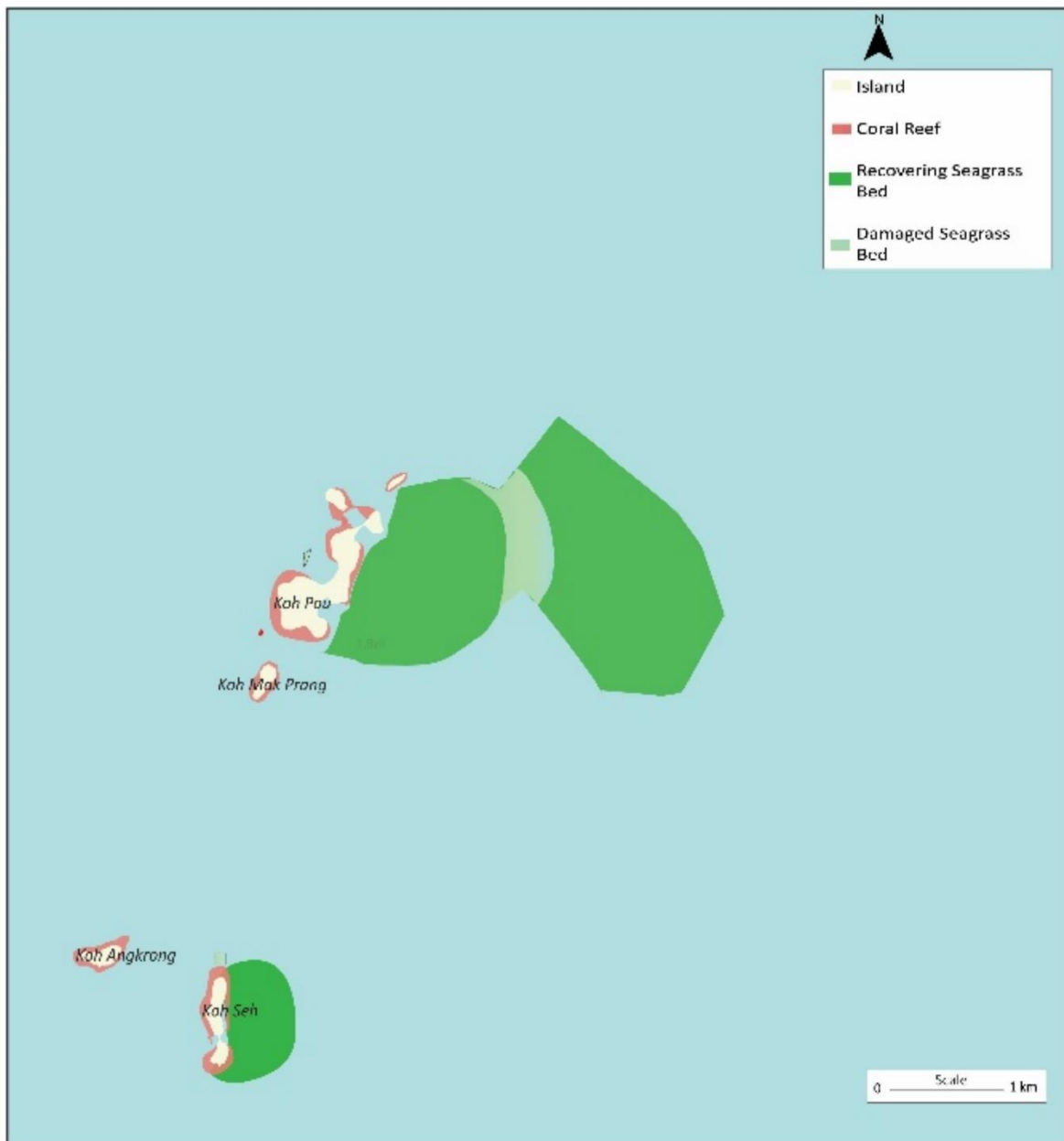


## *Stage I zoning proposal for the Kep Archipelago*

# **Marine Fisheries Management Area**

### *Final Draft for Zoning Proposal*



- Fisheries Administration –  
Fisheries Conservation Department

March 2016

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Marine Conservation Cambodia (MCC) has been working on conservation and community livelihoods in collaboration with the Royal Government of Cambodia Fisheries Administration (RGC FiA), local authorities and local communities since 2008. Our marine monitoring, research and socio-demographic programs were used in the creation of the first Marine Fisheries Management Area in Preah Sihanouk Province. This work contributed to a request by Kep Provincial government for MCC to draft an MFMA scheme for the Kep Archipelago.

MCC is currently undertaking marine surveys around Kep's 13 islands to monitor the coral reefs, seagrass beds and seahorse populations to assist the Provincial Authorities in the creation of the proposed MFMA, Cambodia's equivalent to Marine Protected Areas (MPAs). Over the past 2 years marine environmental data have been systematically collected around the islands of Koh Seh, Koh Angkrong, Koh Mak Prang and Koh Pou to assess current health and status of the marine environments and support the creation of a zoning management plan to assist in balancing fishing pressures and conservation.

Close collaboration with the provincial and national FiA, local government bodies and international institutions is the key to our success. MCC is a respected and credited leader in marine conservation and fisheries community work in Cambodia. As such, we were requested to create a zoning plan for the marine habitats within Kep Province.

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## **List of Abbreviations and Acronyms**

ACDS	ASEAN Catch Documentation Scheme
AMS	ASEAN Member States
ASEAN	Association of Southeast Asian Nations
AWP	Annual Work Plan
CFi	Registered Community Fisheries
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FiA	Fisheries Administration
GIS	Geographic Information System
ICM	Integrated Coastal Management
IUU	Illegal Unreported Unregulated
LLC	Liger Learning Centre
MCC	Marine Conservation Cambodia
MCS	Monitoring Control and Surveillance
MFMA	Marine Fisheries Management Area
MPA	Marine Protected Area
NGO	Non-Governmental Organisation
NPOA	National Plan of Action
OAF	Open Access Fisheries
RGC	Royal Government of Cambodia
RMFO	Regional Marine Fisheries Organization
RPOA	Regional Plan of Action
SEAFDEC	Southeast Asian Fisheries Development Centre
UN	United Nations

## **Executive Summary:**

This report outlines the first stage of the proposal for the establishment of a Marine Fisheries Management Area (MFMA) within the Kep Archipelago. Stage one includes the islands of Koh Seh, Koh Angkrong, Koh Mak Prang and Koh Pou, where a variety of important yet vulnerable marine habitats and resources are located. Destructive fishing methods, for instance trawling and electro-fishing, are devastating the marine habitats and species within this region. The continuation of these illegal activities is leading to dire consequences for the fishers and other residents of the Kep Archipelago. The creation of an MFMA encompassing the islands listed above will protect this region from the devastating impacts incurred by these destructive fishing methods.

The main purposes of the MFMA are clear; to combat the pervasive and destructive use of illegal fishing methods; to protect and enhance the local marine ecosystems; and to more effectively balance fishing activities in the region, thereby improving the livelihood of Kep Province fishers. The founding of the MFMA will form a significant step for the Royal Government of Cambodia in meeting its national goals and to align with national policies on conservation, fisheries management and illegal, unreported and unregulated (IUU) fishing.

This MFMA consists of four different types of zones; conservation, small-scale family fishing, multi-use fishing and finally a buffer zone. The zoning scheme suggested is based upon three years of research identifying the location and state of important marine habitats, especially valuable coral reef and seagrass ecosystems. This mapping was based upon marine surveys (conducted in February-March 2016) carried out to determine the location of habitat boundaries, and prior surveys undertaken by MCC during 2014 to 2015. Data collected from socio-demographic surveys of community fisheries was also taken into account.

MCC's mapping (see 'Zoning Draft Proposal', pp. 47) of Koh Seh, Koh Angkrong, Koh Mak Prang and Koh Pou reveal a degraded but surviving seagrass meadow on the eastern side of Koh Pou, more extensive than previously recorded. Previous reef surveys (MCC 2014; 2015) have determined not only the range of the reefs surrounding the islands, but also the current species abundance and diversity, indicating a vital need for protection.

MCC strongly advocates the staged implementation of a widespread MFMA comprising of the Kep Archipelago. In this report, we list three zoning options to be considered, however this list is not exhaustive and a combination of zones from different options could be implemented. Before the MFMA can be set-up, all relevant parties that will be at least moderately impacted should be informed of its purpose and benefits, as well as the fishing regulations and the locations/sizes of the different zones. Relevant parties include commercial and non-commercial fishers, marine authorities and government departments, marine-based tourism centres etc. Most importantly, the local fishers should be thoroughly informed of how the MFMA will increase their catch quantity and diversity, security against IUU fishing techniques and their livelihood in general.

In the short-term, MFMA implementation will involve the placement of buoys to mark the edges of the different zones, the clear communication with local fishing communities as to the fishing regulations in each zone strengthening of monitoring control surveillance (MCS), and the stricter enforcement of existing fisheries laws to combat IUU fishing within the MFMA. In the long-term, monitoring and evaluation of the MFMA and catch quantities within the Kep Archipelago will greatly improve the effectiveness of the MFMA (see 'Monitoring and Evaluation', pp. 61). Adopting the Association of Southeast Asian Nations (ASEAN)

Catch Documentation Scheme (ACDS) within Kep Province will allow clear indicators for monitoring and evaluation. This will increase the likelihood of successful MFMA implementation and effective adaption in response to changes over its years following establishment. Subsequently, both development of the marine environment leading to a more secure fisheries industry, and stricter enforcement of fisheries law to reduce conflict with IUU fishers will directly align with the goals of the Southeast Asian Fisheries Development Centre (SEAFDEC) for Cambodia formulated in 2016:

- Regulating transshipment and landing of fish/catch across borders
- Preventing poaching in the exclusive economic zones (EEZs) of ASEAN member states
- Controlling illegal fishing and trading practises of live reef food fish, reef-based ornamentals and endangered aquatic species
- Strengthening the management of fishing in the high seas and regional fisheries management organisation (RFMO) area

(SEAFDEC, 2016a)

In essence, no major short-term or long-term national policy changes are needed, as Cambodia's fisheries laws are already sufficient for the management of the MFMA. It is the enforcement of such laws, which is absolutely essential to the maintenance of a sustainable and wholly beneficial MFMA. Effective marine fisheries law enforcement within the MFMA will prevent both Khmer and Vietnamese IUU fishing vessels from destroying the vulnerable marine ecosystems of the Kep Archipelago, protecting local small-scale sustainable fishers from domestic and foreign pressures.

The benefits of the proposed MFMA are numerous and apply on many different levels. Clearly, the MFMA will improve the diversity and abundance of both commercial and non-commercial marine species, increasing the overall quality of the marine habitats, within the Kep Archipelago. This will translate into greater catch quantities for local fishers who, by utilizing sustainable methods, will allow the marine ecosystems to flourish and support many future generations of fishers. An increase in the quality and quantity of marine species will ensure positive expansion and continuation of the local economy through both a thriving fisheries and developing marine ecotourism industry. The strict enforcement of Cambodia's marine fisheries laws against IUU fishing will protect the local small-scale sustainable fishers, increasing their contribution to the local marine-based economy, as well as their capacity to decrease poverty levels. Marine eco-tourism will flourish under effective MFMA management, potentially creating more job opportunities and economic benefits within Kep Province. Overall, the MFMA would be a highly valuable asset to Kep Province and meet many national government targets relating to coastal management and conservation.

Given the importance of Cambodia's marine resources and the great level of the threat these vulnerable resources face, effective conservation and regulation has never been so critical.

## Introduction:

Cambodia's coastline, encompassed within the Gulf of Thailand, contains 64 islands that are home to a great diversity of marine species (ICEM 2003). Fringing coral reefs, seagrass meadows and mangrove forests are key ecosystems spread throughout the islands of Cambodia. A diversity of commercial, non-commercial and endangered marine species can be found within the first stage of this proposed MFMA; for instance, dugongs, seahorses, turtles and dolphins with a high conservation value. Kep's coastal areas once contained an abundance of critical marine resources and ecosystems, which provided ample resources to support local coastal communities. Due to a lack of enforcement of fisheries laws over the last 10-15 years, these ecosystems are no longer abundant, nor hold the ability to support the local demand. This lack of enforcement has led to Kep's coral reef systems and seagrass beds becoming highly degraded. This is especially alarming considering the socio-economic benefit of coral reefs, i.e. the abundance of stock that reefs provide to the fishing industry, and also its role as a key marine tourism attraction. These issues are particularly significant for the coastal fishers within Kep Province, due to the shallow depths and sensitive nature of the habitats.

The Kep Archipelago, like the majority of Cambodia's coastal areas, suffers the detrimental impacts of IUU fishing (emphasis on trawling), foreign fishing and overharvesting of fish stocks (MCC 2015). The consequences are numerous; habitat destruction, species decline, pollution, sedimentation (see 'Minimum required size preventing sedimentation', pp. 48) and a reduced livelihood for coastal fishers. The problem is significant, not only due to the consequences listed, but more alarmingly to where they lead in the future if ignored; marine fisheries collapse, local economic downfall, increased poverty and environmental degradation. Balance between fishing pressures and existing stock is desperately needed to maintain long-term feasibility. Open access fisheries have been identified as a major issue that is hindering attempts to tackle IUU (Fuller *et al.* 2013). The formation of this MFMA will very likely resolve this concern in Kep Province by creating fair regulations concerning fishing vessels and zones.

Two critical factors are needed to lead the Kep Archipelago to a prosperous future supported by its marine resources; firstly, strong prohibition of destructive (IUU) fishing techniques, especially those of which are foreign; secondly, regulation and registration of fishing vessels. This would bring Kep Province in-line with both regional and national policy on IUU. Following this, the dissemination of information on sustainable fishing methods is essential.

Managed marine zones with different levels of fishing moderation, in conjunction with the enforcement of Cambodia's fishing legislature, will form a potent solution to the alarming and extensive destruction of marine resources. MCC proposes the sequential implementation of a widespread MFMA encompassing the Kep Archipelago.

Stage one, as detailed within this report, covers the islands of Koh Seh, Koh Angkrong, Koh Mak Prang and Koh Pou. The MFMA consists of zones centred around small core conservation areas, with fishing moderations increasing sequentially from the outer boundary (see figure 12, pp. 50). Establishing an MFMA around this region will provide a standard against which future stages can be contrasted, as well as raising any problems or possible improvements with the implementation of zones and enforcement of their relevant regulations. Core conservation zones will demonstrate habitat restoration, potentially leading to greater levels of marine resources, thereby increasing the commercial potential of the outer areas (see 'Spill-Over' effect, pp. 49).

