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A MANUAL FOR COMMUNITY FISH REFUGE-RICE FIELD FISHERIES SYSTEM MANAGEMENT IN CAMBODIA

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WorldFish

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Authors: Kim Miratori, Mam Kosal, Vichet Sean, Alan Brooks (WorldFish); Thay Somony, Hav Viseth (Fisheries Administration); Rick Gregory (Independent Consultant)

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Contact: WorldFish Cambodia, #34, Street 228, Sangkat Chaktomuk, Khan Daun Penh, Phnom Penh, Cambodia. Email: WorldFish-Cambodia@cgiar.org

In partnership with

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FOREWORD

Cambodia's rain-fed and flooded rice fields are important and productive sources of inland fish and other aquatic animals, including frogs and snails. These aquatic resources are important to millions of Cambodians, particularly those in rural areas. They make important contributions to rural livelihoods, contributing to food security, nutrition and income generation, particularly as rice field fisheries are an open access resource in Cambodia. Rice field fisheries act as a safety net for many rural families that are poor and vulnerable to factors such as the effects of climate change, agricultural failures and income insecurity. In addition, the more than 112 documented species of fish in Cambodia's rice field systems, together with other aquatic animals, are important to, and play specific roles in, local ecosystems, including contributing to biodiversity.

Through the Fisheries Administration, the Royal Government of Cambodia (RGC) prioritizes Community Fish Refuges (CFRs) to ensure the productivity of rice field fisheries and to enhance wild capture fisheries (Pillar 1 of the Strategic Planning Framework for Fisheries). CFRs also contribute to the RGC's support for the Voluntary Guidelines for Securing Small Scale Fisheries, including the development and implementation of ecosystem friendly and participatory policies, strategies and legal frameworks for the enhancement of responsible and sustainable small-scale fisheries. Effective and well-managed CFRs are considered very important in maintaining capture fisheries production in Cambodia. Through their roles in protecting wild fish during dry periods and providing good habitats for fish to breed, spawn and grow, CFRs maintain and increase fish numbers in the surrounding rice fields. FiA has supported the establishment of 884 CRFs across the country, which have increased the production of rice field fisheries.

This manual for the management of rice field fisheries systems in Cambodia, published in partnership with WorldFish Cambodia, is an important contribution to inland fisheries management in Cambodia. It provides evidence-based step-by-step guidance for selecting existing water bodies and the surrounding communities; conducting needs assessment and action planning with stakeholders, including FiA and other local government and community residents; and training and supporting communities to plan and conduct improvements to physical environments and sustainably manage these environments.

It is our strong hope that both governmental and non-governmental field practitioners, policymakers and planners who wish to provide facilitation to strengthen existing CFRs and RFFs in Cambodia will find this manual useful. It is relevant to the staff of provincial fisheries cantonment, local and international NGOs and development partners, as well as to local community members. However, others beyond Cambodia may also find this manual useful, and may adapt the manual for their particular context. We encourage all interested stakeholders to make effective use of this manual, and to ensure that they share the learning and experience from the application of this manual.

Sincerely yours,

H.E ENG Cheasan
Delegate of the Royal Government of Cambodia
Director General of Fisheries Administration

ACKNOWLEDGEMENTS

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In addition, the authors acknowledge the members of the 134 Community Fish Refuge (CFR) committees and other supporting community members who have improved and managed community fish refuges with support from the Fisheries Administration Cantonment offices, contributing to increased numbers of fish and improved food and nutrition security in surrounding areas.

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INTRODUCTION TO THE MANUAL FOR RFF/CFR SYSTEM MANAGEMENT

What is the manual

This manual is based on findings from the implementation of the USAID-funded Rice Field Fisheries Enhancement Project (RFFEP) in four provinces of Cambodia (Kampong Thom, Siem Reap, Pursat and Battambang) between 2012 and 2016[i].

The manual has been developed to guide relevant stakeholders and target communities in how to approach i) the selection of Community Fish Refuges (CFR) and ii) the process of designing and implementing improvements to the CFRs. It summarizes and distils lessons on how to design functional CFRs and follow-on interventions in order to improve the physical and biological characteristics of CFRs and their connectivity with the surrounding environment. This, in turn, enables them to function as systems that can be sustained and that are capable of delivering fish to be harvested by communities in the adjacent floodplains and rice field environments. The step-by-step process described in this manual is required to achieve an improved CFR system. Field team(s) that carry out this process must also develop the capacity of local CFR management committees to plan, implement, manage and monitor the outcomes.

This manual focuses on providing detailed steps which are involved in establishing and improving a CFR's physical environment and its CFR committee's management structures and practices. For the manual to be effective, users are also encouraged to familiarize themselves with the catch and biological assessment methodologies as well as participatory planning tools referred to in Section 2.5. of this manual. These methodologies and planning tools are important for monitoring the effectiveness of the CFR and local community engagement in and benefits from CFR management. Further information about pond and channel construction is available in Annex 6 of this document. As for capacity development, readers may also refer to the 'Training Module on Community Fish Refuge / Rice Field Fisheries Enhancement in the Good Community Fish Refuges Management Practice for Food Security in Cambodia' (FAO et al. 2016).

Who is this manual for?

This manual is intended for field practitioners, policy makers and planners from both government and non-government groups who wish to provide facilitation to strengthen existing CFRs and RFFs in Cambodia. This may include the staff of provincial fisheries cantonment, local and international NGOs and development partners, and local community members. This manual can also be used by fisheries management practitioners in other countries and regions to enhance the natural productivity of fisheries in floodplain environments – including fish and other aquatic animals (frogs, snails etc.) – to meet local consumption needs and nutritional requirements.

This manual may also be useful for policy makers, offering a practical framework for considering 1) what changes and improvements are needed to sustain capture fisheries in the existing rice-dominated production systems; and 2) how policy and regulatory frameworks can be enhanced to improve synergy in the use of land and water resources.

Finally, development partners may also find this manual helpful in understanding what constitutes a successful CFR intervention, and as guidance on how to fund, monitor and evaluate their programs and policies effectively to ensure that they deliver successful impacts for local livelihoods and nutrition.

How to use the manual

The manual is organized into six sections:

1. An introduction to RFFs and CFRs;

2. CFR identification and selection;

3. Working with stakeholders and communities;
4. CFR capacity management assessment and action planning;
5. Supporting action plan implementation; and
6. Monitoring impacts.

This manual may be used to practically inform the design of interventions and of specific activities within these interventions to improve CFR-RFF systems in Cambodia or other countries with extensive floodplains. Additional materials referenced in this manual may be useful for specific activities such as providing training to CFR management committees (FAO et al. 2016) and informing monitoring of the availability of fish and other aquatic animals (OAA) in rice fields (Boon et al. 2016).

What is included

This manual includes information on:

- Different elements of rice field fisheries / community fish refuge systems;
- Categories of CFRs;
- Minimum requirements for key elements of the RFF/CFR system;
- A step-by-step approach to establishing a CFR using existing water bodies, from initial research and assessment with communities to assessing and building CFR governance and management capacity and sustaining impacts;
- Practical techniques and tools for monitoring and evaluating CFR interventions;
- Examples of tools and specific interventions in regard to biology and water chemistry, physical enhancements to RFF environments, and CFR committees' management and governance of CFR environments.

What is not included

The following information is not covered in this manual:

- Technical information about rice and vegetable cultivation;
- A detailed, holistic literature review about different aspects of the rice field system, including, for example, social cohesion, public health, ecosystem services and different trench patterns;
- Information about tenure and land ownership in rice field fishery areas;
- Information about aquaculture and post-harvest techniques.

How to strengthen the learning process

Key ways in which stakeholders may strengthen the learning process for improved RFF-CFR system management are:

- Ensuring participatory consultation and planning with all relevant people at local level – including village and commune leadership as appropriate – at the site selection, needs assessment and action planning and interventions and management phases. This helps to ensure a common understanding from the outset.
- When introducing information which is somewhat technical and may be new to participants, particularly during the detailed planning and prioritization, it is helpful to show simple graphics and photos to build a common understanding of exactly what is being discussed.
- 'External' people with technical expertise in inland aquatic production systems and/or the identified ideal characteristics of RFF-CFR systems should provide inputs as needed to ensure that assessments and plans are technically sound.
- Annual provincial information-sharing workshops with CFR committees, local authorities and the Fisheries Administration are very important opportunities for participants to discuss progress against annual workplans and in terms of improvements to CFR committee capacity, reflect on and share challenges and lessons, plan ahead with future commitments, and – for committees with outstanding progress – to receive formal recognition.

Section 1 The Rice Field Fishery and Community Fish Refuge systems

1. An Introduction to Rice field Fisheries

Fisheries in Cambodia are inextricably linked with Cambodian society, and fishing – whether it occurs in rivers, lakes or rice fields – forms part of the daily activities of the vast majority of rural Cambodians. McKenney and Tola (2002) describe the roles played by fisheries in livelihood activities, in income generation, in improving food security and nutrition, and in acting as a buffer against the risk of agricultural failures. A substantial portion of total inland production is from Cambodia's rice fields (158,700 tons, 30% of total inland production) (FiA 2018).

Rice Field Fisheries refers to the capture of wild fish and other aquatic animals (OAA) from the flooded rice field agro-ecosystem and its supporting infrastructure such as canals, channels, streams, and other forms of water bodies associated with rice field environments.

Figure 1 provides a simple illustration of how the RFF-CFR system works in seasonally-inundated rice fields in Cambodia.

In the context of Cambodia, access to rice field fisheries is open; it is not restricted to the owner of the rice field. Rice fields provide an important source of fish and other aquatic animals (OAAs) for local communities (between 42 and 165 kg per hectare per year (Hortle 2007)) and are an important source of cash income for the poor and a buffer against seasonal hunger (Ratner et al. 2014). Small fish, when eaten whole, provide much needed vitamins and minerals for cognitive and physical development, including vitamin A, zinc, iron and calcium. This is especially important in Cambodia, where 32% of children under five are stunted (NIS et al. 2015).

In Cambodia, many rural households fish in and around rice fields. However, unlike rice farming, rice field fishing mostly occurs for subsistence and is not always recorded as a livelihood activity in official statistics. Traditionally, people may only spend a short amount of time fishing in the rice fields next to their farms while they complete their daily rice farming activities. Their aim may be to catch enough fish to cook for the day. Such fishing practices provide mostly small catches, and occur in different forms depending on the rice field and the associated ecosystems in which they occur. Children can often be found fishing in rice field fisheries by setting traps or nets or even catching fish bare-handed.

The presence of brood fish in the dry season fish refuge, and the fishes' abilities to disperse and interact in the wider environment in the wet season, present

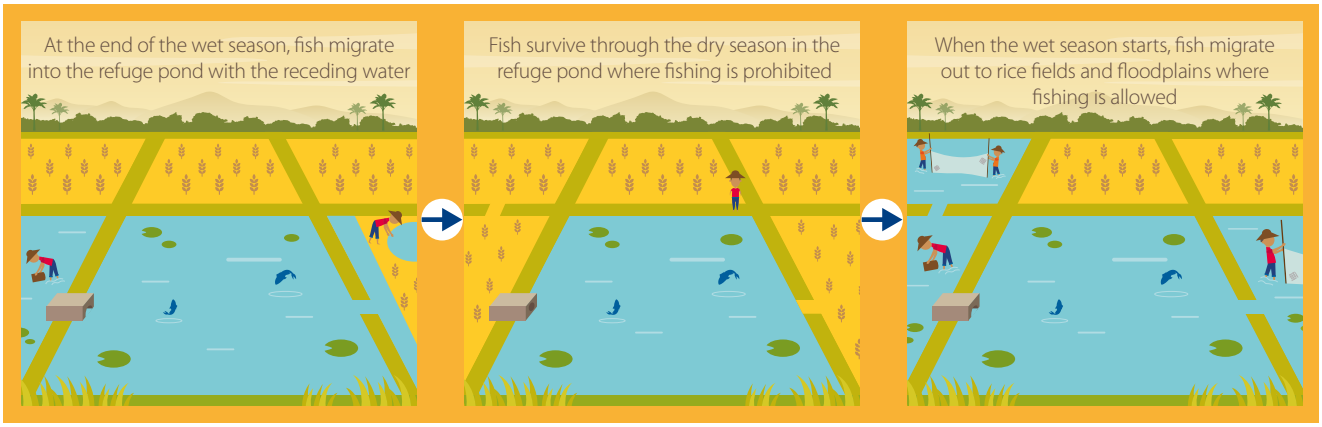


Figure 1: Simple representation of how the rice field fisheries system works

Table 1. Fish catch from different rice field fisheries ecosystems

Studies of RFFs	Locations of studies	Amount of fish caught
Shams et al. (2001)	Svay Rieng	585 kg/HH/year
Gregory & Guttman (2002)	South-eastern Cambodia	158-604 kg/HH/year
Viseth et al. (2008)	Takeo, Kampong Speu, Kampot, and Prey Veng	86-684 kg/HH/year

an opportunity for CFRs to contribute to maintaining a source of local genetic fish resources[ii]. In a rice field study in Svay Rieng, Shams et al. 2001 show that the majority (89%) of the fish caught were Clarias, Channa and Anabas species, all of which command good market prices in rural, urban and export markets of Cambodia. As many as 112 fish species have been documented in rice fields and CFRs (Sieu et al. 2015: 22). Numerous studies have been conducted on the amount of fish caught in RFF systems in Cambodia. While yields varied greatly from study to study, and were dependent on factors such as location and the quality of water supply, all studies showed that RFF systems provide an important source of fish. Table 1 below shows the results of some key studies conducted in Cambodia.

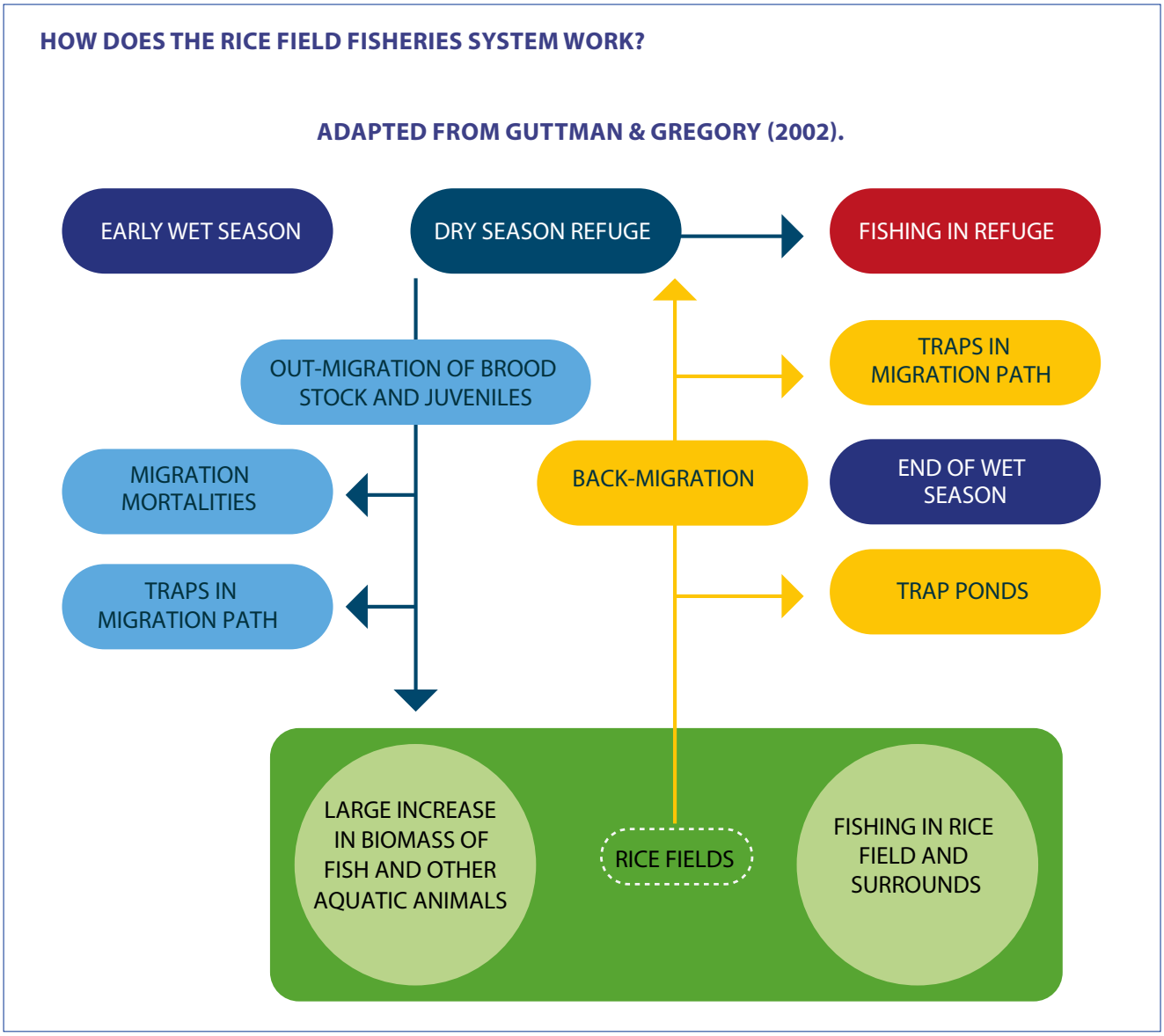
A livelihood baseline survey conducted under RFFEP with 640 households living in 40 target CFR-RFFs showed that fishing is considered the second most important activity for food security (reported by 63% of households) and the second most important source of income for the households after rice farming (Joffre 2013).

