

Chapter 4 **Ecosystem**

“Implementing the Strategic Action Programme for the South China Sea and Gulf of Thailand (SCS SAP Project)”

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Abstract

Cambodia's coastal and marine ecosystems—mangroves and wetlands, coral reefs, and seagrass meadows—remain high-value natural infrastructure that underpins coastal protection, fisheries nurseries, blue-carbon storage, and tourism, but they are under accelerating cumulative pressure. Recent national mapping indicates mangroves are declining overall ($\approx 58,866$ ha in 2014 to $\approx 55,355$ ha in 2025; $\sim -6\%$), with losses concentrated in Koh Kong and peri-urban Preah Sihanouk, while dataset differences ($\approx 45,000$ – $63,000$ ha) underscore the need for harmonized baselines and consistent monitoring. A globally rare sensitivity hotspot is the Botum Sakor peat-forming mangrove complex ($\sim 4,768$ ha), where hydrologic disruption (roads/culverts, drainage, reclamation) risks irreversible peat oxidation, carbon loss, and weakened storm buffering. Wetland connectivity is equally critical in the Peam Krasop–Koh Kapik landscape, where exceptionally high livelihood dependence ($>65\%$ of households deriving 70–90% of income from wetland resources) means small ecological changes can translate quickly into welfare losses. Coral reefs are generally “fair” but structurally simplified by sedimentation, turbidity and fishing pressure (e.g., $\sim 30\%$ mean live cover in Koh Rong), while Cambodia's extensive seagrass—especially the Kep–Kampot corridor—remains highly vulnerable to bottom-contact fishing and turbidity. Management is improving through a mixed system of protected areas, MFMA, Ramsar sites and community co-management, but persistent gaps in monitoring, enforcement capacity, financing, and cross-agency zoning coherence constrain outcomes. Priority, high-return actions include “hydrology-first” safeguards for peat mangroves, anti-trawl exclusion and sustained patrol support for community fisheries, targeted bycatch-risk measures for megafauna, and basic wastewater/runoff controls in growth nodes—scaled through stronger transboundary cooperation across the Gulf of Thailand.

Keywords: *Cambodia; coastal ecosystems; mangroves; peat-forming mangroves; wetlands; Ramsar; coral reefs; seagrass; blue carbon; biodiversity hotspots; ecosystem services; fisheries nursery; coastal protection; turbidity; bottom trawling; IUU fishing; marine protected areas; OECMs; MFMA; community co-management; transboundary cooperation.*

4. Ecosystems

4.1 Key Findings

- **Mangroves** remain strategic natural infrastructure but are shrinking: from ~58,866 ha (2014) to ~55,355 ha (2025) ($\approx -6\%$; ~319 ha/year), with main losses in Koh Kong and peri-urban Preah Sihanouk.
- **Botum Sakor peat-mangroves** (~4,768 ha; peat 0.5–1.0 m, max ~1.35 m; ≥ 26 plant species) are a rare blue-carbon asset, requiring “hydrology-first” protection to avoid irreversible carbon loss and weaker coastal defence.
- **Peam Krasop–Koh Kapik** is one of mainland SE Asia’s largest mangrove–intertidal systems and a key livelihood base; $>65\%$ of nearby households derive 70–90% of income from wetland resources, so nursery loss or salinity/channel change has immediate welfare impacts.
- **Coral reefs** are generally in “fair” condition but under cumulative pressure: Koh Rong reefs dominated by sediment-tolerant massive corals (~30% mean live cover); Kep retains high-cover pockets (e.g., Koh Seh ~64%). Overfishing, turbidity and bleaching drive structural simplification and losses for fisheries/tourism.
- **Seagrass meadows** (~11,500 ha in Kep–Kampot, plus major beds off Peam Krasop and Prey Nob/Steung Hav) are extensive but highly sensitive to trawling and turbidity—recovering where trawl controls hold, declining where dredging, shoreline works and runoff limit light.
- **Globally significant fauna** persist at low abundance: Irrawaddy dolphins (EN) in Kep, dugongs and marine turtles along the coast, fishing cat and smooth-coated otter in mangroves—all facing bycatch and habitat-fragmentation risks.
- **Three sensitivity hotspots** stand out: (i) Botum Sakor peat-mangroves; (ii) Peam Krasop–Koh Kapik connectivity complex; (iii) Kep–Kampot seagrass corridor (blue-carbon and nursery values but strong trawl/light pressures).
- **Low-cost, high-return actions** include hydrologic safeguards in peat-mangroves, anti-trawl networks and patrol fuel for CFIs, targeted closures around megafauna bycatch areas, and basic wastewater controls in growth nodes to prevent major income and asset losses while enabling blue-carbon/tourism gains.
- **Transboundary stakes** are significant: reef and seagrass health affects migratory stocks and tourism across the Gulf of Thailand; aligned standards on water quality, IUU control and spill/emergency readiness with Thailand and Viet Nam can magnify benefits.
- **Management is improving but needs scaling:** the mixed MNP–MFMA–CFi/CPA model works where zoning, enforcement and monitoring are funded; priorities are harmonising MoE–FiA rules (notably Koh Rong), fast-tracking Kampot MFMA, embedding joint habitat/water-quality monitoring, and securing sustained finance (user fees, fines, blue-carbon/seagrass credits).

4.2 Current Status

4.2.1 Mangroves and Wetlands

See [Annex 4-5](#) for the extended explanatory note on mangrove datasets, historical trends, and Ramsar wetland system connectivity relevant to the site-specific information presented in [Sections 4.2.1.1–4.2.1.2](#) below.

4.2.1.1 Status and distribution

Mangrove: National mangrove extent varies widely by dataset ($\approx 45,000$ – $63,000$ ha) and is concentrated in Koh Kong with smaller estuarine belts in Kampot–Preah Sihanouk (Bunting et al., 2022; PEMSEA & MoE, 2019; MoE, 2025a). Historic statistics indicate substantial losses in the 1990s–2000s, but recent MoE mapping (Sentinel-2, 10 m) shows ([Figure 4-1](#)) a slower decline from **58,866 ha (2014)** to **55,355 ha (2025)** ($-3,510$ ha; ≈ -319 ha/year; -6%). Losses are uneven: **Koh Kong accounts for $\sim 64\%$** of the 2014–2025 loss, with smaller losses in Preah Sihanouk and fragmented parcels in Kampot and Kep.

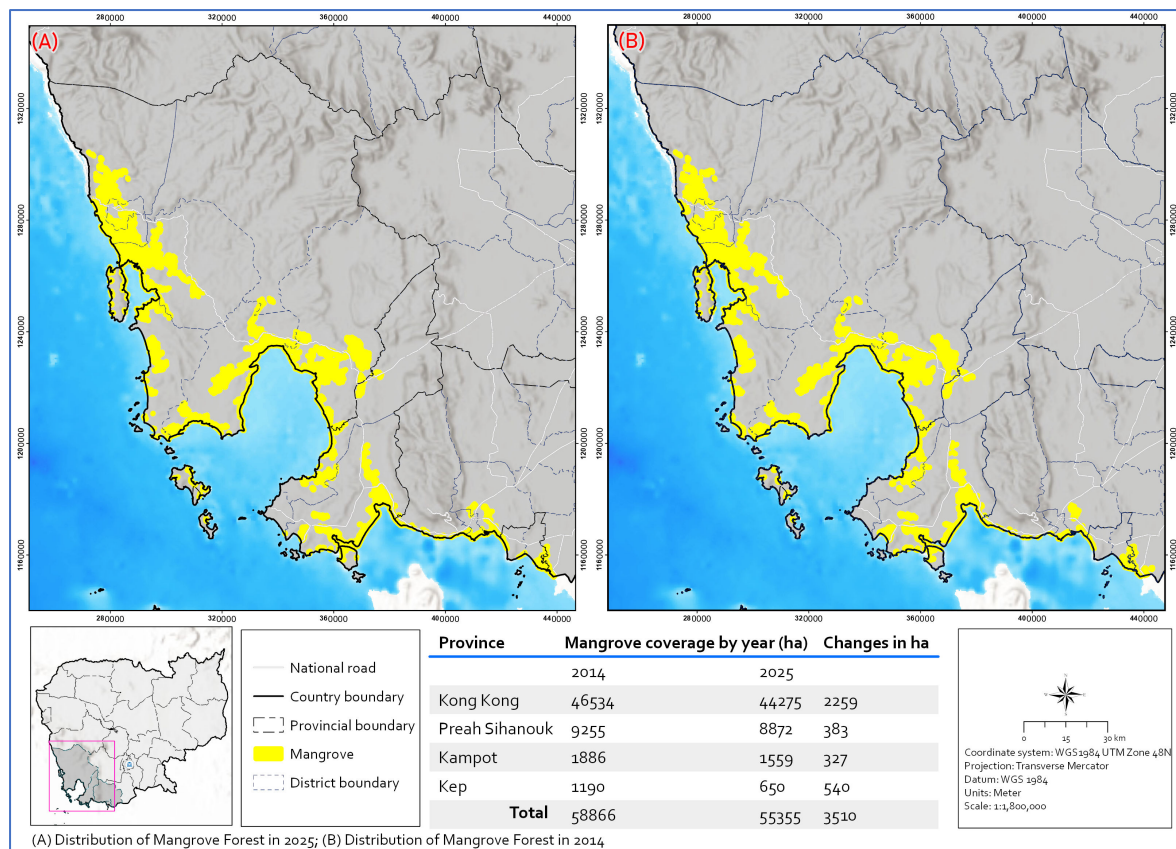


Figure 4-1 Maps of mangrove changes from 2014-2025

Source: MoE, 2025. *Mangrove Assessment (on going project)*

Coastal wetlands: Cambodia’s coastal wetlands and estuarine systems include the **Peam Krasaop Wildlife Sanctuary**, an extensive wetland complex recognized for its international importance under the Ramsar Convention. Peam Krasop complex and Koh Kapik & Associated Islets Ramsar Site—filter nutrients and sediments, support East Asian–Australasian Flyway migrants, and underpin small-scale fisheries (Ramsar Secretariat, 2012; Fauna & Flora, 2024). The Peam Krasaop wetland also hosts community fisheries (CFi) that engage in participatory management. MoE’s efforts to develop management plans under the

SCS SAP highlight the need for integrated wetland management at both local and regional levels.

4.2.1.2 Selected site-specific status and pressures

Site 1. Botum Sakor National Park (Koh Kong)

Following the 2023 reclassification, **Botum Sakor NP is 143,895 ha** (RGC, 2023). It includes **peat-forming mangroves (~4,768 ha; subset)** that are highly carbon-dense and sensitive to hydrologic disruption. Key pressures include infrastructure and concession-linked development that can restrict tidal exchange, plus legacy charcoal production and poaching. Management priority is “hydrology-first” protection (avoid drainage, maintain tidal connectivity, protect core peat zones (Girkin et al., 2022, UN-Habitat, 2019).

Site 2. Peam Krasop Wildlife Sanctuary (Koh Kong)

NSOC 2018 characterizes Peam Krasop as a **mangrove-dominated archipelago** of bays and islands with strong **inter-tidal** and **upstream freshwater** influence, supporting fisheries and **~10,000 residents** dependent on aquatic resources and mangroves for fuelwood, and livelihoods (PEMSEA & MoE, 2019). **Peam Krasop WS totals 16,982 ha** and is a mangrove–estuarine complex with strong livelihood dependence (Fauna & Flora, 2024). It is functionally connected to the **Koh Kapik Ramsar system**, forming one of Cambodia’s most important mangrove–intertidal landscapes for fisheries and coastal protection (Fauna & Flora, 2024; Ramsar Secretariat, 2012). Main pressures are changes in hydrology and water quality linked to surrounding development, aquaculture expansion, and transport infrastructure (IUCN, 2017).

Site 3. Koh Kapik & Associated Islets (Ramsar Site 998) (Koh Kong)

The Koh Kapik–Peam Krasop Ramsar site (~12,000 ha) consists of low-lying alluvial islands, mangroves and intertidal flats, with ~60% inside Peam Krasop WS and ~40% outside. Freshwater from Prek Koh Pao and Prek Khlang Yai/Stung Kep maintains the brackish regime and the plankton–fish base supporting fisheries and waterbirds. The site hosts globally threatened species—e.g., **Nordmann’s greenshank** and **Irrawaddy dolphin**—and underpins local livelihoods, with **>65% of households deriving 70–90% of income** from wetland resources (Ramsar Secretariat, 2012; Ly et al., 2023). Because Koh Kapik is tightly linked to Peam Krasop and Chrouy Pros seagrass, changes in freshwater inflow, channel infill, or mangrove fragmentation quickly affect fisheries and shorebird habitat, underscoring the need to maintain tidal prism and protect inter-islet flats.

