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MINISTRY OF AGRICULTURE, FORESTRY AND FISHERIES

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Mekong Integrated Water Resources Management Project
Phase III – Component 1

TECHNICAL REPORTS

Scientific monitoring of the fish resource with Community Fisheries: protocol definition

2019

Inland Fisheries Research and Development Institute

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TECHNICAL REPORT

Scientific monitoring of the fish resource with Community Fisheries: protocol definition

Prepared by the
Inland Fisheries Research and Development Institute
for the
Fisheries Administration

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Document prepared by:
Eric Baran, Sokhan Savuth, Chhuon La, Touch Bunthang, Chheng Phen and Eng Chea San
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Contact:
Fisheries Administration
Inland Fisheries Research and Development Institute
#186, Preah Norodom Blvd., Phnom Penh, Cambodia
Web: ifredi-cambodia.org

EXECUTIVE SUMMARY

We present a review of fish resource monitoring options for the Mekong Integrated Water Resources Management project Phase III, Component 1. The objective is to develop a scientific monitoring, with community fishers, of the status of the fish resource in the project area and beyond, and the benefits of the overall project for the resource.

A review of scientific fish monitoring protocols in the region shows the diversity of approaches in fisheries biomonitoring, the frequent collaboration of scientists with fishers and the challenge in quantifying the fishing effort.

In a context of co-management, there is a need to consider two complementary approaches: i) work with fishers using their gears to implement a monitoring compatible with the MRC and IFReDI protocols; and ii) continue a scientific fish monitoring with a standardized gear and protocol – in order to get comparable data and to assess trends before, during and after the project.

A detailed review of fish monitoring protocols in Cambodia highlights the existence of two long-term and ongoing monitoring programs at IFReDI, i.e. the trammel net protocol (7 sites sampled twice a year) and the IFReDI/SciCap protocol (32 fishers using their gears in 28 sites). Both protocols include sites in Stung Treng and Kratie Provinces. It is therefore recommended to integrate these two protocols to the project and fund their continued implementation. In the case of the lighter trammel net sampling, it is also recommended to add 3 new sites in the project area.

Regarding the project protocol, we recommend:

- working with fishers using their own gear in their own way;
- focusing on four main ecological zones: the Ramsar zone; the 3S Rivers; the Mekong mainstream between Stung Treng and Kratie, and lateral floodplains;
- selecting five Community Fisheries per ecological zone (i.e. 20 in total);
- involving four professional fishers in each CFi selected (i.e. 80 in total);
- recording fishing operations two days a week;
- recording all species caught, using Khmer names then a correspondence table with Latin names;
- recording, for each fishing operation date, location, habitat, gear name, number and dimensions, time fishing, and for each species caught, total number of individuals, total weight and standard length and weight of 3 individual fishes randomly selected.

A weighting technique aimed at correcting the representativeness of catch results among fishers surveyed in each ecological zone in relation to the total number of fishers in each zone is proposed.

Overall, the proposed protocol reflects needs, integrates practical constraints and capacity building, and is dovetailed with existing monitoring protocols.

CONTENTS

1. INTRODUCTION

The present report is a contribution to the Mekong Integrated Water Resources Management project Phase III (M-IWRM III, 2016-2020). The objective of the latter is to enhance Cambodia's institutional capacity and infrastructure to sustainably manage its water and fishery resources in the northeast of Cambodia. Within this project, Component 1 managed by IFReDI/FiA is tasked with supporting Fisheries and Aquatic Resources Management in Kratie and Stung Treng Provinces. One of its objective in particular is to strengthen public sector fishery management including monitoring and reporting, in view of assessing impacts of water resources development (particularly hydropower) on fisheries.

More specifically, the Monitoring and Evaluation (M&E) system put in place includes a component about the ecological performance of the project initiatives at the level of Community Fisheries (CFi). The Project Appraisal Document (PAD) dated 28 April 2016 indicates in particular, under Sub-Component 1.1 of the project (Establishment of Community Fisheries Management), that *Provincial Implementation Teams (PIT) will provide support to the key management stakeholders (PFiA, CC and CFi) for the design of monitoring and reporting programmes*, in particular on the fish catch.

The project Results framework (Annex 1 of the POD: Results Framework and Monitoring Cambodia) specifies (indicator #7) that "*standard indicators and methodology to monitor fishery and management performance will be designed by IFReDI/FiA*", and that "*Standard indicators and methodology to monitor fishery and management performance will be developed in coordination with existing methodology used by IFReDI*".

In line with these recommendations, the present document proposes options for the development of a monitoring and evaluation program aimed at scientifically monitoring, with community fishers, the status of the fish resource and the benefits of the overall project on the fish resource. Alternatives considered and the reasons for final choices are detailed in text boxes.

2. FISH MONITORING PROGRAMS IN THE REGION

Biological monitoring has been in operation for several years in the region. We review below the main experiences in relation to fisheries management, and highlight common practices as well as challenges.

In Indonesia, studies were conducted in three provinces to identify ecological, social and institutional aspects and benefits of "harvest reserves" (Hoggarth et al. 2003a). The project monitored **10 study sites** during 13 to 14 months. The biological part of the monitoring (Hoggarth et al. 2003b) used **multi-mesh gillnets** (standardized protocol implemented **by the project team)** and was focused on **number and weight of fish per unit effort** (Unit Effort: *m^2 of multi-mesh gillnet/hour*), **number of species per unit effort** and **average weight of individual fish**.

In Bangladesh, WorldFish conducted a study aimed at monitoring the impact of co-management interventions on fishery resources in seven rivers (WorldFish Center 2007). Monitoring was done during 6 years and covered management activities (closed seasons or areas, fishing restrictions, habitat management and sanctuaries), fishing activities and overall catch and effort. A preliminary gear census showed that fishers used more than 100 types of fishing gears in 11 broad categories. The **monitoring** program was then **based on the number of gear units per day**, without detailing the specificities of each gear, its surface area or the time spent fishing. The unit effort was in that case gear-days or person-days (Unit Effort: *gear days.$year^{-1}$*). Routine protocol consisted in assessing during regular spot surveys the gears in operation, as well as **total catch and species from each gear type** (kg/gear/day or kg/person/day). Overall, fishing activity was observed during **4 to 8 days per month and per site**, and total gear-related fishing effort per month was inferred from this sample. Overall production was estimated by summing all estimated production for all gear types each year.

In Myanmar, WorldFish is implementing a fish monitoring aimed at assessing the impact of co-management on fish catches (Baran et al. 2018). The monitoring is done in **8 sites**, inland and along the coast, and involves **fishers, surveyors** and university scientists. The focus is on **number of individuals, weight per species and CPUE**. Length, weight and reproductive stage observations are not included. Given the large gear diversity, the project monitors in each site i) the **gear with the largest catch**, ii) **the gear used by most people**, and iii) **gill nets** (at least three fishers using gill nets). The catch is identified and measured by surveyors with a **focus on 37 dominant or commercially important target species**.

In the Lower Mekong Basin, Patricio et al. (2012) provide an overview of the multiple monitoring programs that have or are being implemented in the four riparian countries, and describe each protocol in a few lines. The latter cover fisheries landing data, taxonomic biodiversity assessments and specimen collection, larval fish sampling, household interviews, socioeconomic surveys, fish market surveys and community-based fish catch monitoring. The protocols relevant to the purpose of the M-IWRM project Phase III Component 1 are described below, and those in Cambodia are detailed in the following section.

In the region, the Mekong River Commission has put in place four main fish monitoring programs (Halls et al. 2013); these include the "dai fishery" in Cambodia, a "lee trap" monitoring in Laos, a fish larvae program and a monitoring program based on the catch of fishers.
In the large-scale Tonle Sap "dai fishery" the parameters monitored during the fishing season (flood recession time) are the **catch biomass, effort, species composition** and **length-frequency** for **main species**. Data are gathered by **DoF enumerators**. Sampling is done on randomly selected *dai* units, with a **stratification** by municipality, lunar phase and *dai* type. Catches are sub-sampled to provide estimates of catch by species and length-weight data.
The "lee trap" fishery is specific to the braided streams and waterfalls environment of Khone Falls in Laos. Monitoring was focused on the **relative abundance** and **biomass** of fish migrating through channels, as indicated by mean daily lee trap catch rates. Monitoring was originally conducted during **3 times per week, five weeks each year during the migration period**, in May-June.
The larvae monitoring, done by scientists, is very specific and uses bongo nets in relation to flow meters to assess the quantity of larvae per cubic meter.
The basinwide monitoring program of small-scale fishers is done in Cambodia as well and detailed in the following section.

In Thailand, Oopatham Pawaputanon (2003) details the institutional monitoring of the Department of Fisheries. The protocol is based on spatial and temporal sampling in sites and at times representing habitats and seasons of interest. Assessments are carried out **by DoF staff** in at least **five study sites and four sampling months** and focus on **fish abundance and diversity**. This protocol generates information about population structure and distribution of inland fish, and is complemented with **sampling of species and sizes** at ports and markets.

In Laos, FISHBIO implemented between 2010 and 2012 a fish monitoring program along the Nam Kading River. The study (Patricio et al. 2018) involved 16 villagers along a 25 km reach of the river. These **four surveyors per village** were trained to identify species based on a standardized list of **fish names in Lao language**, then surveyed other fishers (whose gender and age were recorded). Daily records (**5 days per month**) covered **species caught** (identification at the genus level), **gear types** used, **hours fished** and **total weight by species**. Water level and rainfall data were collected in parallel from the Department of hydrology and meteorology. Data analysis focused on fish richness, dominant and rare species, gear use, fishing effort, catch per fishing effort (CPUE), and temporal and spatial variability.
FISHBIO built on this preliminary experience and included the above biological monitoring into a broader approach aimed at assessing community-based fish resource management in Laos in relation to fish conservation zones. The resulting guidelines (Loury et al. 2019) include governance, socioeconomic and ecological assessments and are very much in line with the M-IWRM III approach that was independently developed as the same time. Fish resource monitoring, as detailed by Loury et al., includes individual data sheets filled by **surveyors**. Each sheet includes **location**, **habitat description**, **gear information** (nature, length, height, mesh size if relevant), **species caugh**t, **catch (kg) by species**, count of "large" and "small individuals for each species or **length** and **weight** of individual fishes based on total sampling or sub-sampling (sub-sampling method is not detailed).

TERMINOLOGY

The Mekong Fish Network proposed the following common terminology (Patricio et al., 2012):
- "community fisher surveys", for surveys conducted by fishers or villagers who have been trained by technical experts to collect specific data;
- "commercial harvest surveys" for surveys conducted by technical experts who directly collect data on fishers' catch;
- "community interview surveys" when technical experts ask fishers questions about their catch, but do not directly measure it, and
- "independent biodiversity surveys" when the protocol is independent from local fishing and is conducted by scientists.

Conclusion:
The above examples shows the diversity of approaches in fisheries biomonitoring, the frequent collaboration of scientists with fishers, the possible involvement of local surveyors (who can be trained fishers) and the challenge in quantifying the fishing effort – which can be expressed in many ways. It can also be noted that in all the cases reviewed, monitoring of fish reproduction stages in relation to length, i.e. assessing how close species get to being fished before they reach their critical ability to reproduce (Schemmel et al. 2017, Prince 2018) is not done by any of the line agencies of the region in charge of monitoring resource status (confirmation in Patricio et al. 2012).

3. FISH MONITORING PROGRAMS IN CAMBODIA

Multiple fish monitoring systems have been implemented in Cambodia over years, starting with the large scale attempt of the Mekong River Commission and the FAO (Stamatopoulos 1995). However the part of the project attempting to monitor all middle-scale and small-scale gears was discontinued in 1997, due to excessive complexity, staff requirements and costs (Van Zalinge 2003), with a remaining focus on one single bagnet fishery ("dai fishery") used to monitor trends only (Halls et al. 2013).

In 2003, in a context of dam impact assessment, two NGOs initiated the monitoring, with **22 fishers**, of fish resources along the Sesan River (April 2003 - April 2004; Baird and Meach Mean 2005). **Four fishing methods** were monitored, including gillnets (10 mesh sizes). Data included **gear** used, **fishing time**, **species** identification (**names in local language**), **number of fish** and **biomass of the catch**, leading to the calculation of CPUEs and the assessment of trends.