The general purpose of the MFMA is to increase the variety and density of both commercial and non-commercial marine species, in addition to enhancing the health and distribution of vital marine habitats within the Kep Archipelago. Together, improvements of these two aspects will build rich marine ecosystems that form the foundation for numerous socio-economic and scientific benefits. The productivity of fishing villages and industries will increase, creating profits for the local and regional economy. This is especially important, owing to the current difficulty that the marine sector of Cambodia's economy faces in meeting increased demands for seafood (Gillet 2004). The MFMA will undoubtedly create opportunities for greater marine tourism and recreational activities, again contributing to the local and regional economy. Finally, scientific discoveries can be reaped within the MFMA, where protection against IUU and exhaustive levels of fishing will fuel the wealth of socio-economically, medicinally or culturally important knowledge to be gained. Through the work of Marine Conservation Cambodia (MCC) being carried out on Koh Seh, Kep has already gained international recognition for 'adding to the world's knowledge on seahorses and expanding the boundaries of science in research work in Southeast Asia' (Duplain & Haisoune 2015).

Aside from the benefits of the MFMA, the advantages of this approach (as opposed to other methods) are numerous. Notably, the formation of the MFMA will align with the Royal Government of Cambodia's commitment to protect 10% of its marine and coastal eco-region by 2020. Regulating geographical areas or 'zones' is more efficient and cost-effective than attempting to regulate the catch species, size and quantity of fishers as well as their fishing technique and presence/absence of registration. Clearly, the latter approach is wasteful, and would require masses of investment, time and effort. Holding the support from local fishing villages regarding MFMA formation is another clear advantage of this management method. Socio-demographic surveys conducted in partnership with the Fisheries Department of Kep and Kampot (see 'Local Socio-demographic Context', pp. 20) strongly indicate that local fishers support the formation of an MFMA, primarily due to the security it will provide against IUU fishing methods. In addition to this, managed fishing zones are also easier for local fishers to locate, understand and follow the rules thereof. The only noteworthy disadvantages of this management strategy is the unemployment to IUU fishers which may result. Fortunately, the halting of IUU fishing activities, combined with the protection of marine areas, will likely increase marine species abundance to the point where biomass will be sufficient for sustainable fishers for many future generations. Sustainable capture fisheries and aquaculture are potentially viable options to implement as alternative livelihoods for current IUU fishers.

## **I. Environmental context: Assessment of marine habitats and resources**

Cambodia's coastline runs for 443 km, with the total coastal area covering 17,237 km<sup>2</sup>. This coastal region forms part of the Gulf of Thailand, which is an inlet within the South China Sea, also bordering Thailand and Vietnam. Cambodia's coastal provinces include Koh Kong, Sihanoukville, Kampot and Kep. Kep Province includes a coastline of 16 km, with 13 islands constituting the Kep Archipelago. The tropical marine ecosystems around the Kep Archipelago are mainly island-fringing reefs, seagrass beds and mangrove forests. Each of these ecosystems hold potential for high biodiversity and provide habitats for a wide variety of fish families and invertebrates. Their value is not only ecological, but also socio-economic, as fishing and marine ecotourism in such a healthy marine environment will contribute to the livelihoods of local communities. Based on collected data around Koh Seh, Koh Pou, Koh Angkrong and Koh Mak Prang it is possible to classify five main habitats: coral reef, sand and shell, mangroves, seagrass, seaweed; many of which are important breeding grounds for vulnerable species such as seahorses, dugongs, dolphins and turtles.

### **a. Coral Reef**

Tropical coral reefs are one of the most diverse ecosystems in the world. The shallow fringing reefs around the Kep Archipelago coastline consist mainly of massive hard coral, a reef-builder that constitutes the foundation of the reef. Their complex structure provides many different ecological niches, not only for fish, but also for a high variety of benthic marine organisms, ranging from sessile creatures like sponges, soft corals, anemones and bivalves, to other invertebrates, including several crustaceans, echinoderms (sea stars, sea cucumbers, sea urchins etc.), and molluscs (octopuses, cuttlefish, nudibranchs, etc.). These encompass a range of both commercial and non-commercial species with high economic and ecological importance - particularly in terms of the fisheries and tourism industries. The net annual benefit of coral reef ecosystems globally is \$29.8 billion (Cesar *et al.* 2003), whilst sustainable coral reef fisheries in South-East Asia were valued in 2002 as being worth over \$2.4 billion per year (Burke *et al.* 2002). In addition to the economic benefits of a thriving coral reef, this environment acts as a natural wave barrier, protecting coastal communities from the effects of coastal erosion and flooding. Defence against such issues are an important aspect of the developing 2016 integrated coastal management (ICM) for Kep Province. The ICM aims to protect highly valuable shorelines - including fishing communities, aquaculture projects and tourism developments. Strengthening of coral reefs will provide a natural and affordable, soft engineering solution. Due to destructive fishing techniques and overfishing, the Indicator Threat Index, used by Rizvi & Singer in 'Cambodia Coastal Situation Analysis' 2011, of coral areas in Cambodia is 90% high and 10% very high (Rizvi & Singer, 2011). Clearly this habitat is in desperate need of protection.

### **b. Seagrass**

The complex marine habitat of seagrass meadows offers a rich food supply and serves as a shelter and nursery for many commercial fish species and invertebrates. For example, local endangered seahorse

species frequently use seagrass for camouflage and as a holdfast. Additionally, seagrass is an essential habitat for blue swimmer crab larvae, which go on to form an important local food source. The leaves of seagrass give juvenile fish and benthic invertebrates a place to hide from predators, and provide a settling substrate for sessile organisms. Additionally, seagrass is a key food source for mega-herbivores (Orth *et al.* 2006) such as dugongs and sea turtles – both species that were sighted in the past in Kep’s regional waters, and may return with environmental improvement. Seagrass meadows stabilise the sediment through their extensive root system, which helps to mitigate the effects of wave action, preventing the abrasion of sediment against marine life from extreme water movement. Trawling nets, used by illegal fishers in seagrass beds leads to major ecological problems. Disturbance caused by trawling and siltation uniformly uproot seagrass and disturb the associated sediment (Mam 2002). Constant disturbance to seagrass habitat greatly restricts its ability to recover, and under such circumstances, population recovery can take years (Clarke & Kirkman 1989; Preen *et al.* 1997). Persistent trawling in a sandy bottom area (substrate suitable for seagrass growth) constantly disturbs the sea bed, up-heaving it, displacing it and eventually removing the sandy sediment layer, leaving silt and mud (Poiner *et al.* 1989). This remaining sediment is not capable of supporting seagrass growth. Seagrass meadows play an important role in nutrient and carbon cycles through photosynthesis and carbon capture. With the imminent threat of global warming, the expansion of seagrass beds will greatly contribute to reducing Cambodia’s carbon footprint. In addition to the environmental benefits, revenue by gaining carbon credits may be generated. In fact, Chevillard J. from Cambodia Climate Change Alliance and the UN Development Programme predicts that ‘The Kingdom’s GDP could decrease by 3.5% per year by 2050 if access to climate concerned finance is not a priority’ (Chevillard 2014). Steps such as acquiring carbon credits will become increasingly necessary for Cambodian policy in the coming years. Protection of seagrass beds will align with prior targets to place 90km<sup>2</sup> of seagrass under sustainable management by 2016 (FiA 2006), and new goals formed in the developing National Action Plan.

### **c. Sand and Shell**

Sand and shell habitats are important for a variety of organisms, such as invertebrates, filter-feeders, echinoderms, and fish species. Molluscs, bivalves and other organisms fulfil the important ecological role of filtering the water of particulate matter and pollution. Shells embedded in the sand leave large interstitial pore spaces, permeating and oxygenating the substrate, whilst also increasing the seabeds stability. Echinoderms populating the sandy substrate act as important habitats for particular fish species. Around the Kep Archipelago this includes many vulnerable seahorse species.

### **d. Algae & Seaweed**

Seaweeds are the macrobenthic forms of marine algae (Trono Jr. 1998). They play important roles as primary producers, holdfasts for sessile organisms, habitat/shelter, whilst providing people with significant resource for food, medicinal and economic purposes. Algae, including seaweeds, can be processed into health supplements, used as a component of fertiliser, makeup and many other common products. Given the variety of potential uses, algae are a strong candidate for aquaculture production. Large-scale algae farms are contained in many Asian countries, due to the high demand for algae products. Vietnam, one of Cambodia’s neighbouring countries, is one of the top ten algae products exporters in Asia (LLC

2016). Seaweed culture (*Eucheuma cottonii*) was introduced to Cambodia in 2001 and by 2005 the production reached the level of 18,000 tonnes (FiA 2011). Following this, the seaweed production dropped drastically to 6,800 tonnes in 2006 and no production of farmed seaweed has been reported after that (hitherto 2011). This is unfortunate given that algae aquaculture may be an important alternative livelihood for IUU fishers after implementation of the proposed MFMA. MCC has been collaborating with Liger Learning Centre students to further investigate the feasibility of implementing and maintaining algae aquaculture farms in Cambodia (LLC 2016). MCC believes that algae should be explored as a viable substitute income for fishers, especially those utilising illegal activities.

### **e. Mangroves**

Mangroves constitute a transitional zone between land and sea in tropical and subtropical marine tidal areas. Mangrove plants are adapted to a range of conditions that define this unique environment. Water temperature, salinity and oxygen concentration vary dramatically with tidal changes in water level, requiring a broad tolerance range from the mangrove trees. Mangroves occur at a relatively higher density within Kep Province mainland as opposed to the islands of the Kep Archipelago. Despite the comparably lower abundance of mangroves on Kep Province islands, mangroves still constitute an important ecosystem for the entirety of Kep Province. Notably, some of these mangroves form part of conservation areas managed by fishing communities.

Like many other transitional ecosystems, mangroves provide important habitats for both marine and terrestrial species. The complex root systems of mangrove trees act as important breeding and nursery grounds for several fish and crustacean families, and are also often used as a shelter when avoiding predators. Furthermore, these unique intertidal ecosystems play an important role in coastal protection against erosion, storm surges and tidal inundation. In Kep Province the maintenance of mangrove forests will address this issue and help to bring the region in line with its Integrated Coastal Management (ICM) plan. Mangroves have a high photosynthesis rate leading to a large amount of carbon capture (Hutchinson *et al.* 2013) and furthermore they act as a natural filter to sediment and agricultural run-off. This will bring similar benefits as with seagrass meadows through carbon credit revenue and forwarding Cambodia's progress in reducing national carbon emission levels.



## II. Endangered species in the Kep Archipelago

A list of Cambodia's endangered marine species include (but not limited to):

- Dolphins (including the Irrawaddy and Spinner species)
- Seahorses
- Dugongs
- Green Turtles
- Hawksbill Turtles
- Leatherback Turtles
- The commercial Top and Turbo Shell gastropods
- Giant Clams

Clearly, the Kep Archipelago could potentially provide a habitat for some of Cambodia's most endangered marine species. These include a wide range of animal groups, for instance fish, gastropods, cephalopods, crustaceans, reptiles and even larger mammal species. There are exceptionally rare sightings of the vulnerable dugong, and both Green and Hawksbill sea turtles in the area. Pods of these mammals have been sighted in Kep waters, and also require immediate conservation. With a desperately needed degree of protection (primarily from IUU) leading to ecosystem recovery, there is a high chance of the populations of these endangered species increasing, thus strengthening their resistance against threatening factors. Increases in population numbers of these highly esteemed species would attract ecotourism to the region – an industry which Kep could greatly benefit from in the coming years. On this note, careful management is required to establish a healthy marine environment that complements a sustainable tourism industry, as to not endanger vulnerable species further.

The Koh Rong Archipelago is an important local habitat of endangered marine species, and exemplifies the causes behind low species abundance. Of the seven highly cherished marine turtle species in the world, three occur within the Koh Rong Archipelago (with sightings also within the Kep Archipelago); the Green, Hawksbill and Leatherback. According to socio-demographic surveys conducted by Diamond *et al.* (2012) within these islands, the greatest threats to these vulnerable turtle species are destructive IUU fishing methods (especially trawling), Vietnamese diving fishers, overfishing, as well as use of nets and hooks. Similarly, in Sihanoukville and Kampot Bay, both spinner dolphins and dugongs have been found in gill and trawler nets which have illegally passed through the seagrass beds (Vibol 2008).

Seahorses provide another key example of a highly valued endangered fish, which inhabit some of the most fragile marine environments in Cambodia (refer to photo 1). So far, seven different species of seahorses have been sighted and identified within Cambodian waters. Most seahorses are found in coastal waters within relatively sheltered habitats such as seagrass, which is of conservation significance in the MFMA zoning scheme owing to its state of degradation in the Kep Archipelago. Anthropogenic activities, including trawling (electrified or not), tube fishing, crab nets and other unsustainable fishing methods, greatly threaten seahorses and their key habitats. MCC has been conducting research and marine surveys on seahorses in the Kep Archipelago since December 2013. Two important research projects MCC partakes in is tagging of seahorses and the detection of seahorses in different habitats. MCC's work with these understudied animals' gains significant information regarding distribution, behaviour, reproduction, habitat choice and more.

These two examples are a small representation of a similar pattern present throughout nearly all Cambodia's endangered marine species; that IUU fishing is the major source of indiscriminate and large-

scale population collapses. The proposed MFMA would aim to prevent the unsustainable fishing techniques that severely threaten these species, thus allowing for greater recovery of population numbers in the waters of Kep Province. Increasing the abundance of these rare species will contribute to a more prosperous tourism sector, together with healthier and more productive marine ecosystems.



**Photo 1: A rare female Japanese Seahorse (*Hippocampus mohnikei*), 2015, MCC, Koh Seh, Kep Province, Cambodia.**

### III. Prospects for Marine Tourism in Kep Province

Marine eco-tourism is a relatively undeveloped sector of Cambodia's economy, despite its vast potential. The islands of Koh Mak Prang, Koh Pou, Koh Seh and Koh Angkrong contain a small number of scuba diving sites, as well as snorkelling for tourists and locals.

Beautiful coral reefs and seagrass plains are still present within the Kep Archipelago, yet are declining rapidly. Currently, these sites are able to attract recreational divers and snorkelers, however if the lack of management and fisheries laws enforcement continues, tourists will seek marine habitats of higher quality and biodiversity. The formation of the prospective MFMA will increase marine eco-tourism potential in the Kep Archipelago, by improving the abundance and variety of marine species, the quality of marine ecosystems, and safeguarding tourism industries against potential conflicts with IUU fishing vessels.

Tourism and recreation account for \$9.6 billion of the total net benefit per year of the world's coral reefs (Cesar *et al.* 2003). A boost in marine eco-tourism in Kep Province will provide great economic benefits and create more jobs, assisting to alleviate poverty and potentially providing an alternate source of income for IUU fishers. Cambodia's international reputation will also increase, as it will be recognized for its remarkable marine ecosystems (refer to photo 2) that are the result of effective policy implementation and ground-level management, primarily through the establishment of the proposed MFMA.