Site 4. Prey Nob District / Ream NP context (Preah Sihanouk)

Ream National Park covers **~21,000 ha (~6,000 ha marine)**, containing a **mosaic** of mangroves, wetlands, seagrass, and coral reefs; multiple communes (around **30,000 people**) overlap/border the park, indicating high human–ecosystem interaction. Seagrass mapping recorded **~98 ha** of meadows in Prey Nob (2021–2022), complementing historical estimates of **~1,800 ha** of mangroves in nearby Ream National Park (FiA/FAO, 2023). Forest change analyses reported **~5,490 ha** of forest loss in Ream NP between 2001 and 2021, signaling persistent pressure on coastal habitats and nursery connectivity (Dialogue Earth, 2023). Rapid urbanization and port/tourism growth have increased pollution and sedimentation risks, amplifying vulnerability to coastal storms and saline intrusion (JICA, 2010; UN-Habitat, 2019).

Site 5. Kampong Trach wetlands & Anlung Pring Protected Landscape (Kampot)

Anlung Pring Protected Landscape (~219 ha) is embedded within seasonal wetlands, shallow floodplains and rice mosaics; it is a **dry-season stronghold** for **Sarus Crane** and part of the **Kampong Trach** wetland complex), embedded in a wider mosaic of seasonal wetlands, rice fields, and shallow floodplains (Royal Government of Cambodia, 2023; EAAFP, 2019). Hydrologic modifications (e.g., small reservoirs, canals) and saline intrusion can disrupt seasonal inundation regimes essential for waterbirds and fisheries (ActionAid, 2021). NSOC also notes that **estuaries and tidal flats** across the coast are concentrated within protected areas (including **Botum Sakor, Ream, Dong Peng, Peam Krasop, Koh Kapik**), underlining the regional coherence of these wetlands (PEMSEA & MoE, 2019).

Site 6. Chumpu Khmao (Prey Nup)

Chumpu Khmao community fishery (CFi) landscape is part of a larger coastal wetland complex; recent restoration planted **12,500** mangrove saplings (April 2025) and complements broader protection under the Prek Kampong Smach MFMA (Khmer Times, 2025; Mangrove Alliance, 2025). Regional records document **Fishing Cat** (Vulnerable) in coastal mangroves, highlighting the area's wildlife value (Mukherjee et al., 2018). The Prey Nup cell lies between **Steung Hav** (610 ha seagrass) and **Kampot** meadows; **Prey Nup** itself holds **~98 ha** of mapped seagrass, useful for community monitoring of trawl exclusion and anchor management (FiA, 2023).

4.2.2 Coral Reefs and Seagrasses

See [Annex 4-6](#) for the extended explanatory note on coral reef and seagrass status/distribution, mapping and monitoring considerations, and extended site-specific pressures and management implications relevant to **Sections 4.2.2.1–4.2.2.2** below.

4.2.2.1 Status and distribution

a) Coral Reef

Cambodia's coral reefs are mainly **fringing reefs** around the islands of **Koh Kong and Preah Sihanouk** (especially **Koh Rong**), with smaller turbidity-tolerant patches in **Kampot and Kep**. They support small-scale fisheries, dive tourism and shoreline protection. Early assessments estimated **~2,700 ha** of reef habitat, and condition in the 2000s was **fair–good** ($\approx 23\text{--}58\%$ live cover) but already affected by overfishing, illegal gears and declining water quality (UNEP/GEF; NSOC 2018). Long-term monitoring in Koh Rong (since 2010, later extended to Koh Sdach and Kep) shows sediment-influenced communities dominated by massive/encrusting corals (e.g., *Porites*, *Diploastrea*), and since 2019 the **Cambodian Coral Reef Monitoring Network (CCRMN)** has standardized protocols for fish biomass and benthic condition (FiA, 2023).

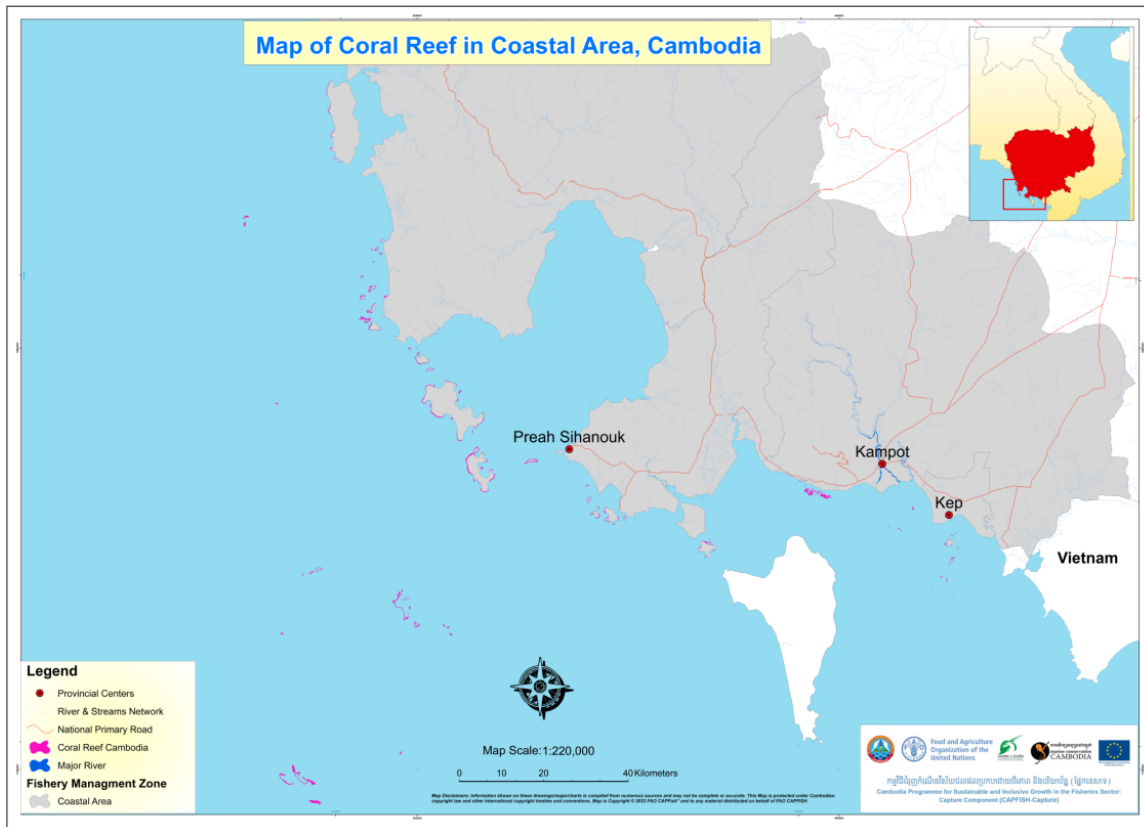


Figure 4-2 Location of coral reef distribution in Cambodia

Source: FAO CAPFish, 2022.

Cambodia likely hosts **~70 coral species**, but distribution data remain incomplete, particularly offshore. Recent mapping (2014 vs. 2025) indicates reefs remain concentrated in **Preah Sihanouk and Koh Kong (>85% of national cover)** with modest, method-bounded changes; restoration priorities include **Koh Rong Sanloem/Prek Svay** and larger Koh Kong reef complexes (MoE, 2025b).

b) Seagrass

Cambodia has extensive seagrass meadows, particularly in **Kampot and Koh Kong**, dominated by *Thalassia hemprichii*, *Halodule uninervis* and *Enhalus acoroides*. These meadows are key feeding grounds for dugongs and green turtles and provide major services—nursery habitat for coastal fisheries, sediment stabilization and blue-carbon storage. Recent surveys (2021–2023) distinguish **large mainland-adjacent meadows** and **smaller island/bay patches**. Mapped examples (~2,333 ha across 11 sites) include **Chrouy Pros Bay (~1,485 ha)**, **Steung Hav (610 ha)** and **Prey Nob (98 ha)**, plus smaller island patches (e.g., Koh Ta Kiev, Koh Bong, Koh Tang) (FiA, 2023). Key pressures are bottom-contact fishing (trawls/push-nets), dredging/shoreline works and land-based eutrophication; because many meadows lie within or near MFMA and high-use corridors, improved gear control, dredging management and wastewater/runoff reductions are the most direct levers to stabilize seagrass extent and nursery function.

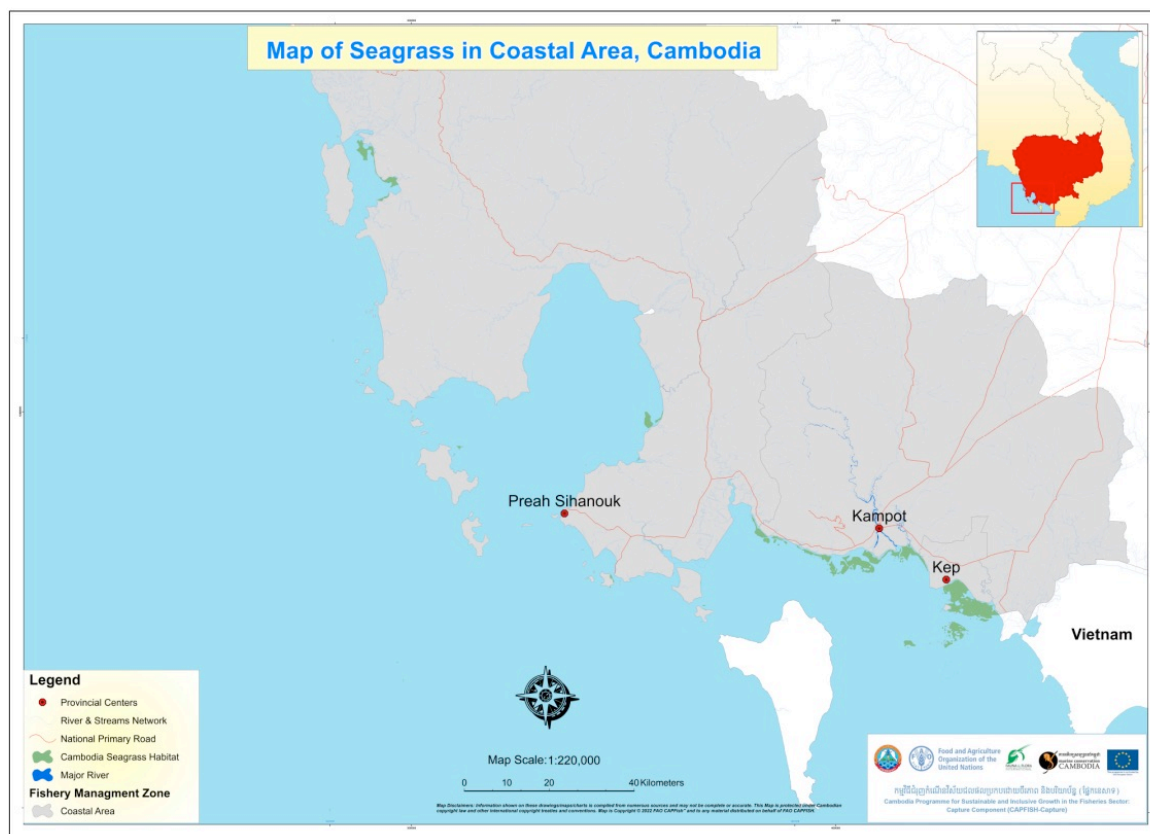


Figure 4-3 Location of Seagrass Distribution in Cambodia
 Source: FAO CAPFish, 2022.

4.2.2.2 Selected site-specific status and pressures

Site 1. Koh Rong Archipelago (Koh Rong Marine National Park)

Koh Rong, first designated as a large MFMA and later a **National Marine Park (Feb 2018)**, spans ~520 km² (~400 km² marine) and is Cambodia’s core area for reef and island-seagrass conservation. MSP baselines map **~1,198 ha of coral reefs** and **~1,360 ha of seagrass** (MoE & NOTC, 2018). Reef surveys in 2019–2020 recorded **~29.8% coral cover**, dominated by sediment-tolerant **Porites** and **Diploastrea**, while fish biomass remains low due to continued fishing pressure (FFI, 2020). The archipelago’s linked **reef–seagrass–mangrove system** is experiencing seagrass loss at **Prek Svay (–2,510 ha)** and **Koh Rong Sanloem (–908 ha)**, largely from tourism and infrastructure growth—underscoring the need for **no-anchor zones, moorings, and dredge controls**.

