# Regional Flyway Initiative · Site Study

January 2026

**RFI Priority Site · Ko Libong Non-Hunting Area and Hat Chao Mai National Park**

Prepared by Ding Li Yong & Mike Crosby, with additional input from Khwankhao Sinhaseni, Kelvin Peh, Evelyn Pina-Covarrubias, James Hogg, Stefano Barchiesi and Radhika Bhargava

BirdLife International, University of Southampton, National University of Singapore, Bird Conservation Society of Thailand



Asian Development Bank

# General Site Information

| | | | | |
|---|---|---|---|---|
| Country | Thailand | | | |
| RFI Site Name | Ko Libong and Hat Chao Mai National Park | | | ID135 |
| City/ Municipality, Province, Region | Sikao and Kantang Districts, Trang Province | | | |
| Geographical coordinates | 7.29 N, 99.44 E | | Area (has) | 276,000 has |
| Key species | Spotted Greenshank (EN) | | | |
| Key habitats (biomes) | Mangroves and intertidal mudflats. | | | |
| Key ecosystem services | Provisioning services | | | |
| Key drivers of change | Port activities and aquaculture. Tourism | | | |
| Conservation status (mark all that applies) | ☐ | Protected Area | ☐ | Flyway Network Site |
| | ☐ | Ramsar Site | ☐ | Others _____ |
| IBA/ KBA name (and number) and other designations | Ko Libong | | | |
| Management Stakeholders | DWNP, including protected area management board of Hat Chao Mai National Park. Trang Provincial Government, and *amphoe* government of Sikao and Kantang. Department of Fisheries and Tourism. | | | |
| With management plan? | | | | |
| Project concept themes | Sustainable fisheries and shellfisheries, coastal wetland management; nature-based tourism | | | |
| Length of project | At least 6 years | | | |
| Sector/s | Fisheries, tourism | | | |
| No. of potential beneficiaries | | | | |
| Indigenous Peoples | ☐ | No | ☐ | Yes, potentially Moklen (sea gypsy) communities |
| Anticipated Implementation Risks | Potential impacts on migratory species and mangroves with poorly planned restoration works. | | | |
| Estimated Project Budget (US$) | 13,850,000 | | | |
| Potential Source/s of Financing | ☐ | Loan (to be identified) | ☐ | Private Sector |
| | ☐ | Grant (to be identified) | ☐ | Public-Private Partnership |

# Table of Contents

## Acronyms

| | |
|---|---|
| ADB | Asian Development Bank |
| AWC | Asian Waterbird Census |
| BCST | Bird Conservation Society of Thailand |
| CSR | Conservation Status Review |
| DOF | Department of Fisheries |
| DMC | Developing Member Country |
| DMCR | Department of Marine and Coastal Resources |
| DWNP | Department of Wildlife, National Parks and Plant Resources |
| DWR | Department of Water Resources |
| EAAFP | East Asian-Australasian Flyway Partnership |
| ECA | Ecologically Critical Area |
| IBA | Important Bird and Biodiversity Area |
| IUCN | International Union for the Conservation of Nature |
| NGO | Non-governmental Organisation |
| ONEP | Office of Natural Resources and Environmental Policy |
| RFI | Regional Flyway Initiative |
| TAO | *Tambon* Administrative Organisation |
| TESSA | Toolkit for Ecosystem Services Assessment |
| USAID | United States Agency for International Development |
| USD | United States Dollars |

# Executive summary

The Ko Libong Non-Hunting Area and Hat Chao Mai National Park are located in Sikao and Kantang Districts in Trang Province and is one of the most important protected coastal landscapes in Peninsular Thailand, where long-term shorebird research and surveys have been carried out by the Department of National Parks. Both protected areas, considered together here due to their proximity and ecological connectedness, overlaps with extensive areas of coastal mudflats, mangroves (c. 3,850 ha in the Trang River Estuary alone), nipah (*Nypa fruticans*) forests, sand beaches, rocky marine shores, as are coral reefs and seagrass beds and dry coastal scrub. Parts of the coastline comprises steep limestone mountains. Ko Libong is among the best-known sites in Peninsular Thailand for migratory shorebird conservation and support significant wintering congregations of the Spotted Greenshank *Tringa guttifer* (EN), alongside populations of at least 15 other shorebirds, including Great Knot *Calidris tenuirostris* and Eurasian Curlew *Numenius arquata*, besides also supporting among the largest Dugong *Dugong dugon* populations in Thailand. Presently, both Ko Libong and Hat Chao Mai are protected areas managed by DNP and were jointly designated as a Ramsar Wetland in 2002, covering an area of 66,313 ha. In 2019, seagrass beds in Hat Chao Mai Marine National Park were designated as the first Dugong Conservation Zone in Thailand. Both sites were subsequently designated as ASEAN Heritage Parks. The landscape surrounding both sites are mostly privately owned and mostly and are under rubber and coconut plantations, while most of the mangroves of the coast are directly managed by the Royal Forest Department.

Economic activity in the coastal zone around Ko Libong and Hat Chao Mai is dominated by fisheries and aquaculture, including mussel and oyster cultivation, and small-scale fisheries. The mangrove forests are leased for the harvesting of fuelwood and other forest products, including charcoal production. Additionally, this site derives substantial revenue from tourism through its attractions such as beaches, coral reefs, waterfalls, and wildlife. Key ecosystem services provided by the site are regulating and provisioning services; the Trang River, for example, provides an important source of freshwater for domestic consumption and aquaculture, while the mangrove foreshore protects from saline intrusion and coastal erosion.

Important interventions proposed for Ko Libong and Hat Chao Mai National Park are focused on strengthening the sustainability of livelihood and economic activities in and around these two sites. A key intervention addresses small-scale fisheries and shellfish aquaculture around both sites, and this is expected to involve work to improve the sustainability of fishing and seafood production through capacity building activities for small-scale operators to ensure that harvest and production processes are biodiversity-friendly, and improvement of fishery infrastructure, in complement with small-scale financing. This can be complemented by work to strengthen the infrastructure for nature-based tourism. There is also a need for better planning of coastal development and a more sustainable management for resources. It is also noted that the site's extensive mangroves could potentially be used to leverage carbon finance that can support site management and biodiversity conservation though benefit-sharing structures would need to be in place. As part of the sites' overall management, there is a need for long-term investment into biodiversity monitoring, in collaboration with local conservation groups, with a focus on dugong and shorebird populations.

# 1. Background of the Regional Flyway Initiative

In July 2021, the Asian Development Bank made a commitment to develop a long-term Regional Flyway Initiative (RFI) in the East-Asian Australasian Flyway (EAAF) (Sovereign Project 55056-001) to protect and restore priority wetland ecosystems and the associated ecosystem services they provide in the EAAF, the most threatened migratory bird flyway globally. The Initiative is slated for implementation in nine ADB developing member countries (DMCs) in East, South and Southeast Asia: Mongolia, People's Republic of China (PRC), Bangladesh, Viet Nam, Cambodia, Philippines, Thailand, Malaysia and Indonesia. In 2023, the geographic scope of the RFI was further extended to two DMCs in Southeast Asia and the Pacific respectively, Lao PDR and Papua New Guinea.

The primary aim of the RFI is to enhance and expand the existing efforts in conserving and managing wetlands of the highest priority for migratory birds within the EAAF through innovative loan and grant financing, and at scale. Consultations and analyses over the development period help identify key interventions to strengthen the management of wetlands, enabling the implementation of nature-based solutions while strengthening biodiversity protection. Over time, the RFI seeks to leverage collaborative opportunities by developing partnerships among important stakeholders including national governments, civil society organizations, communities, regional organizations like the East Asian-Australasian Flyway Partnership (EAAFP), development agencies, the private sector, and other relevant entities.

Through the RFI Technical Assistance (TA) implemented over the RFI's development phase from 2021 to 2024, BirdLife International takes the lead in providing and coordinating technical support for development of the RFI. This is carried out in collaboration with the EAAFP and a consortium of international non-governmental organizations including Wetlands International and the Paulson Institute, as well as two universities, namely the University of Southampton, UK and the National University of Singapore. Over the development phase, the TA team undertook a site selection analysis to identify priority wetland sites in all 10 countries based on recent bird data benchmarked against internationally accepted criteria under the Convention on Wetlands of International Importance (or Ramsar Convention), EAAFP Flyway Network Sites and Important Bird and Biodiversity Areas (IBAs). The team further developed ecosystem services profiles for prioritised wetlands using a multi-pronged approach used the TESSA ecosystem services assessment tool, and data-driven modelling of water-based ecosystem services and stored carbon.

