BIODIVESITY ASSESSMENT REPORT

The Climate Adaptive Irrigation and Sustainable Agriculture for Resilience Project (CAISAR)

SUM Phearun
Phearun168.boss@gmail.com

Table of Contents

List of Tables

List of Figures

List of Abbreviations

AIIB:	Asian Infrastructure Investment Bank
AoA:	Area of Analysis
ASAP:	Asian Species Action Plan
BAP:	Biodiversity Action Plan
CAISAR:	Climate Adaptive Irrigation and Sustainable Agriculture for Resilience
CBD:	Convention on Biological Diversity
CF:	Community Forest
CF:	Community Forests
CFi:	Community Fisheries
CFi:	Community Fisheries
CH:	Critical Habitat
CR:	Critically Endangered
E & S:	Environmental and Social
EN:	Endangered
EOO:	Extent of Occurrence
ESCIA:	Environmental and Social Impact Assessment
ESCMP:	Environmental, Social, and Climate Management Plan
EU:	European Union
FiA:	Fisheries Administration
GCF:	Green Climate Fund
GIS:	Geographic Information System
GN:	Guidance Note
IBAs:	Important Bird Areas
IBAT:	Integrated Biodiversity Assessment Tool
IFAD:	International Fund for Agricultural Development
IFC:	International Finance Corporation
IUCN:	International Union for Conservation of Nature
KBA:	Key Biodiversity Area
KBA:	Key Biodiversity Area
KII:	Key Informant Interviews
LoO:	Likelihood of Occurrence

MoE:	Ministry of Environment
MOWRAM:	Ministry of Water Resources and Meteorology
NGO:	Non-Governmental Organization
OTP:	Ou Tapaong
PKO:	Punleu Komar Organization
PPIC:	Phnom Penh International Consultant Co. Ltd.
PS6:	Performance Standard 6
SK-CFi:	Sdok Khlouk Community Fishery
SMY-CFi:	Samraong Muk Yeik Community Fishery
SKB:	Stung Krang Bat
STSF:	Southern Tonle Sap Floodplain
ToR:	Terms of Reference
TSA:	Tonle Sap Authority
TSRB:	Tonle Sap River Basin
VU:	**Vulnerable**
WCS:	**Wildlife Conservation Society**
WHS:	**World Heritage Sites**

DEFINITIONS

Modified habitat. Areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. 5 Modified habitats may include areas managed for agriculture, forest plantations, reclaimed6 coastal zones, and reclaimed wetlands.

Natural habitats. Areas that are composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.

Introduction

The Climate Adaptive Irrigation and Sustainable Agriculture for Resilience (CAISAR) project in Cambodia is designed to support the Royal Government of Cambodia's National Water Resources Management and Sustainable Irrigation Road Map and Investment Program (2019-2023). The project's primary objective is to enhance the irrigation sector's resilience to climate change while promoting sustainable agricultural practices that also reduce greenhouse gas emissions. CAISAR focuses on improving smart irrigation systems, incorporating renewable energy, and advancing farming techniques to address climate change impacts such as altered rainfall patterns and water-related disasters.

The project's strategy is based on a Theory of Change that posits that upgrading irrigation infrastructure, disseminating knowledge of energy-efficient agricultural technologies, and strengthening agricultural value chains will foster a more resilient and sustainable agricultural sector in Cambodia. This approach is expected to improve crop production, reduce greenhouse gas emissions, enhance climate adaptation, and reinforce the institutional framework for managing these changes.

Financially supported by international organizations such as the Asian Infrastructure Investment Bank (AIIB), the International Fund for Agricultural Development (IFAD), and the Green Climate Fund (GCF), the project targets climate adaptation and livelihood improvement in four Cambodian provinces: Pursat, Kampong Chhnang, Kampong Speu, and Kandal. It is structured around three main components: enhancing farm-level climate resilience, upgrading water infrastructure, and strengthening institutional capacities.

To ensure that environmental, social, and climate considerations are effectively addressed, the Ministry of Water Resources and Meteorology (MOWRAM) will conduct Environmental, Social, and Climate Impact Assessments (ESCIA) and Environmental, Social, and Climate Management Plans (ESCMP), collectively referred to as the “E&S study.” This assessment report focuses primarily on Component 2 of the project and aims to align with relevant standards, contributing to the project's goals of climate resilience and sustainable development.

Furthermore, this study is fully aligned with the International Finance Corporation's Guidance Note 6 (IFC Guidance 6), a comprehensive framework for biodiversity conservation and sustainable management of living natural resources in business operations. IFC Guidance 6 offers guidance on avoiding, minimizing, and mitigating impacts on biodiversity and ecosystems. This biodiversity assessment prioritizes the protection of endangered and critically endangered species and their habitats, promotes sustainable natural resource management, and ensures that development activities adhere to international conservation standards. It also outlines best practices for preserving ecosystem services and fosters stakeholder engagement and equitable benefit-sharing from natural resource use.

The "area of influence" was defined as the geographical region, encompassing globally threatened species or ecosystems, potentially affected, directly or indirectly, by the proposed project. This initial assessment was crucial for identifying and evaluating potential environmental impacts beyond the immediate project site. The area of influence includes the physical and biological environment that could be affected by the project, such as air quality, water resources, soil quality, flora and fauna, human settlements, and cultural heritage. It also considers potential indirect impacts on surrounding areas, including noise pollution, traffic patterns, and socioeconomic conditions.

Renovation of irrigation systems within the Tonle Sap Floodplains offers significant potential benefits to a wide range of stakeholders. Primarily, farmers who rely on these systems for their livelihoods will experience improved water management, increased crop yields, and reduced water wastage. Additionally, the project can contribute to broader ecological benefits by enhancing water quality, reducing soil erosion, and supporting biodiversity conservation. Furthermore, revitalized irrigation systems can contribute to food security, rural development, and poverty reduction in the region.

1.1 Cambodia's Laws Protecting Environment and Biodiversity

Cambodia's government has made significant efforts to protect biodiversity through the establishment of a comprehensive legal framework. Key legislations include the Biodiversity Law (2009), which governs sustainable biodiversity management, and the Environmental Protection Law (1995), which sets broad principles for environmental management. Additionally, the Forest Law (1994) and Wildlife Sanctuary and Protection Law (1993) safeguard critical habitats and species, while the Fisheries Law (1991) ensures sustainable aquatic resource management. The recently introduced Environmental Code (2023) further strengthens regulations on pollution control and biodiversity conservation. Cambodia also participates in international agreements like the Nagoya Protocol, aligning its conservation efforts with global standards. Despite these advancements, effective implementation and enforcement remain essential to achieving long-term biodiversity protection. Below are short sumary of several key national legislations and international agreements:

- **Biodiversity Law (2009):** This foundational law provides a comprehensive legal structure for the sustainable management of biodiversity resources. It addresses habitat protection, species conservation, genetic resource management, and the sustainable use of biodiversity, outlining the government's responsibilities and promoting public participation.
- **Environmental Protection Law (1995):** This law sets general principles for environmental protection and outlines the government's role in environmental management, including pollution control, waste management, and natural resource conservation. It complements the Biodiversity Law by providing a broader environmental governance framework.
- **Forest Law (1994):** Regulating the management, use, protection, and restoration of Cambodia's forests, this law is crucial for balancing economic development with environmental conservation, particularly in biodiversity-rich ecosystems.
- **Wildlife Sanctuary and Protection Law (1993):** This law establishes wildlife sanctuaries and offers protection to wildlife species by prohibiting hunting, trapping, and other activities that threaten wildlife and their habitats.
- **Fisheries Law (1991):** This law governs the management of Cambodia's fisheries resources, setting rules for sustainable fishing practices, protecting aquatic habitats, and ensuring the long-term health of aquatic ecosystems.
- **Environmental Code (2023):** The newly introduced Environmental Code consolidates and updates Cambodia's environmental laws, introducing stricter regulations on pollution control, natural resource management, and biodiversity conservation. It emphasizes climate change adaptation and mitigation and enhances public participation and transparency in environmental decision-making.

- **Nagoya Protocol (2010):** As a party to the Nagoya Protocol under the Convention on Biological Diversity (CBD), Cambodia commits to the fair and equitable sharing of benefits arising from the utilization of genetic resources. This protocol supports Cambodia's efforts to protect its biodiversity while ensuring that the benefits of its genetic resources are shared with local communities and stakeholders.

1.2 Project Objectives, Components, and Activities

The project objective is to increase climate adaptation, mitigate the negative impact of extreme climate events, and improve livelihoods of smallholder farmers and vulnerable rural communities in four provinces of Cambodia, including Pursat, Kampong Chhnang, Kampong Speu, and Kandal provinces (see map below).

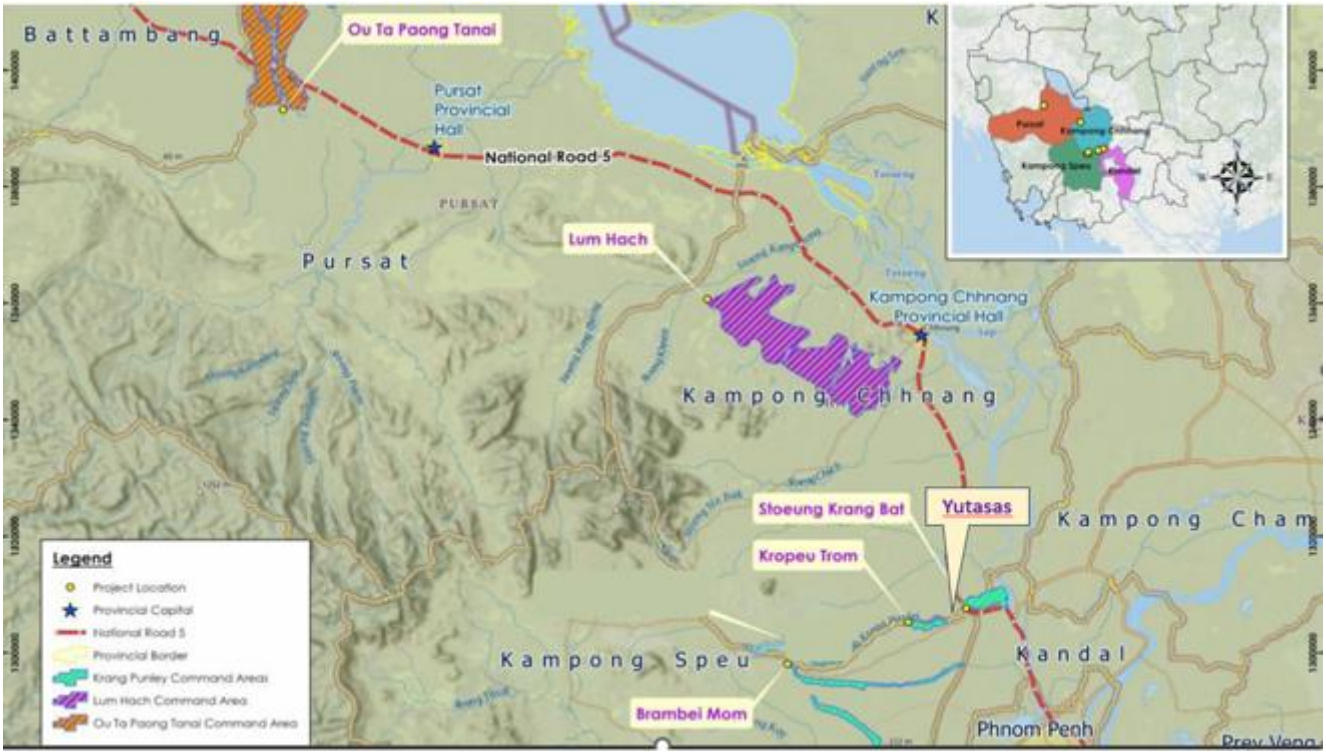

Figure 1 – Locations of six irrigation sub-schemes located in four provinces

The project will be implemented through various activities organized under the following three components:

Component 1. ***Improving farm-level climate adaptation, resilience, and water use efficiency***

The objective of this component is to build climate resilience (CR) of smallholder farmers and enhance sustainable production through evidence-based planning and context-relevant climate resilient practices at the farm level. This component is designed to address the lack of knowledge and skills to deploy technologies and practices at farm level by farmers and the lack of appropriate extension services to propagate them. It will introduce farmers with various climate resilient technologies and practices for both rice and non-rice activities such as vegetable production, poultry and aquaculture.

Sub-component 1.1 Deployment of farm-level climate adaptation and water use efficiency measures

Output 1.1: Increased capacity of farmers to deploy climate resilient (CR) practices at farm level

This output will focus on developing farmer's capacity in deploying CR technologies and practices to transform the agricultural production system to adapt to the changing climate context. Farmer's will be trained to first develop Action Plans (AP) to re-orient farmer behaviour and assist them in transforming the agriculture production system in a manner that is better adapted to factoring in the agro-ecological context and expected climate change impacts.

- Activity 1.1.1 Preparation of community-based action plans (AP) to transform agriculture with CR practices.
- Activity 1.1.2 Preparation of training materials to support implementation of the AP.
- Activity 1.1.3 Conduct trainings to create a pool of expertise to demonstrate and propagate the CR technologies and practices.
- Activity 1.1.4 Train farmers on applying CR technologies using the FFS approach.
- Activity 1.1.5 Strengthening and fostering tailored mechanization service providers for improved mechanization service delivery.
- Activity 1.1.6 community-based monitoring and evaluation (CBME) of implementation

Sub-Component 1.2 Climate adapted, value added, and market-led agricultural investments

Output 1.2 CR value added, and market led agriculture investments secured.

This output involves improving and enhancing some value chains that are key for the project area and include rice, vegetable, chicken and aquaculture value chains, through the use of Public Private Producer Partnerships (4Ps) and increased access to finance, which will improve market access, climate adaptability, and ensure increased income for smallholders in the value chains.

- Activity 1.2.1 Value chain study and planning
- Activity 1.2.2 Establish District Multi-Stakeholder Platforms (MSPs)
- Activity 1.2.3 Public Private Producer Partnership Facility (4PF)

Sub-component 1.3 Improve enabling conditions, capacities and disaster risk management strategies

Output 1.3. Increased access to and use of climate information and advisory services for climate responsive agriculture planning

This sub-component will strengthen the production and dissemination of tailored agro-meteorological information to inform climate responsive management and planning of agriculture in the project target areas through ICT technologies. The aim is to ensure that agro-meteorological services are accessible and useful to farmers to manage climate risks, access to and use of water and efficient cropping systems.

- Activity 1.3.1 Establish ICT based multi-disciplinary platform at provincial level.
- Activity 1.3.2 Building the capacities of the platform to deliver services.
- Activity 1.3.3. Establish the agromet information systems and the outreach mechanisms.
- Activity 1.3.4 Awareness raising and capacity building of farmers and stakeholders in applying the *services.*

Sub-component 1.4 Rural roads

Output 1.4: Increased resilience of farm road infrastructure to climate change

- Activity 1.4.1 Initial planning and identification
- Activity 1.4.1 Initial planning and identification

- Activity 1.4.2 Technical survey and design considerations, preparation of cost estimation
- Activity 1.4.3 Improve 50 Kilometers of farm roads.
- Activity 1.4.4 Handing over of the completed works.

Component 2: Irrigation Infrastructure for increased resilience

Component 2 is linked with Component 1 such that it facilitates the implementation of CR on farm crop and water management practices through improved field level water supply delivery and drainage. It will focus on rehabilitating and modernizing of irrigation and flood protection/drainage infrastructure in the six sub-projects, including irrigation and drainage canals, flood control embankments, and ponds, to provide high-efficiency climate-resilient irrigated agriculture systems for adapting to both increasing flood and drought conditions.

Sub-Component 2.1: Modernization of irrigation scheme and ponds

Sub-Component 2.2: Flood-proofing and Drainage improvements

Sub-Component 2.3: Establishments and training of Farmers Water User Communities (FWUC)

- Activity 2.3.1 Formation of institutional strengthening of the FWUC
- Activity 2.3.2 Build technical capacities of FWCU for canal structure O&M
- Activity 2.3.3 prepare long term financing plan for O&M of the systems including the WUAS.

Sub-Component 2.4: Water information and Management (SCADA)

Component 3. Institutional Strengthening

Sub-Component 3.1 MOWRAM capacity Support.

Output 3.1 Strengthened MOWRAM Capacity

Sub-Component 3.2 Strengthening of NDA and NCDD.

Output 3.2 Improved capacities for climate action monitoring

- Activity 3.2.1 Preparation of Loss and Damage Strategy
- Activity 3.2.2 Strengthen national M&E process for climate action
- Activity 3.2.3 Enhancing Capacity of NDA and other stakeholders.

1.3 Environmental Risks and Impacts

Renovation of irrigation systems within the Tonle Sap Floodplains could have significant environmental consequences. Altering water flow patterns can disrupt the delicate ecological balance of the floodplain, affecting fish migration, breeding, and spawning. Increased water extraction for irrigation may lower water levels, impacting aquatic ecosystems and wetland habitats. Additionally, the use of chemical fertilizers and pesticides in agriculture can contaminate water bodies, harming biodiversity. Furthermore, construction activities associated with the renovation can lead to soil erosion, sedimentation, and habitat destruction for both aquatic and terrestrial species.

1.4 Social Risks and Impacts

The social implications of renovating irrigation systems in the Tonle Sap Floodplains are complex. While the project aims to improve agricultural productivity, it may also lead to land-use changes and displacement of local communities. Small-scale farmers may face challenges in accessing and competing for water resources, potentially exacerbating socioeconomic inequalities. Moreover, the introduction of new technologies and farming practices may require additional training and support for local communities, which could create new demands on

existing resources. Conflict over water rights and access may arise, impacting social cohesion and livelihoods.

2 Objective of the Biodiversity Assessment

Based on a comprehensive biodiversity screening conducted by the E&S screening team, in conjunction with consultations with the ESCIA team, twenty-four potentially present endangered (EN) and critically endangered (CR) species were identified within the project's area of influence. To validate this initial assessment and identify additional species, a thorough literature review was conducted and consultations were held with key government agencies and civil society organizations, including the Fisheries Administration (FiA), Wildlife Conservation Society (WCS Cambodia), and Punleu Komar Organization (PKO). These organizations specialize in the protection of endangered and critically endangered species, empowring community-based organization in protected natural resources, and possess valuable knowledge of their distribution within the project's region.

As part of the biodiversity assessment, the following key activities were undertaken:

1. **Species Presence Confirmation:** Consultation-based assessments were conducted to determine the likelihood of occurrence for the identified 25 species within the area of influence of the 6 sub-schemes.
2. **Critical Habitat Assessment:** The critical habitat status of each species was established, and a baseline was created to monitor changes over time.
3. **Critical Habitat Feature Identification:** Key habitat features relevant to the project were identified to assess potential impacts.
4. **Adverse Impact Assessment:** A high-level assessment was conducted to evaluate whether proposed project activities could negatively affect these species. This assessment was crucial for determining the necessity of implementing net gain measures and their feasibility.
5. **Mitigation Measure Development:** A Biodiversity Action Plan (BAP) was developed, outlining specific mitigation measures to address potential impacts on endangered and critically endangered species.

A comprehensive biodiversity assessment, utilizing the Integrated Biodiversity Assessment Tool (IBAT) and a thorough literature review, identified a total of 25 endangered and critically endangered species across reptiles, mammals, birds, fish, amphibians, plants, and fungi. Sixteen of these species were concentrated in the Ou Tapong (OT) sub-scheme, while five were screened in Lum Hach (LC), two in Prambei Mom (BM) and Krapeu Truom (KT), and five in Yutasas (YT) and Stung Krang Bat (SKB), see Table 1.

Table 1: Second screening list of Endangered and Critically Endangered Birds, Mammals, Reptile and Fishes

No.	Local Name	English Name	Scientific Name	IUCN Category	OTP	LH	CL[(1)]	BM	KT	Yotasas	SKB
I.	**Reptile spices**										
1	អណ្តើកឆ្អឹង	Elongated Tortoise	Indotestudo elongata	CR						Yes	

(1). Chheang Laeung (CL) has been excluded from the project concept design.

2	កន្ធាយក្បាលកង្កែប	Asian giant softshell turtle	Pelochelys cantorii	CR			Yes				
3	អណ្តើកកន្ទុក	Black Marsh Turtle	Siebenrockiella crassicollis	EN	Yes		Yes	Yes			Yes
4	អណ្តើកទឹកសាម	Giant Asian Pond Turtle	Heosemys grandis	CR	Yes						
5	អណ្តើកបិទមុខ	Southeast Asian Box Turtle	Cuora amboinensis	EN	Yes						Yes
II.	Mammal species										
6	ឆោងមច្រមុះ	Hairy-nosed Otter	Lutra sumatrana	EN	Yes						
7	ស្វាព្រាម	Indochinese Silvered Langur	Trachypithecus germaini	EN	Yes						
8	ស្វាក្តាម	Long-tailed Macaque	Macaca fascicularis	EN	Yes						
9	ឆ្កែព្រៃ	Dhole	Cuon alpinus	EN		Yes					
10	ប្រឹងធំ	Large Flying-fox	Pteropus vampyrus	EN		Yes					
III.	Fish species										
11	ត្រីត្រសក់ក្រហម	Jullien's Golden Carp	Probarbus jullieni	CR					Yes	Yes	
12	ត្រីចង្វាស្តើង	Leaping barb/Flying Minnow	Laubuka caeruleostigmata	EN					Yes	Yes	
13	ត្រីប្រាធំ	Striped catfish	Pangasianodon hypophthalmus	EN	Yes			Yes			Yes
14	ត្រីគាហា /ត្រីគុលាង	Mekong giant barb/Giant Carp	Catlocarpio siamensis	CR						Yes	Yes
15	ត្រីកន្ត្រៃប៉ាខ្លា	Siamese Tiger Perch	Datnioides pulcher	CR	Yes	Yes					Yes
IV.	Bird species										
16	ត្រយង់ធំ	Greater Adjutant	Leptoptilos dubius	EN	Yes						
17	រនៀលស	Milky Stork	Mycteria cinerea	EN	Yes						
18	ចាបក្រវែង	Yellow-breasted Bunting	Emberiza aureola	CR	Yes		Yes				
19	ខ្សឹប ឬ ទ្រមាក់អណ្តើក	Bengal Florican	Houbaropsis bengalensis	CR	Yes						
20	ក្ងោក	Green Peafowl	Pavo muticus	EN		Yes					

21	ពពួលទឹក	Masked Finfoot	Heliopais personatus	CR	Yes						
22	ទាព្រៃស្លាបស	White-winged Duck	Asarcornis scutulata	EN	Yes					Yes	
V.	Fungi, amphibians, and aquatic plants										
23	ផ្សិតស័ក	Puffball mushrooms	Calostoma insigne	EN		Yes					
24	កញ្ជាល់ចេកភ្នំក្រាញ	Cardamon Shrub Frog	Philautus cardamonus	EN	Yes						
25	ស្មៅស្ទឹង / ទន្លេ	River-weed	Terniopsis chanthaburiensis	EN	Yes						

The Southern Tonle Sap Floodplain (STSF), a critical component of Cambodia's biodiversity and socio-economic landscape, is a dynamic wetland ecosystem characterized by seasonal inundation. This intricate interplay of water and land supports a diverse array of flora and fauna (fish, bird, mammal, reptile, fungi, plant), contributing to significant agricultural production. However, the region faces increasing threats from development, climate change, and overexploitation.

The STSF's watershed, encompassing portions of Pursat, Kampong Chhnang, Kandal, and Kampong Speu provinces, is a complex hydrological system influenced by the Tonle Sap River, Mekong River, and their tributaries. This intricate network regulates water flow, nutrient transport, and seasonal fluctuations in water levels. The STSF catchment area, comprising diverse land cover types, directly influences water quality and quantity entering the floodplain. Factors such as topography, soil type, and land use practices within the catchment significantly impact sedimentation, nutrient loading, and overall water quality (Chua et al. 2022).

The interconnectedness of the watershed and catchment is essential for the ecological health of the STSF. The flow of water from the catchment into the floodplain through the river system drives various ecological processes. However, human activities such as deforestation, agriculture, and urbanization within the watershed and catchment pose significant threats to the STSF's biodiversity and ecosystem services. To ensure the long-term sustainability of the STSF, it is imperative to implement sustainable land use practices, prioritize forest conservation, and effectively manage water resources. These measures will help mitigate the impacts of human activities and protect the ecological integrity of this vital ecosystem (MoE; TSA).

3 Methodology

3.1 Literature review

The literature review was conducted for this assessment at the national, regional, and sub-scheme levels. The national level review aims to obtain an overall picture of the legal frameworks that govern biodiversity management and conservation in the country, and the current status of biodiversity, management and conservation. The review at the regional level looks at the status quo on biodiversity and management at the Tonle Sap Floodplain because the project area is located upstream of the Tonle Sap Lake. At sub-scheme level, based on IBAT and eBird data (where relevant), the review focuses on species that fall under the IUCN category as Endangered (EN) and Critically Endangered (CN) and assesses its potential impact due to CAISAR’s project

activities, and relevant projects that contribute to the cumulative impacts on biodiversity of the project's area of influence in the long run.

This comprehensive review illuminates the precarious state of Cambodia's critically endangered species. It underscores the multifaceted threats these taxa face, including habitat degradation, illegal hunting, pollution, and other anthropogenic pressures. The diversity of taxa represented, spanning animals, birds, fish, plants, and fungi, highlights the intricate tapestry of Cambodia's ecosystems.

Cambodia's biodiversity is under siege, with numerous species teetering on the brink of extinction. This summary focuses on some of the most vulnerable taxa, many of which are critically endangered with dwindling populations. The urgency of conservation measures cannot be overstated. To safeguard these species and their habitats, Cambodia must prioritize the establishment of protected areas, rigorous enforcement of wildlife laws, promotion of sustainable practices, and comprehensive research to elucidate their ecological roles. Below are the key summary of each species' accounts:

1. **The Elongated Tortoise (*Indotestudo elongata*)** is a critically endangered species facing severe population decline throughout its Southeast Asian range, including Cambodia (ASAP. 2023). Primarily threatened by overharvesting for food and traditional medicine, as well as habitat loss due to deforestation and agricultural expansion, this tortoise inhabits a variety of forest types, playing a crucial ecological role as a seed disperser.

   In Cambodia, it is particularly vulnerable in the Eastern Plains Landscape, where it is subject to intense poaching pressure. Despite being protected by national and international laws, effective enforcement remains a challenge. Conservation efforts in Cambodia focus on anti-poaching patrols, community engagement, and captive breeding programs to bolster wild populations (IUCN Red List. 2019).

2. **The critically endangered Black Marsh Turtle** (***Siebenrockiella crassicollis***) is native to Southeast Asia, including Cambodia. Habitat loss, pollution, and illegal trade have led to a significant decline in its population. These turtles live in slow-moving or stagnant water bodies with abundant vegetation, playing a crucial role in wetland ecosystems as omnivores. Urgent conservation efforts are needed to protect the remaining populations and restore their critical habitats.

   The distribution of the Black Marsh Turtle extends from Southeast Asian countries like Cambodia to others such as Thailand, Vietnam, Laos, and Malaysia. In Cambodia specifically, habitat loss and overexploitation for the pet trade have caused a decline in their numbers. They are usually found in freshwater habitats with dense vegetation where they can find food and refuge. Conservation efforts are underway to establish protected areas and community-based initiatives aimed at safeguarding their remaining habitats from human activities (IUCN. 2023).

3. **The Giant Asian Pond Turtle** (***Heosemys grandis***) is a Crititally Endangered turtle species found in Southeast Asia, including Cambodia. It inhabits slow-moving rivers, streams, marshes, and rice paddies, particularly in areas with abundant aquatic vegetation. This omnivorous species plays a crucial role in maintaining wetland ecosystems by controlling aquatic vegetation and serving as prey for larger predators (Cota 2021).

   In Cambodia, the Giant Asian Pond Turtle historically relied on the Tonle Sap Lake and

its associated wetlands as important habitats. However, rapid development and overharvesting have led to significant population declines. Habitat loss due to infrastructure development, water pollution from human activities and agriculture runoff, as well as overexploitation for meat consumption and the pet trade are major threats to this species (McLeod 2011).

Conservation efforts are urgently needed to protect remaining populations of the Giant Asian Pond Turtle in Cambodia and restore their critical habitats. These efforts may include habitat restoration projects, enforcement of wildlife protection laws against illegal trade practices, community engagement initiatives to raise awareness about conservation issues related to this species, and collaboration with local communities for sustainable management of wetland ecosystems (Platt and Lee 2017).

4. **The Southeast Asian Box Turtle (*Cuora amboinensis*)** is a freshwater turtle species found in Southeast Asia, including Cambodia. It is characterized by its distinctive box-like shell and ability to retract its head and limbs completely inside its shell for protection. This omnivorous species inhabits various aquatic habitats such as rivers, streams, swamps, and rice paddies (Cota et al. 2020). In Cambodia, the Southeast Asian Box Turtle can be found in different regions across the country, particularly in lowland areas with abundant water sources and vegetation. It plays an important ecological role by feeding on various plants, insects, small vertebrates, and carrion (Hendrie et al. 2018).

   However, like many other turtle species in the region, the Southeast Asian Box Turtle faces numerous threats to its survival. Habitat loss due to deforestation and conversion of wetlands for agriculture are major concerns. Additionally, overharvesting for traditional medicine practices and the pet trade pose significant threats to wild populations (Platt 2008). Conservation efforts are necessary to protect this species in Cambodia. These efforts may include habitat restoration projects aimed at preserving suitable habitats for nesting and feeding purposes. Strengthening legislation against illegal wildlife trade is also crucial for combating the illegal collection of these turtles from their natural habitats.

5. **The Hairy-nosed Otter** (***Lutra sumatrana***) is a rare and elusive species found in Southeast Asia, including Cambodia. With its population size decreasing due to habitat destruction and hunting, it is now considered critically endangered. The otter thrives in freshwater wetlands, particularly in mangrove swamps and riverine habitats, making it especially vulnerable to human encroachment and pollution (Khmer Times. 2023). Ecologically significant, the otters play a crucial role in maintaining the health of their ecosystems by controlling fish populations and influencing aquatic food webs.

   In Cambodia, specific conservation efforts are underway to protect the remaining habitats of the Hairy-nosed Otter through collaborations with local communities and government agencies aiming to monitor their populations and mitigate threats such as habitat degradation and illegal hunting (Heng, et al. 2016).

6. **The Indochinese Silvered Langur (*Trachypithecus germaini*)** is a critically endangered primate species found in Cambodia. It has a limited distribution range, primarily confined to the flooded forest around the Tonle Sap Floodplain and the northeastern region of the country, including Virachey National Park and Mondulkiri Protected Forest. The population size is estimated to be less than 1,000 individuals and declining due to habitat loss and hunting pressures. The langurs inhabit semi-evergreen forests, deciduous

dipterocarp forests, and mixed evergreen forest types. They play an important ecological role as seed dispersers for various plant species within their habitat.

Threats to their survival include deforestation for agriculture, logging activities, infrastructure development, and illegal hunting for traditional medicine or pet trade purposes. Conservation measures include protected area management, community-based conservation initiatives such as wildlife monitoring patrols in collaboration with local communities, and awareness campaigns about the importance of protecting this species among stakeholders and local communities alike (Nijman et al., 2009; Gray et al., 2018; WWF Cambodia).

7. **The Crab-eating Macaque or Long-tailed Macaque (*Macaca fascicularis*)** is classified as Endangered by the IUCN, though this categorization is increasingly debated due to rapid population declines in many areas. Widely distributed across Southeast Asia, including Cambodia, this adaptable primate inhabits a diverse range of habitats from rainforests to urban areas (Hansen 2022). As omnivores, they play a crucial role in seed dispersal and ecosystem balance. In Cambodia, they are prevalent in both rural and urban environments.