Site 2. Kep Archipelago (Koh Tonsay & Koh Pou) within the Kep MFMA

The MFMA (~11.3 thousand ha) encompasses reefs and some of Cambodia’s largest seagrass meadows (~6,399 ha). While pockets of high coral cover persist—such as **Koh Seh’s 64% live cover** (409 colonies; 14 genera; low dead coral) in 2019 (Pham et al., 2025)—most nearshore reefs are small and sensitive to sedimentation and illegal gears. Proposed MFMA zoning and **anti-trawl structures** aim to curb bottom-contact fishing on adjacent meadows, supporting coral and seagrass recovery (FiA, 2023; Norrey et al., 2023). Persistent threats remain from illegal trawling and electric fishing.

Site 4. Kampot Beach / nearshore Kampot (proposed MFMA)

The most recent compilation shows a **Kampot nearshore belt** with **~5,158 ha seagrass** (10 spp.) and **~467 ha coral reef**, including a **~305 ha** single reef feature at **Nataya**—one of the largest single reef features on the mainland coast (MCC & FAO, 2023). Baseline assessments flagged sedimentation and gear impacts as principal pressures; a proposed **~8,486-ha MFMA** would formalize zoning and enforcement with three active Community Fisheries groups (Wild Earth Allies, 2020; MCC & FAO, 2023).

Site 3. Koh Sdach–Koh Kong Archipelago

Earlier surveys found “good” condition at several sites but increasing degradation signals over time; current CFI-level accounting shows the largest contiguous reef areas embedded in Samros Koh Sdec (~57% of provincial CFI-mapped reef area) and Phnhy Meas (~19%), which are recommended focal zones for transplantation and artificial-reef pilots given scale and connectivity (MoE 2025c).

4.2.3 Biodiversity Hotspots and Sensitive Areas

Three priority clusters stand out: Botum Sakor’s carbon-dense peat-mangroves, requiring strict hydrological protection (Lo et al., 2018; Girkin et al., 2022); the Peam Krasop–Koh Kapik mangrove–intertidal system, vital for fisheries and migratory waterbirds (Fauna & Flora, 2024; Ramsar Secretariat, 2012); and the Kep–Kampot seagrass corridor, Cambodia’s main seagrass and nursery stronghold but highly trawl- and turbidity-sensitive (MAFF/FiA, 2023; MCC & FAO, 2023).

Hotspot A: Botum Sakor peat-mangrove complex (Koh Kong): globally uncommon, carbon-dense, hydrology-limited

Botum Sakor contains **~4,768 ha of peat-forming mangroves** (peat 0.5–1.0 m; max ~1.35 m; ≥26 plant species), a rare feature in mainland SE Asia with very high blue-carbon stocks (Lo et al., 2018; Girkin et al., 2022).

- **Key pressures:** The system depends on intact tidal exchange; road embankments, canalisation and reclamation depress water tables and risk **irreversible peat oxidation and subsidence**.
- **Key indicators:** peat-zone water level, salinity/DO in creek heads, vertical land motion, mangrove canopy density, disturbance proximity.

Hotspot B: Peam Krasop–Koh Kapik complex (Koh Kong): one of mainland SE Asia’s largest mangrove–intertidal systems, fisheries nursery & flyway node

Peam Krasop WS (16,982 ha) and the **Koh Kapik Ramsar Site (~12,000 ha)** form one of mainland SE Asia’s largest mangrove–intertidal systems (Ramsar Secretariat, 2012; Fauna & Flora, 2024). They support small-scale fisheries and East Asian–Australasian Flyway waterbirds; **70–90% of nearby household income** is wetland-derived (Ramsar Secretariat, 2012; Ly et al., 2023). Function hinges on freshwater inflows (Prek Koh Pao; Prek Khlang Yai/Stung Kep) mixing with tidal exchange, and on connectivity to **Chrouy Pros seagrass (~1,485 ha)**.

- **Key pressures:** altered freshwater regimes, channel infill, mangrove cutting, charcoal legacy sites, and turbidity/nutrient loads.
- **Key indicators:** freshwater inflow, salinity bands, intertidal-flat area, juvenile-fish CPUE, wetland-income share, seagrass-edge integrity.

Hotspot C: Kep–Kampot seagrass corridor: national stronghold for meadow extent/richness and fisheries nurseries, yet trawling/turbidity-sensitive

Kep–Kampot hosts Cambodia’s largest continuous seagrass belt (**Kep ~6,399 ha; Kampot ~5,158 ha; 10 spp.**) forming core nursery grounds for fisheries and feeding habitat for dugongs and turtles (MAFF/FiA, 2023; MCC & FAO, 2023). Over **30 CFis** help steward >24,000 ha of national meadows, with Kep–Kampot as the main anchor.

- **Key pressures:** bottom trawls/push-nets, sediment resuspension, turbidity from shoreline works and river plumes, and anchor scarring near tourist access points.
- **Key indicators:** meadow area by CFi, species richness, light attenuation (Kd), turbidity (NTU), trawl-scar density, megafauna sightings/feeding trails, and enforcement effort.

4.2.4 Endemic, Endangered, Threatened species

Cambodia’s coastal ecosystems support several endangered and migratory species of global significance, including **dugong** (*Dugong dugon*, EN), **Irrawaddy dolphin** (*Orcaella brevirostris*, EN), and three marine turtles—**green** (*Chelonia mydas*, EN), **hawksbill** (*Eretmochelys imbricata*, CR), and **olive ridley** (*Lepidochelys olivacea*, VU)—as well as migratory shorebirds such as the **black-faced spoonbill** (*Platalea minor*, EN). **Irrawaddy dolphins** are present year-round in Kep waters, with documented strandings in 2017–2018 and at least one **dugong** bycatch event, highlighting ongoing gear-interaction risk (Tubbs et al., 2019). **Green** and **hawksbill** turtles forage and migrate along the coast, with sporadic nesting confirming national significance despite low abundance (Duffy et al., 2023). Coastal mangrove mosaics in the wider landscape also support the **Fishing Cat** (*Prionailurus viverrinus*, VU) and **smooth-coated otter** (*Lutrogale perspicillata*, VU), underscoring the cross-habitat value of estuarine and intertidal systems for threatened fauna (Mukherjee et al., 2018).



Figure 4-4 Dugongs with a new feeding trail in Cambodia’s seagrass beds

Sources: MCC, retrieved from Khmer Time, at <https://www.khmertimeskh.com/501750614/positive-signs-for-dugongs-with-a-new-feeding-trail-in-cambodias-seagrass-beds/>

4.3 Discussion and conclusions

4.3.1 Priority transboundary biodiversity issues

Cambodia's coastal–marine ecosystems face interconnected pressures that spread easily across the semi-enclosed Gulf of Thailand, where limited exchange with the South China Sea allows impacts to cross EEZ boundaries (PEMSEA & MoE, 2019). In line with the SCS-SAP, six priority issue clusters dominate: marine pollution, overfishing and IUU, habitat degradation, climate-change impacts, biodiversity loss, and emerging risks linked to hydrologic and sediment connectivity (PEMSEA & MoE, 2019; Ramsar Secretariat, 2012; World Bank, 2020; Norrey et al., 2023; Tubbs et al., 2019; Duffy et al., 2023).

4.3.1.1 Marine Pollution

Untreated municipal wastewater, industrial effluents, agricultural runoff, marine litter and ship-based discharges are the main coastal pollution pathways; once released, they disperse across the Gulf with currents (PEMSEA & MoE, 2019; World Bank, 2021). Water-quality management follows ASEAN Marine Water Quality Guidelines, yet estuaries like Sihanoukville/Kampot show nutrient enrichment and episodic algal blooms (ASEAN Secretariat, 2008/2012; PEMSEA & MoE, 2019). SEZ effluents add BOD/metals, while agricultural runoff drives turbidity that stresses reefs and seagrass (PEMSEA & MoE, 2019). Mismanaged plastics—especially from Sihanoukville—plus ghost gear heighten transboundary debris risks, and growing port activity raises oil-spill risk, underscoring the need for stronger contingency planning (PEMSEA & MoE, 2019; World Bank, 2020, 2021).



Figure 4-5 Wastewater runoff discharging onto a tourist beachfront

Sources: PEMSEA & MoE, 2019.

4.3.1.2 Overfishing and IUU Fishing

Shared small pelagic stocks (anchovies, sardines, mackerel) migrate across EEZs; cumulative pressure is evident Gulf-wide in long-series statistics (FAO, 2024). Cambodia's coastal landings have fluctuated in the 2000s–2020s, with artisanal fishers reporting longer trips for smaller catches—trends aligned with regional declines in coastal demersal and small pelagic

documented since historical trawl surveys (FAO, n.d.). IUU fishing remains a transboundary challenge; Cambodia's NPOA-IUU (2020–2024) and the National Plan of Control & Inspection (NPCI) 2020–2024 target illegal trawling, border incursions, and high-risk habitats like seagrass and coral (FiA/MAFF, 2020a; FiA/MAFF, 2020b). Bottom trawling's collateral damage to seagrass in Kampot–Kep is repeatedly reported in national/partner technical documents (FiA/MAFF, 2023).

4.3.1.3 Habitat Degradation and Loss

Global Mangrove Watch v3.0 shows Cambodia's mangroves at ~62–63 thousand ha in 2020, with most losses occurring in the 1990s–2000s and driven by aquaculture conversion, charcoal production and coastal development (Bunting et al., 2022; PCAsia, 2024; PEMSEA & MoE, 2019). Coral reefs in Koh Rong/Koh Rong Sanloem and the Kep–Kampot archipelagos face sedimentation, destructive fishing and heat-stress bleaching; the 2010 Gulf-wide bleaching event and later heat anomalies are reflected in declining but generally fair–good coral-cover ranges (PEMSEA & MoE, 2019). Seagrass meadows are extensive and transboundary, with ~33,800 ha attributed to Cambodia—largest in Kampot (UNEP/GEF SCS, 2008; SCS-SAP National Profile, 2021). Repeated degradation from trawling, dredging and sedimentation is documented (FiA/MAFF, 2023), and blue-carbon syntheses highlight the high carbon stocks of Cambodian seagrasses, making losses significant for long-term carbon sequestration (Fourqurean et al., 2012).

4.3.1.4 Biodiversity Loss and Migratory Species Decline

Endangered megafauna—dugongs, marine turtles, Irrawaddy dolphins—and migratory shorebirds depend on transboundary habitat networks and face cumulative threats (UNEP/GEF SCS, 2008; FiA/MAFF, 2023). Recent observations of dugong feeding trails in Cambodian seagrass underscore continued, low-abundance presence and cross-border movements with Viet Nam (Khmer Times/MCC, 2025).

4.3.1.5 Climate Change and Associated Impacts

Sea-level rise (SLR), warming, extreme events, and ocean acidification amplify all other pressures. IPCC AR6 WGII (Chapter 10) projects continued SLR with many Asian coasts exceeding the global mean; rising surge and wave risks compound exposure for the Gulf (IPCC, 2022). The World Bank Climate Change Knowledge Portal synthesizes Cambodia projections and SLR-inundation risk for low-lying Koh Kong–Kampot coastlines (World Bank & GFDRR, 2021/2024). Recurrent bleaching/heat stress in 2010 and 2019–2020 is noted in regional monitoring and national summaries (IPCC, 2022; PEMSEA & MoE, 2019).

4.3.1.6 Emerging Environmental Issues

Large-scale port expansion and coastal reclamation alter sediment budgets and hydrodynamics (World Bank, 2021). Rapid growth in ports/SEZs, tourism, and urban construction has outpaced wastewater and solid-waste systems, driving nearshore pollution with transboundary consequences (World Bank, 2021; PEMSEA & MoE, 2019). Offshore oil & gas elevate spill risk; preparedness and response capacity are ongoing priorities (PEMSEA & MoE, 2019). Microplastics are an emerging concern across ASEAN coasts; regional baselines and Mekong studies report microplastics in waters/biota and call for harmonized monitoring (GIZ, 2024; MRC, 2024).