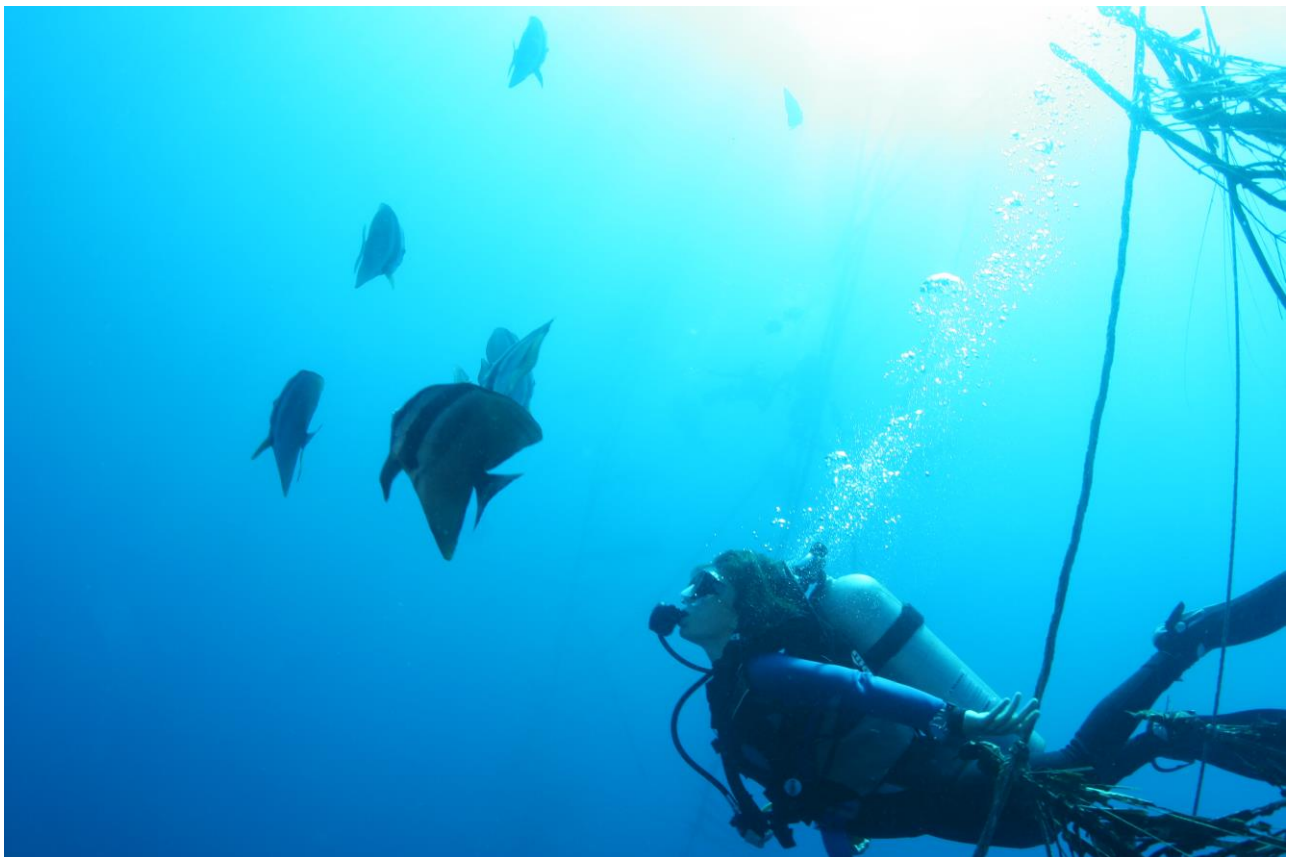


Photo 2: Tourists enjoying the marine life of Southeast Asia, MCC

## IV. Local socio-demographic context

### a. Background

Cambodia's economy is largely dependent on its fisheries sector. Fish act as a significant source of income and employment for over 6 million people, nearly half the population (Director General of FiA 2007). The net weight of fishery catch in Cambodia for 2015 was between 26,500 and 37,500 tonnes, which translates into \$27 – 56 million USD (Funge-Smith 2016). The sector is also vital for food security, with fish providing around 66% of daily animal protein for Cambodians (UNIDO, 2015). Coastal regions, for instance the Kep Archipelago, are significant sources of commercial and non-commercial marine stocks. These marine resources support the coastal and island inhabitants of Kep Province, as well as the tourists. A number of permanent or temporary fishing villages are located on islands within the region, for instance Koh Pou. Destructive IUU fishing vessels and overfishing threaten the livelihood of small-scale Cambodian fishers residing within fishing villages, like those of the Kep Archipelago (ADB 1999). Detrimental fishing techniques, particularly trawling, are the primary cause of habitat destruction and sedimentation in Cambodia (Gillet 2004). These adverse impacts translate into lower catch quantities and a poorer livelihood for small-scale fishers – as recognised in the introductory message from the '2008-2015 Seagrass Management Plan for Kampot Province' (including Kep Municipality) by the then Deputy Governor; "loss of ecosystems impacts both socio-economics and the environment, increasing poverty among Cambodia's people" (Choung Siv Vuth, Kampot, 23<sup>rd</sup> May 2008). In the worst case scenario, desperate fishers may lean towards utilising illegal fishing methods, simply to support their families. Socio-demographic surveys conducted by MCC (in partnership with the Fisheries Department of Kep and Kampot) between February and May 2015 reveal that fishers residing in Kep and Koh Pou faced numerous issues from the effects IUU and overfishing. Fishers revealed their opinions on the causes behind threatening processes and how these threats affect their livelihood. Additionally, fishers were asked questions regarding their view on marine conservation areas and their knowledge of various marine ecosystems.

In order to optimize the effectiveness of the MFMA, multi-level support is needed from government agencies, law enforcers, research groups and all relevant communities (Bustamante *et al.* 2014). Local fishers are directly linked to the success of the MFMA, as their livelihood immediately depends on the productivity of the marine environment. In addition, their actions will also determine the success or failure of the MFMA. As local individual and community actions greatly impact the efficacy of a MFMA, widespread awareness regarding the aim and potential of the MFMA is required. Fishers possess valuable local ecological knowledge that can contribute to informed management decisions. Community involvement in the formation and maintenance of the MFMA can significantly improve its effectiveness, as local participation in management actions leads to exchange of information, and thus the development of plans strategically designed to complement the local condition (Andrew & Evans 2009). The creation of the MFMA would align with Cambodia's Royal Decree on the Establishment of Fisheries Communities (adopted in 2005), which encourages local small-scale fishers to form community organizations for the purpose of promoting sustainable use of fisheries resources within locally defined areas.

Socio-demographic surveys have revealed that some crewmembers of trawling boats used to be crab trap fishers, but could not afford to keep replacing their crab traps that were repeatedly destroyed by trawling boats; thus, work on a trawling boat seemed like the only economically viable option. One fisherman interviewed reported losing an average of 400 of his 2000 crab traps to trawlers every 3 months. Clearly,

one of the major tasks facing fisheries and MFMA management lies in developing viable alternative income opportunities for desperate and/or illegal fishers. Aquaculture and mariculture have great long-term potential within Cambodia (FiA 2011; UNIDO 2015) (see 'Combating IUU' pp. 38). MCC has been cooperating with students of the Liger Learning Centre (LCC) to research potential algae aquaculture species (LLC 2016). This research is important in order to establish forms of employment that reduce the number of small-scale fishers seeking work on illegal fishing vessels out of desperation. Importantly, illegal fishers, who are hindered from participating in destructive fishing techniques through greater fisheries law enforcement, could also seek similar aquaculture based employment. Working on aquaculture projects could be a far more sustainable and secure form of employment for local fishers.

Communicating with the local communities, and explaining the necessity of the MFMA to the persistence of any marine-based livelihood, is absolutely vital if the management area is to be successfully implemented, without creating local resentment and backlash. The expected increase in the diversity and abundance of commercial and non-commercial species inside the MFMA will create a 'spill-over' effect (see 'Spill-Over' effect pp. 49) that is extremely beneficial to local fishers, as it improves the fishing potential outside the MFMA. The benefits of environmental conservation and its role in achieving sustainability in the Kep Archipelago has been effectively communicated to local fishing communities through discussions with MCC. Thus far, those that depend on the marine resources of the area have shown support for changes which the MFMA will help realise and already actively assist through community based conservation; This has included conserving mangrove forest, founding crab banks, and constructing trawler blocks. Consequently, MCC anticipates their collaboration in implementation of the MFMA through following the fisheries regulations put into place, switching to more sustainable practices, and reporting illegal fishing activities to the MFMA's relevant authorities.

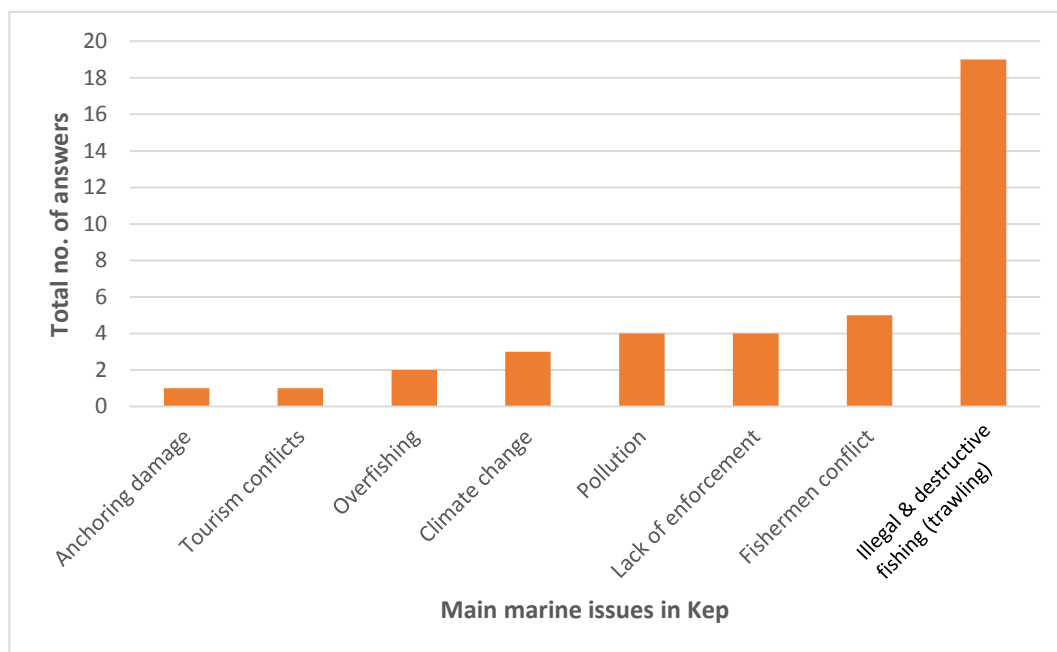
All the following fishing interviews were organised by MCC in partnership with the Fisheries Department of Kep and Kampot between February and August 2015. Interviewees were selected by a fisheries officer based on their availability at the time. Interviews were conducted by groups consisting of MCC staff, one fisheries officer and one independent translator. A set questionnaire was followed, which can be viewed in Annex 1.

## **b. Kep**

Between March and May 2015, MCC and the Fisheries Department of Kep and Kampot gathered information regarding socio-demographics, catch data and individual concerns via interviews conducted with sixteen local Kep fishers. The fishers generally worked on a small-scale long tail boats with two to four crew members catching crab, shrimp and fish to sell at the local market. When questioned about their opinions on changes in catch, overfishing and illegal activities:

- A large percentage of the fishers felt that illegal and destructive fishing is a threat to their livelihood (94%), is responsible for lower their catch quantity (87%) and is one of the main problems of the ocean (94% - see figure 1).
- 88% of fishers had witnessed illegal trawling in shallow waters and rat tail traps, and furthermore 81% had witnessed electric fishing.
- 69% of fishers reported that illegal fishing occurs every day, mainly trawling in shallow waters, electric fishing and rat tail traps.

- If given unlimited authority, 81% would use it to stop illegal fishing and trawling.



**Figure 1: The main issues of Kep marine waters as reported by sixteen Kep fishers between March and May 2015.**

Clearly the issue of IUU, particularly trawling, is having a negative impact on the Kep Community Fishery (CFi). For example, one local had been forced to cease fishing in the past year as another vessel, fishing illegally, ran over and destroyed his nets. Through experience of examples like that, the majority of fishers acknowledge that creating marine protected areas where illegal fishing can be closely monitored and measures made to ensure sustainable fish stocks will be a positive thing.

With regards to the future health of waters in Kep Province, 88% of the fishers interviewed realise the benefit of constructing conservation areas and 75% would in fact request them.

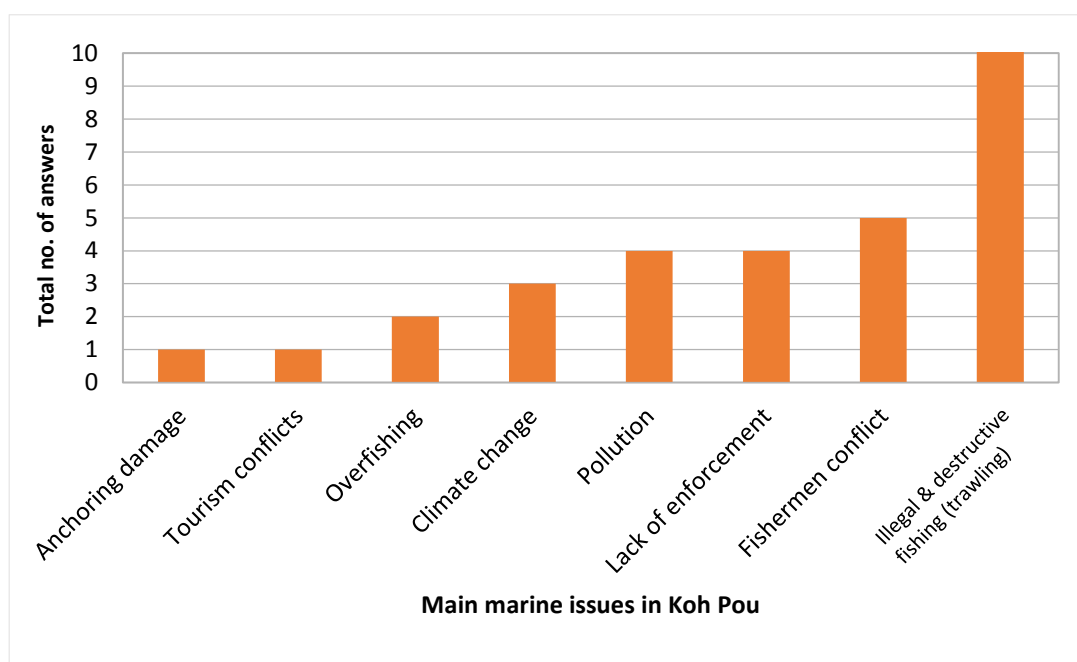
### **c. Koh Pou**

Ten fishers on Koh Pou were interviewed by MCC and the Fisheries Department of Kep and Kampot during February 2015, regarding the socio-demographics and fishing practices of their village. Clearly, as the only population living within the proposed first stage of the MFMA, their local knowledge will be crucial in the management of an effective conservation zone. All fishers interviewed relied on crab trap-fishing for income, primarily targeting blue swimmer crabs. Each, except one that worked as a crewmember, owned a long-tail fishing boat and employs three to five people (employees and family members). The planned MFMA would greatly reduce current conflicts between subsistence and IUU fishers, as well as large-scale, commercial fishing vessels. For example, some fishers reported that as many as 200 traps per month are lost to illegal trawlers that destroy their gear – reiterating their vulnerability to destructive fishing activities. Additionally, the implementation of the MFMA would very likely increase the abundance and diversity of fish stocks, in turn bringing the community greater livelihood and economic benefits.