   However, the species faces significant threats, including habitat loss, illegal trade for the pet and research industries, and human-wildlife conflict. Overexploitation for these purposes has led to population declines, particularly in areas with high human population density (Timmins, Duckworth and Hedges. 202). Despite its current conservation status, urgent measures are needed to protect remaining populations and prevent further declines. While it has a wide distribution, its population has declined significantly in many areas due to habitat loss, hunting, and the pet trade. This decline warrants a more serious conservation status.

8. **The Dhole (*Cuon alpinus*)**, also known as the Asiatic Wild Dog, is a critically endangered canid species with a historically wide range across Asia. While once prevalent, its population has dramatically declined due to habitat loss, fragmentation, human-wildlife conflict, and disease. As an apex predator, the dhole plays a crucial role in maintaining ecosystem balance by controlling prey populations. Their pack-hunting behavior is highly specialized, making them efficient predators. In Cambodia, information on dhole populations is limited, but the species is believed to be rare and possibly extinct.

   The country's rapid deforestation and development have significantly reduced suitable habitat for this elusive carnivore. Protecting remaining forest areas and implementing effective anti-poaching measures are crucial for any potential dhole conservation efforts in Cambodia (Hearn et al. 2016).

9. **The Large Flying-fox (*Pteropus vampyrus*)** is a critically endangered megabat species with a declining population. Once widely distributed across Southeast Asia, including Cambodia, it now faces significant threats due to habitat loss, hunting, and human disturbance. IUCN SSC Asia Bat Specialist Group. 2022, these large bats play a crucial role in seed dispersal, pollination, and ecosystem balance.

   In Cambodia, they are considered keystone species for maintaining forest health. However, deforestation, conversion of forests to agricultural land, and illegal hunting have led to dramatic population declines. Urgent conservation efforts are essential to prevent the extinction of this iconic species and restore its critical habitat.

10. **The Jullien's Golden Carp (*Probarbus jullieni*)** is a critically endangered freshwater fish endemic to the Mekong River basin (Ahmad 2019). Once a dominant species, it has experienced a dramatic population decline due to overfishing, habitat loss, and dam construction. As a large migratory fish, it requires free-flowing rivers with deep pools and access to floodplain habitats for spawning and feeding. Its ecological role as an apex predator is crucial for maintaining the river ecosystem's balance (Rainboth 1996).

    In Cambodia, historical records indicate high abundance, but current populations are significantly reduced due to unsustainable fishing practices and habitat degradation. Urgent conservation measures, including protected areas, community-based fisheries management, and dam mitigation strategies, are essential to prevent the extinction of this iconic Mekong giant (MRC n.d).

11. **The Leaping Barb (*Laubuka caeruleostigmata*)** is a freshwater fish classified as Endangered on the IUCN Red List. Native to the Mekong and Chao Phraya river basins, including Cambodia, this schooling species inhabits the upper water column of large rivers and associated floodplain habitats. It is currently listed as Endangered on the IUCN Red List due to habitat loss and degradation, pollution, and overfishing. The fish is primarily found in the upper and middle reaches of rivers, as well as flooded forests during the rainy season. As a primary consumer feeding on aquatic insects, the Leaping Barb plays a crucial role in the aquatic food web. It plays an important role in the aquatic ecosystem as a prey species for larger fish and birds (Rainboth 1996).

    The primary threats to the Leaping Barb in Cambodia include dam construction, deforestation, and pollution from agricultural runoff and industrial waste. Conservation efforts are focused on protecting and restoring habitat, reducing pollution, and promoting sustainable fishing practices. However, specific ecological functions and its contribution to Cambodian ecosystems require further investigation. Given its endangered status and knowledge gaps, comprehensive research and conservation efforts are essential to ensure the survival of this species (Vidthayanon, C. 2011, Tang 2020).

12. **The Striped Catfish (*Pangasianodon hypophthalmus*)** is a critically endangered freshwater giant fish endemic to the Mekong River basin. Once a commercially valuable and culturally significant species, overfishing, habitat degradation, and dam construction have led to a dramatic population decline. As a migratory species, the Striped Catfish relies on the Mekong River's free flow for its life cycle, including spawning in the upper reaches and utilizing the floodplain for feeding and growth.

    In Cambodia, a crucial habitat for this species, has witnessed a significant decline in Striped Catfish populations, impacting local livelihoods and the overall ecosystem. Urgent conservation measures, including habitat restoration, sustainable fishing practices, and protected areas, are essential to prevent the extinction of this iconic fish and restore its ecological role in the Mekong ecosystem (Nguyen 2023).

13. **The Mekong Giant Barb** (***Catlocarpio siamensis***), also known as and quot;Trey Kol Raing and quot; in Khmer, is a critically endangered freshwater fish endemic to the Mekong River basin, including Cambodia. Once a revered symbol of the country, its population has plummeted due to overfishing and dam construction. As a migratory species, these colossal fish require unobstructed access to the Mekong’s main channel and floodplain habitats for breeding and feeding. Their ecological role as an apex predator is vital for maintaining river health.

In Cambodia, the Tonle Sap Lake and its connected river systems were once prime habitats for the giant barb; however, decades of exploitation and habitat degradation have pushed this iconic species to the brink of extinction, underscoring the urgent need for comprehensive conservation measures. The population size of giant barbs has dramatically decreased with only a few hundred individuals remaining in their natural habitat—deep flowing rivers with clear water and gravel or sandy bottoms necessary for spawning. Efforts are being made in Cambodia to protect and conserve remaining populations through habitat restoration initiatives aimed at preserving their critical spawning grounds within the Mekong River system while also addressing overfishing concerns.

14. **The Siamese Tigerfish (*Datnioides pulcher*)** is a critically endangered freshwater fish native to Southeast Asia, including Cambodia. Once inhabiting the Mekong, Chao Phraya, and Mae Klong river basins, its population has plummeted due to overfishing, habitat destruction, and dam construction. This apex predator requires large, deep rivers with abundant aquatic vegetation for spawning and feeding. As a top predator, it plays a crucial role in maintaining river ecosystem balance.

    In Cambodia, the Mekong River once supported significant populations, but the species is now extremely rare due to extensive human pressures. Urgent conservation efforts are imperative to prevent its extinction and restore its critical habitat.

15. **The Greater Adjutant (*Leptoptilos dubius*)** is critically endangered, facing a precipitous population decline. Once widespread across South Asia, its range has contracted dramatically, with Cambodia representing a crucial stronghold for the species. Its population in Cambodia is small and fragmented, primarily concentrated in the Tonle Sap Lake and surrounding areas (MoE 2016).

    These colossal birds inhabit wetlands, grasslands, and agricultural areas, relying on fish, reptiles, amphibians, and carrion for sustenance. As apex predators, they play a vital role in maintaining ecosystem balance. However, habitat loss, pollution, and human disturbance pose significant threats to their survival. Conservation efforts are urgently needed to protect these iconic birds and their fragile ecosystem (BirdLife International. 2023).

16. **The Milky Stork (*Mycteria cinerea*)** is a critically endangered large waterbird endemic to Southeast Asia. Its population has dramatically declined due to extensive habitat loss, particularly the destruction of mangrove forests (BirdLife International, 2020). As a keystone species, the Milky Stork plays a crucial role in wetland ecosystems by regulating fish populations.

    In Cambodia, this species is considered very rare, with most individuals concentrated in the Prek Toal colony. While the global population is estimated at less than 1,500 mature individuals, the exact population size within Cambodia remains uncertain. Urgent conservation efforts are imperative to protect the remaining habitat and prevent the extinction of this iconic bird (Noor 2020).

17. **The Yellow-breasted Bunting (*Emberiza aureola*)** has undergone a dramatic population decline, leading to its critical endangerment status according to the IUCN Red List. Once abundant across the Boreal and East Palearctic, this migratory bird relies on a specific set of habitats, including boreal forests for breeding and agricultural landscapes, particularly rice fields, during winter (BirdLife International. 2023).

Cambodia, as a crucial wintering ground, plays a vital role in the species' survival. However, the bunting's ecological significance, as a seed disperser and prey for predators, is increasingly threatened by habitat loss, illegal trapping, and climate change. Comprehensive conservation efforts are urgently needed to protect this species and its critical habitats, both in its breeding and wintering grounds (CMS Secretariat. 2017).

18. **The Bengal Florican (*Houbaropsis bengalensis*)** is a critically endangered bird species facing a catastrophic population decline. Once found across a broader range in Southeast Asia, it now has a highly restricted distribution, primarily confined to Cambodia and India (BirdLife International. 2023). This elusive species inhabits tall grasslands, particularly those associated with seasonally flooded plains, where it performs elaborate courtship displays. As an apex predator in its ecosystem, the Bengal Florican plays a crucial role in maintaining grassland biodiversity (Harris 2009).

    However, large-scale habitat loss due to agricultural expansion and infrastructure development, coupled with illegal hunting and climate change, has driven this species to the brink of extinction. Cambodia, once a stronghold for the Bengal Florican, now harbors a significantly reduced population, estimated to be as low as 250 individuals. Urgent conservation efforts, including habitat protection, anti-poaching measures, and community engagement, are imperative to prevent the extinction of this iconic bird (Mahood 2019; WCS Cambodia, n.d).

19. **The Green Peafowl (*Pavo muticus*)** is listed as Endangered on the IUCN Red List. In Cambodia, it is primarily found in the northeastern forests, particularly in the Mondolkiri province, which is home to the largest global population (BirdLife International. 2016). These birds inhabit evergreen forests near permanent water sources. They play a crucial ecological role as seed dispersers and prey for predators (Zheng 2015). In Cambodia, the species is primarily found in protected areas, but its population remains small and fragmented. The Eastern Plains landscape on the Cambodia-Vietnam border is considered a stronghold for the species.

    The primary threats to green peafowl in Cambodia are habitat loss due to deforestation, hunting for their meat and feathers, and illegal trade. Conservation efforts include habitat protection, anti-poaching measures, community-based conservation programs, and captive breeding initiatives. However, the species remains at risk due to ongoing threats. (Loveridge et al., 2017, McGowan 2028). Conservation efforts, including habitat protection, anti-poaching measures, and community engagement, are crucial to prevent the extinction of this iconic bird.

20. **The Masked Finfoot (*Heliopais personatus*)** is a globally endangered species found in Cambodia, among other countries in Southeast Asia. It inhabits slow-flowing rivers, creeks, and ponds in lowland forests and mangroves. Due to its secretive nature and limited distribution, population estimates are difficult to obtain, but it is believed to be rare in Cambodia.

    The primary threats to the species include habitat loss and degradation, particularly deforestation and pollution of water bodies. Conservation efforts in Cambodia focus on habitat protection, community engagement, and research to better understand the species' ecology and distribution. Despite these efforts, the Masked Finfoot remains at risk of extinction in the country (Tonle Sap Biosphere Reserve 2020, and Department of Forestry and Wildlife 2020).

21. **The White-winged Duck (*Asarcornis scutulata*)** is a critically endangered waterfowl endemic to Southeast Asia. With a population estimated at less than 250 mature individuals, this species faces a severe threat of extinction. Its distribution is limited to fragmented lowland forests in countries like India, Myanmar, Thailand, Cambodia, and Indonesia.

    The White-winged Duck is highly dependent on undisturbed, old-growth forests with access to small, permanent bodies of water. It plays a crucial ecological role as a seed disperser and predator of invertebrates. In Cambodia, the species is considered rare and faces ongoing threats from habitat loss due to deforestation and agricultural expansion. Conservation efforts are urgently needed to protect remaining populations and restore suitable habitats for this unique and vulnerable bird (*BirdLife International. 2023)*.

22. ***Calostoma insigne*** is a critically endangered puffball mushroom endemic to Southeast Asia. While specific population data is limited, its distribution is primarily restricted to undisturbed rainforests, making it highly vulnerable to habitat loss. Deforestation and conversion of forests into agricultural land, particularly for palm oil plantations, have significantly reduced its populations. As a mycorrhizal fungus, Calostoma insigne plays a crucial role in forest ecosystem health by forming symbiotic relationships with plant roots. Beyond its ecological importance, this species holds potential as a source of natural antioxidants and anticancer compounds, highlighting its value as a genetic resource (Deloya-Olvera 2023).

    However, its specific ecological functions in Cambodia are still understudied. The primary threats to C. insigne in Cambodia are habitat loss due to deforestation, over-collection for medicinal and culinary purposes, and climate change. Conservation efforts for this species are limited and primarily focus on raising awareness about its importance and protecting its habitat. Conservation efforts focused on protecting remaining rainforest habitats and exploring cultivation techniques are essential to prevent the extinction of this unique and potentially beneficial fungus (Ngadin 2019; Global Fungal Red List Initiative).

23. **The Cardamom Shrub Frog (*Philautus cardamonus*)** is a critically endangered amphibian endemic to the Cardamom Mountains of Cambodia. Restricted to a limited range at high elevations (1000-1700 meters), this small, brown frog is exclusively found in primary evergreen forests. Its population size is unknown, but rapid deforestation and habitat degradation in the region pose severe threats to its survival. IUCN SSC Amphibian Specialist Group 2016, As an inhabitant of the upper montane ecosystem, it likely plays an important role in the forest's intricate food web, although specific ecological functions remain to be studied. Given its restricted distribution and the precarious state of its habitat, urgent conservation measures are essential to prevent its extinction.

    So, there's this little frog called the Cardamon Shrub Frog that lives in Cambodia. It's really small, like, smaller than your pinky finger. It's got a cool brown and tan color and likes to hang out in the forests. But here's the problem: it's in big trouble. People are cutting down all the trees where it lives, and there's not much left for it to call home. If we don't do something to protect the forests, this little frog might disappear forever. Luckily, some people are working hard to save it. They're trying to stop people from cutting down trees illegally and setting aside special areas where the frogs can live safely.

It's a tough fight, but if we all work together, we can help this tiny frog survive (Ohler 2002).

24. ***Terniopsis chanthaburiensis*** is a critically endangered flowering plant endemic to Southeast Asia, specifically southeastern Thailand and southern Laos (Suddee 2019). Despite its limited distribution, recent findings suggest a potential wider range within these countries. As a terrestrial or lithophytic species, it thrives in wet tropical environments (Juffe Bignoli 2011; Tang 2020). However, specific habitat requirements and population size remain largely unknown due to limited research. The plant's ecological role is yet to be fully understood, but its endangered status underscores the potential significance of its contribution to the ecosystem.

    Terniopsis chanthaburiensis is a submerged aquatic plant native to Southeast Asia (. However, based on general knowledge of aquatic plants, its distribution is likely limited to specific rivers or streams with fast-flowing currents and rocky substrates. As an aquatic plant, it plays a vital ecological role in providing habitat and food for aquatic organisms. Threats to this species include habitat loss due to pollution, deforestation, and dam construction, as well as changes in water quality caused by human activities. Conservation efforts would likely involve protecting and restoring aquatic habitats, monitoring water quality, and raising awareness about the importance of this species and its ecosystem.

3.2 Field Assessment

Area of Influence. The potential area of influence of the sub-scheme is estimated based on a) the project target's command area (within which most project activities will take place), b) environmental footprints that would potentially caused by project activities such as the rehabilitation of canals (during project construction) and intensified crop production (during project operation). The area of influence is subject to update when more information becomes available to allow reliable assessment. This information may include a detailed E&S assessment of project impact when a) locations of the construction site, its auxiliaries, and logistic operation is confirmed, b) the extent of the project's impacts (indirect, indirect, and cumulative) are firmed up based on the final target of development outcomes (e.g. total cultivation areas subject to crop intensification). It is noted that while direct and indirect impacts are reasonably foreseen – based on prior experience, cumulative impacts, particularly their spatial extent and severity level, need to be supported by scientific evidence which may be gathered appropriately considering the locations and time when data are collected to reconfirm the impact level.

Field works. Based on the potential area of influence estimated based on proposed activities at the sub-scheme level, two field surveys were conducted for the six sub-schmes during July 25-27 and August 3-9, 2024 (which is the wet season). Prior to fieldwork, GIS-based habitat modelling was conducted to identify key hotspots for each of the six sub-schemes. This aims to facilitate the prioritization of locations that should be subject to field observation and data collection. Key hotspots were also screened based on the potential area of influence initially identified as part of the E&S screening exercise that was conducted for each sub-scheme[2]. Apart from a focus on the potential area of influence, an attempt has been made to visit the potentially vulnerable areas that

[2] Potential area of influence is defined by the respective command areas (which include cultivation area, its supporting utilities such as farm road, technical facilities, and houses…) and areas located adjacent to the above command area that may include paddy fields, natural areas such as forest, pasture, and roads that are potentially used by project's construction contractors in connection with construction material supply site, borrow pits, disposal site, and so forth.

are located beyond but adjacent to the potential AoI, particularly areas that are vulnerable to potential environmental impact due to environmental footprints (e.g. spreading of pesticide residues) that need sound evidence to support the extent of impact – as cumulative impacts.

Techniques used. Field observation was carried out using drone[3] and transect walks. A drone is particularly used for the areas that are difficult to conduct a transect walk and areas that need a broad aerial view at the boundary between the estimated AoI and beyond. Consultations were conducted with representatives of local authorities and community-based organizations to supplement and validate field observations, particularly information on the potential presence of species that have been screened and identified for the AoI. In the sub-schemes where hotspots such as community forests and community fisheries are found (either inside and outside the area of influence, or both, like the cases of Ou Ta Paoing and Lum Hach), local organizations that manage such community forests and community fisheries hotspots were consulted to gather local ecological knowledge and experience, particularly the historical background about the population change of a particular species in relation to human activities (e.g. related to farming and other income generation activities such as hunting for food, and for trading).

Consulation techniques. Key informant interviews and focus group discussions were used for consulting local people. Consultation with local people, particularly those relevant, helped verify the presence and likelihood of occurrence of the species already identified as well as their habitat locations. The assessment adopts the International Finance Corporation's Performance Standard 6 (PS6) and its associated Guidance Note (GN) as a comprehensive framework for identifying and evaluating critical habitat (CH). Characterized by its irreplaceability and vulnerability, CH is essential for preserving biodiversity and ecological integrity. The three-step process outlined in PS6 and GN6 involves identifying CH through specific criteria, assessing its irreplaceability and vulnerability, and mapping its location. By understanding the distribution of CH, projects can effectively mitigate risks to biodiversity and ensure alignment with environmental sustainability goals.

The assessment was conducted vis-a-vis the environmental and social risks and impacts that were initially identified for each of the six sub-schemes. The assessment, in particular, focuses on the direct, indirect, and cumulative effects of identified E&S risks and impacts. As a result, this process will consider relevant threats to biodiversity and ecosystem services due to a) project activities, and b) activities of relevant projects that constitute the cumulative impact on the identified species, including habitat loss, interference with migratory routes or wildlife movement, degradation and fragmentation, invasive alien species, overexploitation, hydrological changes, nutrient loading, and pollution[(4)]. It will also account for the diverse values attached to biodiversity and ecosystem services upon which affected communities' livelihoods depend.

The six sub-schemes are located to upstream of the Tonle Sap Lake, constituting the Tonle Sap Floodplain which is a complex ecosystem. This ecosystem and its ecosystem services are characterized with unique hydrology, rich biodiversity, vital livelihood support, and irrigated agricultural production which are located upstream of the Tonle Sap. Given the link between the project's command area and ecosystems located downstream of these sub-schemes, this assessment also evaluate the significance of the risks and impacts due to project activities. This

[3] A DJI Mavic 3T, an advanced drone equipped with cutting-edge features, was utilized to gather essential data from key biodiversity hotspots, wildlife habitats, and areas crucial for ecological connectivity and functions. With a remarkable flight range of up to 15 kilometers, the drone's capabilities allowed for comprehensive aerial surveys, even in remote or inaccessible regions.

[(4).] World Bank Performance Standards (OP 4.03), 20220. Environmental and Social Review Summary (ESRS Concept Stage)

assessment would focus more on areas immediately located outside the command area and to downstream.

Based on the potential risks and impacts, an adaptive management approach is proposed. Under this project, due to a lack of reliable information to confirm the extent and severity of potential impact – over a time dimension, mitigation and management measures proposed would be responsive – based on the changing conditions that were known based on monitoring results conducted periodically throughout the project cycles. Where necessary, adjustments can be made to mitigation and management measures. This iterative process aims to ensure the project follows the hierarchy of mitigation that avoids impacts. Where avoidance is not possible, adverse effects on the ecosystem and local communities will be minimized.

3.3 Scope of Work and Key Informant Interviews

Key informants were selected based on their knowledge of local wildlife. Approximately 10-12 individuals were chosen from each sub-scheme and interviewed using a semi-structured and structured questionnaire with visual aids (photos). We employed a multi-faceted approach to elicit reliable information, including using all alternative local names and asking questions about species' ecological niches. This allowed us to assess the informants' depth of knowledge.

3.3.1 Forest resources and wildlife

This comprehensive approach will ensure that both the environmental and economic values of forest resources, ecological functions and biodiversity are well framed for protection and safeguarding throughout the project lifecycle. Below are selective key assessment tools that will be used for this study:

1. **Biodiversity Mapping:** Create comprehensive biodiversity maps by integrating data from field assessments, interviews, and existing maps from various management and administrative entities (CF, Community Fisheries (Cfi), KBA, protected areas).
2. **Species Inclusion Criteria:** Limit the assessment to species sighted within the past 1-5 years to ensure a focus on current and relevant data for developing risk and mitigation strategies. Sighting data older than 5 years is important for predicting future trends based on their habitats and ecological changes.
3. **Community Engagement:** Consult with committee members from Community Forests (CF) and Community Fisheries (CFi) to gather their insights on wildlife presence, movement patterns, and potential impacts of the proposed system on their conservation areas.
4. **Species Data Verification:** Verify all species sightings and information against existing literature to ensure accuracy and reliability.
5. **Detailed Species Assessment:** Conduct in-depth inquiries about confirmed species, focusing on morphological characteristics, behavior, habitat preferences, and reproductive strategies. This will provide valuable data on local ecological knowledge and species distribution for informing conservation efforts.
6. **Critical Habitat Identification:** Identify critical habitats for target species based on field data and biodiversity mapping. Highlight areas of significant influence on biodiversity, endangered (EN) and critically endangered (CR) species, and ecological functions to inform mitigation strategies.

7. **A3-Sized Color Maps:** Create A3-sized color maps for each scheme, containing key information such as administration boundaries, specific location names, and unique landscape features (streams, lakes, river reservoirs). These maps will be used to determine the distribution of endangered and critically endangered species based on information provided by key informants.

3.3.2 Aquatic Biodiversity and Fisheries

This study aims to assess the status of endangered fish species in each sub-scheme. It involved data review, interviews with local fishers and authorities, and field surveys. The information will inform impact assessments, mitigation measures, and conservation efforts.

We adopted a similar assessment approach used for forest resources and wildlife, focusing on experienced fishermen. This comprehensive approach ensures a thorough understanding of aquatic biodiversity and fisheries.

Recognizing the challenges of identifying fish without direct observation, we will enhance our assessment by examining fish migration connectivity, and species ecological niches, and cross-verifying data with relevant government agencies and research institutions. This rigorous approach will strengthen the reliability of our findings and inform effective management strategies.

3.4 Methods used for Critical Habitat Assessment

Critical Habitat. Critical habitats are areas of high biodiversity value that include at least one or more of the five values specified in paragraph 16 of Performance Standard 6 and/or other recognized high biodiversity values. Values that are referred to as “critical habitat criteria” include:

- Criterion 1: Critically Endangered (CR) and/or Endangered (EN) species
- Criterion 2: Endemic or restricted-range species
- Criterion 3: Migratory or congregation species
- Criterion 4: Highly threatened and/or unique ecosystems
- Criterion 5: Key evolutionary processes.

In this assessment, the following thresholds are used for the determination of critical habitat status.

- ***Thresholds for Criterion 1:***
  (a) Areas that support globally important concentrations of an IUCN Red-listed EN or CR species (≥ 0.5% of the global population AND ≥ 5 reproductive unitsGN16 of a CR or EN species.
  (b) Areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in GN72(a).
  (c) As appropriate, areas containing important concentrations of a nationally or regionally listed EN or CR species.

- ***Thresholds for Criterion 2:***
  - The term endemic is defined as restricted-range which refers to a limited extent of occurrence (EOO).

- Areas that regularly hold ≥10% of the global population size AND ≥10 reproductive units of a species.
- For coastal, riverine, and other aquatic species in habitats that do not exceed 200 km width at any point (for example, rivers), the restricted range is defined as having a global range of less than or equal to 500 km linear geographic span (i.e., the distance between occupied locations furthest apart).

- ***Thresholds for Criterion 3:***
  (a) Areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle.
  (b) Areas that predictably support ≥10 percent of the global population of a species during periods of environmental stress.

- ***The thresholds for Criterion 4:***
  (a) Areas representing ≥5% of the global extent of an ecosystem type meet the criteria for IUCN status of CR or EN.
  (b) Other areas not yet assessed by IUCN but determined to be of high priority for conservation by regional or national systematic conservation planning.

Primary and secondary data are required for criterion (1) and (3) to guide the determination about whether a habitat has significant importance for a species. Criterion (4) and (5) need to be assessed on a case-by-case basis. A critical habitat is determined for an area, and a critical habitat Area of Analysis (AoA) needs to be defined for the application of the above criteria. The AoA should be extended beyond the project footprint (area of influence) and should be equivalent to the practical site-based conservation management activities that will be proposed.

The CHA approach adopted involve the following steps:

Step 1 - Generate a List of EN and CN Species, and Restricted Range species.

Criteria (1) and (2) are used based on the IUCN Red List generated using IBAT focusing on EN and CR species. Additional data were collected to supplement, including stakeholder consultation, local knowledge, field observation, secondary data (from previous surveys), and habitat mapping.

Step 2 - Screening based on Likelihood of Occurrence

The list of EN and CR species is screened for the Likelihood of Occurrence (LoO) - based on the ecological state of habitats within the AoA. For this CHA, only species that are confirmed Present, or Possibly Present (based on the result of Step 1) are assessed in Step 3.

Step 3 - Determination of Critical Habitat Status

Reliable data on a species' population size, extent of occurrence, other relevant information and expert opinion are required to assess each species retained after Step 2. The following guidance are used to facilitate the interpretation and analysis of critical habitat.

(i) **Recognized areas of high biodiversity value** (such as legally protected areas, Key Biodiversity Areas (KBAs), Important Bird Areas (IBAs), Ramsar Wetlands of International Importance and Natural World Heritage Sites (WHS).

(ii) CR species face an extremely high risk of extinction and their survival in the wild is in a critical state. As such, **if a surviving population of a CR species is present in the**

critical habitat Area of Analysis, the habitat should be considered to have significant importance for the species under PS 6 Criterion 1.

(iii) **Criteria 4 and 5 are to be assessed on a case-by-case basis** using specialist input and reliable data sources considering the presence of conservation initiatives, legally protected areas and internationally recognized areas of high biodiversity value and the reasons for which they are designated.

(iv) Critically Endangered (CR) species, by definition, face an extremely high risk of extinction and their continued survival in the wild is in a critical state. Thus, **if a surviving population of a CR species is present in the critical habitat AoA, the habitat should be considered to have significant importance for the species** - under paragraph 16, Item (i).

Step 4 - Identify Critical Habitat Features of Relevance to the Project

Based on PS 6 paragraph 18, the project's mitigation strategy will be described in a Biodiversity Action Plan and will be designed to achieve net gains[5] of those biodiversity values for which the critical habitat was designated.

4 Assessment Results

Under this chapter, assessment will be done separately for each of the six sub-schemes under the CAISAR project. The assessment for OTP will be presented first, followed by Lum Hach, Brambei Mon, Krapeau Trom, Yutasass, and Steung Krang Bat. It is noted to ensure the assessment method is consistently applied for each sub-scheme, the presentation of each assessment will be structured around the following sub-sections:

- Proposed project activities in each sub-scheme and potential risks and impacts;
- Area of Influence of the sub-scheme;
- Analysis to prepare for determining Critical Habitat status (Steps 1 & 2);
- Determining Critical Habitat status (Step 3);
- Potential Impacts and Feasibility of net gain requirements (Step 4); and
- Mitigation measures.

4.1 Ou Ta Paong

4.1.1 Proposed project activities and potential risks and impacts

Avian species such as the Greater Adjutant, Milky Stork, and Bengal Florican have been documented in the lower section. These birds rely on seasonal wetlands, lakes, waterholes, grasslands, and rice fields for foraging. Additionally, the critically endangered Siamese Tiger Perch and Black Mash Turtle inhabit Boeung Kamsaeng Lake and Svay Daunkav River, respectively, in the upper portion of the command area.

The flooded forest habitat and natural lakes adjacent to the lower section support a diverse array of wildlife, including four critically endangered reptile species: the Black Mash Turtle, Southeast Asian Box Turtle, Giant Asian Pond Turtle, and Elongated Tortoise. These species play crucial

[5] PS 6, Footnote 15 writes "Net gains are additional conservation outcomes that can be achieved for the biodiversity values for which the critical habitat was designated. Net gains may be achieved through the development of a biodiversity offset and/or, in instances where the client could meet the requirements of paragraph 17 of this Performance Standard without a biodiversity offset, the client should achieve net gains through the implementation of programs that could be implemented in situ (on-the-ground) to enhance habitat, and protect and conserve biodiversity."

roles in the ecosystem, contributing to nutrient cycling, seed dispersal, and maintaining ecological balance. Furthermore, the region is home to two critically endangered mammal species: the Indochinese Silvered Langur and Long-tailed Macaque. These primates are essential for forest regeneration and seed dispersal, helping to maintain the health and resilience of the forest ecosystem. This area, particularly its lower section, serves as a critical habitat for a diverse array of endangered and critically endangered species.

Given the significant ecological value of the Ou Tapaong Command Area, any irrigation system renovations must be carried out with utmost care to minimize negative impacts on biodiversity. This may involve implementing measures such as habitat restoration, creating wildlife corridors, and ensuring that water management practices are sustainable and supportive of biodiversity. By carefully considering the ecological implications of the project, it is possible to balance the needs of agriculture with the conservation of endangered species and their habitats. Under OTP, various activities will be carried out that cause the following E&S risks and impacts:

Table 2: Projection activities that may cause potential impacts on the environment and social aspects at Ou Tapaong sub-scheme

No.	Project activities that cause impacts	E&S Risks & Impacts
1	Construction activities (rehabilication of canal and farm roads), land use changes, and water management practices	**Habitat loss and fragmentation** could lead to habitat loss and fragmentation, affecting species' survival and connectivity. This activity may involve dredging, excavation, or modification of existing water channels and infrastructure. These activities can lead to habitat destruction, disturbance to nesting and foraging sites, disruption of natural water flow patterns, and alteration of hydrological regimes. This can directly impact both terrestrial and aquatic biodiversity.
2	Increased agricultural activities, sedimentation, and pollution	**Water quality degradation** could impact aquatic ecosystems and species that rely on clean water.
3	Hydrological changes due to modifications to water flows and regimes	**Altered habitat** conditions that disrupt ecological processes.
4	Increased human activities	**Labor influx (during project construction) and Increased** human activities (during project operations pose additional threats to biodiversity. Increased human activity within the command area which could potentially disrupt wildlife behavior (nesting/foraging), increase poaching or predation risks if not properly managed.
5	Dredging of waterways and Alteration of water levels	Changes in water levels within the command area due to irrigation system renovation may negatively impact wildlife dependent on specific habitats for breeding or foraging purposes. For example, changes in seasonal wetlands or lakes' floodplains can disrupt breeding patterns for avian. Changes in water levels and habitat quality could force endangered species to relocate, potentially leading to competition with other species or exposure to new threats.