The presence of fish in rice fields provides important ecosystems services for rice production and for human consumption and nutrition. Fish improve the fertility of soils and naturally aerate the water (Giap et al. 2005; Dugan et al. 2006) whilst also playing roles in pest management of rice crops (Berg 2001 and Halwart and Gupta 2004). By eating flies, snails and other insects which damage important plants and rice crops, as well as eating aquatic weeds and algae that carry diseases, fish occupy significant niches in rice fields. In turn, rice fields provide fish with planktonic and benthic food (Mustow 2002).

The rice field fisheries/community fish refuge approach has distinctive characteristics that differ from rice-fish culture. Rice-fish farming typically involves growing rice and cultured fish together in the same closed field, either simultaneously or one after another. By contrast, the rice field fisheries/fish refuge pond approach relies on wild indigenous species, the natural flooding cycle, a perennial water body to act as a dry season refuge outside of the rice field, and connections between the two systems in the wet season (Halwart and Gupta, 2004). A well-managed, productive RFF-CFR system contains a range of fish habitats that provide fish with full year-round protection, particularly during the dry season, and also provide for their out migration to the rice field through channels in the flooding season.

2. The Rice field Fishery System

The diagram below illustrates how the Rice Field Fishery system works.



Over the past several decades, this easily accessible local resource has faced increasing threat from a general increase in fishing pressure, but also from the expansion of, and changes in, agricultural practices. Fish have been known to use rice fields as breeding, spawning and feeding grounds and as growth habitats for thousands of years. As such, rice fields should be considered an integral part of fisheries management so that they can contribute significantly to overall fish production and local economies (De Silva et al. 2013a). However, agriculture intensification, usually involving the heavier application of chemical inputs (De Silva et al. 2013a) and modified ecosystems such as irrigation/road infrastructure development and the degradation of flooded forests, have created obstructions to fish movement. In such cases, there may not be enough fish retained in dry season water bodies, affecting reproduction and recruitment onto the floodplains and reducing the fish production from rice field ecosystems when the water returns.

3. What is a Community Fish Refuge (CFR)?

A Community Fish Refuge is a fish protection measure that is intended to improve the productivity of RFFs. CFRs refer to communal village-based natural and/or human-made ponds/water bodies near a village(s) within the rice fields system, managed directly by local

community members with technical assistance from Fisheries Administration (FiA) staff (Joffre et al. 2012). In many cases, technical assistance has been provided either by NGOs with the necessary skills or by donor-funded projects (see Joffre et al. 2012 for examples). A CFR generally has dikes or weirs to control water. Fish can either use these to enter the refuge naturally, or the pond/water body can be re-stocked with wild fish from time to time by farmers. A CFR acts as a seasonal refuge or a year-round shelter for fish to stay (mainly) free from fishing and to breed, spawn and grow.

Enhancing the management of CFRs is one way that RFFs can be made more productive in a sustainable manner. The strategic planning framework (SPF) for the Cambodian fisheries sector (2010-2019) (FiA 2010) sets a target that at least 1,200 communes (75% of total) will have sustainable and effective fish refuges by the end of 2019. The updated SPF for 2015-2024 (FiA 2015) recognizes the importance of CFR-RFF systems for sustaining capture fisheries associated with rice fields and contributing to maintaining capture fisheries production at 600,000 tons per year. In Cambodia the CFR-RFF approach is recognized as the key intervention to increase production from rice fields. Studies have suggested that the presence of a fish refuge pond can increase fish productivity from rice fields up to six-fold, even on a 'self-recruiting' basis where fish are free to move naturally (Thouk 2009). In addition, the Cambodian Fisheries Administration (FiA) has also encouraged and supported communities to develop, maintain and protect individually owned small ponds in rice fields on a voluntary basis to provide additional refuges for back-migrating fish.

4. Domains/Components and Zones of Influence

The major domains/components for a RFF/CFR system in Cambodia consist of 1) a Community Fish Refuge[iii], 2) a migration channel and 3) the floodplain rice fields.

A Community Fish Refuge is a perennial water body in which fish and OAA can survive extended dry periods before returning to the floodplain when water levels rise.

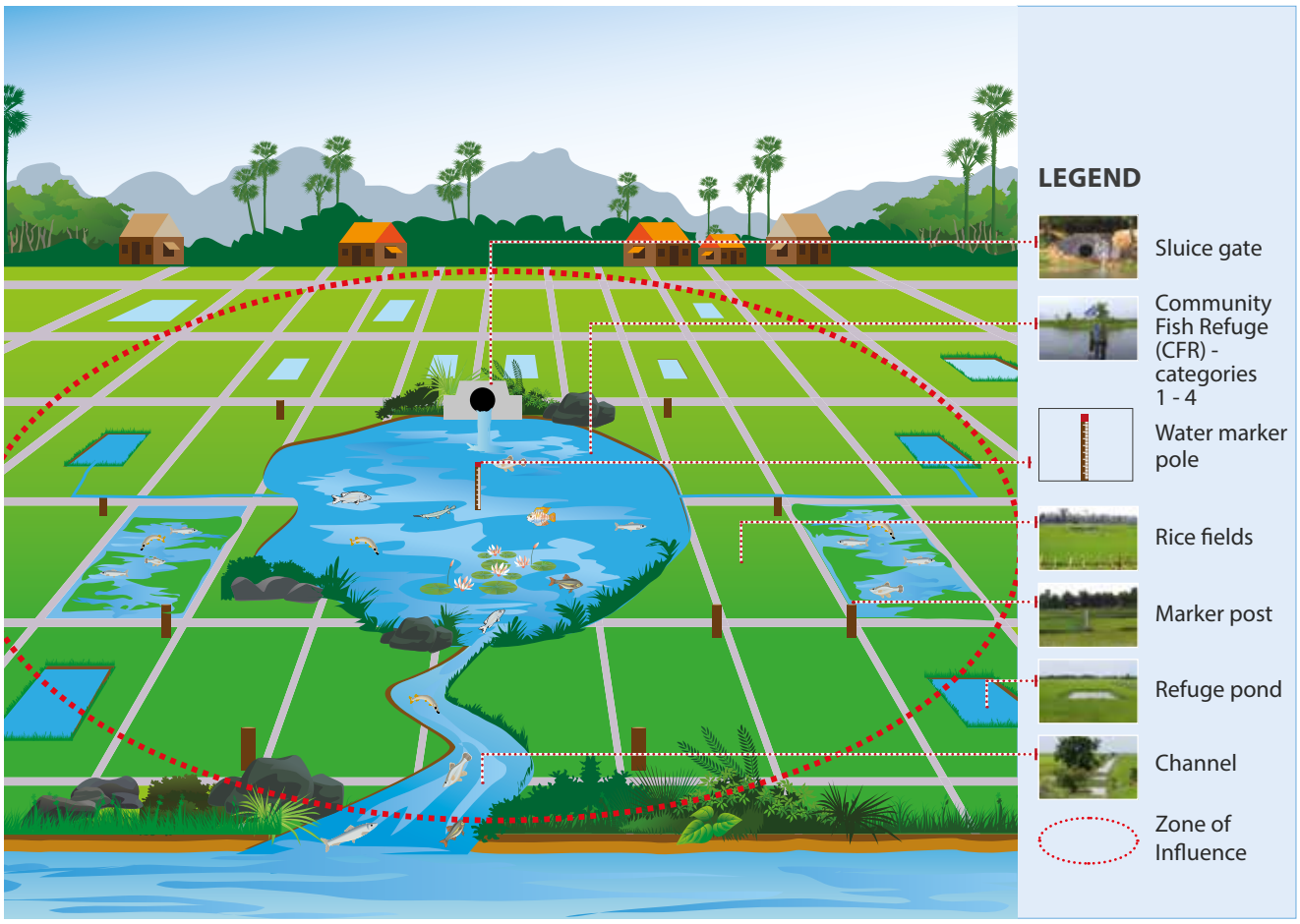
A migration channel is a supporting structure in a variety of forms including a canal, stream, or another form of water body or facility to provide connections between a CFR and a flooded rice field agro-ecosystem. An adequate and unobstructed water flow through the channel network is required to ensure good connectivity between the CFR and rice field.

The floodplain rice fields refer to a flooded rice agro-ecosystem where fish can disperse during the flooding season to feed and breed, and where fish and other aquatic animals (OAAs) can be caught.

The *Zone of Influence* (ZoI) of a CFR refers to the area that is influenced by the CFR. This is the radius that adult fish or juveniles from the CFR can reach in order to breed and grow. For this reason, it is important to consider the whole ZOI in the management of rice field fisheries. In this manual, rice fields are often referred to as the Zone of Influence of a CFR. It may also be areas where some habitat improvements have been done. For example, ponds dug in rice fields themselves are considered secondary options for creating fish refuge habitats beside the CFRs. These improvements can help sustain fish and other aquatic animals during short droughts that often occur in Cambodia between July and August each year.

Chart 1 on the next page gives a topographical view of a RFF/CFR system, including the key components described in this section.

Chart 1: the main physical components of the Rice Field Fisheries / Community Fish Refuge system (see text on next page for CFR category descriptions).



In addition to physical components, a Community Fish Refuge Committee, comprised of a group of 5-10 local volunteers who are elected by the community living in the Zone of Influence of the CFR, is responsible for managing and improving the CFR and providing protection from illegal fishing. In the context of Cambodia, with support from the local authorities and Fisheries Administration Cantonment, the CFR Committee can receive official recognition of the CFR from the Provincial Department of Agriculture. To achieve this recognition, the committee must meet a number of requirements, including having developed appropriate CFR by-laws, having filled designated positions on the committee, and other requirements.

Structure and roles of the CFR committee

In general, CFR committees are structured as follows[iv]:

- Committee Chief: usually this is the candidate for the CFR committee who receives the highest number of votes. S/he oversees the committee.
- Deputy Chief: s/he supports the Committee Chief.
- Secretary: responsible for organizing meetings and maintaining records of meetings and other relevant documents.
- Cashier: responsible for maintaining records of funds raised for RFF-CFR system management.
- CFR patrolling team: these people are responsible for patrolling the CFR and the wider Zone of Influence in coordination with the Fisheries Administration Cantonment to protect against illegal fishing. Members of the patrol team are allowed to stop illegal fishers and confiscate their fishing equipment. They must immediately report this to the local police or the Commune Council Chief, who will then report this to the FiA-C for further action according to the Law on Fisheries.

- Awareness-raising / information sharing: these people are responsible for sharing information about the purpose of the CFR and its committee, and activities planned and conducted by the committee.

By-laws of the CFR

Each CFR committee is responsible for establishing by-laws to:

- Define the roles and responsibilities of each CFR committee member;
- Define what actions are and are not allowed in the CFR and the extended no-fishing area, including:
  - What type of fishing gear is and is not allowed in the Zone Influence;
  - How patrol team members are allowed to stop and detain illegal fishers and confiscate their fishing gear;
  - Whether traditional/customary harvesting of fish from the CFR will be allowed.

These by-laws must be submitted to local authorities for approval before being submitted to the Fisheries Administration at Cantonment level. Acceptance of these by-laws is one of the requirements for the CFR receiving formal recognition from the Provincial Department of Agriculture.

CFR management and governance

Figure 2 below outlines the organizations at sub-national and national level that are involved with the governance and management of CFR-RFF systems in the context of Cambodia.

5. Categories of CFR

In Cambodia, CFRs can be characterized into four different categories (Brooks et al. 2015).

- Category 1 represents CFRs in upland reservoirs;
- Category 2 represents CFRs which are community ponds outside flood-prone areas (for the Tonle Sap Lake (TSL) floodplain, this area is roughly defined by highways 5 and 6);
- Category 3 represents CFRs which are community ponds prone to flooding (typically located inside highways 5 and 6);
- Category 4 represents CFRs within a large natural water body, particularly in the Tonle Sap floodplain.

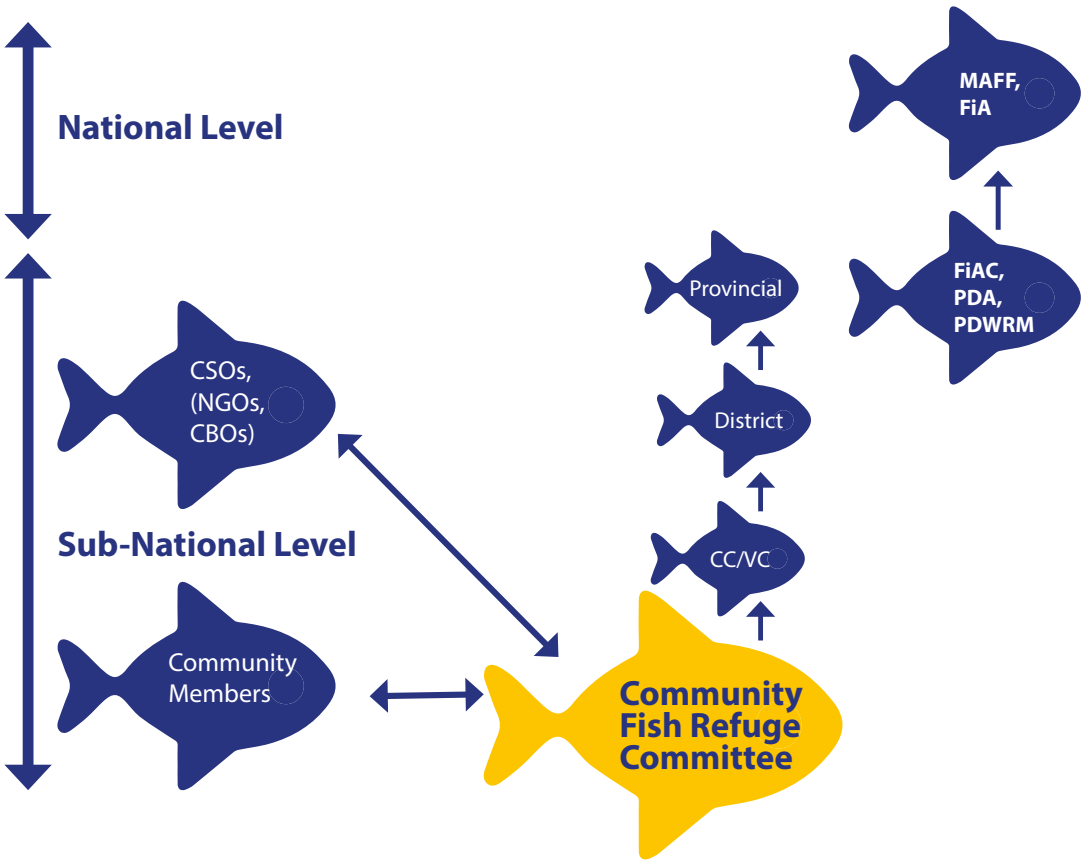


Figure 4: Organizations involved in management and governance of CFR-RFF systems

Category 1. Irrigation Reservoir
(e.g. Kuch Noub-Pursat)

- Large water body, usually an upland reservoir, with a section managed as a CFR;
- Associated with irrigated dry season rice fields
- Equipped with water control structures;
- Long ditch(es) and/or channel(s) to rice fields;
- Water volumes fluctuating and rapidly changing;
- Water supply to rice fields is controlled;
- Where there is increasing use of pesticides due to agricultural intensification.