In 2006, a monitoring of Tonle Sap fish sanctuaries was undertaken (Chheng Penh 2010). The study covering **8 fish sanctuaries** and **5 test sites** was sampled **two seasons a year**. Experimental fishing was done **by scientists**, using **two sets of trammel net**s (1 set = three 20x3m panels of increasing mesh size, from 7.5 to 30mm for the internal layer and 30mm to 120 mm for external layers). Thus, **one sample in one site consisted of two sets of trammel nets** operating from 4 a.m. to 9 a.m. Biological variables measured were **species, biomass** and **total length** of individuals based on a **sub-sample of five individuals per species** randomly selected. Environmental variables included "the five most critical water quality parameters", i.e. temperature, pH, dissolved oxygen "DO", conductivity and water transparency/turbidity.
The ongoing trammel net monitoring by IFReDI corresponds to the continuation of this original protocol, but with a modified geographic distribution (7 sites in 5 provinces[1], including in Kratie and Stung Treng); each site remains sampled twice a year. Thus, this protocol provides **many years of data throughout the country with a standardized sampling method**.

In 2007, Hortle et al. (2008) undertook a research project on yield and value of the rice field fishery, monitoring the **fishing effort and catch** of local fishers in **nine sites** (four times each month in each site during one season). **Fishers used their usual gears**, and **effort was the number of man-days fishing** (the exact time each gear was used during each day was not recorded). Fishers kept their catches for the **surveyors** to identify **species and their biomass**, and **length monitoring** was done **for the five most common fish species**. This monitoring was discontinued at the end of the study.

In 2011 (from April to November), the Fishery Administration and the FAO Regional Fisheries Livelihoods Programme for South and Southeast Asia (RFLP) developed a program for the participatory monitoring of management measures developed, with a focus on fish catches (Peng Bun Ngor and Kong Heng. 2012). The monitoring involved **26 fishers** from five community fisheries in four coastal provinces of Cambodia for daily monitoring using logbooks. **Eleven key fishing gears** were selected with recording of gear details and **fishing effort**, **species** caught (**local names** and code), **catch biomass** (in total and by key species), **maximum length** by species, **prices** (total and by key species), and weather conditions. Beyond biological data analyses, the study concludes that "a field guide with proper local Khmer names, English names and scientific names and a brief description on the identification of the species should be produced and made available".

The AMCF and FEVM fisher catch monitoring programs of the Mekong River Commission have been operating basinwide since 2003 (Halls et al. 2013). Up to **three fishers** record their catches at each monitoring site, **in 40 then 23 sites** in 4 countries. **In Cambodia, 6 sites** have been monitored: Siem Pang and Talarborivat in Stung Treng Province, Veunsai and Lum Phat in Ratanakiri , Sambo in Kratie and Ponhea Leu in Kandal; Cambodia records cover the 2007-2014 and 2017-2018 period. The **22 fishers** initially involved in the protocol (16 now) recorded their **daily catch** in **logbooks, by species (weight, number of fish, and maximum fish length)** and **effort (hours fished by gear type and size**).

[1] Kratie: Rokar Kandal village; Stung Treng : Bachong and Sdao 1 villages; Ratanakiri: Banfang village and Dey lo village; Prey Veng: Prek Khsay Kor village; Kandal: Svay Chrum village

A more detailed monitoring program was developed in 2014 by the SciCap monitoring project (Boon et al. 2016). The four-component approach consisted of i) **21 specially trained fishers in seven sites**[2] (i.e. 3 fishers per site) noting **daily and weekly catches** in **logbooks**; ii) "community researchers" gathering and checking the information of fishers; iii) DoF/project staff doing bi-monthly surveys and iv) technical expert bi-annual supervision. The initial survey was focused on the downstream reaches of the **3S Rivers** in northeast Cambodia (Stung Treng and Ratanakiri Provinces). The information recorded **each day** consists of **gear type, size and quantity, location, time set and time recovered, most abundant species caught and weight,** and **GPS locations** of fishing areas. The information recorded **once a week** consists of **identification and weight of each species, selection of largest, smallest and intermediate fish for each species** (ten in total), measurement of **standard length and individual weight** for these ten fish of each species, preserved **tissue samples** of each of these species, **location, gear type and size, time equipment was set and collected, and water conditions**. In 2016, twenty organizations or universities had adopted or endorsed this methodology (e.g.: WWF 2016), and data were compiled in a reference database still in use.

After 2016, the SciCap monitoring protocol was expanded into a IFReDI/SciCap monitoring protocol through projects successively funded by Conservation International, SciCap or the MacArthur foundation. This on-going protocol now involves 32 fishers and their various gears in 28 villages from **nine provinces throughout the country**[3] (i.e. 1 to 2 fishers per site, 3 to 4 sites per province, including Stung Treng and Kratie). Monitoring includes **daily records (gear, fishing time, 5 environmental parameters, species, weight per species)** and more detailed **weekly records (same as daily + length and weight of 10 individuals per species** and tissue sample). This approach is compatible with the MRC AMCF and FEVM programs, and has also been replicated by Oxfam, WWF and FACT. It provides **multiple years of data throughout the country, while allowing an analysis and comparison of trends** in northern Cambodia, the Tonle Sap and southeast Cambodian floodplains.

Last, the EU-funded programme "Fisheries and Livestock in Cambodia" is considering a detailed monitoring protocol as part of the Lower Sesan 2 Dam monitoring activity. Gotzek and Johnston (in prep.) proposed and implemented a **standardized protocol** based on **gillnets of defined mesh sizes** meant to avoid i) variability inherent in the MRC monitoring, i.e. in fishing effort, gear type, site selection, and ii) SciCap protocol biases, i.e. focus on commercially dominant species. Sets of four 70x2.5m gill nets of 1-3, 7, 10 and 12 cm mesh size are deployed 16-24 hours long **by project staff** in each site and environmental data are collected (water depth, description of habitat, notes on water flow, etc). All fish species are recorded (**abundance by species, size and weight of individuals**).

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[2] Ratanakiri Province: Veun Sai market/landing site, Tiem Leu Village, Kampong Cham Village, Lumphat Village, Dei Lou Village. Stung Treng Province: Kamphun Village, Phluk Village.

[3] Battambang Province: Anlong Ta' our; Kbal Tol; Prek Tal; Kandal Province: Baren Kroum; Chrouy Metrie Leu; Prek Toch; Kompong Chhnang Province: Chhnok Trou; Chong Koh; Kanleng Phe; Koh Thkov; Kompong Thom Province: Koh Tapov; Kompong Chamlang; Neang Sav; Kratie Province: Chheuteal Phlours; Koh Phdao; Krakor; Pursat Province: Chrouy Sdei; Kompong Thkol; Trapang Romdeng; Ratanakiri Province: Deilout; Kompong Cham; Phum bei; Siem Reap Province: Kouk Kdol; Peam Ta Our; Phum bei; Prek Sramouch; Stung Treng Province: Kamphun; Oh Sway and Sre Krasang

Conclusion:

The existence of two long-term and ongoing monitoring programs at IFReDI, i.e. trammel net and IFReDI/SciCap, calls for a project monitoring protocol compatible with these two protocols. This implies that the present protocol integrates components generating compatible data that allow i) feeding these protocols and their existing databases, and ii) comparing data and situations before, during and after the project.

OTHER FISH MONITORING PROGRAMS REVIEWED

• In 2005, the Culture and Environment Preservation Association (CEPA), with support from a IUCN project, established in the Stung Treng Ramsar site a community-based research project named Sala Phoum. The project included a participatory fish survey (94 fishers involved) and resulted in a photoguide of local fish resources (MWBP 2006, Allen et al. 2008) describing species found, their biology, ecology and habitats, fish methods and fish prices, and documenting abundance trends in a qualitative way.

• In a similar spirit, the 3S Rivers Protection Network (3 SPN) initiated in 2009 a 6-month community-based study on "changes in fish catches in the Srepok River". The study also focused on a qualitative description of fish species and their abundance trend.

• Biodiversity monitoring in the Tonle Sap Lake was reviewed by Seak et al. (2012); the review lists fish catch monitoring and other uncommon methods such as transect count by boat (visual observation) or transect estimate by paddle (the paddle being used as a sound sensor detecting fish vibrations and noise), but does not provide technical details for catch monitoring.

• Hortle (2012) designed a program to monitor rice field fisheries in Cambodia, but this program defines a standardized approach for scientists to implement, and is not based on a collaboration with fishers using their own gears.

• In 2015, a short study (February – June) was conducted as part of a MSc thesis to compare fish catches between methods used by fishermen (6 fishers in 6 sites) and standard gillnet scientific sampling (Gnim Sodavy 2015). The study found that among 112 species harvested in total, 45 species only are common to both methods.

4. TECHNICAL OPTIONS AND OBJECTIVES OF MONITORING

4.1. Technical options for fish monitoring

Hoggarth et al (1999) review the justifications and options for monitoring, and highlight the importance of monitoring biomass, species composition (diversity) and Catch per Unit Effort. There are four main approaches to monitor biomass harvested and diversity:

- **sampling the resource with a standard gear** and a rigorous fixed protocol (e.g. gill nets recommended by the FAO, trammel nets used by the FiA in Cambodia, etc.);
- **monitoring the catch of fishers** by working with them using surveyors.
- **logbooks filled by fishers.** This option is similar to the previous one, but the work is done by fishers themselves. It requires training of these fishers and reliance on their records;
- **monitoring of landings.** This methods is common to monitor trends in fish yields. This approach is used by multiple Departments of Fisheries worldwide.

We review below the pros and cons of each method:

Sampling the resource with a standard gear

Pros: this provides the most reliable assessment of trends in the resource, and results comparable in multiple sites. The uses of trammel nets in particular ensures the lowest selectivity, i.e. the best diversity assessment (Chheng Phen and So Nam 2012).
Cons: this requires sampling by a trained team and an intensive schedule in order to cover seasonal variability and migration pulses. Panels of gill nets constitute a standard methodology (e.g. Lévêque et al. 1988), but their catch is usually low and very dependent on the skills of the person who sets them.

Monitoring the catch of fishers

Pros: this allows integrating the change of gears by fishers to follow seasonal changes in species availability, and the monitoring can be quasi-permanent (as opposed to much less frequent sampling sessions by scientists).
Cons: The diversity of gears is a major complication in calculating fishing efforts and a global unit effort – unless the unit considered is "one day of fisher". The selection of partner fishers needs to be carefully done, since their skills or wealth influences the choice of gear, the performance (biomass measured) and selectivity (species diversity).

Logbooks filled by fishers.

Pros: records can be daily, or at least more frequent than with a team of surveyors. This allows a good coverage of the fish diversity, as well as the temporal and spatial diversity in the fishing area.
Cons: this approach requires training of fishers and reliance on their records, as the information is impossible to check. Taxonomic identification in particular is in the hands of fishers, and is often limited to that of local fish names.

Monitoring of landings

Pros: this methods minimizes the sampling effort and allows the integration of a larger number of fishers. Sampling can be done ideally when the boat lands.

Cons: The major impediment is the loss of fishing effort measurement (increasing fish yield may reflect increasing fishing effort rather than a healthy growing stock), and this approach is exposed to the risk of losing the fraction of the catch used for self-consumption.

Conclusion:

In a context of co-management, the need to consider two complementary approaches is clear:

- work with fishers based on catches from their gears and implement a monitoring compatible with the MRC and SciCap protocols – at the expense of fuzzy fishing effort data; and
- carry on a scientific fish monitoring with a standardized gear and protocol – in order to get comparable data and to cover trends before, during and after the project- hence a focus on a trammel net based protocol.

4.2. Objectives of fish monitoring

Meetings, in March 2019, with FiA partners in Phnom Penh then at Cantonment offices in Stung Treng and Kratie highlighted that various outcomes were expected from this monitoring, corresponding to different purposes. **Four main purposes were identified** (Figure 1):

- **CFi resource management performance**, i.e. assessment of trends in catch (biomass and composition) in each CFi following the development and implementation of a management plan
- **resource monitoring**, i.e. assessing the status of the fish resource in Kratie and Stung Treng provinces, more specifically the possible ecological changes in species composition in different habitats (ecology) or the size and weight of individual fishes;
- **CFi socioeconomic monitoring**, i.e. assessing the income from fishing at the fisher's level, acknowledging that income is not fully related to biomass given species composition changes and fish price elasticity; and
- **capacity building**, so that CFis become familiar with the monitoring of their resources, as a way to better manage them through adaptive management plans.