4.3.2 Risk Assessment and Valuation of Economic Losses

With >65% of Koh Kapik households wetland-dependent, ~11,500 ha of seagrass in Kep–Kampot, and reefs generally “fair” with high-value refugia, even small management lapses can trigger disproportionate economic losses. Conversely, low-cost actions—peat-mangrove hydrologic safeguards, anti-trawl structures and CFI patrol fuel, and basic wastewater upgrades—deliver high benefit–cost returns once avoided income losses, avoided damages, and blue-carbon values are included (Ramsar Secretariat, 2012; FFI, 2020; Norrey et al., 2023; World Bank, 2021; Fourqurean et al., 2012).

4.3.2.1 Livelihood risk and losses

Household dependence around Koh Kapik–Peam Krasop is exceptionally high: more than 65% of households derive 70–90% of income from wetland-based fishing and gleaning (Ramsar Secretariat, 2012; Ly et al., 2023). Under a conservative elasticity (income roughly proportional to catch for small-scale fishers), a 10–20% reduction in nursery function or access would transmit almost one-for-one to village income losses of 10–20%, with second-round effects on food security and debt service for the poorest quintiles (Ramsar Secretariat, 2012; Ly et al., 2023). When shocks are spatially covariate (e.g., a mangrove die-back or a major pollution event), coping options shrink and recovery times lengthen, amplifying welfare losses relative to idiosyncratic shocks.

4.3.2.2 Blue-carbon opportunity costs

The Botum Sakor peat-mangrove complex (~4,768 ha) stores very large carbon stocks; hydrological disturbance (culverts/roads, drainage) risks peat oxidation and subsidence, resulting in long-lived CO₂ emissions and the loss of storm-buffering capacity (Lo, Quoi, & Visal, 2018; Girkin et al., 2022). Even without a site-specific MRV, applying standard blue-carbon ranges for mangrove peat implies that preventing oxidation yields avoided emissions valued under emerging carbon finance; conversely, failure to maintain water levels creates a liability via foregone credits plus increased disaster losses from weakened surge attenuation (Girkin et al., 2022; Lo et al., 2018).

4.3.2.3 Reef deterioration

Coral communities in Koh Rong MNP average ~30% live cover and are dominated by sediment-tolerant massive taxa, though pockets of high cover persist in Kep (e.g., Koh Seh ~64%) (FFI, 2020; Pham et al., 2025). Reef degradation reduces structural complexity and nursery/refuge functions, which can directly depress reef-associated catch and incomes for small pelagic and demersal handline and trap fisheries in coastal fishing communities (FFI, 2020). It also threatens tourism: declining reef quality reduces dive and snorkel demand, and regional evidence suggests even moderate live-cover losses can cut dive days and operator revenue (Burke et al., 2011). Reefs also dissipate wave energy; their decline increases expected annual damages to beachfront assets and public infrastructure during storm seasons (Burke et al., 2011). In the semi-enclosed Gulf of Thailand, cumulative pressures—overfishing, destructive gear, sedimentation, and mass bleaching—create transboundary costs as fish move across EEZs and tourism markets benchmark regionally (PEMSEA & MoE, 2019; Burke et al., 2011).

4.3.2.4 Seagrass losses

Kep–Kampot (~11,500 ha combined; ~10 species in Kampot) and Chrouy Pros/Prey Nob (~1,583 ha combined) anchor Cambodia’s seagrass extent but are sensitive to bottom trawling, turbidity, and dredging (MAFF/FiA, 2023; MCC & FAO, 2023; FiA/FAO, 2023).

Historical assessments indicate major contractions in parts of the Kep–Kampot corridor, with mixed dynamics over 2014–2025—localized recovery where anti-trawl enforcement is sustained, and continued attrition where turbidity and shoreline works intensify (MAFF/FiA, 2023; MCC & FAO, 2023). These changes create economic risks through reduced nursery function, lowering catches and incomes for small-mesh gillnet and trap fleets targeting juvenile coastal finfish and invertebrates. Degraded meadows may also concentrate fishing effort and raise entanglement risk for Irrawaddy dolphins and dugongs, causing biodiversity losses and reputational/tourism costs (Tubbs et al., 2019; Duffy et al., 2023). Finally, seagrasses are important blue-carbon stores (global mean ~139 Mg C_{org} ha⁻¹ in biomass plus soils), so meadow loss implies forgone sequestration and potential emissions from disturbed sediments (Fourqurean et al., 2012).

4.3.3 Current management and institutions

4.3.3.1 Lead agency and coordination

The Ministry of Environment (MoE) is the lead agency for coastal and marine environmental management. MoE administers the Code on Environment and Natural Resource (2023) and Protected Areas Law (2008) and designates/manages national protected areas and Marine National Parks (MNPs). MoE coordinates closely with the FiA/MAFF, Ministry of Water Resources and Meteorology (MOWRAM), provincial departments, and local authorities through inter-agency Coastal Coordination Committees chaired by provincial governors with MoE technical support (PEMSEA & MoE, 2019). This arrangement overlays MoE’s conservation mandate (Protected Areas Law, 2008) with FiA’s fisheries/ecosystem management and co-management mandate (Fisheries Law, 2007) (Royal Government of Cambodia, 2007, 2008; PEMSEA & MoE, 2019).

4.3.3.2 Key sites and zoning coherence

Protected areas, MFMA, Ramsar sites and community management: Cambodia’s coastal governance combines MoE-managed protected areas (e.g., Botum Sakor National Park; Peam Krasop Wildlife Sanctuary) and internationally designated wetlands (Koh Kapik and Associated Islets Ramsar Site) with MAFF/Fisheries Administration area-based fisheries measures (MFMA/EAFM) and community co-management (CFis/CPAs). Key overlaps require clear zoning and joint enforcement: the Koh Rong Archipelago MFMA (Prakas, 2016) was later designated as Koh Rong Marine National Park under MoE (Sub-decree No. 14, 2018; 52,498 ha), so rules, patrols and user rights need MoE–FiA alignment. In Kep, the Kep Archipelago MFMA (Prakas No. 193, 2018) covers Koh Po and Koh Tonsay and complements adjacent protected-area and seagrass stewardship efforts. Along the Koh Kong coast, Koh Kapik Ramsar Site overlaps PKWS and parts of the wider Botum Sakor landscape, highlighting the need to manage mangrove/peat systems coherently across instruments and concessions. In Kep–Kampot, operational and proposed MFMA link CFis across contiguous seagrass/reef belts. Community participation is widespread, with **>70 CFis** across the four coastal provinces supporting inshore fisheries management alongside CPAs in mangrove blocks (FiA/MAFF, 2023; PEMSEA & MoE, 2019). *Table 4-1* summarizes the main MPAs and OECM-related measures discussed in this chapter and highlights where habitat priorities (mangroves, wetlands, coral reefs and seagrass) align—or potentially conflict—across different management instruments.

Table 4-1 Cambodian MPAs and OECMs: Coastal area-based management: MPAs, Ramsar systems, MFMA/EAFM, and community co-management

Name of MPAs and OECMs	Year of establishment	Year of update	Total Area (ha)	Mangrove area (ha)	Wetland area (ha)	CR area (ha)	SG area (ha)
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Butom Sakor National Park	1993	2023	143,895	4,768 peat-forming mangroves, subset	--	--	--
Peam Krasop Wildlife Sanctuary	1993	2023	16,982	9,000	2,500 (Connect Koh Kapik Ramsar ~12,000)	--	Connect: Chrouy Pros (~1,485 ha)
Prey Nob Protected Area				9,351	--	--	98
Preah Sihanouk Ream National Park	1993	2023	21,000	6,500	1,800	--	--
Kep NP + Kampot coastal designated area	1993	2023	Kep: 5,000 Kamot: 7,200	800	350	--	--
Koh Po and Koh Tonsay Archipelago	2018	--	11,307	--	--	67.83	3,900
Koh Rong MFMA	2016	--	40,535	--	--	624	--
Koh Rong MNP	2018	--	52,498	--	--	1,198	1,360

Note: Available Habitat-area figures (mangroves/wetlands/coral/seagrass) are not consistently reported in legal instruments and are often based on mapping or project sources; they should be treated as **indicative** and should not be summed across habitats to avoid double counting. See [Annex 4-7](#) for the extended explanatory note for Coastal area-based management: MPAs, Ramsar systems, MFMA/EAFM, and community co-management

4.3.3.3 Management tools in practice

A broader suite of management tools has emerged in the past five years, combining spatial protection, community enforcement, and improved monitoring. **No-take zones and seasonal closures** now safeguard key reef–seagrass nurseries (FFI, 2020; FiA/MAFF, 2023), while **community patrols with FiA/MoE** continue to deter inshore trawling, compressor fishing and destructive gears (FFI, 2020; PEMSEA & MoE, 2019). **Anti-trawl structures** placed along sensitive meadow margins help exclude trawls, cut sediment resuspension, and support recovery where local enforcement is consistent (Norrey et al., 2023). Parallel investments in **updated habitat mapping and monitoring**—including community-led reef/seagrass surveys, seabed baselines and periodic water-quality checks—guide adaptive zoning and track outcomes (FiA/MAFF, 2023; FFI, 2020). Where resources such as boats, fuel, stipends and data systems are sustained, these measures show early signs of seagrass and reef improvement.

On land-based pressures, MoE’s **National Waste Management Strategy and Action Plan 2018–2030** underpins marine-litter reduction, with pilot segregation and beach-cleanup programs in Sihanoukville and Kampot and initial work on a **National Source Inventory for Plastics** (MoE, 2018; World Bank, 2021; PEMSEA & MoE, 2019). MoE also conducts **periodic water-quality monitoring** in Sihanoukville, Kampot and Koh Kong—analysing BOD, nutrients, coliforms and plastics—where repeated exceedances of ASEAN marine-water benchmarks have prompted stronger wastewater and drainage controls (ASEAN Secretariat, 2008/2012; PEMSEA & MoE, 2019).

4.3.4 Gaps and Priority Challenges

Despite progress in laws, institutions, and pilots, Cambodia still faces structural and operational barriers to effective coastal and marine ecosystem and biodiversity management. These gaps cut across policy, governance, technical, financial, social, and regional dimensions and constrain responses to the transboundary issues identified earlier (PEMSEA & MoE, 2019; World Bank, 2021).

Policy and Legal Gaps: Cambodia has core environmental and sectoral laws—the Code on Environment and Natural Resource (2023), the Law on Fisheries (2007), and the Protected Areas Law (2008)—but they do not yet amount to an enforceable, integrated coastal zone management regime; mandates are dispersed and coordination provisions are limited (PEMSEA & MoE, 2019). While environmental impact assessments are required (Sub-Decree on the Environmental Impact Assessment Process), practice and monitoring have been uneven, and cumulative/ transboundary effects are rarely assessed systematically (Royal Government of Cambodia, 1999; Cambodia Law & Policy Journal, 2015). Pollution control and marine-litter provisions are still developing; recent policy work urges clearer standards and penalties for coastal dischargers and port/oil-spill risks (PEMSEA & MoE, 2019; World Bank, 2021).

Institutional and governance challenges: Institutional capacity constraints—staffing, equipment, and budget—limit monitoring and enforcement at provincial level for both MoE and the Fisheries Administration (PEMSEA & MoE, 2019). Overlaps among MoE, MAFF, MLMUPC and sub-national authorities create gaps and duplication without a robust, formal coordination mechanism for the coast (PEMSEA & MoE, 2019). Decentralization has expanded local roles, but many sub-national administrations and community institutions (CFis/CPAs) still need stronger legal authority and sustained support to enforce rules (PEMSEA & MoE, 2019).

Technical and data gaps: Long-term, spatially consistent datasets on habitat condition, fish stocks, pollution, and biodiversity remain limited and fragmented across agencies; no centralized open system curates coastal/marine data for decision-making (PEMSEA & MoE, 2019). National and regional studies note gaps in microplastics, species movements, and socio-economic impact evidence and call for harmonized indicators and joint monitoring (GIZ, 2024; MRC, 2024; PEMSEA & MoE, 2019). Laboratory capacity, remote-sensing/GIS tools, and routine staff training in ecosystem-based management and climate risk assessment are still insufficient in many coastal provinces (PEMSEA & MoE, 2019).

Financial constraints: Budgets for environmental monitoring, compliance, and community engagement are modest relative to need; donor projects are often time-bound and site-specific, with limited mechanisms for sustained O&M (PEMSEA & MoE, 2019; World Bank, 2021). Economic instruments (e.g., MPA user fees, pollution charges, and PES/blue-carbon finance) are nascent, constraining durable financing for MPA enforcement and pollution control (World Bank, 2021).