In Thailand, a total of 36 wetland sites, including several Asian Waterbird Census (AWC) count sites, were initially assessed through data analysis and expert consultation, of which 18 were short-listed for assessment. Of this pool of sites, twelve (12) were defined and identified to be RFI priority sites on the basis that they support more than 1% the flyway population of at least one EAAF migratory waterbird species. Nine (9) of the RFI sites identified are coastal wetlands, a consequence of the country's long coastline along the Gulf of Thailand and Peninsular Thailand, with the largest cluster of priority sites concentrated in the Inner Gulf of Thailand (four: Pak Thale-Laem Pak Bia, Khok Kham, Bang Pu, Khlong Tamru). 15 EAAF species exceeded the 1% threshold at the site level in Thailand, with species such as Spotted Greenshank exceeding 10% of the estimated population in just one site (Laem Pak Bia) on a

regular basis. Other species with important non-breeding populations in Thailand includes Spoon-billed Sandpiper, Great Knot, and Sarus Crane.

## 2. Site profile of Ko Libong Non-Hunting Area and Hat Chao Mai National Park

*Location*: This RFI site encompasses two adjacent protected areas, Ko Libong Non-Hunting Area and Hat Chao Mai National Park, which are in Sikao and Kantang Districts, Trang Province on the west coast of Peninsular Thailand, about 830 km north of Bangkok. The non-hunting area includes Ko Libong, an island about 3.5 km offshore, and the nearby mainland coast including the Trang River mouth. The national park includes the mainland coast to the north of the Trang River, and several small offshore islands.

*Area*: The Ko Libong Non-Hunting Area and Hat Chao Mai National Park RFI site covers an area of 276,000 ha, including coastal waters.

*Altitude*: Mostly sea level, but the forested hills on Ko Libong and in Hat Chao Mai National Park rise to 311 m and 432 m respectively.

*Geographical coordinates*: 7.29 N, 99.44 E

*Description of site*: This site is a complex of many coastal wetland types including mudflats, mangroves, *Nypa* forests, estuarine waters, sandy beaches, rocky marine shores, coral reefs, seagrass beds and dry coastal scrub, with areas of coastline that comprise mostly steep limestone hills. Key areas for migratory waterbirds include the eastern two-thirds of Ko Libong Island which comprises of mangrove forests fringed by mudflats to the south and sand flats to the north. The Trang River Estuary is covered with approximately 38.5 $km^2$ of mangrove forests. The vegetation in adjacent areas includes beach scrub dominated by *Casuarina equisetifolia*, rubber plantations, some of which contain much secondary growth, and other cultivation around villages on the mainland, especially coconut and bananas.

*Site administration, management and land tenure*: Ko Libong (or Ta Libong) Non-Hunting Area was declared by the Government of Thailand in 1979 and Hat Chao Mai Marine National Park in 1981. These two protected areas were jointly designated as a 66,313 ha Ramsar Site in 2002. An area of seagrass beds in Hat Chao Mai Marine National Park was approved as the first Dugong Conservation Zone in Thailand in 2019. The Tourism Authority of Thailand (TAT) announced in 2019 that both Ko Libong Non-Hunting Area and Hat Chao Mai Marine National Park were designated as new ASEAN Heritage Parks. Had Chao Mai Marine National Park and Ta Libong Islands Non-Hunting Area are state owned, and the surrounded areas are privately owned and mostly used as rubber and coconut plantations. Most of the areas of mangrove are excluded from the protected areas and are state owned and managed by the Royal Forest Department, who lease them out to concessionaires.

*Social and economic values*: This site has inshore and offshore fisheries which are important on a local scale as a source of food and employment. The mangrove forests are harvested for fuelwood and other forest products, and for charcoal production. The mangroves and tidal flats are a source of invertebrates including bivalve molluscs, sea cucumbers, anemones, priapulids and mud crabs, and are also used for cage fish farming and shrimp farming. In the surrounding area the land is used for the cultivation of rubber, bananas, coconut palms and rice. This site has many tourist attractions, including white sand beaches, coral reefs, waterfalls, and wildlife such as Dugongs and congregations of waterbirds; boats are sometimes rented from the local villagers by birdwatchers or general tourists. The Trang River is important as a source of fresh water for domestic consumption and aquaculture, the prevention of saline intrusion and coastal erosion, and provision of habitats to many living organisms.

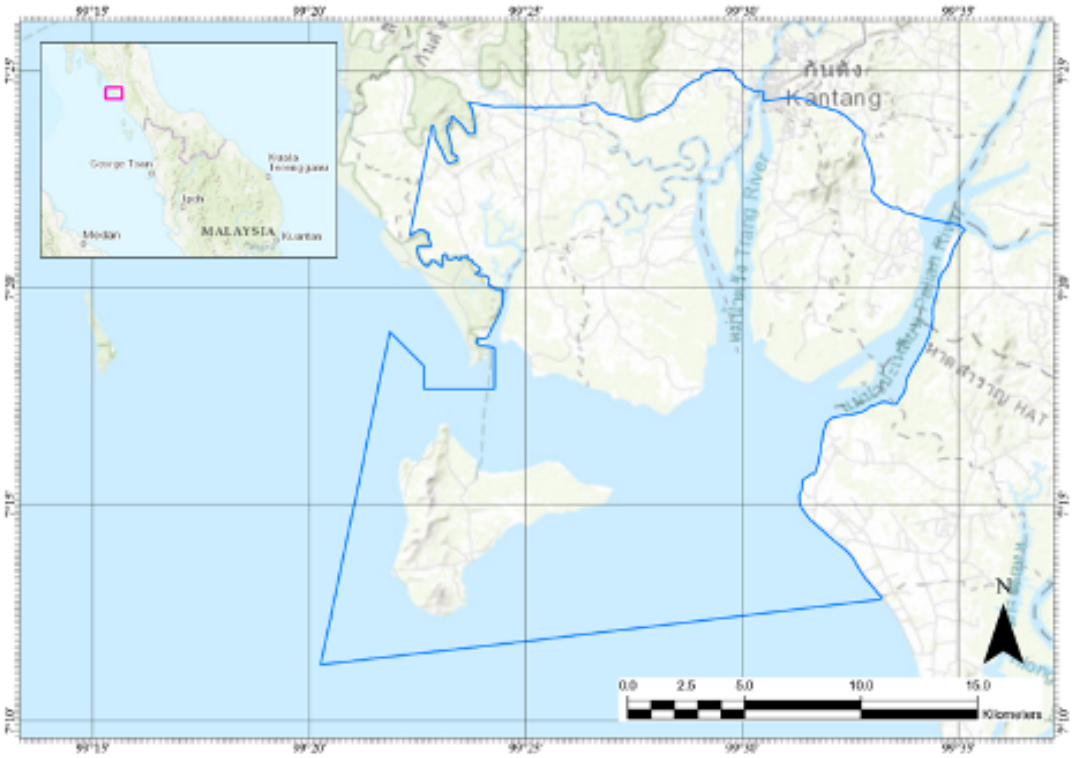


***Figure 1. Map of Ko Libong Non-Hunting Area and Hat Chao Mai National Park, showing its boundary (in blue) and location within Thailand (in pink) (Map: Evelyn Pina Covarrubias)***

