented global targets to be achieved by 2030[25]
- Four long-term goals for 2050

The immediate implementation of these targets is essential to realizing the framework's 2050 vision.

### d) The Ramsar Convention on Wetlands (Ramsar Convention)

The Ramsar Convention provides an international framework for the conservation and sustainable use of wetlands. Recognising the importance of wetlands for biodiversity, particularly waterfowl, the Convention aims to halt the global loss of wetlands and promote their wise use. 11 coastal and marine wetlands in Thailand have been officially designated as Wetlands of International Importance under the Ramsar Convention.

### e) The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

CITES regulates international trade in endangered species of wild fauna and flora to ensure their survival. By controlling trade in wildlife and forest products, CITES protects species threatened by overexploitation, although it does not regulate domestic trade or native species management.

### f) The World Heritage Convention

Established in 1972, the Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention) promotes international cooperation in safeguarding cultural and natural heritage sites of outstanding universal value for future generations.

[25] Full details of four long-term goals for 2050 and 23 targets can be accessed through CBD/COP/15/L25 (https://www.cbd.int/article/cop15-final-text-kunming-montreal-gbf-221222

# Appendix 6-2

## National Policies and Strategies Relevant to Biodiversity

Thailand's national policies and strategies related to biodiversity are designed to align with global and regional commitments, including the Sustainable Development Goals (SDGs), the CBD, and the KMGBF. These national instruments translate international obligations into actionable plans that support the conservation, restoration, and sustainable use of biodiversity, particularly within marine and coastal ecosystems. The following key strategies demonstrate Thailand's efforts to integrate biodiversity considerations into its broader sustainable development and climate agendas.

### a)Thailand's 2030 Agenda and Sufficiency Economy Philosophy (SEP)

Thailand's 2030 Agenda and SEP are foundational to the country's sustainable development efforts. Every government agency is required to integrate SEP into its missions, plans, and policies, thereby promoting a sustainable development approach. The agenda includes 5 goals and 18 targets directly related to biodiversity management, ranking them among the top 30 national priorities.

### b) The 20-Year National Strategy (2017-2036)

The 20-Year National Strategy (2017-2036) is Thailand's first long-term national strategy, aimed at securing the country's sustainability, prosperity, and security in line with SEP. Strategy 5: Eco-Friendly Development and Growth focuses on the conservation and preservation of natural resources and the environment, while promoting balanced utilisation and sustainable economic growth.

### c) The 13th NESDP (2023-2027)

Aligned with the 20-Year National Strategy, the NESDP (2023-2027) is a medium-term development framework for Thailand. It incorporates the SDGs, resilience, and SEP, focusing on structural reforms, policy adjustments, and mechanisms to create a society that nurtures human potential while keeping pace with global dynamics. The NESDP comprises thirteen benchmarks, categorised into four areas:

- Production and service sectors.
- Economic and social opportunity and equality.
- Environmental sustainability and natural resource management.
- National transformation, supported by capable human resources and effective governance.
- Milestones related to biodiversity and sustainability include:
- Establishing Thailand as a sustainable tourism destination.
- Transitioning to a low-carbon society with a circular economy.
- Reducing vulnerability to natural disasters and climate change.

### d) The National Environmental Quality Management Plan (2023-2027)

Similar to the NESDP, Thailand's Environmental Quality Management Plan (2023-2027) aims to establish an environmentally friendly society by conserving, restoring, and utilising natural

resources equitably. The Royal Gazette (2021) published this five-year plan, which outlines twelve guiding principles for environmental and resource regulation, including:

- Sustainable development.
- Ecosystem approach.
- Precautionary principle.
- Extended producer responsibility.
- Polluters pay principle.
- Beneficiaries pay principle.
- Public-private partnerships.
- Resource efficiency.
- Good governance.
- Human rights.
- Integration.
- Environmental justice.

The plan also promotes five strategic goals to optimize sustainable marine resource use, including:

- Managing biodiversity and terrestrial resources to maintain balance.
- Restoring and conserving marine ecosystems.
- Establishing a climate-friendly society.
- Controlling urban pollution.
- Modernizing natural resource management practices.

**e) The Climate Change Master Plan (2015-2050)**

The Climate Change Master Plan (2015-2050) addresses critical climate change issues, focusing on adaptation, reducing emissions, and promoting low-emission growth. It includes three main areas of action:

- Adapting to the impacts of climate change.
- Reducing greenhouse gas emissions and promoting low-carbon growth.
- Building institutional capacity.

The plan proposes measures to mitigate coastal erosion, including changes to coastal land use patterns and expanding biodiversity conservation areas as part of short- and medium-term goals.