Enforcement and compliance issues: Illegal mangrove clearance, unregulated coastal construction, and untreated industrial discharges persist amid limited inspections and sanctions (PEMSEA & MoE, 2019). For fisheries, patrols and monitoring-control-surveillance remain capacity-constrained; Cambodia adopted the National Plan of Action to Prevent, Deter and Eliminate IUU Fishing (2020–2024) and the National Plan of Control and Inspection for Marine Fisheries (2020–2024), but implementation challenges remain (FiA/MAFF, 2020a, 2020b; SEAFDEC, 2025). Judicial handling of environmental cases and the sensitivity of actions involving influential actors also weaken deterrence (PEMSEA & MoE, 2019).

Limited awareness and participation: Public awareness of long-term ecological consequences remains uneven; private investors may lack incentives or knowledge to comply with safeguards. Where community CFis/CPAs are engaged, results improve, but inclusive consultation and co-management are not yet systematic across provinces (PEMSEA & MoE, 2019).

Regional and transboundary challenges: Cambodia participates in **ASEAN**, **COBSEA**, and **PEMSEA**, yet joint monitoring, harmonized standards, and shared stock assessments remain limited; oil-spill readiness and marine-litter monitoring are not fully aligned across Gulf countries (PEMSEA & MoE, 2019). Disparities in legal frameworks and capacity across borders create enforcement loopholes exploited by IUU fleets (FiA/MAFF, 2020a, 2020b).

4.3.5 Recommended priority actions

a) Strengthening legal and policy frameworks

Existing laws should be revised and operationalized with explicit ICZM provisions, and the mandate of the NCCMD clarified. A National Coastal and Marine Policy should align ministry roles and set measurable objectives for pollution control, habitat conservation, and fisheries management. In the medium term, marine spatial planning (MSP) regulations should be enacted to zone areas for conservation, fisheries, industry, and tourism, anchored in the Pentagonal Strategy and SDG 14.

b) Building institutional capacity and coordination

Priorities include expanding MoE coastal monitoring units with laboratory capacity and GIS/remote-sensing capability, and formalizing an inter-ministerial ICZM mechanism (MoE, FiA/MAFF, MLMUPC, and provinces) to resolve overlaps and improve implementation. Decentralization should be strengthened through training on coastal planning, enforcement, and climate risk for subnational authorities. Community governance should be reinforced by supporting CFis/CPAs with legal recognition, technical training, and micro-grants, scaling lessons from Peam Krasop and Koh Rong.

c) Enhancing data, research, and technology

A national coastal–marine data centre hosted by MoE should curate water quality, habitat maps, fisheries, and socio-economic data and connect to regional platforms. Long-term monitoring should be expanded for nutrients, marine litter, habitat condition, and fish stocks, supported by Sentinel/satellite mapping, drones for patrols, and VMS/e-CDT for fisheries. Partnerships with universities, UNEP/COBSEA/PEMSEA, and development partners should support methods and technology transfer.

d) Securing sustainable financing

Financing should combine higher domestic allocations with instruments such as MPA user fees/eco-levies, payments for ecosystem services, and blue-carbon finance for mangroves/seagrass. Public–private investment should be blended for wastewater and solid-waste infrastructure, and a share of environmental fines earmarked for site-level O&M and community patrols.

e) Strengthening enforcement and compliance

Resources for inspectors and MCS patrols should increase, alongside graduated, transparent penalties and case tracking. Risk-based inspections should be expanded and supported by wider roll-out of VMS/e-CDT. Community co-enforcement should be enabled through hotlines and feedback loops that trigger action and ensure report-back.

f) Raising awareness and education

Targeted campaigns for communities and operators should emphasize ecosystem values and the costs of degradation. Coastal topics should be integrated into school curricula, while green-tourism certification and marina/harbour best practices are promoted. National marine-litter awareness and source-reduction programmes should be expanded.

g) Climate change adaptation and resilience

Climate risk screening should be mainstreamed in coastal permits and designs, supported by enforceable setbacks and ecosystem-based adaptation (mangrove restoration; reef/seagrass protection). Early-warning systems should be strengthened and livelihoods diversified (climate-smart aquaculture, eco-tourism). Actions should align with Cambodia's NDC and NAP to mobilize adaptation finance.

h) Regional and transboundary cooperation

Bilateral cooperation with Viet Nam and Thailand should address shared stocks, IUU control, and oil-spill response. Cambodia should engage actively in ASEAN/COBSEA monitoring networks and promote harmonized Gulf standards on water quality, litter metrics, and emergency protocols. Data sharing and replication of community-based management models should be pursued through PEMSEA and SEAFDEC channels.

4.4 Methodology and Analyses

This section describes how ecosystem status and trends were assessed for Cambodia's coastal zone (mangroves/wetlands, coral reefs, and seagrasses), how pressures and governance responses were integrated, and how risks and economic implications were derived. Analyses cover the four coastal provinces with site zoom-ins at Botum Sakor, Peam Krasop–Koh Kapik, Koh Rong Archipelago, Kep–Kampot, and selected seagrass/reef cells. The report was structured by the main steps include:

1. **Frame questions & spatial extent.** Define policy-relevant questions (extent, condition, pressures, risks) and map analysis boundaries (PAs, MFMA, CFIs, 20-km coastal buffer; reef/seagrass polygons).
2. **Assemble datasets.** Compile official monitoring, partner surveys, and remote-sensing products; standardize to common projection and metadata
3. **Construct indicators.** Calculate ecosystem-specific extent/condition and cross-cutting pressure/governance indicators; harmonize units and baselines.
4. **Detect change & hotspots.** Apply time-series comparisons and pressure–state overlays; identify sensitivity “hotspots” using multi-criteria thresholds.
5. **Risk & valuation.** Translate ecological change into expected livelihood, protection, and carbon consequences using transparent assumptions.
6. **Triangulate & QA/QC.** Cross-check with field notes, partner reports, and independent products; document uncertainty.
7. **Synthesize for management.** Aggregate results to provincial/site summaries and map actionable priorities.

*(All datasets, processing parameters, assumptions, and full citations are provided in **Annex**)*

Glossary

Term	Definition
Adaptive management	Iterative management that adjusts actions based on monitoring results and learning over time.
Anti-trawl structures	Physical barriers installed to prevent bottom trawling in sensitive nearshore habitats, especially seagrass meadows.
Area-based management	Managing human activities through spatial measures (e.g., MPAs, MFMA, Ramsar sites, community zones) to achieve conservation and sustainable use outcomes.
ASEAN Marine Water Quality Guidelines	Regional reference benchmarks and procedures for marine water quality management and monitoring used by ASEAN member states.
Benthic cover	Proportion of the seafloor covered by living corals, algae, seagrass, rubble, sand, etc.; used to assess reef condition.
Biodiversity hotspot	Area of high ecological value (and often threatened species/habitats) that is under significant pressure.
Blue carbon	Carbon captured and stored in coastal ecosystems (mangroves, seagrasses), including long-term storage in soils and peat.
Bycatch	Non-target species caught unintentionally during fishing; a key threat for dolphins, turtles, and dugongs.
CCRMN (Cambodian Coral Reef Monitoring Network)	National network standardizing coral reef monitoring protocols (including fish biomass and benthic condition).
CFis (Community Fisheries)	Community institutions recognized under fisheries co-management to manage and protect inshore fisheries and habitats.
CPAs (Community Protected Areas)	Community-based management units within protected areas that support conservation and local stewardship.
Cumulative impacts	Combined effects of multiple pressures (fishing, sedimentation, wastewater, dredging, climate stress) that together degrade ecosystems.
EAFM (Ecosystem Approach to Fisheries Management)	Fisheries management that considers habitats, food webs, and species interactions alongside catches and effort.
EEZ (Exclusive Economic Zone)	Sea area where a coastal state has rights over resources; impacts can still be transboundary.
EIA (Environmental Impact Assessment)	Process to assess environmental risks of projects, including cumulative and transboundary impacts.
Ecosystem services	Benefits people obtain from ecosystems (fisheries, coastal protection, tourism, carbon storage).
Fragmentation	Breaking continuous habitat into smaller patches, reducing connectivity and resilience (e.g., mangrove belts near development).
Habitat connectivity	Functional links among habitats (mangrove–wetland–seagrass–reef) supporting life cycles and ecosystem processes.
Hydrology-first protection	Managing and safeguarding natural water flows and tidal exchange as the foundation for wetland and peat-mangrove conservation.
IUU fishing	Illegal, Unreported and Unregulated fishing that undermines sustainability and compliance, often across borders.
ICZM (Integrated Coastal Zone Management)	Coordinated coastal management across sectors and agencies to reduce conflicts and cumulative impacts.
Indicator	Measurable variable tracking ecosystem status, pressures, or management performance (e.g., mangrove extent, turbidity).
Intertidal flats	Shore zones exposed at low tide; important for shorebirds and fisheries productivity in wetland complexes.
Mangrove peat / peat-forming mangroves	Carbon-dense mangrove soils that form peat; highly sensitive to drainage and altered tidal exchange.
Marine National Park (MNP)	A protected area with marine components designated by MoE (e.g., Koh Rong Marine National Park).
MCS (Monitoring, Control and Surveillance)	Fisheries compliance system including patrols, inspections, and tracking tools.

Megafauna	Large marine animals (dolphins, dugongs, turtles) sensitive to bycatch and habitat loss.
MFMA (Marine Fisheries Management Area)	Area-based fisheries management measure under FiA/MAFF, often linked to community co-management.
MSP (Marine Spatial Planning)	Framework to allocate marine space among uses (conservation, fisheries, tourism, industry) to reduce conflicts.
Natural infrastructure	Ecosystems providing infrastructure-like services (storm buffering, wave attenuation, water filtration).
No-take zone	Managed area where extraction (e.g., fishing) is prohibited to protect habitats and allow recovery.
NTU (Nephelometric Turbidity Units)	Standard unit measuring water turbidity (cloudiness), a key pressure on reefs and seagrass.
OECM (Other Effective Area-Based Conservation Measure)	Area governed and managed to deliver sustained biodiversity outcomes, not necessarily designated as a protected area.
Peat oxidation	Decomposition of peat when drained/exposed to oxygen, releasing CO ₂ and causing subsidence.
Ramsar site	Wetland recognized under the Ramsar Convention as being of international importance.
Sedimentation	Deposition of sediments that can smother corals and reduce light for seagrass; often driven by runoff and shoreline works.
Seagrass meadow	Underwater flowering plants forming meadows that support fisheries nurseries, stabilize sediments, and store carbon.
Sensitivity hotspot	Site where ecological sensitivity and consequences of disturbance are particularly high.
Tidal prism	Volume of water exchanged in a tidal cycle; reductions can degrade mangroves and wetlands.
Transboundary impacts	Effects crossing borders (shared stocks, marine litter, pollution plumes, oil spill risks) in the Gulf of Thailand.
Turbidity	Water cloudiness from suspended particles; reduces light for seagrasses and stresses coral reefs.
User fees / eco-levies	Revenue mechanisms (e.g., MPA entrance fees) that can finance monitoring, enforcement, and operations.
Valuation (ecosystem/economic)	Estimating economic benefits or losses linked to ecosystem change (livelihood losses, avoided damages, carbon value).
VMS (Vessel Monitoring System)	Satellite/GPS tracking system for fishing vessels used to support compliance and enforcement.
Wastewater controls	Measures to reduce untreated/partially treated discharges that drive nutrient loading and contamination in nearshore waters.