6	Use of chemicals and nutrient loading	If pesticides/fertilizers are used during agricultural practices within the command area as part of irrigation system renovation projects, it could lead to contamination of soil and water resources affecting both terrestrial and aquatic biodiversity.
7	Species displacement and disruption of foraging and breeding habits	Changes in water levels and habitat quality could force endangered species to relocate, potentially leading to competition with other species or exposure to new threats. Additionally, alterations to the irrigation system could disrupt the foraging and breeding habits of endangered birds and other wildlife.
8	Land Use Changes	The changes in land use that may occur as a result of the project, such as agricultural expansion or deforestation.
9	Biodiversity	The potential impacts of the project on water flow, water quality, and sedimentation patterns.
10	Introduction of invasive species through irrigation canals	Irrigation canals may facilitate the introduction of invasive plant or animal species into native aquatic ecosystems like Water Hyacinth, Mimosa Pigra, Tilapia etc. These invasives can outcompete native species for resources such as food and habitat space

4.1.2 Areas of Influence

The Ou Tapaong Irrigation Sub-scheme's estimated area of influence encompasses a) the entire command area (some 14,000 hectares, including the upper, middle, and lower parts), and b) any other areas outside the command area where project activities leave an environmental footprint during project implementation and sub-scheme operations. While the first is clear in terms of the boundary, the latter needs additional information based on the final project engineering design and environment monitoring data to establish the additional area of influence that is outside of the command area (due to the project's environmental footprint).

In line with the methods set forth under Section 3.2 (above), a detailed assessment was conducted for the OTP command area (as Modified Habitat) while a preliminary assessment was carried out for the area located immediately outside and to the downstream of the OTP command area. It is noted within the OTP command area, that there is a lake called Boeng Kanseang or Kanseang Lake which is home to fishes and birds. Analysis to determine critical habitat (Steps 1 and 2 of the CHA method)

4.1.3 Analysis to prepare for determining CH status

4.1.3.1 Critical Habitat Area of Analysis

Critical habitat is defined as an Area of Analysis (AoA), and the project's command area is used as an AoA.

4.1.3.2 Species with Potential Occurrence within the AoA

A list of threatened species with potential occurrence was generated for OTP. The coordinates of OTP (via KMZ file) are used to inform the IBAT radius of screening. Since the default radius of

IBAT screening is 50km, steps were taken to narrow down to the sub-scheme's area of influence to identify only EN and CR species that are potentially present in the sub-scheme area of influence. The narrowing-down aims to practically identify EN and CR species that could be found in the sub-scheme area of influence and to determine the Critical Habitat status of the identified species. After three rounds of screening focusing on EN and CR species, 11 EN and CR species are found as potentially present in the sub-scheme area of influence. These species include 4 reptile species, 2 mammals, 2 fishes, and 3 birds (See list of 11 EN and CR species in Table 3 below).

Description of screening for narrowing down

For Ou Ta Paong, three rounds of screening have been conducted. The first screening (Round 1) was conducted in December 2023. Round 2 was carried out in April 2024, and Round 3 in August 2025. The purpose of repeated screening is to validate the screening results (for the same area) with a wide range of local stakeholders. The screening aims to identify only EN and CR species that are potentially present in the OTP area of influence, covering reptiles, mammals, fish, birds, amphibians, and aquatic plants. Screening was done based on the IBAT report generated and provided by the AIIB.

In the first two rounds of screening, 17 EN and CR species were identified in the OTP area of influence (See Table below). In the 3rd round of screening (in August 2024), however, 11 (out of a total of 17 species) were confirmed as "potentially present" in the OTP's area of influence.

So, the assessment for Ou Ta Paong focuses on the confirmed list of **11 species** that are categorized by IUCN as EN and CR species, including 4 reptile species (Black Marsh Turtle, Giant Asian Pond Turtle, Southeast Asian Box Turtle, and Elongated Tortoise), 2 mammals (Indochinese Silvered Langur and Long-tailed Macaque), and 2 fishes (Striped catfish and Siamese Tiger Perch), and 3 birds (Greater Adjutant, Milky Stork, and Bengal Florican) (See Table below for the list of confirmed species and see Figure 1 for potential locations of these species in the project's area of influence).

Table 3: Confirmed List of endangered and critically endangered species for the Ou Tapaong sub-scheme

No.	Local Name	English Name	Scientific Name	IUCN Cat	Screened Species from Round 1&2 (Total=17)	Confirmed Species in Round 3 (Total = 11)
	I. Reptile spices					
1	អណ្តើកល្អក	Black Marsh Turtle	*Siebenrockiella crassicollis*	EN	Yes	Yes
2	អណ្តើកសាម	Giant Asian Pond Turtle	*Heosemys grandis*	CR	Yes	Yes
3	អណ្តើកបិទមុខ	Southeast Asian Box Turtle	*Cuora amboinensis*	EN	Yes	Yes
4	អណ្តើកព្រួច	Elongated Tortoise	*Indotestudo elongata*	CR	No	Yes
	II. Mammal species					
5	អាមាមច្រមុះ	Hairy-nosed Otter	*Lutra sumatrana*	EN	Yes	No
6	ស្វាព្រាម	Indochinese Silvered Langur	*Trachypithecus germaini*	EN	Yes	Yes
7	ស្វាក្តាម	Long-tailed Macaque	*Macaca fascicularis*	EN	Yes	Yes
	III. Fish species					

8	ត្រីប្រាំង	Striped catfish	*Pangasianodon hypophthalmus*	EN	Yes	Yes
9	ត្រីកន្ត្រៃបន្ទាត់	Siamese Tiger Perch	*Datnioides pulcher*	CR	Yes	Yes
	IV. Bird species					
10	ត្រយង់ធំ	Greater Adjutant	*Leptoptilos dubius*	EN	Yes	Yes
11	អន្សើលស	Milky Stork	*Mycteria cinerea*	EN	Yes	Yes
12	ចាបប្រចង់ង	Yellow-breasted Bunting	*Emberiza aureola*	CR	Yes	No
13	ខ្ទីប ឬ ត្រមាក់អណ្តើក	Bengal Florican	*Houbaropsis bengalensis*	CR	Yes	Yes
14	ពពូលទឹក	Masked Finfoot	*Heliopais personatus*	CR	Yes	No
15	ទាព្រៃស្លាបស	White-winged Duck	*Asarcornis scutulata*	EN	Yes	No
	V. Amphibians, and aquatic plants					
16	កណ្តាស្យាំងចេកភ្នំក្រវាញ	Cardamon Shrub Frog	*Philautus cardamonus*	EN	Yes	No
17	ស្មៅស្ទឹង / ទន្ទេ	River-weed	*Terniopsis chanthaburiensis*	EN	Yes	No

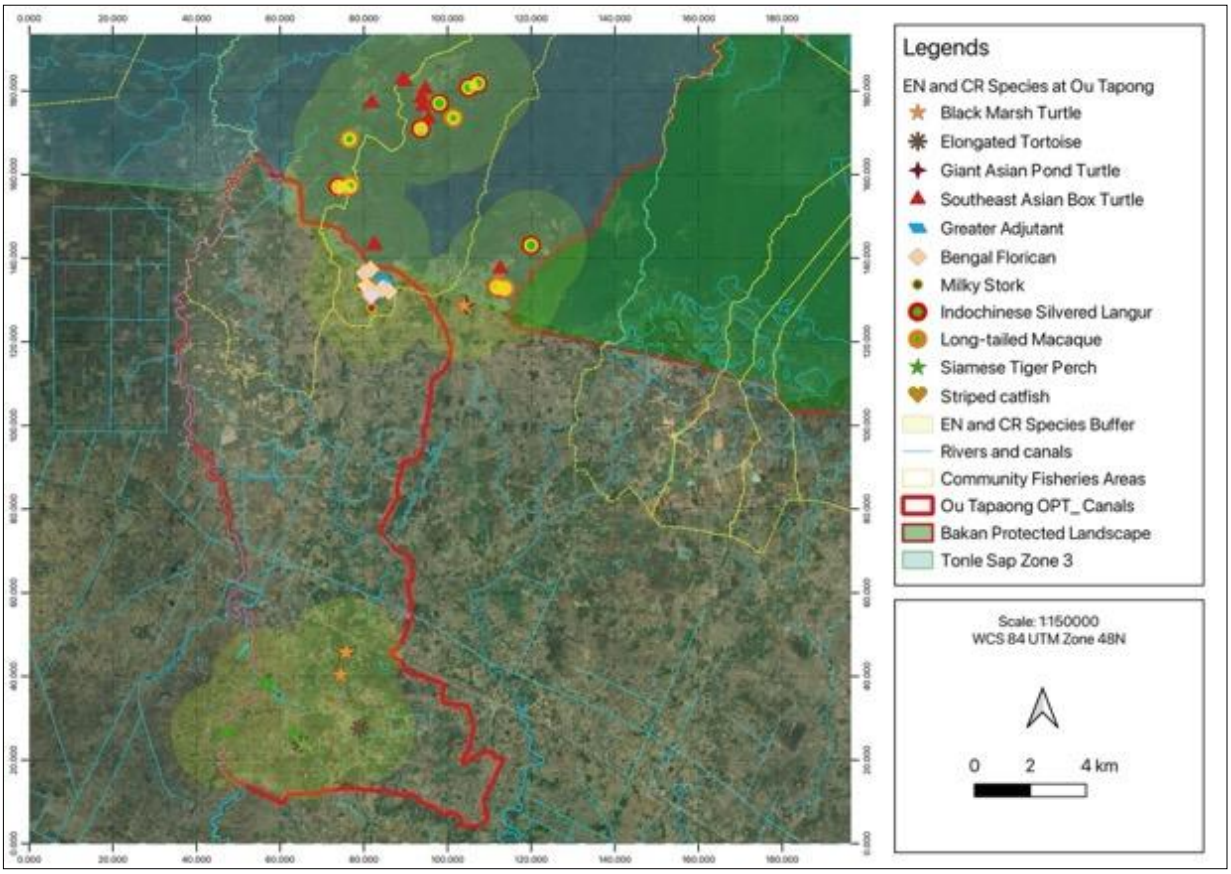

Figure 2: Map showing the observed distribution of identified EN and CR species (with the potential movement of 1-2 km within and around suitable habitats (2020 to 2024)

4.1.3.3 Ecological State of Habitats within the AoA

Understanding of the ecological state of habitats is necessary to assess the Likelihood of occurrence (LoO) of the above 11 screened species - as part of the CHA. For this CHA, species were classified into four LoO categories: Present, Possible, Unlikely and Not Present. Species known to be Present or with a Possible LoO are further assessed in Step 3. This understanding takes into account the classification of habitats as either modified or natural based on levels of human-induced disturbance to species composition and ecological functions. In this session, a brief assessment of the 11 confirmed species are presented. The assessment discusses historical range, distribution, habitat conditions, current status, and potential threats identified by key informants[6].

The OTP command area has been in existence since the 1970s. The OTP is a mixture of paddy fields, farm roads, and residential areas. Natural rivers, such as the OTP river, have been changed and various sections by local people to support living and farming activities. The OTP command area, therefore, the ecosystem within the OTP command area has been subject to human-induced changes over the past several decades. As such, the OTP command area is a modified habitat.

4.1.3.3.1 Reptiles (4 species)

The Black Mash Turtle was observed in both upper and lower sections of the command area, as well as along the main Ou Tapaong river (which is being used as a key canal feeding irrigation water for the command area). Conversely, the Elongated Tortoise was only found in the upper reaches while the Giant Asian Pond Turtle and Southeast Asian Box Turtle were found only in the lower section within Tonle Sap Zone 3 (figure 2 above). Details are below:

- **The Black Mashed Turtle** *(Cuora galbinifrons)* was confirmed to be present in the area of influence based on the accounts of four local informants. Residents from the upper reaches of Ou Tapaong reported historical sightings of this species within the past 10-20 years although recent spotting have been scarce. Key informants who live in the lower part of the command area and had livelihoods closely intertwined with the Tonle Sap Management Zone indicated that there have been ongoing efforts to bring the Black Mashed Turtle back to the region albeit its rarity. One informant successfully captured a Black Mashed Turtle just before the interview. This species is highly valued in the local market, particularly among middlemen, and is often used for traditional medicinal purposes.
- **Elongated Tortoise:** This species wasn't initially screened for the interview but it was identified and spotted by two key informants at the upper section of the Ou Tapaong based on the turtle images that were shown to facilitate the identification of species. No such sightings have been documented in the lower portions of the command area. One informant, a local resident near Ou Tapaong, provided a firsthand account of capturing this species. After a thorough examination of the accompanying photographs and a

[6] Community councils and committees, including community fisheries (CFi) and farmer water user community (FWUC), were convened on July 25 and August 4, 2024. These meetings aimed to identify potential field assessment areas and select individuals with deep local ecological knowledge and experience for interviews. A total of 13 key informants were interviewed in Ou Topaong. Five of these individuals were from the upper command area, while seven were from the lower command area. Additionally, one representative from Punleu Komar Organization, which supports the Samraong Muk Yeik Community Forest Initiative, was included. Notably, the Samraong Muk Yeik and Sdok Khlouk Community Fisheries locations overlaps with portions of the Lower Ou Tapaong Command Area.

comparison with verified identifying features, this species is confirmed present as reported by the local informant.

- **Giant Asian Pond Turtle:** Three local informants who were interviewed in the lower Ou Tapaong River region confirmed the presence of the Giant Asian Pond Turtle. One informant reported spotting this species in Boeung Kum Traeng, a wetland within Tonle Sap Zone 3 while the other two informants indicated their encounters with this species in the mountainous regions of Kravanh District.
- **Southeast Asian Box Turtle:** During our survey in the lower section of the Ou Tapaong, we obtained valuable information about the Southeast Asian Box Turtle. All seven informants in this area confirmed the presence of this species in nearby wetlands and flooded forest areas within Tonle Sap Zone 3, which is close to the command area boundary. While three informants reported recent encounters with this species, the remaining four mentioned that they had encountered it 10 to 20 years ago. They explained that the turtle was once abundant but has become very rare in recent years. Similarly, all turtle species, including the Southeast Asian Box Turtle, are threatened by ongoing illegal hunting for trading purpose. Some people were hesitant to share recent information about these species.

  Mr. Pheoun Moeun, Deputy Chief of Samraong Muk Yeik Community Fishery (SMY-CFi) is exceptionally knowledgeable about wildlife species in his Cfi area. He has been actively participating in forest patrols and community activities. He mentioned that some people who go fishing in the forest occasionally bring back one or two turtles with them but he preferred not to disclose this information.

  One key informant admitted that they captured a turtle from a nearby forest and sold for income. Income was shared among the four individuals. While informants were willing to share their past incidents, they were reluctant to provide details about the recent events because these activities are illegal.

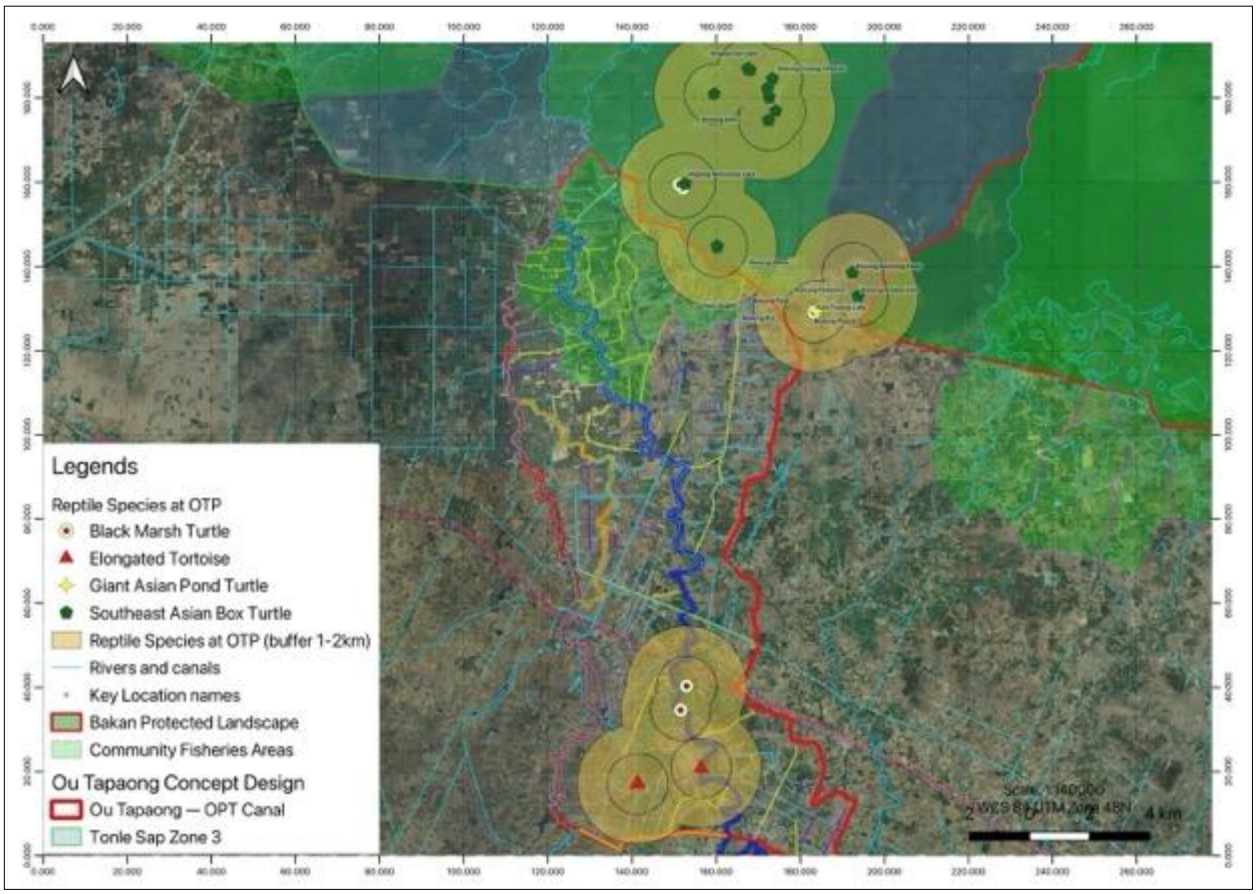

Figure 3: Distribution of identified turtle and tortoise species in and outside the OTP Command Area

4.1.3.3.2 Birds (3 species)

Despite extensive interviews with key informants residing in the upper reaches of Ou Tapaong, numerous endangered or critically endangered bird species were reported within their community. Conversely, only three of six bird species were confirmed by both key informants and CFi committees in the lower section. The following paragraphs summarize the primary findings and justifications for each species' presence, along with the associated level of confidence. These conclusions are based on in-depth interviews, technical expertise, and consultations with relevant units, which provided valuable assistance in verifying species of high conservation significance. Several species were initially identified by local residents.

- **Bengal Florican:** Five informants confirmed the presence of the Bengal Florican in the area of influence. Two individuals reported sightings within the past 10-20 years while three others have observed the species within the last five years and in the past. Notably, one informant witnessed a pair (male and female) as recently as March 2024 (see Figure 3). The lower reaches of Ou Tapaong exhibit a diverse mosaic of habitats, including open wetlands, grasslands, flooded forests, and minimally intensified paddy fields, creating a relatively undisturbed environment that is potentially conducive to Bengal Florican populations. Notably, the Ou Tapaong Command Area is situated only 1 kilometre from the Bakan Protected Landscape (BPL), a region characterized by similar ecological conditions (figure 3).

Established in July 2023 through a joint effort by the Ministry of Environment and the Wildlife Conservation Society (WCS), the BPL aims to safeguard the southernmost Bengal Florican subpopulation within the Tonle Sap Great Floodplain. Moreover, the BPL serves as a critical wintering habitat for the Yellow-breasted Bunting, Manchurian Reed-warbler, and Cambodia's unique population of the Chinese Grassbird, along with other globally threatened avian and wildlife species (WCS 2023).

- **Greater Adjutant:** During field assessments within the study area, multiple informants reported sightings of Greater Adjutants. While most individuals were unable to definitively distinguish between the Greater Adjutant and the similar-looking bird, which is Lesser Adjutant), one informant positively identified a Greater Adjutant within the Ou Tapaong Command area. This sighting occurred in recent years (figure 3). Unfortunately, due to the time of the observation, the Greater Adjutant had likely already migrated to its breeding grounds at Prek Toal Ramsar Site, a protected wetland area situated in Koh Chiveang community, Ek Phnom District, Battambang province (MoE 2012).

  Prek Toal Ramsar Site is the sole known breeding habitat for the greater adjutant in Southeast Asia and is recognized as the second-largest breeding colony for this species globally, following Assam, India. In December 2015, the Royal Government of Cambodia and the Ramsar Convention Secretariat designated the Prek Toal Core Area as a Wetland of International Importance due to its exceptional biological, social, and economic value. This designation solidified Prek Toal's status as Cambodia's fourth Ramsar Site (WCS 2016). Following the breeding season, greater adjutants migrate across the Tonle Sap Floodplain to their foraging habitats, with the lower section of Ou Tapaong serving as a critical foraging ground.

  Despite the challenges faced during the field observation due to the time of year, the confirmed sighting of a Greater Adjutant in the study area is a significant finding. It suggests that the species may still be present in the region and that a suitable habitat may exist for its continued survival.

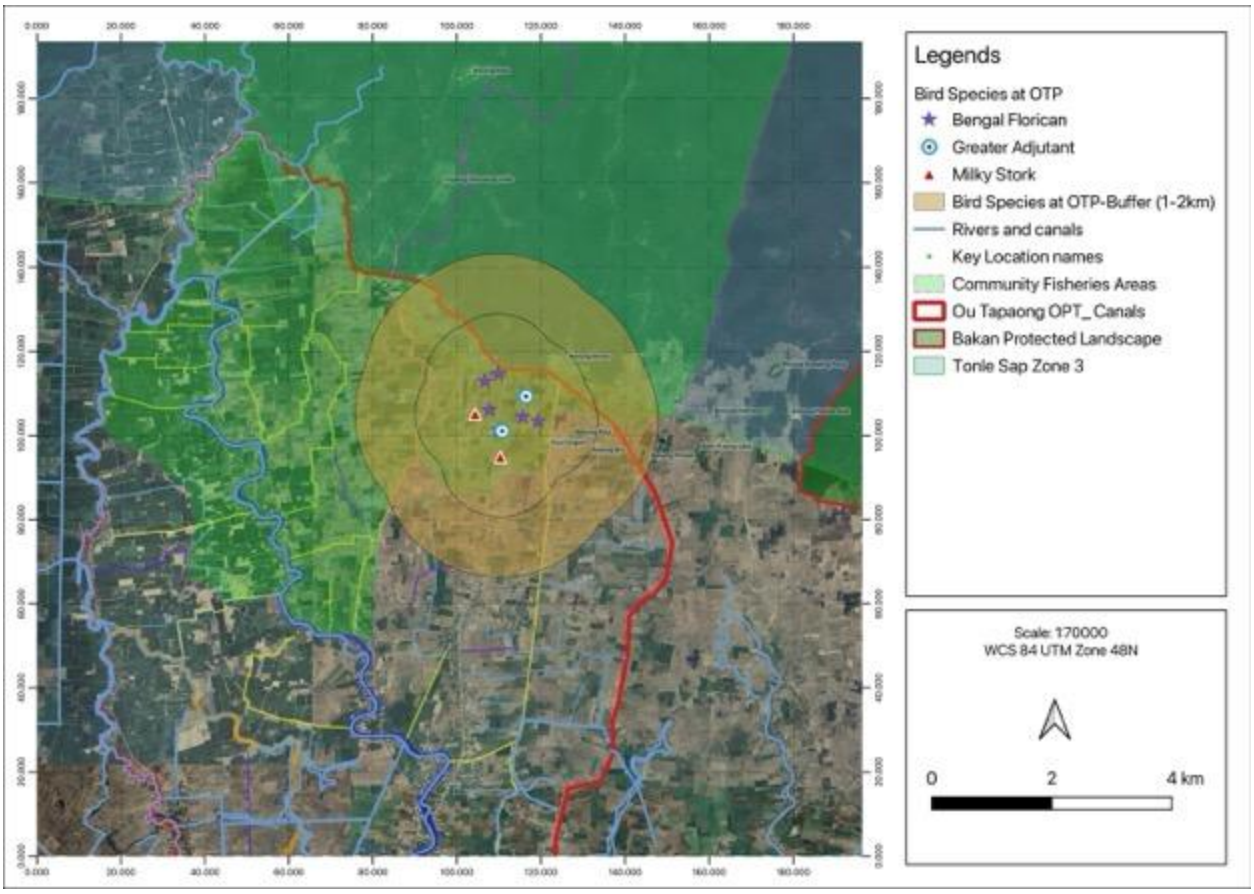

Figure 4: *A spatial distribution map was generated for three bird species—the Bengal Florican, Greater Adjutant, and Milky Stork—within the lower Ou Tapaong Command Area. 1-2 km buffer zones were included to approximate their minimum movement range around suitable habitats.*

- **Milky Stork:** Despite repeated attempts to elicit accurate information, many key informants were unable to distinguish between the Painted Stork and the Milky Stork, two similar-looking bird species. This confusion is a common challenge in bird identification, especially for non-experts. While the Milky Stork is considered extremely rare in Cambodia, with sightings typically limited to 1-3 individuals, some informants claimed to have encountered larger groups. This discrepancy can be attributed to misidentification and the difficulty of accurately counting birds in the field.

  Based on my experience in bird identification and conservation, I was able to evaluate the credibility of the information provided. Two informants offered the most reliable accounts, describing sightings of 2-3 Milky Storks feeding alongside numerous Painted Storks in seasonal wetland areas near flooded forests (figure #3). These observations align with the limited available data on Milky Stork distribution and behavior in Cambodia. When the flooding season arrives, they migrate to degraded forest areas in the uplands. Milky Stork and Great Adjutant are migratory birds that move both locally and across international borders. The Prek Toal Ramsar Site serves as the only known breeding ground for Milky Stork and Greater Adjutant in Southeast Asia; after breeding, they migrate to other wetland areas throughout the country.

Figure 5: *Photograph of a Milky Stork foraging alongside a flock of Painted Storks (credit: Sang Mony, Sam Veasna Conservation Tour), and a map illustrating the distribution of Milky Stork sightings in Cambodia from 2020 to 2024, extracted from eBird data.*

- **Yellow-breasted Bunting**: The Yellow-breasted Bunting is a small, migratory songbird found in Southeast Asia, including Cambodia. It is characterized by its bright yellow breast and throat, contrasting with its olive-green upperparts. The Yellow-breasted Bunting is a winter visitor and spring passage migrant in Cambodia, often found in rice fields, scrub, grasslands, and marshes in the lowlands. In Cambodia November to May, the species has been recorded in the Tonle Sap Floodplain and the Lower Mekong Delta. Yellow-breasted Buntings are typically observed in rice fields, scrublands, grasslands, and marshes in the lowlands of Cambodia (Ly et al. 2022).

  The local population often mistakenly identifies this species as a sparrow or a weaver due to their similar size, appearance, and shared habitats. After conducting inquiries, none of the locals could confirm whether they had observed this species in the area. This highlights a common gap in local ecological knowledge regarding small bird species like this one. Identifying such species typically requires individuals with advanced birdwatching experience, who can locate them in the appropriate habitat at the right time.

  Based on an overall assessment of the habitat conditions in the lower part of Ou Tapaong, we can confirm that this area has the potential to serve as a wintering habitat for this species. Additionally, the boundary of the Ou Tapaong Command Area is just 1 km away from the Bakan Protected Landscape.

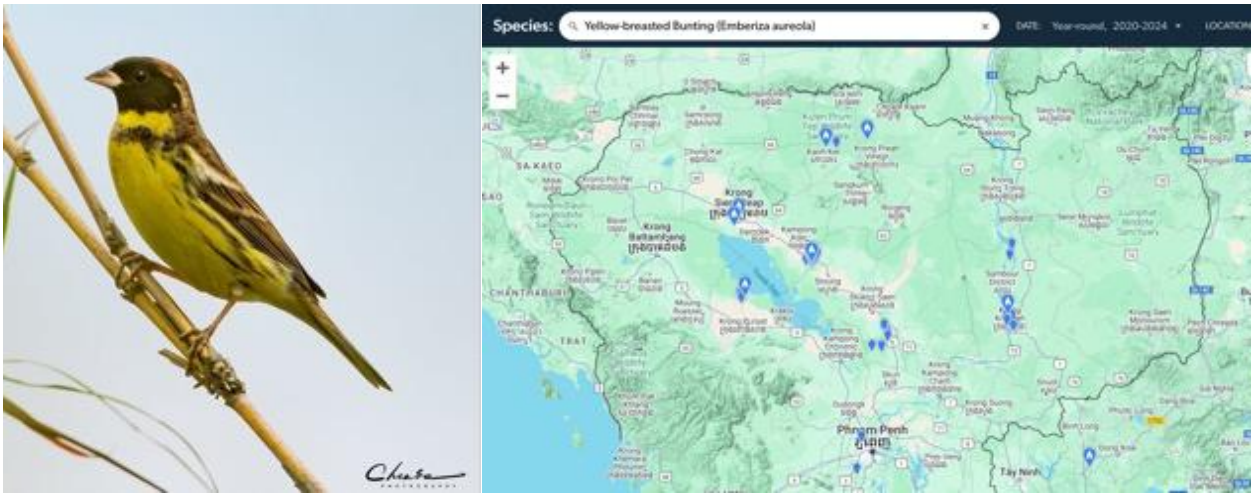

Figure 6. *Photo of Yellow-breasted Bunting (Emberiza aureola) and its distribution map from eBird data (2020-2024)recorded by birdwatcher and wildlife overserves.*

- **Wild-winged Duck:** Regarding the Wild-winged Duck, there was some confusion among informants who mistakenly identified it as the Knob-billed Duck (Sarkidiornis melanotos). However, after discussing key identification features and ecological characteristics, such as breeding and nesting habitats, we determined that none of them had actually encountered the Wild-winged Duck before. Due to it's tiny population, Wild-winged Duck is very sensitive, and live in the forest close to the lake, wetland, river and waterhold with less disturbance. Due to its limited population, the Wild-winged Duck is particularly sensitive to disturbances and prefers to reside in relatively undisturbed forests adjacent to lakes, wetlands, rivers, and watering holes. This preference for quieter, less populated areas helps to ensure the survival of this vulnerable species.

4.1.3.3.3 Mammals/ primates (2 species)

No suitable habitats or sightings of three mammal species were identified in the upper section of Ou Tapaong. Two primate species (Indochinese Silvered Langur and Long-tail Macaque) were confirmed at the lower section in the Flooded Forest habitat of the Tonle Sap Zone 3 and CFi Areas. Additionally, multiple reports indicated the presence of Hairy-nosed Otters in the region, particularly in the deep waters of the flooded forest near the Tonle Sap Great Lake's mouth. The following paragraphs summarize the key findings and justifications for the presence of these two primate species, along with their associated confidence levels. These conclusions are based on comprehensive interviews, technical expertise, and consultations with relevant units, which contributed to the verification of species with high conservation importance.

- **Indochinese Silvered Langur:** Six local informants (86%) reported frequent encounters with Indochinese Silvered Langurs within the flooded forests of Tonle Sap Zone 3 which is outside of the OTP command area. These sightings, primarily near natural lakes, have been confirmed by multiple individuals engaged in livelihood activities within these areas. While the population of Indochinese Silvered Langur was once plentiful, informants noted a significant decline in recent decades, with only smaller troops now being observed. The species is known to inhabit areas near rivers and large bodies of water.