Category 2. Community Pond No Flooding
(e.g. Lbeuk Keteyuos–Siem Reap)

- Community pond with water control structures and is usually not flooded;
- Often a shallow CFR where some parts dry out; and
- Short channels connecting to rice fields.

Category 3. Community Pond Flooding
(e.g. Trapaing Thlok Meanchey–Kg Thom)

- Community pond with water control structures and frequently flooded;
- Often a shallow CFR and some parts dry out; and
- Short channels connecting to rice fields.

Category 4. Within Large Water Body
(e.g. Boeng Rolum-Kg Thom)

- Natural depression forming large water body, extensive flooding areas;
- Relatively small compared to total area of water body;
- Widespread and diffuse connections to the rice fields;
- Deep water rice with the fields vulnerable to flooding; and
- Some flood recession rice cultivation.

6. History of CFR / RFF development

The CFR / RFF concept was first introduced to Cambodia in 1995 through the Aquaculture and Aquatic Resources Management (AARM) project, with support from the Asian Institute of Technology (Meusch & Viseth 2001). The main objective of the CFR system is to enhance wild fish populations by using community-managed water bodies as dry season protection for brood stock fish. Sustaining brood stock through dry periods and the dry season, together with enhanced connections between the CFR and the rice field, means that fish can mature and reproduce in rice fields as the floodwaters expand.

It is thought that CFRs help to maintain genetic diversity within local fish populations and boost early wet season breeding activity and recruitment onto the floodplain. Between 1995 and 2013, a total of 779 CFRs were set up by JICA, DFID/DANIDA and FAO (FiA 2013). FiA has embarked on a program to promote the development of 1,200 CFRs in 75% of all communes by 2019, with an intention to increase wetland and rice field fishery productivity through habitat protection and improved interconnections within and across the systems.

CFRs have also been established in reservoirs where the priority for water management is for irrigation. In Cambodia there are over 2,500 irrigation schemes, some of which are managed by Farmer Water User Groups. Most of these irrigation schemes fail to deliver benefits for fish production and in terms of managing competing demand for water use by different sectors (De Silva et al. 2013b). Establishing and managing CFRs within these irrigation schemes will potentially help address the issues with management and maintenance of irrigation schemes by encouraging the allocation of optimal water use.

A study in 2013 showed that only 54% (419) of all CFRs were functioning well, with CFR committees organized and undertaking regular patrolling, meetings, law enforcement and some funding for CFR management. The other 360 CFRs (46%) were not functioning and had none of the above arrangements; some of these CFRs had been abandoned (FiA 2013)[v]. There is a clear need for support to manage CFR-RFF systems more carefully so that results can be improved.

From 2012 to 2016, the first rigorous research on CFRs was carried out as part of the USAID-funded, Worldfish-implemented Rice Field Fisheries Enhancement Project (RFFEP). The project aimed to improve the productivity of rice field fisheries at 40 sites in four provinces (Kampong Thom, Siem Reap, Battambang and Pursat) by improving the ecological functions and the governance of existing Community Fish Refuges (CFRs) and developing best practice models for scale out and scale up.

The major outcomes and achievements of RFFEP are listed below:

- The diversity of fish species in the rice fields remained high throughout the project -- over 100 species were reported in the project surveys;
- Fish biomass in CFRs increased by over 30% at the project sites between 2013 and 2015;
- Fish productivity per hectare of rice field increased by 20 to 120 % depending on location and year, from 78kg/hectare/year in 2013 to 99kg/hectare/year in 2015.
- Annual average fish catch per household by those living around the project-supported rice fields increased on average by 9%, from 211kg in 2012 to 230kg in 2015;
- Annual average fish catch per household by those in the poorest quintile increased by 71%, from 156kg in 2012 to 268kg in 2015;
- For those households who reported selling fish (30% of the households surveyed), average increase in cash income from selling fish in 2015 was ten times that in 2012;
- The amount of small micronutrient-rich fish consumed at home increased by 13% on average, and the consumption by children under the age of 5 increased by 23%.

The main challenges encountered by the project were as follows:

- Environmental changes and annual fluctuations in rainfall and seasonal flood patterns made it difficult to analyze and interpret the data collected through project monitoring surveys;
- The capacity of local communities, NGO partners and local authorities was initially very limited in terms of their abilities to implement technical interventions, take initiatives in the management

of CFRs, and contribute their own financial resources to support those activities;

- At some of the project sites the local committees faced user conflict over water use in the CFR in the dry season, with competing interests in using the water for rice farming, animal raising, human consumption and fish conservation, especially during the drought year of 2015 – 2016.

Section 2

The RFF/ CFR development process

Based on experience implementing the RFFEP, the development of sustainable RFF management of CFRs can be divided into three phases: 1) site selection, 2) needs assessment and action planning, and 3) intervention and management.

The site selection phase involves initiating a process for the identification of suitable existing sites for CFR improvement[vi], and results in an agreement with relevant stakeholders and authorities on their selection. This then gives impetus for the needs assessment and action planning phase. This phase involves identifying needs for improvements to the current CFR-RFF system and habitats in the selected site, as well as the capacity for their effective management and the setting up of a monitoring and evaluation (M&E) framework. The intervention and management phase consists of the implementation of an agreed plan that involves actions to improve the current physical structure and environmental conditions of the CFR-RFF system, as well as actions to improve the capacity of the community to manage the systems and monitor the delivery of the plan and performance of the CFR-RFF system. The three phases are described in more detail in the following sections.

Chart 2 Showing the steps and key activities in a CFR-RFF system improvement

1. Site selection

Site selection represents the first important step in establishing a successful CFR-RFF system, including ensuring that intended objectives will ultimately be met while delivering the highest value for money spent. In the context of Cambodia, the process starts by looking at potential areas for intervention within the existing CFR-RFF system, and results in a set of existing CFR-RFFs being selected and agreed by all relevant stakeholders. Because selected sites will need to follow strict resource conservation practices to be successful, it is important to think about potential for conflict over water and fish resources between CFR committee and community members. Based on experience with the RFFEP, careful site selection and participatory consultation and planning according to this manual will help to prevent such conflict (Miratori and Brooks 2015) in most years.

1.1. Desk review and field visits

This exercise aims to identify CFR-RFFs with potential for improvement. This involves reviewing the existing literature, including published and non-published reports and maps, and scoping the geographical area for CFR-RFF sites where a project to strengthen existing CFR-RFFs could take place. Having identified a potential site, the project implementation team should visit a few individuals who have relevant knowledge and understanding of the local area, including CFR-RFFs. These individuals should include staff from relevant government agencies at the national and subnational level, and NGOs active in the area. The purpose of this is to gain insight into the landscape and the physical infrastructure that is already in place. In the Cambodian context, a part of the exercise is to pay a visit to one or two CFR-RFF sites to get ideas from local community members about how their RFF system works, and how potential CFR-RFF sites should be selected. This will offer a better understanding of the types of areas with CFRs-RFF that are available for selection (see footnote 5 about this manual being based on existing and not new CFRs), and allows the researcher/team to build a list of desirable characteristics and attributes as part of developing site selection criteria.

1.2. Development of CFR site selection criteria

The key output from this step is a set of criteria developed using information from the desk review and based on discussion within the implementation team. This exercise should take into account all aspects of CFR-RFF development and management needs, including the physical, biological, social, legal and institutional dimensions. Examples of potential criteria for site selection are provided in Box 1 below.

The potential criteria chosen should be validated with a small group of relevant stakeholders, including government fishery agencies, local authorities and relevant NGOs. This validation should be carried out in a meeting held at an easily accessible location with adequate facilities to conduct the meeting. The team should then try out the selection criteria in the field (2-3 actual sites) in order to finalize the selection criteria. More detailed selection criteria are provided in a separate document (see Annex 5). It is important to validate the selection criteria with the community and all local authorities, the Fisheries Administration and with partner NGOs. This ensures that true consensus is reached by the communities from the outset, empowers the communities to take ownership, and also helps to avoid future conflict over shared use of limited community resources (Miratori and Brooks 2015). This is important considering the impacts of unseasonal dry periods / droughts and sudden unfavorable changes to the prices of essential market commodities such as fish and rice.

Box 1. Examples of criteria with utility for CFR-RFF site selection

Physical aspects:

- The CFR has not dried out during the dry season over the past 5 years;
- The CFR has low coverage/density of aquatic plants and/or with potential for improvement;
- The CFR has a connection, or potential for a connection, to surrounding rice fields;
- The CFR site has the potential to serve as a source of aquatic genetic resources;
- The CFR is large enough to sustain biological production.

Social and economic aspects

- The selected site offers potential benefits to poor members of the community;
- Practices that require water during droughts or dry season for cooling, watering and cleaning livestock and irrigating vegetable gardens will not be prevented by designating the local water body as a CFR. Win-win' compromises are possible;
- The CFR site is accessible to all, not only the land owner;
- There is potential for multiple additional benefits;
- The local community has strong commitment, and makes contributions, to improving the CFR, meaning that active participation by the local community in further improvements can be expected.

Legal

- No conflict over land ownership of the CFR or rice field areas;
- No potential conflict over water/land usage;
- The CFR site is legally or locally recognised.

Institutional

- The authorities and FiA (Fisheries Administration of Cambodia) agree to or support the development of a CFR committee and commit to participate in and implement the intervention;
- A functional community organization (CFR committee) is already in place or there is potential for a local CFR committee to be established.

1.3. Preliminary field reconnaissance

A quick assessment should be made at each CFR site by the implementation team together with relevant stakeholders, including the Village Chief, Commune Council (CC), existing CFR committee or Farmers' Water User Group (FWUG) Committee (where applicable) and other community representatives. Prior arrangements should be made for local people to meet at the site for the assessment. The assessment should use the criteria developed and agreed upon in advance in Step 1.2. (above). The preliminary field reconnaissance of each site should take one to two hours. After the reconnaissance, the team should have gained a clearer idea about whether the site can be selected for intervention.

1.4. CFR- RFF assessment and selection

The information collected for each potential CFR-RFF should be assessed against the agreed criteria. This information about the sites should be presented in a table, with sites ranked according to how they meet the criteria. A short explanation should be provided on why individuals sites meet or do not meet the sets of criteria. It is useful to then circulate the matrix for comments and feedback from selected members of stakeholder groups who had been involved earlier, i.e. government fishery agencies, provincial line government agencies and the local authority. With this feedback the implementation team should produce a consolidated analysis of results, providing a justification for the ranking as relevant. Based on the ranking, the **key output from this step** is a tentative list of the selected sites in a presentable format. The final decision about which sites will be selected should be made in the action planning session (see below) with the participation of broader community representatives.

1.5. Selection results sharing

A site selection results-sharing workshop should be organized at a site accessible to the participants and with access to facilities that allow for the easy presentation of information and that are suitable for discussion by the participants. To control the size of the workshop, participants from no more than 20 different CFR sites should attend each event. It is also recommended that only the key members from each site participate. It is recommended that four participants attend from the sites that best meet the selection criteria (one participant each from CFR committee; CFR member; local authorities, and other interest groups such as FWUG) and two participants from sites that do not meet the selection criteria (one from the CFR committee and one from the local authority). The workshop must also present results from the site assessment so that participants from the different sites can understand why their area was or was not selected. This should result in an understanding of how and why certain CFR-RFF sites were decided-upon, agreement on the final site selection, and mobilization and engagement for future local support (Hortle 2013).

The workshop/meetings can also serve as inception meetings for the project, and can be a useful opportunity to present background information about the project interventions and milestones, information about who might be involved, who the potential beneficiaries are and how benefits will accrue to the communities.

Thus, the **key output from this step** is a workshop with representatives from a maximum of 20 CFRs to present site assessment results and serve as an inception meeting for the project.

2. Needs assessment and action planning

The main objectives of this component are to:

1. identify and prioritize the need for both physical improvements to the CFR-RFF system and improvements to the capacity for sustainable management of the CFR-RFF; and
2. to develop a detailed implementation plan for each site.

It is recommended that the activities involved in this component include:

2.1. Design of ideal scenarios

An 'ideal scenario' for the physical aspects of the CFR-RFF system should be developed for each selected CFR. In the scenario development, different sets of elements with corresponding characteristics should be clearly defined. This should be done for each of the three general domains (CFR, channels and rice fields) and their sub-components[vii]. This design of ideal scenarios should be done in accordance with the

desired functions of domains and sub-components, and should cover both physical and biological attributes (see Table 2 below for example).

The sub-components may include, but not be limited to: 1) CFR: the physical environment, fish and other uses; 2) channels: the physical environment, fish, fishing, and other uses; 3) rice fields: the physical environment, rice farming practices, fishing, and other uses. Under the CFR, key elements might include: the dimensions of the water body, types and density of aquatic vegetation, the density of bushes and trees in or near the CFR, water quality.

A good channel for fish movement, Siem Reap

Ideal characteristics for each element can be determined for each CFR category by external 'experts', key stakeholders and the relevant CFR committee members, particularly those with knowledge and experience of inland aquatic production systems and/or the identified characteristics (Hortle 2013). This can help to ensure that what is proposed accounts for all necessary aspects. Together, the stakeholders should collectively form an ideal scenario for the CFR. Examples of ideal scenarios for a CFR Category 2 – No Flooding and for different CFR-RFF components for each CFR category are given in Annex 1.

2.2. Design capacity assessment tool

It is recommended that a tool is developed for assessing CFR committees' capacities for CFR-RFF management. The capacity assessment tool used in the RFFEP (see Annex 3) assesses five characteristics of CFR management / governance: organizational management; planning and implementation; resource mobilization; communications and networking; and representation and participation (Miratori and Brooks 2015). It is recommended that the capacity assessment tool which is developed is designed to assess CFR management capacity through a participatory assessment with community representatives, CFR committees and relevant stakeholder groups in the community. A scoring system can be used to give a rough estimate of current management capacity, with '1' representing the lowest capacity and '3' representing the highest. This will lead to greater understanding of the capacity needs and required actions.

The capacity assessment tool should be developed

Blocking fish movement/pathways using a bamboo fence, Trapaing Veng CFR, Siem Reap

simultaneously with the site information collection instrument and, along with the ideal scenarios, should be presented for consultation at a stakeholder workshop, preferably held at the provincial level. The workshop should have up to 25 participants, including commune and village chiefs or councilors, all CFR committee members and senior community members, FiA-C staff and local NGOs active in the area.

2.3. Site information collection

Prior to field information collection, a Site Information Collection instrument should be developed. The development of this instrument should be informed by the ideal scenarios for the CFR-RFF system and the management capacity assessment tool.

With the information collection instruments in hand, it is useful for the implementation team to visit each of the identified CFR-RFF sites and organize a multi-stakeholder session, preferably held at the CFR location, with local authority representatives, community

leaders, existing CFR committee members, community members, landowners and other relevant people. The session will usually take about half a day for each site. In addition, the team may choose to conduct Key Informant Interviews (KIIs) with selected individuals who may hold more relevant information but are hard to reach or who cannot attend the multi-stakeholder session. The private nature of the KIIs means that more sensitive information can be obtained. Data and information collected for each site should be recorded in a tabular form, contributing to a site profile (an example is provided in Annex 2) to be used later in the improvement needs assessment.

2.4. Assessing improvement needs

The profile for each CFR, with information collected during the field visit, can be used as a snapshot of the current state of the CFR-RFF system. When this information is combined with information on ideal scenarios developed in Section 2.1 above, it is useful as a basis for an assessment of CFR improvement needs. The differences between the desired (ideal) and the current states should be considered gaps in improvement needs. This assessment of improvement needs is conducted by contrasting the ideal scenario with the current status of the CFR, and should ideally be conducted by the same teams who developed the ideal scenarios. Having these same groups of people involved will help to ensure continuity and shared understanding, and help to ensure that improvement needs are realistic and suited to the particular context (Hortle 2013). The results from this assessment are not definite but are starting points to inform community facilitation for each CFR-RFF planning workshop. An example of a needs assessment for physical improvements is provided in Table 2 below.