Key results of the interviews are summarised below:

- 100% of the fishers stated that illegal and destructive fishing methods were of the main problems of the sea (see figure 2).
- 100% of the fishers reported that they frequently (as much as daily/nightly) witness illegal or destructive fishing practices in the Koh Pou area.

IUU fishing practices include pair-trawling, electric trawling, supplied air fishing, small mesh size nets, and the use of toxins or 'medicines' to catch fish, of which Vietnamese fishers were largely to blame. Interviewees displayed unanimous concern about these fishing practices, and furthermore that the current law-enforcement was not enough to stop the destruction.



**Figure 2: The main issues in Koh Pou marine waters as reported by ten Koh Pou fishers during February 2015.**

- 60% of fishers noted that their catch numbers and the size of their catch have notably declined in recent years.
- It was estimated that 150 people have moved to the island in the last decade, many of whom are seeking better fishing conditions.

When asked about marine ecosystems, responses were variable and indicated that the majority of the fishers know about the importance of healthy sea grass, coral reef and mangroves, while others know very little. Those who demonstrated a general understanding acknowledged that the coral reef and sea grass ecosystems in the area face constant decline; they thought that this was due to illegal and destructive fishing practices, particularly trawling.

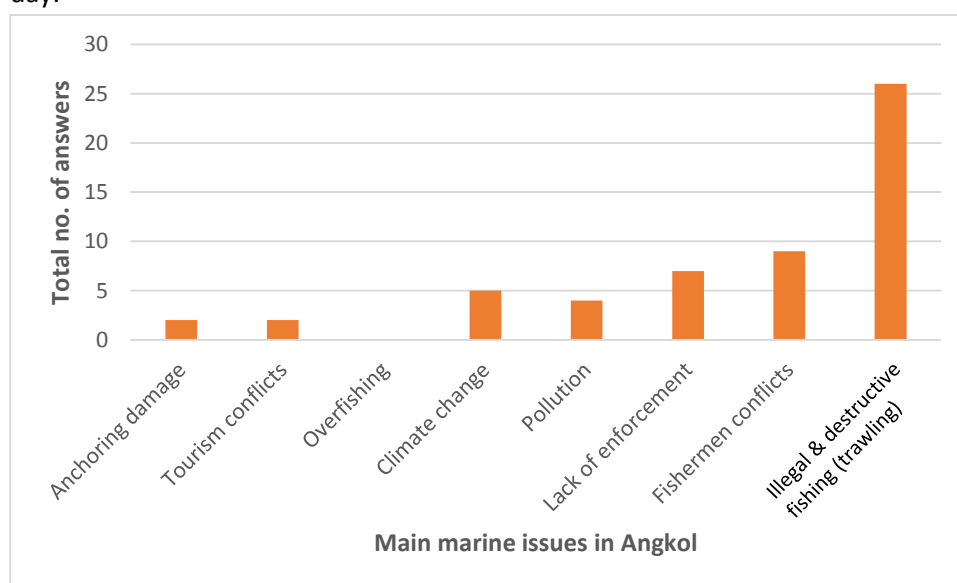
Interviewees were asked what changes they would make to address the present marine issues that most concern them if they had unlimited power. 60% of the fishers answered that they would eradicate illegal fishing in the area because it is having such negative impacts on their livelihood. 40% of the fishers stated that they would enlarge or create a conservation area. Clearly, the implementation of an MFMA is aligned with the best interests of local fishers.

#### d. Angkol

Between April and August 2015, twenty fishers of Angkol CFI were interviewed regarding fishing practises in the region. Results of the investigation mirrored those of Kep and Koh Pou, with a high proportion of the community being concerned about the security of their livelihoods as small-scale fishers, in waters where destructive and IUU fishing is an ever-increasing issue.

Results of these interviews, focussing on the key issue of illegal fishing, are shown below:

- 100% of fishers stated that illegal and destructive fishing methods were one of the main problems of the sea (see figure 3).
- 100% of fishers felt that the reason for less catch was due to overcapacity or illegal fishing methods.
- 90% of fishers has witnessed trawling in shallow waters, with 55% claiming that this illegal act occurred every day.



**Figure 3: The main issues in Angkol marine waters as reported by twenty Angkol fishers during between April and August 2015.**

The majority of fishers had excellent knowledge about the benefits of seagrass, coral reef and mangrove ecosystems. All fishers thought that conservation areas were beneficial and furthermore, 85% would request them. When questioned what they would do if they had unlimited power, 80% of fishers replied that they would stop illegal fishing, particularly trawling.

The first stage of the MFMA includes waters regularly fished by Angkol, and the implementation of this management plan will greatly benefit their community. As figure 3 clearly shows, a reduction of IUU fishing is sorely needed by this community. Through the implementation of monitored fishing zones to reduce any confrontation between small and large scale vessels, stricter fisheries law enforcement and long term monitoring of catch traceability at landing sites (see 'Vessel registration and Monitoring Control & Surveillance' pp. 30) this can be achieved. Additionally, the fishers' activity in an area benefiting from the 'spill-over' effect (see 'Spill-Over' effect pp. 49) around Conservation Zones will increase their catch biodiversity and abundance. In time this will lead to sustainable and stable economic growth within their community.



## **V. IUU, Threats & Resource-Use Conflicts**

The fragile environments found in the Kep Archipelago are being seriously degraded by continual subjection to multiple threats that have arisen through the development of fishing techniques in the last decades. In addition to this, small-scale fishers are suffering conflicts with larger vessels and the devastating economic impact of decreasing catch. The implementation of this MFMA will drastically improve the situation on both fronts by tackling:

- Unmonitored IUU fishing.
- Use of destructive fishing techniques and unsustainable overharvesting of stock.
- Confrontation between small-scale, traditional fishers and larger vessels.
- Sedimentation - mainly from trawling activities.

To gain comprehension of the emergence of IUU and destructive fishing techniques, background knowledge about the evolution and development of modern-day fishing methods used in Cambodian waters is necessary.

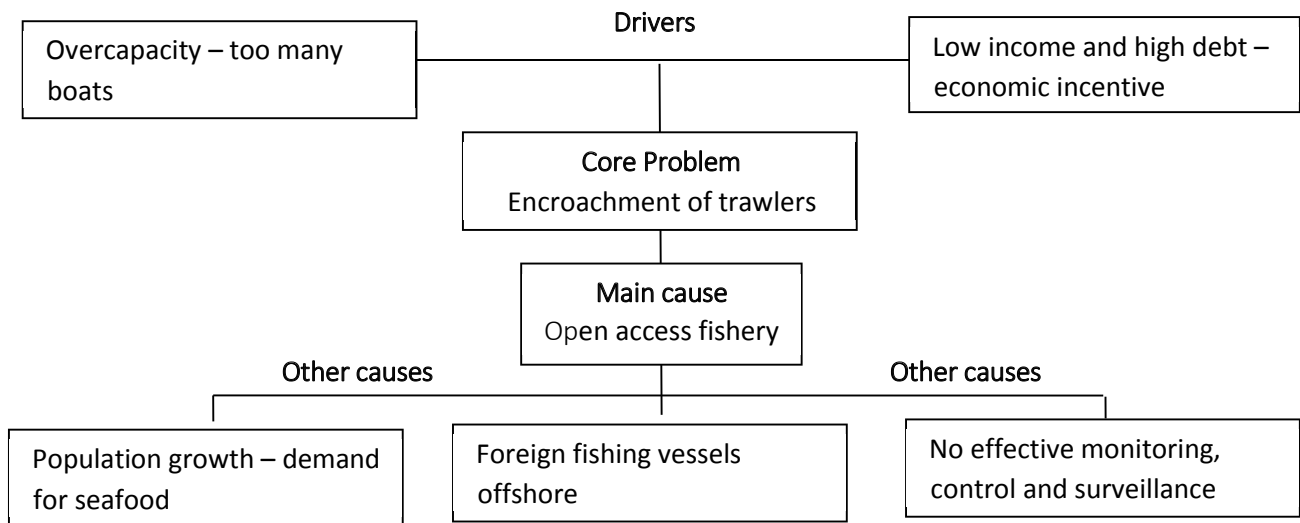
### **a. Development of fishing techniques**

#### **Development:**

Cambodia has only relatively recently made a transition to commercial fishing. While the majority of fishers in the past practiced methods of small-scale subsistence fishing, a post war development in infrastructure brought importation of modern fishing techniques and equipment. This included trawling (reintroduced in 1982), cyanide poisoning, electric shocking, tube fishing, and use of gill nets (large, small-mesh plastic nets).

Although in small communities small-scale fishing techniques have been retained, the expansion of destructive, and often illegal, fishing practises are leading to extensive damage. The key example for the Kep Archipelago is the development of trawling vessel technology, which has progressed from small to large vessels (with increases in horsepower), then the utilisation of electric cables (refer to photo 3) and finally pair trawling in a desperate scraping of the ocean bottom.

Below (figure 4) is a problem tree, as presented at the National Conference concerning IUU in Cambodia, January 2016, Kampongsom (Preah Sihanouk Province), which traces the causes and effects of trawlers.



**Figure 4: Problem tree tracing the causes and effects of illegal trawlers.**



**Photo 3: A Vietnamese electric trawler vessel photographed illegally fishing in the Kep Archipelago, MCC March 2014**

**Current situation:**

Today, Cambodian fishing activities have limited management with weak enforcement of fishing regulations (SEAFDEC, 2016). This allows criminal and highly destructive methods to be practised on a daily basis – in particular, the activities of IUU fisheries. The absence of surveillance officers at landing zones, poor catch per unit monitoring (CPU) and inadequate enforcement of fishing licenses (Fishing Vessel Registration, Licensing and RFVR, 2016) is allowing IUU and destructive fisheries to hugely overfish Cambodian stocks and degrade the marine environment. Corruption within law enforcement agencies is an additional problem, with reports of “unofficial” facilitation and gratuity payments being made, and a feeling of reluctance from the Department of Fisheries to enforce bans on IUU vessels (Gillett 2004). According to article 103 (see ‘Article 103’ pp. 37) of the ‘Law on Fisheries’ (FiA 2007), these activities committed by fishery administration officers are highly illegal with a potential punishment of between 1 to 3 years’ imprisonment.

The FAO estimates that around 57% of commercial fish stock is exploited to the full capacity and the remaining is already overexploited or depleted. Due to a lack of official monitoring, it is probable that the situation in Cambodia is in fact worse, and many more stocks will completely collapse if these fishing practices are continued.

**Future:**

Already, villagers in 75% of coastal villages experience food shortages (Monyneath 2001) and with continued overfishing and decline of stocks, this will only worsen. IUU directly affects the standard of living for the majority of coastal communities, impacting their nutrition, economy and job availability. In terms of marine ecosystems, if IUU continues at the same or an increasing rate, biodiversity and abundance of all species will decline. As vulnerable environments including coral reefs and seagrass beds suffer continual damage from trawling and other destructive fishing methods, fish, invertebrate and larger reptile and mammal species lose their sheltered habitats, food sources and breeding grounds, decimating populations. For these reasons, an MFMA and correct enforcement of laws in the Kep Archipelago is vital. Protecting productive areas and carefully allowing small-scale fishing will allow for rejuvenation of ecologically, economically and socially important sites – to the benefit of both local communities and the marine environment.

## **b. Illegal, unreported and unregulated (IUU) fishing**

'IUU in Cambodia' (2016) defines the aspects of IUU fishing;

### **Illegal:**

Illegal fishing refers to activities that are in violation of regional, state, national or international laws/obligations. This includes foreign or national vessels operating without permission in waters under the jurisdiction of a State, or against the relevant measures adopted by a RFMO. Illegal fishing in Cambodia has two sources; foreign and domestic. Both sources mainly occur in the form of destructive fishing techniques (e.g. pair trawling and electric trawling). Foreign vessels fishing without authority from their own flag State are also considered to be acting illegally. Domestic vessels which utilise mesh sizes below the minimum legal limit, banned fishing gear, or that lack registration or a license required to fish, are acting unlawfully. Furthermore, despite its alarming frequency, trawling in waters shallower than 20 metres is a criminal act.

### **Unreported:**

Unreported fishing refers to those which have not been reported, or have been misreported, to the relevant national authority, in contravention of national laws and regulations. Additionally, it refers to the lack of reporting, or the misreporting, of fishing activities to the relevant RFMO in contravention of the reporting procedures of that organization. Unreported fishing in Cambodia mainly refers to Thai and Vietnamese vessels that fish in Cambodian waters, as well as the lack of reporting of IUU fishing to the relevant authorities. Furthermore, the purposeful negligence of catch quotas and the misreporting of catch quantity/species is classed as unreported fishing.

### **Unregulated:**

Unregulated fishing activities include those conducted in areas or targeting marine stocks where no relevant conservation and management measures are in place. Fishing activities that are carried out in a manner inconsistent with State responsibilities for the conservation and management of marine resources under international law, are also considered unregulated. Finally, vessels performing fishing activities within the domain of an RFMO without displaying nationality, or flying the flag of a State not party to the RFMO are considered to be carrying out unregulated activities. Some examples of unregulated fishing in Cambodia include the large proportion of Cambodian boats without license or registration, open access fisheries and foreign vessels freely fishing in Cambodian waters with no impact assessment.

Other forms of IUU fishing activities include (Funge-Smith 2016; SEAFDEC Secretariat 2016):

- Catching of prohibited or protected species.
- Fishing with a fake license, registration or vessel numbers.
- Registered boats that do not follow the relevant vessel specifications detailed in registration.
- Vessels carrying more than one flag, fishing in waters outside the permitted or designated fishing areas.
- Landing of fish in unauthorized ports or across borders.
- Transfer of catch at sea.

Clearly, IUU fishing can arise in an enormous variety of forms, whether through unlawful method, catch, documentation, vessel specifications etc. Numerous factors that catalyse the development of IUU fishing will be discussed, for instance overcapacity, low relative risk of punishment and open-access fisheries.