Mr. Chem Sophal from Punleu Komar Organization highlighted that his organization provides support for the Samraong Muk Yeik Community Fishery (SMY-CFi) and Sdok Khlouk Community Fishery (SK-CFi) in managing and protecting fisheries resources and flooded forests within their Community Fishery Area (figure 6). Portions of these CFi Areas overlap with the Lower section of Ou Tapaong Command Area. This effort is part of the EU "Our Tonle Sap" Project, led by the Wildlife Conservation Society and funded by the European Union. Mr Sophal emphasized the presence of numerous endangered and critically endangered species, including the Indochinese Silvered Langur, within this CFi Area. To confirm the presence of any Community Fisheries (CFIs) within the specified area, we interviewed the Chief of Pursat Fishery Administration Cantonment. Our inquiry revealed that two CFi areas overlap with the designated region, as illustrated in the accompanying map (see map below).

Long-tailed Macaque: Indochinese Silvered Langurs and Long-tailed Macaques were commonly reported by key informants residing within the Tonle Sap Zone 3. These informants, who frequently engaged in fishing activities in the surrounding forests, encountered Long-tailed Macaques regularly. They added that these primates, known for their social nature, live in troops and communicate vocally to alert their group members of potential threats or discoveries. Some troops inhabit flooded forests situated close near the command area.

However, informants expressed deep concern over the significant decline in the population of Long-tailed Macaques over the past several years. This alarming trend has prompted urgent action from conservation organizations. In response to the deteriorating situation, the primate specialist group upgraded the conservation status of this species from Vulnerable to Endangered in March 2022. This elevated status underscores the urgent need for increased protection measures to mitigate the species' decline, which is primarily driven by the high demand for these primates in the illegal pet trade (*Primate Conservation Alliance. 2022)*

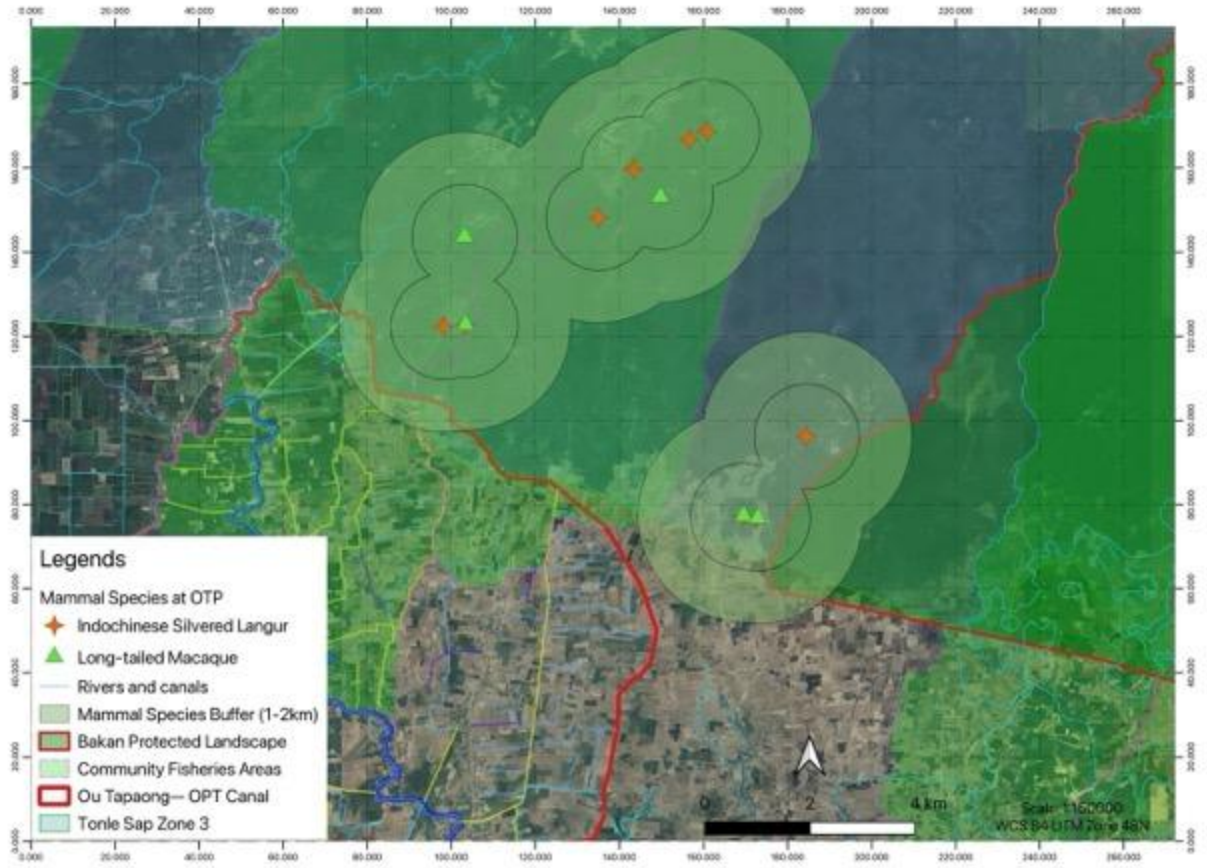

Figure 7: *A spatial distribution map was generated for two primate species—the Indochinese Silvered Langur and Long-tailed Macaque—within the lower Ou Tapaong Command Area. 1-2 km buffer zones were included to approximate their minimum movement range around suitable habitats.*

4.1.3.3.4 Fishes (2 species)

Overall, these statements provide valuable insights into sightings and knowledge about Siamese Tiger Perch and Striped Catfish within different sections of the Ou Tapaong Command area. The following paragraphs summarize the key findings and justifications for the presence of these two fish species confirmed by key informants, along with their associated confidence levels and their ecological knowledge of fish diversity and migration.

- **Siamese Tiger Perch:** According to four key informants in the upper section of the Ou Tapaong Command area, Siamese Tiger Perch has been consistently observed in Boeng Kansaeng Lake, located in the southwest part of the Ou Tapaong Command Area. Three of them reported encountering a few individuals of this fish species in 2023 and 2024 (figure #7), while another informant saw them about 20 years ago during the fully flooded period. This particular informant stopped fishing for many years after becoming older.

  The Siamese Tiger Perch is believed to migrate from Tonle Sap Great Lake to the upstream through Svay Daun Kav River (along the western boundary of command area) and then move into Boeng Kansaeng through its tributary canal during flooding periods. Common fishing gear used includes line nets, cast nets, and small fish traps. The informants mentioned that catching this species is extremely rare, with only one to two individuals caught per season using line nets. They possess extensive knowledge about fish and make a living through fishing.

On the other hand, two key informants from the lower Ou Tapaong section stated that although they are familiar with Siamese Tiger Perch, they have never seen them in their area. One informant mentioned having seen this species in 1979 but not recently. Similarly, Mr. Chem Sophal from Punleu Komar Organization confirmed his awareness of this species but stated that it is not present in the lower Ou Tapaong Area.

- **Striped catfish**: One informant recalled seeing the Striped Catfish approximately 7 years ago in a small wetland area during the peak of flooding. This species is exceptionally rare, and it is known to migrate to this specific area when the entire region becomes submerged in floodwater.

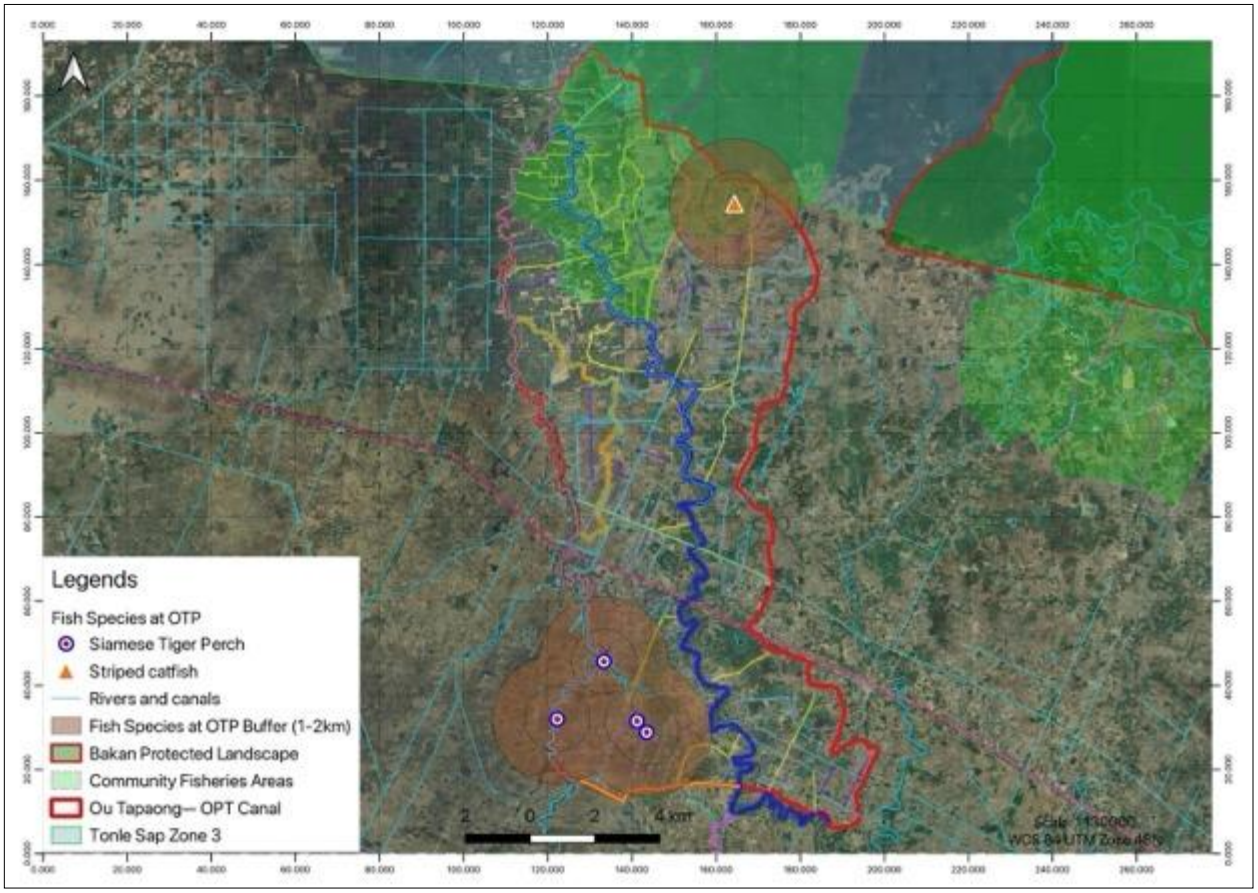

Figure 8: *A spatial distribution map was generated for two fish species—the Siamese Tiger Perch, and Striped Catfish (old record-7 years ago)—within the lower Ou Tapaong Command Area. 1-2 km buffer zones were included to approximate their minimum movement range around suitable habitats.*

4.1.3.4 Occurrence of Protected Areas near the Sub-scheme Area

A review of protected areas in the vicinity of the sub-scheme has been conducted as a preparatory step before proceeding with Step 3 of the CHA.There are four areas located near and downstream of the OTP sub-scheme (See Table below). The preliminary assessment focuses on the two that are closest to the OTB: Flood Forest Conservation, b) Bakan Grassland Protected Area[7].

[7] Bakan grassland is a protected area for birds designated by sub-decree No. 144 in 2023.

No.	Name of Protected Area	Designated by	Main target and requirement	Distance (km) to OTP sub-scheme
1	Flooded Forest Conservation	Royal Government of Cambodia: Sub-decree No. 197 dated 29 August 2011	Protect the flooded forest around the Tonle Sap lake for fishery productivity and ecological functions	0 (share the border)
2	Bakan Grassland protected area	Royal Government of Cambodia: Sub-decree No. 144, dated 04 July 2023	Protect the ecosystem in the area and ensure the sustainable use of the area.	2
3	Dei Roneat Important Bird Area (IBA)	BirdLife Internation	The IBA supports breeding colonies of Darter (Anhinga melanogaster), Lesser Adjutant (Leptoptilos javanicus) and Greater Adjutants (L. dubius).	12
4	Tonle Sap Biosphere Reserve (LSBR)	Royal Government of Cambodia: Royal Decree in 2001[8]	The Tonlé Sap Biosphere Reserve is a distinctive ecological region encompassing the Tonlé Sap, or Great Lake of Cambodia. The reserve was successfully designated a UNESCO Biosphere Reserve in 1997 and subsequently enshrined in the Cambodian Royal Decree in 2001.	16

4.1.4 Determination of Critical Habitat Status (Step 3)

This section assess the information (obtained from the above sub-section) vis-a-vis the criteria (presented in Section 3.4 - CH assessment method). This assessment aims to determine whether any species (identified in the list of 11 EN and CR species) qualify Critical Habitat feasures.

[8] https://www.unesco.org/en/articles/national-conference-tonle-sap-biosphere-reserve-brings-together-stakeholders-discuss-sustainable

English Common Name	Scientific name	IUCN Red List Status	Restricted Range	IBAT listing	Confirmed based on 3 screenings	Likelihood of Occurrence with AoI (Present, Possible, Unlikely and Not Present)	Reasons for Exclusion and data sources	Critical Habitat Determination of Species
Reptiles								
Black Marsh Turtle	*Siebenrockiella crassicollis*	EN	No	Yes	Yes	Present	Strongly and accurately confirmed by key informants	Consultation with local people indicated that the Black Marsh Turtle is present in the project area.
Giant Asian Pond Turtle	*Heosemys grandis*	CR	No	Yes	Yes	Present	Strongly and accurately confirmed by key informants	Consultation with local people indicated that the species is present in the project area.
Southeast Asian Box Turtle	*Cuora amboinensis*	EN	No	Yes	Yes	Possible (scare)	Strongly and accurately confirmed by key informants	Consultation with local people indicated that the species is present in the project area.
Elongated Tortoise	*Indotestudo elongata*	CR	No	Yes	Yes	Possible (scare)	Strongly and accurately confirmed by key informants	Consultation with local people indicated that the species is present in the project area.
Mammals								
Hairy-nosed Otter	*Lutra sumatrana*	EN		Yes	No	Not present		
Indochinese Silvered Langur	*Trachypithecus germaini*	EN	No	Yes	Yes	Unlikely (scare)	Strongly and accurately confirmed by key informants	Consultation with local people and relevant NGOs working in that area indicated that this species present in the flooded forest within Tonle Sap Zone in adjacent to the command area boundary.
Long-tailed Macaque	*Macaca fascicularis*	EN	No	Yes	Yes	Not present	Strongly and accurately confirmed by key informants	Consultation with local people and relevant NGOs working in that area indicated that this species present in the flooded forest within Tonle Sap Zone in adjacent to the command area boundary.
Fishes								
Striped catfish	*Pangasianodon hypophthalmus*	EN	No	Yes	Yes	Unlikely (scare)	Strongly and accurately confirmed by key informants	Consultation with local people indicated that the species is present in the project area but very rare. They encountered them only during high flooding year.

English Common Name	Scientific name	IUCN Red List Status	Restricted Range	IBAT listing	Confirmed based on 3 screenings	Likelihood of Occurrence with AoI (Present, Possible, Unlikely and Not Present)	Reasons for Exclusion and data sources	Critical Habitat Determination of Species
Siamese Tiger Perch	*Datnioides pulcher*	CR	No	Yes	Yes	Present		Consultation with local people indicated that the species is present in the project area especially in Boeung Kansaeng Lake.
Birds								
Greater Adjutant	*Leptoptilos dubius*	EN	No	Yes	Yes	Possible		Consultation with local people indicated that the species is present in the project area.
Milky Stork	*Mycteria cinerea*	EN	No	Yes	Yes	Possible		Consultation with local people indicated that the species is present in the project area.
Yellow-breasted Bunting	*Emberiza aureola*	CR		Yes	No			
Bengal Florican	*Houbaropsis bengalensi*	CR	No	Yes	Yes	Present		Consultation with local people and conservation NGO indicated that the species is present in the project area.
Masked Finfoot	*Heliopais personatus*	CR		Yes	No			
White-winged Duck	*Asarcornis scutulata*	EN		Yes	No			
Amphibians, and aquatic plants								
Cardamon Shrub Frog	*Philautus cardamonus*	EN			Yes	No		
River-weed	*Terniopsis chanthaburiensis*	EN		Yes	Yes	No		

4.1.4.1 Habitat of significant importance to CE and EN species

As presented in Section 4.1.3.3 (Ecological State), species that qualify as critical habitat features include:

- **Reptile** (4 species): Black Marsh Turtle, Giant Asian Pond Turtle, Southeast Asian Box Turtle, and Elongated Tortoise,
- **Mammals** (2 species): Indochinese Silvered Langur and Long-tailed Macaque),
- **Fishes** (2 species): Striped catfish and Siamese Tiger Perch, and
- **Birds** (3 species): Greater Adjutant, Milky Stork, and Bengal Florican.

First of all, the Ou Tapaong command area was assessed as a modified habitat because the command area which is around 14,000 hectares is a mixture of paddy fields, rivers, shrubland, seasonal ponds, farmers, and houses. Rivers such as Ou Ta Paong River and Svay Donkeo River have been substantially modified at various locations of the river for water collection, storage, as well as for other living and farming purposes.

In this assessment, we divided Ou Tapaong Command Area into three parts: 1) the upper part to the south, 2) the middle part along National Road 5, and 3) the lower part to the north which is situated within the floodplain of Tonle Sap Zones 2 and adjacent to Tonle Sap Zone 3 for key informant interview and habitat assessment purposes as this command area is large and maintain different demographic and natural habitat conditions. On August 7, 2024, the Cambodian government discussed the decision to register two zones (Zone 2 and Zone 3) of the Tonle Sap Lake Basin as state land to protect the natural resources of the lake. This decision will prohibit any further requests for land concessions in these zones. The Ministry of Land Management, Urban Planning and Construction hopes that this will help to preserve the biodiversity of the lake[9]. The assessment focused on the upper and lower parts because these areas are known to have a diverse biodiversity landscape. While the survey revealed variations in knowledge about wildlife among local communities, it also highlighted the need for increased awareness and understanding across all areas.

[9] Land Management, Urban Planning and Construction, Cambodia (2024). Zones 2 and 3 of the Tonle Sap Lake will be registered as state land to preserve this precious natural resource for inheritance for all generations.

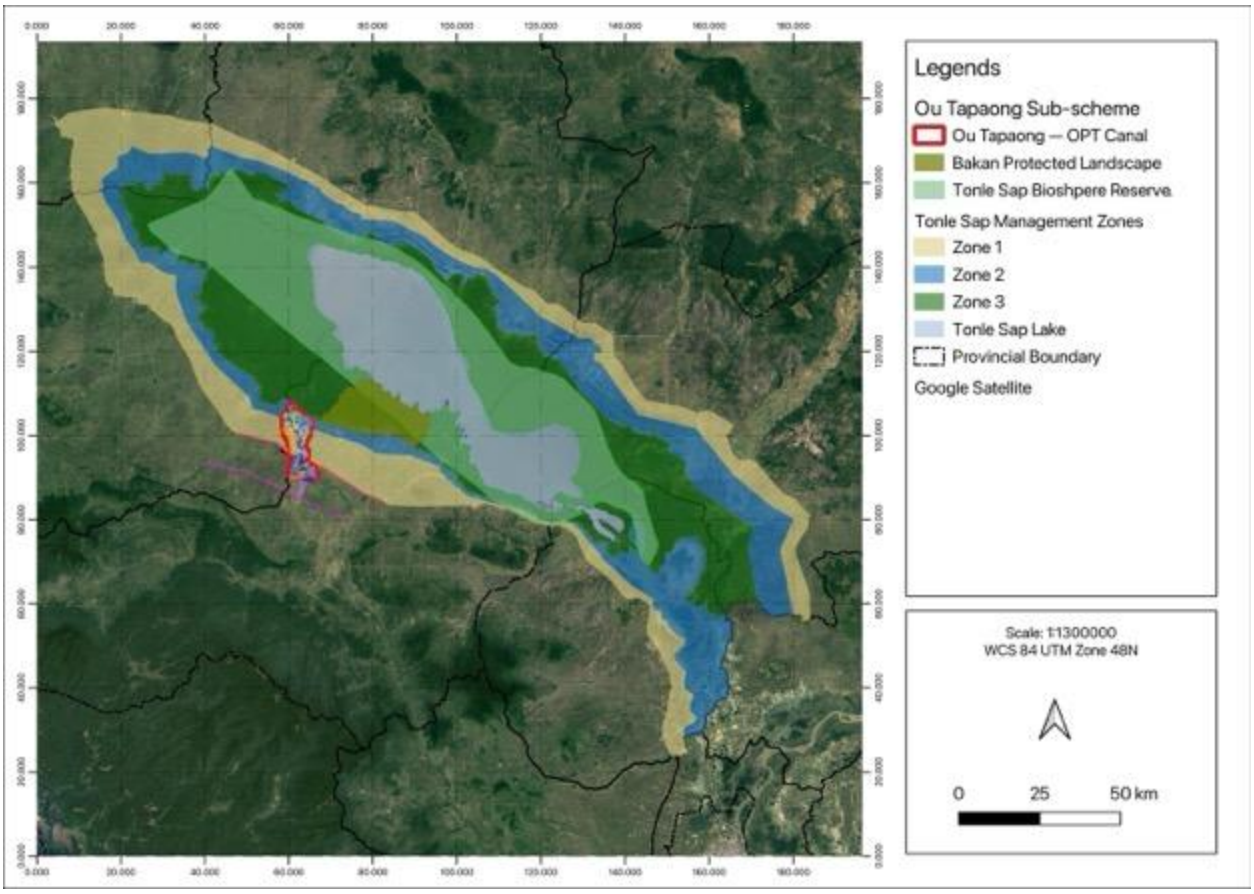

Figure 9: Map of Ou Tapaong command area and other existing protected area within the Tonle Sap Basin

The southern part of the command area is predominantly agricultural, with limited remaining natural habitats. Boeng Kansaeng, the largest seasonal wetland, faces challenges in water retention during the dry season. While the command area mostly gets water for irrigation from the Svay Daunkaev and Pursat rivers, the water volume is insufficient to maintain natural flows (e.g. Ou Tapaung River). Additionally, human interventions such as earth dams and conversion of waterways into fish ponds have fragmented the natural habitats and as such hindered the movement of aquatic species (Figures 8 and 9).

The northeastern part of the command area, though dominated by agriculture, includes a significant area of flooded forests. This diverse habitat supports a range of endangered and critically endangered species. However, the entire water system faces challenges that limit its suitability for species requiring extensive, interconnected habitats. The lowest part of this area is connected to a very healthy flooded forest habitat, consisting of many small and large waterholes, and wetland areas, creating a mosaic habitat that provides suitable ecological niches for many endangered and critical species in the area. This huge flooded forest habitat is part of the Tonle Sap Multiple Use Area, Tonle Sap Biosphere Reserve under the Ministry of Environment, and Tonle Sap Management Zone under the administration mandate of the Tonle Sap Authority, and Flooded Forest Protected Area under the Fisheries Administration. Additionally, a portion of Ou Tapaong's lower command area overlaps with two Community Fisheries (CFIs) areas.

The critical habitat for these bird species within the Ou Tapaong Irrigation sub-scheme includes flooded forests, wetlands, lakes, rivers, grassland, abandoned and fellow rice fields, and

waterways. The flooded forests in Tonle Sap Zone 3 serve as crucial habitats for several endangered and critically endangered primate species like the Indochinese Silvered Langur and Long-tailed Macaque and are charaterised with lakes and wetlands inside that are crucial foraging habitats for birds. Based ont this key finding we can identify and cacharaterise critical habitats of various EN and CR species presence within and close thie command area as below:

- Flooded forests, particularly those in Tonle Sap Zone 3, are particularly significant for biodiversity. These forests provide crucial habitat for endangered primates such as the Indochinese Silvered Langur and Long-tailed Macaque. Additionally, the lakes and wetlands within these forested areas offer essential foraging grounds for various bird species including Greater Adjutant and Milky Stork.
- Wetlands, such as Boeung Kansaeng, play a vital role in supporting aquatic and terrestrial biodiversity. These areas provide essential food, shelter, and breeding grounds for a variety of species including birds, reptiles, and fish.
- Rivers and waterways, like the Svay Daun Kav River, serve as important corridors for fish migration and connectivity between different habitats. This can indirectly benefit birds by providing a healthy aquatic ecosystem.
- Grasslands and open areas, while less diverse than forested habitats, can still support certain Bengal Florican, Yellow-breasted Bunting and other bird species. Abandoned and fallow rice fields may also offer temporary refuge for many bird birds including the Florican. The Bengal Florican utilizes this habitat for nesting and feeding during the dry season. The Yellow-breasted Bunting winters in this region before returning to its breeding ground in Siberia, Russia, from May to November

Based on the biodiversity assessment conducted at Ou Tapaong Irrigation Sub-scheme, several critical habitats have been identified, and described below. These habitats support a range of endangered and critically endangered species, highlighting their ecological significance. The critical habitat assessment activities that should be taken for the Ou Tapaong Command area, considering IFC PS 6 guidance on biodiversity conservation and sustainable management of living natural resources, are as follows:

1. **Baseline Studies:** Conduct comprehensive baseline studies to identify and understand the biodiversity values in the area. This should include a literature review, stakeholder engagement and consultation, field surveys, and other relevant assessments. The focus should be on identifying key species (such as Greater Adjutant, Milky Stork, Bengal Florican), fish (Siamese Tiger Perch and Striped Catfish), reptiles (Black Marsh Turtle, Southeast Asian Box Turtle, Giant Asian Pond Turtle, Elongated Tortoise), mammals (Indochinese Silvered Langur and Long-tailed Macaque), and their habitats.
2. **Habitat Mapping:** Map out the different habitats present within the Ou Tapaong Command area. This should include flooded forests, lakes (such as Boeung Kamsaeng Lake), rivers (Svay Daunkav River), waterholes, grasslands, and fellowed rice fields used by bird species for foraging.
3. **Threat Assessment:** Assess potential threats to critical habitats identified in step 2. Consider factors such as habitat loss due to infrastructure development or land-use changes related to irrigation system renovation.

4. **Stakeholder Engagement**: Engage with relevant stakeholders including local communities living in or around critical habitats to gather their knowledge about biodiversity values in the area.
5. **Mitigation Measures:** Develop mitigation measures specific to each identified critical habitat that aligns with IFC PS 6 guidance on avoidance of impacts whenever possible; implementation of measures to minimize habitat fragmentation; restoration activities during operations or after project completion; implementation of set-asides for protection; consideration of biodiversity offsets where appropriate based on no net loss principle.
6. **Environmental and Social Impact Assessment (ESIA):** Conduct an ESIA that considers all potential impacts on critical habitats identified through steps 1-5 above.
7. **Monitoring Plan:** Develop a comprehensive monitoring plan that includes regular monitoring of key species populations within critical habitats identified in step 2 above.

Figure 10: *Boeung Kansaeng located in Ou Tampaong's upper reaches, offers sighted records of Siamese Tiger Parch. The area's upper part in this photo is a settlement along the Svay Daunkav River.*

Figure 11: Overview of Boeung Kansaeng, located upstream of Ou Tapaong Command Area. A canal connects to Stueng Svay Daunkav River (left) and Ou Tapaong (right), a potential fish migration route during floods.

Figure 12: *Aerial photograph depicting the Ou Tapaong Stream/canal fragmented by earth dams, roads, and ponds, illustrating its diversion for non-intended purposes*.

Figure 13: *Aerial photograph of intake flooded forest habitat within Tonle Sap Zone 3 and the continuous land encroachment, converting forest land for rice cultivation.*

4.1.4.2 Habitat of significant importance to endemic or restricted-range species

None of the species under EN and CR classification are restricted-range species (based on IBAT report for Ou Ta Paong).

4.1.4.3 Habitat supporting globally or nationally significant concentrations of migratory or congregation species

None of the IBA that are recognized for significant concentrations of migratory birds or other species are found within the vicinity of the sub-scheme. No other evidence of significant concentrations of migratory or congregatory species is available. The AoA for OTP, therefore is expected to qualify as critical habitats under this criterion.

4.1.4.4 Highly threatened or unique ecosystems

Each of the reservoirs are modified habitat and is associated with numerous rice paddies. There is no evidence that these areas are highly threatened or unique ecosystems, and no critical habitats are recognized under this criterion.

4.1.4.5 Ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described above in (a) to (d)

Boeung Kansaeng Lake still maintains hydrological connectivity for fish migration from Stueng Svay Daunkav River through its canals, where the Siamese Tiger Perch was confirmed. Some small wetland areas at the lower part of the OTP command area support ecological functions and connectivity for confirmed birds, reptiles and fish species for their local movement, nesting, and foraging ground. So, that is necessary to support biodiversity values that require applying biodiversity mitigation measures and protection efforts (described under the above criteria) have been identified. Pumping, drainage, and discharge of chemical inputs into that wetland can have a significant impact on the biodiversity and survival rate of EN and CR species present in that area.

4.1.5 Potential Impacts & Feasibility of Net Gain Requirements (Step 4)

Step 4 (as described in the above CHA method) requires a high-level assessment of the potential for critical habitat features to be affected by the investment activities of the sub-scheme (both construction and operation). This step is necessary to determine if Net Gain measures need to be demonstrated and whether the necessary measures are feasible.

In the section below, species that are assessed as “Present” or “Possible” in sub-scheme AoI (as shown in the above table) are included in the impact assessment. These include the following 8 species: 1) Four reptiles (Black Marsh Turtle, Giant Asian Pond Turtle, Southeast Asian Box

Turtle, Elongated Tortoise), 2) Three birds (Greater Adjutant, Milky Stork, and Bengal Florican), and 3) One fish (Siamese Tiger Perch).

4.1.5.1 Potential impacts

1) **Reptiles** (Substantial risk)

All four species of reptiles are found in the upper and lower part of the OTP command area, particularly in areas near natural water courses (rivers and streams). During construction, these reptiles are potentially affected directly due to a) disturbances from noise and vibration due to increased vehicle activity and human presence, b) being hit by vehicles, equipment from increased traffic movement and river dredging/training at Ou Ta Paong river, excavating of the extended canal of Kbal Hong and other relevant canals, c) caught by workers, local people, and hunters. During project operation, these reptiles may be directly affected, including a) being caught by local people and hunters, and b) pesticide residues from intensified crop production.

2) **Birds** (Moderate risk)

Greater Adjutant, Milky Stork, and Bengal Florican are found seasonally in the command area, mainly in the lower/downstream part which is subject to annual flooding. These birds are migratory and as such are rare. Local people don't catch these birds for food. However, since these birds feed on aquatic species available from the command area, they may be affected by the feeds that are contaminated with pesticide residues.

4.1.5.2 Net gain assessment

Additionally, during construction activities, these birds may be indirectly affected through disturbance and habitat loss caused by increased human activity and changes in water levels. It is important to note that the Ou Tapaong Command Area serves as a critical habitat for these endangered bird species, making it crucial to minimize any potential negative impacts.

Based on the potential impacts identified above, it is evident that measures need to be implemented to achieve a net gain in biodiversity within the Ou Tapaong Command Area. These measures should focus on minimizing direct disturbances and habitat loss during construction activities, as well as implementing sustainable agricultural practices to prevent pesticide contamination of food sources for these bird species.