Table 2: An example of an assessment of improvement needs (Annexes 1 and 2 provide more information on how this matrix is developed)

(Sub-) Component	Key element	Characteristics under ideal scenario	Current situation	Assessment of required interventions
CFR - Environment	Dimensions - area, minimum in dry season	5% of large water body (LWB) size, 1 ha minimum	1 ha of protected area	
	Dimensions - depth, minimum dry season	1-2 m deep over 60% of area, 2-3 m deep over 40% of area	0.5-1 m deep over 100% of area during March to April	1) Expand conservation site to upstream 2) dialogue with water users 3) agree processes to manage pumping of water from CFR to dry season rice
	Percent of surface area cover by aquatic vegetation	25% in patches and some low density	Vegetation (cover area 20%, dominant species and others)	No improvement needed
	Density of brush parks / tree branches	10 brush parks x 40 m2 = 400 m^2	Zero brush park / snags	Install brush parks / snags and concrete ring
	Trees in and near CFR	Plant along CFR, upper drawdown zone and within 20 m of riparian zone	2000 m^2	Plant trees in riparian zone/bank - upstream

(Sub-) Component	Key element	Characteristics under ideal scenario	Current situation	Assessment of required interventions
	Water quality – nutrients	Secchi disc 30-45 cm in April-May, green water	PH (8), PO4 (0.25), NO3 (0), Secchi disc (41-43 cm), clear water.	No improvement needed
	Water quality - turbidity	No clay in water column	No clay in water column	No improvement needed

With the management capacity assessment tool (detailed in Annex 3) it is recommended that the implementation team facilitate a participatory self-assessment of CFR-RFF management capacity with community and local stakeholders (Miratori and Brooks 2015). It is useful to hold a break-out session for the assessment with the CFR management committee (if it is in place), local authorities and community members at large.

2.5. Detailed planning and prioritization

It is recommended that this step is achieved through a number of 'mini-workshops' at the community level with a larger group of stakeholders. In total, these mini-workshops can take the equivalent of two days (spread over several separate meetings). It is recommended that this is facilitated by the team who developed the ideal scenarios and the assessment of CFR improvements needed. Recommended participants in the event include community leaders and key community members / existing CFR committee members, members of the local authority, landowners and other community interest groups.

Key steps in these workshop include:

Step 1. Introduce the CFR-RFF system concepts

It is useful for participants to be introduced to CFR-RFF concepts in order to gain some background information and a basic understanding of key aspects of a CFR-RFF system. This session is quite technical in nature and it is important to allocate sufficient time to enable participants to develop a good understanding of the key components/domains of a CFR-RFF system. CFR types and how they function should be explained so that participants can use this understanding to inform their own system assessment for improvement needs. Graphic presentations using photos and/or other visual materials of different RFF domains and CFR types is desirable, as this helps to ensure a common understanding of exactly what is being discussed (Miratori and Brooks 2015).

Step 2. Build a realistic vision

Conducting a participatory resource mapping exercise with participants is useful to illustrate the current state of the CFR-RFF system and the management capacity in place from the perspective of the participants. It is useful for facilitators to make reference to the earlier introduction to the system and its key components, and also to share with the participants the key information received from the field visits and the site profile.

Following the participatory resource mapping, visioning exercises are useful to capture what the participants believe their system should be like in the next four to five years. This should be followed by a presentation (delivered by the facilitator team) of the ideal scenarios developed earlier, linking the agreed resource mapping elements to the elements and characteristics that the participants would like to see in their CFR-RFF ideal scenarios.

In summary, the recommended activities in step 2 are therefore as follows:

- Participants develop a resource map of the current state/status of their CFR/RFF system. If some

information within the CFR profile (site profile) is missing from the current map, it is useful for the facilitator to make suggestions to add this information into the map;

- Participants build a vision of their RFF system over the next 4-5 years. If some characteristics within the ideal scenario are missing from the vision, it is recommended that the facilitator provide suggestions to add to the vision;

Result of a visioning exercise

- Participants finalize their vision and present it back to the meeting for further discussion, approval and agreement.

Step 3. Facilitate problem tree analysis

Using the resource map and the agreed vision, the participants should then identify the main problems and barriers that will constrain efforts to achieve their vision. This should cover both the physical improvements and management capacity needs for the selected CFR-RFF system. The results of the site selection assessment in Section 1.4 should not be disclosed to the participants, but should inform the session through facilitation. Key constraints/problems should then be prioritized and analyzed with the participants using a problem tree analysis method. This process will help participants to:

- Identify the root causes constraining their community from meeting their vision;
- Define potential solutions for removing or mitigating the root causes.

Ideally this process will also elicit ideas about how to respond to shocks such as unexpected dry periods or droughts, or unfavorable price changes for rice and vegetables that might interrupt livelihood activities. Plans for protecting water in the CFR should account for the fact that such livelihood shocks may require poorer and vulnerable households to 'opt-out' of the agreed six-month CFR management action plans.

Step 4. Conduct a stakeholder analysis to:

- Identify existing stakeholders active in the area;
- Assess the interests and resources accessible to support the implementation of priority actions (see Step 5 below), particularly local resources such as community rice banks, community savings and pagoda funds as well as in-kind contributions.

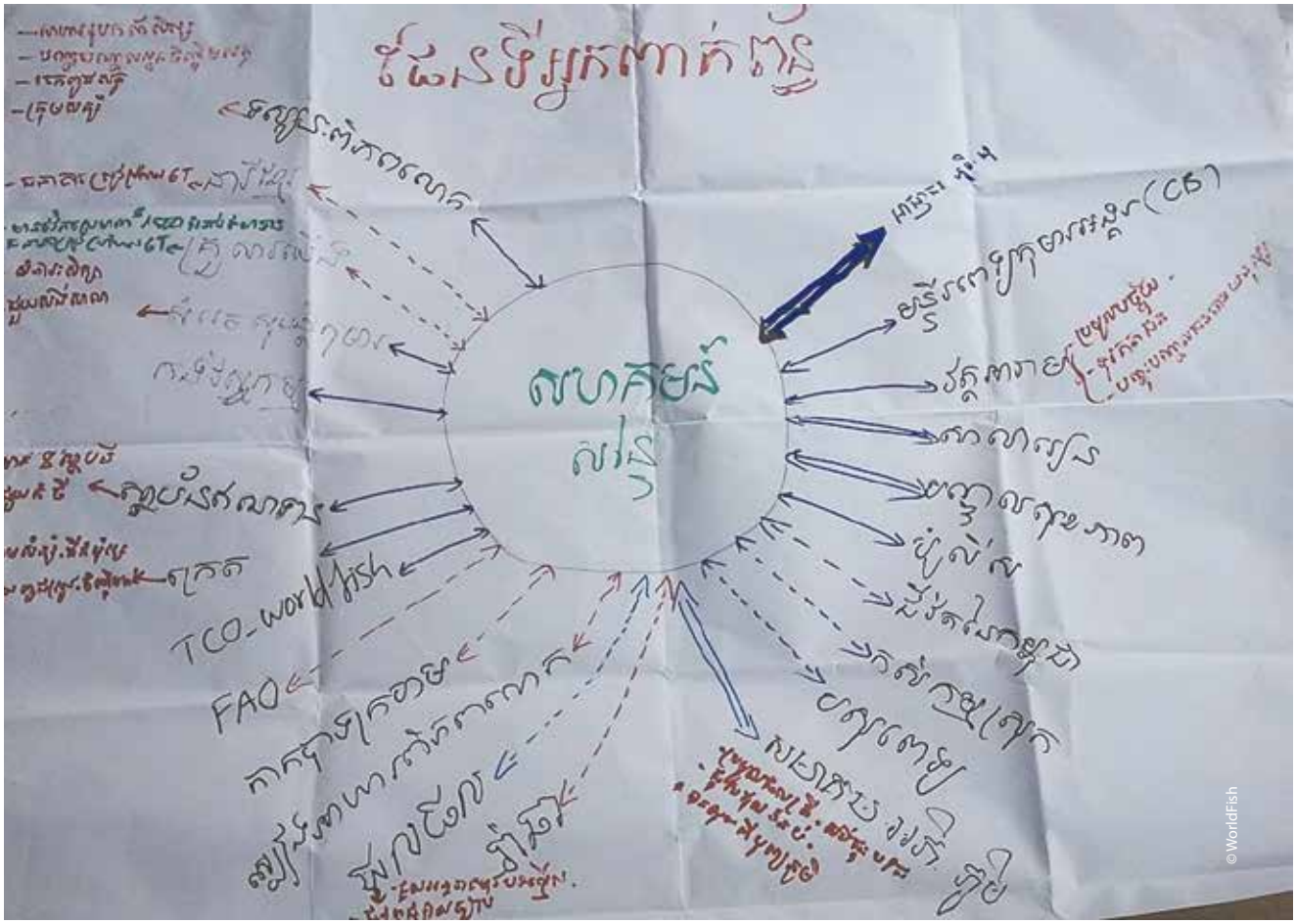
Step 5. Develop an action plan and prioritize actions for the next 6-month implementation

With the help of a simple table, participants should identify actions to address the root causes of the key problems / constraints to reach the ideal situation in both physical environments and management capacity. While the process is independent from the earlier assessment made by the implementation team, the results of this earlier assessment should inform the process without directly influencing the results. Therefore, the facilitator should make sure that appropriate questions about the key aspects identified by the implementation team in its assessment are posed for participants' consideration. A six-month action plan should then be developed from the list of identified and agreed actions.

Thus, the activities in step 5 are as follows:

- Based on the community stakeholders' vision, and using the action plan template as a monitoring tool, create an action plan to help the community achieve their vision;
- Based on the stakeholder analysis in step 4, confirm the resources (people, finance, materials and network) to support the implementation of activities in the action plan.

An example of the results from resource mapping



An example of the results from a stakeholder analysis

Table 3: Example of a six month action plan for Santei CFR, May 2014 – October 2014

Activity	How to ensure the activity is delivered?	Main responsible person(s)	Start & end date
Drain water to avoid flooding of village and rice field	➧ Study the need for canal expansion; ➧ Meeting to discuss canal expansion and planning; ➧ Mobilize resources to implement the canal expansion plan	➧ Village development community; ➧ Village and commune authorities	May - Oct.
Store water for irrigation and for enhancing fisheries resources	➧ Meeting to raise awareness on repair of a dike; ➧ Generate income from fishing in reservoir 78; ➧ Select contractor for dike repair; ➧ Conduct M&E on dike repair	➧ Village-commune authorities; ➧ [Person A]; [Person B]; ➧ Local villagers; ➧ Water management committee	May - Oct

2.6. Setting up an M&E framework

A core focus of any CFR-RFF intervention is to facilitate improvements in two aspects. Monitoring can be designed to capture improvements in five main areas across the two aspects:

1. The performance of the CFR-RFF system:
   - CFR physical and biological components;
   - Management capacity and effectiveness of CFR committees;
   - Engagement and support from other community members and stakeholders.
2. The resulting benefits to local livelihoods and food security:
   - Catch within the CFR Zone of Influence by local communities;
   - Contribution to local fish consumption and income.

Specific indicators of change in these five areas are relevant for all CFR-RFF interventions (see examples in the tables below) and can be monitored during and after the intervention period to assess progress, results, and outcomes.

Design of a monitoring and evaluation (M&E) system includes selection of indicators and planning the implementation of the monitoring program. Answering the questions of how, how often and by whom each indicator will be monitored is an important part of M&E design and should take place prior to implementation (the tables below provide examples of how these questions may be answered). If the M&E system is designed and implemented early in the intervention (ideally immediately after the CFR-RFF is selected) it will produce baseline measurements against which to evaluate change (see Establishment of baselines section below).

2.6.1. Establishment of baselines

Baselines should be established from the outset of the project / activities through initial (first iteration) monitoring, ideally as soon as a CFR-RFF is selected. As the intervention progresses, the monitoring program will continue to generate data at established intervals. Results from successive intervals can be compared to the baseline to assess progress.

In RFFEP, indicators were selected and incorporated into a two-part M&E system that mirrored the two aspects above. Indicators for aspect 1, which are highly informative for the management of individual CFR-RFFs, were incorporated into local monitoring programs. Indicators for aspect 2, which are more useful at broader scales such as regional or national projects and policies, were incorporated into a project-wide monitoring program. For locally-implemented monitoring, best practice is to conduct indicator selection and M&E design during the participatory planning process (after agreement upon the CFR Management Committee's detailed action plan), making sure to align them with the intervention objectives identified by participating communities and stakeholders.

One important consideration in the development of an M&E framework is the availability of resources such as time and funding. Best practice is to select indicators and design the M&E system in a manner that efficiently uses resources and optimizes return (of information) on investment. In general, aspect 1 indicators require relatively few resources, while aspect 2 indicators require more resources and may need to be selected and scheduled carefully to maximize M&E effectiveness. The various indicators in the tables below may not be required nor feasible for every CFR-RFF intervention, and can be selected according to intervention objectives and available resources.

2.6.2. Monitoring the physical and biological components

Table 4: Example of a plan for monitoring physical and biological components of a CFR

What to measure	How	How often	By whom	Resource demand
CFR water levels	Using a colored water marker pole installed in the CFR	At least fortnightly; more frequently in the dry season	CFR management committee	Very low
Water quality in the CFR	Secchi disk (water clarity), thermometer (water temperature)	At least monthly; more frequently when water levels are low	CFR management committee	Low
Condition of the CFR vegetation	Visit the CFR and observe key components, including grass/ foliage cover around the CFR to prevent erosion, and aquatic plant cover of the water	At least every six months	CFR management committee	Low
Biomass in the CFR	Numbers, size and species of fish and OAA	2-4 times per year, in both dry and flooding / wet seasons	Project team and CFR-RFF committee	Moderate

2.6.3. Monitoring the management capacity and effectiveness of CFR committees

Table 5: Example of a plan for monitoring management capacity and effectiveness of CFR committees

What to measure	How	How often	By whom	Resource demand
Progress against the five indicators of CFR committees' effectiveness in making and implementing decisions to meet their CFR-RFF objectives: 1. Organization management; 2. Planning and implementing the plan; 3. Resource mobilization; 4. Linkages / networking; 5. Representation and participation	Scoring carried out through a participatory assessment with community representatives, CFR committees and relevant stakeholder groups in the community	At the start and near the end of the project; or every two years.	By the CFR management committee, led by the committee chief.	Low

2.6.4. Monitoring levels of engagement and support from other community members and stakeholders

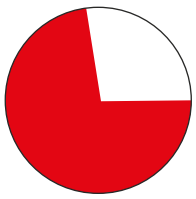
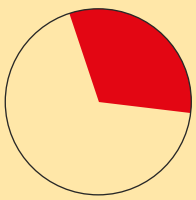
Table 6: Example of plans for monitoring levels of engagement and support from the community

What to measure	How	How often	By whom	Resource demand
Community members' and wider stakeholders' (e.g. Commune Council's) contributions in cash, labor and other in-kind contributions	A simple logbook as a record of contributions	Record contributions as they are made	CFR management committee secretary	Low
Community members engagement in patrolling	A logbook recording the names of CFR patrol members	Record as names are added and removed	CFR management committee secretary	Low

2.6.5. Monitoring at the activity level

Monitoring at the activity level (i.e. monitoring of CFR Committees' action plans) is also appropriate. Each CFR-RFF should have its own set of activity indicators.

Table 7: An example of activity monitoring conducted by community members

Activity	How to ensure the activity is delivered?	Main responsible person(s)	Achievement
Draining water to avoid flooding of village and rice field	• Study the need for canal expansion; • Meeting to discuss canal expansion and planning; • Mobilize resources to implement the canal expansion plan	• Village development community; • Village and commune authorities	
Store water for irrigation and enhancing fisheries	• Meeting to raise awareness on repair of a dike; • Generate income from fishing in reservoir 78; • Select contractor for dike repair; • Conduct M&E on dike repair	• Village-commune authorities; • CFR management committee members; • Local villagers; • Water management committee	

Planning for sustaining the benefits of a CFR-RFF system is recommended as part of establishing a monitoring and evaluation system (see section 2.6.6. Monitoring the potential for sustainability below).

2.6.6. Monitoring the potential for sustainability

Sustainability in this context refers to the continued maintenance of the CFR-RFF system by local communities in order to achieve continued benefits even after the initiating, external donor-funded project has ceased.

It is useful to distinguish between i) monitoring potential for sustainability which is carried-out by a project team through a donor-funded project and ii) monitoring carried-out by long-term stakeholders such as community members and local government without inputs from a donor-funded project.

Potential for such sustainability can be assessed throughout a donor-funded project by 1) monitoring key indicators and 2) asking key questions of the CFR Management Committee and connected community members.

Key indicators that will support sustainability include:

- Increased fish catches;
- Regular participation in CFR committees by different stakeholders including the Commune Council;
- Successful fundraising and financial commitments to CFR action plans;
- CFR action plans are incorporated into Commune Investment Plans (CIPs).