#### **Factors leading to IUU fishing:**

Overcapacity of fishing vessels is a major driver of IUU fishing in Cambodia (Funge-Smith 2016). Marine resources are in decline and struggling to replenish due to frequent and intense fishing pressure. In this situation, fishers may be induced to utilise illegal and destructive fishing methods out of desperation for sparse marine resources. These methods are indiscriminate and frequently result in the capture of non-target species, which are composed mostly of prematurely caught juveniles (Ahmed & Chanthana 2015). For example, socio-demographic surveys conducted by MCC during August 2015 at Prek Tanean revealed that trawler by-catch can be higher than 80%, and also consists of habitat such as seagrass and coral (refer to photo 4 and 6). Catching low quantities of commercial species perpetuates overfishing, creating drastic declines in marine populations. Following this, illegal and destructive techniques may be used in an effort to capture scarce commercial species. Finally, this reduces population numbers further and destroys habitats, once again increasing the level of fishing intensity and fulfilling a perpetual cycle of ecosystem destruction. Furthermore, this cycle has been swiftly intensified by the rapid development of fishing technologies (Siriraksophon 2016).

Exacerbating the issues of overharvesting is the relatively low risk of punishment faced for fishers acting unlawfully. Where the chance of income outweighs the chance of punishment, IUU fishing techniques are much more likely to be utilized (Funge-Smith 2016). In Cambodia, the lack of catch monitoring and enforcement of fisheries laws leads to a very low likelihood of punishment in any form. Fishing vessels operating unlawfully reduce costs in terms of licensing, registration and vessel specifications (SEAFDEC 2016a). They also may ignore catch quotas, enter closed fishing areas, and target undersized or rare species, increasing potential income. As an example of this, Thai and Vietnamese vessels frequently enter Cambodian waters for fishing, contributing to the overcapacity issues (Bangkok Post 2009; Styllis & Sothear 2014). According to Article 38 (see 'Article 38' pp. 36) of the 'Law on Fisheries' (FiA 2007), foreign vessels fishing in Cambodia must be under agreement with the Ministry of Agriculture, Forestry and Fisheries after gaining approval from the Royal Government of Cambodia. Clearly this law is poorly imposed on foreign vessels; however, its enforcement would undermine IUU fishing in the Kep Archipelago. Overall, domestic and foreign fishers face minimum incentive to fish lawfully, thus they may be driven to adopt IUU fishing techniques.

The presence of open-access fisheries (OAFs) in Cambodia greatly hinders efforts to combat IUU and overfishing. Owing to the lack of regulation in OAFs, fishing intensity is typically higher than the socially optimal level, economic profits from fishing are dissipated, and marine stocks are degraded or even driven to extinction (Fuller *et al.* 2013). Clearly, OAFs are not sustainable or cost-effective. The proposed MFMA seeks to establish regulated zones, which will overcome the issues faced and consequences caused by OAFs. Together with improved fisheries law enforcement, vessel registration and formation of monitoring system, the impacts OAFs have caused environmentally, socially and economically, will be rectified by this MFMA.

### **Vessel registration and Monitoring Control & Surveillance (MCS):**

As it stands currently, Cambodia faces numerous issues with boat licensing and registration. Relatively few vessels apply for a fishing license, the enforcement of licenses is inadequate and additionally, fishers generally do not have any rationale for acquiring a fishing license (SEAFDEC 2016d). Presently, the improvement of law enforcement and the distribution of information to boat owners regarding fisheries laws are being attempted in an effort to resolve these issues. This is important, given that the lack of a license and the non-payment of fishing fees by non-subsistence fishers is illegal according to Article 32 and 45 (see 'Article 32' and 'Article 45' pp. 36) of the 'Law on Fisheries' (FiA 2007).

'Monitoring and control on fishing vessels registration' forms no. 3. 2. 5 of the Annual Work Plan (AWP) 2016 for the FiA (FiA 2016). Activities to be carried out in order to complete this goal include meetings with FiA cantonments and boat owners, registering fishing boats in each fishing village, and lastly, monitoring and controlling fishing activities. The indicator for this goal is the number of fishing vessels registered within coastal areas. Clearly, cooperation between the FiA and other relevant authorities/parties is required, for instance with the Marine Police, regional Fisheries departments and fishing communities. Additional support may also be required by relevant agencies, given that limited budget and manpower is one of the challenges faced in combatting IUU fishing (SEAFDEC 2016b). Together, these agencies can cooperatively develop greater levels of licensing and registration, whether by information dissemination or enforcement of relevant fisheries laws.

Importantly, vessel registration allows for an MCS system to be established, a key step towards achieving sustainable fisheries. A MCS is defined as follows (FAO 1981);

**Monitoring:** the continuous requirement for the measurement of fishing effort characteristics and resource yields;

**Control:** the regulatory conditions under which the exploitation of the resource may be conducted; and,

**Surveillance:** the degree and types of observations required to maintain compliance with the regulatory controls on imposed fishing activities.

In a fisheries context, the purpose of a MCS system is to ensure that control measures, once agreed and adopted, are sufficiently implemented (Bergh & Davies 2002). Abiding by conservation measures is vital to the effective management of fishery resources. MCS places emphasis on encouraging compliance by fishers, as opposed to enforcing regulations upon them. However, the consequences of non-compliance must be fairly established relative to the effect they will have on the fishery. In the case of the proposed MFMA, fisheries laws against IUU fishing should be strongly enforced, whilst small-scale sustainable fishing should be encouraged.

MCS systems assist in achieving compliance with measures by providing feedback and information to the management strategy, which can be used to focus on compliance issues or otherwise. MCS information may be collected from official landing ports where catch monitoring can be recorded. Catch monitoring, a key aspect of MCS, provides essential information regarding catch quantities relative to fishing capacity (FiA 2016), as well as trends in the size and population of marine stocks. Unfortunately, owing to little official data on fleet composition, fishing effort and marine catch in Cambodia, it is not feasible to perform an assessment of fishing capacity (FiA 2016). Bearing in mind that the assessment of Cambodia's fishing capacity is considered to be the first step towards developing a National Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (NPOA-IUU), the need to implement MCS is of

great significance (National FiA 2016).

Importantly, catch monitoring also hinders IUU fishing vessels, which lack registration and thus cannot dock at official landing ports where catch monitoring is conducted. The issue of IUU fishing products entering the market is addressed in the 'ASEAN Guidelines for Preventing the Entry of Fish and Fishery Products from IUU Fishing Activities into the Supply Chain' (SEAFDEC 2016a). One of the primary objectives of these guidelines is to establish strategies and measures to prevent the entry of fish and fishery products from IUU activities into the supply chain. MRAG (2009) estimated the annual production from IUU fishing activities to be between 11 and 26 million metric tonnes, accounting for 10 to 22% of the world's total fisheries production, and valued around US\$9 to 24 billion per year. In Southeast Asia, some studies estimate the total IUU fisheries production to be valued close to US\$5.8 billion (SEAFDEC 2016a). Clearly, this issue is pervasive and desperately needs combating via policy and ground-level changes, which a MCS framework will provide. In addition to this, an MCS would align Cambodia's interests with that of the FAO Code of Conduct for Responsible Fisheries (Bergh & Davies 2002). This infers that implementation of the proposed MFMA aligns regional and national action with international instruments, i.e. the United Nations (UN).

As part of these ASEAN Guidelines, a strategy for data collection and reduction of IUU fishing is the ASEAN Catch Documentation Scheme (ACDS). The ACDS aims to improve the traceability of fishery products, the credibility of fishery products for intra-regional and international trade, and additionally prevent the entry of IUU fishery products into the supply chain of AMS (SEAFDEC 2016a). Following the principles outlined in the ACDS would greatly improve Cambodia's catch monitoring and ease of fisheries law enforcement. Given Cambodia's red card status with the European Union (EU) since November 2013 (European Commission 2015b), the scope of its international fisheries trade is limited. However, with the establishment of the ACDS and other sustainable policy and practical changes, for instance the implementation of the proposed MFMA, Cambodia could expunge its red card. Supporting this, in December 2014 Belize had its red card rebuked, after adopting 'lasting measures to address the deficiencies of its fisheries systems' (European Commission 2015a). By following Belize's lead, Cambodia as a whole could reap vast economic benefits for Cambodia, especially for fishery industries.

Cambodia is one of eleven countries that provides technical advice and assistance for the Regional Plan of Action (RPOA) to Promote Responsible Fishing Practices Including Combating Illegal, Unreported and Unregulated Fishing in the Region (RPOA-IUU 2016). Notably, SEAFDEC is one of four organizations that fulfils a similar role. The RPOA aims to sustain vital fishery resources through the strengthening of fisheries management and the promotion of sustainable fishing practises in the region. Actions consist of conservation of marine resources and their environment, management of fishing capacity, and combatting IUU fishing in specific regions, including the Sub-Regional Gulf of Thailand. These actions are vital to ensuring food security and poverty alleviation in the region. The formation of the proposed MFMA would align Cambodia's regional actions to that outlined in the RPOA, a vital step in developing sustainable long-term fishing practises. In turn, adopting the RPOA in Cambodia would set the foundation for embracing larger national and international instruments, for instance the developing National Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (NPOA-IUU), and the International Plan of Action (IPOA) to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing'.





**Photo 4: The catch of a trawler illegally fishing in seagrass beds in the Kep Archipelago, MCC September 2015**

#### **IUU in the Kep Archipelago:**

In this region, trawling is the most major issue, with a nightly presence of foreign and local vessels heard and seen on shallow seagrass beds, reefs and breeding grounds. Their activity is evidenced through the presence of large quantities of seagrass washed up at harbours and beaches within Kep Province as a direct consequence of trawling. However, IUU within the Kep Archipelago takes many forms, and each is proving to be highly destructive in such shallow, sensitive waters.

Below is a table listing the most common practises and the fisheries laws which they violate (referenced in full beneath Table 1):

<b>Fishing Type</b>	<b>Environmental Impact</b>	<b>Social Impact</b>	<b>Nationality of Boats</b>	<b>Violation of Fisheries Laws</b>
<b>Shell collecting, tube,</b>	Total targeting of vulnerable species in a single area. This leaves	Un-sustainability of fishing method leaves areas with no more	Khmer and Vietnamese.	Article 20.4 Article 23.2 Article 23.6



<b>curio and aquarium fishing</b>	few/no organisms to reproduce, severely reducing their populations. Damage to seabed substrates.	species of value to collect and leads to unemployment in both the fisheries and tourism sector. Loss of valued local species.		Article 38 Article 52
<b>Small mesh size nets</b>	Non-selective fishing method targets small species and juvenile individuals, placing populations at high risk of decline. High by-catch levels reduces ecosystem biodiversity.	Un-sustainability of fishing method leaves areas with no more species of value to collect and leads to unemployment in both the fisheries and tourism sector. Loss of valued local species.	Khmer and Vietnamese.	Article 20.6 Article 21 Article 38
<b>Net dragging and hand trawling</b>	Long-term damage to vulnerable seabed substrates, habitats and both commercial and non-commercial species populations.	Damaging, non-selective fishing method leaves habitat diminished and unable to support commercially valued species. This decrease in catch is un-sustainable and leads to unemployment in the fisheries sector. Loss of valued local species and habitat reduce ecotourism prospects.	Khmer and Vietnamese.	Article 38 Article 52.1 Article 52.4
<b>Single boat trawling</b>	Complete destruction and long-term damage to vulnerable seabed substrates, habitats and both commercial and non-commercial species populations across a 6-10m wide track (see photo 3). Sediment stirred up by seabed disturbance causes abrasion and prevents sunlight reaching coral and seagrass habitats.	Damaging, non-selective fishing method leaves habitat diminished and unable to support commercially valued species. Destruction of seabed leaves exceptionally long recovery time for ecosystems and therefore catch levels remain low. This decrease in catch is un-sustainable and leads to unemployment in the fisheries sector. Loss of valued local species and	Khmer and Vietnamese.	Article 38 Article 49 Article 52.1 Article 52.4

		habitat reduce ecotourism prospects.		
<b>Big single encircle net trawling (18-20 crew) (refer to photo 5)</b>	Complete destruction and long-term damage to vulnerable seabed substrates, habitats and both commercial and non-commercial species populations. This decimates a singularly large area. Sediment stirred up by seabed disturbance causes abrasion and prevents sunlight reaching coral and seagrass habitats.	Damaging, non-selective fishing method leaves habitat diminished and unable to support commercially valued species. Destruction of seabed leaves exceptionally long recovery time for ecosystems and therefore catch levels remain low. This decrease in catch is un-sustainable and leads to unemployment in the fisheries sector. Loss of valued local species and habitat reduce ecotourism prospects.	Vietnamese.	Article 38 Article 47 Article 49 Article 52.1 Article 52.4
<b>Pair trawling</b>	Complete destruction and long-term damage to vulnerable seabed substrates, habitats and both commercial and non-commercial species populations across a wide area produced by hauling the net between two paired vessels. Sediment stirred up by seabed disturbance causes abrasion and prevents sunlight reaching coral and seagrass habitats.	Damaging, non-selective fishing method leaves habitat diminished and unable to support commercially valued species. Destruction of seabed leaves exceptionally long recovery time for ecosystems and therefore catch levels remain low. This decrease in catch is un-sustainable and leads to unemployment in the fisheries sector. Loss of valued local species and habitat reduce ecotourism prospects.	Vietnamese.	Article 11 Article 20.8 Article 38 Article 47 Article 49 Article 52.1 Article 52.4
<b>Electric trawling</b>	Complete destruction and long-term damage to vulnerable seabed substrates, habitats and both commercial and non-commercial	Damaging, non-selective fishing method leaves habitat diminished and unable to support commercially valued species. Destruction of	Khmer and Vietnamese.	Article 11 Article 20.1 Article 21 Article 38 Article 49

	species populations. This extends from subterranean to pelagic organisms, devastating biodiversity. Electric pulses also stun and kill organisms outside of the catch area, extending damage caused. Sediment stirred up by seabed disturbance causes abrasion and prevents sunlight reaching coral and seagrass habitats.	seabed leaves exceptionally long recovery time for ecosystems and therefore catch levels remain low. This decrease in catch is un-sustainable and leads to unemployment in the fisheries sector. Loss of valued local species and habitat reduce ecotourism prospects.		Article 52.1 Article 52.4
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**Table 1: Common IUU practises in the Kep Archipelago and the fisheries laws which they violate.**

***The Kingdom of Cambodia's Law on Fisheries (2007) – Laws Applicable to Fishing Activities in the Kep Archipelago:***

Chapter 3 – The Fishery Domains:

Article 11:

The Marine Fishery Domain refers to marine water or brackish water that extends from the coastline at the highest high tide of the coastal lines to the outer limits of the EEZ of the Kingdom of Cambodia.