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Annex 4

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List of Acronym

ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
BOD	Biochemical Oxygen Demand
CBD	Convention on Biological Diversity
CCRMN	Cambodian Coral Reef Monitoring Network
CFi	Community Fisheries
COBSEA	Coordinating Body on the Seas of East Asia
CPA	Community Protected Area
DO	Dissolved Oxygen
e-CDT	electronic Catch Documentation and Traceability
EAAFP	East Asian–Australasian Flyway Partnership
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
FFI	Fauna & Flora International
FiA	Fisheries Administration
GFDRR	Global Facility for Disaster Reduction and Recovery
GIS	Geographic Information Systems
GMW	Global Mangrove Watch
ICZM	Integrated Coastal Zone Management
IUCN	International Union for Conservation of Nature
IUU	Illegal, Unreported and Unregulated (fishing)
JICA	Japan International Cooperation Agency
Kd	Light attenuation coefficient
MAFF	Ministry of Agriculture, Forestry and Fisheries
MCC	Marine Conservation Cambodia
MFMA	Marine Fisheries Management Area
MLMUPC	Ministry of Land Management, Urban Planning and Construction
MNP	Marine National Park
MoE	Ministry of Environment
MOWRAM	Ministry of Water Resources and Meteorology
MRV	Measurement, Reporting and Verification
MSP	Marine Spatial Planning
NAP	National Adaptation Plan
NCCMD	National Committee on Coastal Area Management and Development
NDC	Nationally Determined Contribution
NPCI	National Plan of Control and Inspection (for Marine Fisheries)
NPOA-IUU	National Plan of Action to Prevent, Deter and Eliminate IUU Fishing
NSOC	National State of the Oceans and Coasts
O&M	Operations and Maintenance
ODC	Open Development Cambodia

PEMSEA	Partnerships in Environmental Management for the Seas of East Asia
PES	Payment for Ecosystem Services
RIS	Ramsar Information Sheet
RS	Remote Sensing
SDG	Sustainable Development Goal
SEZ	Special Economic Zone
SLR	Sea-level rise
SOP	Standard Operating Procedures
UN-Habitat	United Nations Human Settlements Programme
VMS	Vessel Monitoring System

Annex 4-1 Data sources

Mangroves

- **MoE Mangrove Assessment (2014, 2025):** national wall-to-wall mapping (Sentinel-2, 10 m) with consistent methods—chosen as the primary pair for recent trend detection and provincial disaggregation.
- **NSOC/PEMSEA compilations (1997, 2011):** used to contextualize the earlier contraction phase and to compare long-run magnitudes.
- **Global Mangrove Watch (v3.0):** global consistency check on 1996–2020 trajectories and spatial plausibility.

Coral reefs

- **CCRMN / FiA national monitoring (since 2019):** standardized line-intercept/photo-quadrats and belt transects for fish/invertebrates—used for mean live cover, life-form composition, and qualitative trend signals.
- **Legacy site surveys (Koh Rong/Kep/Kampot/Koh Sdach):** provide pre-2019 context and species-level richness.

Seagrass

- **MoE Seagrass Assessment (2014, 2025):** provincewide tallies with CFI-resolved meadows (Kep–Kampot) to support management-relevant accounting.
- **FFI–FiA 2021–2023 mapping (Koh Kong–Preah Sihanouk):** eleven-site campaign (e.g., Chrouy Pros, Steung Hav, Prey Nob) for area/patch morphology and ground validation.
- **MCC/FAO and partner baselines:** used where community patrol and anti-trawl pilots supply fine-scale edges and scars.

Wetlands/biodiversity & governance

- **Ramsar (Koh Kapik & Associated Islets) and Peam Krasop WS documents:** ecological function and household dependence.
- **Protected-area legal updates (ODC) & management plans:** boundary changes, governance status.
- **Bycatch/megafauna records:** peer-reviewed/technical notes (Irrawaddy dolphins, dugongs, turtles) to anchor risk pathways.

Water quality/pollution (context)

- **ASEAN Marine Water Quality Guidelines** and MoE routine checks (nutrients, BOD, coliforms) to interpret pressures on reefs/seagrass near growth nodes.

These sources were chosen for (i) national coverage with recent vintages, (ii) method transparency enabling cross-walks, and (iii) direct linkage to management units (MFMAs/CFis/CPAs/MNPs).

Annex 4-2 Indicator construction & computations

Change in mangrove extent (2014→2025)

- Harmonized class keys across the two MoE epochs; excluded known reclass artifacts (e.g., aquaculture pond edges, nipa-dominant fringes misread as non-mangrove).
- Reported both absolute (ha) and relative (%) change; flagged hotspot polygons where losses cluster (>500 ha within a 5-km radius).

Coral condition & structure

- **Live coral cover (%)**: site means (\pm SD) from line-intercept/photo-quadrats; aggregated to island groups and provinces (inverse-variance weighting where available).
- **Life-form composition**: massive/encrusting vs branching/foliose shares to infer sediment/light stress.
- **Fish/invertebrate indicators**: density/biomass summarized by functional groups when transect lengths and ID levels were consistent; otherwise used qualitative categories (low/moderate/high relative to Gulf references).

Seagrass extent & sensitivity

- **Area (ha)**: meadow polygons merged per CFi; overlaps resolved by priority to the most recent, ground-validated layer.
- **Edge stability & trawl scars**: where GPS patrol tracks and drone imagery existed, computed edge retreat/advance ($\text{m}\cdot\text{yr}^{-1}$) and scar density ($\text{km}\cdot\text{km}^{-2}$).
- **Light limitation proxy**: used turbidity notes and depth-of-occurrence shifts (when repeated depth belts were available) as qualitative K_d proxies.

Blue-carbon screening (order-of-magnitude)

- For policy framing only (not crediting): multiplied areas by Tier-1/2 stock factors from peer-reviewed syntheses for **mangrove peat** and **seagrass soils**; reported as ranges (± 25 –50%) and **not** used for valuation without site-level MRV.

Socio-ecological coupling

- Linked habitat units to adjacent CFis/settlements (2-km coastal buffer) to flag livelihood exposure where **>50%** of local income is wetland/fishery-derived (per Ramsar/field studies).
- For hotspot narratives, combined hydrologic connectivity (freshwater inlets, tidal prisms), nursery adjacency (mangrove \rightleftharpoons seagrass corridors), and enforcement footprint (patrol hours, anti-trawl deployments).

Trend language

- “Decline/Recovery” used only when (a) at least two independent observations with consistent method exist, or (b) one observation with strong ancillary evidence (e.g., trawl-scar proliferation, dredging chronology) and expert validation.

Annex 4-3 Spatial & temporal frame

Spatial definitions. Provincial boundaries follow official census geographies. Ecosystem units combine (i) national/provincial extents (mangroves, coral, seagrass, wetlands), (ii) legally designated areas (MNPs, MFMA, Ramsar/WS/NP/PL), and (iii) community zones (CFis/CPAs) for co-management analyses. Where zoning overlaps (e.g., Koh Rong MNP over earlier MFMA), rules are harmonized by the most recent legal designation for maps/tables.

Time horizon

- **Mangroves:** long-run references (1997–2011) from NSOC compilations; recent change from **2014–2025** using MoE’s ongoing Mangrove Assessment (Sentinel-2, 10 m).
- **Coral reefs:** condition/cover from 2010–2025 (legacy baselines; standardized national series since ~2019 with CCRMN).
- **Seagrass:** extent/condition anchored on **2014–2025** (provincewide compilations plus 2021–2023 mapping in Koh Kong/Preah Sihanouk; 2014 & 2025 for Kep–Kampot).
- **Wetlands/biodiversity:** site dossiers use source-year snapshots (Ramsar sheets, management plans, recent field reports).

Conflict/definition discontinuities. Where historical land-cover/extent products used different class keys (e.g., “mangrove woody wetland” vs “mangrove forest”), we built a cross-walk and report uncertainties with ranges rather than single-point change rates.

Annex 4-4 Quality assurance, triangulation & treatment of uncertainty

Cross-source checks. Mangrove totals were compared against GMW v3.0 tiles and legacy NSOC figures to validate provincial magnitudes and loss geography; discrepancies >5% triggered manual inspection (cloud/shadow, aquaculture glare, tidal phase). For seagrass, MoE polygons were cross-checked with FFI–FiA site campaigns and CFi sketch maps; conflicts favored the most recent ground-validated layer.

Method consistency. Coral cover aggregates only pooled transects with matching protocols; when methods differed, we presented site-level values and refrained from computing provincial means.

Administrative and zoning changes. Where protected-area boundaries changed (e.g., Peam Krasop WS, Botum Sakor NP), historical extents were re-tabulated to the **then-current** boundary for time-slice comparisons; we avoid per-hectare inferences across moving denominators.

Small-area volatility. Kep’s small base and patchy nearshore reefs/meadows produce larger percentage swings; interpretations emphasize direction and management implications rather than fine-grained year-to-year rates.

Attribution limits. We avoid over-attributing change to single drivers when co-varying pressures (trawling, turbidity, shoreline works, heat stress) are plausible; language remains conditional (“consistent with...”, “suggests...”), pending targeted studies.

Uncertainty reporting.

- Mapping: report class-level error where available (user’s/producer’s accuracy); otherwise qualify results as **indicative** and present rounded totals.
- Blue-carbon: provide wide ranges and flag the need for site MRV (plots/cores, hydrology) before any crediting or firm valuation.
- Biodiversity/bycatch: rely on documented events and conservative inference for risk pathways.

Reproducibility. Spatial layers and tabulations are archived with metadata on source, date, method, CRS, and any edits (smoothing, gap-filling). Summary scripts (where used) are versioned to regenerate province and hotspot tables/figures.

Annex 4-5 Extended explanatory note on mangrove and wetland status and site pressures

(Supporting Sections 4.2.1.1 and 4.2.1.2 of the main chapter)

A) Mangrove extent datasets and historical change

A1. Why national mangrove estimates differ

National mangrove extent varies widely (≈45,000–63,000 ha) because estimates depend on (i) the classification rules used to separate mangroves from other coastal woody vegetation, (ii) sensor resolution and cloud/tide conditions, and (iii) whether narrow fringing stands and mixed mangrove–scrub mosaics are included. Despite these differences, all sources agree that mangroves are concentrated in **Koh Kong**, with smaller estuarine belts in **Kampot–Preah Sihanouk** and minor patches in **Kep**. Dominant genera commonly reported include *Rhizophora*, *Avicennia* and *Sonneratia*.

A2. Historic decline (NSOC baseline) and likely drivers

Historic statistics compiled in NSOC 2018 indicate that Cambodia’s coastal mangroves declined from **63,041 ha (1997)** to **50,860 ha (2011)**—a net loss of **12,181 ha** over 14 years (≈**–870 ha/year**; **–19.3%** from the 1997 baseline). Spatially, the steepest contractions were reported in the **Botum Sakor/Koh Kong complex** and **Kampong Trach (Kampot)**, which align with known fronts of aquaculture/estate expansion, settlement growth and charcoal production during the late-1990s to mid-2000s period (PEMSEA & MoE, 2019). This historic interval is important for interpretation: it suggests that a large share of national mangrove loss occurred during earlier development phases, and that present-day loss rates should be interpreted against this longer-term trajectory.

A3. Recent mapping (MoE Mangrove Assessment 2014–2025) and provincial pattern

According to MoE’s ongoing Mangrove Assessment (Sentinel-2, 10 m), national mangrove extent declined from **58,866 ha (2014)** to **55,355 ha (2025)**—a net loss of **3,510 ha** across 11 years (≈**–319 ha/year**; **–6.0%** relative to the 2014 baseline). Losses are uneven: **Koh Kong accounts for ~2,259 ha (≈64%)** of total loss and **Preah Sihanouk ~383 ha (≈11%)**, with remaining losses dispersed across **Kampot and Kep** as smaller, discontinuous parcels (MoE,

2025). The lower absolute rate compared with the 1997–2011 interval may reflect improved protection and co-management in some areas, but it may also partly reflect differences in methods and mapping thresholds; therefore, extent trends should be triangulated with field evidence on fragmentation, hydrologic change, and land conversion.

A4. Interpretation note

For the main chapter, it is best to report (i) the MoE 2014–2025 trend as the most current national mapping signal, and (ii) the NSOC 1997–2011 trend as historical context. These two together show a long-term decline with evidence of slower recent net loss, while emphasizing that “extent” alone does not capture degradation from hydrologic disruption, pollution stress, or fragmentation.

B) Coastal wetlands and estuarine systems (Ramsar complexes and livelihood dependence)

B1. What is included as “coastal wetlands”

Cambodia’s coastal wetlands include estuaries, tidal flats, mangrove-lined channels, brackish lagoons and associated floodplain mosaics. These systems provide core ecosystem services: filtering sediments and nutrients, buffering storm surges, supporting high nursery productivity for fisheries, and maintaining habitat for migratory waterbirds along the East Asian–Australasian Flyway.