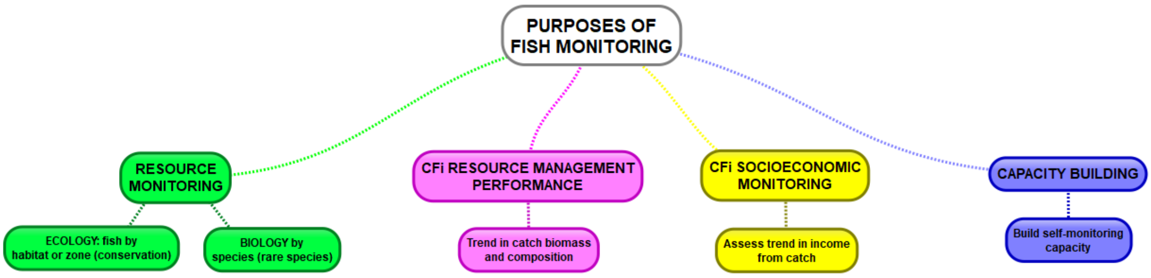


Figure 1: the four main purposes of fish monitoring

These different purposes have different implications in terms of number of number of CFi surveyed, number of fishers participating, and variables surveyed (Figure 2):

- *CFi resource management performance* either implies monitoring each of the 70 project CFis, or a representative fraction of them; data gathering is then focused on biomass and top commercial species;
- *resource monitoring* implies either monitoring different ecological zones through the CFis located in these zones (all of them or a sub-sample), or monitoring the biology of individual species (individual weights and lengths), through a fraction of all CFis;
- *CFi socioeconomic monitoring* implies working in each CFi if individual monitoring is sought, or in a sub-sample of CFis if the focus is on trends among CFis; in all cases the priority here is biomass monitoring and top commercial species;
- *capacity building i*mplies working in all CFis, with as many fishers as possible, and the focus is on top commercial species and biomasses.

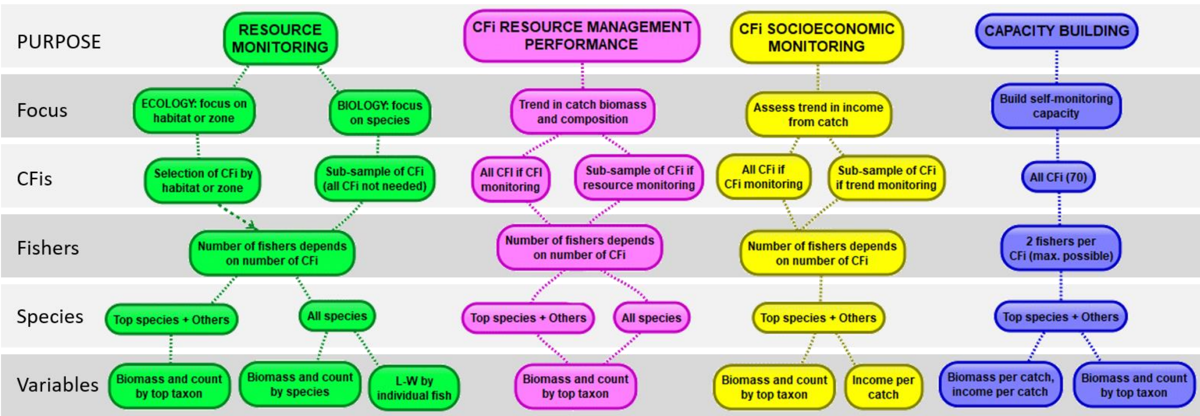


Figure 2: Implications of the various fish monitoring protocol options

In all cases the requirement is to have at least 2 fishers involved per CFi, in order to cover the variability in fishing sessions and skills. If all CFis are involved, with all fishing sessions recorded, the protocol generates an amount of data (2x70= 140 data sheets daily) unmanageable considering the budget and staff available.

In addition to variables listed in Figure 2, the protocol can vary the number of days of data recording per week or month.

After extensive discussions with the project team and cantonment offices, several priorities were highlighted and decided jointly at a meeting held in Phnom Penh on 01/04/2019.

Priorities highlighted

- the main purpose of the monitoring is to assess the impact of project investment on i) the fish resource; ii) capacity of communities, and iii) livelihoods;
- since the focus is more on the monitoring of the resource than on the performance of each CFi, all CFis do not have to be involved in the monitoring; the most important aspects are to cover species abundance and diversity;
- the focus should be on trends in fish resources in different habitats;
- given the importance of biodiversity protection and monitoring, species recording should not be limited to the dominant commercial species but should cover all fish species;
- environmental variables should also be measured on a regular basis in each CFi selected, but cannot, for practical reasons, be measured by each fisher during each fishing operation.

In addition to defining the main modalities of a specific project-based protocol, the meeting also concluded about the need to continue existing monitoring protocols, so that data gathered during the course of the present project can be related to previous monitoring data, and feed these long-term protocols beneficial to the whole country.

Gathering sale value data only covers gross income and requires a two-step process: i) after the catch (biological data) and ii) after the sale (economic data). Such two-step process compromises the feasibility and reliability of the data recording; furthermore, a proper socioeconomic monitoring should also include the cost of fishing in order to produce net income data, which is not possible as part of the present initiative. For these reasons, income monitoring is not included here.

We present below a protocol developed on these bases.

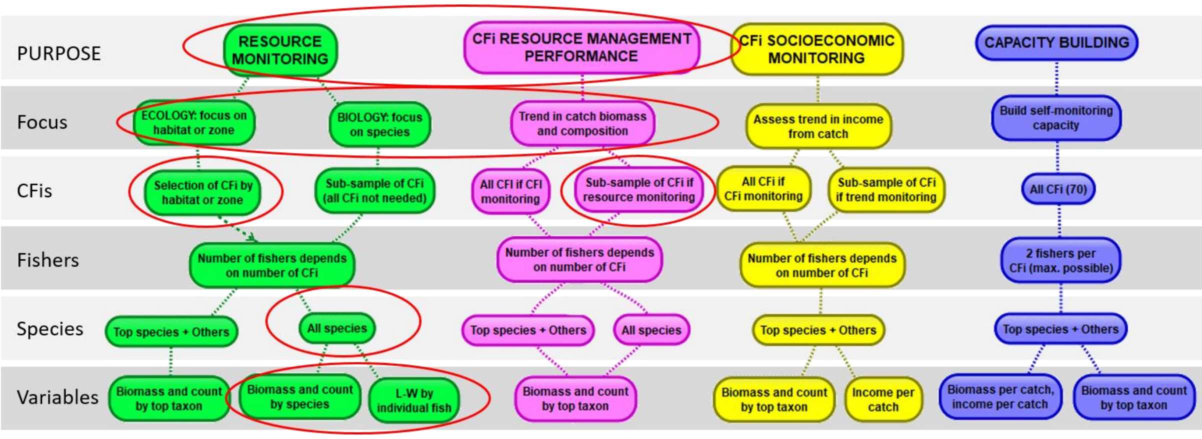


Figure 3: Options preferred for the fish monitoring

ALTERNATIVES CONSIDERED AND THE WAY FORWARD

The need to work with *all* Community Fisheries involved to ensure capacity building is a strong requirement of the project. Furthermore, the project Results framework (Annex 1 of the POD: Results Framework and Monitoring Cambodia) specifies (indicator #7) that "*IFReDI/FiA will design and support CFis to implement monitoring systems for fisheries and to evaluation of Management Plan*". The World Bank Review of the project dated 25 September 2017 also indicates that "*It would be better if members of the community could participate in the monitoring if possible so that they can see for themselves the outcomes of their management efforts*".

These perspectives are fully recognized, but:

- involving all 3,420 full-time fishers of the 70 CFi selected (21% of 16,289 CFi members) into fish monitoring is not technically feasible;
- implementing a protocol gathering data for a scientifically robust analysis requires computer, data management and data analysis means that are not available within Community Fisheries; conversely, data analysis by FIA scientists does not really qualify as local CFi capacity building -even though results are presented back to communities. Real capacity in self-monitoring implies that the information is analyzable by CFi themselves;
- FiA is not in the position to analyze the performance of each CFi management plan beyond the project life nor for all CFi of the country; such approach would therefore not be sustainable.

More generally, discussions around the protocol definition have highlighted the fact that two objectives and scales need to be distinguished: i) *fish resource monitoring and trend assessment* and ii) *CFi resource management performance.* Thus, scientific *fish resource monitoring* -by FiA officers using catch data- corresponds to assessing fishery trends on a large scale to inform national resource management, whereas *CFi resource management performance* corresponds to analysis at the CFi level for adaptation of local Management Plans. See table below:

	Fish resource monitoring	CFI resource management performance
Scale	Kratie and Stung Treng provinces	CFi fishing area
Purpose	Scientific assessment of the project benefits in terms of fish resource sustainability	Adaptation of the Management Plan for improved local benefits
Target	FiA, decision makers CFi for information	CFi FiA for information
Information manager	FiA	CFi members
Information management	Using computers, databases, statistics	Using local CFi resources (to be determined)
Needs	Data from fishers, data analysis and reporting	Training and a method reflecting local capacity

CFi resource management performance assessment therefore requires a capacity-building effort focused i) on the variables of relevance to CFi members and ii) in relation to their own information analysis means and skills. This may exclude computer-based data if the CFi does not have electricity, computer or data management skills.

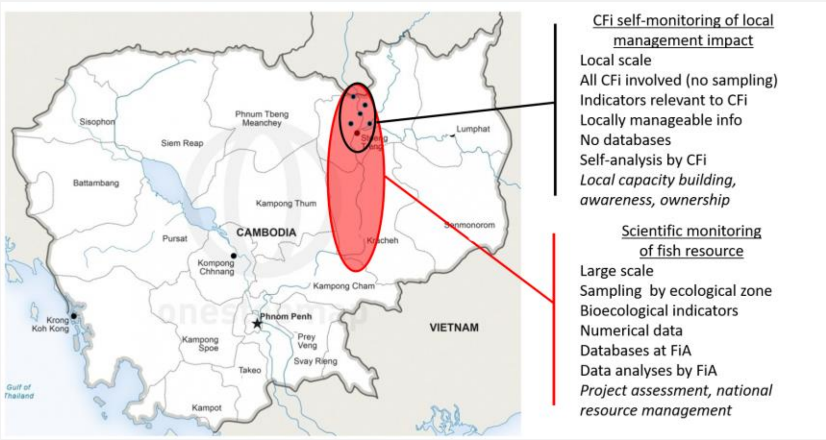
Alternatives considered and the way forward (continued)

For these reasons, we opted for:

• the present protocol for scientific fish resource monitoring at the province level,

and in parallel

• the development of a training course for CFi to become able to monitor by themselves, with their own means.



The latter option refers to adaptive management at the CFi level, in an autonomous way ultimately independent from the FIA inputs. Such approach is recommended by the FAO, the UNEP or the Ecosystem Approach to Fisheries Management. This will be the subject of a companion report, the present one being focused on scientific monitoring on a large scale in collaboration with fishers in a selection of aquatic habitats.

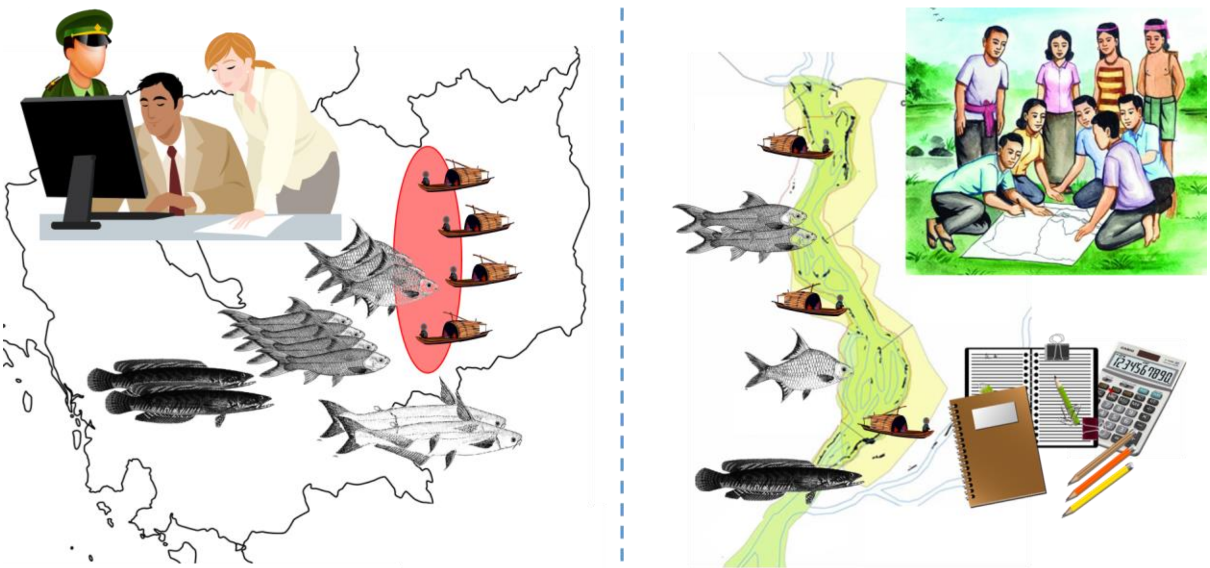


Figure 4: Illustrated summary of the difference in scale, approach and means between scientific monitoring of the fish resource with fishers and self-monitoring of CFi management performance

5. NEW PROJECT-SPECIFIC FISH MONITORING PROTOCOL

The fish monitoring protocol proposed below results from the above review of fish monitoring protocols in the region and integrates recommendations from the February 2012 Mekong Fish Network workshop involving 20 regional institutions (Patricio et al. 2012). It also reflects a consultation, in February and June 2019, of FiA scientists, Cantonment officers, fishers and CFi members (5 each time), as well as a consultation of project administrative officers in order to integrate budget and procurement constraints.