The Marine Fishery Domain is divided into:

- Inshore fishery area, which extends from the coastline at higher high tide to the 20m deep line.
- Offshore fishing area, which extends from the 20m deep line to the outer limits of the EEZ of the Kingdom of Cambodia.
- Fishery conservation area, seagrass area, and coral reef area which are habitats for marine aquatic animals and plants.
- Mangrove forest area including mangrove and forest zone which are important feeding and breeding habitats for aquatic animals, and protected inundated areas.

Chapter 5 – Protection and Conservation of Fisheries:

Article 20:

All kinds of fishery activities in the fishery domain by using the following gears shall be absolutely prohibited:

- 1 – Electrocuting devices, explosive stuff or all kinds of poisons.
- 4 – Spear fishing gears, Chhbok, Sang, Snor with projected lamp.
- 6 – Net of all kinds of seines with mesh size of less than 1.5cm in inland fishery domain.
- 8 – Pair trawler or encircling net with attractive illuminative lamp for fish concentration.

Article 21:

Producing, buying, selling, transporting and storing and electrocuting devices, all type of mosquito net fishing gears, mechanised motor pushed nets, inland trawler that are used for fishing purpose shall be prohibited.

Article 23:

The following activities are permitted under permission:

- 2 – Transporting, processing, buying, selling and stocking endangered fishery resources.
- 6 – Buying or selling ornamental shells of rare species.

Chapter 7 - The Management of Fishery Exploitation:

Article 32:

All types of fishing exploitation in the inland and marine fishery domains, except subsistence fishing, shall have:

- 1 – To get a fishing license.
- 2 – To pay tax and fishing fees to the state.
- 3 – To follow the regulations stipulated in the fishing license.

The hiring of fishing lots for exploitation can be undertaken through investment, public bidding or hiring, by agreement for those fishing lots, which have no bidders interested in bidding.

The legal procedures for investment, public bidding, hiring by agreement, and payment of fishery fees shall be determined by sub-decree.

Article 38:

Fishing exploitation or aquaculture of foreigners must be under the agreement with the Ministry of Agriculture Forestry and Fisheries after obtaining the approval from the Royal Government of the Kingdom of Cambodia.

Chapter 9 – Marine Fishery Exploitation:

Article 45:

All types of fishery exploitation in the marine fishery domain, except subsistence fishing, shall be allowed only in the possession of a license and these exploitations shall follow the conditions and obligations in fishing logbook.

The model of the fishing logbook shall be determined by the proclamation of the Minister of Agriculture, Forestry and Fisheries.

Article 47:

Fishers shall tranship fisheries products at a fishing port determined by the FiA.

Foreign fishing vessels that are permitted to fish in the marine fishery domain shall inform the FiA prior to port calls in marine fishery domains of the Kingdom of Cambodia.

Other terms and conditions on transhipment of fishery products and anchoring of the foreign fishing vessels shall be determined by the fisheries administration.

Article 48:

Based on precise scientific information that the fishing practises have been or are being the cause of serious damage to fish stock, the FiA has the rights to immediately and temporarily suspend fishing activities and propose for a re-examination of the fishing agreement in order to seek for the decision from the Minister of Agriculture, Forestry and Fisheries.

Article 49:

Trawling in the inshore fishing areas shall be forbidden, except for the permission from the Minister of Agriculture, Forestry and Fisheries at the request of the FiA to conduct scientific and technical research.

Article 50:

All fishing vessels which are not licensed to fish in the marine fishery domain shall not keep their trawl fishing gears stowed in a manner that they are ready for fishing.

Article 52:

Shall be prohibited:

- 1 – Fishing or any form of exploitation, which damages or disturbs the growth of seagrass or coral reef.
- 2 – Collecting, buying, selling, transporting or stocking of corals.
- 3 – Making port calls and anchoring in a coral reef area.
- 4 – Destroying seagrass or coral by other activities.

All of the above activities mentioned in points 1, 2 and 3, may be undertaken only when permission is given from the Minister of Agriculture, Forestry and Fisheries.

#### Chapter 15 – Penalties:

Article 103:

Any of the following activities committed by the Fisheries Administration Officer shall be considered as an offence and shall be subjected to an imprisonment from 1 to 3 years and can be fined from 5,000,000 to 50,000,000 Riels:

- 1 – Provide any permission against this laws.
- 2 – Participate in full or in part and directly or indirectly in any activity or fishery exploitation against this law.
- 3 – Forgive any fishery offence class 1.
- 4 – Running the fishing lot either as owner or a share-holder while being a civil servant.
- 5 – Do not timely report or complain the fishery offence class 1 which appears in their competence.
- 6 – Intentionally neglect in fulfilling duty or deceivingly give wrong information in writing, which causes the fishery offence class 1.

#### **Alternative employment:**

It is of great importance that alternative livelihood opportunities are available for the IUU fishers who are impacted by the implementation of the proposed MFMA. Aquaculture projects are a strong candidate with great long-term potential in Cambodia (FiA 2011; UNIDO 2015). MCC researchers have been working with students of the Liger Learning Centre (LLC) to investigate designs for low-cost, semi-intensive aquaculture systems for blue swimmer crabs, seaweed, algae, molluscs and other commercial marine species (LLC 2016). As of 2009, marine aquaculture in Cambodia formed less than one percent of marine fisheries production (FAD 2011), indicating a necessity for further investment in this neglected sector. Aquaculture establishment in Kep Province would align this region with the interests of international bodies such as the European Union (EU 2014), which is a significant step in receiving grants for further aquaculture development. As part of the Fisheries Administration of Cambodia's 'Strategic Planning Framework for Fisheries: 2010 – 2019' (FiA 2011), four objectives are stated;

1. At least 85,000 trained fish farmers actively engaged in aquaculture by the end of 2019.
2. Fish seed production is increased to 250,000,000 per year by the end of 2019.

3. A surveillance, monitoring and control system for fish disease outbreaks is developed and implemented by the end of 2014.

4. Research and development to identify commercially viable production of indigenous species in cooperation with regional interventions i.e. MRC.

Clearly, forming effective and productive aquaculture systems are a high priority of the FiA. In establishing these systems, illegal fishers and those severely affected by them will be enabled to adopt alternate employment, as opposed to continuing/beginning damaging fishing techniques. This is a key step in reducing the widespread issue of IUU in Kep Province.

#### **Combating IUU:**

The effectiveness of the proposed MFMA is heavily reliant on the elimination of IUU fishing methods from within its boundaries. Destructive and illegal fishing has indisputably caused widespread devastation to precious marine ecosystems within the Kep Archipelago. MCC's research (MCC 2014; 2015) around numerous Kep islands has highlighted the severity of these issues to relevant authorities and agencies. According to Article 48 of the 'Law on Fisheries' (FiA 2007), the FiA has the authority to temporarily suspend fishing activities given scientifically validated evidence that shows particular fishing practises to have been or are being the cause of serious damage to fish stocks. Despite having scientific evidence and a sufficient level of jurisdiction, it seems illegal and destructive fishing methods remain relatively untouched from relevant authorities. Article 49 (see 'Article 49' pp. 37) of the 'Law on Fisheries' (FiA 2007) states that inshore trawling is unlawful, but despite this local fishers claim that inshore trawling remains the most frequent and widespread of illegal fishing methods in the Kep Archipelago (see 'Local socio-demographic context' pp. 20). The issue of IUU fishing is widespread and multi-faceted, however numerous short-term and long-term actions can be immediately taken, many of which have already been discussed. Combating IUU fishing techniques is in accordance with the Fisheries Annual Work Plan (AWP) (FiA 2016), no. 3. 2. 4. According to the AWP, activities to be undertaken in achieving this objective include attending consultations (International, National, Regional etc.), meetings (Technical Working Group, National Committee etc.), workshops (Capacity Building for FiA staff etc.), as well as conducting assessments of the issues relating to IUU fishing, developing the National Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (NPOA-IUU) fishing and publishing 3000 copies of this document, and negotiating with neighbouring countries. Indicators for this work plan objective include completing the NPOA-IUU and the capacity building of stakeholders on IUU fishing.

Regional and national policy needs to be aligned with international laws and agreements, for example by implementing SEAFDEC's ACDS and the RPOA-IUU. Cooperation amongst relevant agencies needs to be enhanced, to form synergistic actions to enforce fisheries law against IUU fishing vessels. Similarly, collaboration between ASEAN Member States (AMS) to share IUU information should be established. The establishment of a MCS system, with emphasis on assessment of Cambodia's fishing capacity and catch monitoring system, is of high importance. Furthermore, official landing ports will hinder IUU fishery products from entering the market. Vessel registration is a key component of MCS, as the catch quantity, species and fishing technique of vessels can be recorded and contrasted against national and regional standards. Additionally, as IUU fishing vessels will have difficulty becoming registered, they will be unable to dock at official landing ports. The use of the ACDS (SEAFDEC 2016a) will increase the traceability of fishery products, hindering IUU fishing from entering the market. In conjunction with greater levels of fisheries law enforcement on the ground-level, the level and likelihood of punishment may induce IUU

fishers to adopt alternate livelihoods such as aquaculture projects, or sustainable fishers not to utilise illegal fishing techniques.

A final step in mitigating IUU is the utilisation of educational campaigns to spread information regarding fisheries laws and regulations, their purpose and advantages. Fishing communities will greatly benefit from this, gaining the knowledge of fisheries laws and learning their effect in deterring IUU fishing methods.



**Photo 5: An encircle-net trawler illegally fishing within the Kep Archipelago, MCC October 2015**



**Photo 6: By-catch seen on an illegal trawler boat in Koh Rong Samloem, MCC May 2009**



## **VI. Protected Areas and Zoning:**

### **a. Background**

Cambodia has rich marine resources and habitats including; coral reefs, sea grass beds and mangroves, which together form an ecological network of biodiversity. The Kep Archipelago in particular is a hotspot for marine resources, which are extremely significant to the livelihoods of local fishers, and furthermore largely support the regional economy. Unfortunately, the habitats and species which constitute these marine resources are in desperate need of protection and regeneration from the catastrophic effects of IUU fishing. Both local and foreign vessels use indiscriminate and destructive fishing methods that have decimated biodiversity in the region. Evidently, the implementation of an MFMA in the Kep Archipelago is of the utmost importance to the protection and conservation of not only the marine ecosystems it encompasses, but also to livelihoods of local fishers.

The establishment of an MFMA within the Kep Archipelago would be a tremendous leap towards a sustainable and thriving future for Cambodia. History demonstrates that the Kep Archipelago is capable of supporting an abundance and diversity of commercial and non-commercial species. Formation of the proposed MFMA would provide the protection required for the sorely needed recovery and rejuvenation of these cherished species. The Kep provincial government recognizes the need for management actions which focus on the protection and regeneration of marine ecosystems. Local sustainable fishers desperately need well managed marine environments to support their way-of-life, as well as safeguarding against IUU fishing vessels, who pose a risk to them and future generations of sustainable fishers.

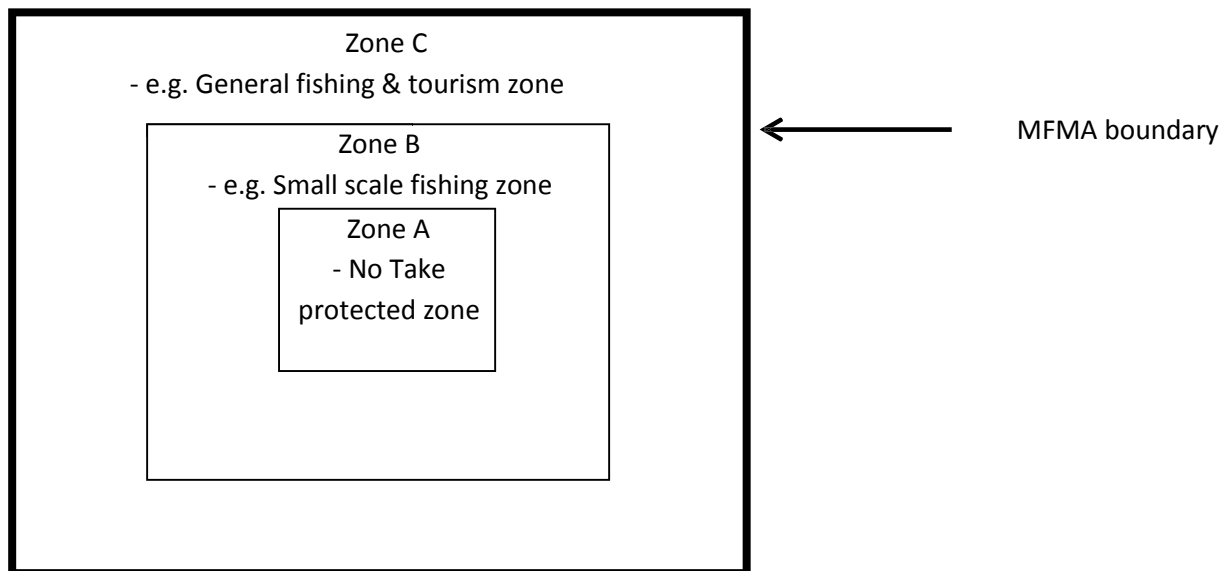
### **b. MFMA zoning**

Zonation is the process of allocating spatial and temporal designations to defined areas within a larger region. It is a key management tool in the creation of MFMAs. This specific method defines areas to be used for particular activities such as research, education, fishing, tourism and the protection of key habitats and nursery grounds of marine species. The zoning of the proposed MFMA in the Kep Archipelago has three major objectives: first, to resolve the issue of widespread IUU fishing methods; second, to protect critical marine stocks, vulnerable species and habitats which will assist in the restoration of productive marine ecosystems; and third, to produce greater livelihood for local Kep Province fishers. Furthermore, this MFMA seeks to create a balance between demand and actual sustainable harvesting of current stocks, reducing the potential collapse of Kep's marine resources.

Zoning schemes generally include both areas under strict protection and those with fewer regulations. Sub-zones may also be included, which can be modified on a seasonal or temporal basis (e.g. for boat access or following the breeding cycle of marine organisms) and are also dependent on the environmental characteristics of the area. In general, the scheme should aim to provide a balance between conservation and resource use. The scheme should seek to achieve simplicity, ensuring ease of implementation and avoiding difficulty interpreting the information and boundaries. For the suggested MFMA, MCC proposes clear demarcation of zones using flags and buoys as this follows the example of local fishery communities and should be widely understood (see photo 7).