**f) Thailand's National Adaptation Plan (NAP)**

Thailand's National Adaptation Plan (NAP) provides a framework for climate change adaptation, aiming to build resilience, reduce vulnerabilities, and increase adaptive capacity. The NAP aligns with Thailand's broader national frameworks, including the National Strategy (2018-2037), the Master Plan under the National Strategy, the NESDPs, and the Climate Change Master Plan (2015-2050). It addresses six key sectors: 1) Water resource management; 2) Agriculture and food security; 3) Tourism; 4) Public health; 5) Natural resource management; and 6) Human settlements and security.

The NAP employs strategies to enhance resilience across these sectors, ensuring alignment with sustainable development principles.

Thailand's National Adaptation Plan (NAP) presents several different areas of focus that interact with coastal communities and sustain the health of these communities in the face of climate change (Department of Climate Change and Environment, 2023). Thailand states that it seeks to achieve the following goals, through the NAP, by 2037

- 2023-2027: Build a basis and instruments for policymaking and mainstreaming.
- 2028-2032: Strengthen policy instruments and mainstreaming across the priority sectors
- 2033-2037: Ensure climate resilience in the country's development actions

Table A6-2. presents the strategic directions, priority actions, and anticipated outcomes related to the management of marine and coastal ecosystems as outlined in Thailand's National Adaptation Plan (NAP) 2023. The focus is on building ecosystem resilience, reducing vulnerability to climate change, and integrating biodiversity and ecosystem services into national development.

**Table A6-2.1: Strategic Guidelines and Expected Outcomes for Marine and Coastal Ecosystem Management under Thailand's National Adaptation Plan (NAP), 2023**

| Guideline/ Measures | Output |
|---|---|
| 1) Conserve and protect marine and coastal resources, including increasing and rehabilitating mangrove areas for an ecological balance through a participatory | Specific measures for the conservation and rehabilitation of marine and coastal resources in each marine and coastal community are developed with public participation, and integrated into the strategic plan of the area with effective implementation. |
| 2) Support the conservation of endemic and endangered species in marine and coastal ecosystems affected by climate change, as well as prevent invasive alien species, which could become widespread due to the changing climatic conditions. | Research on breeding rare or endangered species are available, and regulations and measures for conserving and protecting biodiversity resources in marine and coastal ecosystems, especially threatened species, are in place. |
| (3) Expedite the designation of the EPAs in marine and coastal areas with fragile ecosystems and threats to biodiversity resources, which are outside the PAs. | Marine and coastal areas with fragile ecosystems and threats to biodiversity resources are designated as EPAs. |
| 4) Assessment of Thailand's Ocean Health Index and development of surveillance and monitoring systems for changes to seawater as a result of climate change factors. | Surveillance and monitoring systems for changes to seawater as a result of climate change factors are developed. |
| (5) Prepare an integrated plan for coastal zone management across the country to reduce the impact of coastal erosion through a participatory approach. | Integrated plans for coastal zone management are developed comprising protection, restoration, or rehabilitation measures of coastal areas across the country, and mainstreamed into the area-based strategic plan in each locality with effective implementation. |
| (6) Strengthen the capacity of coastal areas to respond to and prevent the impact of storm surges. | Plans to mitigate the impact, establish evacuation routes in the event of storm surges in coastal areas are developed, and response manuals and drills are produced and conducted. |
| (7) Enable networks of people organisations, community-based organisations, and LAOs along the coastal zones to conserve and rehabilitate marine and coastal resources. | Networks of people organisations, community-based organisations, and LAOs collaborate to develop measures on nature-based coastal restoration and participate in regulating the utilisation of mangrove areas. |

EPAs: Environmental Protected Areas; LAO: Local Administrative Organisations; PA: Protected Areas

To achieve the goals outlined in Thailand's National Adaptation Plan (NAP), the implementation of both sector-specific and cross-cutting measures is essential to ensure a synergistic and integrated approach to climate adaptation. These cross-cutting measures include the development of comprehensive databases, research, and technological innovations related to climate change adaptation. Additionally, the establishment of enabling mechanisms—such as regulatory frameworks, financial instruments, capacity-building programs, and incentives—is crucial. Strengthening the capacity, knowledge, and awareness of government officials and relevant stakeholders, including youth and the business sector, is also vital to foster a deeper understanding of climate risks and to empower all sectors to take effective adaptation actions.