5.1. Approach and gears monitored

The proposed approach, reflecting both requirements about i) monitoring the resource and ii) assessing the performance of the resource management, will consist in **working with fishers using their own gear in their own way** and keep fishing as they used to.

The MRC database, compiling 52,518 fishing operations in Cambodia during nine year, shows that 18 fishing gears are used by fishers:

Gill net (76.11%); Line and hooks (11.66%); Big horizontal cylinder trap (6.67%); Cast net (3.47%); Vertical Vase trap (0.48%); Snakehead Wedge Trap (0.36%); Big bamboo cylinder vertical entrance trap (0.24%); Drop door traps (0.21%); Barrage Trap (0.20%); Horizontal cylinder trap for rice fields (0.18%); Spear (0.15%); Wedge-shaped scoop basket (0.12%); Pumping (0.06%); Giant wedge cone trap (0.05%); Tree Arrow Harpoon (0.02%); Giant Cast net (0.02%); Catch by Hand (0.01%); Lift net (0.01%);

Thus, four fishing gears are used in more than 95% of all fishing operations: gill nets, line and hooks, horizontal cylinder trap and cast net (3.47%). While acknowledging this dominance, the protocol proposed will cover all fishing gear types used (in order to avoid confusion and distinguish fishing efforts, one data sheet will be used for each gear and fishing operation).

5.2. Study zones

The focus will be on four main ecological zones:

- <u>the Ramsar zone</u>: this area is specific for its multiple islands, its microhabitat diversity and its high biodiversity (Timmins 2006, Allen et al. 2008). Furthermore, its importance to fisheries is also recognized (Almack and Kura 2012, Schofield 2013)
- <u>the 3S rivers zone</u>: these rivers represent an important fish habitat and migration route (Baird and Shoemaker 2008; Baran and Seng Sopheak 2011, Baran et al. 2014). Nowadays, the Sekong River remains the only undammed 3S river in Cambodia. Monitoring fish resources downstream of the Lower Sesan 2 Dam is also important in assessing overall trends in large scale drivers influencing the fish resource of the project CFis;

- the Mekong mainstream zone: the monitoring should also focus on the Mekong mainstream between Stung Treng and Kratie, as this is the main migration corridor between upstream Mekong and the Cambodian floodplains, featuring a concentration of ecologically important deep pools;
- the floodplain zone: in complement to the previous river sites, floodplain areas adjacent to the rivers should also be monitored; they serve as a wet season breeding and feeding ground for fish, and are a specific habitat for black fish important to fishers' catches.

Conclusion:
Four ecological zones are identified for monitoring: the Ramsar zone; the 3S Rivers; the Mekong mainstream between Stung Treng and Kratie, and lateral floodplains.

ALTERNATIVES CONSIDERED
A randomization of CFi selected for monitoring combined with the constraint of working with 20 CFi (see below) would not have allowed covering the diversity of habitats existing in the project area. Sampling each major fish habitat is an important stratification factor highlighted in all fish sampling methodological recommendations (e.g. Oliveria et al. 2014, Kelly et al. 2015).

5.3. Community Fisheries involved

Number of community fisheries involved in each zone
Practical considerations based on logistical constraints, training requirements, budget, frequency of data gathering and amount of data gathered lead to selecting **five Community Fisheries per ecological zone**. Thus, fish resources will be monitored through data gathering in 20 CFis, i.e. 28% of all CFis. See more details in section "Statistical aspects".

Ramsar zone
Stung Treng PIT has identified, based on logistical and interaction criteria, the following Community Fisheries:
Anlong Svay 2, Krala Peas, Koh Sneng, Anlong Koh Kang and Phum Thmei.
3S Rivers zone
Since there are no partner CFI along the Srepok River, the project will work with all 2S rivers CFis, i.e.: Chur Tameo, Phlouk Meanchey, Sdau 1, Sdau 2, and Talat Samki Rungreung.
Mainstream zone
Among the multiple CFis located along the mainstream, we selected as a priority CFis not located along a minor channel, in order to avoid issues related to narrowness and shallowness. Since Stung Treng PIT is already dealing with Ramsar and 3S CFis, we also selected as a priority CFis in Kratie Province; these are:
Ampil Teuk, Kampong Krabei, Kohsaksit, Voadthonak and Anlong Preah Kou.

Floodplain zone

All floodplain sites are located in Kratie Province. Kratie PIT has selected, based on logistical and interaction criteria, the following Community Fisheries:

Kampi, Prek Ta Am, Ou Lung, Ta Mau and Russey Keo.

All CFi selected for monitoring are detailed in Figure 5:

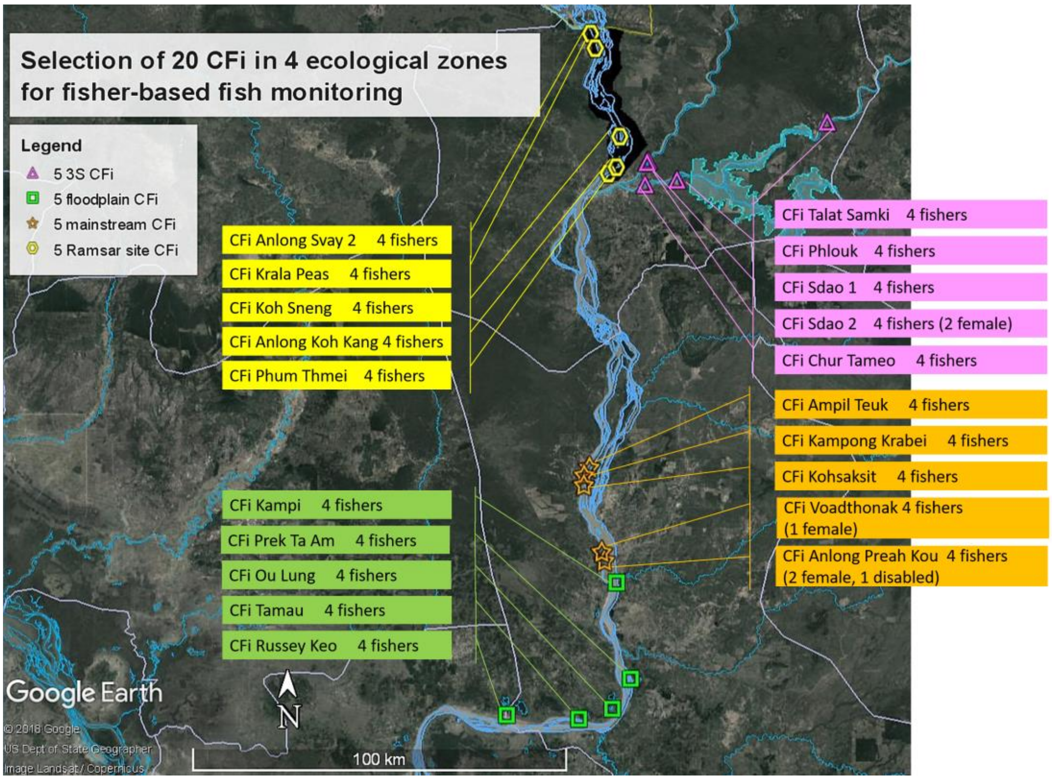


Figure 5: CFi selected for scientific fish monitoring

ALTERNATIVES CONSIDERED

The team did start with the ambition to involve all 70 CFi, for the reasons detailed above. However, a preliminary analysis revealed that this option was impossible:

• involving 5 fishers in 70 CFi would have implied the training and financing of 70x5=350 fishers. This would have been a huge effort, for a monitoring program then 15 to 20 times larger than any fisher-based monitoring program in the region, including the current MRC program in Cambodia (16 fishers to date);

• the effort required to set up such a huge program was incompatible with project implementation time frame, with the annual budget plans already approved, with logistical constraints, and would have resulted at best in only one year of actual monitoring before the end of the project;

• 350 fishers recording their daily fish catch like in the MRC protocol would have produced more than 1500 data sheets every week. Such information overload would have been unmanageable given the project staffing, and unjustified.

The argument according to which "each CFi should be involved" is addressed in the alternative option detailed in text box "Alternatives considered and the way forward" of section 4.2.

5.4. Number of fishers involved

In each CFi selected for fish monitoring, the project should involve 4 fishers. This number is as close as possible as the number recommended in the Project Appraisal Document (five fishers), given the budget available. It reflects the need to cover the variability in fishing gears, fishing frequency, fishing skills and fisher's availability. It also reflects overall feasibility, while contributing to significant capacity building in selected sited and increasing the sampling intensity of the MRC/SciCap protocol that works with three fishers in each site (surveys based on 4 fishers remaining compatible and comparable with those based on 3 fishers only).

During the selection phase, it is required to select as a priority:

- professional fishers who rely mainly on fishing for their household income and fish at least 25 days a month (MRC standards for collaboration);
- fishers who have been fishing in the CFi village for at least 10 years and are therefore familiar with all habitats.
- fishers operating locally, in the CFi area;
- literate individuals who can fill in data sheets

USD 20 should be paid monthly to fishers enrolling in the fish monitoring protocol to cover data recording costs.
As of the end of July 2019, the project team had identified 80 fishers meeting the requirements; these include 5 women and 1 handicapped person.

5.5. Species targeted

Species
As mentioned in Section 4.2, **all species caught should be recorded**, which is similar to the approach of both IFReDI/SciCap and MRC monitoring protocols.
Given the large number of fishers involved in the protocol and the impossibility of training them all in Latin taxonomy, species will be recorded by fishers using common Khmer names.

The MRC database, compiling 2892 dates of fishing, during nine years, by 22 fishers, identified 370 species. Of these, 16 species represent 90% of catches, and 40 species represent 95 % of catches.
The 40 dominant species are:

Henicorhynchus lobatus (38.05%); *Paralaubuca riveroi* (11.33%); *Paralaubuca typus* (9.77%); *Henicorhynchus siamensis* (8.18%); *Labiobarbus siamensis* (7.75%); *Paralaubuca barroni* (3.86%); *Pangasius macronema* (3.51%); *Puntioplites falcifer* (2.21%); *Hypsibarbus malcolmi* (1.08%); *Anabas testudineus* (0.88%); *Hemibagrus spilopterus* (0.65%); *Channa striata* (0.55%); *Scaphognathops stejnegeri* (0.53%); *Helicophagus waandersi* (0.48%); *Puntioplites proctozysron* (0.42%); *Puntius orphoides* (0.38%) *Hypsibarbus lagleri* (0.37%), *Cyclocheilichthys tapiensis* (0.37%); *Hypsibarbus pierrei* (0.37%); *Pristolepis fasciata* (0.36%); *Micronema bleekeri* (0.34%); *Pangasius larnaudii* (0.30%); *Labeo chrysophekadion* (0.28%); *Clarias batrachus* (0.26%); *Botia modesta* (0.23%); *Osteochilus hasselti* (0.21%); *Bagrichthys obscurus* (0.21%); *Amblyrhynchichthys truncatus* (0.21%); *Pangasius conchophilus* (0.20%); *Cosmochilus harmandi* (0.19%); *Micronema cheveyi*

(0.19%); *Barbonymus schwanenfeldii* (0.19%); *Notopterus notopterus* (0.19%); *Xenentodon cancila* (0.18%); *Cyclocheilichthys repasson* (0.18%); *Clarias macrocephalus* (0.17%); *Pangasius pleurotaenia* (0.17%); *Hampala dispar* (0.17%); *Cyclocheilichthys enoplos* (0.16%) and *Pseudomystus siamensis* (0.16%);

A scroll-down list of 40 species is provided for standardized data entry (see Annex 1) and the field form allows entering fish names that are not pre-entered in the list.