Key questions which may be useful to ask CFR committee and connected community members include:

1. How likely is it that your CFR will be achieving the same benefits for the community one year from now? (very likely, likely, 50:50, not likely, very unlikely). Why is this?
2. What factors will make it more likely that your CFR will continue achieving the same benefits for your community one year from now?
3. What factors will make it less likely that your CFR will continue achieving the same benefits for your community one year from now?
4. What can be done to ensure that your CFR management committee and community members will continue their commitment to achieving the same benefits?

Examples of indicators of potential for sustainability include:

Monitoring for and supporting sustained benefits requires specific training for the people who will conduct monitoring after external funding finishes (probably CFR committee members). The key factor in monitoring potential for sustainability is: is there a 'mechanism' at CFR management committee and community level for responding to and resolving needs or problems in the CFR-RFF system? For example, when illegal fishing threatens a CFR-RFF system, does the community mobilize people, resources and funds to resolve this issue successfully? And does this happen regardless of whether the originating project is still operating?

Table 8: Potential indicators for monitoring the sustainability of a CFR-RFF intervention

Indicators	How	How often	By whom
[Qualitative indicator] Level of support amongst committee and community members for CFR-RFF interventions.	Questions asked during scheduled community meetings or forums.	3 monthly basis	CFR committee members and other champions of community fisheries.
Financial commitments made by private and local government actors	CFR plans integrated into CIPs	6 monthly basis	CFR chairperson or delegate

3. Intervention and management

This is the start of concrete actions on the ground to build local capacity and mobilize participation by different stakeholder groups, to make improvements to the physical and biological attributes of a CFR-RFF system and to improve management of these resources.

Whilst this section is separated into three parts (development of CFR management capacity; improving bio-physical attributes; and improving management of the CFR and rice fields), it is preferable that these actions are carried out in parallel, as in practice they are interlinked.

3.1. Development of CFR management capacity and awareness

Where the intervention focuses on an existing CFR-RFF site, a management committee may already be in place but may not be functioning effectively, or it may not be functioning at all. The purpose is thus to reinvigorate the management committee and equip it with necessary knowledge and capacity for effective CFR-RFF management. Where no management committee is in place, a new committee will need to be established. In such cases it is recommended that an additional self-assessment is conducted after the committee is in place to measure its capacity needs. This will inform the development of training and other capacity strengthening support as needed.

It is recommended that the CFR committee be made up of local volunteers, elected by community members living in the CFR's ZOI. A CFR committee should be made up of 5 - 11 members depending on the population size and number of villages in the ZOI. The main duties of the committee should be; to ensure effective CFR management, including developing CFR bylaws and a management action plan; encouraging fundraising activities, targeting commune councils, NGOs, community members and other local sources; defining the CFR's boundary, managing fish migration routes and other domains of the RFF systems; and reviewing progress with the support of local communities, authorities and the Fisheries Administration (FiA).

CFR committee capacity building refers to strengthening the skills, competencies and abilities of the committee to develop and implement a CFR action plan, mobilize resources, etc. It is recommended that the participants invited to such training should not be limited to CFR committee members. Members of other community interest groups and stakeholders including local NGO staff may also be included in a two and a half-day session. Misunderstandings can be minimized by ensuring that all relevant stakeholders are aware of the training; that collaboration of resource user groups is actively encouraged leading to the better integration of land and water management.

3.1.1. Stakeholder awareness and empowerment

Awareness raising refers to the process that involves relevant stakeholders to learn about and understand the importance of rice field fisheries systems and to work out how to manage their system in a participatory and sustainable way. Various stakeholders such as farmer water user groups, agricultural communities, local authorities, traditional groups such as pagoda committees, mosque committees, elderly associations and other community based organization groups may be invited to attend the sessions as appropriate.

Empowerment is the process of strengthening the capacity of relevant stakeholders to prioritize action plans and take actions to meet their common outcomes and objectives. Empowerment capabilities can include power in decision-making; access to information; resource mobilization; and exercising one's rights etc.

The following steps may be taken to improve awareness and enhance stakeholder involvement:

Meet[viii] with local authorities (commune councilors and village chiefs) to:

- Motivate them by appreciating their work;
- Tell success stories of development activities that have been planned and implemented by communities and local authorities without external funding support;
- Ask questions related to RFF systems in their target areas;
- Explore their visions to improve this system.

Organize with commune councilors and village chiefs for a village meeting to be held with CFR committees, community representatives and other CSOs working in the target villages/communes to ensure participation by villagers from across the village.

It is recommended that:

- Existing local community groups such as rice bank committees, village development committees etc. and other NGOs working in the villages are also invited to participate in the meeting;
- The main meeting should be for half a day and should ideally be held the day following the meeting with local authorities;
- The meeting should offer opportunities for sharing ideas and success stories, and exploring visions for future actions.

The success of CFRs in maintaining productive RFFs is dependent upon a wide range of users and other stakeholder groups. Effective land and water use is an important factor. Therefore awareness sessions about sustainable land and water management practices should aim for and encourage positive contributions from other village interest groups, commune-level authorities and NGOs active in the area.

3.1.2. Other awareness-raising and training

Capacity building in this section refers to formal and informal training courses, workshops, field visits, coaching and mentoring. The relevant topics for training include the technical aspects of CFR, including CFR general concepts such as refuge ponds, cement rings, and biological monitoring process. It is recommended that the training also covers management characteristics including fisheries law, presentation skills, rice field system governance, book keeping and how to develop and integrate the CFR management plan activities into Commune Investment Plans. The training can also include the advantages of micro-nutrient rich fish species and how fish can be cooked to maintain nutrition and vitamins.

3.1.3. Capacity building for multiple stakeholders

The capacity building of NGOs' partner staff, CFR committees, commune councils, fishery agency staff, police officers, teachers and students from secondary schools who will be involved in implementing the intervention will help to mobilize their engagement in identifying the problems encountered, the root causes, appropriate options to address the problems, and their direct involvement in resource mobilization, building networks, managing the RFF system and improving technical capacities (Miratori and Brooks 2015). Moreover, mobilizing them in these areas provides them a better understanding of the required management practices, and encourages them to think about how to ensure the long term sustainability of the CFR-RFF system (see 2.6.6. Monitoring the potential for sustainability).

3.1.4. Capacity building for Local NGO Partners

Three major steps are recommended to strengthen local NGO partner capacities:

- Engagement of NGO partner staff including senior management and field staff in field visits to allow them to get involved, build ownership and feel more responsible for the outcomes of the project and its sustainability;
- Assessment of NGO partners' staff capacity needs on governance, skill in facilitating community visioning, problem tree analysis, stakeholder analysis and community action planning;
- The provision of capacity building should be divided into two stages:

1. The formal training process should focus on good facilitation skills and use of participatory analytical tools e.g. community visioning, problem tree analysis, stakeholder analysis and community-led action plan development;
2. Field practice with coaching by project staff should provide, hands-on practice by trainees in selected villages and with follow-on coaching by experienced project staff who would provide supervised practice and feedback, and help with identifying and resolving any issues with training.

The training should aim to help NGO partners' staff build positive attitudes and facilitation skills to deal with problems encountered in their daily work; to introduce and reinforce self-motivation into their lives; and to avoid or mitigate negative thoughts. In these ways, local NGO partners are able to help communities/ CFR management committees manage their CFR-RFF system more effectively.

3.1.5. Building sustainability of the interventions

It is recommended that four stepwise activities be implemented for the formation of a sustainable, well-connected and motivated CFR committee. Experience implementing RFFEP has shown that these steps also contribute to the improved financial sustainability of a CFR[ix]:

Step 1. A series of follow-up visits to be organized over the length of the CFR management committee's action (i.e. a period of 6 months or other chosen period) to support committees with their action plans, provide coaching and build important networks with other institutions within the village and commune.

Step 2. A stakeholder workshop with the CFR management committee and other relevant stakeholders should be held to focus on five main activities:

- Reviewing and reflection of key successes and challenges;
- Role-plays by skilled facilitators to enact the characteristics of good governance and management using the five types of characteristics defined (see Annex 3);
- Participatory assessment (see Annex 4) using a simple descriptive assessment tool which describes the current status for each of the five characteristics of management/governance (discussed in Section 2.4.);
- An exposure visit to other CFR sites; and
- A draft of the next 6-month plan.

The recommended length of this stakeholder workshop is two and a half-days, depending on the availability of CFR management committee members. Also, if there is an opportunity to celebrate their successes, a high-ranking official or other appropriate person may be invited to champion the process and present a small gift as a token of appreciation for the work done. This process allows management committee members and local authorities, to reflect-on and assess their progress, in terms of governance and management in a participatory way that promotes their ownership. Finally, it can help to catalyze and encourage committees, particularly where they may have lost momentum, motivation or are lacking strong leadership.

Step 3. Second-level engagement should follow during the second 6-month action plan. In this engagement, more emphasis should be placed on improving governance, identifying opportunities for integrating some elements of the plan into the Commune Investment Plan and fund-raising via private sector support and the committee's innovative approaches. Ideally, there should be about 2–3 visits over the 6-month period for each CFR committee.

Step 4. Six months after the first-level engagement (as described above) a stakeholder workshop should be arranged with a similar agenda similar to that of the first. However, since external support will have to end eventually, the focus should be on identifying and agreeing on opportunities for institutional sustainability of the committee and finding further support from local funding sources including from local interest groups such as NGOs, commune funds and fisheries cantonment (see section 2.6.6. – Monitoring the potential for sustainability for further details).

3.2. Improvement of the bio-physical systems.

This section describes ways that CFR and RFF environments can be improved to maximize their biodiversity and productivity.

3.2.1. Ensuring an adequate CFR surface area and water depth

A CFR may be used as a source of community water supply, usually for rice irrigation during dry spells in the wet season, but also for irrigating nearby vegetable gardens. Whilst this is a good use of the resource (and sometimes it may be the most important function of the water body) it is recommended that at least 5% of the total water surface area, above a depth of 1.5m, be retained for a CFR pond (Hortle 2013). For a large CFR water body, a minimum of 1 ha of surface area should be retained.

The objective of the CFR should be to improve the habitat in ways that will increase overall abundance and diversity of species, especially the smaller planktivorous species. In principle, the more varied the CFR environment created, the better it will be able to support different fish species (Roni et al. 2005). If possible CFR should have a range of different depths to provide for different fish species and age class needs. For example fry/fingerlings will tend to gather in shallow water and may not survive in a water body of uniform depth.

The shape of the CFR should also be varied to create more heterogenic environments. Increasing the perimeter length of a water body will allow for the planting of trees at strategic locations for substrate and

shading effects. However, creating irregular structures will complicate earth moving calculations- when you hire a construction company they will want to be paid based on the quantity of soil excavated. It may be impractical to ask them to create irregular shaped CFRs.

To help communities manage water levels in the CFR, a depth marker pole can be installed The pole can be painted in different colors to show; when water levels have risen high enough to inundate the surrounding rice fields (blue) and when no further water should be extracted, (red). Once the water level has dropped to the red color on the pole, committees and community members (who may pressure the committee members to allow more water extraction) will know that further extraction will affect the fish populations.

A further advantage of the marker pole arrangement is that it can encourage communities to maximize the amount of available stored water for other uses such as topping up small-scale fish farm ponds or irrigating vegetable gardens (as in the picture above).

Deepening a part of a CFR to ensure it can retain water all year round, Boeng Tramses CFR, Pursat

A CFR after deepening, Boeng Tramses CFR, Pursat

Installation of a marker pole for a CFR pond

3.2.2. Ensuring adequate provision of vegetation in and around the CFR

Aquatic vegetation (macrophytes) such as water hyacinth can choke the water body, reducing its biological productivity and accelerating siltation. For categories 2 and 3, vegetation cover should not exceed 25% of the surface area, especially around the perimeter of a CFR. Given that vegetation grows quickly in these environments, care must be taken to ensure vegetation cover is present but kept in check. Vegetation cover provides safe refuge areas for juvenile fish and also for nesting substrates for some species (e.g. Snakeskin Gouramis) (Hortle 2013), and some aquatic plants can reduce water turbidity and help provide oxygen through photosynthesis.

View of CFR before intervention, Nov. 2012. Amount of aquatic animals caught: 232.50g/fishing event, Aren CFR, Pursat

View of CFR after project intervention, Nov. 2013). Amount of aquatic animals caught: 2,186.50g/fishing event. Aren CFR, Pursat

Brush park installed in CFR, Aren CFR, Pursat

Gourami nest in littoral zone, Boeng Daiphtaul, Battambang

At many locations mineral turbidity can occur, often caused by run-offs from embankments and surrounding streams, and particularly where there is frequent access by cattle and water buffalos. High turbidity, characterized by brown water, results in a loss of productivity of the water body as primary production of plankton (green water) is reduced, mainly due to lack of sunlight penetration in the water column (Hortle 2013). To help stabilize slopes and reduce erosion, grass should be planted on the embankment and the slope surrounding the water body. These are usually quite easy to establish because where water levels are fairly constant. But more difficult if CFR water levels fluctuate by several meters in a year. In these instances larger plants or shrubs should be used to retain the soil and protect from erosion.

On the top of CFR banks, trees provide the additional benefit of providing shade in some areas, producing leaf fall and fruits which can increase fish production, and attracting birds contributing to increased biodiversity of the area (FiA pers. comm.). Cambodia has several unique tree species that flourish on the Tonle Sap floodplain. A guideline developed by Conservation International (Dong and Heng n.d.) may be useful in this regard. Information is needed at community level about suitable tree species and where and when to plant seedlings. Where flooding of the refuge pond embankment is unlikely, hardy crops such pineapples or lemon grass may be cultivated.

CFR with poor bank management, Boeng Kamhengsa, Kampong Thom

CFR with good bank management, Lbeuketeiyus, Siem Reap

Good for fish: Morning glory, Water lily, Water mimosa, Water hyacinth, Duck weed, Rose periwinkle (Kamping Poy Nhi), Sesbania (snor) to the recommended extent are all good for fish (Hortle 2013).

Not so good for fish: Lotus, Mimosa pigra

3.2.3. Brush parks and other substrates

Many fish species feed on plants, microbes, detritus and algae growing on substrates such as tree branches, grasses and rocks. Brush parks of tree branches offer the best surface area for encouraging the growth of these small microbes collectively known as periphyton. They also provide attractive resting areas for predatory species as well as shelter for juvenile fish to hide from predators. Brush parks can be removed from CFRs when water levels drop significantly. For some species the brush park also provide substrates for breeding (Hortle 2013).

The use of brush parks in Cambodia is, controversial. According to the Law on Fisheries 2006, brush parks, locally known as samrahs, are banned, if used as fish aggregating devices or FADs because they lure and trap mature fish, effectively not allowing them to breed. However, in conservation areas and CFRs, where

Artificial reef made from plastic bottles,
Anlos Dong, Battambang

fishing is not permitted, brush parks are permissible if they are not used to assist in the harvesting of fish (FiA pers. comm.).

The use of tree branches may not be environmentally sustainable if harvested from standing trees. Samrahs should only be built from dead wood. Based on experience, a tree harvesting area of about 200 m^2 is recommended per CFR, but there is no known research to provide more guiding information. As an alternative to dead wood, a Masters student from Royal University of Phnom Penh (RUPP) conducted an experiment using plastic bottles as an artificial reef. This proved to be just as good as branches, would of course be more durable, decaying a lot slower than branches, and may be usefully combined with the collection of rubbish, including waste plastic, from around the CFR (Sreymon 2015).

Care must be taken that the plastic bottle samrahs are strongly constructed to prevent the bottles becoming detached and littering the water body.

3.2.4. Ensuring adequate provision of supporting infrastructure

Building meeting halls or guarding facilities may be required, depending upon the size and value of the CFR. Guardhouses should not be too small but large enough for multiple purposes. It is recommended that guardhouses are built so that a guard can live there permanently, so that the incremental cost for a larger guard house will be justifiable. Experience from RFFEP has showed that, once a guard is in residence and keeps dogs, the incidences of poaching are significantly reduced if not completely abolished.

Small guardhouse that will probably never be used, Boeng Voul, Pursat

Bigger guardhouse which will be used, and can also be used as dwelling, Boeng Krung, Battambang

At some locations, a meeting hall with adjoining rooms will also work well as a guardhouse and of course also serve as a meeting venue for many functions.