The proposed MFMA will follow a plan in which different types of management zones with different permitted activities coalesce to form one large regulated area (see figure 5). The inner most layer consists

of strictly protected 'No Take' Zones where specific regeneration of ecosystems is required – for example; coral reefs, seagrass beds and mangrove forests. Here, tourist activities and all fishing practices are prohibited, however research is endorsed. The aim of the other zones will be to protect and increase biodiversity in the area, but also allow for specific sustainable fishing practices and other activities, such as snorkelling and scuba diving. This allows for the local fisheries industry to continue with any unobtrusive methods, while protecting the ecosystems from excessive damage. Additionally, activities that may contribute to the local economy; such as snorkelling and scuba diving with tourists and carefully planned industrial/commercial developments may be permitted.



**Figure 5: The general layout of an MFMA, including common uses of different zones.**



**Photo 7: An example of successful implementation of surface marker buoys at Koh Rong, MCC June 2009**

### **i. Socio-demographic data collection**

In order to conserve marine resources on a long-term scale, both socio-economic and ecosystem objectives need to be fully integrated within the creation and management of the MFMA. Neither element of the management plan can sustainably succeed without the other. In terms of socio-economics, local communities which rely on Kep's coastal region for food and income need the benefits that environmental conservation will bring – particularly through reversing the effects of destructive and excessive fishing. This MFMA will facilitate habitat restoration, likely leading to increased biodiversity and growth rates, and thus could create the ability for fishery catches to be maintained at high yet sustainable levels. Equally, to preserve a healthy ecosystem, a local community benefitting socially and economically from a thriving fisheries industry is central. Local knowledge and support will ensure stocks are protected and fished appropriately for generations to come. Using SEAFDEC's catch monitoring system (ACDS) will allow not only relevant authorities, but also fishers, to quantify the effectiveness of the MFMA.

Interviews conducted with fishers within Kep Archipelago communities have revealed that the local people have a vast practical knowledge of the reef gained through fishing experience. There is an opportunity to combine this knowledge with scientific information, which will enable a more holistic view of the marine environment's status. MCC can offer discussions and presentations aimed at equipping fishers with knowledge of their influence on the reef ecosystems. This would be beneficial to both parties, as the fishers depend heavily on the health of the reef in order to maintain their livelihoods, and their

cooperation will support efforts to improve local marine health. Local knowledge empowers communities, enabling them to participate in reef conservation and in turn contributing to reef health. Based on community interviews we anticipate participation from local fishers. Such interviews have revealed that IUU fishing practices are one of the major contributing factors to the destruction of the coral reef and seagrass environments around the Kep Archipelago, and it is clear that the communities need to be involved with the MFMA in order to establish a long lasting solution to the issue.

Using the surveys carried out in fishing communities along the coastline of Kep itself regarding socio-economic information, fishing practices, resource knowledge and first-hand perception of issues in the region allows:

Integrated management of marine ecosystems whilst also considering the needs of the people who depend upon the fisheries. Effective planning should bring long-term benefits to local communities, but if social and economic criteria are not taken into account, the MFMA will be created with a purely environmental view which may eventually lead to resource use conflicts with local people.

A clear and well-defined multiple use zoning plan. Collection of information about local fishing gears, techniques and target species will reduce competition and conflicts between human uses of the area and increase ecological conservation.

A clear picture of people's requirements, expectations and perceived issues related to fisheries resource management in their area. Alternative sources of income can also be explored, which would contribute to decreasing anthropogenic pressure on fisheries resources; for example, through development of aquaculture projects, and in the future, marine ecotourism.

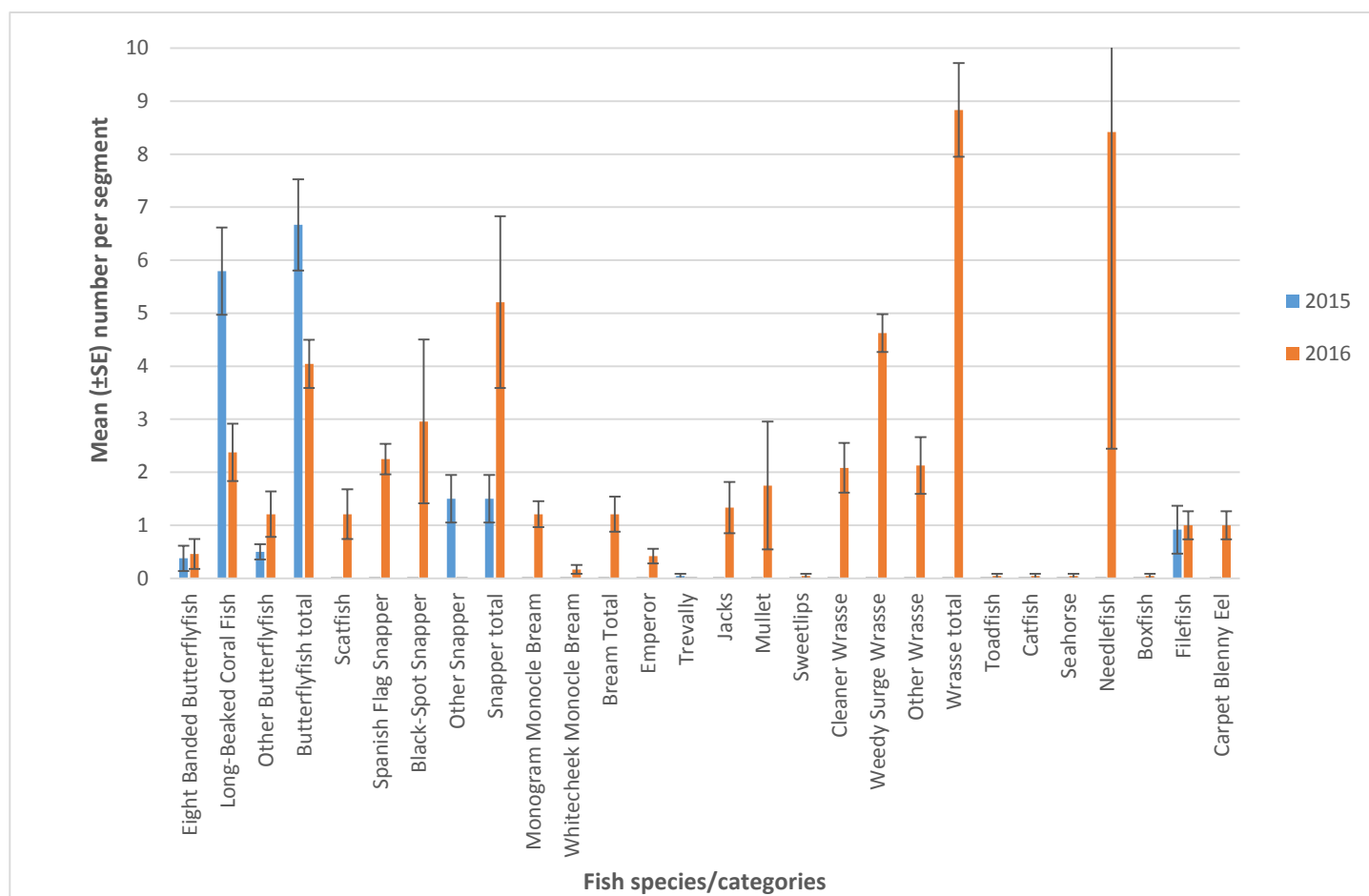
## **ii. Marine survey data collection**

Marine Conservation Cambodia has conducted marine surveys of the fringing reefs surrounding Koh Seh, Koh Angkrong and Koh Mak Prang (MCC 2014; 2015). Survey sites were established around each island (refer to Annex 2, 3 and 4), which were used to collect vital information regarding the abundance of certain fish, invertebrate and substrates. This data allows MCC to track changes in the species composition and structure of the reefs, indicating whether they are in a state of recovery, decline or maintenance. In turn, this leads to more effective decisions regarding conservation of vulnerable ecosystems.

In 2016, MCC is in the process of establishing a more scientifically sound methodology for current and future reef surveys. 2016 surveys will provide a strong baseline for which future years can be compared. Data compiled from MCC's recently completed 2016 reef surveys of eastern Koh Seh demonstrates substantial increases in the abundance and diversity of its fish species (refer to figure 6), relative to 2015 (refer to Annex 5 for 2015 & 2016 mean fish abundances). For the entirety of eastern Koh Seh reef, virgate rabbitfish, scatfish, sergeant fish, Spanish flag snapper, other snapper, monogram monocle bream, emperor, jacks, orange-spotted grouper, blue-lined grouper, chocolate grouper, cleaner wrasse, weedy surge wrasse, other wrasse, sweeper and carpet blenny eel all increased significantly relative to 2015 (refer to Annex 6 for all t-test results).

Overall at least 23 fish species were observed that were not in previous years' surveys. Within these 23 species, 5 have been confirmed by MCC staff members (boxfish, dusky rabbitfish, emperor, new species in the jack family and longfin grouper) to be completely new species to Koh Seh, as compared to February 2015, the time of MCC's reef surveys last year. Outside of those recorded during surveys, an additional 7

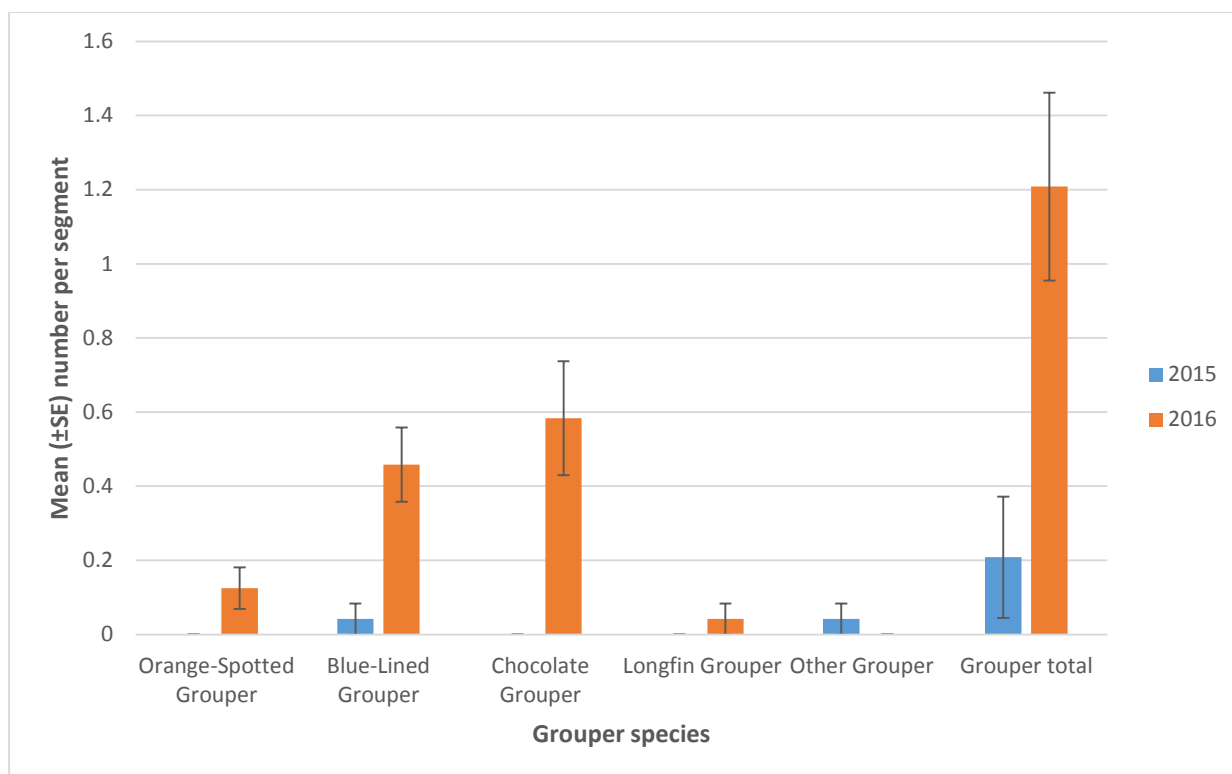
new species (big eye trevally, duskytail grouper, feather star, giant clam, paradise whiptail, spadefish, white spotted rabbitfish) to the marine environment of Koh Seh have been personally observed by MCC staff.



**Figure 6: Mean (±SE) count per 20 meter segment of each fish species/category during MCC's reef surveys of eastern Koh Seh in 2015 and 2016.**

Importantly, the populations of significant grazer and predator species enlarged between 2015 and 2016. This is noteworthy, as these species play key roles in establishing and maintaining healthy and productive marine ecosystems, in which regulation through herbivory or predation results in stable trophic systems (see 'Trophic Cascades' pp. 49). Grazing rabbitfish and sergeant fish populations within eastern Koh Seh greatened between 2015 and 2016, with significant growth being displayed by sergeant fish ( $p=0.04$ ) and virgate rabbitfish ( $p=0.05$ ).

Predatory grouper species demonstrated strong growth in population numbers at eastern Koh Seh (refer to figure 7). Together with the previously mentioned conclusive increases in orange-spotted ( $p=0.05$ ), blue-lined ( $p<0.01$ ) and chocolate grouper ( $p<0.01$ ), total grouper abundance also grew significantly between 2015 and 2016 ( $p<0.01$ ).



**Figure 7: Mean ( $\pm$ SE) count per 20 meter segment of each grouper species/category during MCC's reef surveys of eastern Koh Seh in 2015 and 2016.**

## **VII. Zoning Draft Proposal**

### **a. Zoning adapted to local context**

Zoning of an MFMA has two major purposes; firstly, to reduce conflicts between legal and illegal fishers, and secondly, to protect critical stocks and habitats for the purpose of replenishing the immediate and surrounding area. The Zoning Plan should be designed with basic conservation criteria principally emphasizing restrictions on fishing practice and equipment, fishing period regulations, as well as control of tourism activities. The goals should follow a long-term plan and should manage areas of abundant biodiversity in a sustainable manner whilst concerning the needs of surrounding communities. A top priority is the conservation of the ecosystems and the services it provides for the local communities. As a resource it can provide jobs in industries such as algae farming, other aquaculture projects, and even ecotourism. Creating too many zones within the MFMA would lead to confusion and would eventually be ineffective. Being the first MFMA of its kind in Cambodia, it should follow a framework that is as simple as possible in order to make it understandable to a diversity of stakeholders. In this case the area would be divided into four zones: A Conservation 'No Take' Zone, a Small-Scale Family Fishing Zone, a Multi-Use Zone and a Buffer Zone. These four zones are convenient enough for local communities to manage their area at a local level. Moreover, by providing a gradation of restrictions, a balance of uses of the marine environment that satisfy the requirements of many resource users, a multiple-use zoning plan is easier to implement and enforce as opposed to managing large restricted areas.

The basic principle of multiple zoning is to have areas within the MFMA that are strictly protected, buffered by areas with fewer restrictions. For example, the core Conservation Zone consists of a sanctuary with high ecological importance (vulnerable habitats with endangered species like the seahorse breeding ground) where only research diving and scientific activities are allowed.