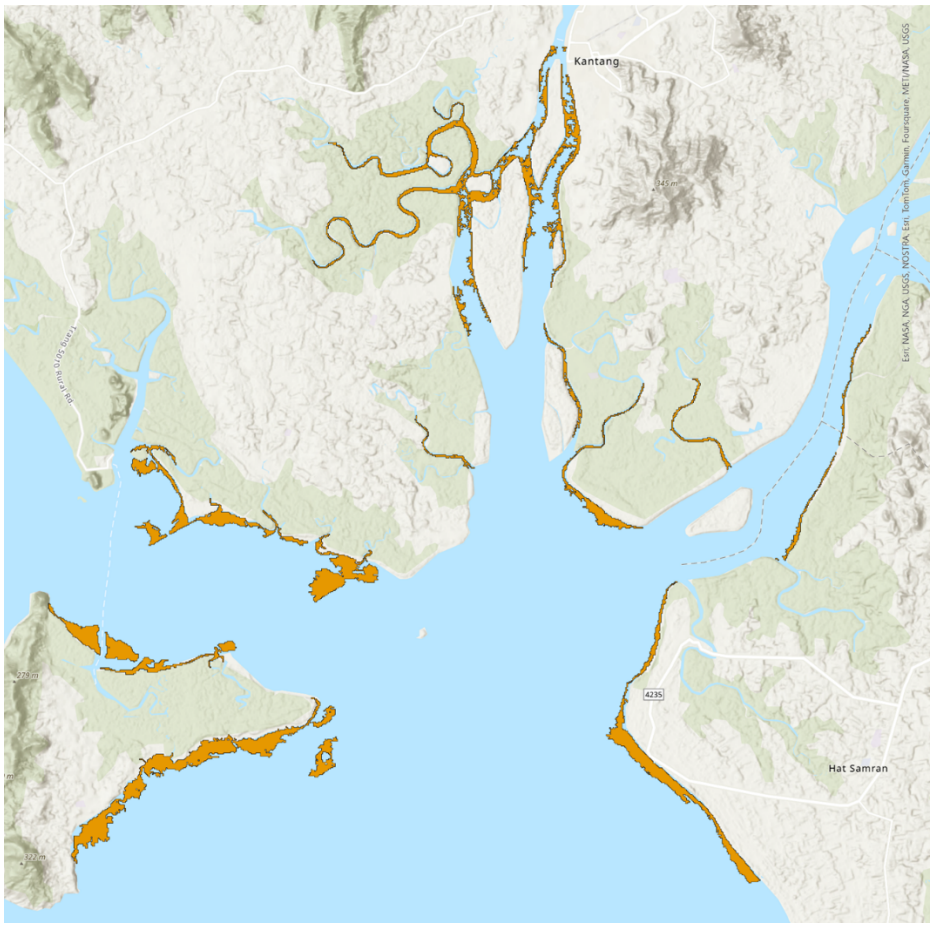


*Figure 2. Extent of mudflat cover in the Ko Libong – Hat Chao Mai landscape (Map: Radhika Bhargava)*

# 3. Biodiversity value of Ko Libong Non-Hunting Area and Hat Chao Mai National Park

## 3.1. Key habitats

This site is a complex of many coastal wetland types including mudflats, mangroves, *Nypa* forests, estuarine waters, sandy beaches, rocky marine shores, coral reefs, seagrass beds and dry coastal scrub, with areas of coastline that comprise mostly steep limestone hills. The vegetation in adjacent areas includes beach scrub dominated by *Casuarina equisetifolia*, rubber plantations, some of which contain much secondary growth, and other cultivation around villages on the mainland, especially coconut and bananas.

## 3.2. Importance of Ko Libong NHA and Hat Chao Mai National Park for migratory waterbird species

Ko Libong Non-hunting Area is an important wintering and staging area for migratory shorebirds and terns and has been extensively surveyed by the DWNP. It most notably it regularly supports a significant wintering population of the globally threatened Spotted Greenshank *Tringa guttifer* (EN). Count data from the 2017 and 2018 Asian Waterbird Census (AWC) and the Thailand Shorebird Survey 2021-2022, supplemented by data on Spotted Greenshank from Zöckler et al. (2018), was averaged in the RFI analysis for Ko Libong Non-Hunting Area and Hat Chao Mai National Park, and then compared to the Conservation Status Review (CSR1) 1% population estimates to calculate a score for each species. Two species were found to regularly exceed the 1% population estimate based on available data (see Table 1) and CSR1 score. Ko Libong Non-Hunting Area and Hat Chao Mai National Park was also found to support significant numbers of two near-threatened waterbird species, Eurasian Curlew *Numenius arquata* and Bar-tailed Godwit *Limosa lapponica*. Additionally, nine threatened or near-threatened migratory bird species are present in lower numbers, namely; Grey Plover (VU)m Black-tailed Godwit (NT), Chinese Egret (VU), Ruddy Turnstone (NT), Great Knot (EN). Broad-billed Sandpiper (VU), Curlew Sandpiper (VU), Red-necked Stint (NT) and Asian Dowitcher (NT). Historically, Masked Finfoot (CR) has been reported in mangroves in the site, but there are no recent records.

***Table 1. List of migratory species (based on the EAAFP list of species) with globally significant congregations in Ko Libong coastline.***

| Scientific name | IUCN | Average count | CSR1 | CSR1 score |
|---|---|---|---|---|
| Tibetan Sandplover *Anarhynchus atrifrons* | LC | 357 | 300 | 1.2 |
| Spotted Greenshank *Tringa guttifer* | EN | 10 | 10 | 1.0 |

## 3.3. Other notable biodiversity

Ko Libong Non-Hunting Area supports an important population of Dugong *Dugong dugon* (VU), estimated at 180 individuals in 2019 (out of a total Thai population of 200). Non-migratory bird fauna includes Wreathed Hornbill *Rhyticeros undulatus* (VU) although records are likely sporadic, and small populations of the Large Green Pigeon *Treron capellei* (VU) in Hat Chao Mai National Park. Several globally threatened mammal, reptile and tree species are recorded from the site, including Dusky Langur *Trachypithecus obscurus* (EN), Small-clawed Otter *Aonyx cinereus* (VU), Large-spotted Civet *Viverra megaspila* (EN), Elongated Tortoise *Indotestudo elongata* (CR) and *Dipterocarpus kerrii* (EN). Irrawaddy Dolphin *Orcaella brevirostris* (EN), Indo-Pacific Finless Porpoise *Neophocaena phocaenoides* (VU) are both known from the coastal waters in Hat Chao Mai and Ko Libong.

# 4. Ecosystem services

## 4.1. Ecosystem services provided by Ko Libong Non-Hunting Area and Hat Chao Mai National Park

Ko Libong Non-hunting Area and Hat Chao Mai National Park overlap with diverse coastal habitats, providing valuable provisioning and cultural ecosystem services (see Figure 3). The results from the RFI workshop[1] highlight the top ecosystem services provided by the site, emphasising their essential and non-substitutable nature (Table 2). Provisioning services, particularly fresh water, benefit communities both within, adjacent to, and distant from the site. This service has seen an increase in the past and is expected to continue increasing in the future. Food provision, however, benefits communities within and adjacent to the site and has experienced a decrease in the past, with further decreases anticipated. Genetic resources are valuable to adjacent and distant communities, having shown an increase in the past and projected to continue rising, indicating their growing importance for biodiversity conservation. Cultural services, including recreation ecotourism and knowledge systems and education, benefit communities at all distances. Both services have experienced an increase in the past and are expected to continue increasing in the future, reinforcing Ko Libong's significance to local communities and broader populations.

[1] Asian Development Bank. (2023, November 27-29). Thailand: Wetland Ecosystem Services Workshop [Workshop]. Thailand. https://events.development.asia/learning-events/thailand-wetland-ecosystem-services-workshop

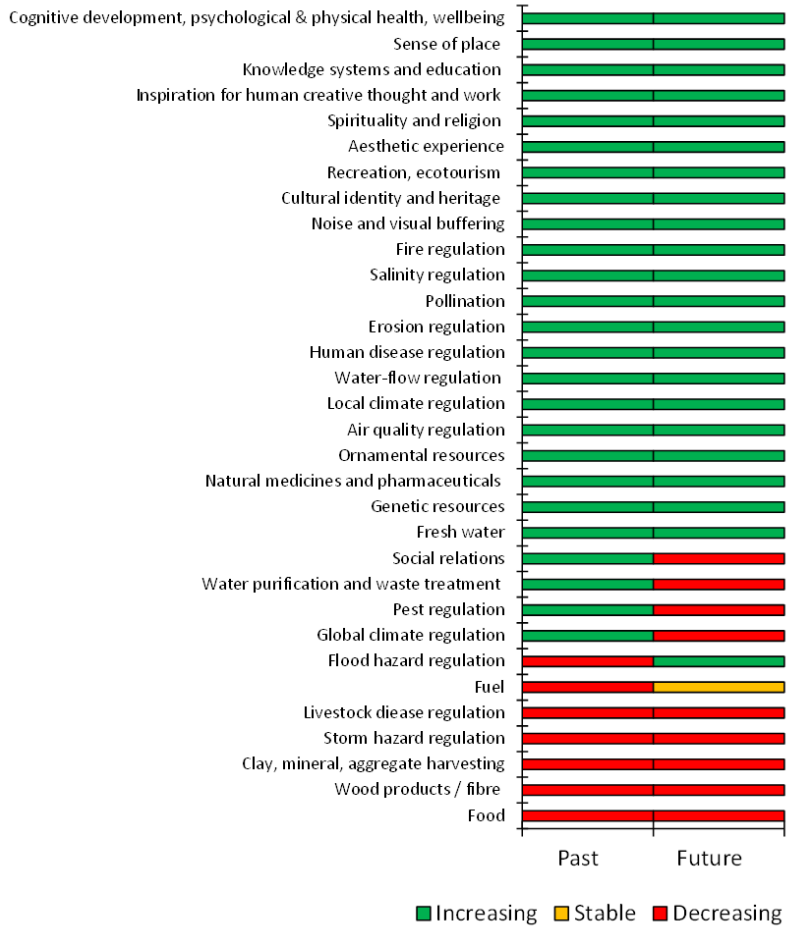


***Figure 3. List of ecosystem services provided by Ko Libong Non-Hunting Area and Hat Chao Mai National Park, as identified through stakeholder consultation at the Regional Flyway Initiative workshop.***