During training, **fishers will be provided the guidebook of fish species and information** -with photos, identification criteria and standardized Khmer names- developed by the project team based on previous works of IFReDI and the NAGAO foundation.

ALTERNATIVES CONSIDERED AND THE WAY FORWARD

It would have been ideal that fishers identify species according to scientific taxonomic criteria and record them using their Latin names. However training 80 fishers to learn, within a few weeks, these criteria, to learn complex Latin names and how to write them in roman script would have been highly unrealistic: the project team faced the challenge, in some CFi, of finding five fishers literate in Khmer capable of being involved in the data gathering program.

In order to meet the need for a clear set of equivalences between Khmer names and scientific Latin fish names, the project developed a companion report (FiA 2019: Index of 99 Latin-Khmer and Khmer-Latin fish names). For each fish species a code is provided; that code can be used by fishers for data recording.

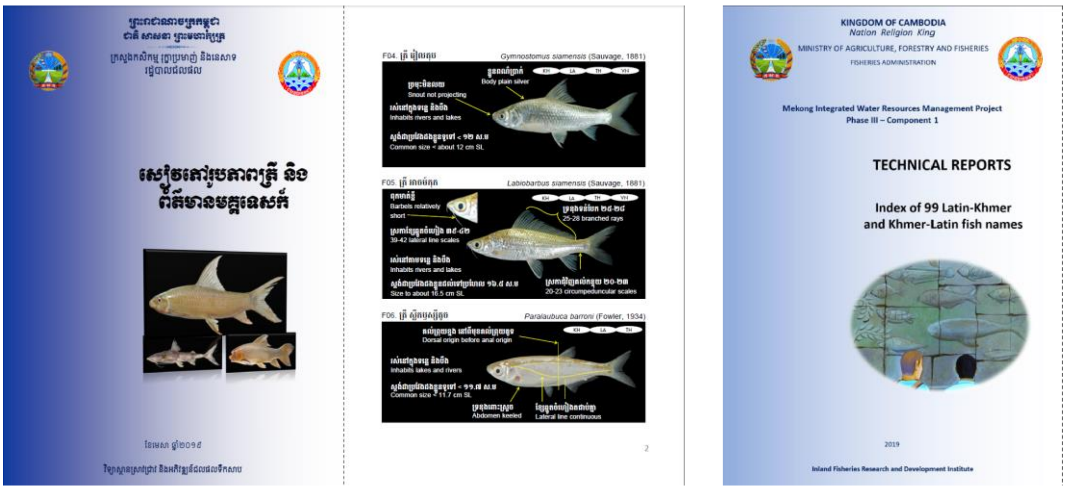


Figure 6: Fish identification book and taxonomic equivalence table produced by the project for CFi fishers

5.6. Frequency of sampling

Requesting each fisher to record each fishing session generates two constraints: i) data recording becomes heavy for fishers, which results in a loss of quality due to hasty or made-up records, and ii) data sheet gathering and data entry becomes very demanding, requesting specific human resources. For these reasons, the frequency of sampling was considered so that the two obstacles are minimized.

Fishers should record data two days a week. These days should be the first two days of the week (by default, Monday and Tuesday) so that recording is not decided at leisure by the fisher when the catch is small.

With such frequency, in each zone [5 CFis x 4 fishers x 2 days] will generate 40 data sheets per week, i.e. 80 data sheets per week per province. Since each data sheet should be computerized in about 15mn, this represents about 3 days of data entry per week, i.e. one part-time dedicated data-entry PIT staff. This leaves time for the provincial consultant to clean data each week, before forwarding data to Phnom Penh for compilation.

5.7. Variables measured

Several studies have reviewed the parameters required for rapid assessment or long-term monitoring of small scale tropical fisheries, in particular Pido et al. (1996), Halls et al. (2005 a and b), or DoF and SEAFDEC (2010) in Myanmar. All these approaches focus on abundance, biomass yielded and fishing effort as primary variables, with fish length or gonadal maturity as possible additional variables.

The variables proposed below for recoding reflect the above references and also those gathered for the IFReDI/SciCap and MRC monitoring protocols; however, the latter protocols operate with highly trained fishers, whereas the present project cannot propose and rely on such extensive scientific training. Furthermore, the present project does not need to record a number of environmental parameters that may be useful for ecological studies, but are not necessary for trend monitoring (and that have never been analysed in relation to catches in the IFReDI/SciCap and MRC monitoring protocols). For these reasons, **we recommend that fishers of the project measure the following variables**:

Date
Location (CFi)
Name of fisher
Gear name and dimension

Gill net	Line and hooks	Horizontal cylinder trap	Cast net	Others
Height	Length	Height	Diameter	Height (if relevant)
Length	Nb of hooks	Length		Length (if relevant
				Number (if relevant)

Time set / time fishing started
Time checked / time fishing ended
Local habitat (Deep pool, Floodplain/swamp; Lake/pond/reservoir; Rice field; River/stream/channel; Flooded forest; Others).
Species A: total number, total weight
Standard length and weight of 3 individuals randomly selected
Species B: total number, total weight
Standard length and weight of 3 individuals randomly selected
Species C: total number, total weight
Standard length and weight of 3 individuals randomly selected
etc., until all species are recorded. A template sheet is provided in Annex 2.

A review of fish lengths measured in the different protocols shows that the MRC records fork length or total length, SciCap measures standard and total length, and the trammel net protocol measures total length. Lengths measured are from the tip of the longest jaw to i) the end of the spine (standard length); ii) the center of the fork in the caudal fin (fork length) or iii) the longest caudal lobe (total length); see Kahn et al. 2004 and Figure 7. These different measures are correlated (Özcan Gaygusuz et al. 2006) but the correlation depends on the body shape group of the fish species. By default we recommend to record the most common and robust length measurement, i.e. **measure standard length**. For length measurements, **fish should be randomly selected**, i.e. by picking three individuals in a basket without looking.

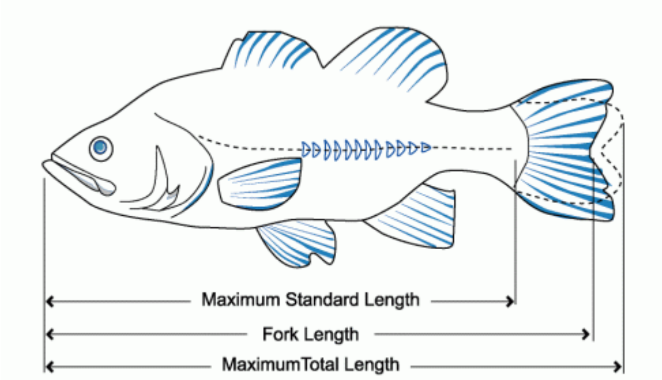


Figure 7: The three ways to measure fish length (source: FishXing software manual)

An analysis of the MRC daily catch data shows that fishers catch on average 3.57 species per day. This corresponds to an average of 3.57 x 3 = 10.7 length and weight measurements per day of recording per fisher, or 21 per week.

From a catch monitoring perspective, this frequency corresponds to 5 CFis x 4 zones x 4 fishers x 2 days of recording/week =160 individual catch records per week.
From a fish biology perspective, 21 length and weight measurements per fisher per week also correspond to 1680 individual length/weight records every week for the two provinces. Such frequency can contribute to documenting the biology of uncommon or rare species, and is largely sufficient for length and cohort analyses of dominant commercial species (Prince et al. 2018).

From a fishing effort perspective, data gathered will allow measuring CPUE with a fair level of precision (catch per m^2 of gill net, per m^2 of trap, per hook). However, an alternative perspective consists in analysing trends in catch with *one day of fisher as a unit effort*, regardless of the gears used and their dimensions. This is the approach taken in Bangladesh, acknowledging the diversity of fishing strategies and gears (WorldFish Center 2007).

Fifty partner Community Fisheries will also be provided a set of probes for the monitoring of environmental variables (temperature, pH, dissolved oxygen and turbidity). Since this protocol is different from the current one focused on fish, it will be detailed in another document.

ALTERNATIVES CONSIDERED

The random selection of three fishes for length and weight measurements is not perfect nor exempt of possible bias. However, in absence of a scientist-supervised measurement of all individuals caught for specific cohort analyses, this option to be implemented by fishers on a daily basis and large number of species is a reasonable option in relation to the other fisher-based protocols of the region, i.e. count of “large” and “small individuals for each species (FishBio), only maximum length by species (RFLP study, MRC monitoring), selection of 10 largest, smallest and “intermediate” fish for each species (SciCap) or random selection of 10 individuals per species (IFReDI/SciCap). Picking and measuring 30 fish at random for each species as recommended for parametric statistical analyses would have put an unrealistic daily burden on each fisher, and would have generated an unnecessarily high amount of data for common species.

5.8. Practical aspects

The project should provide each fisher with:

- Logbook sheets, a writing pad and pencils (not ink pens which are not waterproof)
- One tailor meter to measure fish length; ichthyometers (i.e. metered boards) are unnecessary
- One 500 grams suspension scale for individual fish and one 10 kg scale for species weighting
- 5 woven baskets to sort and weight species(not plastic bags, for environmental reasons)
- Envelopes (to hand over weekly or monthly data sheets to the project)

Figure 8: Items needed by fishers for data gathering

Figure 9: Data gathering process

Data sheets in envelopes from several fishers should/can be compiled by the CFi head, so that PIT staff can collect them about once a week.

Data entry will be done in province offices using the database format provided.

Data will be checked every week by the project officer in charge. Data checking will include data cleaning as detailed during training sessions.

Data files will be sent to the project office in Phnom Penh at least every month, and compiled into one single database.

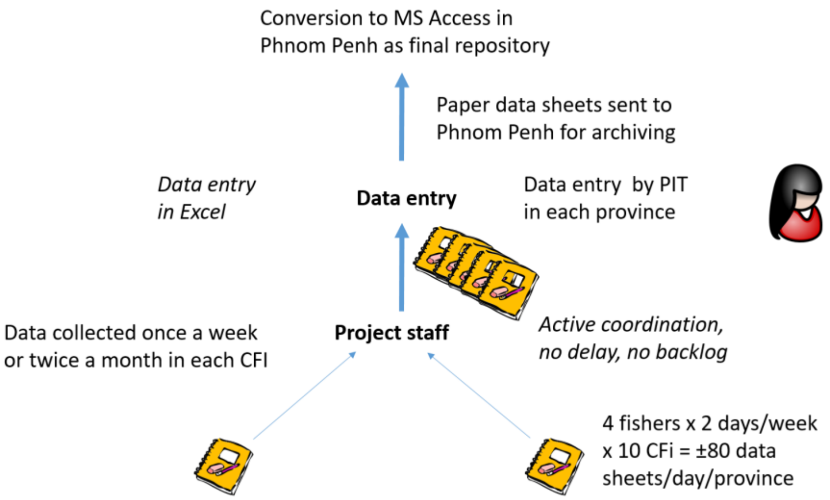


Figure 10: Data compilation and processing

5.9. Statistical aspects of the sampling design

The survey designed here is a sampling of fishers' catch. From a statistical perspective the population of fishers is actually stratified into four ecological strata or zones: Ramsar; 3S rivers; mainstream and floodplains. Each of these zones is represented by 20 fishers from five CFis. Eighty fishers out of 3420 full time fishers recorded in all 70 CFi represent 2.3% of the total number of fishers, i.e. a small but reasonable sample size by usual standards (Scherrer 1984, Ford 2000).

The number of fishers surveyed (4) is not a constant proportion of the number of fishers in each zone (**Error! Reference source not found.**), which implies weighting catch results in future analyses of fish s ampling data.

Weighting accounts for differences in the proportions of the population sampled resulting from the stratified/clustered sampling design, and should be applied i) when total catch is to be inferred from the sampled fishers to the whole set of fishers in a given zone, and ii) as a correction for proportions, when stratified or clustered sampling ratios vary and not coincide with population proportions (Maletta 2007; Yansaneh 2008).
The correction to be applied consist in using weights specific to each stratum = zone; they can be designated πk = % of stratum in population / % of stratum in sample, which is calculated as:

$$\pi_k = \frac{N_K/N}{n_K/n}$$

with N_k = total number of cases in the stratum; N = total number of cases in the population; n_k = size of the sample from strata and n = number of samples from all strata.