B2. Peam Krasaop–Koh Kapik as the national flagship wetland complex

The **Peam Krasaop Wildlife Sanctuary** and the **Koh Kapik & Associated Islets Ramsar Site** form a connected mangrove–intertidal landscape recognized for international importance. The system’s productivity depends on the balance between **freshwater inflows** and **tidal exchange**, which maintains brackish conditions that support plankton production and fish recruitment. Intertidal flats and island channels are especially important for waterbird feeding and for small-scale fisheries (Ramsar Secretariat, 2012; Fauna & Flora, 2024).

B3. Livelihood linkage and sensitivity

Coastal wetland households around the Koh Kapik–Peam Krasaop system exhibit high dependence on wetland resources, meaning that changes in nursery function, salinity regimes or channel morphology can translate rapidly into income and food-security impacts. This is why wetland protection is not only a biodiversity priority but also a direct livelihood-risk management measure in Koh Kong.

B4. Community co-management and operational challenges

The Peam Krasaop wetland system includes community fisheries (CFIs) that support participatory management and improve compliance where patrol resources and clear rules are sustained. Key operational challenges include (i) cross-boundary enforcement where parts of the Ramsar landscape extend beyond protected-area boundaries, and (ii) maintaining hydrologic connectivity where roads, embankments, canalization or shoreline works reduce tidal prism and alter flushing.

B5. Planning relevance (SCS SAP and integrated wetland management)

Under the SCS SAP, planning efforts emphasize integrated wetland management at local and regional levels, including management plans that align protected areas, fisheries zoning and community rules. Priority management themes typically include: maintaining tidal connectivity and freshwater inflows, preventing conversion of intertidal flats and mangrove edges, improving water-quality controls in upstream catchments, and sustaining community patrol capacity to deter illegal cutting and destructive fishing.

C. Selected site-specific status and pressures — expanded notes

C1. Site 1. Botum Sakor National Park (Koh Kong)

Status & ecological importance. Botum Sakor is a very large protected landscape following the 2023 reclassification (143,895 ha). Within its estuarine apron, peat-forming mangroves (~4,768 ha) sit over marine clay and contain deep organic soils, making them an exceptional **blue-carbon reservoir** and a high-value “natural infrastructure” for storm buffering. The defining feature is that peat stability depends on **continuous tidal exchange and high water tables**—once peat dries, oxidation and subsidence can cause long-lived carbon loss and weakened coastal protection.

Main pressures

- **Hydrologic restriction** from roads/embankments and undersized culverts can reduce tidal prism, trap sediments, shift salinity bands, and lower water tables—directly threatening peat integrity.
- **Concessionary development and associated access roads** increase fragmentation risk and accelerate edge effects (clearing, disturbance, easier entry).
- **Legacy charcoal production and local extraction pressure** can simplify stand structure and increase vulnerability to storms and erosion.
- **Poaching and wildlife disturbance** rise when access expands, undermining biodiversity values that support conservation legitimacy.

Management implications

- Apply a “**hydrology-first**” rule: protect tidal connectivity as the primary management objective in peat zones.
- Use **no-conversion cores** over peat tongues; treat drainage/canalization as “high risk” activities.
- Require **culvert/bridge sizing and maintenance** to maintain tidal exchange and water levels.
- Establish a simple compliance package: zoning map + signage + joint patrol priorities focused on peat blocks and tidal creeks.

Priority indicators

- Water level in peat-zone creeks, salinity in creek heads, canopy density/fragmentation, evidence of drainage/blocked culverts, and shoreline erosion/accretion near outlets.

C2. Site 2. Peam Krasaop Wildlife Sanctuary (Koh Kong)

Status & ecological importance. Peam Krasaop is a mangrove-dominated archipelago with strong tidal and upstream freshwater influence; it supports fisheries and livelihoods for local residents, and is now 16,982 ha after downsizing. The site contains multiple mangrove

structural zones, indicating ecological gradients from intertidal flats through short-stature stands to taller riverine stands. Its key significance is **connectivity**: Peam Krasaop links with the Koh Kapik Ramsar system and nearshore habitats, forming one of Cambodia's most important mangrove–estuarine complexes for nursery functions and surge attenuation.

Main pressures

- **Water-quality and hydrology stress** from surrounding development: increased runoff, sediment, and nutrient inputs can reduce mangrove vigor and nursery productivity.
- **Aquaculture expansion and land conversion risk** can fragment mangroves and alter flushing patterns.
- **Transport infrastructure** can reshape channels and tidal exchange, affecting salinity and sediment budgets.
- **Localized extraction pressure** (fuelwood, small timber) can degrade accessible margins if not governed by community rules.

Management implications

- Manage Peam Krasaop as a **land–sea system**: zoning should protect tidal channels, intertidal flats, and mangrove edges that function as nursery corridors.
- Strengthen joint MoE–FiA coordination with adjacent community fisheries where access and livelihood uses are high.
- Prioritize low-cost measures that reduce chronic stress: buffer zones for runoff, control of clearing, targeted patrol support for community enforcement.

Priority indicators

- Channel/tidal connectivity, turbidity and nutrient proxies (simple water checks), mangrove fragmentation, and community catch/CPUE as a proxy for nursery function.

C3. Site 3. Koh Kapik & Associated Islets (Ramsar Site 998) (Koh Kong)

Status & ecological importance. Koh Kapik (~12,000 ha) is a Ramsar-designated wetland of alluvial islands, mangroves, and intertidal flats. A defining governance feature is that only ~60% falls inside Peam Krasaop WS while ~40% lies outside—so outcomes depend on **cross-boundary coordination**, not only sanctuary management. Ecologically, the system relies on freshwater inflows (Prek Koh Pao and Prek Khlang Yai/Stung Kep) mixing with tides to maintain brackish productivity that supports fisheries and waterbirds. The site also has high livelihood reliance (>65% of households with 70–90% wetland-derived income), so ecological change rapidly becomes a welfare issue.

Main pressures

- **Reduced freshwater inflow or altered timing** (upstream changes, diversions) can shift salinity and reduce plankton/fish productivity.
- **Channel infill/sedimentation** can shrink tidal prism and reduce habitat quality for shorebirds and fisheries.
- **Mangrove fragmentation** weakens storm buffering and nursery connectivity.
- **Cross-boundary enforcement gaps** (outside-WS areas) create weak points where clearing or unregulated activities can undermine the whole system.

Management implications

- Treat Koh Kapik as a **connectivity-managed Ramsar landscape**: protect inter-islet flats, keep channels open, maintain freshwater inflows, and coordinate rules across administrative boundaries.
- Prioritize simple “system integrity” protections (no conversion of flats, avoid blocking channels, maintain tidal prism).
- Link livelihood protection with management: community compliance improves when rules clearly protect fishing productivity.

Priority indicators

- Freshwater inflow proxies, salinity band shifts, channel width/depth condition (rapid field checks), intertidal flat condition, and community income/catch dependence as a sensitivity indicator.

C4. Site 4. Prey Nob District / Ream NP context (Preah Sihanouk)

Status & ecological importance. Ream National Park (~21,000 ha; ~6,000 ha marine) is a mixed habitat mosaic (mangroves, wetlands, seagrass, coral) surrounded by multiple communes and high human use. This makes it a “high interaction” protected area: management outcomes depend heavily on boundary compliance, land-based pollution control, and coordination with coastal development planning. Nearby mapping has recorded ~98 ha of seagrass in Prey Nob (2021–2022), and historical mangrove estimates around Ream are ~1,800 ha—useful signals of nursery habitat and coastal resilience values.

Main pressures

- **Habitat conversion and encroachment pressure** reflected in reported forest loss trends.
- **Rapid urbanization + port/tourism growth** increasing wastewater, runoff, and sedimentation loads that degrade nearshore habitats.
- **Shoreline works/dredging and coastal construction** that affect turbidity, seagrass light conditions, and estuary function.
- **Multiple users and access points** increase enforcement complexity and raise cumulative impacts (small activities add up).

Management implications

- Focus on **boundary integrity + land-based controls**: wastewater/drainage management and sediment control are as important as patrols.
- Use zoning to separate high-use areas (tourism/boat access) from sensitive seagrass/mangrove edges; apply no-anchor zones where needed.
- Strengthen collaborative governance with local authorities because pressures originate largely outside the park boundary.

Priority indicators

- Water-quality proxies (turbidity, coliform where feasible), seagrass extent and scarring, mangrove edge loss, and compliance indicators (patrol effort, violations).

C5. Site 5. Kampong Trach wetlands & Anlung Pring Protected Landscape (Kampot)

Status & ecological importance. Anlung Pring (~219 ha) is embedded in seasonal wetlands and rice mosaics and serves as an important dry-season refuge for key waterbirds (including

Sarus Crane). Its ecological function depends on **seasonal inundation timing and shallow-water persistence**, which also supports local fisheries and wetland productivity.

Main pressures

- **Hydrologic modifications** (canals, small reservoirs, drainage) can shift inundation timing/depth and reduce habitat suitability.
- **Saline intrusion** can alter wetland vegetation and food availability and reduce freshwater productivity.
- **Landscape fragmentation** from agricultural intensification can reduce ecological connectivity across the wider wetland complex.

Management implications

- Protect the wetland's **seasonal water regime** (retain shallow-water dynamics; avoid drainage that eliminates dry-season refuges).
- Integrate wetland conservation into local land and water planning (align irrigation/drainage with biodiversity and fisheries needs).
- Use a small set of practical measures: water-level management rules, buffer strips, and community awareness on dry-season sensitivity.

Priority indicators

- Seasonal water depth/duration, salinity in dry season, waterbird counts, and local fish catch indicators.

C6. Site 6. Chumpu Khmao (Prey Nup)

Status & ecological importance. Chumpu Khmao is a community fishery (CFi) landscape within a broader coastal wetland system. Recent restoration planting (12,500 mangrove saplings) indicates active community stewardship. The area also has biodiversity significance (e.g., fishing cat records in the wider mangrove landscape), and it sits within a coastal corridor between major seagrass cells (Steung Hav and Kampot meadows), making it strategically placed for community-based monitoring and compliance.

Main pressures

- **Localized clearing and gear impacts** typical of multi-use wetlands (small but cumulative).
- **Water-quality stress** from nearby settlements/activities affecting mangrove and nearshore conditions.
- **Connectivity pressures** (if adjacent corridors degrade, the site loses nursery function and resilience).

Management implications

- Build on existing restoration by linking it to **enforceable CFi rules** (gear restrictions, no-cut zones, patrol support).
- Promote “simple, visible” management: signage, community patrol schedules, and reporting mechanisms for violations.
- Use the site as a **community monitoring node** for nearby seagrass (anchor management, trawl exclusion signals) and mangrove survival rates.

Priority indicators

- Mangrove seedling survival and canopy recovery, violations/patrol effort, and simple nearshore habitat checks (seagrass presence/scarring where relevant).

D. Data note

Mangrove “extent” figures differ by dataset and method; they are best interpreted as **trend signals** rather than exact totals. Wetland extent and condition are even less consistently quantified in legal instruments and often rely on Ramsar documentation, habitat mapping, and project assessments. For reporting, avoid mixing extent totals across incompatible sources and prioritize clarity on (i) the dataset used, (ii) the year, and (iii) the main uncertainty drivers (classification, tide, validation coverage).

Annex 4-6 Extended explanatory note on coral reefs and seagrass in Cambodia

(Supporting Sections 4.2.2.1 and 4.2.2.2 of the main chapter)

A. Coral reefs (status, distribution, and interpretation)

A1. Distribution and reef types

Cambodia’s coral reefs are predominantly **fringing reef systems** associated with island groups along the Gulf of Thailand. The highest concentration occurs around the **Preah Sihanouk archipelagos** (especially the Koh Rong Archipelago) and the **Koh Kong island complex** (including Koh Sdach and nearby island chains). Smaller reef patches are present along the mainland-influenced waters of **Kep and Kampot**, where higher turbidity favors sediment-tolerant reef assemblages and limits reef development to discontinuous, shallow patches. This spatial pattern reflects the interaction of (i) substrate availability around islands, (ii) sediment and nutrient loads from nearshore development and rivers, and (iii) wave exposure and circulation in the semi-enclosed Gulf.

A2. Extent and uncertainty (why figures vary)

Early national assessments estimated approximately **~2,700 ha** of reef habitat, largely concentrated in Koh Kong and Preah Sihanouk. More recent mapping and validation comparing **2014 vs. 2025** indicate that reefs remain strongly concentrated in **Preah Sihanouk and Koh Kong (>85% of national mapped cover)**, with changes over time generally described as **modest and method-bounded**—meaning that apparent gains/losses can partly reflect classification thresholds, sensor resolution, water clarity at image acquisition, and validation coverage rather than true ecological change. For this reason, reef “extent” should be interpreted alongside **condition indicators** (live coral cover, structural complexity, fish biomass) and **pressure indicators** (turbidity, fishing intensity, tourism footprint).