***Table 2. List of top ecosystem services provided by Ko Libong Non-Hunting Area and Hat Chao Mai National Park.***

| Ecosystem services | Essential or non-substitutable | Benefits to communities | | | Change | |
|---|---|---|---|---|---|---|
| | | Within the site | Adjacent to the site | Distant to the site | Past | Future |
| *Provisioning services* | | | | | | |
| Fresh water | Yes | ✓ | ✓ | ✓ | Increase | Increase |
| Food | Yes | ✓ | ✓ | | Decrease | Decrease |
| Genetic resources | | ✓ | ✓ | ✓ | Increase | Increase |
| *Cultural services* | | | | | | |
| Recreation, ecotourism | Yes | ✓ | ✓ | ✓ | Increase | Increase |
| Knowledge systems and education | | ✓ | ✓ | ✓ | Increase | Increase |

## 4.2. Global climate regulating services

Based on systematic reviews (Chen and Lee, 2022; Stankovic et al., 2023), the amount of carbon stored in Ko Libong Non-Hunting Area and Hat Chao Mai National Park is estimated to range from 302,000 to 1,660,000 tonnes, while the annual carbon sequestration rate is estimated to be between 8,090 and 61,000 tonnes per year.

## 4.3. Coastal protection services

The coastal protection services provided by Ko Libong Non-Hunting Area and Hat Chao Mai National Park were assessed using both biophysical indices and monetary values (see Tables A1 and A2, and Annex 1 for details). When compared to both the average of the nine RFI coastal sites and the average of all other coastal areas in Thailand (Table A3 in Annex 1), Ko Libong Non-Hunting Area and Hat Chao Mai National Park shows some only partly mixed results in terms of risk level:

(1) for the potential exposure to coastal hazards, Ko Libong Non-Hunting Area and Hat Chao Mai National Park is below average (index: 2.63 vs. 2.75 for RFI coastal sites and 2.70 for all other coastal areas);

(2) for the contribution to reducing coastal risk as a proportion of population density with 2.5 km of the coast, Ko Libong Non-Hunting Area and Hat Chao Mai National Park is also below average (21 vs. 63 people/ha for RFI coastal sites and 30 people/ha for all other coastal areas); but

(3) for the contribution to reducing coastal risk as a percentage of the maximum potential exposure, Ko Libong Non-Hunting Area and Hat Chao Mai National Park is consistently above average (6.21% vs. 5.44% for RFI coastal sites and 3.92% for all other coastal areas).

In monetary terms (Table A4 in Annex 1), the total annual benefits per hectare of mangroves at Ko Libong Non-Hunting Area and Hat Chao Mai National Park are 0 (compared to the national RFI average of 1,987 USD/ha) because the relevant population and property are directly exposed onto the coast to experience these benefits. However, when flooding extends well inland such as in the event of 100-year return period storms, the benefits of mangrove protection from the total area of Ko Libong Non-Hunting Area and Hat Chao Mai National Park are above the average of all RFI sites in Thailand (3.6 vs. 4.0 million USD).

# 5. Drivers of change and their potential impacts on Ko Libong Non-Hunting Area and Hat Chao Mai National Park

## 5.1. Current drivers of change and their level of impact

Stakeholders at the RFI workshop[2] identified several drivers of change impacting Ko Libong and Hat Chao Mai (see Table 3) and their corresponding levels of impact on the site. High-impact drivers include commercial and industrial areas, which significantly alter the natural landscape and contribute to habitat degradation. Erosion and siltation, marine and freshwater aquaculture, recreational activities and tourism, and water extraction or diversion within the wetland disrupt the ecological balance and pose substantial threats to the wetland's integrity.

Medium-impact drivers encompass activities of site managers, annual and perennial non-timber crop production, and avalanches/landslides, which modify the natural habitat. Other medium-impact factors include dams and hydrological modifications that alter water flow, fishing, habitat clearing, and habitat shifting. Housing and settlement development, industrial mining, invasive plant species, and isolation from other natural habitats further stress the ecosystem. Additional pressures include livestock farming, loss of keystone species, ports, research activities, restoration for conservation, roads and railroads, sewage and wastewater, shipping lanes, storm and flooding events, temperature extremes, tourism infrastructure, and vandalism.

As with most parts of the region, low lying coastal sites such as Ko Libong are at risk from the effects of sea-level rise. Norris et al. (2024) indicate that sea-level at the site will increase by 0.3m up to 2050 and 0.7m by the late century under a high emissions pathway. Under both studies there will be increased flooding, increased saline intrusion, changes to the extent of mangroves and changes to the available area for sea-bird food foraging. Temperatures are also expected to increase, exacerbating heat stress. Rainfall is likely to be more variable, with larger dry periods and increased rainfall in shorter timeframes. These effects will have impacts on both the biodiversity and on the resident population, and will impact on livelihoods.

[2] Asian Development Bank. (2023, November 27-29). Thailand: Wetland Ecosystem Services Workshop [Workshop]. Thailand. https://events.development.asia/learning-events/thailand-wetland-ecosystem-services-workshop

*Table 3. Drivers of change and their potential impact on the integrity of Ko Libong Non-Hunting Area and Hat Chao Mai National Park based on consultations with stakeholders.*

| Driver of change | Impact |
|---|---|
| Commercial and industrial areas | High |
| Erosion and siltation/deposition | |
| Marine and freshwater aquaculture | |
| Recreational activities and tourism | |
| Water extraction/diversion within the wetland site or catchment | |
| Activities of site managers | Medium |
| Annual and perennial non-timber crop production | |
| Avalanches/landslides | |
| Dams within or upstream of the wetland site, which alter the hydrological regime | |
| Dams, hydrological modification and water management/use | |
| Fishing, killing and harvesting of aquatic resources | |
| Habitat clearing | |
| Habitat shifting and alteration | |
| Housing and settlement | |
| Industrial, mining and military effluents | |
| Invasive plant species | |
| Isolation from other natural habitats | |
| Livestock farming and grazing | |
| Loss of keystone species | |
| Other 'edge effects' that degrade the wetland site values | |
| Ports with large scale loading and unloading of goods | |
| Research, education and other work-related activities | |
| Restoration for conservation | |
| Roads and railroads | |
| Sewage and wastewater from wetland site facilities | |
| Shipping lanes and canals | |
| Storm and flooding | |
| Temperature extremes | |
| Tourism and recreation infrastructure | |
| Vandalism, destructive activities or threats to staff and visitors | |
| Wood pulp and plantations | |
| Agricultural and forestry effluents | Low |
| Air-borne pollutants | |
| Collecting terrestrial plants or plant products (non-timber) | |
| Destruction of cultural heritage buildings, gardens, sites, etc. | |
| Drought conditions | |
| Droughts | |
| Drug cultivation | |
| Earthquakes/tsunamis | |
| Energy generation, including from hydropower dams, wind farms and solar panels | |
| Excess energy | |
| Excess ponding of water onsite | |
| Fire and fire suppression | |
| Flight paths | |
| Garbage and solid waste | |
| Household sewage and urban wastewater from outside the wetland site | |
| Hunting, killing and collecting of terrestrial animals | |
| Increased fragmentation within the wetland site | |
| Introduced genetic material | |
| Invasive animal species | |
| Logging and timber harvesting | |
| Loss of cultural links, traditional knowledge and/or management practices | |
| Loss of hydrological connectivity | |
| Natural deterioration of important cultural wetland site values | |
| Pathogens | |
| Utility and service lines | |

## 5.2. Potential alternative state of Ko Libong Non-Hunting Area and Hat Chao Mai National Park under current drivers of change

Stakeholders at the RFI workshop[3] defined the most plausible future alternative state (to 2035), and how this will translate to a net change in the cover of different types of wetland habitat types within this site (current habitat cover vs future alternative cover; Figure 4). The alternative state of the site assumes there will be no changes in the current drivers of change impacting the site, and the current management regime.