The equation or weight here corresponds to:

$$\frac{\text{Number of fishers } in \text{ zone A}}{\text{Number of fishers sampled in zone A}} \quad \text{x} \quad \frac{\text{Total number } of \text{ fishers } in \text{ all zones}}{\text{Number of fishers sampled in all zones}}$$

Note: this weighting only applies to the calculation of yield per zone, and not to species richness by zone or to dominances among species.

6. INTEGRATION AND CONTINUATION OF TWO EXISTING FISH MONITORING PROGRAMS

The Project Appraisal Document (28 April 2016) indicates, in its Annex 2 (§ 6. Implementation of CFi Management Plan, point d.), that *"IFReDI will undertake a trammel net survey to estimate fish abundance, biomass and diversity in the FCZ to help assess their effectiveness at protecting fish stocks and diversity. The evaluation will compare management outcomes from observed previous year(s), and across the CFis*".

We detail below the elements of a project-specific fish monitoring program that builds on, and extends, existing monitoring protocols described in section 2.

Overall, the continuation, during the course of the project, of protocols initiated before the project adds, *for a minor cost*, a lot of value to the project data by allowing an assessment of the project impact

i) in space, by comparing the project area and its management initiatives with different areas of the country (are trends inside and outside the project area similar?) and
ii) in time, by comparing the only two years of project data gathering with several years of comparable data *before* and *after* the project (see figure below)

Beyond project M&E immediate objectives, both aspects contribute to a solidly grounded long term and large-scale monitoring of the fish resource essential to informing FiA's overall management approach.

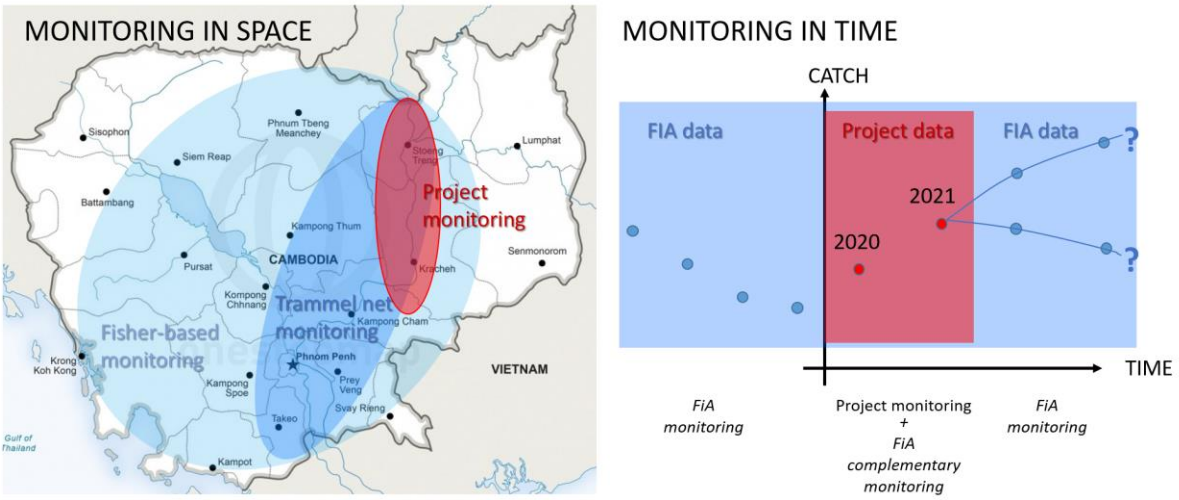


Figure 11: Geographic and temporal dimensions covered by the project fish resource monitoring and complementary monitoring protocols proposed.

IFReDI trammel net monitoring program

This protocol can complement the monitoring by CFis based on individual fishing gears, by providing a standardized sampling and covering a larger geographical scope.

Trammel nets (Figure 12) are a fish stock monitoring tool more effective than gill nets (Acosta 1997, Long 2003) and have been consistently used by IFReDI for biological monitoring in Cambodia (Chheng Phen 2010, Chheng Phen and So Nam 2012, Chheng Phen et al. 2016).

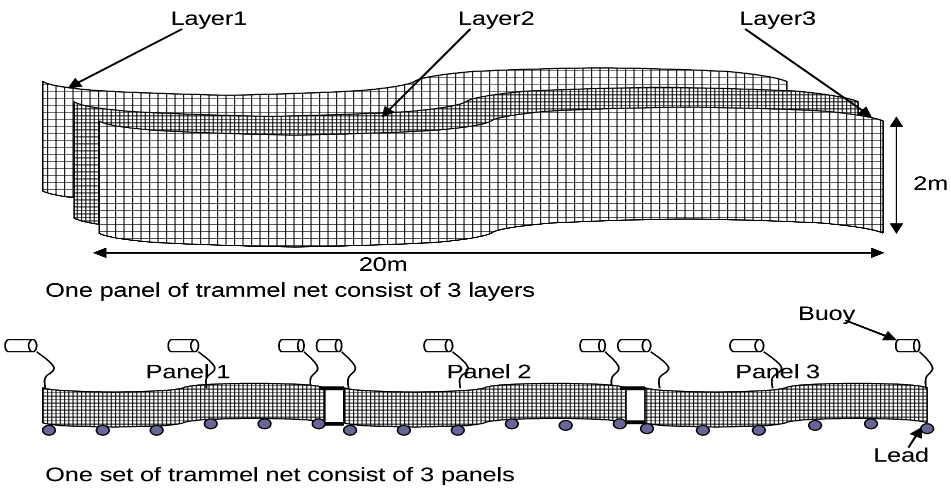


Figure 12: Trammel net structure and mounting

One fish monitoring session requires two sets of trammel nets. Each set consists of three connected panels. Each panel is made of three layers, i.e. two outside layers of large mesh size and an inside layer with a mesh size four times smaller (first panel: two outside layers of 30 mm mesh size, one 7.5 mm inside layer; second panel: 60 mm and 15 mm; third panel: 120 mm and 30 mm). Each panel is 20 m long and 2 m high. Two sets of trammel nets are set in each site at 4 a.m. and checked every hour until 9 a.m. All individual fishes are identified to the species level, weighted and measured.

Sampling is currently done twice a year (in March and September) in 7 sites countrywide, including in the Tonle Sap River and Lake.

As part of the present project, **we recommend:**

- **i)** **funding and continuation of the existing trammel net protocol** in its current 7 sites in order to assess the impact of project activities on the Mekong fish resources on a larger scale), and
- **ii)** **adding 3 new sites focused on the project area**, i.e.:
  - o on the Mekong mainstream upstream of Stung Treng
  - o on the Sekong River
  - o on the Sesan River upstream of the Lower Sesan 2 reservoir.

IFReDI – SciCap monitoring program

For several years, the IFReDI – SciCap monitoring program described in section 3 has been implemented throughout the country. This monitoring program focused on a citizen science fisher network has been endorsed by multiple organizations and NGOs, and has generated a continuous 6-year quality-controlled data set from community fishermen. It is –purposely- similar to and compatible with the project monitoring proposed here.

The approach consists in collaborating with trained expert fishers using their own gear; the protocol involves around 32 fishers in nine provinces and includes daily and weekly records.

Daily records:

Environmental parameters (moon, wind, current, etc.)
Fishing gear details
Time spent fishing
Catch of the day
Species caught (Khmer names)
Quantity by species and by gear
Weight by species and by gear

Weekly samples

Species caught (Khmer names)
Quantity and weight by species
10 individual lengths and weights
10 tissue samples

The IFReDI – SciCap monitoring program provides a unique opportunity to i) monitor the resource in greater detail in Stung Treng and Kratie Provinces; ii) dovetail the two monitoring protocols; iii) provide a baseline of the resource before the project starts its own monitoring; iv) compare local trends with trends countrywide, and v) assess the impact of the World Bank project beyond local sites and two provinces.

For these reasons, **we recommend funding and continuation of the existing IFReDI/SciCap protocol through the present project.**

Both IFReDI monitoring programs are modest in size and annual cost; the cost of their continuation is fully compatible with the budget available for fish resource monitoring in the project, and they offer a high qualitative return for the investment.

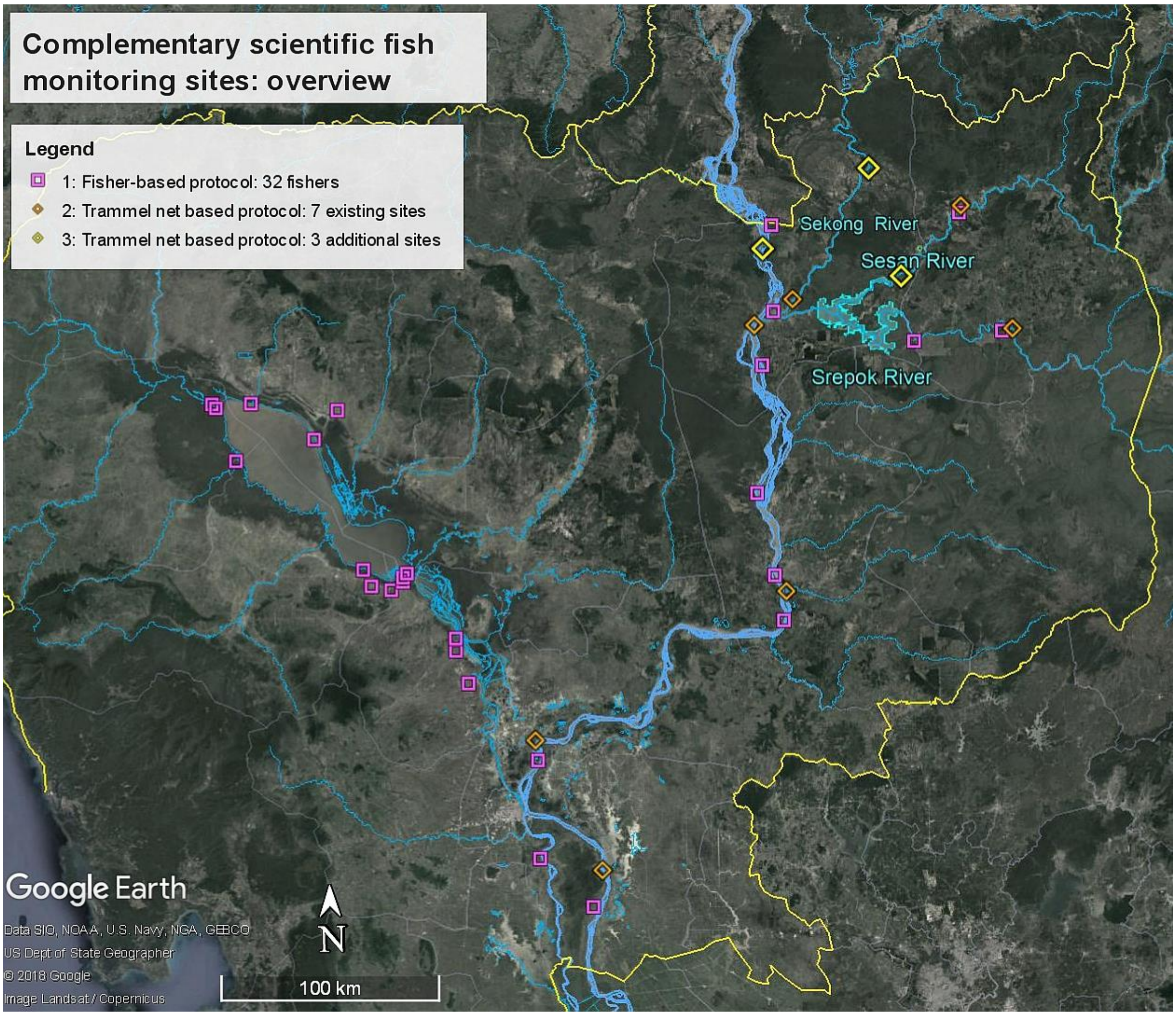


Figure 13: Distribution of the 32 fishers and 7+3 trammel net sites complementing the fish monitoring of the project within and outside the project area

7. CONCLUSIONS

Based on a review of fish monitoring protocols in the region and in Cambodia, and of the objectives and constraints of the project, we recommend:

- working with fishers using their own gear in their own way;
- focusing on four main ecological zones: the Ramsar zone; the 3S Rivers; the Mekong mainstream between Stung Treng and Kratie, and lateral floodplains;
- selecting five Community Fisheries per ecological zone (i.e. 20 in total, which represents 28% of all CFis);
- involving four professional fishers in each CFi selected (i.e. 80 in total);
- recording fishing operations two days a week;
- recording all species caught, using Khmer names then a correspondence table with Latin names;
- recording, for each fishing operation date, location, gear name, number and dimensions, time fishing, and for each species caught, total number of individuals, total weight and standard length and weight of 3 individual fishes randomly selected.