Fencing may be required to prevent cattle and water buffalo from excessive wallowing in the CFR or destabilizing the slopes due to their frequent access. If the CFR is also used for animal bathing and cooling then a section in the CFR should be assigned for this purpose.

Fencing off CFR from water buffalos, Enteakuma CFR, Kampong Thom

Fencing CFR from cattle, Boeng Kantout CFR, Pursat

3.2.5. Improvements of channels

Channels are essential in linking the CFR to floodplain rice growing areas, so that fish can migrate freely. Investments can include: cleaning the channels, dredging to a depth of at least 0.5m during the wet season; and ensuring that a well-functioning water gate or sluice is provided. In some instances a spillway may also work. It is advisable that a no fishing zone be established 50 - 100 meters from the CFR and migration channel Culverts and spillways are alternatives when ideal channels are not possible (for example, if there is a road between the CFR and the floodplain). Two channels from each side of the CFR should be provided as the minimum water connection. More channels which are in good condition would of course provide better connectivity and assist fish migrations more.

Earth outlet/inlet at Trapaing Thlok Meanchey CFR, Kampong Thom

3.2.6. Improvements of the rice field system

The main way of improving fish productivity in the rice fields is of course to retain water as long as possible, maintaining a depth of about 25cm in the fields throughout the rice growing period. During the early monsoon, many Cambodian rice fields may dry out. One way to mitigate the loss of fish during such times is to adapt the field by creating a deeper area of the field that does not dry out. One method that has been used is to install cement rings into a corner of the field for fish to take refuge in when water recedes from the field (Taylor and Sengvilaykham 2010). Technically the rings look feasible but the full quantification of

Earth outlet/inlet at Trapaing Thlok Meanchey CFR, Kampong Thom

benefits is yet to be done. However, other experience shows that cement rings only extend water availability for a short period, and may not help the survival of fish (Yumiko Kura, pers. comm. 2018). In addition, they pose a risk to children and also cattle who may injure themselves, especially during the wet season / floods. Small ricefield ponds may be a more practical solution to this problem.

For areas inside the Tonle Sap flood zone, in order to prevent farmers with rice fields close to the CFR from catching most of the fish in ricefield trap ponds, a 'no-fishing within 100m zone', sign should be erected using concrete poles. For areas outside the Tonle Sap Lake flood zone, refuge ponds or trap ponds may be constructed within rice field areas as long as they are small, (< than 100 m^2) in size. The ponds may be as deep as 3 meters to ensure water retention during the dry season. Farmers should be encouraged to retain some fish through to the dry season so that these trap ponds contribute to the CFR effect.

Pole installed to show no fishing area in rice fields, Santey CFR, Siem Reap

3.3. Management of the CFR-RFF System

Once community capacity has been enhanced and the bio-physical aspects of the CFR / RFF have been improved, then effective management must be put into place. Institutional capacity building should be done simultaneously with the development of the RFF system (Miratori and Brooks 2015). The aim of CFR-RFF management is to maximize sustainable productivity through good governance[x]. In other words, the habitat must be managed in a way that ensures expected returns. This may not always be the maximum fish yield from the system but rather an optimum level that satisfies the multi-purpose functions of the RFF ecosystem, of which of course rice production is usually treated as the main priority.

Rice field refuge pond with small home garden, Damnak Kranh CFR, Pursat

Pole marker with three different colors showing the level of water in the pond, Aren CFR, Pursat

At this stage the ideal scenario for bio-physical systems should be close to being achieved. The RFF system should have

- a CFR with deep refuge, good quality water which is not turbid, some aquatic vegetation but not more than 25% of area cover,
- operational sluice or water gates
- brush parks installed for habitat enhancement
- vegetated slopes to prevent erosion
- clean migration channels of >1 meter wide and 50cm deep, connected to rice fields
- rice fields which maintain a good depth of water and which may have small temporary refuge areas and no fishing zones, demarcated with concrete poles.

3.3.1. CFR water management

Water volume and depth

For CFRs to achieve their purpose, an absolute minimum water volume and water depth has to be maintained year round. High temperatures in the hot season have a strong effect on water evaporation and can quickly lead to lowering water level. CFR should be sited in water bodies that have not dried out completely for at least twenty years. The extraction of water for irrigation can rapidly reduce the water volume after the rainy season. One way to 'communicate' to committees and their members is to maintain a minimum volume through the use of the marker pole for all to see (see section 3.2.6. above). This may require repainting the pole and readjusting water levels every year. Even though physical improvements such as deepening may have been carried out, the physical condition of CFRs can change quite quickly, for example high erosion/sedimentation can reduce water depth. CFR Management Committees should be aware of potential for such changes and prepare resources accordingly.

Water can be retained in the CFR by closing water gates and allowing for water to be kept for a longer period. This is especially relevant for category 2 and 3 CFRs that are usually large rectangular ponds.

Water quality

The management of water quality in the CFR should not be over-looked nor its importance under-estimated. This relates to Section 2.5. step 3 which involves helping communities to anticipate and plan for shocks and changing priorities around CFR water use.

The fish stock may be confined to the CFR water for as much as nine months once the CFR is disconnected from the surrounding wetlands. Therefore, it is important that the conditions within the CFR are optimized to ensure that a multi-species fish assemblage can thrive. The basic biology within the CFR will be a mix of different feeding ecologies, mainly planktivorous and carnivorous. Managing a balance that maximizes production and diversity is not an exact science since the populations of the various species is unknown. However, the idea of maintaining good water quality is the basis of good management practices.

Ideally water in the CFR will be a green color with the human hand still visibility, when the arm is submerged; roughly translating to a visibility of 30 centimeters (Rouse 1979). The water should not be a brown color, typically indicating heavy mineral turbidity, which reduces sunlight penetration and plankton growth.

Key factors affecting plankton density most relevant to the CFR are the concentration of important nutrients such as carbon, phosphorous, nitrogen and potassium and mineral turbidity. The concentration of essential elements for plankton 'food' will be determined by assessing concentrations in the incoming channel water or run-off. Run- off from heavily fertilized agricultural land will be nutrient-dense, (but may also contain pesticide residues). Often though CFR water in Cambodia has low concentrations of these essential elements (Sieu et al. 2015). One remedy is to add them in the form of fertilizer; however, this is expensive and the returns are unknown and should only be done in newly excavated CFR which tend to be unproductive. The benefits have to be carefully calculated because as soon as connectivity with the rice fields is restored there will be a flushing out of nutrients from the CF R.

Probably the most important factor to note is the incidence of mineral turbidity, a common problem in Cambodia. The frequent heavy rainfall and flash flooding in Cambodia cause rapid soil erosion leading to turbidity. The soil must therefore be stabilized by vegetation to reduce erosion. This means managing floodplain forest bushes planted where necessary at the time of the initial technical intervention. This also means taking care of these bushes and facilitating their natural propagation to cover as much soil area as possible. Every year the floodplain forest species of bushes and grasses may need to be replanted where gaps have appeared.

Improving the concentration of essential elements by applying Urea and DAP fertilizer into CFR, Boeng Teamses CFR, Pursat

Improving the concentration of essential elements by apply Urea and DAP into CFR, Aren CFR, Pursat

Ceremony at floodplain tree planting event, Boeng Daiphtaul CFR, Battambang

3.3.2. Aquatic plant management

Once any infesting aquatic plants, such as water hyacinth have been removed during habitat restoration (section 3.2.2.), steps must be taken to prevent any reoccurrence of the infestation. Infestation by water hyacinth in large water bodies may be prevented with the installation of a cable along the surface of the water as shown in the photo below. In some instances physical removal may be arranged in campaigns involving community members, students and also local authorities.

Installed cable to stop weeds from moving into CFR, Boeng Kampeng CFR, Pursat

Pupils removing floating weeds from CFR, Boeng Kampeng CFR, Pursat

Floating weed removal for use in composting for rice farming, Boeng Kampeng CFR, Pursat

Water hyacinth can be used for composting, handicrafts, and as material to keep gardens afloat (as practiced in some villages around Tonle Sap) and as a substrate for bacterial treatment (floating latrines). If labor is available, the water hyacinth can be chopped and returned to the water where it will be decomposed by bacteria and provide a substrate for periphyton growth which provides valuable additional food for some species of fish (Hortle 2013). Research on using beetles to control the level of biological growth, namely plants has been reported in Lake Victoria (Ecosmagazine 2000) in Uganda but this potential is unknown to Cambodia.

Neptunia oleracea, Boeng Preash Ponley CFR, Pursat

It is important the management committee ensures that a 2-3 meter border of aquatic plants around the littoral zone is maintained. This creates a zone of cooler water in the hot season. Smaller-leaved aquatic plants that do not propagate rapidly such as a hyacinth are preferred e.g. water lily, morning glory and water mimosa. These plants provide cover for juvenile fish and may support some species requiring cover and substrate for breeding. Warmer water in the littoral zone will promote faster growth of small fish during the winter months of the dry season (December, January). Plants around the edge of the CFR may also help deter poaching.

Installed Samrahs in CFR, Aren, Pursat

3.3.3. Micro habitats / eco-shelter (brush park)

Once the samrahs or 'eco-shelters' are installed, there is a little management effort required to ensure that branches or other materials are submerged as water level changes with season. Any substrate above water level is serving no purpose to increase available fish food. It is recommended the whole samrahs be replaced or added every 3-5 years mainly due to natural decomposition.

Ipomoea aquatica, Boeng Preash Ponley CFR, Pursat

3.3.4. Fish stock management

Stocking of local fish species may be necessary to recreate a balanced wild fish population. At locations where indigenous species of fish species highly favored by local people have disappeared, stocking is recommended as a way to reintroduce these species. However, poor conditions in the CFR can result in the aquatic environment being unable to sustain certain species. See section 3.4. M&E of impacts of the interventions and Annex 1: Characteristics of CFR ideal scenarios for further information about methods and indicators for monitoring wild fish species, and ideal scenarios for stocking specific fish species.

At the moment, FiA has no specific stocking policy for CFRs but does recommend stocking large size fingerlings (to reduce predation) between November - January after the CFR water body has become disconnected from the surrounding wetlands. At this time the water may be biologically rich as the water recedes from the rice fields, providing good conditions

for stocked fish to grow and thrive, although most CFRs will have abundant predatory fish present at this time.

Re-stocking CFRs with indigenous species from the surrounding area, including from one CFR to another, is allowed in Cambodia; however, currently there are no Government regulations or guidelines on stocking native fish (FiA pers. comm. April 2018). However, FiA encourage fish from a pond that has dried out or been pumped out to be re-stocked into another CFR (FiA, pers. comm. April 2018).

In some CFRs, the stocking of silver barb (Barbonymus gonionotus) or similar cyprinid species is recommended to boost their abundance and rice field yields for the benefit of local fishers. Stocking density rates are recommended at 2,000 large 8-10cm fingerlings per hectare of water area (De Silva et al. 2006; Murray 2006; Hortle 2013). Apart from the immediate benefits of harvesting stocked fish later in the year, another good reason for doing this is that as local farmers enjoy the benefits of increased CFR and rice field productivity they will retain their interest in managing the system. If the system is managed well, repeated stocking should not be necessary. This is an obvious benefit to the rural people since no high investment costs for repeated fish stocking are required.

Climbing perch, snakehead and catfish are favored by rural people and may be deliberately stocked in the CFR. The RFFEP conducted a fish species preference study involving 400 respondents to better understand the fish species people like to catch and consume. The top three favored species were climbing perch, snakehead and catfish, which was predictable. However, the small Esomus sp. was also shown to be favored, which is a good result since these are part of the target species to increase abundance for consumption, especially for children to benefit from the high micro-nutrient concentrations in these small species. As mentioned above, an abundance of small 'prey' species will likely increase the populations of the highly favored channids and clariads. The Parambassis species (glass perches) are very abundant at poorly managed locations. It is believed that decrease in the abundance of this species can be used as an indicator of good CFR management (based on Sieu et al. 2015).

Perception of fish preference by households under RFFEP Survey

Top 5 (of 24 fish genera)

1. Channas (snakeheads)

2. Clarias (walking catfish)

3. Anabas (climbing perches)

4. Macrognathus (swamp eels)

5. Esomus (carps, barbs)

Bottom 5 (of 24 fish genera)

1. Parambassis (glass perches)

2. Thynnichthys (carps, barbs)

3. Trichopsis (gouramies)

4. Pristolepis (catopas)

5. Mastacembelus (swamp eels)

Re-introduction of locally extinct species

It is recommended that re-introducing 'locally extinct species' to CFR should follow the protocol below.

Step 1- Agree a short list of species to be (re) introduced to the CFR;

Step 2- Understanding the reason for species x decline;

Step 3- Setting goals and objectives;

Step 4- Government permission for relocating of species;

Step 5- Deciding on the size and number of fish to be introduced;

Step 6- Improving CFR habitats that will favour the species to be introduced;

Step 7- Reintroducing brood stocks or juveniles of the species to the CFR;

Step 8- Facilitate the movement of the rare species to and from the CFR;

Step 9- Observe the status of the species, as it becomes caught by local people;

Step 10- Monitor of impact of re-introduction.

Removal of fish from the CFR

Some experts are of the opinion that communities should be allowed to harvest some fish from the CFR at certain times or for certain periods. Others argue that allowing communities to fish in the CFR at any time would undermine the whole approach. It can be argued that the job of the CFR is to protect the minimum fish stock required to repopulate the surrounding ricefields. Anything above this is surplus and should harvested by the community. Once community capacity, awareness and understanding had been built to a high level, then allowing communities to make local rules determining when and how they remove from the CFR and how much biomass can be removed, each year, would encourage more informed management of the CFR. Harvesting fish from CFRs as a traditional/customary practice for village events can be acceptable in some cases (FiA pers. comm. May 2018). Traditional harvesting from CFRs is or has recently been practiced as part of annual village ceremonies in Trapeang Thlok Meanchey and Trapeang Neang Nory in Kampong Thom, in Otamoan in Siem Reap and in Boeng Kantuot in Pursat.

The selling of tickets on designated 'fishing days' could generate useful funds for the CFR committee to use in habitat restoration work etc. There is also the need to remove giant predatory fish (e.g. Wallago atu) that may stay in a CFR for several years, and have significant negative effects on fish biomass and biodiversity. Community fishing days targeting 'giants' would give something back to the community for managing the resource well.

3.3.5. Management of migration channels

To ensure that fish are free to migrate from the CFR water body into the rice fields, enforcement and awareness of the designated 'no fishing zones' must be dispersed across the whole Zone of Influence. Migration channels should require little attention other than ensuring that they do not become blocked by debris or become badly silted. Channels should have plenty of grass and shrubs on their embankments, and thus provide soil stabilization from erosion and prevent the loading of CFRs with water that is heavily laden with silt. It may be necessary for guards to patrol the channel regularly to ensure that no traps are installed, either during the out migration or back migration periods. Fishing is particularly productive around culvert areas or other 'bottlenecks' in the RFF system, so special measures may be necessary to prevent poaching at such locations.

3.3.6. Management of rice fields

As ricefields are usually individually owned, it is up to the farmer to decide whether he manages his field in a way that promotes or harms aquatic life. Good management can include. Making sure that water depths exceed 15 cm throughout the rice growing period; and cement rings or small ponds are built in the corners of fields prone to drying during the early monsoon; and pesticides and herbicides are used sparingly.

Fishing in and around the ricefield can commence at any time and farmers are encouraged to invest in species-specific gillnets for small cyprinids, especially the micronutrient rich Esomus and Darkina species (Roos et al. 2012; Thilsted 2012; Bogard et al. 2015). These nets may be 10-30m long and placed in the fields and checked every day.

Rice field refuge pond, Damnak Kanh, Pursat

Rice field refuge ring, Damnak Kanh, Pursat

Small mess size of gill net, Boeng Preash Ponley CFR, Pursat

Esomus metallicus and Trichopsis vittata caught by small gill net, Boeng Preash Ponley CFR, Pursat

The use of harmful pesticides is a key threat to fish and other aquatic animals (Halwart and Gupta 2004). In some instances fish appear to not be seriously affected by pesticides applied during the wet season, although an in-depth study is required to assess this more thoroughly. Pesticides and herbicides are usually used early in the wet season in Cambodia, and as the whole floodplain becomes inundated with water during the flood, pesticide residue may become diluted to less harmful levels. Recent advances in rice

genetics and pest eradication have resulted in less use of pesticides[xi], but there is anecdotal evidence of unscrupulous traders selling harmful products to farmers and recommending the application of too-high doses.