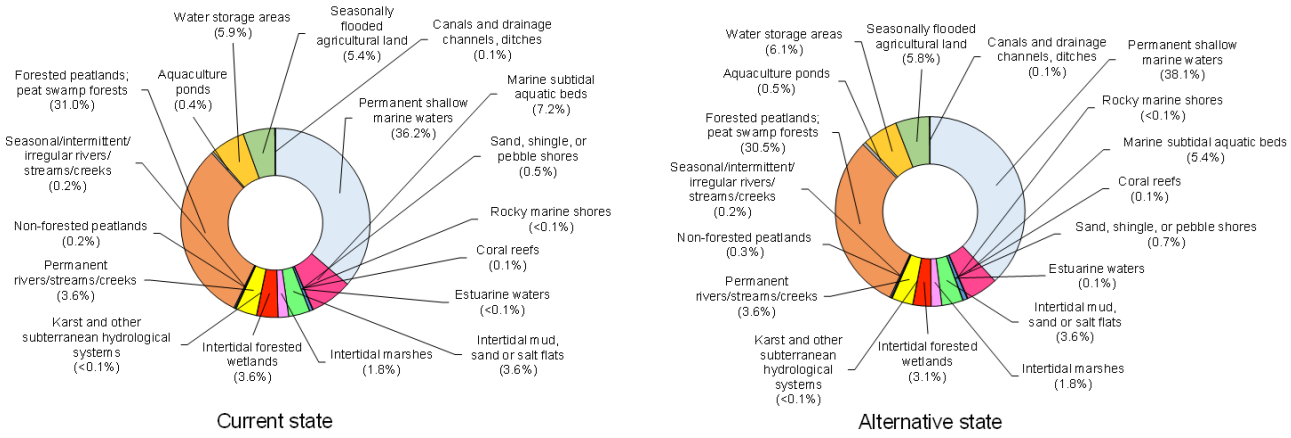


***Figure 4. The proportional change in the extent of different habitat types between the current and alternative states of Ko Libong Non-Hunting Area and Hat Chao Mai National Park.***

## 5.3. Expected changes in the ecosystem services of Ko Libong Non-Hunting Area and Hat Chao Mai National Park

Stakeholders at the RFI workshop[4] documented the future trends in the provision of ecosystem services in Ko Libong Non-hunting Area and Hat Chao Mai National Park, indicating if the ecosystem services provided by this site (to 2035) will increase, decrease, or will remain stable if the current drivers of change impacting this site will continue in their present condition, with the intervention remains unchanged.

Provisioning services, particularly food provision, are expected to increase in the long term (Figure 3, Table 2). However, there is concern that regulating services, such as air quality and global climate regulation, as

[3] Asian Development Bank. (2023, November 27-29). Thailand: Wetland Ecosystem Services Workshop [Workshop]. Thailand. https://events.development.asia/learning-events/thailand-wetland-ecosystem-services-workshop

[4] Asian Development Bank. (2023, November 27-29). Thailand: Wetland Ecosystem Services Workshop [Workshop]. Thailand. https://events.development.asia/learning-events/thailand-wetland-ecosystem-services-workshop

well as flood and storm hazard regulations may decrease in the long term, while cultural services, particularly recreation and tourism, remain stable.

Ko Libong Non-hunting Area and Hat Chao Mai National Park overlap with diverse coastal habitats, providing valuable provisioning and cultural ecosystem services (Figure 3). The results from the RFI workshop[5] highlights the top ecosystem services provided by the site, emphasising their essential and non-substitutable nature (Table 2). Provisioning services, particularly fresh water, benefit communities both within, adjacent to, and distant from the site. This service has seen an increase in the past and is expected to continue increasing in the future. Food provision, however, benefits communities within and adjacent to the site and has experienced a decrease in the past, with further decreases anticipated. Genetic resources are valuable to adjacent and distant communities, having shown an increase in the past and projected to continue rising, indicating their growing importance for biodiversity conservation. Cultural services, including recreation ecotourism and knowledge systems and education, benefit communities at all distances. Both services have experienced an increase in the past and are expected to continue increasing in the future, reinforcing Ko Libong's significance to local communities and broader populations.

In the alternative state, the loss of 15% of mangrove, 25% of seagrass and 2% of peatland will result in a loss of stored carbon, estimated to be between 29,900 and 285,000 tonnes, and a decrease in carbon sequestration rate (carbon accumulation) by approximately 339 to 3,730 tonnes per year.

A loss of 245.6 ha of mangroves (see Table A5 in the appendices) is equivalent to a 0.5% of the total land use for the site. However, it was not possible to estimate the reduction in coastal protection because the total annual total benefits per hectare of mangroves in Ko Libong Non-hunting Area and Hat Chao Mai National Park are 0 as explained in 4.3.

[5] Asian Development Bank. (2023, November 27-29). Thailand: Wetland Ecosystem Services Workshop [Workshop]. Thailand. https://events.development.asia/learning-events/thailand-wetland-ecosystem-services-workshop

## 6. Capacity needs in Ko Libong Non-Hunting Area and Hat Chao Mai National Park

Stakeholder consultations and analyses with government and civil society identified at least two stakeholder groups with clear roles in the long-term sustainable management of Ko Libong Non-hunting Area and Hat Chao Mai National Park. Table 4 summarizes the current and potential roles of these stakeholder groups in relation to the management of the Ko Libong Non-hunting Area and Hat Chao Mai National Park. There are opportunities to strengthen biodiversity monitoring, communications, stakeholder coordination, and other to be identified with local stakeholders.

***Table 4. Capacity needs for key stakeholders involved in the management of Ko Libong Non-hunting Area and Hat Chao Mai National Park.***

| Stakeholder group | Current role in wetland management | Possible future role in wetland management | Current capacity for sustainable wetland management | Capacity development needed to improve wetland management | Form of capacity development (e.g. training, organisational strengthening etc.) |
|---|---|---|---|---|---|
| Volunteer groups for dugong conservation | Undertake dugong monitoring. | Undertake dugong monitoring | Limited. Need to strengthen capacity on monitoring approaches. | Training programmes on biodiversity (dugong monitoring) | Training through a 'young ambassadors' through the (RPR Ambassador programme)'. |
| Local community groups (including Si Ban community) | Develop agreements and regulations for local communities on environmental protection. | Work with government agencies to endorse regulations and agreements. Seek mandate for active legal enforcement. | Limited. Current capacity is focused on supervising and encouraging community participation. | Strengthen communication and coordination with local stakeholders, including members of local communities. | Training sessions and workshops to revise the regulations on a regular basis (once every three years) |
| Seagrass restoration groups | Work with government agencies to enhance seagrass areas through restoration and protection. | - | - | - | - |
| Mangrove conservation groups. | Work with government agencies to restore mangrove areas. Develop guidance on usage. | - | - | - | - |

| Stakeholder group | Current role in wetland management | Possible future role in wetland management | Current capacity for sustainable wetland management | Capacity development needed to improve wetland management | Form of capacity development (e.g. training, organisational strengthening etc.) |
|---|---|---|---|---|---|
| Ecotourism operators. | A key beneficiary. Currently little or no role in site protection. | - | - | - | - |

# 7. Opportunities for RFI interventions

## 7.1. Recommended Interventions

The most significant risks to Ko Libong Non-Hunting Area and Hat Chao Mai National Park are related to human disturbances from ports, aquaculture, and tourism. The proposed interventions aim to strengthen wetland restoration and management on the Trang River estuary, explore the feasibility of carbon-based credits for wetlands in Trang estuary and Ko Libong, strengthen sustainable and wildlife-friendly ecotourism, and strengthen local livelihoods for small-scale fishing communities (including migrant workers).