In conclusion, based on the assessment results, it is recommended that comprehensive actions be taken to protect critical habitats for species such as reptiles (Black Marsh Turtle, Giant Asian Pond Turtle, Southeast Asian Box Turtle Elongated Tortoise), birds (Greater Adjutant, Milky Stork, Bengal Florican), ensuring their survival alongside irrigation system renovation projects.

4.1.6 Mitigation measures

To minimize the above risks, the following measures need to be implemented.

4.1.6.1 During design

Given the rich biodiversity in the OTP command area and the adjacent area (downstream), during the design phase, ecological considerations need to be prioritized:

- Avoidance or Minimization: Avoid/ minimize the project's footprint and impacts by exploring and selecting engineering options that balance the need for irrigation use and

the potential impact on identified EN and CR species. Engineering design considers the selection of designs that avoid/ minimize the need for clearing and grubbing. Existing vegetation should be protected by adopting a design that avoids vegetation clearance. Areas prone to erosion should be protected.

- Riparian buffer zones along Ou Ta Paong and other rivers and stream needs to be protected to minimize run-off pollution.

4.1.6.2 During construction

Rehabilitation of farmers and irrigation systems (including river training, dredging, and canal deepening/widening…) may cause adverse impacts to wildlife present in and near the construction areas. The following measures are proposed to avoid/minimize the risk to wildlife present in the command area:

- Minimizing Habitat Loss: Avoid clearing vegetation outside the project area and implement measures to protect existing trees and vegetation.
- Implementing strict environmental management plans that include guidelines for minimizing noise and vibration disturbances during construction activities.
- Implementing effective traffic management systems to minimize the risk of vehicle collisions with reptiles and other wildlife.
- Erosion and Sediment Control: Employ erosion control measures to prevent sedimentation in water bodies and downstream impacts.
- Waste Management: Proper construction measures need to be taken for pollution prevention (for soil and water).
- Wildlife Protection: Where needed, install fencing to prevent wildlife animals to enter construction sites, and minimize physical construction activities in areas known as being home to EN and CR species such as rivers and streams for turtles.
- Chance Find Procedure: Train and ensure contractor's workers know how to apply chance find procedures to avoid affecting animals that could be encountered during construction.
- Best practices: Adopt environmentally friendly construction practices, such as minimizing soil disturbance and preventing pollution.
- Training and Education for Project workers: To ensure that construction site labor staff are aware of biodiversity concerns and understand their role in protecting habitats and species, the following training and education initiatives should be implemented:
    - Environmental Awareness Training: Provide comprehensive training on the biodiversity values of the project area, including the importance of critical habitats and the potential impacts of construction activities.
    - Identification of EN and CR Species in the project area: Train staff to recognize endangered or critically endangered species that may be present in the area, enabling them to avoid harming these species.
    - Habitat Protection: Educate staff on the importance of protecting habitats, such as avoiding clearing vegetation unnecessarily, minimizing soil disturbance, avoid eating local wildlife animal.

- Waste Management: Train staff on proper waste management practices to prevent pollution and habitat degradation.
- Emergency Response: Prepare staff to respond to environmental emergencies, such as oil spills or accidental habitat damage.

- The Project's Code of Conduct needs to be implemented (perused and signed by contractors) to prohibit staff and construction workers from hunting, wildlife harvest, or committing any form of trade in wildlife products from the area.

4.1.6.3 During operation

During the operation phase, crop production will be upscaled thanks to increased irrigation water access. The number of crops per production area will be increased. Increased agricultural production will potential increase the scope and scale of water and soil contamination, primarily due to increased use of agricultural chemicals (e.g. pesticide and fertilizers). The following measures are proposed to minimize this risk.

- **Introduction and adoption of Good Agriculture Practice:** Environmental-friendly crop production techniques will be introduced to farmers and adoption of such techniques will be promoted, linking with market demand for premium farm produce.
- **Monitoring Water Quality:** Water quality will be monitored regularly to ensure water is not contaminated to the level that affects wildlife in the long term.
- **Biodiversity Monitoring:** Establish a long-term biodiversity monitoring program to assess the project's impacts on EN and CR species found in the project area, and other relevant flora and fauna.
- **Community Engagement:** Raise awareness of the community about the need to protect wildlife in the project area and take actions towards to changing attitudes on the consumption of threatened wildlife. Support community-based conservation initiatives to protect biodiversity and promote sustainable livelihoods.
- **Collaboration:** Explore and collaborate with another ongoing and future wildlife program.
- **Adaptive Management:** Adjust water management practices based on monitoring results and changing conditions within and outside the command area of OTP where other ongoing projects are likely to induce a cumulative impact on the biodiversity in the command area, and the larger production area in Ou Ta Pong.
- Promoting sustainable farming practices that reduce reliance on pesticides while maintaining crop yields.

- **Biodiversity offsets**: Consider implementation in case the significant residual impact is expected despite avoidance and minimization measures.
- **Maintaining ecological flows in rivers and streams:** It is crucial to maintain natural flow regimes in rivers and streams to support the ecological functions of these habitats. This can be achieved by setting minimum flow requirements during critical periods for fish migration or reproduction. Water allocation plans should consider the needs of both human water use and environmental flows.

4.1.6.4 Biodiversity Action Plan (OTP), (if relevant, to achieve net gain)

A comprehensive Biodiversity Action Plan (BAP) should be developed to achieve net gain in biodiversity with a clear outline below:

Biodiversity Action Plan for Ou Tapaong Irrigation Sub-scheme

Executive Summary

- This conservation action plan outlines strategies to mitigate potential negative impacts on biodiversity within the Ou Tapaong irrigation scheme. The plan is based on a critical habitat assessment that identified significant biodiversity values in the area, particularly for endangered and critically endangered species. The proposed actions align with the International Finance Corporation's Performance Standard 6 (PS6) on biodiversity conservation and sustainable management of living natural resources.

Key Objectives

- Protect critical habitats: Identify and conserve areas crucial for biodiversity, such as flooded forests, wetlands, and rivers.
- Minimize negative impacts: Implement measures to reduce the adverse effects of irrigation scheme development on wildlife and their habitats.
- Enhance biodiversity: Promote habitat restoration and conservation activities to support species recovery.
- Engage with stakeholders: Foster collaboration with local communities and relevant government agencies to ensure effective conservation efforts.

Habitat Mapping

- Map out the different habitats present within the Ou Tapaong Command area. This should include flooded forests, lakes, rivers, waterholes, grasslands, fellows rice fields used by bird species for foraging.
- Threat Assessment
- Assess potential threats to critical habitats identified in step 2. Consider factors such as habitat loss due to infrastructure development or land-use changes related to irrigation system renovation.

Mitigation Measures

- Develop mitigation measures specific to each identified critical habitat that align with IFC PS 6 guidance on avoidance of impacts whenever possible; implementation of measures to minimize habitat fragmentation; restoration activities during operations or after project completion; implementation of set-asides for protection; consideration of biodiversity offsets where appropriate based on no net loss principle.
- Carefully design project activities to avoid direct impacts on critical habitats.
- Identify alternative project locations or routes that avoid sensitive areas.
- Modify project designs to minimize the footprint and disturbance of critical habitats.
- Implement temporary measures to protect critical habitats during construction.

Minimization:

- Implement responsible construction practices to minimize adverse effects on critical habitats, such as avoiding unnecessary clearing of vegetation and minimizing soil disturbance.
- Establish effective waste management systems to prevent pollution.
- Implement erosion control measures to prevent sedimentation in aquatic habitats.
- Develop pollution prevention strategies to reduce water and air pollution.
- Habitat Protection and Restoration:

- Establish measures to protect and restore flooded forests, wetlands, and other natural habitats within and around the command area.
- Promote sustainable land use practices like agroforestry, conservation agriculture, and sustainable forest management.

Species Conservation:

- Develop species-specific conservation plans for endangered and threatened species identified in the area.
- Monitor populations of these species regularly and assess their habitat needs
- Consider implementing captive breeding programs or reintroduction efforts if necessary
- Implement habitat management measures that improve the quality and suitability of their habitats

Carbon Sequestration:

- Carbon Sequestration is the process of capturing and storing atmospheric carbon dioxide (CO2). It's a crucial strategy in mitigating climate change by reducing the amount of greenhouse gas in the atmosphere.
- Forest and wetland restoration: Re-establishing or enhancing forest and wetland areas can significantly increase carbon sequestration. These ecosystems act as carbon sinks, absorbing carbon dioxide from the atmosphere.
- Soil carbon enhancement: Implementing agricultural practices that improve soil organic matter content can increase carbon storage in the soil.
- Blue carbon: Protecting and restoring wetland and flooded forest ecosystem, can contribute to carbon sequestration.

Community Engagement:

- Involve local communities in biodiversity conservation efforts through participatory planning, monitoring, and implementation
- Educate communities about the importance of biodiversity i nthe sub-scheme area
- Foster community awareness about endangered species present within their vicinity
- Promote sustainable livelihoods that support conservation,such as community-based ecotourism,sustainable agriculture, and fisheries management
- Research and Monitoring:
- Conduct further research assessing biodiversity and ecological processes within Ou Tapaong Irrigation Sub-Scheme
- Establish long-term monitoring programs track changes in biodiversity and habitat conditions which will provide valuable data for evaluating effectiveness of ongoing conseravtion effots

Sustainable Water Management:

- Ensure irrigation systems and water use practices do not harm critcal haibitats. Optimise irrigation efficiency,reducing water polution and protecting water sources.

Biodiversity Offsets:

- If significant residual impacts are expected despite avoidance and minimisation meausres, biodiveristy.

4.2 Lum Hach

4.2.1 Proposed project activities and potential risks and impacts

Green Peafowl have been observed year-round in all three community forests; both their offspring and adults were sighted by community patrol teams there. However, they face heightened vulnerability due to habitat degradation, fragmentation issues, land encroachment concerns, and hunting pressures from human activities. By carefully considering the ecological implications of the project, it is possible to balance the needs of agriculture with the conservation of endangered species and their habitats. Under Lum Hach, various activities will be carried out that cause the following E&S risks and impacts:

Table 4: Projection activities that may cause potential impacts on the environment and social at the Lum Hach sub-scheme

No.	Project activities that cause impacts	E&S Risks & Impacts
1	Construction activities (rehabilication of canal and farm roads), land use changes, and water management practices	**Habitat loss and fragmentation** could lead to habitat loss and fragmentation, affecting species' survival and connectivity. This activity may involve dredging, excavation, or modification of existing water channels and infrastructure. These activities can lead to habitat destruction, disturbance to nesting and foraging sites, disruption of natural water flow patterns, and alteration of hydrological regimes. This can directly impact both terrestrial and aquatic biodiversity.
2	Increased agricultural activities, sedimentation, and pollution	**Water quality degradation** could impact aquatic ecosystems and species that rely on clean water.
4	Increased human activities	**Labor influx (during project construction) and Increased** human activities (during project operations pose additional threats to biodiversity. Increased human activity within the command area which could potentially disrupt wildlife behavior (nesting/foraging), increase poaching or predation risks if not properly managed.
5	Dredging of waterways and Alteration of water levels	Changes in water levels within the command area due to irrigation system renovation may negatively impact wildlife dependent on specific habitats for breeding or foraging purposes. For example, changes in seasonal wetlands or lakes' floodplains can disrupt breeding patterns for avian. Changes in water levels and habitat quality could force endangered species to relocate, potentially leading to competition with other species or exposure to new threats.
6	Use of chemical inputs and nutrient loading	If pesticides/fertilizers are used during agricultural practices within the command area as part of irrigation system renovation projects, it could lead to contamination of soil and water resources affecting both terrestrial and aquatic biodiversity.

7	Species displacement and disruption of foraging and breeding habits	Changes in water levels and habitat quality could force endangered species to relocate, potentially leading to competition with other species or exposure to new threats. Additionally, alterations to the irrigation system could disrupt the foraging and breeding habits of endangered birds and other wildlife.
8	Land Use Changes	The changes in land use that may occur as a result of the project, such as agricultural expansion or deforestation and habitat fragmentation.
9	Biodiversity degradation, edge eddects, and soil erosion	The potential impacts of the project on water flow, water quality, and sedimentation patterns. The changes in microclimate and increased disturbance at forest edges can negatively impact forest ecosystems and wildlife species.

4.2.2 Areas of Influence

The Lum Hach Irrigation Sub-scheme has a limited area of influence due to its small size and the surrounding farmland. The critical habitats identified within the area include Toul Samraong, Phnom Banon, and Chan Trak Community Forests. These areas are characterized by small, fragmented, and degraded dry deciduous forests (DDFs). However, these forests are crucial for the conservation of Green Peafowl, which have been confirmed to be present in these areas. The protection and restoration of these community forests should be a priority in the biodiversity action plan.

4.2.3 Analysis to prepare for determining CH status

4.2.3.1 Critical Habitat Area of Analysis

Critical habitat is defined as an Area of Analysis (AoA), and the project's command area is used as an AoA.

4.2.3.2 Species with Potential Occurrence within the AoA

A list of threatened species with potential occurrence was generated for the LH Command Area. The coordinates of this command area (via KMZ file) are used to inform the IBAT radius of screening. Since the default radius of IBAT screening is 50km, steps were taken to narrow down to the sub-scheme's area of influence to identify only EN and CR species that are potentially present in the sub-scheme area of influence. The narrowing-down aims to practically identify EN and CR species that could be found in the sub-scheme area of influence and to determine the Critical Habitat status of the identified species. After three rounds of screening focusing on EN and CR, only one endangered bird species of Green Peafowl was confirmed see table 5 below.

Description of screening for narrowing down

For Lum Hach, three rounds of screening have been conducted. The first screening (Round 1) was conducted in December 2023. Round 2 was carried out in April 2024, and Round 3 in August 2024. The purpose of repeated screening is to validate the screening results (for the same

area) with a wide range of local stakeholders. The screening aims to identify only EN and CR species that are potentially present in the Lum Hach area of influence, covering reptiles, mammals, fish, birds, and mushrooms. Screening was done based on the IBAT report generated and provided by the AIIB.

In the first two rounds of screening, 5 EN and CR species were identified in this area of influence (see Table below). In the 3rd round of screening (in August 2024), however, one of five species was confirmed as "potentially present" in the LH's area of influence. So, the assessment for Lum Hach focuses on the confirmed list of **1 species** that are categorized by IUCN as Endangered species.

Table 5: Confirmed List of endangered and critically endangered species for the Lum Hach sub-scheme

No.	Local Name	English Name	Scientific Name	IUCN Cat	Screened Species from Round 1&2 (Total=5)	Confirmed Species in Round 3 (Total = 1)
I. Mammal species						
1	ឆ្កែព្រៃ	Dhole	Cuon alpinus	EN	Yes	No
2	ប្រើដធំ	Large Flying-fox	Pteropus vampyrus	EN	Yes	No
II. Fish species						
3	ត្រីកន្ទ្រៀប ឡា	Siamese Tiger Perch	*Datnioides pulcher*	CR	Yes	No
III. Bird species						
4	ក្អែក	Green Peafowl	Pavo muticus	EN	Yes	Yes
IV. Mashroom						
5	ផ្សិតកែវ	Puffball mushrooms	Calostoma insigne	EN	Yes	No

4.2.3.3 Ecological State of Habitats within the AoA

Understanding of the ecological state of habitats is necessary to assess the likelihood of occurrence (LoO) of Green Peafowl - as part of the CHA. For this CHA, species was classified into four LoO categories: Present, Possible, Unlikely and Not Present. Species known to be Present or with a Possible LoO are further assessed in Step 3. This understanding takes into account the classification of habitats as either modified or natural based on levels of human-induced disturbance to species composition and ecological functions. In this session, a brief assessment of the one confirmed species is presented. The assessment discusses historical range, distribution, habitat conditions, current status, and potential threats identified by key informants.

The remaining forest patches within the Lum Hach Irrigation Sub-scheme are characterized by small size, fragmentation, and degradation. They are classified as very open and degraded Dry deciduous forests (DDFs), which are not suitable for many species, including Long-tailed Macaques, Large Flying-fox, and Puffball mushrooms. The limited availability of suitable habitats is a significant factor contributing to the scarcity of biodiversity in the area.

The biodiversity assessment at Lum Hach Irrigation Sub-scheme initially identified several potential endangered (EN) or critically endangered (CR) species using the Integrated Biodiversity Assessment (IBAT) and key informant interviews. However, further investigation revealed that only Green Peafowl was confirmed to be present within the Toul Samraong, Phnom Banon, and Chan Trak Community Forests (see map in Figure 14 below).

Species Distribution:

- **Green Peafowl:** Found in all three community forests, indicating their adaptability to the local environment and the importance of these habitats for their conservation.
- **Dhole:** Despite initial screenings, no confirmed sightings were made within the study area. This may be attributed to factors such as habitat fragmentation, human disturbance, or low population densities.
- **Flying-fox:** The survey result is similar to the dhole, no flying-fox was confirmed within the study area. This could be due to habitat loss, hunting pressure, or other factors affecting their survival.
- **Siamese Tiger Perch:** This species was not found within the study area, likely due to its preference for larger water bodies like the Tonle Sap Great Lake. Three KII reportd that they countered this specie when they went for fishing at Tonle Sap every year but they had never seen this species within this area (Lum Hach).
- **Puffball mushrooms:** Although not confirmed within the study area, there is potential for their presence in higher elevations of the Cardamom Mountains.

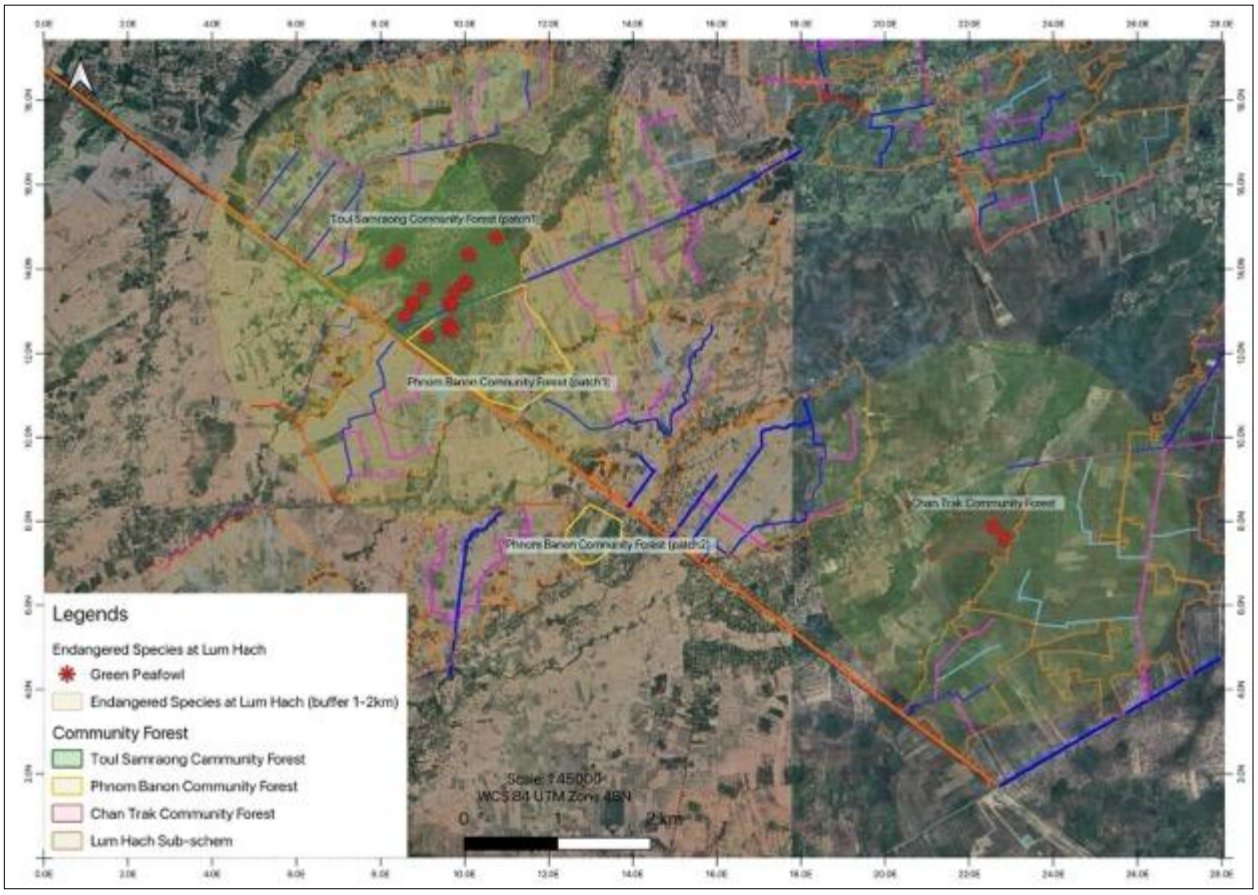

Figure 14: *Green Peafowl distribution in Toul Samraong, Phnom Banon, and Chan Trak Community Forests, as confirmed by local sources from 2020 to 204.*

4.2.4 Determination of Critical Habitat Status (Step 3)

A habitat assessment was conducted in key areas known for endangered species within the region. Interviews with local authorities, community committees, and key informants confirmed the

presence of Green Peafowl in three community forest areas.

Two of these forests, Toul Samraong and Phnom Banon (a large patch), share a boundary and are primarily composed of dry, open dipterocarp forests with some closed dipterocarp areas along the natural canal. These three community forests are small, fragmented, and surrounded by farmland, with some remaining degraded forest land nearby. Despite their poor ecological connectivity, they are crucial for supporting the small remaining Green Peafowl population.

During a meeting, it was discovered that two community forest boundaries had been revised, and one had changed its name from Trapeang Mlu to Phnom Banon. All forest representatives confirmed that their areas were undergoing registration with the Ministry of Land Management, Urban Planning, and Construction (PLMUPC). However, some key informants expressed

concerns about ongoing land encroachment into their community areas. Despite previous complaints, the offenders continue to use and sell the land without any repercussions.

Figure 15: *The upperpart of Hum Hack next to Boribou river catchment area*

Figure 16: *Overview from the above of the general condition of Toul Samroang and Phnom Banon Community Forests*

Figure 17: *Overview from the above of the general condition of Chan Trak Community Forest*

Figure 18: *An expert consulted with the Toul Samraong CF management committee to verify the identification of a canine species, ensuring it was correctly identified as either a dhole or a jackal.*

4.2.4.1 Habitat of significant importance to CE and EN species

As presented in Section 4.2.3.3 (Ecological State), species that qualify as critical habitat features for Green Peafowl is listed as Endangered Species in the IUCN RedList. The natural dry forest habitats within the community forests of the Lum Hach Irrigation Sub-Scheme are critical for the survival of the Green Peafowl population. These forests provide essential resources for Green Peafowl, including food, shelter, and breeding sites. However, the quality and extent of these habitats can vary significantly, affecting their suitability for the species (Figures 16 and 17).

4.2.4.2 Habitat of significant importance to endemic or restricted-range species

None of the species under EN and CR classification are restricted-range species (based on IBAT report for Ou Ta Paoing).

4.2.4.3 Habitat supporting globally or nationally significant concentrations of migratory or congregatory species

None of the IBA that are recognized for significant concentrations of migratory birds or other species are found within the vicinity of the sub-scheme. No other evidence of significant concentrations of migratory or congregatory species is available. The AoA for LH, therefore is expected to qualify as critical habitats under this criterion.

4.2.4.4 Highly threatened or unique ecosystems

Each of the reservoirs are modified habitat and is associated with numerous rice paddies of there the three community forest areas are trimmed out from the command area. There is no evidence that these areas are highly threatened or unique ecosystems, and no critical habitats are recognized under this criterion. However, the concern of illegal agriculture expansion into the community forest areas was questioned by some key informants (management committee and patrol members of community forests).

4.2.4.5 Ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described above in (a) to (d)

No ecological functions that are necessary to support biodiversity values (described under the above criteria) have been identified.

4.2.5 Potential Impacts & Feasibility of Net Gain Requirements (Step 4)

Step 4 (as described in the above CHA method) requires a high-level assessment of the potential for critical habitat features to be affected by the investment activities of the sub-scheme (both construction and operation). This step is necessary to determine if Net Gain measures need to be demonstrated and whether the necessary measures are feasible. In the section below, species that are assessed as “Present” or “Possible” in sub-scheme AoI (as shown in the above table) are included in the impact assessment on one bird (Green Peafowl).

4.2.5.1 Potential impacts on Green Peaflow (Substantial risk)

The Green Peafowl is found in three community forest areas located within the vicinity of Lum Hach command area. During construction, these species is potentially affected directly due to a) disturbances from noise and vibration due to increased vehicle activity and human presence, b) caught by workers, local people, and hunters.

4.2.5.2 Net gain assessment

Based on the assessment conducted for the Lum Hach Irrigation Sub-scheme, it has been determined that there is a net loss of biodiversity and ecological value within its area of influence. The critical habitat analysis identified only one endangered species, the Green Peafowl, with a confirmed presence in the sub-scheme's area of influence. The ecological state of habitats within this area is classified as very open and highly susceptible to human disturbances, posing potential threats to the Green Peafowl population.

It is evident that despite efforts to balance agricultural needs with conservation, there are significant risks and impacts on biodiversity within this project. Therefore, measures must be taken to mitigate these risks and minimize further loss of ecological value in order to achieve a

net gain for biodiversity in the long term. This may include prioritizing protection and restoration efforts for critical habitats such as Toul Samraong, Phnom Banon, and Chan Trak Community Forests within the sub-scheme's area of influence.

4.2.6 Mitigation measures

To mitigate these potential impacts, the following measures should be implemented.

4.2.6.1 During design

- Identify and avoid sensitive areas, such as known habitats for Green Peafowl or other endangered species.
- Minimize the footprint of construction activities to reduce habitat disturbance.
- Develop plans for habitat restoration and compensation in case of unavoidable impacts..

4.2.6.2 During construction

- Implement an environmental management plan to minimize impacts on biodiversity.
- Use appropriate measures to prevent soil erosion and sedimentation in water bodies.
- Properly manage construction waste to prevent pollution.
- Habitat Protection: Set up buffer zones around critical habitats during construction activities to minimize disturbances; Implement measures such as temporary fencing or signage to prevent unauthorized access into protected areas.
- Waste Management: Establish proper waste management systems onsite; and Provide training for workers on waste disposal procedures
- **Training and Education for Labor Staff**: To ensure that construction site labor staff are aware of biodiversity concerns and understand their role in protecting habitats and species, the following training and education initiatives should be implemented:
    - Environmental Awareness Training: Provide comprehensive training on the biodiversity values of the project area, including the importance of critical habitats and the potential impacts of construction activities.
    - Species Identification: Train staff to recognize endangered or critically endangered species that may be present in the area, enabling them to avoid harming these species.
    - Habitat Protection: Educate staff on the importance of protecting habitats, such as avoiding clearing vegetation unnecessarily and minimizing soil disturbance.
    - Waste Management: Train staff on proper waste management practices to prevent pollution and habitat degradation.
    - Emergency Response: Prepare staff to respond to environmental emergencies, such as oil spills or accidental habitat damage.

4.2.6.3 During operation

Sustainable Agricultural Practices:
Promote sustainable farming practices among local farmers surrounding the irrigation sub-scheme.

Provide training on agroforestry techniques that integrate tree planting with crops to enhance habitat connectivity.

- **Water Management:** Ensure that irrigation practices do not harm biodiversity.
- **Monitoring and Evaluation:** Continuously monitor biodiversity impacts and adjust project activities as needed.

4.2.7 Biodiversity Action Plan

Below is an outline of a biodiversity action plan for this sub-scheme.

Biodiversity Action Plan for Lum Hach Command Area

1. Habitat Restoration and Conservation

- Reforestation: Plant native tree species to restore degraded forest areas, focusing on areas with high ecological value and potential for species recovery.
- Habitat Connectivity: Create corridors or buffer zones between fragmented forest patches to facilitate species movement and gene flow.
- Land Use Planning: Develop and implement sustainable land use plans that prioritize biodiversity conservation and minimize negative impacts on habitats.

2. Species Conservation

- Green Peafowl:
  - Develop a specific conservation plan for Green Peafowl, including habitat management, population monitoring, and community-based conservation initiatives.
  - Implement measures to reduce human-wildlife conflict, such as habitat modification and education programs.
  - Consider establishing a captive breeding program as a last resort.
- Other Species:
  - Conduct surveys to determine the presence of other potential endangered or critically endangered species.
  - Develop species-specific conservation plans based on survey results.

3. Community Engagement

- Capacity Building: Provide training and education to local communities on biodiversity conservation and sustainable practices.
- Community-Based Conservation: Support community-led initiatives, such as community forestry and wildlife monitoring.
- Sustainable Livelihoods: Promote sustainable livelihoods that support biodiversity conservation, such as ecotourism, sustainable agriculture, or community-based enterprises.

4. Research and Monitoring

- Biodiversity Surveys: Conduct regular biodiversity surveys to monitor species distribution, abundance, and population trends.
- Ecological Monitoring: Establish long-term monitoring programs to track changes in ecosystems and species populations.

4.3 Brambei Mom

4.3.1 Proposed project activities and potential risks and impacts

By carefully considering the ecological implications of the project, it is possible to balance the needs of agriculture with the environment and ecosystem functions. Under Brambei Mom, various activities will be carried out that cause the following E&S risks and impacts:

Table 6: Projection activities that may cause potential impacts on the environment and social aspects at Brambei Mom sub-scheme

No.	Project activities that cause impacts	E&S Risks & Impacts
1	Construction activities (rehabilication of canal and farm roads), land use changes, and water management practices	**Habitat loss and fragmentation** could lead to habitat loss and fragmentation, affecting species' survival and connectivity. This activity may involve dredging, excavation, or modification of existing water channels and infrastructure. These activities can lead to habitat destruction, disturbance to nesting and foraging sites, disruption of natural water flow patterns, and alteration of hydrological regimes. This can directly impact both terrestrial and aquatic biodiversity.
2	Increased agricultural activities, sedimentation, and pollution	Water quality degradation could impact aquatic ecosystems and species that rely on clean water.
3	Dredging of waterways and Alteration of water levels	Changes in water levels within the command area due to irrigation system renovation may negatively impact wildlife dependent on specific habitats for breeding or foraging purposes. Changes in water levels and habitat quality could force endangered species to relocate, potentially leading to competition with other species or exposure to new threats.
4	Use of chemicals and nutrient loading	If pesticides/fertilizers are used during agricultural practices within the command area as part of irrigation system renovation projects, it could lead to contamination of soil and water resources affecting both terrestrial and aquatic biodiversity.
5	Biodiversity degradation, edge effects, and soil erosion	The potential impacts of the project on water flow, water quality, and sedimentation patterns. The changes in microclimate and increased disturbance at forest edges can negatively impact forest ecosystems and wildlife species.
6	Blockage of migration routes by dams or other structures	Dams or other structures can block migratory pathways used by fishes during specific seasons or

		life stages, preventing them from accessing their preferred habitats or breeding grounds.

4.3.2 Areas of Influence

The Brambei Mom Irrigation Innovation sub-scheme has an extensive area of influence that includes adjacent communities and ecosystems dependent on its water resources. The areas directly affected by the project's activities include agricultural lands within a certain radius from irrigation canals or reservoirs.

4.3.3 Analysis to prepare for determining CH status

4.3.3.1 Critical Habitat Area of Analysis

Critical habitat is defined as an Area of Analysis (AoA), and the project's command area is used as an AoA.

4.3.3.2 Species with Potential Occurrence within the AoA

A list of threatened species with potential occurrence was generated for Brambei Mom. The coordinates of BM (via KMZ file) are used to inform the IBAT radius of screening. Since the default radius of IBAT screening is 50km, steps were taken to narrow down to the sub-scheme's area of influence to identify only EN and CR species that are potentially present in the sub-scheme area of influence. The narrowing-down aims to practically identify EN and CR species that could be found in the sub-scheme area of influence and to determine the Critical Habitat status of the identified species. After three rounds of screening, there's on EN and CR species confirmed.