Dead Channa striata and an empty packet of insecticide packet near Boeng Rumlech, Pursat

3.4. M&E of impacts of the interventions

Monitoring consists of regular, iterative, assessments of progress to determine whether the intervention is on track to deliver intended results and whether changes to its course of action are needed. Results or outcomes of the intervention's progress are recorded (for example, amounts of fish and OAA in the CFR may be regularly measured to determine the effects of physical improvements and increased patrolling). Best practice is to align monitoring with relevant objectives (for example, if a project provides critical funding to CFR interventions, monitoring can be aligned with the project's results model), as well as to align planned results (outputs and outcomes) with the FiA's long-term Strategic Planning Framework (SPF) for Fisheries – maintaining capture fisheries production (Pillar 1, indicator 1.1.) and ensuring communes have a sustainable and effective fish refuge.

If funding for professional M&E is available the following surveys could be conducted:

1. *Biological monitoring survey* was conducted on a quarterly basis to observe trends / changes in water quality and the diversity and abundance of fish, water birds, and other aquatic animals. Gillnets, fyke traps, and hook and lines were used to sample the fish and OAA within each CFR. Other sampling methods are possible and are discussed in FAO guidelines (Backiel and Welcomme 1980). Types and number of gear were modified in subsequent years according to CFR size and resources available. More detailed information on the sampling method is provided in a separate Biological Monitoring Survey Protocol (Hortle 2012[xii]).

2. *Capacity assessment survey* measured the effectiveness of the CFR committee in making and implementing decisions to meet their CFR-RFF objectives. To assess governance, five characteristics were measured: 1) organizational management, 2) planning and implementation, 3) resource mobilization, 4) networking/communications and 5) representation and participation. Regular monitoring of the governance capacity of CFR committees encouraged the committees to commit to further improvement and achievement of the rating for good governance practices and sustainability (see section 3.1. Development of CFR management capacity and awareness for more detail and Annex 3 for an example of the capacity assessment tool).

3. *Catch and consumption survey* was conducted six times annually to observe trends and changes in households' fishing activity, catch and use of fish and other aquatic animals (OAAs) and aquatic plants, and household food consumption. Although ideal sample size would be proportionate to the number of households in each CFR, a sampling of 10 households per RFF system was utilized in consideration of resources available. Another option is to conduct four surveys annually (rather than six). More detailed information on the sampling method is available in a separate Catch and Consumption Survey Protocol[xiii].

4. *Livelihood survey* was conducted to assess whether and how the income, assets, and overall welfare of households within the CFR-RFF and the surrounding area (Zone of Influence) may have changed as a result of the project intervention. While this survey is not essential to CFR-RFF management, it helps characterize the targeted population and the importance of fish and fishing for rice-farming households. Such information can be used to improve the design of the intervention.

3.4.1. Monitoring the benefits to local livelihoods and food security

Catch within the CFR zone of influence by local communities

Because fishers are numerous and dispersed over large areas, catch monitoring is highly time- and resource-intensive, and is beyond the scope of most community-level management programs. During RFFEP, catch monitoring was infrequent (six times each year) and relied upon fisher recall captured in household surveys. To provide more rigorous measurement of rice field catch that could be integrated with national data from other inland fisheries, an adaptation of Daily Catch and Effort methods in Boon et al. 2016, as a supplement or replacement to the recall-based data, is recommended. Improvements in monitoring rice field catch are important for CFR-RFF interventions, and also have potential to contribute to improved statistics about catch from rice fields in Cambodia.

What to measure	How	How often	By whom	Resource demand
Fish caught in the rice fields	Household surveys and/or catch diaries	Quarterly	Project team and CFR-RFF committee	High

Contribution to local fish consumption and income

What to measure	How	How often	By whom	Resource demand
Consumption of fish and OAA	Household surveys	Quarterly	Project team and CFR-RFF committee	High
Participatory assessment of changes in the livelihoods of community members within the zone of influence	Livelihood survey if resources are available; participatory qualitative assessment – questions about changes in livelihoods which may be related to increased catch, consumption and sale of fish and OAA.	At start and completion of project; or after two years of CFR-RFF management	Project team and CFR-RFF committee	High

If resources are available, a formal evaluation can provide critical insight on the efficacy and significance of the intervention, as well as lessons learned to inform the remaining intervention period and similar future interventions. An evaluation typically takes place near the end of the intervention, with an optional mid-term evaluation. Reflection meetings or workshops are recommended as part of a participatory evaluation wherein CFR committee members and other interested stakeholders discuss intervention progress and CFR committee capacity, reflecting on challenges and lessons, and planning ahead with commitments for future results.

CONCLUSIONS

The CFR-RFF system is an open-access resource. It is a sustainably improved environment, which is very useful for resource conservation and management, as well as for improved food and nutrition security and improved livelihoods. The improved bio-physical environments mean that fish are protected from habitat loss during dry seasons, and increased patrolling provides fish with protection from unsustainable fishing practices. The CFR thus maintains a source of local genetic fish resources. This contributes to increased fish numbers. In tandem with improvements to bio-physical environments, the RFF/CFR approach engages people as stakeholders in this resource who stand to benefit from such improvements. By carefully identifying communities who have high potential to benefit, based on proven experience, the approach provides good potential for sustained benefits to both community fisheries and to communities' food and nutrition security and livelihoods.

In order to provide good potential for such impacts, it is very important for a CFR-RFF intervention to follow all the steps outlined in this manual, starting from site selection and participatory planning. It is important to have a very good facilitator to engage people in the planning stage, and to encourage them to participate actively throughout the process, including changing their attitudes and behaviors as needed. To be successful, a CFR-RFF intervention needs to build trust with communities, elicit a successful vision, and create future expectations to drive action in line with this manual. It is important to know how to encourage and empower people to engage and take on-going responsibility for sustaining the system and its benefits.

Key to creating lasting benefits is ensuring that key 'mechanisms' exist to implement the relevant activities. When a need or a problem in the CFR-RFF system appears (for example, illegal fish harvesting from the CFR), is there a mechanism in the RFF/CFR system to recognize this and to provide solutions? And does this exist irrespective of external, donor-funded/charitable support?

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Annex 1: Characteristics of CFR ideal scenarios

(Sub) Component	Key elements	Characteristics under Ideal Scenario for Cat. 2 CFR - No Flooding
CFR		
Environment	Dimensions - Area, minimum dry season	0.5 ha minimum
	Dimensions - Depth, minimum dry season	1-1.5 m deep over 60% of area, 1.5-3m deep over 40% of area
	Aquatic vegetation percent surface area cover	25% in patches and some low density
	Density of Brush parks/ tree branches	10 Brush parks x 20 m2 = 200 m2
	Trees in and near CFR	Plant around south and west banks, 50% of total edge minimum
	Water quality - nutrients	Secchi disc 30-45 cm in March-May, green water
	Water quality - turbidity	No clay in water column
Fish	Indigenous fish	Acceptable minimum catch rates from bio-monitoring and committee believes there are sufficient fish
	Silver barb density	2000 fish per hectare (stock at 10 cm)
Fishers	No fishing in CFR	No fishing in CFR
Channels		
Environment	Number position	At least 2 channels on each side of CFR where there are RFs, total minimum 4 channels
	Size/shape	1-1.5 m wide, 20-50 cm deep
	Connectivity	Connect to some rice field refuge ponds near CFR by RF
	Culverts/pipes	None on channels
	Water-gates to canals	None
	Large irrigation canals	None
	Secondary canals to RFs	None
Management-Fishers	Fishing activity - seasonal closure	Fish only in open season
	Fishing activity - restricted area	No fishing within 50 m around CFR and in channels
	Fishing activity - illegal methods	No electrofishing, pumping, poisons, fine mesh
Rice Fields		
Environment	Water depth/duration	Depths > 30 cm for 3 months
	Rice field refuge ponds	One pond per ha
	Rice field refuge rings	One ring per ha

(Sub) Component	Key elements	Characteristics under Ideal Scenario for Cat. 2 CFR - No Flooding
Management-Farmers	Use of chemicals (pesticides, herbicides…)	No pesticides within 50 m of CFR IPM in RFF area
Management-Fishers	Fishing activity - seasonal closure Fishing activity - restricted area Fishing activity - illegal methods	Fish only in open season Rice field refuge ponds closed in dry season No electrofishing, pumping, poisons, fine mesh
Others	Income Generating Activities (IGA)	Increase fish catch by family: up to 50 kg/ha

a) Ideal CFR Scenario

Key Elements	CATEGORY 1	CATEGORY 2	CATEGORY 3	CATEGORY 4
Area, minimum dry season	5% or 1ha	0.5ha	0.5ha	5% or 1ha
Depth / % Area, minimum dry season	1-2m/60% 2-3m/40%	1-1.5m/60% 1.5-3m/40%	1-1.5m/60% 1.5-3m/40%	1-2m/60% 2-3m/40%
Aquatic vegetation, % surface area cover	25%	25%	25%	25%
Eco-shelter / tree branches	10 x 40m^2	10 x 20m^2	10 x 20m^2	10 x 40m^2
Trees in and near CFR	Within 20m of drawdown zone	S/SW banks 50% edge	S/SW banks 50% edge	Within 20m of drawdown zone
Water quality – nutrients	Secchi Disc 30-45cm dry season; green water – no clay			
Fish stocking	Indigenous sp. seeding	Indigenous sp. seeding + silver barb 2000/ha	Indigenous sp. seeding + silver barb 2000/ha	Indigenous sp. seeding
Fishing	No fishing in CFR; Rules on gears and seasons are followed in the rest of large water body for Categories 1 and 4			

b) Ideal Channel Scenario

Key Elements	CATEGORY 1	CATEGORY 2	CATEGORY 3	CATEGORY 4
Number of channels	2+ water gates linked to more sub-channels with RFs adjacent	Min. 4 channels (2+ channels on each side of the CFR where there are RFs)	Min. 4 channels (2+ channels on each side of the CFR where there are RFs)	At least 3 channels where RFs are adjacent
Size & shape of channel	Variable, but directly linked to RFs	1-1.5m wide 20-50cm deep	1-1.5m wide 20-50cm deep	Variable, but directly linked to RFs

Key Elements	CATEGORY 1	CATEGORY 2	CATEGORY 3	CATEGORY 4
Connectivity	Connect to some rice field refuge ponds by rice field near CFR	Connect to some rice field	Connect to some rice field	Connect to some rice field refuge ponds by rice field near CFR
Water gates/ culverts/pipes	Traditional bottom-up or flap gates	None on channels		
Fishing in Channels	No fishing within 50m around CFR and in channel (100m for Cat: 4). No electrofishing, pumping, poisons, fine mesh			

c) Ideal Rice Field Scenario

Key Elements	CATEGORY 1	CATEGORY 2	CATEGORY 3	CATEGORY 4
Rice field water depth	Depth > 30cm for 3 months			
# Refuge ponds in rice fields	One pond per ha	One pond per ha	One pond per ha	One pond per ha
# Cement rings in rice fields	One ring per ha	One ring per ha	One ring per ha	One ring per ha
Use of chemicals	IPM in RFF area	No pesticides within 50m of CFR IPM in RFF area	No pesticides within 50m of CFR IPM in RFF area	No pesticides within 50m of CFR
Fishing season	Fish only in open season (Categories 1 and 4). Rice field refuge ponds closed in dry season			
Fishing methods	No electrofishing, pumping, poisons, fine mesh			

Annex 2: Example of an CFR site profile

CFR-RFF site profile

Location	**Ang Chork**
	Chork Thum village, Kor Koh commune, Moung district, Battambang
Co-ordinates	12°50'52.33"N/103°22'0.12"E
Number of villages in RFF boundary	4: Chrok Toch, Chork Thum, Preal Nil, Stung Chork
Number of households in RFF boundary	1,200HHs
Describe the RFF location and its communities [agro-ecological features, agriculture and fishing , main economy, scale of wealth and poverty)	The RFF is located in the lowland rain-fed rice, surrounded by rice. It is 0.7 km from the village, 48 km from the Tonle Sap basin (dry season), and is 3 km above road #5. It is never flooded by the Tonle Sap, but gets some water flow from the mountain. People's main occupations in this area are rice farming, fishing (around 50% fishing in reservoir and in rice field), and migrating to sell labor in Thailand.
Temporary category assignment	Reservoir for irrigation in upland area
Proximity to urban centers and markets	
Distances (kms)	32 km to provincial capital 10 km to town with market 0.7 km to village

Reliance, dependence and use of water body/CFR

Use of water body (e.g. irrigation, fish for rice fields, washing and cleaning, animal in dry season)	Primary for irrigation Secondary for fish Tertiary 1 for animals
Importance of RFF and CFR for fish supply as perceived by the community members present	Extremely important
Approximate % of total fish eaten from CFR and RFF (relative to fish from other sources)	>75%
Estimate of weight of fish caught per year from rice field by average household	300-500kg
How many 'average households' catching this estimated weight per year	200-300
Months during the year when people catch, consume and sell fish from RFF (CFR and RF)	All year
Additional information	In dry season fish can only be found in the stream

Physical Characteristics

1. Community Fish Refuge (CFR)

Season, area and depth	Maximum in monsoon: 100 ha x 6 m Minimum is dry season: 12 ha x 2.5 m
CFR designated area *[this applies to sites where there is a demarcated area within the main water body]*	1.5
Water level and quality	
Transparency (Monsoon)	Less than 30cms transparency (elbow to hand)
Transparency (Dry)	Less than 30cms transparency (elbow to hand)
Drought frequency	Never dries up
Flooding frequency	Never floods
Draining by pumping	Never
Additional information	
Infrastructure and vegetation	
Vegetation	25%
Presence of Samra (brush parks)	None
Presence of sluice and culverts	None
Additional Information	Water lily, lotus

2. Connectivity and channels

Distance between CFR & RF	26m to 100m
Number of channels	More than 3
Type of channel	Sluice, spillway, irrigation channel but functioning well
Condition of channel	Very good condition. Well maintained or new
Gravity or pumping to RF	Always gravity fed
Additional information	Some pumping in dry season

3 Rice Fields

Wet season rice	Rice
Area connected to CFR (ha)	450
Dry season rice *(relevant when CFR connected to irrigation systems)*	Rice
Area connected to CFR (ha)	70
Trap ponds and cement rings	Trap pond: 10 (2010), no cement ring
Additional Information	

Previous CFR and channel renovation work

Deepen CFR	1 to 5 years ago
Widen and renovate channels	1 to 5 years ago
Vegetation cleared	Never
Frequency vegetation cleared	(Never) more than 10 years vegetation cleared
Additional information	No

Management

Year of formation of CFR	2010
Year of formation of CFR management committee	2010
Frequency of FiA visits since formation	3-5 times
Management plan	None
Management meeting	1-2 times since formation of CFR
Effectiveness of committee	Some new rules and guidelines followed but illegal fishing in CFR continues
Incidence of illegal fishing	Illegal fishing 'known' to occur out of sight and especially at night
Is guarding of CFR required? [if households nearby maybe it is not required)	Yes
If required what is frequency of guarding during WET season *(the "who" is guarding is built into answer)*	Rarely and casual i.e. committee members as they pass by on other chores
If required what is frequency of guarding during DRY season *(the "who" is guarding is built into answer)*	Rarely and casual i.e. committee members as they pass by on other chores
Demarcated area in hectares *(see notes for selection]*	1.5
When were fish last stocked in the CFR?	2008 and 2011
Frequency of stocking	Every 3-5 years
Amount stocked	40,000 fingerlings
Kgs per year stocked	
Who provided resources for stocking *{state agency for the relevant year above)*	FiAC
Analysis of species for most recent stocking	
Species	Sliver barb

Kg	NA
Number	40,000
Approx. length of fish (cm)	NA
Fishing gear used in rice fields	Gill net 40 %, cast net 40%, bamboo trap (tru/lorb) 10%, line and single hooks 10%
Relevant information to add	

Agriculture and irrigation within RFF boundary

Rice type within boundary and area for each type	Early maturity, late maturity
Area of rice cultivated using different techniques	Broadcast
Hectares	520
Fertilizer type	
	Urea 75 Kg, 16:20:00 75kg
Rate of application	150 kg/ ha
Pesticides type	Herbicide
Rate of application	0.3 l/Ha
Relevant information to add	In downstream 170 Ha and in reservoir 350 Ha

Engagement with local authorities & support services

Support from Village Chief	Very supportive and actively encourage CFR management
Interaction with Commune Council	Frequent interaction with CC actively supporting CFR
Engagement with extension services	Some occasion interaction when funds available for training

Annex 3: CFR management capacity assessment tool

Characteristics of governance of CFR committee	**Poor** (1 score) or Seed sowing 	**OK** (2 scores) or young tree 	**Good** (3 scores) or Tree 
1-Organization management	No regular meeting, rules and regulations were decided by only a few of the members of CFR committees, communication is not regular, verbal communication to (general) members, most members have unclear idea of the role of the CFR committees.	Regular meetings (less than 6 times per year), rules and regulations were decided by some of the members of CFR committees, communication is less regular, verbal communication to (general) members, some members have unclear idea of the role of the CFR committees.	Regular meetings (at least 6 times per year), rules and regulations were decided by most of the members of CFR committees, regular communication, verbal communication to (general) members, few members have unclear idea of the role of the CFR committees.
2-Planning and Implementing the plan	Activities are not planned and no activities are implemented by the committee independently. Conflicts are not able to be solved by CFR committees with consensus from all members. They always wait for support from NGOs.	Activities are planned by only a few CFR committee members, with little support from the majority of members and other stakeholders. Some activities are implemented by the committee independently. Conflicts are sometimes solved by CFR committees with consensus from all members.	Activities are planned by community people with support from the majority of members and other stakeholders. Most activities implemented by the committee with support from the majority of members and other stakeholders. Conflicts are always solved by CFR committees with consensus from all members.
3-Resource mobilization	CFR committees have not mobilized community contributions and have no appropriate book keeping system.	CFR committees have regularly mobilized community contributions and also find external technical / financial support. Has appropriate book keeping system, but general members are mainly unaware of their resource status.	CFR committees have regularly mobilized community contributions and also find external technical / financial support. Has appropriate book keeping system regular updating of records, which are known by all members of CFR committees and community people.