*Table 5. Summary of key RFI interventions proposed for Ko Libong and Hat Chao Mai coastal landscapes.*

| Intervention | Outcome | Indicators | Cost (USD) | Timeframe | Potential Stakeholders |
|---|---|---|---|---|---|
| *Component 1. Strengthen wetland restoration and management on the Trang River estuary* | | | | | |
| Undertake environmental and social impact assessments. | Best practices, guidelines, and standards for proposed RFI interventions | Environmental and social impact assessment report finalized and disseminated with key local stakeholders.<br><br>Guidelines for evaluating proposed project components on their positive and negative impacts, taking into account local planning law, developed.<br><br>Guidelines and standards for an iterative process on redesigning project components developed and implemented.<br><br>Number of consultations conducted with local stakeholders for a participatory process in developing standard and guidelines for project interventions<br><br>Number of stakeholder groups engaged in the assessment and development of project interventions' guidelines | 100,000 | Up to 1.5 years. | DWNP<br><br>DMCR<br><br>Sikao and Kantang district (*amphoe*) government<br><br>Consultancy companies |
| Undertake hydrological and climate change impact assessment. | Best practices, guidelines, and standards for proposed RFI interventions | Hydrological and climate change impact assessment report that identify preferred areas for habitat restoration and build resilience across the site finalised and disseminated with key stakeholders.<br><br>Number of consultations conducted with local stakeholders for a | 100,000 | Up to 1.5 years. | |

| Intervention | Outcome | Indicators | Cost (USD) | Timeframe | Potential Stakeholders |
|---|---|---|---|---|---|
| | | participatory process in the impact assessment study<br><br>Number of stakeholder groups engaged in the impact assessment study | | | |
| Restore targeted degraded (overharvested) mangrove forests and disused fishponds along the Trang River estuary, and on the coastline between Hat Chao Mai and Ko Libong. | Improved management and conservation of Hat Chao Mai and Ko Libong through increased mangrove cover along the Trang River estuary<br><br>Mangroves / other degraded habitat such as disused fishponds and salt pans restored.<br><br>Suitable nature-based solutions applied on the Trang River estuary, and on the coastline between Hat Chao Mai and Ko Libong. | Area (target of up to 100 ha) of degraded coastal habitat restored with suitable mangrove species.<br><br>Coastal area (for at least XX km) protected using natural materials.<br><br>Number of stakeholder groups engaged in the mangrove restoration activities. | 500,000 | 5 years | DMCR<br><br>DWNP, including Hat Chao Mai management<br><br>Sikao and Kantang district (*amphoe*) government<br><br>Research institutions |
| Improve site management, including identifying measures to address unsuitable commercial development on the Trang coast | Improved management through a revised site management plan, a biodiversity monitoring program focusing on shorebirds and dugong, and | Site management plan updated to address threats and disturbance, and improve site conditions, and disseminated to key stakeholders.<br><br>Number of consultations conducted with local stakeholders for a participatory process in | 100,000 | 2 years | DWNP, including Hat Chao Mai management<br><br>Sikao and Kantang district (*amphoe*) government<br><br>Research institutions |

| Intervention | Outcome | Indicators | Cost (USD) | Timeframe | Potential Stakeholders |
|---|---|---|---|---|---|
| | increased capacity of key stakeholders and community members for biodiversity monitoring | the site management planning.<br><br>Number of stakeholder groups engaged in the site management planning.<br><br>One biodiversity monitoring framework and programme focusing on shorebird and dugong established and implemented.<br><br>A capacity-building program for the biodiversity monitoring framework.<br><br>Number of people trained in biodiversity monitoring.<br><br>Number of people engaged in biodiversity monitoring.<br><br>A biodiversity monitoring group established.<br><br>Number of biodiversity monitoring activities implemented with regular field-based counts and assessments of threats | | | Conservation NGOs. |
| *Component 2. Explore the feasibility of carbon-based credits for wetlands in Trang estuary and Ko Libong* | | | | | |
| Assess feasibility of carbon financing for the site, and other wetlands with high mangrove cover in the Thai Peninsula. | Feasibility and suitability of carbon financing better understood for key wetland sites in Thailand.<br><br>Preparatory work for carbon financing under suitable carbon | Feasibility report for carbon credits completed, disseminated with key stakeholders, and endorsed by respective management authority.<br><br>Investment guidelines for carbon financing from mangrove conservation drafted and endorsed by government agencies. | 100,000 | 2 years | ONEP<br><br>DWNP<br><br>Trang provincial government, Sikao and Kantang *amphoe* government<br><br>Consulting companies |

| Intervention | Outcome | Indicators | Cost (USD) | Timeframe | Potential Stakeholders |
|---|---|---|---|---|---|
| | credit mechanisms undertaken. | Number of consultations conducted with local stakeholders for a participatory process in the feasibility study<br><br>Number of stakeholder groups engaged in the feasibility study. | | | |
| *Component 3. Strengthening sustainable and wildlife-friendly ecotourism* | | | | | |
| Develop nature-based ecotourism, with a focus on birdwatching and wetland tourism.<br><br>Strengthen awareness of wetlands. | Improved site management and protected through ecotourism benefits, increased capacity of local stakeholders on nature-based tourism, and enhanced appreciation wetland habitats. | Number of nature-based tourism infrastructure (i.e. at least 0.5 km of boardwalk in mangrove forest outside the park and signage) established and improved.<br><br>Number of people benefitting from ecotourism activities.<br><br>Awareness-raising activities established for ecotourism<br><br>Number of awareness-raising activities implemented to target participants<br><br>Number of people trained from target participants. | 300,000 | 3 years | Royal Forest Department<br><br>DWNP |
| Develop actions to mitigate the potentially negative aspects of mass tourism. | Improved site management through controlled impacts of ecotourism activities. | Site management plan to address threats and disturbance posed by unsustainable tourism (given the relatively high impact of mass tourism) developed and consulted with key stakeholders<br><br>Number of consultations conducted with key | 100,000 | 2 years | Department of Tourism<br><br>DWNP |

| Intervention | Outcome | Indicators | Cost (USD) | Timeframe | Potential Stakeholders |
|---|---|---|---|---|---|
| | | stakeholders for participatory process in the development of site management plan.<br><br>Number of stakeholder groups engaged in the development of the site management plan. | | | |
| Strengthen ecotourism opportunities with a focus on small-scale local operators. Including improved access to financing (microcredit). | Improved site management through ecotourism benefits, livelihood opportunities for some local communities for alternative income streams, increased capacity of local operators to provide high-value ecotourism, and microfinancing mechanisms. | A capacity building (and training) program on ecotourism, wetlands, bird watching tourism, and financial management developed and implemented.<br><br>Number of capacity-building activities conducted for target participants.<br><br>Number of people and local tour operators (target of at least 20) trained on ecotourism, wetlands, birdwatching, and financial management in target stakeholders.<br><br>A financing mechanism (for local loans and grants) created for local communities<br><br>Number of people benefitting from the established financing mechanism and ecotourism opportunities | 300,000 | 4 years | Tourism operators<br><br>Department of Tourism<br><br>Sikao and Kantang *amphoe* government |
| *Component 4. Strengthening local livelihoods for small-scale, fishing communities (including migrant workers)* | | | | | |

| Intervention | Outcome | Indicators | Cost (USD) | Timeframe | Potential Stakeholders |
|---|---|---|---|---|---|
| Improve livelihood and income-generating activities for local communities with a focus on small-scale fisheries, and migrant workers. | Improved site management through stronger livelihood and financing support access for local communities, and increased capacity for fishing communities.<br><br>Improved provisioning services (for food resources, e.g. fish)<br><br>Fishery resources are better managed and conserved. | A training program for local fishers developed and implemented.<br><br>A financing mechanism developed for local communities.<br><br>Number of training activities implemented for local fishers.<br><br>Number of people (target of up to 100 households) trained.<br><br>Number of people benefitting from the financing mechanisms. | 500,000 | 6 years | Sikao and Kantang *amphoe* government<br><br>Conservation and community NGOs |
| Improve infrastructure for small-scale fisheries at local fishing ports. | Improved site management through sustainable fishery approaches and better local infrastructures for storage and processing of seafood products. | Number of local infrastructures for storage and processing of seafood products at local fishing ports, established and improved.<br><br>Number local enterprises supported with business plans.<br><br>A training program on sustainable fishery approaches, developed.<br><br>Number (target of up to 50) of fishing enterprises trained on sustainable fishery approaches, including fishing guidelines, production. | 1,000,000 | Up to 2 years | Department of Fisheries<br><br>Fishery and seafood cooperatives<br><br>Trang provincial government<br><br>Sikao and Kantang *amphoe* government<br><br>Fishery and shellfish farm operators |