Description of screening for narrowing down

For Brambei Mom, three rounds of screening have been conducted. The first screening (Round 1) was conducted in December 2023. Round 2 was carried out in April 2024, and Round 3 in August 2024. The purpose of repeated screening is to validate the screening results (for the same area) with a wide range of local stakeholders. The screening aims to identify only EN and CR species that are potentially present in the Brambei Mom area of influence, covering reptiles, mammals, fish, birds, and mushrooms. Screening was done based on the IBAT report generated and provided by the AIIB.

The four sub-schemes (Brambei Mom, Krapeu Truom, Yotasas, and Stueng Kang Bat) are integral components of the Stoeung Krang Ponley River catchment system, a tributary of the Tonle Sap. These areas share geographic connectivity and ecological functions. Semi-structured and structured interviews were conducted to collect data on species information, distribution, and fisheries ecosystems. In the first two rounds of screening, 2 EN and CR species including 1) one reptile (Black Marsh Turtle), and 2) one fish species (Striped Catfish) were identified in this area of influence. In the 3rd round of screening (in August 2024), however, none of these species was confirmed" in the Brambei Mom's area of influence.

4.3.3.3 Ecological State of Habitats within the AoA

Understanding of the ecological state of habitats is necessary to assess the likelihood of occurrence (LoO) of the above 2 screened species - as part of the CHA. For this CHA, species were classified into four LoO categories: Present, Possible, Unlikely and Not Present. Species known to be Present or with a Possible LoO are further assessed in Step 3. This understanding takes into account the classification of habitats as either modified or natural based on levels of human-induced disturbance to species composition and ecological functions. In this session, a brief assessment of the 11 confirmed species are presented. The assessment discusses historical range, distribution, habitat conditions, current status, and potential threats identified by key informants.

The four sub-schemes (Brambei Mom, Krapeu Truom, Yotasas, and Stueng Kang Bat) are integral components of the Stoeung Krang Ponley River catchment system, a tributary of the Tonle Sap. These areas share geographic connectivity and ecological functions. Semi-structured and structured interviews were conducted to collect data on species information, distribution, and fisheries ecosystems. Two National Fisheries Day ceremonies were held at Kbol and Anlong Chrey Reservoirs, during which millions of fish were released by the former prime minister. The aquaculture department of the Technology Institute of Kampong Speu also releases fish into these reservoirs. Investigations with relevant government departments confirmed that no endangered or critically endangered species were released during these events.

4.3.4 Habitat Assessment

Brambei Mom Command Area is located within the Stoeung Krang Ponley River catchment system, a tributary of the Tonle Sap. These areas are geographically and ecologically interconnected. The habitat is characterized by three large reservoirs (Anlong Chrey, Brambei Mom, and Kdol) in the upper reaches, while the lower areas consist of riverine, wetland, and agricultural landscapes. The water quality, vegetation density, and soil composition vary across these habitats. However, the hydrological functions of the system are disrupted by numerous dams and spillways along the main canal and irrigation canals, hindering fish migration from downstream to upstream. This may be one factor contributing to the absence of the targeted species in the area.

Semi-structured interviews were conducted with multiple fishermen at Anlong Chrey and Brambei Mom reservoirs. Many claimed to have seen or caught Striped Catfish, Mekong Giant Barb, and Isok barb/Jullien's Golden Carp. To verify their claims, we sent photographs of the fish to Thach Panara, head of the Inland Fisheries Research and Development Institute. It was determined that all of the fishermen had mistakenly identified Mekong Giant Barb as Rohu (Labeo rohita). Additionally, none of the fishermen reported encountering any turtles or tortoises in their fishing area. Despite consulting visual aids, we were unable to confirm the reported sightings of Jullien's Golden Carp and Striped Catfish due to a lack of clear identification evidence.

Ten key informants were interviewed with the support of commune councils. None reported encountering the targeted species within the command area. Discussions with the Chief of Brambei Mom commune revealed a history of large-scale fish farming in the area, including Pangasianodon sp. and Hypsibarbu sp. A flood event years ago led to the release of these fish into the Anlong Chrey reservoir, resulting in increased catches by local fishermen. However, it remains uncertain whether the Pangasianodon sp. was indeed Striped Catfish.

Figure 19: Interviewing and verifying Mekong Giant Barb with similar look of other fish species and their ecological niches

Figure 20: *Local fishermen in Brabei Mom mistakenly identified their catch of Rohu (Labeo rohita) as Mekong Giant Barb.*

4.3.5 Determination of Critical Habitat Status (Step 3)

This section assesses the information (obtained from the above sub-section) vis-a-vis the criteria (presented in Section 3.4 - CH assessment method). Based on the assessment result there are no EN and CR with their critical habitat confirmed for this sub-scheme.

4.3.5.1 Habitat of significant importance to CE and EN species

As presented in Section 4.3.3.2 (Ecological State), no EN and CR species confirmed.

4.3.5.2 Habitat of significant importance to endemic or restricted-range species

None of the species under EN and CR classification are restricted-range species (based on IBAT report for for Brambei Mom).

4.3.5.3 Habitat supporting globally or nationally significant concentrations of migratory or congregation species

None of the IBA that are recognized for significant concentrations of migratory birds or other species are found within the vicinity of the sub-scheme. No other evidence of significant concentrations of migratory or congregatory species is available. The AoA for Brambei Mom, therefore is expected to qualify as critical habitats under this criterion.

4.3.5.4 Highly threatened or unique ecosystems

Each of the reservoirs are modified habitat and is associated with numerous rice paddies. There is no evidence that these areas are highly threatened or unique ecosystems, and no critical habitats are recognized under this criterion.

4.3.5.5 Ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described above in (a) to (d)

No ecological functions that are necessary to support biodiversity values (described under the above criteria) have been identified.

4.3.1 Mitigation measures

4.3.1.1 During design

During the design phase of construction activities, it is important to consider measures that minimize impacts on biodiversity to protect natural habitats nearby. Key mitigation measures during this stage may include:

- Avoidance of Critical Habitats: Identify critical habitats within the construction area and adjust project design accordingly to avoid direct impacts on these areas.
- Buffer Zones: Establish buffer zones around critical habitats where construction activities are limited or restricted to minimize disturbances.

4.3.1.2 During construction

During the actual construction phase of the project, effective mitigation measures should be implemented to further minimize impacts on biodiversity:

- Dust Control Measures: Implement dust control measures such as dampening surfaces or covering materials during earthwork activities to prevent sedimentation in nearby water bodies.
- Waste Management Practices: Properly manage waste generated from construction activities by implementing recycling programs, segregating waste types, and ensuring proper disposal procedures are followed.

4.3.1.3 During operation

After completion of construction, ongoing operation activities should also incorporate mitigation measures:

- Habitat Monitoring Program: Establish a habitat monitoring program that regularly assesses changes in biodiversity within impacted areas throughout operations.
- Water Quality Management: Implement proper water quality management practices such as minimizing pollution discharge into surrounding ecosystems through regular maintenance checks of irrigation infrastructure.

4.4 Krapeu Trom

4.4.1 Proposed project activities and potential risks and impacts

By carefully considering the ecological implications of the project, it is possible to balance the needs of agriculture with the environment and ecosystem functions. Under Krapeu Trom, various activities will be carried out that cause the following E&S risks and impacts:

Table 7: Projection activities that may cause potential impacts on the environment and social aspects at Krapeu Trom sub-scheme

No.	Project activities that cause impacts	E&S Risks & Impacts
1	Construction activities (rehabilication of canal and farm roads), land use changes, and water management practices	**Habitat loss and fragmentation** could lead to habitat loss and fragmentation, affecting species' survival and connectivity. This activity may involve dredging, excavation, or modification of existing water channels and infrastructure. These activities can lead to habitat destruction, disturbance to nesting and foraging sites, disruption of natural water flow patterns, and alteration of hydrological regimes. This can directly impact both terrestrial and aquatic biodiversity.
2	Increased agricultural activities, sedimentation, and pollution	Water quality degradation could impact aquatic ecosystems and species that rely on clean water.
3	Dredging of waterways and Alteration of water levels	Changes in water levels within the command area due to irrigation system renovation may negatively impact wildlife dependent on specific habitats for breeding or foraging purposes. Changes in water levels and habitat quality could force endangered species to relocate, potentially leading to competition with other species or exposure to new threats.
4	Use of chemicals and nutrient loading	If pesticides/fertilizers are used during agricultural practices within the command area as part of irrigation system renovation projects, it could lead to contamination of soil and water resources affecting both terrestrial and aquatic biodiversity.
5	Biodiversity degradation, and soil erosion	The potential impacts of the project on water flow, water quality, and sedimentation patterns. The changes in microclimate.
6	Blockage of migration routes by dams or other structures	Irrigation structures, such as dams and weirs, can create physical barriers that prevent fish from migrating upstream or downstream. This can disrupt their reproductive cycles and reduce their survival rates.

4.4.2 Areas of Influence

Potential areas of influence might include:

- **Downstream areas:** The lower reaches of the Stoeung Krang Ponley River and the Tonle Sap Lake, may be affected by water quality, sediment loads, and fish migration from Krapeu Trom.
- **Upstream areas:** The upper reaches of the Stoeung Krang Ponley River and its tributaries, which may be influenced by water flow regulation and sediment transport from Krapeu Trom.
- **Adjacent ecosystems:** Forests, wetlands, and agricultural areas that are connected to Krapeu Trom through hydrological or ecological processes.

4.4.3 Analysis to prepare for determining CH status

4.4.3.1 Critical Habitat Area of Analysis

Critical habitat is defined as an Area of Analysis (AoA), and the project's command area is used as an AoA.

4.4.3.2 Species with Potential Occurrence within the AoA

A list of threatened species with potential occurrence was generated for Krapeu Trom (KT). The coordinates of KT (via KMZ file) are used to inform the IBAT radius of screening. Since the default radius of IBAT screening is 50km, steps were taken to narrow down to the sub-scheme's area of influence to identify only EN and CR species that are potentially present in the sub-scheme area of influence. The narrowing-down aims to practically identify EN and CR species that could be found in the sub-scheme area of influence and to determine the Critical Habitat status of the identified species.

Description of screening for narrowing down

For Krapeu Trom, three rounds of screening have been conducted. The first screening (Round 1) was conducted in December 2023. Round 2 was carried out in April 2024, and Round 3 in August 2024. The purpose of repeated screening is to validate the screening results (for the same area) with a wide range of local stakeholders. The screening aims to identify only EN and CR species that are potentially present in the OTP area of influence, covering reptiles, mammals, fish, birds, amphibians, and aquatic plants. Screening was done based on the IBAT report generated and provided by the AIIB.

In the first two rounds of screening, there were two fish species (Isok barb/Jullien's Golden Carp and Leaping barb/Flying Minnow) were screened for the first two rounds. After three rounds of screening focusing on EN and CR species, only Flying Minnow is confirmed as potentially present in the sub-scheme area of influence.

4.4.3.3 Ecological State of Habitats within the AoA

Understanding of the ecological state of habitats is necessary to assess the Likelihood of occurrence (LoO) of the above 11 screened species - as part of the CHA. For this CHA, species were classified into four LoO categories: Present, Possible, Unlikely and Not Present. Species known to be Present or with a Possible LoO are further assessed in Step 3. This understanding takes into account the classification of habitats as either modified or natural based on levels of human-induced disturbance to species composition and ecological functions. In this session, a brief assessment of the one confirmed species is presented. The assessment discusses historical range, distribution, habitat conditions, current status, and potential threats identified by key informants.

The Krapeu Trom command area has been in existence since the 1970s. The KT is a mixture of paddy fields, farm roads, and residential areas. Natural rivers, such as the Stueng Krang Ponlai serve as the sole ecological and hydrological connection between its upstream watershed and the Tonle Sap River basin downstream. This river is crucial for fish migration during the flooding season. However, reservoirs, spillways, and drought conditions have disrupted these essential ecological functions.

4.4.3.3.1 Fish (1 species)

Krapeu Trom, like Brambei Mom, is situated within the same river catchment area in the lower reaches, near the Tonle Sap's annual floodplain. Two fish species, the Isok barb/Jullien's Golden Carp (Probarbus jullieni) and Leaping barb/Flying Minnow (Laubuka caeruleostigmata), were targeted for interviews in this command area. Among ten key informants interviewed, only one reported encountering the Jullien's Golden Carp once in 2022, approximately 500 meters downstream of the reservoir facility during a flooding event (see map below). This individual stated that the species migrated upstream from the Tonle Sap during the flood season but became trapped in spillways. They added that if flooding is insufficient, fish populations decline, and rare species may no longer be present in the area.

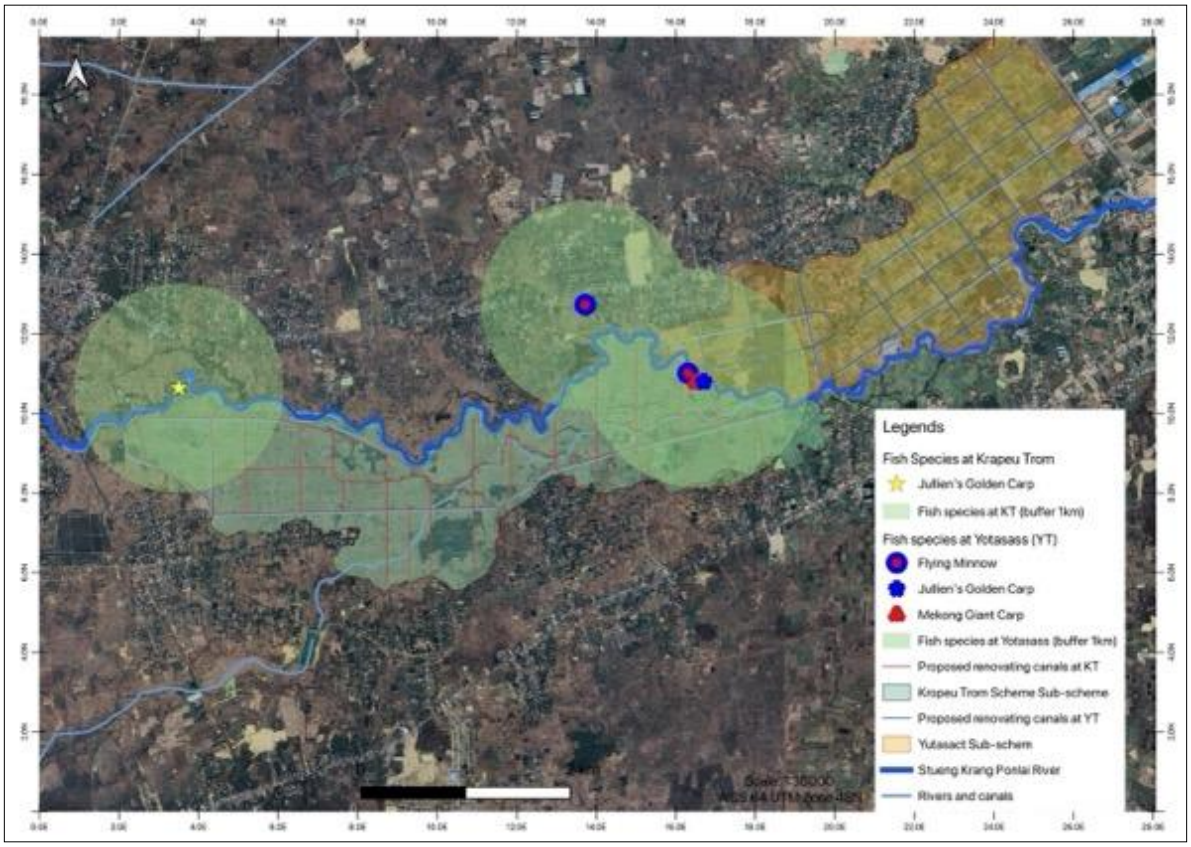

Figure 21: *A spatial distribution map was generated for four fish species at Krapeu Trom and Yotasas Command Area. 1 km buffer zones were included to approximate their minimum movement range around suitable habitats*.

4.4.4 Determination of Critical Habitat Status (Step 3)

This section assesses the information (obtained from the above sub-section) vis-a-vis the criteria (presented in Section 3.4 - CH assessment method). This assessment aims to determine whether any species qualify for Critical Habitat features.

4.4.4.1 Habitat of significant importance to CE and EN species

As presented in Section 4.4.3.3 (Ecological State), the species that qualifies as a critical habitat feature is the Flying Minnow. Krapeu Trom Command Area is part of Stueng Krang Ponlai River system (Tonle Sap's tributary) and situated approximately 11 km from Tonle Sap River. The area was influenced by flood-plus water from Stueng Krang Ponlai upstream and the push-up of flood water from Tonle Sap River Basic allowing fish to short distance migration for food and breeding.

Although climate change has caused dry and drought more frequently, this area still receives a good amount of flood from its upstream and downstream making a good connectivity and providing ecological function for migratory fish.

4.4.4.2 Habitat of significant importance to endemic or restricted-range species

None of the species under EN and CR classification are restricted-range species (based on IBAT report for sub-scheme).

4.4.4.3 Habitat supporting globally or nationally significant concentrations of migratory or congregation species

None of the IBA that are recognized for significant concentrations of migratory birds or other species are found within the vicinity of the sub-scheme. No other evidence of significant concentrations of migratory or congregatory species is available. The AoA for KT, therefore is expected to qualify as critical habitats under this criterion.

4.4.4.4 Highly threatened or unique ecosystems

Each of the reservoirs are modified habitat and is associated with numerous rice paddies. There is no evidence that these areas are highly threatened or unique ecosystems, and no critical habitats are recognized under this criterion.

4.4.4.5 Ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described above in (a) to (d)

No ecological functions that are necessary to support biodiversity values (described under the above criteria) have been identified.

4.4.5 Mitigation measures

4.4.5.1 During design

During the design phase of construction activities, it is important to consider measures that minimize impacts on biodiversity to protect natural habitats nearby. Key mitigation measures during this stage may include:

- Avoidance of important habitats: Identify important habitats within the construction area and adjust project design accordingly to avoid direct impacts on these areas.
- Buffer Zones: Establish buffer zones around important habitats where construction activities are limited or restricted to minimize disturbances.

4.4.5.2 During construction

During the actual construction phase of the project, effective mitigation measures should be implemented to further minimize impacts on biodiversity:

- Dust Control Measures: Implement dust control measures such as dampening surfaces or covering materials during earthwork activities to prevent sedimentation in nearby water bodies.
- Waste Management Practices: Properly manage waste generated from construction activities by implementing recycling programs, segregating waste types, and ensuring proper disposal procedures are followed.

4.4.5.3 During operation

After completion of construction, ongoing operation activities should also incorporate mitigation measures:

- Habitat Monitoring Program: Establish a habitat monitoring program that regularly assesses changes in biodiversity within impacted areas throughout operations.
- Water Quality Management: Implement proper water quality management practices such as minimizing pollution discharge into surrounding ecosystems through regular maintenance checks of irrigation infrastructure.
- Water Quality Monitoring: Implement a water quality monitoring program to track changes in water quality and identify potential pollution sources.
- Fish Population Monitoring: Monitor fish populations to assess the effectiveness of mitigation measures and identify any declines or threats.
- Public Awareness and Education: Conduct public awareness campaigns to educate local communities about the importance of habitat conservation and sustainable resource management.

4.5 Yutasas

4.5.1 Proposed project activities and potential risks and impacts

Given the presence of endangered and critically endangered species and the sensitive habitat in the Yotasas Yotasas command area, the proposed irrigation renovation scheme must be implemented with careful consideration to minimize negative impacts on biodiversity. By carefully considering the ecological implications of the project, it is possible to balance the needs of agriculture with the conservation of endangered species and their habitats. Under Yutasas, various activities will be carried out that cause the following E&S risks and impacts:

Table 8: Projection activities that may cause potential impacts on the environment and social aspects at Yutasas sub-scheme

No.	Project activities that cause impacts	E&S Risks & Impacts
1	Construction activities (rehabilication of canal and farm roads), land use changes, and water management practices	**Habitat loss and fragmentation** could lead to habitat loss and fragmentation, affecting species' survival and connectivity. This activity may involve dredging, excavation, or modification of existing water channels and infrastructure. These activities can lead to habitat destruction, disturbance to nesting and foraging sites,

		disruption of natural water flow patterns, and alteration of hydrological regimes. This can directly impact both terrestrial and aquatic biodiversity.
2	Increased agricultural activities, sedimentation, and pollution	Water quality degradation could impact aquatic ecosystems and species that rely on clean water.
3	Dredging of waterways and Alteration of water levels	Changes in water levels within the command area due to irrigation system renovation may negatively impact wildlife dependent on specific habitats for breeding or foraging purposes. Changes in water levels and habitat quality could force endangered species to relocate, potentially leading to competition with other species or exposure to new threats.
4	Use of chemicals and nutrient loading	If pesticides/fertilizers are used during agricultural practices within the command area as part of irrigation system renovation projects, it could lead to contamination of soil and water resources affecting both terrestrial and aquatic biodiversity.
5	Biodiversity degradation, and soil erosion	The potential impacts of the project on water flow, water quality, and sedimentation patterns. The changes in microclimate.
6	Barriers to fish migration routs	Irrigation structures, such as dams and weirs, can obstruct fish migration, preventing them from accessing critical spawning grounds or nursery areas. This disruption of their natural life cycles can lead to reduced populations and species decline. To mitigate these negative impacts, it's essential to design and operate irrigation systems with fish-friendly considerations. Addressing this issue may includes incorporating measures like fish passage facilities[10], such as fish ladders or fish lifts, to enable safe movement upstream and downstream. Additionally, implementing effective water quality management practices and raising public awareness about the importance of protecting fish populations, particularly near fish passage areas, can contribute to the conservation of aquatic ecosystems.

4.5.2 Areas of Influence

The area of influence for the Yatasas Yotasas irrigation renovation scheme encompasses the direct and indirect impacts of the project. This includes:

[10] Fish passage is essential for fish to navigate water systems and access diverse habitats. Fish passage technologies, like fish ladders, help preserve fish populations and aquatic ecosystems. Fish need to migrate 10 miles or 1,000 miles to access different habitats, food, and environments that support their life cycles.

- **Direct Impacts:** The immediate area where the irrigation infrastructure will be constructed and operated, including canals, pumping stations, and reservoirs.
- **Indirect Impacts:** The surrounding areas that may be affected by changes in water flow, land use, or other project-related activities. This includes the Stueng Krang Ponlai River, the Tonle River, and the habitats of endangered species within the Yotasas Yotasas command area.

4.5.3 Analysis to prepare for determining CH status

4.5.3.1 Critical Habitat Area of Analysis

Critical habitat is defined as an Area of Analysis (AoA), and the project's command area is used as an AoA.

4.5.3.2 Species with Potential Occurrence within the AoA

A list of threatened species with potential occurrence was generated for Yutasas. The coordinates of Yutasas (via KMZ file) are used to inform the IBAT radius of screening. Since the default radius of IBAT screening is 50km, steps were taken to narrow down to the sub-scheme's area of influence to identify only EN and CR species that are potentially present in the sub-scheme area of influence. The narrowing-down aims to practically identify EN and CR species that could be found in the sub-scheme area of influence and to determine the Critical Habitat status of the identified species. After three rounds of screening focusing on EN and CR species, 6 EN and CR species are found as potentially present in the sub-scheme area of influence. These species include 3 reptile species, and 3 fishes (See list of 11 EN and CR species in Table below).

Description of screening for narrowing down

For Yutasas, three rounds of screening have been conducted. The first screening (Round 1) was conducted in December 2023. Round 2 was carried out in April 2024, and Round 3 in August 2024. The purpose of repeated screening is to validate the screening results (for the same area) with a wide range of local stakeholders. The screening aims to identify only EN and CR species that are potentially present in the Yutasas area of influence, covering reptiles and fish. Screening was done based on the IBAT report generated and provided by the AIIB.

In the first two rounds of screening, 5 EN and CR species were identified in the Yutasas area of influence (See Table 9 below). In the 3rd round of screening (in August 2024), however, 3 (out of a total of 5 species) were confirmed as "potentially present" in the Yutasas's area of influence.

So, the assessment for Yutasas focuses on the confirmed list of **3 species of fish** that are categorized by IUCN as EN and CR species (see map in Krapeu Trom section above).

Table 9: Confirmed List of endangered and critically endangered species for the Yutasas sub-scheme

No.	Local Name	English Name	Scientific Name	IUCN Cat	Screened Species from Round 1&2 (Total=5)	Confirmed Species in Round 3 (Total = 3)
I. Reptile spices						
1	អណ្តើកព្រៃ	Elongated Tortoise	Indotestudo elongata	CR	Yes	Yes

II. Fish species						
2	ត្រីត្រសក់ក្រហម	Jullien's Golden Carp	Probarbus jullieni	CR	Yes	Yes
3	ត្រីចង្ហាស្ទឹង	Leaping barb/Flying Minnow	Laubuka caeruleostigmata	EN	Yes	Yes
4	ត្រីឆាយា /ត្រីគុណរាំង	Mekong giant barb/Giant Carp	Catlocarpio siamensis	CR	Yes	Yes
II. Bird species						
5	ទាមែ្រស្នាបស	White-winged Duck	Asarcornis scutulata	EN	Yes	No

4.5.3.3 Ecological State of Habitats within the AoA

Understanding of the ecological state of habitats is necessary to assess the Likelihood of occurrence (LoO) of the above 3 screened species - as part of the CHA. For this CHA, species were classified into four LoO categories: Present, Possible, Unlikely and Not Present. Species known to be Present or with a Possible LoO are further assessed in Step 3. This understanding takes into account the classification of habitats as either modified or natural based on levels of human-induced disturbance to species composition and ecological functions. In this session, a brief assessment of the 3 confirmed species are presented. The assessment discusses historical range, distribution, habitat conditions, current status, and potential threats identified by key informants.

The Yutasas command area has been in existence since the 1970s. This command area is a mixture of paddy fields, farm roads, and residential areas. Natural rivers, such as the Stueng Krang Ponlai, are the sole ecological and hydrological connection between its upstream watershed and the downstream Tonle Sap River basin. This river is crucial for fish migration during the flooding season. However, reservoirs, spillways, and drought conditions have disrupted these essential ecological functions.

4.5.4 Determination of Critical Habitat Status (Step 3)

This section assesses the information (obtained from the above sub-section) vis-a-vis the criteria (presented in Section 3.4 - CH assessment method). This assessment aims to determine whether any species (identified in the list of 3 EN and CR species) qualify for Critical Habitat features.

Table 10: Critical Habitat Status of each conformed species in Yutasas command Area

English Common Name	**Scientific name**	**IUCN Red List Status**	**Restricted Range**	**IBAT listing**	**Confirmed based on 3 screenings**	**Likelihood of Occurrence with AoI** (Present, Possible, Unlikely and Not Present)	**Reasons for Exclusion and data sources**	**Critical Habitat Determination of Species**
Bird species								
White-winged Duck	*Asarcornis scutulata*	EN	No	Yes	No			
Fish speices								
Jullien's Golden Carp	Probarbus jullieni	CR	No	Yes	Yes	Present (rare)	Strongly and accurately confirmed by key informants	Stueng Krang Ponlai, at the lower part of the reservors of this sub-scheme.
Leaping barb/Flying Minnow	Laubuka caeruleostigmata	EN	No	Yes	Yes	Present (rare)	Strongly and accurately confirmed by key informants	Stueng Krang Ponlai, at the lower part of the reservors of this sub-scheme.
Mekong giant barb/Giant Carp	Catlocarpio siamensis	CR	No	Yes	Yes	Present (rare)	Strongly and accurately confirmed by key informants	Stueng Krang Ponlai, at the lower part of the reservors of this sub-scheme.
Reptile Species								
Elongated Tortoise	Indotestudo elongata	CR	Np	Yes	No			

4.5.4.1 Habitat of significant importance to CE and EN species

As presented in Section 4.1.3.3 (Ecological State), species that qualify as critical habitat features include:

Based on the interviews and habitat assessments, three of the five endangered species were confirmed to be present in the Krapeu Trom section: Jullien's Golden Carp, Flying Minnow, and Mekong Giant Barb (see map above in Krapeu Trom section).

- **Jullien's Golden Carp:** A female fisher reported encountering this rare species in the lower part of the reservoir during a flood in 2022. She caught five individuals using a fishing net. The other informants had not seen this species in several years. After careful verification, it was determined that the fishers were familiar with the species and had not mistaken it for another.
- **Flying Minnow:** Two informants reported encountering this small fish species in 2022 and 2023. One caught them in the lower part of the Yotasass reservoir, where they had migrated from a downstream area. The other found them in her natural fish pond after pumping it. Both informants were confirmed to be familiar with the species.
- **Mekong giant Barb**: A key informant reported catching five individuals of this species in July 2022 after heavy rains. The fish were small, approximately 1.5 kilograms each, and were found in the lower part of the reservoir. The informant was familiar with the species and believed that they were attempting to migrate upstream but were trapped by the reservoir..

4.5.4.2 Habitat of significant importance to endemic or restricted-range species

None of the species under EN and CR classification are restricted-range species (based on IBAT report for Yutasas).

4.5.4.3 Habitat supporting globally or nationally significant concentrations of migratory or congregation species

None of the IBA that are recognized for significant concentrations of migratory birds or other species are found within the vicinity of the sub-scheme. No other evidence of significant concentrations of migratory or congregatory species is available. The AoA for Yutasas, therefore is expected to qualify as critical habitats under this criterion.

4.5.4.4 Highly threatened or unique ecosystems

Each of the reservoirs are modified habitat and is associated with numerous rice paddies. There is no evidence that these areas are highly threatened or unique ecosystems, and no critical habitats are recognized under this criterion.

4.5.4.5 Ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described above in (a) to (d)

No ecological functions that are necessary to support biodiversity values (described under the above criteria) have been identified.

4.5.5 Mitigation measures

To minimize the negative impacts of the irrigation renovation scheme on biodiversity, the following mitigation measures should be implemented:

4.5.5.1 During design

During the design phase of construction activities, it is important to consider measures that minimize impacts on biodiversity in order to protect natural habitats nearby. Key mitigation measures during this stage may include:

- Avoidance and Minimization: Plan the project to avoid these sensitive areas whenever possible. If avoidance is not feasible, minimize impacts through careful design and engineering.
- Sustainable Design: Incorporate sustainable design principles to reduce the project's environmental footprint, such as minimizing water consumption and energy use.
- Fish Passageways: If necessary, construct fish passageways to facilitate fish migration and maintain connectivity between aquatic habitats.

4.5.5.2 During construction

During the actual construction phase of the project, effective mitigation measures should be implemented to further minimize impacts on biodiversity:

- Minimizing Disturbance: Use low-impact construction techniques to minimize disturbance to habitats and wildlife.
- Erosion Control: Implement measures to prevent soil erosion, such as temporary erosion control structures and revegetation.
- Wildlife Protection: Take precautions to protect wildlife during construction, such as fencing off sensitive areas and avoiding construction activities during breeding seasons.
- Train and educate labor staff to avoid harming biodiversity during construction.

4.5.5.3 During operation

After completion of construction, ongoing operation activities should also incorporate mitigation measures:

- Water Management: Implement efficient water management practices to minimize water wastage and reduce the impact on aquatic ecosystems.
- Monitoring and Adaptive Management: Establish a monitoring program to track the project's impacts on biodiversity and adjust operations as needed to address any negative effects.
- Community-Based Conservation: Involve local communities in conservation efforts, such as habitat restoration, monitoring, and enforcement of regulations.
- Mitigation of Pollution: Implement measures to prevent pollution from the project, such as proper disposal of waste and maintenance of equipment.