### g) The NBSAP

Building on previous biodiversity plans (ONEP 2015: ONEP 2017) such as the Master Plan for Integrated Biodiversity Management (2015-2021) and the Biodiversity Management Action Plan (2017-2021), Thailand is currently finalising the NBSAP 2023-2027, alongside a Long-term Biodiversity Strategy (2024-2050). The NBSAP framework follows three primary principles: the Sufficiency Economy Philosophy, urgency and challenge, and transformational change. It introduces new approaches and modifications to earlier plans, offering eight key guidelines:

- A collaborative approach across all sectors of society.
- Guidelines for achieving national biodiversity goals suited to the local context.
- Balancing conservation with sustainable use.
- Integrated ecosystem management and spatial planning.
- Protecting the rights of stakeholders, with a focus on gender, youth, and vulnerable groups.
- Cooperation in implementing relevant international conventions.
- Raising awareness and promoting education on biodiversity.
- Establishing financial mechanisms and securing additional funding sources.

The NBSAP focus on three core strategies, each with specific goals, detailed in Table A6-2. Moreover, ONEP (2024a) emphasises that the success of the NBSAP (2023-2027) relies on a robust implementation framework that integrates national biodiversity targets across all sectors. The four key mechanisms for success include:

- Integrating sectoral plans.
- Increasing stakeholder participation and awareness.
- Leveraging financial and capital mechanisms to support implementation.
- Monitoring and assessing plan execution.

## Table A6-2.2: Three strategies and its targets under the NBSAP

| | |
|---|---|
| **Strategy 1:** Strengthen conservation efforts by increasing the protection of important habitats and species through improving management practices, expanding protected areas and developing measures to protect threatened species. The strategy aims to increase protected areas by at least 30 percent of the country's total area by 2030 and to enhance conservation of important habitats and species at risk of extinction. | Four targets under strategy 1 include the following.<br><br>1) Goal 1: To reduce the loss of important biodiversity areas through effective spatial planning;<br><br>2) Goal 2: To increase the protection of important biodiversity areas and restore degraded ecosystems to ensure that natural areas remain healthy and can support species conservation, by increasing OECMs and establishing appropriate rehabilitation and management measures;<br><br>3) Goal 3: To enhance the conservation status of threatened species, by establishing appropriate protection and management measures; and<br><br>4) Goal 4: To enhance the resilience of ecosystems to climate change and pollution, by developing appropriate adaptation and management measures |
| **Strategy 2:** Promote sustainable use of biodiversity resources in a way that is fair and beneficial to local communities, including the sustainable management of agricultural, forestry, tourism, and fisheries areas to ensure balanced and non-destructive use. The strategy aims to increase the value and income of local communities from goods and services from biological resources, enforce regulations on access and benefit-sharing, and promote sustainable agriculture and sustainable forest management so that natural resources are used in a balanced and sustainable manner. | Three targets under strategy 2 include the following.<br><br>1) Goal 5: To increase the value and income of local communities from the bioresource base, by promoting a bioeconomy;<br><br>2) Goal 6: To improve the sustainable management of production and service sectors, including tourism, by establishing appropriate management measures, promoting sustainable agriculture, forestry, resource management, fisheries and tourism; and<br><br>3) Goal 7: To establish mechanisms for access and benefit-sharing from genetic resources, by promoting the implementation of mechanisms and regulations for access and benefit-sharing. |
| **Strategy 3:** Integrate the importance of biodiversity into national and sectoral policies, planning processes, and development projects, by incorporating biodiversity into policies and plans in all development. Strategy 3 aims to focuses on integrating biodiversity into policies and plans of all sectors by promoting the establishment of at least five local biodiversity management plans and the disclosure of information on biodiversity of not less than 20 percent, which will enable national development and planning to coordinate and promote biodiversity conservation effectively. | Four targets under strategy 3 include the following.<br><br>1) Goal 8: To integrate biodiversity into the operations of all sectors, by developing guidelines for integrating biodiversity management into the operations of various sectors and developing local biodiversity management plans;<br><br>2) Goal 9: To mobilise financial resources for biodiversity conservation, by mobilising financial resources from domestic and international sources;<br><br>3) Goal 10: Develop information and knowledge systems on biodiversity, including promoting awareness by developing information systems to support decision-making and raising awareness in various sectors;<br><br>4) Goal 11: Develop capacity and cooperation in technology transfer, including research, by exchanging knowledge and creating academic cooperation both domestically and internationally; and<br><br>5) Goal 12: Strengthen policy and legal frameworks for biodiversity by developing appropriate policy and legal frameworks. |

### *h)* The National Marine and Coastal Resources Management Policy and Plan (NMCRMP) B.E. 2566-2570 (2023–2027)

The NMCRC B.E. 2566-2570 (2023–2027) emphasises the conservation, protection, restoration, and sustainable utilisation of marine and coastal resources (DMCR, 2024a). It aligns with the global Sustainable Development Goals (SDGs) and Thailand's 20-Year National Strategy, ensuring that resource use is both efficient and equitable.