| Intervention | Outcome | Indicators | Cost (USD) | Timeframe | Potential Stakeholders |
|---|---|---|---|---|---|
| Support local shellfish farming (including green mussel and oyster) and crab-harvesting cooperatives and small-scale fisheries– including improved access to financing (microcredit). | Improved site management through sustainable seafood production practices and microfinance mechanism.<br><br>Sustainable seafood harvesting practices promoted and encouraged for small-scale fisheries along the Trang River, potentially crab-farming opportunities for mud crab fisheries promoted. | Training on sustainable seafood production practices.<br><br>Standards for sustainable fishing practices agreed upon with stakeholders and progressively introduced.<br><br>Microcredit mechanism to support small-scale fishing and seafood operators established, in collaboration with fishery cooperatives.<br><br>Number (target of at least 20) of small loans and grants disbursed per year.<br><br>Number of people trained on sustainable seafood production practices.<br><br>Number of local shellfish farmers adopting sustainable practices. | 500,000 | 6 years | Department of Fisheries<br><br>Fishery and seafood cooperatives<br><br>Oyster and mussel farm operators<br><br>Trang provincial government<br><br>Sikao and Kantang *amphoe* government<br><br>Community NGOs |
| Implement initiatives to promote gender inclusion, better work conditions, skill training and finance management for women and migrant workers (from Myanmar) | Improved management through inclusive conservation. | Assessment study to identify barriers, determine needs for job market entry and better working conditions for fishery workers, and next steps for inclusive practices finalized and disseminated with key stakeholders.<br><br>Training program for up to 200 women from local and migrant communities to improve skills<br><br>Number of people, focused on women and migrant workers, trained | 150,000 | 3 years | Sikao and Kantang *amphoe* government<br><br>Fishery cooperatives<br><br>Community NGOs |

| Intervention | Outcome | Indicators | Cost (USD) | Timeframe | Potential Stakeholders |
|---|---|---|---|---|---|
| | | Number of training activities implemented. | | | |
| **Total investment for 6 years** | | | **USD 13,950,000** | | |

## 7.2. Potential Financing

The estimated project cost is USD 13,950,000 over 6 years. This budget supports environmental and social assessments to mitigate risks on coastal restoration and ecotourism, sustainable fishing and seafood practices, supporting eco-tourism activities and infrastructure development, establishment of a financing mechanism, mangrove restoration, assessment of carbon financing, and capacity-building for local stakeholders on biodiversity monitoring, ecotourism, financial management, and sustainable fisheries. Table 5 summarizes the projected budget distribution across the proposed project components.

With coastal protection benefits recorded as USD 0 per hectare annually, it is not possible to calculate a meaningful benefit–cost ratio for this intervention. This reflects the absence of directly exposed population or infrastructure in the area, rather than a lack of ecological value.

## 7.3. Proposed Institutional Arrangements

The project is expected to be led and coordinated on-site by the town (and *tambon*) government and the Department of Wildlife (DWNP) through its management board of Hat Chao Mai National Park and Ko Libong Non-hunting area, potentially with support from conservation organisations. The timeframe of the project is expected to span at least six years.

## 7.4. Project Beneficiaries

There likely small communities of Moken people on the Trang coastline. Scoping work planned under the project should aim to identify key communities around the project landscape.

There are also opportunities for strengthening engagement migrant workers (especially fishery workers from Myanmar) and some project activities is expect to benefit this group of stakeholders.

## 7.5. Anticipated Implementation Risks

*Stakeholder engagement:* Proposed interventions rely on support from local communities, particularly for the adoption of sustainable fishing and seafood practices, ecotourism, and co-management. Establishing strong stakeholder buy-in from local leaders and community engagement will facilitate better implementation of the proposed interventions.

*Environment:* Most proposed interventions are relatively soft and have a low environmental impact, but it may be necessary to consider the effects of expanding tourism in Ko Libong NHA and Hat Chao Mai National Park, which could increase anthropogenic pressures and lead to greater disturbance of wildlife. Planning with stakeholders to reduce noise pollution during the construction of ecotourism facilities and ongoing ecotourism activities, as well as managing waste pollution from increased tourist traffic, is essential.

Scoping studies on gender-related issues and on the broader benefits and risks for local communities will help address potential socioeconomic impacts of the project. There is a genuine risk that coastal restoration and tourism infrastructure works, if poorly designed and managed, may result in biodiversity loss, including increased disturbance to migratory shorebirds.

# References


Andalay Resort: Koh Libong. Available at: http://andalayresort.com/history.html

ASEAN Centre for Biodiversity: Hat Chao Mai National Park. Available at: https://asean.chm-cbd.net/hat-chao-mai-national-park

ASEAN Heritage Parks: Hat Chao Mai National Park and Mu Ko Libong Non-hunting Area. Available at: https://www.aseanbiodiversity.org/asean-heritage-parks/hat-chao-mai-national-park-and-mu-ko-libong-non-hunting-area/

Asian Waterbird Census (AWC): Thailand data for 2017-2018. See https://eaaflyway.net/asian-waterbird-census

BirdLife International Important Bird Area factsheet: Ko Li Bong (Thailand). Available at: https://datazone.birdlife.org/site/factsheet/ko-li-bong-iba-thailand

IUCN Red List of Threatened Species. Available at: www.iucnredlist.org

Kahaku: Fishes of Libong. Available at: https://www.kahaku.go.jp/research/db/zoology/Fishes_of_Libong/intro02.html

Mundkur, T. & Langendoen, T. (2022) *Report on the Conservation Status of Migratory Waterbirds of the East Asian – Australasian Flyway Partnership.* First Edition. Draft Report to the East Asian – Australasian Flyway Partnership. Wetlands International, Ede, The Netherlands. Available at: https://www.wetlands.org/publication/eaaf-conservation-status-review1/

Norris, L., et al. (2024) *Climate risk report for the Southeast Asia region*, Met Office, ODI, FCDO. https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/services/government/climate-risk-report-for-sea---v6-final-updated.pdf

Pimathi, R., Jukmongkol, R., Round, P. D. and Tordoff, A. W. (eds) (2004) *Directory of Important Bird Areas in the Kingdom of Thailand: key sites for conservation.* Bangkok, Thailand: Bird Conservation Society of Thailand and BirdLife International.

Ramsar Site Information Sheet: Had Chao Mai Marine National Park - Ta Libong Island Non-Hunting Area - Trang River Estuaries. Available at: https://rsis.ramsar.org/ris/1182

Scott, D.A. (1989) *A Directory of Asian Wetlands.* IUCN: Gland, Switzerland & Cambridge, U.K. Available at: https://portals.iucn.org/library/node/5933

Seacology: Libong Island. Available at: https://www.seacology.org/project/libong-island/

TAT News: Two of Thailand's national parks designated as ASEAN Heritage Parks. Available at: https://www.tatnews.org/2019/10/two-of-thailands-national-parks-designated-as-asean-heritage-parks/

Thailand Shorebird Survey (2021-2022): Shorebird surveys conducted by the Bird Conservation Society of Thailand from 2021-2022.

Tourism Thailand: Hat Chao Mai National Park. Available at: https://www.tourismthailand.org/Attraction/hat-chao-mai-national-park

Tourism Thailand: Ko Libong. Available at: https://www.tourismthailand.org/Attraction/ko-libong

UNEP-WCMC. Protected Area Profile from the World Database on Protected Areas: Mu Ko Libong. Available at: https://www.protectedplanet.net/8043

Wikipedia: Hat Chao Mai National Park. Available at: https://en.wikipedia.org/wiki/Hat_Chao_Mai_National_Park

Wikipedia: Ko Libong. Available at: https://en.wikipedia.org/wiki/Ko_Libong

Wikiwand: Hat Chao Mai National Park. Available at: https://www.wikiwand.com/en/Hat_Chao_Mai_National_Park

Zöckler, C., Li, D., Chowdhury, S. U., Iqbal, M., & Yu, C. (2018) Winter distribution, habitat and feeding behaviour of Nordmann's Greenshank *Tringa guttifer*. *Wader Study* 125(1): 7-14. Available at: https://www.waderstudygroup.org/article/10820/ DOI 10.18194/ws.00106

# **Annex 1**. Supplementary information on coastal protection services

To further validate the identification of the top ecosystem services by means of stakeholder consultation, an expectedly essential or non-substitutable regulating service across all RFI sites, namely coastal protection and flood mitigation (i.e., storm and flood hazard regulation), was assessed based on a combination of globally available datasets supplemented by web-based tool Co$tingNature (Mulligan, 2022). Estimates for coastal protection by mangroves (after the effects of coral reefs) were spatially inferred in QGIS from a selection of metrics expressing different biophysical and monetary values modelled by Chaplin-Kramer et al. (2023) and Menéndez et al. (2020), respectively.

The key metrics selected for biophysical values (Table A1) were current maximum potential exposure to coastal hazards, which is a vulnerability risk index calculated in InVEST[1] for several hazard variables (i.e., wind, waves, sea level rise, geomorphology, and bathymetry) in the hypothetical absence of current mangrove extent, and nature's (i.e., the mangroves') contribution to reducing this coastal risk, both as an absolute value multiplied by the local population affected and a percentage of the maximum potential exposure.