- Awareness raising: Raising public awareness about endangered fish species and educating people about the importance of not catching fish at fish passage areas is crucial for their conservation.

4.5.6 Biodiversity Action Plan for three sub-schemes (Brambei Mom, Krapeu Trom, and Yutasas)

Protect and restore biodiversity within the Brambei Mom, Krapeu Trom, and Yutasas sub-schemes.

Overall, these Conservation Action Plans aim to minimize habitat loss, reduce pollution, promote sustainable water management practices, protect endangered species' habitats, raise public awareness about conservation issues, and monitor biodiversity changes over time. By implementing these measures effectively, it is possible to achieve a net gain in ecological value for these sub-schemes while balancing agricultural needs with environmental conservation.

Objectives:

- **Habitat Preservation:** Maintain and restore the ecological integrity of natural habitats, including wetlands, forests, and waterways.
- Species Conservation: Protect endangered and critically endangered species and their populations.
- **Sustainable Resource Management:** Promote sustainable agricultural practices that minimize negative impacts on biodiversity.
- **Community Engagement:** Foster local community involvement in conservation efforts.

Strategies:

- **Habitat Restoration:**
  - Restore degraded habitats through reforestation, wetland restoration, and erosion control measures.
  - Create wildlife corridors to connect fragmented habitats.
- **Species Conservation:**
  - Develop and implement species-specific conservation plans for endangered and critically endangered species.
  - Establish protected areas or reserves to safeguard critical habitats.
  - Monitor populations and track their recovery.
- **Sustainable Agriculture:**
  - Promote sustainable agricultural practices, such as organic farming and integrated pest management.
  - Provide incentives for farmers to adopt environmentally friendly methods.
- **Water Management:**
  - Improve water management practices to minimize water pollution and maintain healthy water flows.
  - Implement measures to reduce sedimentation and erosion.
  - Community Engagement:
  - Educate local communities about the importance of biodiversity conservation.

    - Involve communities in conservation efforts through participatory planning and monitoring.

Implementation:

- Partnerships: Collaborate with government agencies, NGOs, local communities, and other stakeholders to implement conservation measures.
- Monitoring and Evaluation: Establish a monitoring and evaluation framework to track progress and assess the effectiveness of conservation actions.
- Resource Allocation: Secure adequate funding and resources to support conservation activities.
- Policy Development: Advocate for policies that promote biodiversity conservation and sustainable development.

Specific Actions for Each Sub-Scheme: Based on the study's findings, specific actions could include:

- **Brambei Mom:**
    - Prioritize habitat restoration in areas affected by construction activities.
    - Implement measures to improve water quality and reduce pollution.
    - Monitor fish populations to assess the impact of irrigation practices.
- **Krapeu Trom:**
    - Focus on protecting the habitats of endangered fish species, such as the Flying Minnow.
    - Improve water flow connectivity to facilitate fish migration.
    - Implement measures to reduce sedimentation and erosion in the Stueng Krang Ponlai River.
    - For Krapeu Trom sub-scheme specifically, incorporate fish passage facilities such as fish ladders or fish lifts to enable safe movement upstream and downstream for migratory fish specie

- **Yutasas:**
    - Develop a comprehensive conservation plan for the endangered species identified in the area.
    - Protect and restore wetlands and forests within the command area.
    - Implement measures to reduce the impact of agricultural activities on biodiversity.

Additional Considerations:

- Climate Change: Incorporate climate change adaptation measures into the conservation plan.
- Monitoring and Evaluation: Develop a robust monitoring and evaluation system to track progress and adapt strategies as needed.
- Community Involvement: Ensure that local communities are actively involved in the planning, implementation, and monitoring of conservation efforts.

4.6 Stueng Krang Bat

4.6.1 Proposed project activities and potential risks and impacts

Many endangered and critically endangered species of fish and reptiles inhabit the Inandared area, a vital fish migration habitat within the Tonle Sap River Basin. The proposed Stueng Krang Bat irrigation sub-scheme aims to balance agricultural development with biodiversity conservation. Key components include the construction of irrigation canals, water storage facilities, and drainage systems to enhance water management. These infrastructure improvements will support increased agricultural productivity while minimizing negative impacts on the area's rich biodiversity.

Given the ecological significance of the Stueng Krang Bat irrigation sub-scheme and the presence of endangered and critically endangered species, any proposed project activities must be carefully planned and implemented to minimize negative impacts on biodiversity. Under Stueng Krang Bat, various activities will be carried out that cause the following E&S risks and impacts:

Table 11: Projection activities that may cause potential impacts on the environment and social aspects at Stueng Krang Bat sub-scheme

No.	Project activities that cause impacts	E&S Risks & Impacts
1	Construction activities (rehabilication of canal and farm roads), land use changes, and water management practices	**Habitat loss and fragmentation** could lead to habitat loss and fragmentation, affecting species' survival and connectivity. This activity may involve dredging, excavation, or modification of existing water channels and infrastructure. These activities can lead to habitat destruction, disturbance to nesting and foraging sites, disruption of natural water flow patterns, and alteration of hydrological regimes. This can directly impact both terrestrial and aquatic biodiversity.
2	Increased agricultural activities, sedimentation, and pollution	Water quality degradation could impact aquatic ecosystems and species that rely on clean water.
3	Dredging of waterways and Alteration of water levels	Changes in water levels within the command area due to irrigation system renovation may negatively impact wildlife dependent on specific habitats for breeding or foraging purposes. Changes in water levels and habitat quality could force endangered species to relocate, potentially leading to competition with other species or exposure to new threats.
4	Use of chemicals and nutrient loading	If pesticides/fertilizers are used during agricultural practices within the command area as part of irrigation system renovation projects, it could lead to contamination of soil and water resources affecting both terrestrial and aquatic biodiversity.
5	Biodiversity degradation, and soil erosion	The potential impacts of the project on water flow, water quality, and sedimentation patterns. The changes in microclimate.

6	Blockage of migration routes by dams or other structures	Irrigation structures, such as dams and weirs, can obstruct fish migration, preventing them from accessing critical spawning grounds or nursery areas. This disruption of their natural life cycles can lead to reduced populations and species decline. To mitigate these negative impacts, it's essential to design and operate irrigation systems with fish-friendly considerations. Addressing this issue may includes incorporating measures like fish passage facilities, such as fish ladders or fish lifts, to enable safe movement upstream and downstream. Additionally, implementing effective water quality management practices and raising public awareness about the importance of protecting fish populations, particularly near fish passage areas, can contribute to the conservation of aquatic ecosystems.
7	Biodiversity	The potential impacts of the project on water flow, water quality, and sedimentation patterns.
8	Introduction of invasive species through irrigation canals	Irrigation canals may facilitate the introduction of invasive plant or animal species into native aquatic ecosystems like Water Hyacinth, Mimosa Pigra, Tilapia etc. These invasives can outcompete native species for resources such as food and habitat space.
9	Habitat loss or degradation due to land use changes	Land use changes associated with agricultural expansion or infrastructure development can lead to habitat loss or degradation of critical areas such as wetlands or floodplain ecosystems that support diverse fish populations.

4.6.2 Areas of Influence

The area of influence for the Stueng Krang Bat irrigation sub-scheme encompasses both modified and natural habitats within its command area. It extends along the Tonle Sap River, encompassing floodplains, wetlands, and associated ecosystems. The project activities have the potential to directly or indirectly impact biodiversity within this region.

The area of influence for the Stueng Krang Bat irrigation sub-scheme includes both direct and indirect impacts. Direct impacts may occur within the project area itself, such as construction sites and irrigation canals. Indirect impacts may extend to surrounding areas, including the Tonle Sap River, wetlands, and adjacent ecosystems.

4.6.3 Analysis to prepare for determining CH status

4.6.3.1 Critical Habitat Area of Analysis

Critical habitat is defined as an Area of Analysis (AoA), and the project's command area is used as an AoA.

4.6.3.2 Species with Potential Occurrence within the AoA

A list of threatened species with potential occurrence was generated for Stueng Krang Bat (SKB). The coordinates of SKB (via KMZ file) are used to inform the IBAT radius of screening. Since the default radius of IBAT screening is 50km, steps were taken to narrow down to the sub-scheme's area of influence to identify only EN and CR species that are potentially present in the sub-scheme area of influence. The narrowing-down aims to practically identify EN and CR species that could be found in the sub-scheme area of influence and to determine the Critical Habitat status of the identified species. After three rounds of screening focusing on EN and CR species, 5 EN and CR species are found as potentially present in the sub-scheme area of influence. These species include 3 reptile species, and 2 fishes (see a list of 6 EN and CR species in Table 13 below).

Description of screening for narrowing down

For Ou Ta Paong, three rounds of screening have been conducted. The first screening (Round 1) was conducted in December 2023. Round 2 was carried out in April 2024, and Round 3 in August 2024. The purpose of repeated screening is to validate the screening results (for the same area) with a wide range of local stakeholders. The screening aims to identify only EN and CR species that are potentially present in the SKB area of influence, covering reptiles, mammals, fish, birds, amphibians, and aquatic plants. Screening was done based on the IBAT report generated and provided by the AIIB.

In the first two rounds of screening, 5 EN and CR species were identified in the SKB area of influence (See Table below). In the 3rd round of screening (in August 2024), however, 6 (one additional critically endangered species) were confirmed as "potentially present" in the OTP's area of influence.

So, the assessment for SKB focuses on the confirmed list of 6 species that are categorized by IUCN as EN and CR species including 3 reptile species (Asian giant softshell turtle, Black Marsh Turtle and Southeast Asian Box Turtle) and 3 fish species (Striped catfish, Mekong Giant Barb and Siamese Tiger Perch). See Table below for the list of confirmed species and see Figure 1 for potential locations of these species in the project's area of influence.

Table 12: List of endangered and critically endangered species based on the IBAT Screening result vs. key informant interview at Stueng Krang Bat Sub-scheme

No.	Local Name	English Name	Scientific Name	IUCN Cat	Screened Species from Round 1&2 (Total=5)	Confirmed Species in Round 3 (Total = 3)
I. Reptile spices						
1	កន្ធាយក្បាលធង្គ់	Asian giant softshell turtle	Pelochelys cantorii	CR	No	Yes
2	អណ្តើកព្រ័ត	Black Marsh Turtle	Siebenrockiella crassicollis	EN	Yes	Yes
3	អណ្តើកបិទមុខ	Southeast Asian Box Turtle	Cuora amboinensis	EN	Yes	Yes
III. Fish species						

4	ត្រីព្រាធំ	Striped catfish	Pangasianodon hypophthalmus	EN	Yes	Yes
5	ត្រីកាហា /ត្រីគុលរាំង	Mekong Giant Barb	Catlocarpio siamensis	CR	Yes	Yes
6	ត្រីកន្ត្រៃប៉ខ្ពា	Siamese Tiger Perch	Datnioides pulcher	CR	Yes	Yes

4.6.3.3 Ecological State of Habitats within the AoA

Understanding of the ecological state of habitats is necessary to assess the Likelihood of occurrence (LoO) of the above 11 screened species - as part of the CHA. For this CHA, species were classified into four LoO categories: Present, Possible, Unlikely and Not Present. Species known to be Present or with a Possible LoO are further assessed in Step 3. This understanding takes into account the classification of habitats as either modified or natural based on levels of human-induced disturbance to species composition and ecological functions. In this session, a brief assessment of the 11 confirmed species are presented. The assessment discusses historical range, distribution, habitat conditions, current status, and potential threats identified by key informants.

The SKB command area has been in existence since the 1970s. The SKB is a mixture of paddy fields, farm roads, and residential areas. The Stueng Krang Bat (SKB) irrigation sub-scheme was initially screened for a biodiversity assessment, utilizing the Integrated Biodiversity Assessment (IBAT) approach and key informant interviews. Located on the edge of the Tonle Sap River and annual floodplains of the Tonle Sap and Mekong Rivers, this area holds significant ecological importance. The initial screening identified six EN and CR of reptiles and fish species for this command area. These included the Black Marsh Turtle, Southeast Asia Box Turtle, Striped catfish, Mekong giant barb/Giant Carp, and Siamese Tiger Perch.

Upon conducting key informant interviews (KII), it was confirmed that several endangered (EN) and critically endangered (CR) species inhabit SKB. These included reptiles such as the Black Marsh Turtle, Southeast Asia Box Turtle, and Asian giant softshell turtle along with fish species like Striped catfish, Mekong giant barb/Giant Carp, and Siamese Tiger Perch. The confirmation of these vulnerable species underscores the ecological significance of SKB's command area (see map below).

This information emphasizes the importance of further biodiversity surveys in this region to comprehensively document all wildlife present. Furthermore, these findings highlight potential conservation efforts needed to protect these threatened or endangered species identified through initial screening at SKB.

Ten key informants were selected in collaboration with the commune council and village chiefs for interviews. These individuals were chosen based on their extensive local ecological knowledge and experience in fishing within their communities. The following paragraphs summarize the key information gathered from interviews regarding each confirmed species.

.

4.6.3.3.1 **Reptiles (3 species)**

Asian giant softshell turtle: This species was not initially screened for interviews at this sub-scheme but was confirmed during the interview process. Only one informant reported encountering the Asian Giant Softshell Turtle in 2024 at Boeung Thom. This extremely rare species was last sighted by this informant many years ago. It prefers large lakes and river

systems with abundant vegetation and flooded forests. The remaining key informants had not seen this species in many years, and some had never encountered it in their lifetimes.

Black Marsh Turtle: Two key informants confirmed their familiarity with this species. One informant reported encountering the Black Marsh Turtle in the area over a decade ago but has not seen it since then. A second informant also recalled encountering the species more than ten years ago, but not within the specific command area.

Southeast Asian Box Turtle: Five key informants confirmed their familiarity with the Southeast Asian Box Turtle. Two of these informants reported encountering the species in the Boeung Thom and Rek Trors areas in 2022. Another two informants encountered the turtle 7 years ago near the spillway close to the village and in Reahny Longvaek, which has since been converted into a real estate development project. One informant reported seeing the species in the same location for over a decade but has not observed it recently.

4.6.3.3.2 Fish Species

Striped Catfish: The local fishermen in the Stueng Kran Bat Command Area have consistently encountered the Striped Catfish species during the flooding season for several years. However, they have noticed a rapid decline in population size, with individuals being caught at much smaller sizes. The estimated catch by comparison to previous years is only around 30%. The fishermen report encountering these fish annually during full flooding and receding periods, with sightings randomly occurring within approximately 900m distance surrounding the village area. These fish typically migrate from the Tonle Sap Lake to the Stueng Kraing Ponlai River in August or September, depending on flood levels. Once in the Stueng Kraing Ponlai River, they disperse throughout the floodplain during the flooding season. All key informants reported consistently catching this species in the following areas for all reported fish species: Veal Braing (the floodplain area around the village), Trek Tor, Boeung Kralor Meach, Boeung Braing, Stueng Krang Ponlay River, Boeung Thom, and Boeung Toek La-ork.

Mekong Giant Barb: Local fishermen in the Stueng Kran Bat Command Area have consistently encountered the Mekong Giant Barb species during the flooding season for several years. However, they have noticed a rapid decline in population size, with individuals being caught at much smaller sizes. The fishermen do not intentionally target these fish species they are at the fingerling stage, but they often become trapped in line nets. Two of the fishermen mentioned that they had encountered this species around a decade ago but stopped going out for fishing for many years. Seven fishermen reported encountering them every year during flooding and early receding periods near the village and within the floodplain area.

The catch sizes are small during flooding season but grow significantly (2 to 3 km per individual) during receding periods. Another fisherman noted that there has been a decrease in both catch amounts and size of these fish over time, with fewer being caught with nets each year. They also mentioned that some of these fish get stuck in large lakes near the Tonle Sap River when floods occur. Overall, it is estimated that there has been a significant decline of more than 70% in catch amounts, and today's Mekong Giant Barb are much smaller compared to previous years at this time of year due to their rarity and the delay and not enough floods.

Striped Catfish: The information provided by the local fishermen regarding the Striped Catfish species in the command area is varied. Two of them reported recent sightings in 2022 and 2023 between 3 to 5 individuals per catch, while one informant mentioned their last encounter was 7 years ago, and two others stated that they haven't seen this species in over a decade. The encounters typically occurred during flooding and receding periods. The number of individuals

caught has been very low, and the size of the fish has been decreasing year by year. One fisherman mentioned that he encountered this species in the Tonle Sap River but not around the village area.

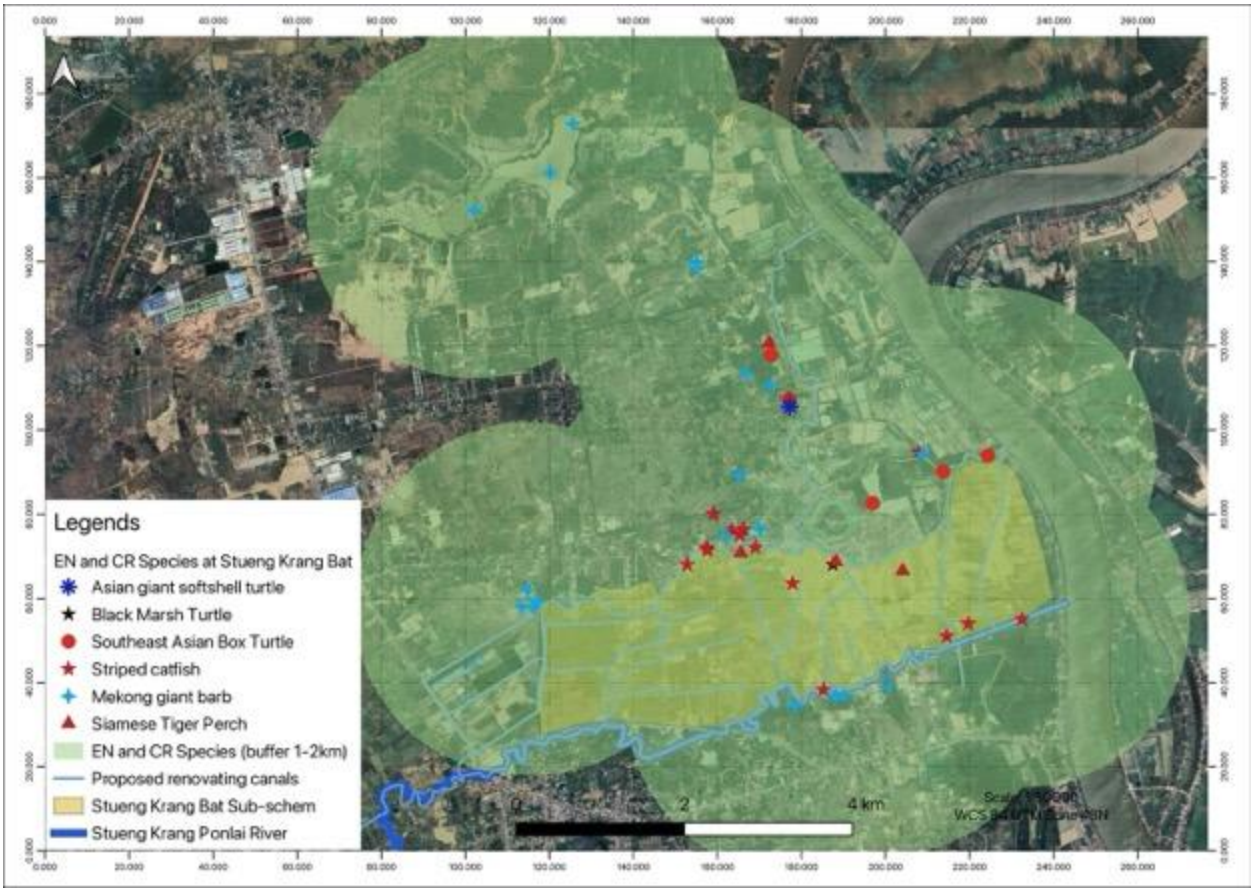

Figure 22: *Map showing the distribution of endangered (EN) and critically endangered (CR) species, with 1-2 km buffers indicating their potential movement ran ge within and around suitable habitats as identified by key informants sighted from 2020 to 2024.*

4.6.4 Determination of Critical Habitat Status (Step 3)

This section assesses the information (obtained from the above sub-section) vis-a-vis the criteria (presented in Section 3.4 - CH assessment method). This assessment aims to determine whether any species (identified in the list of 11 EN and CR species) qualify for Critical Habitat features.

Table 13: Critical Habitat Status of each conformed species in SKB Command Area

English Common Name	**Scientific name**	**IUCN Red List Status**	**Restricted Range**	**IBAT listing**	**Confirmed based on 3 screenings**	**Likelihood of Occurrence with AoI** (Present, Possible, Unlikely and Not Present)	**Reasons for Exclusion and data sources**	**Critical Habitat Determination of Species**
Fish speices								
Striped catfish	Pangasianodon hypophthalmus	EN	No	Yes	Yes	Present (rare)	Strongly and accurately confirmed by key informants	Tonle Sap Floodplain and Stueng Krang Ponlai.
Mekong Giant Barb	Catlocarpio siamensis	CR	No	Yes	Yes	Present (rare)	Strongly and accurately confirmed by key informants	Tonle Sap Floodplain and Stueng Krang Ponlai.
Siamese Tiger Perch	Datnioides pulcher	CR	No	Yes	Yes	Present (rare)	Strongly and accurately confirmed by key informants	Tonle Sap Floodplain and Stueng Krang Ponlai.
Reptile Species								
Asian giant softshell turtle	Pelochelys cantorii	CR	No	No	Yes	Unlikely	Strongly and accurately confirmed by key informants	Tonle Sap Floodplain and Stueng Krang Ponlai.
Black Marsh Turtle	Siebenrockiella crassicollis	EN	No	Yes	Yes	Present (rare)	Strongly and accurately confirmed by key informants	Tonle Sap Floodplain and Stueng Krang Ponlai.
Southeast Asian Box Turtle	Cuora amboinensis	EN	No	Yes	Yes	Possible (rare)	Strongly and accurately confirmed by key informants	Tonle Sap Floodplain and Stueng Krang Ponlai.

4.6.4.1 Habitat of significant importance to CE and EN species

As presented in Section 4.6.3.3 (Ecological State), species that qualify as critical habitat features include:

The habitat assessment identified both modified and natural habitats within the command area. Modified habitats include areas substantially altered by human activity, such as agricultural land, natural lakes, wetlands, and river systems. Natural habitats consist of viable assemblages of native plants and animals, where primary ecological functions and species composition remain largely intact. Identifying critical habitats is essential for understanding the ecological requirements of different fish species within the project areas. The critical habitats identified in the assessment are diverse and support a range of endangered and critically endangered species. These habitats include:

- **Floodplains:** The floodplains, particularly those connected to the Tonle Sap Lake and Mekong River, provide important habitats for fish species during the flooding season. These areas are periodically inundated, creating a dynamic ecosystem that supports fish migration, spawning, and feeding.
- **Rivers and Streams:** The rivers and streams within the sub-schemes serve as crucial habitats for fish migration and spawning. The Stueng Krang Ponlai River in Krapeu Trom sub-scheme plays a vital role in connecting upstream watersheds to the Tonle Sap River basin.
- **Wetlands:** Wetlands such as marshes, swamps, lakes, and ponds are critical for supporting aquatic biodiversity. They provide breeding grounds for fish species and serve as important habitats for reptiles like Black Marsh Turtle and Southeast Asia Box Turtle.
- **Aquatic Vegetation:** Aquatic plants play a key role in providing food, shelter, and spawning sites for various fish species. They contribute to the overall health of aquatic ecosystems by improving water quality through nutrient uptake.

4.6.4.2 Habitat of significant importance to endemic or restricted-range species

None of the species under EN and CR classification are restricted-range species (based on IBAT report for SKB).

4.6.4.3 Habitat supporting globally or nationally significant concentrations of migratory or congregation species

This command area lies on the heart of Tonle Sap River Basin (TSRB) receiving annual flooding and submerging under the water seasonally. The whole floodplain area provides a signification congregation under the water during the wet season from August or September to January or February (depending on the flood situation) creating significant habitat for migratory fish, congregating downstream to upstream and vice versa..

4.6.4.4 Highly threatened or unique ecosystems

The Stueng Krang Bat irrigation sub-scheme is located in an area of high ecological importance within the Tonle Sap River system. The area is characterized by its proximity to the Tonle Sap Lake, the Mekong River, and their connecting channels, which provide a diverse range of

habitats for fish species. This complex network of waterways supports a diverse range of fish species, making it a global hotspot for aquatic life. The confirmed presence of endangered and critically endangered species in the sub-scheme area highlights its ecological significance..

4.6.4.5 Ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described above in (a) to (d)

Stueng Kang Ponlai or Krang Bat and its floodplain area serve as critical habitat for EN and CR species of fish and reptiles. These ecological functions are necessary to support biodiversity values (described under the above criteria). Protecting flooded forest habitats and maintaining hydrological functions and connectivity are key to securing the free movement of these rare species.

4.6.5 Mitigation measures

To minimize the negative impacts of the irrigation sub-scheme on biodiversity, the following mitigation measures should be implemented:

4.6.5.1 During design

During the design phase of the Stueng Krang Bat irrigation sub-scheme, careful consideration should be given to incorporating measures that minimize potential impacts on biodiversity. This includes:

- Designing fish-friendly structures for water diversions and crossings: To ensure the continuity of fish migration and minimize habitat fragmentation, it is important to design infrastructure such as weirs, dams, and culverts with features that allow fish passage. Fish ladders, bypass channels, or nature-like fishways can be incorporated into these structures to facilitate the upstream and downstream movement of fish.
- Corridor Design: Incorporate biological corridors into the design, connecting fragmented habitats to promote species movement and enhance ecological connectivity.
- Ecosystem Restoration: Implement strategies for ecosystem restoration, such as reestablishing native vegetation or reintroducing locally extinct species in degraded areas.
- Avoidance and Minimization: Plan the project to avoid these sensitive areas whenever possible. If avoidance is not feasible, minimize impacts through careful design and engineering.
- Sustainable Design: Incorporate sustainable design principles to reduce the project's environmental footprint, such as minimizing water consumption and energy use.
- Fish Passageways: Construct fish passageways to facilitate fish migration and maintain connectivity between aquatic habitats.

4.6.5.2 During construction

During the construction phase of the sub-scheme, it is essential to implement mitigation measures that minimize disturbances and protect biodiversity:

- Maintaining ecological flows in rivers and streams: It is crucial to maintain natural flow regimes in rivers and streams to support the ecological functions of these habitats. This can be achieved by setting minimum flow requirements during critical periods for fish

migration or reproduction. Water allocation plans should consider the needs of both human water use and environmental flows.

- Preventing the introduction of invasive species: Measures should be taken to prevent the introduction of invasive plant or animal species into native aquatic ecosystems through irrigation canals or other means. This can include regular cleaning and maintenance of irrigation infrastructure to remove potential invasive species propagules, as well as implementing biosecurity measures at canal entrances.
- Environmental Management Plan: Develop and implement an Environmental Management Plan (EMP) that includes specific measures to prevent habitat destruction, minimize sedimentation, control erosion, manage construction waste properly, and prevent water bodies.
- Buffer Zones: Establish buffer zones around sensitive habitats or critical ecosystems to protect them from direct impacts associated with construction activities.
- Habitat Protection Measures: Implement measures to protect nesting grounds, breeding sites, or other critical habitats during construction activities by implementing exclusion zones or temporary relocation strategies.
- Minimizing Disturbance: Use low-impact construction techniques to minimize disturbance to habitats and wildlife.
- Erosion Control: Implement measures to prevent soil erosion, such as temporary erosion control structures and revegetation.
- Wildlife Protection: Take precautions to protect wildlife during construction, such as fencing off sensitive areas and avoiding construction activities during breeding seasons.
- Train and educate labor staff to avoid harming biodiversity during construction.

4.6.5.3 During operation

Once the sub-scheme is operational:

- Monitoring Programs: Establish long-term monitoring programs to assess any ongoing impact on biodiversity during operation and ensure early detection of any adverse effects.
- Adaptive Management Approach: Adopt an adaptive management approach that allows for adjustments in operational practices based on monitoring results and changing environmental conditions.
- Ecological Education Programs: Develop educational programs for local communities about environmental conservation practices related to agriculture activities within affected communities
- Water Management: Implement efficient water management practices to minimize water wastage and reduce the impact on aquatic ecosystems.
- Community-Based Conservation: Involve local communities in conservation efforts, such as habitat restoration, monitoring, and enforcement of regulations.
- Mitigation of Pollution: Implement measures to prevent pollution from the project, such as proper disposal of waste and maintenance of equipment.
- Monitoring fish populations and water quality to assess the effectiveness of mitigation measures: Regular monitoring programs should be established to assess changes in fish populations over time, including abundance, distribution, size structure, and diversity.

Monitoring should also include assessing water quality parameters such as temperature, dissolved oxygen levels, nutrient concentrations, and pollutant levels.

- Habitat rehabilitation initiatives - restore degraded habitats by removing obstructions (e.g., dams), improving water quality through erosion control measures (e.g., reforestation), promoting riparian vegetation planting along river banks etc

4.6.6 Conservation action for Stueng Krang Bat Sub-scheme

A comprehensive Biodiversity Action Plan (BAP) should be developed to achieve net gain in biodiversity with clear outline below:

Proposed Conservation Action Plan for Stueng Krang Bat Irrigation Sub-Scheme

Executive Summary

This conservation action plan outlines strategies to mitigate potential negative impacts on biodiversity within the Stueng Krang Bat irrigation sub-scheme. The plan is based on a thorough assessment of the area's biodiversity, including the identification of endangered and critically endangered species. The proposed actions align with the International Finance Corporation's Performance Standard 6 (PS6) on biodiversity conservation and sustainable management of living natural resources.

Key Objectives

Protect endangered species: Implement measures to conserve the Black Marsh Turtle, Southeast Asian Box Turtle, Striped Catfish, Mekong Giant Barb, and Siamese Tiger Perch.

Maintain habitat quality: Preserve and restore critical habitats, including floodplains, rivers, wetlands, and aquatic vegetation.

Minimize negative impacts: Reduce the adverse effects of irrigation activities on biodiversity through careful planning and implementation.

Engage with stakeholders: Foster collaboration with local communities, government agencies, and other stakeholders to ensure effective conservation efforts.

Action Plan

1. Biodiversity Assessment and Monitoring

- Conduct comprehensive biodiversity surveys: Regularly assess the distribution and abundance of endangered and critically endangered species within the sub-scheme.
- Monitor habitat conditions: Track changes in water quality, sedimentation patterns, and habitat fragmentation.
- Evaluate the effectiveness of mitigation measures: Assess the impact of conservation actions on biodiversity and adjust strategies as needed.

2. Habitat Protection and Restoration

- Identify and protect critical habitats: Delineate and conserve areas of high ecological significance, such as floodplains, wetlands, and river systems.
- Restore degraded habitats: Implement habitat restoration measures, including reforestation, wetland restoration, and removal of invasive species.
- Maintain ecological flows: Ensure that irrigation practices do not compromise the natural flow regimes of rivers and streams.

- Protect fish passage: Incorporate fish-friendly structures and practices to facilitate fish migration and connectivity.

3. Mitigation Measures

- Avoidance and minimization: During project planning and design, prioritize avoidance of sensitive habitats and minimize impacts through careful site selection and engineering.
- Habitat protection: Implement measures to protect critical habitats during construction and operation, such as establishing buffer zones and avoiding disturbance of nesting sites.
- Water quality management: Control pollution and sedimentation to maintain water quality for aquatic species.
- Invasive species control: Prevent the introduction and spread of invasive species through appropriate management practices.
- Community-based conservation: Engage local communities in conservation efforts, such as habitat restoration and monitoring.