A detailed review of fish monitoring protocols in Cambodia highlights the existence of two long-term and ongoing monitoring programs at IFReDI, i.e. the trammel net protocol (7 sites sampled twice a year) and the IFReDI/SciCap protocol (32 fishers using their gears in 28 sites). Both protocols include sites in Stung Treng and Kratie Provinces. It is therefore recommended to integrate these two protocols to the project and fund their continued implementation. In the case of the lighter trammel net sampling, it is also recommended to add 3 new sites in the project area.

Overall, the proposed protocol reflects needs, integrates practical constraints and capacity building, and is dovetailed with existing monitoring protocols.

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9. ANNEX 1: LIST OF CAMBODIA SPECIES IN THE MRC DAILY FISH MONITORING DATABASE

Row Labels	Number of fish	%	Cumulative %	Rank
Henicorhynchus lobatus	1422239	38.05		1
Paralaubuca riveroi	423550	11.33	49.38	2
Paralaubuca typus	365350	9.77	59.16	3
Henicorhynchus siamensis	305853	8.18	67.34	4
Labiobarbus siamensis	289493	7.75	75.09	5
Paralaubuca barroni	144381	3.86	78.95	6
Pangasius macronema	131312	3.51	82.46	7
Puntioplites falcifer	82444	2.21	84.67	8
Hypsibarbus malcolmi	40299	1.08	85.75	9
Anabas testudineus	32999	0.88	86.63	10
Hemibagrus spilopterus	24352	0.65	87.28	11
Channa striata	20391	0.55	87.83	12
Scaphognathops stejnegeri	19871	0.53	88.36	13
Helicophagus waandersi	17926	0.48	88.84	14
Puntioplites proctozysron	15761	0.42	89.26	15
Puntius orphoides	14030	0.38	89.64	16
Hypsibarbus lagleri	13768	0.37	90.00	17
Cyclocheilichthys tapiensis	13712	0.37	90.37	18
Hypsibarbus pierrei	13646	0.37	90.74	19
Pristolepis fasciata	13492	0.36	91.10	20
Micronema bleekeri	12582	0.34	91.43	21
Pangasius larnaudii	11110	0.30	91.73	22
Labeo chrysophekadion	10565	0.28	92.01	23
Clarias batrachus	9580	0.26	92.27	24
Botia modesta	8668	0.23	92.50	25
Osteochilus hasselti	8029	0.21	92.72	26
Bagrichthys obscurus	7854	0.21	92.93	27
Amblyrhynchichthys truncatus	7803	0.21	93.14	28
Pangasius conchophilus	7421	0.20	93.33	29
Cosmochilus harmandi	7249	0.19	93.53	30
Micronema cheveyi	7116	0.19	93.72	31
Barbonymus schwanenfeldii	7001	0.19	93.91	32
Notopterus notopterus	7001	0.19	94.09	33
Xenentodon cancila	6692	0.18	94.27	34
Cyclocheilichthys repasson	6640	0.18	94.45	35
Clarias macrocephalus	6462	0.17	94.62	36
Pangasius pleurotaenia	6445	0.17	94.79	37
Hampala dispar	6190	0.17	94.96	38
Cyclocheilichthys enoplos	5930	0.16	95.12	39
Pseudomystus siamensis	5885	0.16	95.28	40
Osphronemus exodon	5563	0.15	95.43	
Thynnichthys thynnoides	4676	0.13	95.55	
Puntioplites bulu	4584	0.12	95.67	
Polynemus longipectoralis	4553	0.12	95.79	
Hypsibarbus wetmorei	4473	0.12	95.91	
Bagrichthys macracanthus	4347	0.12	96.03	
Cyclocheilichthys lagleri	4331	0.12	96.15	
Parambassis wolffi	4316	0.12	96.26	
Hypsibarbus suvattii	4278	0.11	96.38	
Luciosoma bleekeri	3854	0.10	96.48	

Row Labels	Number of fish	%	Cumulative %	Rank
Hemibagrus wyckioides	3689	0.10	96.58	
Rasbora tornieri	3617	0.10	96.68	
Hemibagrus filamentus	3584	0.10	96.77	
Belodontichthys truncatus	3471	0.09	96.86	
Clupisoma sinensis	3294	0.09	96.95	
Brachirus orientalis	3185	0.09	97.04	
Mastacembelus armatus	2997	0.08	97.12	
Hemisilurus mekongensis	2936	0.08	97.20	
Mystus mysticetus	2864	0.08	97.27	
Rasbora aurotaenia	2859	0.08	97.35	
Chitala blanci	2790	0.07	97.42	
Channa gachua	2759	0.07	97.50	
Macrognathus siamensis	2616	0.07	97.57	
Lobocheilos melanotaenia	2589	0.07	97.64	
Trichogaster trichopterus	2495	0.07	97.70	
Cyclocheilichthys apogon	2482	0.07	97.77	
Heterobagrus bocourti	2411	0.06	97.83	
Barbonymus gonionotus	2397	0.06	97.90	
Botia helodes	2274	0.06	97.96	
Micronema apogon	2189	0.06	98.02	
Ompok bimaculatus	2156	0.06	98.08	
Barbonymus altus	2115	0.06	98.13	
Boesemania microlepis	2094	0.06	98.19	
Scaphognathops bandanensis	2034	0.05	98.24	
Lycothrissa crocodilus	1966	0.05	98.30	
Hampala macrolepidota	1933	0.05	98.35	
Rasbora myersi	1881	0.05	98.40	
Pangasius bocourti	1815	0.05	98.45	
Laides longibarbis	1756	0.05	98.49	
Gyrinocheilus pennocki	1736	0.05	98.54	
Mystus singaringan	1732	0.05	98.59	
Cynoglossus microlepis	1707	0.05	98.63	
Rasbora hobelmani	1706	0.05	98.68	
Osphronemus goramy	1698	0.05	98.72	
Trichogaster microlepis	1691	0.05	98.77	
Datnioides undecimradiatus	1631	0.04	98.81	
Bagarius suchus	1408	0.04	98.85	
Cirrhinus microlepis	1316	0.04	98.88	
Cirrhinus jullieni	1303	0.03	98.92	
Cirrhinus molitorella	1139	0.03	98.95	
Osteochilus melanopleura	1071	0.03	98.98	
Bagarius yarrelli	1064	0.03	99.01	
Osteochilus microcephalus	998	0.03	99.03	
Pangasius polyuranodon	950	0.03	99.06	
Raiamas guttatus	896	0.02	99.08	
Chitala lopis	876	0.02	99.11	
Oxyeleotris marmorata	875	0.02	99.13	
Mystus albolineatus	861	0.02	99.15	
Osteochilus waandersii	838	0.02	99.18	
Kryptopterus cryptopterus	791	0.02	99.20	
Clarias meladerma	781	0.02	99.22	
Heteropneustes kemratensis	728	0.02	99.24	
Labeo dyocheilus	728	0.02	99.26	

Row Labels	Number of fish	%	Cumulative %	Rank
Channa marulioides	710	0.02	99.28	
Channa micropeltes	693	0.02	99.29	
Probarbus labeaminor	693	0.02	99.31	
Pangasius micronemus	665	0.02	99.33	
Pangasianodon hypophthalmus	662	0.02	99.35	
Mystus multiradiatus	647	0.02	99.37	
Probarbus jullieni	641	0.02	99.38	
Mystus atrifasciatus	614	0.02	99.40	
Cyclocheilichthys furcatus	581	0.02	99.41	
Labeo rohita	577	0.02	99.43	
Puntius rhombeus	565	0.02	99.44	
Leptobarbus hoeveni	559	0.01	99.46	
Cyclocheilichthys armatus	550	0.01	99.47	
Oreochromis niloticus	546	0.01	99.49	
Parambassis siamensis	540	0.01	99.50	
Catlocarpio siamensis	514	0.01	99.52	
Cyprinus carpio	512	0.01	99.53	
Hemiarius stormii	506	0.01	99.54	
Hemibagrus wyckii	496	0.01	99.56	
Kryptopterus micronema	490	0.01	99.57	
Monopterus albus	433	0.01	99.58	
Megalops cyprinoides	414	0.01	99.59	
Cyclocheilichthys heteronema	394	0.01	99.60	
Paralaubuca harmandi	392	0.01	99.61	
Mystus wolffii	385	0.01	99.62	
Rasbora paviei	359	0.01	99.63	
Probarbus labeamajor	334	0.01	99.64	
Mystacoleucus marginatus	326	0.01	99.65	
Chitala ornata	321	0.01	99.66	
Botia eos	315	0.01	99.67	
Mekongina erythrospila	313	0.01	99.68	
Bangana behri	306	0.01	99.69	
Henicorhynchus ornatipinnis	301	0.01	99.69	
Albulichthys albuloides	278	0.01	99.70	
Puntius binotatus	278	0.01	99.71	
Discherodontus ashmeadi	276	0.01	99.72	
Coilia lindmani	265	0.01	99.72	
Bagarius bagarius	259	0.01	99.73	
Poropuntius speleops	257	0.01	99.74	
Mystacoleucus chilopterus	254	0.01	99.74	
Brachirus panoides	246	0.01	99.75	
Monotrete barbatus	246	0.01	99.76	
Wallago attu	246	0.01	99.76	
Longiculter siahi	234	0.01	99.77	
Osteochilus lini	234	0.01	99.78	
Macrochirichthys macrochirus	230	0.01	99.78	
Wallago leerii	221	0.01	99.79	
Mystus gulio	220	0.01	99.79	
Crossocheilus atrilimes	212	0.01	99.80	
Polynemus borneensis	209	0.01	99.81	
Mystacoleucus greenwayi	200	0.01	99.81	
Onychostoma gerlachi	196	0.01	99.82	
Labiobarbus lineata	192	0.01	99.82	

Row Labels	Number of fish	%	Cumulative %	Rank
Clarias gariepinus	181	0.00	99.83	
Rasbora trilineata	176	0.00	99.83	
Arius caelatus	170	0.00	99.83	
Garra fasciacauda	165	0.00	99.84	
Garra cambodgiensis	160	0.00	99.84	
Schistura laterivittata	160	0.00	99.85	
Toxotes microlepis	151	0.00	99.85	
Tor sinensis	148	0.00	99.86	
Onychostoma fusiforme	143	0.00	99.86	
Barbichthys nitidus	138	0.00	99.86	
Arius maculatus	132	0.00	99.87	
Pangasius siamensis	132	0.00	99.87	
Pseudecheneis sulcatoides	129	0.00	99.87	
Osteochilus schlegeli	126	0.00	99.88	
Brachirus harmandi	119	0.00	99.88	
Macrobrachium rosenbergii	119	0.00	99.88	
Macrognathus taeniagaster	114	0.00	99.89	
Pangasius pangasius	114	0.00	99.89	
Glossogobius giuris	113	0.00	99.89	
Kryptopterus bicirrhis	105	0.00	99.90	
Tor laterivittatus	102	0.00	99.90	
Ophisternon bengalense	88	0.00	99.90	
Monotrete cambodgiensis	86	0.00	99.90	
Macrognathus circumcinctus	85	0.00	99.91	
Pangasius djambal	84	0.00	99.91	
Esomus longimana	81	0.00	99.91	
Trichogaster pectoralis	81	0.00	99.91	
Rasbora pauciperforata	80	0.00	99.91	
Rasbora borapetensis	71	0.00	99.92	
Mystacoleucus atridorsalis	70	0.00	99.92	
Tenualosa thibaudeaui	65	0.00	99.92	
Datnioides quadrifasciatus	62	0.00	99.92	
Misgurnus anguillicaudatus	60	0.00	99.92	
Pangasius krempfi	60	0.00	99.92	
Ompok hypophthalmus	58	0.00	99.93	
Meretrix lyrata	57	0.00	99.93	
Arius venosus	54	0.00	99.93	
Serpenticobitis cingulata	54	0.00	99.93	
Botia sp. cf. lecontei	53	0.00	99.93	
Clarias nieuhofi	53	0.00	99.93	
Hyporhamphus limbatus	53	0.00	99.93	
Acanthopsoides delphax	52	0.00	99.94	
Puntius brevis	52	0.00	99.94	
Achiroides melanorhynchus	50	0.00	99.94	
Macrognathus semiocellatus	50	0.00	99.94	
Crossocheilus reticulatus	49	0.00	99.94	
Pangasius nasutus	49	0.00	99.94	
Poropuntius deauratus	49	0.00	99.94	
Puntioplites waandersi	48	0.00	99.95	
Rasbora atridorsalis	48	0.00	99.95	
Channa lucius	44	0.00	99.95	
Kryptopterus schilbeides	44	0.00	99.95	
Tenualosa toli	44	0.00	99.95	