The plan's vision is:"Marine and coastal resources are abundant, creating a balance between conservation and sustainable, fair utilisation."

1. The plan sets out four main objectives:
2. To maintain the abundance of marine and coastal resources and achieve a balance between conservation and sustainable use.
3. To promote the sustainable and appropriate utilisation of marine and coastal resources through inclusive participation from all sectors.
4. To enhance the efficiency of management mechanisms and tools at national, regional, and international levels.

To sustainably and systematically prevent and address coastal erosion problems.

- The plan identifies four key goals:
- Coastal and marine areas are effectively and systematically managed to conserve biodiversity.
- Mangrove forest areas are increasing.
- Damage, risk, and impacts from natural disasters and climate change are reduced.

The quality of Thailand's marine environment improves sustainably.
To achieve these goals, the plan outlines five sub-plans and guidelines, as detailed in Table A6-2.3

**Table A6-2.3: Sub-plans and guidelines pertaining to the NMCRC (2023-2027)**

| Sub-plan | Guidelines |
|---|---|
| Sub-plan one: Conserve, protect, restore, and prevent marine and coastal resources with 5 guidelines | **Guideline 1.1** Conserve and maintain marine and coastal resources as a basis for balanced and sustainable national development;<br>**Guideline 1.2** Restore and rebuild marine and coastal resource bases to reduce negative impacts from the country's social and economic development;<br>**Guideline 1.3** Drive action to achieve the goal of protecting and conserving biodiversity by 30% by 2030<br>**Guideline 1.4** Restoration of aquatic animal resources and maintenance of their abundance at a level that provides maximum sustainable productivity; and Guideline 1.5 Promote and support the intelligent and sustainable management of marine mineral and energy resources. |
| Sub-plan two: Promote and support the development of the Blue Economy based on the balanced and sustainable use of marine and coastal resources with 5 guidelines | **Guideline 2.1** Increase efficiency in marine litter management and proactive control of marine and coastal pollution;<br>**Guideline 2.2** Support the development of marine and coastal industries to be environmentally friendly and sustainable;<br>**Guideline 2.3** Support and promote spatial management of marine and coastal resources;<br>**Guideline 2.4** Effectively control fishing operations and promote sustainable fisheries development; and<br>**Guideline 2.5** Promote sustainable marine and coastal tourism development and control tourism that creates negative impacts. |
| Sub-plan three: Strengthen the efficiency of tools and mechanisms to support integrated marine and coastal resource management with 7 guidelines | **Guideline 3.1** Strengthen the role and capacity of the Provincial Marine and Coastal Resources Committee;<br>**Guideline 3.2** Integrate modern marine and coastal resources information management systems that cover all dimensions and serve as standards for use in management of all sectors;<br>**Guideline 3.3:** Create economic tools and promote the integration of cooperation from various sectors in the management of marine and coastal resources;<br>**Guideline 3.4** Promote participation and support for coastal communities and local administrative organisations in terms of organisation, networks, knowledge, roles, tools, and budget for management;<br>**Guideline 3.5**: Continuously strengthen human resource potential, academic knowledge in research, and management of marine and coastal resources;<br>**Guideline 3.6** Develop and promote knowledge and understanding of sustainable use of marine and coastal resources to all sectors; and<br>**Guideline 3.7** Research and develop innovations in marine and coastal resources for sustainable resource management |
| Sub-plan four: Develop effective coastal erosion prevention management and reduce the impacts of climate change with 4 guidelines | **Guideline 4.1** Promote and support integration between agencies and develop innovations to prevent and reduce coastal erosion in critical areas and important tourism areas of the country;<br>**Guideline 4.2** Develop legal tools and mechanisms for coastal erosion prevention and resolution that are comprehensive and complete in all dimensions.;<br>**Guideline 4.3** Conserve and restore marine and coastal resources to become effective carbon sinks; and<br>**Guideline 4.4** Prepare a risk management plan for marine and coastal resources from various threats. |
| Sub-plan five: Strengthen international cooperation in the sustainable use of the oceans and marine and coastal resources with 3 guidelines | **Guideline 5.1** Strengthen and support international cooperation in exploration, study, research, technology development and innovation related to sustainable management of the oceans and marine and coastal resources.;<br>**Guideline 5.2** Support international and regional cooperation to combat IUU fishing; and<br>**Guideline 5.3**: Continuously strengthen the capacity of personnel and agencies responsible for international cooperation on oceans and marine and coastal resources |

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