A3. Condition and ecological signals

Available evidence suggests that reef condition in the 2000s typically ranged from **fair to good** (≈23–58% live cover). Long-term monitoring in Koh Rong (initiated around 2010 and later extended to Koh Sdach and Kep) indicates reefs that are **sediment-influenced**, with benthic communities often dominated by **massive and encrusting genera** such as *Porites* and *Diploastrea*. This dominance is an important ecological signal: massive/encrusting forms are generally more tolerant of periodic turbidity and sedimentation, but their prevalence often coincides with **reduced branching coral abundance**, lower structural complexity, and altered

fish assemblages over time. In practice, this means reefs can remain “alive” (moderate live cover) while still experiencing **structural simplification** and reduced nursery/refuge function for reef fish.

A4. Monitoring and comparability (CCRMN and why it matters)

Since 2019, the **Cambodian Coral Reef Monitoring Network (CCRMN)** has standardized protocols across sites for fish biomass, benthic cover, invertebrates, and structural complexity. This is important for two reasons:

1. It improves **comparability** across provinces and years (reduces “apples vs oranges” monitoring), and
2. It supports management evaluation—i.e., whether zoning/enforcement (MNPs, MFMA, CFis) is associated with measurable improvements in fish biomass or reduced physical damage.

A5. Species diversity and data gaps

Cambodia likely hosts around **~70 coral species**, but distribution data remain incomplete—particularly offshore. Several historical/partner surveys have mapped nearshore reefs, but **species inventories** and **standardized biodiversity baselines** remain limited in many areas. Localized coral extraction persists in some communities, typically small-scale, but it can be significant where reef patches are small or already degraded.

A6. Management interpretation and priorities

The key management implication is that Cambodia’s reefs are strongly shaped by **chronic, cumulative pressures** rather than single catastrophic events. Priority actions typically include:

- Reducing **sedimentation and water-quality stress** (shoreline works, dredging controls, wastewater/runoff management)
- Strengthening fisheries compliance (illegal gears, compressor fishing where relevant)
- Managing tourism impacts (anchoring, trampling, unregulated snorkel/diver pressure)
- Targeting restoration where it has the highest chance of success (e.g., reef areas with stable substrate, manageable turbidity, and enforceable no-anchor zones)

Recent mapping-based restoration priorities highlight **Koh Rong Sanloem/Prek Svay** (high tourism pressure) and larger Koh Kong reef complexes such as **Samros Koh Sdach, Phnhhy Meas and Chrouy Pros**, reflecting a strategy of focusing on places with both ecological scale and practical management leverage.

B. Seagrass (status, distribution, and interpretation)

B1. Distribution and meadow configurations

Cambodia hosts extensive seagrass meadows, particularly in **Kampot and Koh Kong**, with notable nearshore beds also recorded around Preah Sihanouk coastal cells. Recent surveys describe two dominant configurations:

1. **Large mainland-adjacent meadows** (often shallow, continuous, and highly exposed to fishing and turbidity pressures), and

2. **Smaller island/bay patches** (more sheltered but vulnerable to localized tourism and anchoring).

Dominant taxa commonly include *Thalassia hemprichii*, *Halodule uninervis*, and *Enhalus acoroides*—a composition typical of shallow tropical Indo-Pacific meadows.

B2. Why seagrass matters (services and sensitivity)

Seagrass provides (i) **nursery habitat** that supports coastal fisheries productivity, (ii) **sediment stabilization** that improves water clarity and shoreline resilience, and (iii) important **blue-carbon storage** in below-ground biomass and soils. It is also the key feeding habitat for **dugongs** and foraging green turtles. However, seagrass is highly sensitive to two stress pathways:

- **Light limitation** (turbidity, suspended sediment, eutrophication-driven algal growth), and
- **Physical disturbance** (bottom trawling/push-nets, dredging, propeller scarring, anchor damage).

These pathways are critical because they link seagrass condition directly to manageable pressures: gear restrictions, dredging controls, and wastewater/runoff management.

B3. Mapped examples and extent (with caution)

Recent mapped examples (~2,333 ha across 11 sites) include **Chrouy Pros Bay (~1,485 ha)**, **Steung Hav (610 ha)** and **Prey Nob (98 ha)**, with smaller island patches (e.g., Koh Ta Kiev, Koh Bong, Koh Tang, Koh Thmei/Thmor Tom). These figures are valuable for spatial planning but should be treated as mapping-based extents that can vary with water clarity, seasonality, and classification thresholds. For management, it is often more useful to track:

- Meadow persistence (stable vs shrinking),
- Disturbance signatures (trawl scars, anchor scars), and
- Local light/turbidity trends in high-use corridors.

B4. Governance linkages (why MFMA's matter for seagrass)

A key feature of Cambodia's seagrass is that many major meadows occur **within or adjacent to MFMA's** and high-use nearshore corridors (fishing, tourism, port approaches). This makes fisheries zoning and enforcement (trawl bans, no-anchor zones, seasonal closures) one of the most direct levers for improving meadow condition—often more immediately than longer-term restoration planting.

C. Selected site-specific status and pressures — expanded notes

C1. Site 1. Koh Rong Archipelago (Koh Rong Marine National Park)

Designation and governance context. Koh Rong was initially managed under fisheries zoning (MFMA) and later designated as a **Marine National Park (Feb 2018)**. This governance transition creates a practical need for **MoE–FiA coordination** so that zoning boundaries, permitted activities, and enforcement roles are consistent for residents, fishers, and tourism operators.

Ecological status (reef and seagrass). Spatial planning baselines map approximately ~1,198 ha of coral reefs and ~1,360 ha of seagrass. Reef surveys in 2019–2020 recorded ~29.8% coral cover, with communities dominated by sediment-tolerant *Porites* and *Diploastrea*, while fish biomass remains low—consistent with continuing fishing pressure.

Main pressures

- **Tourism growth** (anchoring, coastal infrastructure, beach development, trampling)
- **Dredging/shoreline works** and sediment plumes that reduce water clarity and stress seagrass
- **Fishing pressure** and gear impacts that suppress fish biomass and alter reef trophic structure

Management implications (priority actions)

- Establish and enforce **no-anchor zones** + install **moorings** in high-use bays
- Strengthen enforcement of **gear restrictions** and spatial closures
- Apply strict controls on **dredging/shoreline works** near sensitive seagrass and reef edges
- Use the CCRMN/partner monitoring to track outcomes (fish biomass, benthos, complexity)

C2. Site 2. Kep Archipelago (Koh Tonsay & Koh Pou) within the Kep MFMA

Status and ecological significance. The Kep MFMA (~11.3 thousand ha) encompasses reefs and some of Cambodia’s largest seagrass meadows (~6,399 ha), making it nationally important for fisheries nursery services and blue-carbon potential.

Condition signals. While some reef pockets retain high coral cover (e.g., Koh Seh reported at ~64% live cover in 2019), many nearshore reefs are small and vulnerable to turbidity and physical disturbance. Seagrass condition is particularly sensitive to bottom-contact fishing and resuspension of sediments.

Main pressures

- **Illegal trawling and bottom-contact gears** (direct seagrass damage, sediment resuspension)
- **Electric fishing and destructive gears** (fish community impacts)
- **Sedimentation/turbidity** from coastal activities and nearshore disturbance

Management implications

- Maintain/expand **anti-trawl networks** and patrol effort focused on meadow margins
- Clarify MFMA zoning and restrictions in user-friendly formats (maps/signage)
- Prioritize seagrass condition monitoring (extent + scars) as the key performance indicator

C3. Site 3. Kampot Beach / nearshore Kampot (proposed MFMA)

Status. The most recent compilation reports a nearshore belt with ~5,158 ha seagrass (10 spp.) and ~467 ha coral reef, including a large single reef feature at **Nataya (~305 ha)**. A proposed ~8,486-ha MFMA is intended to formalize zoning and enforcement in collaboration with three active CFis.

Main pressures.

- **Sedimentation and turbidity** (river plumes, shoreline works) reducing light availability
- **Gear impacts** (bottom-contact fishing) affecting meadow integrity
- **Incremental coastal development** increasing nutrient loads and physical disturbance

Management implications.

- The proposed MFMA offers the key mechanism to implement enforceable rules: trawl exclusion, gear restrictions, zoning for sensitive habitats, and community-supported patrols
- Pair zoning with basic water-quality controls (runoff/wastewater) to protect the light environment necessary for meadow persistence

C4. Site 4. Koh Sdach–Koh Kong Archipelago

Status and trend signal. Earlier surveys described good condition at some sites, but later assessments suggest increasing degradation signals over time. Current accounting indicates large contiguous reef areas embedded in **Samros Koh Sdach** and **Phnhhy Meas**, which are practical focal zones due to their scale and connectivity.

Main pressures.

- **Fishing pressure and destructive/illegal gears**
- **Sedimentation/turbidity** in more mainland-influenced waters
- **Limited enforcement coverage** across dispersed island complexes

Management implications.

- Focus conservation investment on “high-leverage” reef blocks (largest contiguous areas) where enforcement and restoration pilots (transplantation/artificial structures) can be monitored and maintained
- Integrate reef protection with local fisheries management to improve compliance incentives

D. Data note

Mapping-based reef and seagrass extent figures are sensitive to methods (imagery, season, water clarity, classification thresholds). For management, pair extent maps with **condition indicators** (live coral cover, structural complexity, fish biomass; seagrass scars and light/turbidity proxies) and **pressure indicators** (trawl activity, dredging footprint, tourism intensity).

Annex 4-7 Explanatory note for Coastal area-based management: MPAs, Ramsar systems, MFMA/EAFM, and community co-management

Protected areas, MFMA and community management: Cambodia’s coastal governance is implemented through a layered set of area-based instruments that combine MoE-managed protected areas and marine parks with MAFF/Fisheries Administration fisheries zoning (MFMA) and community co-management. Table 4.xx summarizes the main MPAs and OECM-related measures discussed in this chapter and highlights where **habitat priorities (mangroves, wetlands, coral reefs and seagrass)** align—or potentially conflict—across different management instruments.

The table shows three major governance “clusters” where zoning coherence is essential. **First, Koh Kong’s mangrove–wetland complex** is anchored by **Botum Sakor National Park (143,895 ha)** and **Peam Krasaop Wildlife Sanctuary (16,982 ha)**, with significant mangrove blocks (including **peat-forming mangroves**) and functional connectivity to the **Koh Kapik Ramsar system (~12,000 ha)** and the **Chrouy Pros seagrass area (~1,485 ha)**. In this landscape, coherent zoning is needed to safeguard hydrology, mangrove integrity, and nearshore fisheries habitat while balancing access and enforcement across adjacent designations.

Second, the **Preah Sihanouk coastal system** includes **Ream National Park (~21,000 ha)** with substantial mangrove/wetland values (mangrove **~6,500 ha**; wetland **~1,800 ha**) and adjacent nearshore use areas. Here, coherence depends on maintaining consistent rules between protected-area management and coastal development controls so that habitat protection is not undermined by land-based pressures.

Third, the **Kep–Kampot and offshore archipelago systems** are characterized by coral-reef and seagrass mosaics managed through both protected-area and fisheries instruments. **Koh Po and Koh Tonsay Archipelago (11,307 ha)** contains mapped reef and seagrass features (**67.83 ha reef**; **3,900 ha seagrass**). The **Koh Rong seascape** illustrates the most important overlap issue: **Koh Rong MFMA (2016; 40,535 ha)** predates **Koh Rong Marine National Park (2018; 52,498 ha)**, and both aim to protect key habitats (reef **~1,198 ha**; seagrass **~1,360 ha**; plus additional reef values reported in the MFMA row). To avoid confusion and compliance gaps, MoE–FiA coordination is required to align **boundaries, zoning rules, permitted gears/activities, and enforcement responsibilities** within the shared seascape.

Community co-management underpins these systems by strengthening local compliance and stewardship, especially in inshore fisheries and mangrove blocks. Where community rules intersect with protected-area zoning or MFMA regulations, harmonized boundaries and clear user guidance (maps, signage, and agreed enforcement protocols) are essential to ensure that communities, tourism operators and fishers face a single, coherent spatial management framework.