4. Stakeholder Engagement

- Involve local communities: Collaborate with residents and stakeholders to understand their concerns and knowledge about biodiversity.
- Establish participatory platforms: Create mechanisms for ongoing dialogue and decision-making.
- Promote awareness: Raise public awareness about the importance of biodiversity conservation and the potential impacts of irrigation schemes.

5. Collaboration with Conservation Organizations:

- Collaborate with recognized conservation organizations or academic institutions specializing in reptile/fish research for technical support in monitoring activities and best practices for habitat management.

6. Environmental Education Programs:

- Implement environmental education programs targeting local communities aimed at raising awareness about the importance of protecting critical habitats and promoting sustainable agricultural practices that minimize negative impacts on wildlife.

7. Fish-friendly Infrastructure Design:

- Ensure that all infrastructure development (such as canals, weirs) is designed with fish-friendly features like fish ladders or bypass channels to allow safe fish migration upstream/downstream during different seasons.

8. Invasive Species Control Measures:

- Develop invasive species control measures specific to irrigation canals to prevent the introduction/spread of invasive plant or animal species into native aquatic ecosystems like water hyacinth or tilapia fish.

Conclusion

This conservation action plan provides a framework for protecting biodiversity within the Stueng Krang Bat irrigation sub-scheme. By implementing these strategies, the plan aims to contribute to the long-term conservation of endangered species and the maintenance of healthy ecosystems in the Tonle Sap River Basin.

5 Key Considerations

The low section of this area is rich in biodiversity. By the way, some endangered and critically endangered bird species like Greater Adjutant, Milky Stork, and Bengal Florican are confirmed at the lower section of this area, and critically endangered fish of Siamese Tiger Perch and Critically Endangered Black Mash Turtle are confirmed at the upper part of this area at Boeung Kamsaeng Lake and Svay Daunkav River. Furthermore, four other EN and CR species of reptile including the Black Mash Turtle, Southeast Asian Box Turtle, Giant Asian Pond Turtle, and Elongated tortoise and two CR mammal species including the Indochinese Silvered Langur and Long-tailed Macaque are confirmed in the flooded forest habitat and natural lack in adjacent to the lower section of this command area's boundary. Those bird species are using seasonal wetlands, lakes, waterholes, grasslands, and fellow rice fields as their foraging habitat. Lum Hach is especially important for Green Peafowl. These species have small populations and are highly dependent on their habitats.

The fish surveys conducted in Krapeu Trom and Stueng Krang Bat irrigation sub-schemes have revealed the presence of various fish species, including endangered and critically endangered ones. The information gathered from key informant interviews provides insights into the abundance and distribution of these species within the project areas. Based on assessment results for Krapeu Trom sub-scheme at least two rare fish species have been confirmed present from 2020 to 2024 - Isok barb/Jullien's Golden Carp (Probarbus jullieni)and Leaping barb/Flying Minnow (Laubuka caeruleostigmata). On Yotasas Irrigation subscheme at least three endangered species had been confirmed present - Jullien's Golden Carp; Flying Minnow; and Mekong Giant Barb. And finally at Stueng Krang Bat Subscheme three EN/CR fish species –the Striped catfish; Mekong Giant barb; Siamese Tiger Perch

The key considerations from these findings are the importance of prioritizing ecological considerations during the design phase, implementing strict environmental safeguards during construction, and engaging in ongoing monitoring and adaptive management during the operation phase. Additionally, educating staff on biodiversity concerns, involving local communities in conservation efforts, promoting sustainable land use practices, establishing habitat protection measures, considering biodiversity offsets for significant residual impact, cultivating community-based conservation initiatives should also be prioritized. These actions are essential for mitigating potential impacts on biodiversity and maximizing the benefits of both OTP, LH and ather 4 sub-schems. Bellow are key interventions should considered and adopted for sustainable development an protection for biodivesity and ecosytem.

Habitat Conservation and Restoration:

- Critical Habitats: Identify and protect critical habitats, such as flooded forests, wetlands, and areas important for endangered species.
- Habitat Restoration: Implement measures to restore degraded habitats and improve their suitability for biodiversity.

Sustainable Resource Management:

- Fishing Practices: Promote sustainable fishing practices to prevent overfishing and protect fish populations.

- Agriculture: Encourage sustainable agricultural practices that minimize negative impacts on biodiversity and water quality.
- Water Management: Implement sustainable water management practices to ensure adequate water availability for both human needs and ecological functions.

Community Engagement and Participation:

- Involvement: Involve local communities in decision-making, monitoring, and conservation efforts to build ownership and support.
- Sustainable Livelihoods: Promote sustainable livelihoods that are compatible with biodiversity conservation.

Monitoring and Evaluation

- Regular Monitoring: Establish a long-term monitoring program to track changes in habitat quality, species populations, and the effectiveness of mitigation measures.
- **Adaptive Management:** Be prepared to adjust conservation strategies based on monitoring results and changing conditions.

Policy and Governance

- Strengthened Policies: Ensure that existing policies and regulations are adequate for protecting biodiversity and promoting sustainable resource management.
- Enforcement: Enforce environmental laws and regulations to prevent illegal activities that harm biodiversity.
- Institutional Capacity: Strengthen the capacity of government agencies and NGOs to effectively implement conservation measures.

A quick conclusion from this first assessment and observation, these healthy flooded forest and wetland ecosystem are exposed to high risk to more land encroachment and conversion for agricultural expansion when the water are available in the area. The expansion of irrigation and agricultural intensification can pose significant threats to flooded forest habitats, wetlands, and critically endangered species. Here are some of the major threats associated with these activities: anticipated

a. Habitat Loss and Fragmentation

- Conversion of Land: Flooded forests and wetlands may be drained or filled to create more arable land for agriculture, leading to significant loss of habitat.
- Fragmentation: Remaining natural habitats may become isolated patches, making it difficult for species to migrate, find mates, and maintain healthy populations.

b. Alteration of Water Regimes

- Water Extraction: Increased irrigation often involves the extraction of large volumes of water from rivers and aquifers, altering natural water flows and drying out wetlands.
- Flood Control Measures: The construction of dams and levees for irrigation can disrupt the natural flooding cycles that many species depend on for breeding and feeding.

c. Pollution

- Nutrient Runoff: Fertilizers used in agriculture can run off into water bodies, causing eutrophication, which leads to algal blooms and decreased oxygen levels that can harm aquatic life.
- Pesticides and Herbicides: These chemicals can contaminate water sources, posing risks to aquatic species and entering the food chain, affecting predators.

d. Invasive Species

- Introduction of Non-Native Species: Changes in land use and water management can introduce invasive plant and animal species that outcompete native species and alter ecosystem dynamics.

e. Loss of Biodiversity

- Species Decline: Habitat loss and degradation can lead to declines in species populations, particularly those already classified as critically endangered.

  Disruption of Ecosystem Services: The loss of biodiversity can disrupt ecosystem services such as water purification, flood control, and carbon storage.

Citations

Chua, S. D. X., Lu, X. X., Oeurng, C., Sok, T., and Grundy-Warr, C. (2022). Drastic decline of flood pulse in the Cambodian floodplains (Mekong River and Tonle Sap system), Hydrol. Earth Syst. Sci., 26, 609–625.

Ahmad, A.B. (2019). Probarbus jullieni. The IUCN Red List of Threatened Species 2019: e.T18182A1728224.

ASAP. (2023). Pilot reintroduction of Elongated Tortoise in Cambodia. Asian Species Action Partnership.

Auliya, M. (2007). An Identification Guide to the Tortoises and Freshwater Turtles of Brunei Darussalam, Indonesia, Malaysia, Papua New Guinea, Philippines, Singapore and Timor Leste. TRAFFIC Southeast Asia, Petaling Jaya, Malaysia. pp. 90.

Beastall, C.A. and Chng, S.C.L. (2021). Identification of Commonly Traded Wildlife in Southeast Asia. TRAFFIC, Southeast Asia Regional Office, Petaling Jaya, Selangor, Malaysia.

BirdLife International. (2016). *Green Peafowl - BirdLife Species Factsheet*. [Online]

BirdLife International. (2019). Heliopais personatus (Masked Finfoot). The IUCN Red List of Threatened Species.

BirdLife International. (2020). Species factsheet: Milky Stork Mycteria cinerea.

BirdLife International. *(2023). Asarcornis scutulata.* The IUCN Red List of Threatened Species 2023: e.T22725367A193011912.

BirdLife International. (2023). *Emberiza aureola*. The IUCN Red List of Threatened Species 2023: e.T22722631A198764946.

BirdLife International. (2023). Species factsheet: Bengal Florican Houbaropsis bengalensis.

CMS Secretariat. (2017). *International Single Species Action Plan for the Conservation of the Yellow-breasted Bunting (Emberiza aureola)*. Technical Series No. 47. Bonn, Germany: Convention on the Conservation of Migratory Species of Wild Animals.

Cota, M., Hoang, H., Horne, B.D., Kusrini, M.D., McCormack, T., Platt, K., Schoppe, S. and Shepherd, C. 2020. Cuora amboinensis. The IUCN Red List of Threatened Species 2020.

Cota, M., Horne, B.D. and Shepherd, C. 2021. Heosemys grandis. The IUCN Red List of Threatened Species 2021: e.T9943A3152603.

Cox, M.J., Van Dijk, P.P., Nabhitabhata, J. and Kumthorn, T. (2010). A Photographic Guide to Snakes and Other Reptiles of Peninsular Malaysia, Singapore and Thailand. New Holland Publishers (UK) Ltd. pp. 144.

Das, I. (2010). A Field Guide to the Reptiles of South-East Asia. New Holland Publishers (UK), England. pp. 369.

Deloya-Olvera, C., et al. (2023). Exploring the Bioactive Potential of Calostoma insigne, an Endangered Culinary Puffball Mushroom, from Northeastern Thailand. Foods, 13(1), 113.

Department of Forestry and Wildlife (2020). National Biodiversity Strategy and Action Plan for Cambodia.

Hansen, M.F., Ang, A., Trinh, T.T.H., Sy, E., Paramasivam, S., Ahmed, T., Dimalibot, J., Jones-Engel, L., Ruppert, N., Griffioen, C., Lwin, N., Phiapalath, P., Gray, R., Kite, S., Doak, N., Nijman, V., Fuentes, A. and Gumert, M.D. 2022. Macaca fascicularis (amended version of 2022 assessment). The IUCN Red List of Threatened Species 2022: e.T12551A221666136.

Harris, R. B., Davies, V. D., Bun Keanwet, O., and Edgar, N. (2009). Distribution, status and conservation of the Bengal Florican Houbaropsis bengalensis in Cambodia. Bird Conservation International, 19(4), 371-378.

Hearn A., Ross J., Wilting A., Gray T.N.E., Kamler J.F. and Lynam A.J. (2016). Cuon alpinus (errata version published in 2019). The IUCN Red List of Threatened Species 2016: e.T5953A163903232.

Hendrie D., Timmins R.J., Nguyen T.Q., Do V.N., and Pham C.T.T (2018). Cuora amboinensis (Amboina box turtle): A new country record from northeastern Cambodia.

Hendrie D., Timmins R.J., Nguyen T.Q., Do V.N., and Pham C.T.T (2018). Cuora amboinensis (Amboina box turtle): A new country record from northeastern Cambodia.

Heng**,** et al. **(**2016). The hairy-nosed otter Lutra sumatrana in Cambodia: distribution and notes on ecology and conservation. Cambodian Journal of Natural History, 2, 1-10.

IUCN SSC Amphibian Specialist Group (2016). "Philautus cardamonus". IUCN Red List of Threatened Species. 2016: e.T58826A85539866. doi:10.2305/IUCN.UK.2016-3.RLTS.T58826A85539866.en

IUCN SSC Asia Bat Specialist Group. (2022). Pteropus vampyrus (errata version published in 2022). The IUCN Red List of Threatened Species 2021: e.T18766A167209519.

IUCN. (2019). Indotestudo elongata, 096. The IUCN Red List of Threatened Species 2019: e.T96A12017882. IUCN Tortoise and Freshwater Turtle Specialist Group.

IUCN. (2021). *Pelochelys cantorii*. The IUCN Red List of Threatened Species.

IUCN. (2023). Siebenrockiella crassicollis. The IUCN Red List of Threatened Species. Version 2023-2.

Juffe Bignoli, D. 2011. *Terniopsis chanthaburiensis*. *The IUCN Red List of Threatened Species* 2011: e.T195173A8949165.

Khmer Times (2023). Endangered hairy-nosed otters found in four provinces. https://www.khmertimeskh.com/501196138/endangered-hairy-nosed-otters-found-in-four-provinces/

Loveridge, A., Gray, D., Phan, N., and Duckworth, J. W. (2017). Abundance estimates for the endangered green peafowl Pavo muticus in Cambodia: identification of a globally important site for conservation. *Bird Conservation International*, 27(1),

Mahood, S. (2019). Catastrophic ongoing decline in Cambodia's Bengal Florican Houbaropsis bengalensis population. Bird Conservation International, 30(2), 1-15.

McGowan, G., Zhang, Z., Lei, F., and Li, Y. (2018). Status and distribution changes of the endangered Green Peafowl (Pavo muticus) in China over the past three decades (1990s–2017). *Avian Research, 11*, 1-13.

McLeod C.R., Horne B.D., Murphy J.C., and Chea R. (2011). Current Status of Heosemys grandis (Giant Asian pond turtle) wild populations at Phnom Tamao Wildlife Rescue Centre near Phnom Penh.

Mekong River Commission (MRC). (n.d.). Mekong Fish species - Probarbus jullieni and Probarbus labeamajor. archive.iwlearn.net

MoE. (2026). National Biodiversity Status Report 2016. Ministry of Environment, Cambodia.

Ngadin, A.A. 2019. *Calostoma insigne*. *The IUCN Red List of Threatened Species* 2019: e.T125434353A125435555

Nguyen, T. T. K., Nguyen, V. H., Phan, T. V., Nguyen, T. T. H., and Nguyen, H. T. (2023). From Staple Food to Scarce Resource: The Population Status of an Endangered Striped Catfish Pangasianodon hypothalamus in the Mekong River, Cambodia. Water, 15(11), 9103.

Noor, Y. R., Umar, A., Mardiasuti, A., Gumilang, R. S., and Iqbal, M. (2020). Observation of Milky Stork Mycteria cinerea breeding on Pulau Dua, Banten, Indonesia, after 45 years. SIS Conservation, 2, 29-32.

Ohler, A., Swan, S.R., and Daltry, J.C. (2002). A recent survey of the amphibian fauna of the Cardamom Mountains, Southwest Cambodia with descriptions of three new species. Raffles Bulletin of Zoology, 50(2), 465-481.

Platt S.G., Ko W.K., Rainwater T.R., and Lee J.C.I. (2017). First record of Heosemys grandis from Siem Reap Province based on an historic specimen collected before 1912.

Platt S.G., Rainwater T.R., Bảo L.N., and Le //M.D.(2008). Cuora amboinensis (Amboina box turtle): First known occurrence from Vietnam since 1942.

Platt S.G., Rainwater T.R., Bảo L.N., and Le M.D.(2008). Cuora amboinensis (Amboina box turtle): First known occurrence from Vietnam since 1942.

Rainboth, W. J. (1996). Fishes of the Cambodian Mekong. FAO Species Identification Field Guide for Fishery Purposes. Rome: Food and Agriculture Organization of the United Nations.

Rainboth, W. J. (1996). Threatened Fishes of the World: Probarbus jullieni (Sauvage, 1880) (Cypriniformes: Cyprinidae). Environmental Biology of Fishes, 47(2), 201-201.

Primate Conservation Alliance. (2022). Primate Conservation Status Update. *Primate Conservation Alliance*. Washington, D.C.

Ly, S., et al. (2022). Emerging evidence shows the global importance of the Boeung Prek Lapouv Protected Landscape, Cambodia for yellow-breasted buntings Emberiza aureola. *Cambodian Journal of Natural History*, 2, 70-79.

WCS 2023. Bakan Grassland Officially Protected: A Major Step for Cambodia's Biodiversity and 30x30 Goals. *WCS News Release*.

Suddee, S., and Wongkamhaeng, K. (2019). New records of Terniopsis (Podostemaceae) from Thailand and Laos. *PhytoKeys*, 83080, 13-24.

Tang, D., and Kato, M. (2020). Culture of river-weed Terniopsis chanthaburiensis (Podostemaceae). *Aquatic Botany*, 161, 103228.

Tang, D., and Kato, M. (2020). Culture of river-weed Terniopsis chanthaburiensis (Podostemaceae). *Aquatic Botany*, 161, 103228.

Timmins R., Duckworth J.W., and Hedges S. (2022). Macaca fascicularis (amended version of 2015 assessment): The IUCN Red List of Threatened Species.

Tonle Sap Biosphere Reserve (2020). The Masked Finfoot: A Unique Bird of the Tonle Sap.

Vidthayanon, C. 2011. *Laubuca caeruleostigmata*. *The IUCN Red List of Threatened Species* 2011: e.T4602A11029692.

WCS Cambodia. (n.d.). Wildlife Bengal Florican. cambodia.wcs.org

WCS Cambodia (2026). Prek Toal Core Area Becomes A Ramsar Site. *Newsroom*

Zheng, G. (2015). *The ecology and conservation of Green Peafowl in Yunnan, China*. Unpublished PhD thesis, Sun Yat-sen University, Guangzhou, China.

ANNEX

5.1 Annex 1: Species Factsheets[11]

No	Species	Population Dynamics	**Habitat Requirements**	**Ecological Significance**
Reptile Species				
1	Elongated Tortoise (Indotestudo elongata)	The population of the Elongated Tortoise is declining due to habitat loss and hunting. It is listed as endangered on the IUCN Red List, with small, fragmented populations remaining in Southeast Asia.	This species thrives in deciduous and evergreen forests, often found in areas with dense undergrowth. They prefer moist environments and are usually located near water sources.	The Elongated Tortoise plays a critical role in seed dispersal, aiding forest regeneration. Its foraging habits help control vegetation, maintaining a balance in the forest ecosystem.
2	Black Marsh Turtle (Siebenrockiella crassicollis)	The Black Marsh Turtle is critically endangered due to overharvesting for the pet trade and loss of wetland habitats. Its population has drastically decreased in the wild.	This turtle inhabits slow-moving rivers, swamps, and marshes, often hiding under vegetation or debris. They prefer freshwater ecosystems with abundant cover.	As a scavenger, the Black Marsh Turtle helps in the breakdown of organic matter in wetland environments. Its presence indicates healthy aquatic ecosystems.
3	Giant Asian Pond Turtle (Heosemys grandis)	The Giant Asian Pond Turtle faces threats from habitat destruction and collection for the food trade. Its population is declining, with several subpopulations becoming isolated.	his species is found in freshwater bodies such as ponds, lakes, and rivers, typically in forested areas. It prefers habitats with abundant aquatic vegetation.	The Giant Asian Pond Turtle plays a vital role in controlling aquatic vegetation and contributing to the nutrient cycle within its ecosystem.

(11) **Data sources:**

- Conservation Biology journal articles, Turtles of the World (Rhodin et al., 2017).
- Asian Turtle Trade Working Group Reports, Amphibians and Reptiles of Southeast Asia.
- BirdLife International reports, Storks, Ibises and Spoonbills of the World (Hancock et al., 1992).
- Fishes of the Cambodian Mekong (Rainboth, 1996), regional fisheries studies.
- Dholes: Ecology and Conservation (Kamler et al., 2015), carnivore ecology papers.
- Macaque Societies (Thierry et al., 2004), studies on human-wildlife conflict.
- Behavior and Ecology (Johnsgard, 1999), avian conservation studies.
- IUCN Red List of Threatened Species: The IUCN Red List is a comprehensive resource that provides detailed information on the conservation status, population trends, habitat requirements, and threats faced by species globally. Website: IUCN Red List
- Research Articles and Conservation Reports: Peer-reviewed research papers and conservation reports from journals like *Biodiversity and Conservation*, *Conservation Biology*, and *Journal of Tropical Ecology* offer detailed studies on specific species' population dynamics, habitat requirements, and ecological significance.
- Field Guides and Species Monographs: Books and monographs such as *"Amphibians and Reptiles of Southeast Asia"* and *"The Mammals of Southeast Asia"* provide species-specific information, particularly for less-studied species.
- Fungal Biodiversity Databases: For fungal species like Calostoma insigne, databases like the *Fungal Diversity Survey* and *MycoBank* provide information on species distribution, ecological roles, and taxonomy.
- Global Biodiversity Information Facility (GBIF): GBIF provides open access to data on biodiversity, including species occurrences and ecological roles. This was particularly useful for lesser-known species like Terniopsis chanthaburiensis. Website: GBIF
- Conservation Organizations and NGOs: Information from organizations such as WCS, WWF, BirdLife International, and TRAFFIC provides insights into conservation efforts and threats facing specific species, especially those that are critically endangered.
- National Biodiversity Strategy and Action Plans (NBSAPs): Various countries' biodiversity action plans offer detailed species-level information that is often region-specific, particularly for species found in restricted geographic areas.

4	Southeast Asian Box Turtle (Cuora amboinensis)	The Southeast Asian Box Turtle is experiencing population declines due to overexploitation and habitat loss. It is widely harvested for the pet and food trades.	This species inhabits a range of environments, including freshwater wetlands, forest streams, and agricultural areas. It requires both terrestrial and aquatic habitats to thrive.	As an omnivore, the Southeast Asian Box Turtle aids in seed dispersal and helps maintain the balance of aquatic and terrestrial ecosystems.
Mammals				
5	The Hairy-nosed Otter (Lutra sumatrana)	The Hairy-nosed Otter is one of the rarest otters in the world, with populations drastically reduced due to habitat destruction and poaching. Its population is fragmented and isolated.	This otter prefers undisturbed freshwater ecosystems such as rivers, lakes, and peat swamp forests. It requires dense vegetation for shelter and abundant fish populations for food.	The Hairy-nosed Otter is a top predator in its ecosystem, playing a crucial role in regulating fish populations and maintaining the health of aquatic environments.
6	Indochinese Silvered Langur (Trachypithecus germaini)	The Indochinese Silvered Langur is classified as endangered, with populations declining due to habitat destruction and hunting. Fragmentation of forests is leading to isolated populations.	This primate inhabits tropical forests, including lowland, montane, and mangrove forests. It relies on dense canopy cover for foraging and protection.	The Indochinese Silvered Langur plays an essential role in seed dispersal and forest regeneration, contributing to the maintenance of biodiversity.
7	Long-tailed Macaque (Macaca fascicularis)	Although widespread, the Long-tailed Macaque faces threats from habitat loss and human-wildlife conflict. Some populations have adapted to urban environments	This species is highly adaptable, found in a variety of habitats including forests, mangroves, and urban areas. It requires access to water sources and trees for shelter and foraging.	The Long-tailed Macaque is an important seed disperser, aiding in forest regeneration and maintaining the diversity of plant species.
8	Dhole (Cuon alpinus	The Dhole, or Asiatic wild dog, is endangered, with its population declining due to habitat loss, depletion of prey, and disease. Small, isolated populations remain in protected areas	Dholes are adaptable but prefer forested environments, including tropical dry forests, grasslands, and montane forests. They require large territories with abundant prey.	As apex predators, Dholes play a crucial role in regulating prey populations, maintaining the balance within ecosystems.
9	Large Flying-fox (Pteropus vampyrus)	The Large Flying-Fox is facing population declines due to habitat destruction, hunting, and disturbance of roosting sites. It is listed as near-threatened.	This species inhabits tropical and subtropical forests, often found in mangroves, swamps, and coastal regions. It requires large trees for roosting and feeding.	The Large Flying-Fox is a critical pollinator and seed disperser, particularly for large fruit trees, playing a significant role in maintaining forest health and regeneration.

Fish Species				
10	Julieni barb	The Julieni Barb is critically endangered, with its population severely declining due to overfishing, dam construction, and habitat degradation in the Mekong River basin.	This species is found in large rivers, particularly in the middle and lower Mekong River, requiring deep pools with strong currents and gravel substrates for spawning.	The Julieni Barb is an important part of the riverine ecosystem, contributing to the balance of aquatic life and supporting local fisheries.
11	Leaping Barb (Laubuka caeruleostigmata)	The Leaping Barb is vulnerable due to habitat loss, water pollution, and overfishing. Its population is fragmented and declining.	This species inhabits freshwater streams and rivers with clear, fast-flowing water. It prefers areas with abundant aquatic vegetation.	The Leaping Barb plays a role in maintaining the health of freshwater ecosystems by controlling algae growth and contributing to nutrient cycling.
12	The Striped Catfish (Pangasianodon hypophthalmus)	The Striped Catfish is commonly farmed, but wild populations are declining due to overfishing, habitat alteration, and pollution in the Mekong River.	This species inhabits large rivers with slow-moving water and prefers deep pools and floodplain areas for breeding.	The Striped Catfish is a significant species for the riverine food web, supporting both the aquatic ecosystem and local human populations through fisheries.
13	The Mekong Giant Barb (Catlocarpio siamensis	The Mekong Giant Barb is critically endangered, with its population rapidly declining due to overfishing, dam construction, and habitat destruction in the Mekong River.	This species requires large, deep rivers with slow-moving water and floodplain areas for spawning.	As one of the largest freshwater fish, the Mekong Giant Barb is vital for maintaining the ecological balance of the Mekong River, supporting local fisheries, and contributing to the river's biodiversity.
14	The Siamese Tigerfish (Datnioides pulcher)	The Siamese Tigerfish is vulnerable due to habitat loss, overfishing, and the aquarium trade. Its population is declining in the wild.	This species inhabits freshwater rivers and lakes with clear water and abundant vegetation. It prefers areas with submerged structures for hiding and hunting.	The Siamese Tigerfish is an important predator in its ecosystem, helping to control the populations of smaller fish and maintaining the balance of aquatic life.
Bird Species				
15	The Greater Adjutant (Leptoptilos dubius)	The Greater Adjutant is endangered, with populations declining due to habitat destruction, disturbance at nesting sites, and hunting. It is primarily found in isolated pockets in Southeast Asia.	This large stork species prefers wetlands, including marshes, swamps, and floodplains. It requires large trees for nesting and roosting.	The Greater Adjutant plays a crucial role in wetland ecosystems as a scavenger, helping to clean up carrion and maintain the health of the environment.

16	The Milky Stork (Mycteria cinerea)	The Milky Stork is endangered, with populations decreasing due to habitat destruction, pollution, and disturbance at breeding sites.	This species inhabits coastal wetlands, mangroves, and estuaries, relying on shallow waters for foraging and tall trees for nesting.	The Milky Stork contributes to the health of wetland ecosystems by preying on fish, crustaceans, and small aquatic animals, helping to control their populations.
17	The Yellow-breasted Bunting (Emberiza aureola)	The Yellow-breasted Bunting is critically endangered due to habitat loss, hunting, and changes in agricultural practices. Its population has declined by over 90% in recent decades.	This migratory bird species inhabits open grasslands, wetlands, and agricultural fields. It requires a mix of open spaces and dense vegetation for breeding and foraging.	The Yellow-breasted Bunting plays a role in seed dispersal and insect population control, contributing to the health of both grassland and wetland ecosystems.
18	The Bengal Florican (Houbaropsis bengalensis)	The Bengal Florican is critically endangered, with populations declining due to habitat loss, agricultural expansion, and human disturbance. It has a very limited range and is found in fragmented populations.	This species inhabits grasslands and open plains, requiring tall grass for nesting and open spaces for displaying during the breeding season.	The Bengal Florican plays an important role in grassland ecosystems by helping to control insect populations and dispersing seeds, contributing to the maintenance of these habitats.
19	The Green Peafowl (Pavo muticus)	The Green Peafowl is vulnerable, with populations declining due to habitat destruction, hunting, and human disturbance. It is now restricted to fragmented populations in Southeast Asia.	This species inhabits a range of environments, including tropical forests, grasslands, and open woodlands. It requires access to water and dense vegetation for shelter.	The Green Peafowl plays a role in seed dispersal and insect population control, helping to maintain the balance of the ecosystems it inhabits.
20	The Masked Finfoot (Heliopais personatus)	The Masked Finfoot is critically endangered due to habitat destruction, particularly the loss of wetland and mangrove forests. Its population is small and fragmented.	This secretive bird species inhabits freshwater wetlands, mangroves, and forested rivers, requiring dense vegetation for nesting and foraging.	The Masked Finfoot contributes to the health of wetland ecosystems by preying on aquatic invertebrates and small fish, helping to control their populations.
21	The White-winged Duck (Asarcornis scutulata)	The White-winged Duck is critically endangered, with an estimated population of fewer than 1,000 individuals in the wild. The species has experienced a significant decline due to habitat destruction, especially the loss of swamp forests and riverine habitats, as well as hunting and human disturbance.	This species primarily inhabits dense, swampy forests near rivers and wetlands. It requires large, undisturbed forested areas with access to slow-moving or stagnant water bodies for feeding and nesting. The presence of thick vegetation provides necessary cover from predators and human disturbance.	The White-winged Duck plays a vital role in the ecosystems it inhabits, particularly in maintaining the health of wetland and forested areas. It contributes to the control of aquatic invertebrate populations and the dispersal of plant seeds, thus supporting the regeneration and biodiversity of its habitat.

Fungus Species				
22	Calostoma insigne	Calostoma insigne is a species of fungus that is relatively rare, with little known about its population trends. The species is listed as endangered in the IUCN Redlist. It's vulnerable to changes in its environment, including deforestation and changes in microhabitats caused by climate change.	This fungus is typically found in moist, tropical forests, often growing in leaf litter or on decaying wood. It thrives in environments with high humidity and is dependent on the presence of mature forests with a stable microclimate.	Calostoma insigne plays a crucial role in nutrient cycling within forest ecosystems. As a decomposer, it helps break down organic material, returning nutrients to the soil, which supports the growth of plants and maintains forest health. The species also contributes to the diversity of fungi within its habitat, which is important for overall ecosystem resilience.
Amphibian Species				
23	Cardamom Shrub Frog (Philautus cardamonus)	The Cardamom Shrub Frog is a relatively poorly studied species, but it is listed as the endangered due to its restricted range in the Cardamom Mountains of Cambodia. Habitat loss, particularly deforestation for agriculture and logging, poses a significant threat to its population.	This species is typically found in montane forests, particularly in dense shrublands and forest undergrowth. It requires a humid, moist environment, often near streams or other water sources, for breeding and foraging.	The Cardamom Shrub Frog plays an important role in its ecosystem as both a predator and prey species. It helps control insect populations, contributing to the balance of the forest ecosystem. Additionally, as an amphibian, it serves as an indicator species, with its health reflecting the overall condition of the environment.
Plant Species				
24	Terniopsis chanthaburiensis	Terniopsis chanthaburiensis is a plant species that is likely rare and potentially at risk due to habitat loss and environmental changes. Specific population data is limited, but like many plant species with restricted ranges, it may be vulnerable to deforestation and land conversion.	This plant species is found in the humid tropical forests of Southeast Asia, particularly in the Chanthaburi region. It thrives in shaded, moist environments, often in the understory of dense forests. It requires a stable climate and a specific microhabitat that provides the right balance of light, moisture, and soil nutrients.	Terniopsis chanthaburiensis contributes to the biodiversity of its forest habitat. As a flowering plant, it may play a role in the ecosystem as a food source for pollinators and other animals. Its presence also contributes to the overall structural diversity of the forest, which is important for maintaining a healthy and resilient ecosystem