Row Labels	Number of fish	%	Cumulative %	Rank
Metzia lineata	41	0.00	99.95	
Tor tambroides	41	0.00	99.95	
Botia lecontei	39	0.00	99.95	
Botia longidorsalis	38	0.00	99.95	
Botia caudipunctata	37	0.00	99.96	
Tor polylepis	36	0.00	99.96	
Dasyatis laosensis	35	0.00	99.96	
Helostoma temminckii	35	0.00	99.96	
Parambassis apogonoides	35	0.00	99.96	
Channa grandinosa	34	0.00	99.96	
Racoma grisea	34	0.00	99.96	
Cynoglossus feldmanni	33	0.00	99.96	
Hypsibarbus vernayi	33	0.00	99.96	
Lobocheilos gracilis	32	0.00	99.96	
Cyclocheilichthys mekongensis	31	0.00	99.96	
Botia morleti	30	0.00	99.97	
Botia splendida	30	0.00	99.97	
Butis koilomatodon	30	0.00	99.97	
Esomus metallicus	30	0.00	99.97	
Butis butis	28	0.00	99.97	
Hypophthalmichthys molitrix	28	0.00	99.97	
Opsarius caudiocellatus	28	0.00	99.97	
Cynoglossus puncticeps	27	0.00	99.97	
Homaloptera vulgaris	27	0.00	99.97	
Pangio fusca	27	0.00	99.97	
Hypophthalmichthys nobilis	25	0.00	99.97	
Oxygaster pointoni	25	0.00	99.97	
Kryptopterus dissitus	24	0.00	99.97	
Parachela maculicauda	24	0.00	99.97	
Chela laubuca	23	0.00	99.98	
Pangasius mekongensis	23	0.00	99.98	
Rasbora palustris	23	0.00	99.98	
Tor ater	23	0.00	99.98	
Gambusia affinis	22	0.00	99.98	
Labiobarbus sp. cf. lineata	22	0.00	99.98	
Labeo pierrei	21	0.00	99.98	
Opsarius pulchellus	20	0.00	99.98	
Serpenticobitis octozona	20	0.00	99.98	
Corica laciniata	19	0.00	99.98	
Schistura athos	19	0.00	99.98	
Arius argyropleuron	18	0.00	99.98	
Aaptosyax grypus	17	0.00	99.98	
Anguilla marmorata	17	0.00	99.98	
Botia sidthimunki	17	0.00	99.98	
Plotosus canius	16	0.00	99.98	
Laocypris hispida	15	0.00	99.98	
Lepidocephalichthys hasselti	15	0.00	99.98	
Neolissochilus blanci	15	0.00	99.98	
Pareuchiloglanis myzostoma	15	0.00	99.98	
Balantiocheilos melanopterus	14	0.00	99.99	
Carcharhinus dussumieri	14	0.00	99.99	
Mystus rhegma	14	0.00	99.99	
Cirrhinus cirrhosus	13	0.00	99.99	

Row Labels	Number of fish	%	Cumulative %	Rank
Tor tambra	13	0.00	99.99	
Toxotes chatareus	13	0.00	99.99	
Cirrhinus spilopleura	12	0.00	99.99	
Monotrete baileyi	12	0.00	99.99	
Pseudomystus stenomus	12	0.00	99.99	
Puntius partipentazona	12	0.00	99.99	
Rasbora septentrionalis	12	0.00	99.99	
Luciocyprinus striolatus	11	0.00	99.99	
Netuma thalassinus	11	0.00	99.99	
Pangio myersi	11	0.00	99.99	
Parachela oxygastroides	11	0.00	99.99	
Piaractus brachypomus	11	0.00	99.99	
Pseudohemiculter dispar	11	0.00	99.99	
Acanthocobitis sp. cf. bilotorio	10	0.00	99.99	
Discherodontus parvus	10	0.00	99.99	
Botia sp. cf. beauforti	9	0.00	99.99	
Devario gibber	9	0.00	99.99	
Systomus johorensis	9	0.00	99.99	
Acanthopsoides gracilentus	8	0.00	99.99	
Clupeichthys aesarnensis	8	0.00	99.99	
Cosmochilus cardinalis	8	0.00	99.99	
Folifer brevifilis	8	0.00	99.99	
Gyrinocheilus aymonieri	8	0.00	99.99	
Arius sagor	7	0.00	99.99	
Gobiobotia yuanjianensis	7	0.00	99.99	
Labiobarbus kuhli	7	0.00	99.99	
Macrognathus maculatus	7	0.00	99.99	
Pangio filinaris	7	0.00	99.99	
Polynemus melanochir	7	0.00	99.99	
Achiroides leucorhynchos	6	0.00	99.99	
Arius malacanthus	6	0.00	99.99	
Coilia macrognathos	6	0.00	99.99	
Moolgarda seheli	6	0.00	99.99	
Neolissochilus stracheyi	6	0.00	99.99	
Pangasianodon gigas	6	0.00	99.99	
Stolephorus insularis	6	0.00	99.99	
Strongylura incisa	6	0.00	100.00	
Apocryptodon madurensis	5	0.00	100.00	
Carinotetraodon lorteti	5	0.00	100.00	
Ctenopharyngodon idella	5	0.00	100.00	
Danio tweediei	5	0.00	100.00	
Eleotris acanthopomus	5	0.00	100.00	
Gobiobotia longibarba	5	0.00	100.00	
Mastacembelus erythrotaenia	5	0.00	100.00	
Monotrete suvattii	5	0.00	100.00	
Nandus nebulosus	5	0.00	100.00	
Netuma bilineatus	5	0.00	100.00	
Odontamblyopus tenuis	5	0.00	100.00	
Silurichthys hasseltii	5	0.00	100.00	
Sinilabeo discognathoides	5	0.00	100.00	
Bangana elegans	4	0.00	100.00	
Cirrhinus prosemion	4	0.00	100.00	
Hemimyzon papilio	4	0.00	100.00	

Row Labels	Number of fish	%	Cumulative %	Rank
Lutjanus malabaricus	4	0.00	100.00	
Pareuchiloglanis gracilicaudata	4	0.00	100.00	
Troglocyclocheilus khammouanensis	4	0.00	100.00	
Clarias cataractus	3	0.00	100.00	
Devario leptos	3	0.00	100.00	
Epalzeorhynchos frenatum	3	0.00	100.00	
Glyptothorax fuscus	3	0.00	100.00	
Hemibarbus labeo	3	0.00	100.00	
Himantura krempfi	3	0.00	100.00	
Kryptopterus palembangensis	3	0.00	100.00	
Luciosoma setigerum	3	0.00	100.00	
Monotrete turgidus	3	0.00	100.00	
Mystacoleucus ectypus	3	0.00	100.00	
Scomberomorus sinensis	3	0.00	100.00	
Sinilabeo cirrhinoides	3	0.00	100.00	
Boraras urophthalmoides	2	0.00	100.00	
Channa melasoma	2	0.00	100.00	
Cynoglossus bilineatus	2	0.00	100.00	
Ellochelon vaigiensis	2	0.00	100.00	
Epalzeorhynchos munense	2	0.00	100.00	
Himantura imbricata	2	0.00	100.00	
Himantura undulata	2	0.00	100.00	
Hyporhamphus intermedius	2	0.00	100.00	
Mugil cephalus	2	0.00	100.00	
Neobarynotus microlepis	2	0.00	100.00	
Pangio anguillaris	2	0.00	100.00	
Pentaprion longimana	2	0.00	100.00	
Poropuntius consternans	2	0.00	100.00	
Puntius spilopterus	2	0.00	100.00	
Scatophagus argus	2	0.00	100.00	
Schistura coruscans	2	0.00	100.00	
Schistura sigillata	2	0.00	100.00	
Scleropages formosus	2	0.00	100.00	
Serpenticobitis zonata	2	0.00	100.00	
Arius crossocheilos	1	0.00	100.00	
Arius leptonotacanthus	1	0.00	100.00	
Botia beauforti	1	0.00	100.00	
Clarias fuscus	1	0.00	100.00	
Clupisoma longianalis	1	0.00	100.00	
Cynoglossus lingua	1	0.00	100.00	
Dasyatis zugei	1	0.00	100.00	
Gymnothorax tile	1	0.00	100.00	
Hemimyzon pengi	1	0.00	100.00	
Hemimyzon tchangi	1	0.00	100.00	
Himantura signifer	1	0.00	100.00	
Mahidolia mystacina	1	0.00	100.00	
Monodactylus argenteus	1	0.00	100.00	
Monotrete leiurus	1	0.00	100.00	
Oreochromis aureus	1	0.00	100.00	
Rastrelliger brachysoma	1	0.00	100.00	
Sikukia gudgeri	1	0.00	100.00	
Synaptura commersonnii	1	0.00	100.00	
Synaptura marginata	1	0.00	100.00	

Row Labels	Number of fish	%	Cumulative %	Rank
Terapon puta	1	0.00	100.00	
Tetraodon fluviatilis	1	0.00	100.00	

10. ANNEX 2: DATA GATHERING SHEETS

Fisheries Administration

Mekong-IWRMP-III / Component 1

Fish catch monitoring sheet

Date:______________________ Time set:______________________

Location (CFi):_____________ Time checked:_________________

Name of fisher:_____________ Gear:__________________________

Habitat

Deep pool	Floodplain/ swamp	Lake/pond/reservoir	Rice field	River/stream/channel	Flooded forest	Others name:……………

Gear name and dimension

Gill net	Line and hooks	Horizontal cylinder trap	Cast net	Others name:…………….
Height.............m	Length............m	Height................m	Diameter.........m	Height.................m
Length..............m	Number.............	Length.............m		Length..................m
		Number…………		Number................

Fish catch

Species code…………………..…	Total number……………..heads	Total weight…………………..…Gram
- Fish # 1	Standard length……………...cm	Weight:..............................gram
- Fish # 2	Standard length……………….cm	Weight:..............................gram
- Fish # 3	Standard length…………..….cm	Weight:..............................gram

Species code…………………..…	Total number……………..heads	Total weight…………………..…Gram
- Fish # 1	Standard length……………...cm	Weight:..............................gram
- Fish # 2	Standard length……………….cm	Weight:..............................gram
- Fish # 3	Standard length…………..….cm	Weight:..............................gram

Additional sheet

Date:______________________ Gear:_________________________

Location (CFi):____________ ______________________________

Name of fisher:____________

Species code………………..…	Total number……………..heads	Total weight………………..…Gram
- Fish # 1	Standard length…………….…cm	Weight:..............................gram
- Fish # 2	Standard length………………cm	Weight:..............................gram
- Fish # 3	Standard length………….….cm	Weight:..............................gram

Species code………………..…	Total number……………..heads	Total weight………………..…Gram
- Fish # 1	Standard length…………….…cm	Weight:..............................gram
- Fish # 2	Standard length………………cm	Weight:..............................gram
- Fish # 3	Standard length………….….cm	Weight:..............................gram

Species code………………..…	Total number……………..heads	Total weight………………..…Gram
- Fish # 1	Standard length…………….…cm	Weight:..............................gram
- Fish # 2	Standard length………………cm	Weight:..............................gram
- Fish # 3	Standard length………….….cm	Weight:..............................gram

Species code………………..…	Total number……………..heads	Total weight………………..…Gram
- Fish # 1	Standard length…………….…cm	Weight:..............................gram
- Fish # 2	Standard length………………cm	Weight:..............................gram
- Fish # 3	Standard length………….….cm	Weight:..............................gram

Species code………………..…	Total number……………..heads	Total weight………………..…Gram
- Fish # 1	Standard length…………….…cm	Weight:..............................gram
- Fish # 2	Standard length………………cm	Weight:..............................gram
- Fish # 3	Standard length………….….cm	Weight:..............................gram

Background

The project “Mekong Integrated Water Resources Management - Phase III” is funded by the World Bank. The objective of this project is to establish the foundation for effective water resource and fisheries management in the northeast of Cambodia.

Within this project, Component 1 (Fisheries and aquatic resources management in Northern Cambodia) is executed by the Fisheries Administration and implemented by the Inland Fisheries Research and Development Institute. The objective of this component is to improve the management of fish and aquatic resources in selected areas in Kratie and Stung Treng provinces.

Fisheries Administration
Inland Fisheries Research and Development Institute
#186, Preah Norodom Blvd., Phnom Penh, Cambodia
Web: ifredi-cambodia.org