Characteristics of governance of CFR committee	**Poor** (1 score) or Seed sowing 	**OK** (2 scores) or young tree 	**Good** (3 scores) or Tree 
4-Linkages / Networking	The CFR committee is officially recognized by the commune council (CC) and FiAC, CFR committee executives not attend coordination meetings with the CC. No submission of priority plans to be included in commune investment plan (CIP).	The CFR committee is officially recognized by the commune council (CC) and FiAC, CFR committee executives regularly attend coordination meetings with the CC – at least <5 times per year. The CFR committee develops and submits priority plans to be included in commune investment plan (CIP) and very few activities get support from the CC.	The CFR committee is officially recognized by the commune council (CC) and FiAC, CFR committee executives regularly attend coordination meetings with the CC – >6 times per year. The CFR committee develops and submits priority plans to be included in commune investment plan (CIP) and some activities get support from the CC. Succeeded in gaining support from other NGOs and in involving the private sector in its activities.
5-Representation and Participation	Mostly women do not participate in decision making do not inform members of decisions made, finances or lessons learned.	Some women members are active in decision making and implementation of activities. Members are regularly informed about decisions made, finances and lessons learned through formal communication (village meetings, etc.).	Majority of members are active in decision making and implementation of activities. Members are regularly informed about decisions made, finances, lessons learned through formal communication (village meetings, etc.).

Annex 4: Tips on how to conduct a participatory assessment

- ✓ The facilitator should explain to the participants about the rationale of conducting this assessment and what the outputs would be. The facilitator should explain that the assessment is being conducted to see how strong the CFR committee is in particular criteria: i)-Organizational Management, ii)-Planning, iii)-Resource Mobilization, iv)-Linkages/Networking and v)-Representation and Participation. The assessment results will be shared with participants (LNGO, FiAC, Local Authorities, CFR committees) so that they will be able to know where they are strong and where they are weak.
- ✓ The facilitator should make it clear that at the end of the assessment the results will be illustrated more clearly using a graph. A copy of the assessment results should be kept with the CFR committee so that an assessment can be made on how the system has been improved at a later stage.
- ✓ The overall score should be summed up, and this can be represented by a matrix as shown in Annex 3.
- ✓ The relevant (score) data from the assessment for each criteria of the CFR committee's capacity shall be entered into an excel sheet by the CFR committee (provided as an example in Annex 3).
- ✓ A chart on the average capacities of each CFR committee shall be developed using the data in the excel sheet mentioned above. This chart should be put for discussion by CFR committees and relevant stakeholders from within the same commune and village. Following this discussion, a plan should be developed to address specific areas of the identified weaknesses.
- ✓ The assessment results should be used as baseline to help CFR committees to develop priority action plans to improve their characteristics of governance.

Annex 5: Detailed site selection criteria for RFF/CFR intervention

The Site selection of CFRs-RFFs should be considered from the early stage of project implementation as it plays a significant role in pre-planning discussion. A good site selection process requires a few months depending on the level of stakeholder involvement and the depth of environmental analysis required.

The site selection process begins by working with existing partner NGOs, FiA, FiAC, CFR committees and relevant local authorities. Site selection will be done carefully because the effectiveness and even the success or failure of the project depends on the locations that the project is going to support for the next 5 years.

The following are detailed steps for this selection process:

- Meet with FiA + FiAC to agree on selection criteria and master inventory data form for each CFR.
- Form selection committee and start selection process
- Present the selection results to WorldFish management for finalizing
- Document the selection results and present these to an inception workshop at national and provincial level.

The information collected about selected sites during this process can also be used to inform needs assessment and action planning (see section 4.2.1. and 4.2.2.)

B-Site selection form

The following form can be used to gather detailed information about a potential site. This information can be used for site selection, and also to inform physical and management capacity needs assessments for selected sites.

Category	Information
CFR Name	
I-General Information	
Location	
- Village	
- Commune	
- District	
- Province	
Co-ordinates (X,Y), GPS	
Beneficiary villages (estimated villages)	
Beneficiary households (estimated HHs)	
- Khmer community (estimated # HHs)	
- Muslim community (estimated # HHs)	
- Other ethnic community (estimated # HHs)	
- Vietnamese community (estimated # HHs)	
% of households doing fishing	
Category of CFR	
CFR distances (km)	
- From village	
- From provincial town	

Category	Information
From TLS	
II-Reliance, dependence and use of water body/CFR	
Use of water body (e.g. irrigation, fish for rice fields, washing and cleaning, animal in dry season)	
Primary	
Secondary	
Tertiary	
Importance of RFF for fish supply to community people	
very important	
important	
less important	
% of total fish eaten from RFF compared to other sources	
Estimate of weight of fish caught per year from RFF by average household (kg/HH/year)	
Number of households do fishing in the benefit villages (ZoI)	
Number of months can fish in RFF (month/year)	
III-Physical characteristics	
3.1 CFR	
Whole Water Body	
whole water body in dry season	
size (ha)	
depth (m)	
Whole water body in wet season	
size (ha)	
depth (m)	
Community Fish Refuge (CFR)	
CFR in dry season	
size (ha)	
depth (m)	
CFR in wet season	
size (ha)	
depth (m)	
Distance from CFR not allowed for fishing (m)	
Water level and quality	
Transparency (wet) cm	
Transparency (dry) cm	
Drought frequency (month)	

Category	Information
1). Never dries up	
2). Dries up once in 10 years	
3). Dries up 2-5 times in 10 years	
4). Dries up more than 5 times in 10 years	
5). Dries up every year	
Flooding by TLS (month)	
1). Never floods	
2). Floods once in 10 years	
3). Floods 2-5 times in 10 years	
4). Floods more than 5 times in 10 years	
5). Floods every year	
Flooding from upstream/rain (month)	
1). Never floods	
2). Floods 1 time in 10 years	
3). Floods 2-5 times in 10 years	
4). Floods more than 5 times in 10 years	
5). Floods every year	
Infrastructure and vegetation	
% of aquatic plant cover CFR	
Presence of samra (brush parks) (m2)	
Presence of sluice and culverts (number)	
3.2 Connectivity and channels	
Distance between CFR & RF (include CFR bank) (m)	
Number of inlet-outlet/ watergate	
Type of inlet-outlet/ watergate	
1. Earth,	
2. Culvert	
3. Water gate	
5. Spillway/overflow	
Condition of CFR outlet/inlet	
Good	
Fair	
Poor	
Number of channels in RFF	
Connected to CFR	
No connected to CFR	

Category	Information
Type of channel	
1. Earth	
2. Concrete	
3. Both (concrete and earth)	
Condition of channel	
➧ Good	
➧ Fair	
➧ Poor	
Gravity/pump to RF	
1. Pumping	
2. Gravity	
Connectivity to other water ways	
➧ Stream and river	
➧ Natural lake	
➧ Reservoir	
3.3 Rice Fields	
Wet season rice area (ha)	
Dry season rice area (ha)	
Number of trap ponds and cement rings	
1.Number of trap ponds	
2. Number of cement rings	
IV-Management	
Previous CFR and channel renovation work in last five year	
Deepen CFR in last five years (yes or no)	
Widen and renovate channels in last five years (yes or no)	
Vegetation cleared from CFR in last two years (yes or no)	
When were fish last stocked in the CFR?	
Amount of fish last stocked	
➧ Kgs stocked	
➧ Number fingerlings	
Fish species (specify)	
Frequency of stocking	
➧ Never	
➧ Every 6 to 10 years	
➧ Every 3-5 years	
➧ Every 2 years	

Category	Information
➧ Every year	
Who provided resources for stocking (specify)	
Agriculture and irrigation within RFF boundary	
Type of rice variety within RFF	
1. Early variety	
2. Medium variety	
3. Late variety	
Type of rice cultivation technique	
1. Broadcasting	
2. Transplanting	
Chemical fertilizer application (yes or no)	
Rate of application (kg)	
Pesticide application (yes or no)	
Rate of application	
➧ Kilogram	
➧ Liters	
Herbicide application (yes or no)	
Rate of application	
➧ Kilogram	
➧ Liters	
Engagement with local authorities & support services	
Year of CFR committee establishment	
CFR committee functioning (yes or no)	
Management plan (yes or no)	
Management meeting (yes or no)	
CFR fund raising systems (yes or no)	
Incidence of illegal fishing in CFR (yes or no)	
Active participation from various stakeholders (community, LO, CBOs) (yes or no)	
Active support from Village Chief and CC (yes or no)	
FiA willing to support CFR establishment (yes or no)	
Engagement with extension services (NGOs, private sector….) (yes or no)	
➧ If yes, specify these institutions	
➧ These institutions willing for collaboration (yes or no)	
Potential for conflict during the intervention (yes or no)	

Annex 6: Technical guidelines on pond and channel construction

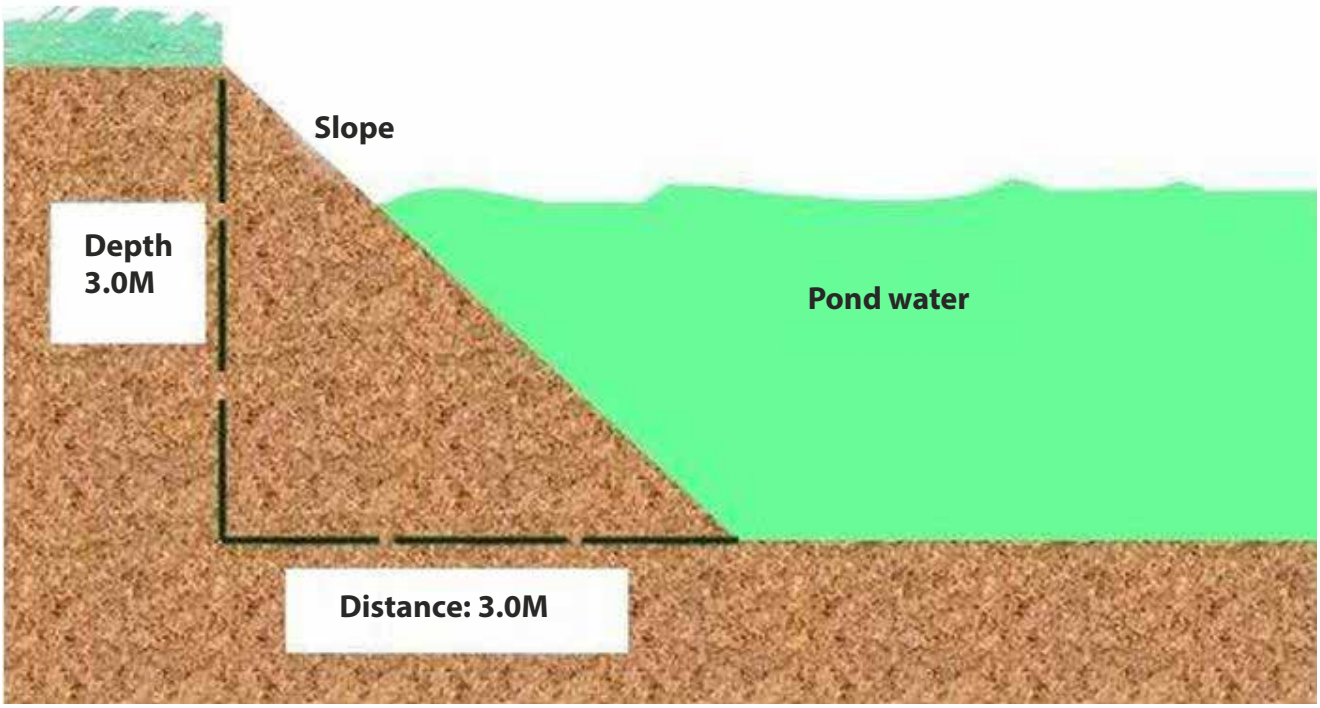
Source: Slightly adapted from USAID, 2008, *Aquaculture Business Handbook: For Micro, Small and Medium-Sized Enterprises in Cambodia,* pp. 3-4.

Pond Construction Technique

- Dig the pond in a rectangular shape.
- The pond should be between 150-1,800m^2.
- A depth of 1.5 to 3.0 meters is sufficient.
- A 500m^2 size is an average, manageable pond.
- The bottom must be flat and inclined to the sides of the pond.

The pond must be constructed using the proper slope as shown in the picture below to prevent erosion. Some soil types are more susceptible to erosion than others, and therefore ponds with these more easily-eroded soils need a different side slope to control this erosion (see the table below).

Soil type	Depth of pond	Slope rate
Clay	1.0m	1.0m
Clay loam	1.0m	1.5m
Sandy loam	1.0m	1.5-2m



- A dike must be constructed to prevent surface water and waste matter from draining into the pond and causing the fish to die;
- Grass should be grown on the pond dike to reduce erosion that causes water turbidity;
- When constructing the dike, a pipe must be buried in the ground to be used for water inlet and outlet.

i The project was extended to a second phase: Feed the Future Cambodia Rice Field Fisheries II project – (RFF II) funded by USAID 2016 to 2021.

ii The two main requirements for in situ conservation of any population of wildlife in any protected area are: i) to maintain a genetically effective population size; i.e., a number of effective breeders, so as to avoid the inbreeding depression and loss of genetic variation (which small, isolated populations are always at risk of) and ii) to ensure their habitats are not further degraded or lost. (Pullin 2008: 101).

iii CFRs only exist in rice field systems if they are created or improved by human activity. The information in this manual is based on the availability of existing CFRs (i.e. the context of Cambodia rice field fisheries).

iv Not all CFR committees will follow this exact structure

v FiA CFR statistics in Excel format, supplied by FiA.

vi It should be noted that the site selection process proposed is based on there being sufficient numbers of existing CFR water bodies available for selection. Therefore, this process does not include explanation of how to find a suitable location for a new CFR and establish a new CFR in that location.

vii Importantly, not all CFR-RFF systems in Cambodia have all three of these domains.

viii Half a morning should be enough for such a meeting.

ix As part of the USAID-funded RFF II project, as of 30 March 2018 approximately US$33,340 was raised by CFR Committees, 244 activities were integrated into Commune Investment Plans, and 39 activities were financially supported by Commune Councils.

x WorldFish has developed guidelines for good governance of a rice field fishery. This includes specific, measurable characteristics of good governance: Miratori and Brooks 2015. Good governance of rice field fishery management. Penang, Malaysia: WorldFish. Program Brief: 2015-19. Available from: http://pubs.iclarm.net/resource_centre/2015-19.pdf

xi http://irri.org/our-work/research/better-rice-varieties/disease-and-pest-resistant-rice

xii A copy of this document may be requested from WorldFish Cambodia.

xiii A copy of this protocol for Rice Field Fisheries Phase II project may be requested from WorldFish Cambodia.

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