**Table A1.** Contribution of mangroves to coastal protection as a critical natural asset in Ko Libong Non-Hunting Area and Hat Chao Mai National Park based on site-level (biophysical) values inferred from Chaplin-Kramer et al. (2023) and expressed as ranges to represent the resulting uncertainty. Key metrics are in italics.

| **Critical contribution of mangroves to coastal protection (metrics)** | **Risk levels** |
|---|---|
| Current population density within 2.5 km of the coast (number of people per hectare) | 126 – 134 |
| *Current maximum coastal risk to be mitigated, or potential exposure to coastal hazards (unitless index)* | *2.56 - 2.70* |
| Maximum coastal risk to be mitigated, or potential exposure to coastal hazards in 2050 according to IPCC's Shared Socioeconomic Pathway #1 'Sustainability' (unitless index) | 2.87 - 3.04 |
| Maximum coastal risk to be mitigated, or potential exposure to coastal hazards in 2050 according to IPCC's Shared Socioeconomic Pathway #3 'Regional Rivalry' (unitless index) | 3.07- 3.25 |
| Maximum coastal risk to be mitigated, or potential exposure to coastal hazards in 2050 according to IPCC's Shared Socioeconomic Pathway #5 'Fossil-fueled Development' (unitless index) | 3.34- 3.54 |
| Current proportional risk reduction, nature's contribution to reducing coastal risk as a proportion of maximum coastal risk (unitless index) | 0.16- 0.17 |
| *Nature's contribution to reducing coastal risk as a proportion of population density within 2.5 km of the coast (# of people per hectare)* | *20 – 22* |
| *Nature's contribution to reducing coastal risk as a percentage of the maximum potential exposure (%)* | *5.87 - 6.55* |

The key metrics selected for economic values (Table A2) were the annual expected flood protection benefits to total stock, which is the monetary value of the averted damages to the industrial and residential stocks (i.e., property) in 2015 US$, the same total annual benefits expressed per hectare of mangroves, and the total benefits in the event of a 100-year return period storm, which are the rarest of cyclonic conditions but cause the most flood damages to property (i.e., maximum level of coastal protection by mangroves).

**Table A2**. Coastal protection benefits offered by mangroves in Ko Libong Non-Hunting Area and Hat Chao Mai National Park based on site-level (monetary) values inferred from Menéndez et al. (2020) and expressed as ranges to represent the resulting uncertainty. Key metrics are in italics.

| **Benefits of mangroves in terms of coastal protection (metrics)** | **Avoided costs (US$)** |
|---|---|
| Mangrove extent (hectares)[2] | 11,680 – 11,867 |
| Annual expected flood protection benefits to people (number of people) | 0 |
| Annual expected flood protection benefits to Industrial Stock (US$) | 0 |
| Annual expected flood protection benefits to Residential Stock (US$) | 0 |
| *Annual expected flood protection benefits to Total Stock (US$)* | *0* |
| *Annual expected flood protection benefits to Industrial Stock per hectare of mangroves (US$ per hectare)* | *0* |
| 1-in-100-year return period damage in terms of area flooded (number of hectares) | 842 – 869 |
| *Total expected flood protection benefits of mangroves per 100-year return period storms (US$)* | *3,509,642 - 3,620,190* |

**Table A3.** Biophysical benefits from RFI coastal wetland sites (expressed as ranges to represent the resulting uncertainty) and at the national level.

| **Site name** | **Max pot exp (index)** | **Risk reduction (index * pop)** | **Risk reduction (% max pot exp)** |
|---|---|---|---|
| Bang Pu | No Data | No Data | No Data |
| Khlong Tamru (Bang Pakong) | 3.22 (±0.17) | 147 (±39) | 4.87 (±0.25) |
| Khlong Yai | 2.15 (±0.07) | 59 (±16) | 7.27 (±1.91) |
| Koh Kham | 3.02 (±0.09) | 0 (±0) | 5.18 (±0.16) |
| Ta Libong | 2.63 (±0.07) | 21 (±1) | 6.21 (±0.34) |
| Krabi Estuary | 2.69 (±0.07) | 17 (±1) | 5.68 (±0.28) |
| Pak Nam Prasae | 2.63 (±0.20) | 53 (±1) | 5.94 (±0.44) |
| Pak Thale | 3.23 (±0.08) | 28 (±8) | 3.36 (±0.85) |
| Ao Phang Nga | 2.45 (±0.10) | 12 (±1) | 6.02 (±0.35) |
| Thailand RFI average | 2.75 | 63 | 5.44 |
| Thailand national average | 2,70 | 30 | 3.92 |

**Table A4.** Monetary benefits from RFI coastal wetland sites (expressed as ranges to represent the resulting uncertainty) and at the national level.

| Site name | Total annual benefits (US$) | Per mangrove area (US$/ha) | For 100-yr return period storms (US$) |
|---|---|---|---|
| Bang Pu | 723,608 (±1,023,384) | 985 (±1,393) | 1,252,086 (±1,252,144) |
| Khlong Tamru (Bang Pakong) | 4,064,792 (±101.810) | 1,698 (±43) | 1,028,638 (±46,938) |
| Khlong Yai | 299,013 (±35,045) | 37 (±4) | 0 (±0) |
| Khok Kham | 9,699,944 (±5,444,336) | 12,815 (±7,193) | 17,562,472 (±14,369473) |
| Ko Libong and Hat Chao Mai | 0 (±0) | 0 (±0) | 3,564,916 (±55,274) |
| Krabi Estuary | 0 (±0) | 0 (±0) | 4,150,201 (±45,319) |
| Pak Nam Prasae | 557,410 (±3,584,456) | 300 (±1,929) | 1,464,757 (±2,408,230) |
| Pak Thale | 806,609 (±1,685,154) | 1,967 (±4,109) | 962,707 (±1,130,299) |
| Ao Phang Nga | 81,744 (±96,861) | 86 (±102) | 5,723,399 (±12,351,015) |
| Thailand RFI average | 1,803,680 | 1,987 | 3,967,686 |
| Thailand RFI total | 16,233,119 | Not Applicable | 18,146,703 |
| Thailand national average | 789,242 | 2,702 | 9,197,142 |
| Thailand national total | 85,257,773 | Not Applicable | 377,082,842 |

**Table A5**. Key habitat types in Ko Libong Non-Hunting Area and Hat Chao Mai National Park based on stakeholder-based assessment at the Regional Flyway Initiative workshop in November 2023.

| Habitat type | Current state | | Alternative state (2035) | |
|---|---|---|---|---|
| | Area (ha) | Cover (%) | Area (ha) | Cover (%) |
| Permanent shallow marine waters | 16370.6 | 36.23 | 17189.1 | 38.04 |
| Marine subtidal aquatic beds | 3274.1 | 7.25 | 2455.6 | 5.43 |
| Coral reefs | 24.6 | 0.05 | 40.9 | 0.09 |
| Rocky marine shores | 16.4 | 0.04 | 16.4 | 0.04 |
| Sand, shingle, or pebble shores | 245.6 | 0.54 | 327.4 | 0.72 |
| Estuarine waters | 8.2 | 0.02 | 32.7 | 0.07 |
| Intertidal mud, sand or salt flats | 1637.1 | 3.62 | 1637.1 | 3.62 |
| Intertidal marshes | 818.5 | 1.81 | 818.5 | 1.81 |
| Intertidal forested wetlands | 1637.1 | 3.62 | 1391.5 | 3.08 |

| Habitat type | Current state | | Alternative state (2035) | |
|---|---|---|---|---|
| | Area (ha) | Cover (%) | Area (ha) | Cover (%) |
| Karst and other subterranean hydrological systems | 16.4 | 0.04 | 16.4 | 0.04 |
| Permanent rivers/streams/creeks | 1637.1 | 3.62 | 1637.1 | 3.62 |
| Seasonal/intermittent/irregular rivers/ streams/creeks | 81.9 | 0.18 | 81.9 | 0.18 |
| Non-forested peatlands | 98.2 | 0.22 | 114.6 | 0.25 |
| Forested peatlands; peat swamp forests | 13996.9 | 30.98 | 13759.5 | 30.45 |
| Aquaculture ponds | 163.7 | 0.36 | 245.6 | 0.54 |
| Water storage areas | 2652.0 | 5.87 | 2750.3 | 6.09 |
| Seasonally flooded agricultural land | 2455.6 | 5.43 | 2619.3 | 5.80 |
| Canals and drainage channels, ditches | 49.1 | 0.11 | 49.1 | 0.11 |
| Total | 45182.8 | 100.00 | 45182.8 | 100.00 |