In the surrounding Small Scale, Family Fishing Zone, local subsistence fishers may use unobtrusive methods (lines and traps) to continue to fish crab and squid only. Additionally, monitored recreational usage may be approved. For example, guided snorkelling and scuba diving.

In the Multi-Use Zone most legal fishing techniques and boat anchoring permitted. Indiscriminate net fishing however will be prohibited, and all vessels regulated by CPU measurements. Here ecotourism could be expanded through opportunities to do scuba diving and recreational fishing.

Finally, the Buffer Zone will be 1km surrounding the entire MFMA that allows for some flexibility at the border. Any vessels not adhering to the MFMA sanctions can be warned of their proximity to a protected zone and asked to change course.

Although it is difficult to deal simultaneously with the needs and interests of the local community, alongside conservation requirements and the increase of tourism development, examples around the world have proved that a well-planned and implemented "zonation" area works. Also, many examples show that the best scenarios of protected area management have been driven by local communities, which led to the conclusion that local communities should be greatly involved in the MFMA co-management process, under the direction of the FiA, to assist in monitoring and controlling the area. CFAs boundaries should be kept and left to the communities to manage; however, they should not form an independent entity, but be included in the general MFMA zoning process.

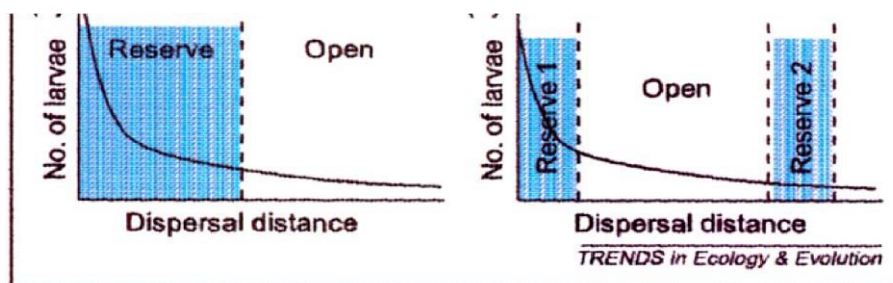
## b. Key Principals of the MFMA

### Minimum required size preventing sedimentation:

This MFMA is designed with a 4 kilometre distance extending from Conservation Zones to the exterior of the Multi-Use Zone. This distance is an unequivocally essential aspect of the MFMA, as it will protect key marine ecosystems and small-scale fishers from the adverse effects of sedimentation. Sediment stirred from the ocean bottom, whether due to trawling, coastal development or natural phenomena, has the potential to disperse a large distance from the point of disturbance. Sediment can be harmful to marine habitats and species by abrading against surfaces, smothering organisms, blocking sunlight (Rogers 1990) and hindering settlement of organisms (Hodgson 1990). Trawlers disturb the seabed on a large-scale, creating large and turbid clouds of suspended sediment (Churchill 1989), and thus pose a considerable threat to the effectiveness and health of the MFMA. Based on long-term observations of water turbidity and sediment suspension by MCC staff, it is believed that a 4 kilometre distance from the Conservation Zones is the absolute minimum required to safeguard the protected marine ecosystems from the detrimental impacts of sedimentation.

### Connectivity:

Connectivity is a new global approach for effective MFMA/MPA design, owing to its ability to maximise the potential rehabilitation of the specific region, whilst improving conservation efforts and the practise of other activities (e.g. fishing). Connectivity occurs when larvae or fish disperse between marine ecosystems, helping to replenish and bolster each other against environmental and anthropogenic impacts. MCC views connectivity as a noteworthy aspect necessary to facilitate an effective and interconnected MFMA. Larval and fish dispersal between the populations of protected areas (e.g. the proposed Conservation Zones – see figure 8) should help in the formation of meta-populations (large populations consisting of at least two smaller but connected populations) (Tremblay *et al.* 2015). Dispersal within meta-populations increases genetic diversity, leading to the overall improved health of the populations that comprise them, as well as strengthening their resilience against catastrophic events such as natural disasters and mass IUU fishing. In the context of this report, connectivity of marine populations between Conservation Zones is a high priority for the MFMA. Setting up nearby Conservation Zones that contain a relative abundance of species creates the high potential of forming connections between populations, leading to greater biodiversity and density of marine species. Clearly, this will create numerous region-wide benefits for species, ecosystems, tourists and fishers.



**Figure 8: The number of larvae that settle at a particular distance from the original point of dispersal (Sale *et al.* 2005). MCC's proposed MFMA will follow the design on the right, by incorporating connected Conservation Zones.**



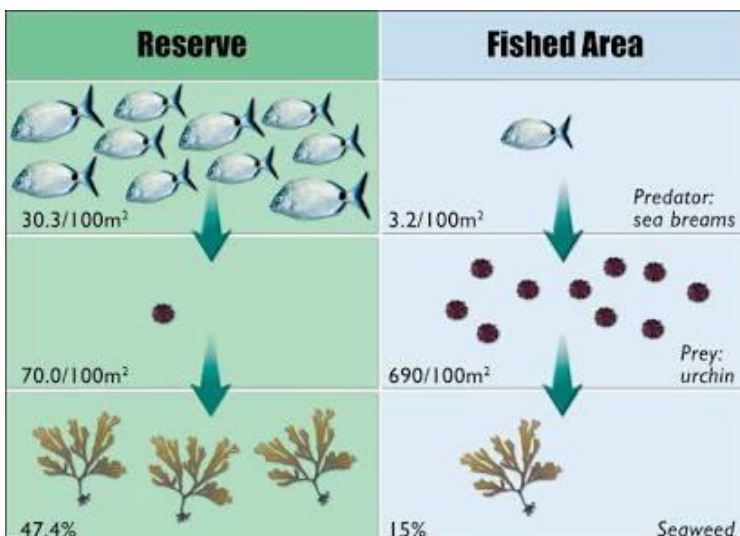
### **‘Spill-Over’ effect:**

‘No-Take’ Conservation Zones will act as extremely important sources of marine species to surrounding fishing zones. Increasing the diversity and abundance of marine species within this highly protected zone will subsequently cause parallel increases outside Conservation Zones as well, by means of movement, migration and larvae dispersal. This phenomenon, known as the ‘spill-over’ effect, has abundant evidence to demonstrate its benefits to fishers, tourists and all other parties utilising the area surrounding the Conservation Zone. As an example of this, Russ *et al.* 2011 conducted research on a ‘No Take’ reserve in the Philippines which demonstrated an increase in species richness outside its boundaries of 78%. This increase translated into benefits for the local community utilising the surrounding marine environment.

### **Trophic Cascades:**

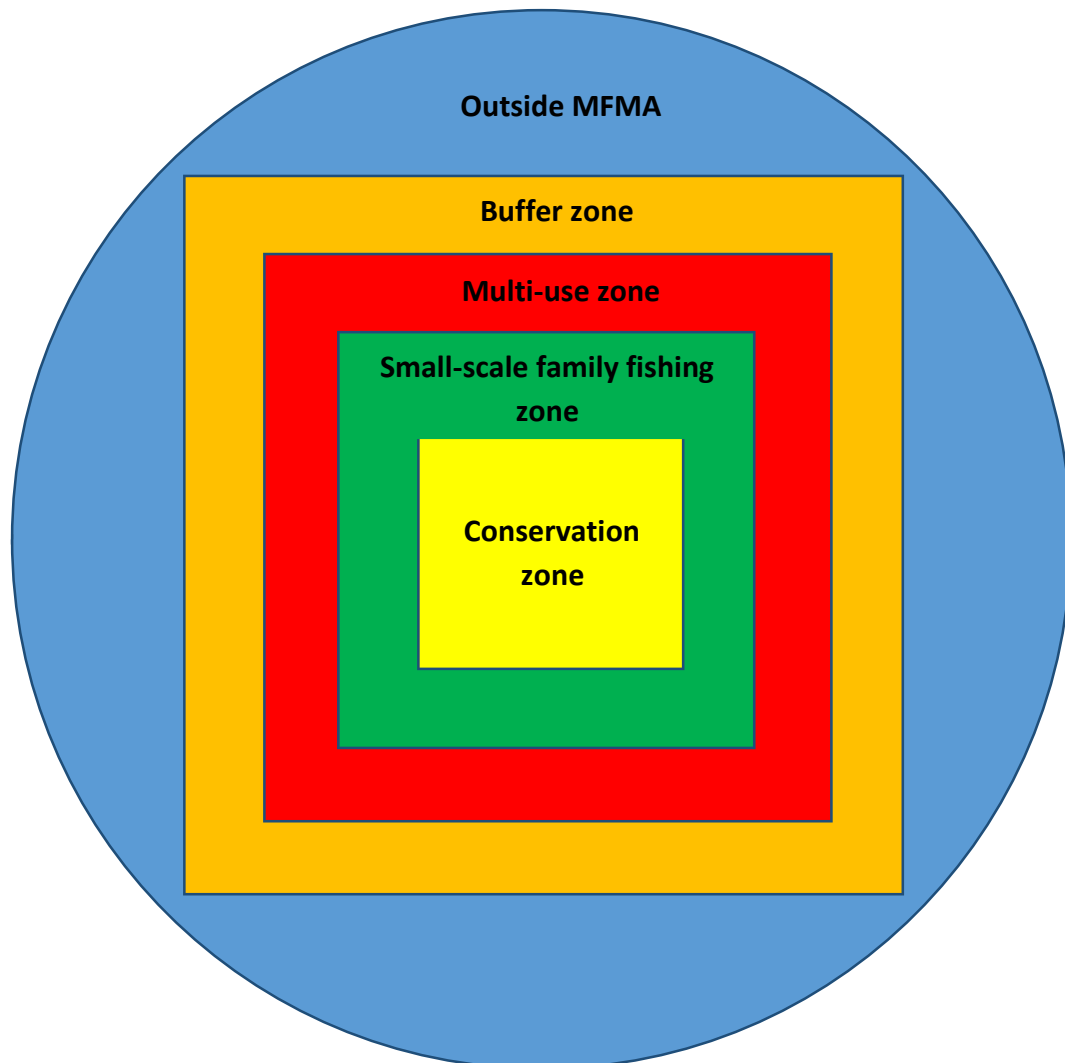
Trophic levels refer to the different levels of the food chain in marine and terrestrial environments, beginning with primary producers (plants and algae) at level one, progressing through to herbivores, small predators and large predators. In marine environments, seagrass beds and coral reefs are made up of primary producers that form two highly productive ecosystems – both of which provide habitat, shelter and food for an array of marine species. Without these producers forming the base of the food chain, all organisms of higher trophic levels cannot sustain themselves and thus the food web and ecosystem will collapse. Likewise, the removal of top predators from a food chain creates an imbalance throughout particular trophic levels, which may lead to ecosystem degradation through ‘trophic cascades’. Overharvesting of top predators may lead to an overabundance of herbivores, which can rapidly destroy healthy seagrass and algal habitats. For example, figure 9 depicts a trophic cascade occurring in the fished area outside the no-take reserve within Torre Guaceto MPA in Italy (Guidetti 2006). The trophic cascade has been caused by overfishing of predatory fish and resulted in urchin barrens. Inside the reserve, predatory fish are able to thrive and maintain the urchin numbers at a sustainable level, producing a healthy ecosystem. Clearly, affecting the abundance or behaviour of any part of the food chain can lead to ecosystem-wide effects through trophic cascades. Fisheries should consider the consequences of over fishing their target species and destructive fishing methods to avoid these adverse impacts.

With the large fishing community present in the Kep Archipelago, marine ecosystems with trophic stability are essential to sustain local catch of commercial fish and invertebrate species. Currently, the overfishing of predatory fish is leading to a trophic cascade event. The proposed MFMA will provide the protection of environments necessary for stocks to recover, and rebalance the trophic levels and health of ecosystems.



**Figure 9: Example of a trophic cascade occurring in the fished area outside the no-take reserve within Torre Guaceto MPA in Italy (Guidetti 2006).**

**c. Defining the zones (Figure 10)**



**Figure 10: Basic MFMA Zoning Plan including 4 main zones.**

## **“No-Take” Fishery Conservation Zone (yellow)**

**Total area:** [size to be determined on final draft via GIS]

**Generalities:** The Fishery Conservation Zone follows the definition used in ‘Law on Fisheries’ (Fisheries Administration 2007), which refers to; ‘classification of freshwater or marine fishery domains, clearly defined by a geographical boundary in which aquatic animals and aquatic plants are to shelter, to spawn, to feed, and to grow. Fishery conservation areas are fishery protected areas, in which any activity that has a negative effect on fishery resources is strictly prohibited, except for scientific research purposes following reasonable principles’.

The Conservation Zone is comprised of areas with high ecological importance. Vulnerable ecosystems which act as breeding grounds, shelter, or provide habitat to rare species are a focus here, as well as those which provide valuable services to locals. To maximize protection, only scientific research activities licensed by the FiA are allowed, with other activities such as fishing, anchoring and tourism being forbidden. Habitats within the Conservation Zone should be researched, given the lack of knowledge about Cambodia’s marine environment. New scientific discoveries will lead to better understandings of marine species reproductive cycles, behaviour, migratory patterns and so on. In turn this will lead to improved and more cost-effective conservation, as well as increased knowledge of local species for island villagers and tourism centres.

**Local context:** The Conservation Zone includes the threatened but ecologically significant habitats of seagrass meadows, coral reefs and mangroves. All three are highly fragile marine habitats that are of extreme importance to numerous species, but unfortunately are highly threatened by a number of destructive fishing practices, particularly trawling. These habitats are crucial for prevention of coastal erosion, a direct consequence of coastal development. They also play a key role in both carbon and nutrient cycles, allowing for masses of carbon to be sequestered and excessive nutrients to be filtered (mangroves especially). The destruction of these habitats not only destroys biologically important environments, but also increases the risk of coastal flooding, land erosion, and even adds to the current international issue of climate change and ocean acidification through the release of the stored carbon. The planned Conservation Zones encompass areas that have suffered the consequences of destructive fishing methods leaving the habitats and species in a state of decline. Despite this, representative species from a variety of marine families survive and persist within these areas, clearly displaying the strong potential for recovery.

### **Small-Scale Family Fishing Zone (green)**

**Total area:** [size to be determined on final draft via GIS]

**Generalities:** Fishing activities within the Small-Scale Family Fishing Zone follow the definition used in 'Law on Fisheries' (Fisheries Administration 2007) for 'Family-scale Fishing'; refers to small-scale traditional fishing using only single fishing gear, and generally not for commercial purposes. Fishing practices which are non-destructive to habitats are endorsed, alongside marine research and recreational activities such as diving and snorkelling etc. Anchoring is strictly forbidden (use of mooring buoys only) and tourism-related damage shall be closely monitored. A speed limit will be enforced due to safety concerns (e.g. divers surfacing) and certain types of boats will be forbidden (e.g. jet skis and trawlers).

This level of protection allows fish in the protected zone to reach full maturity. The subsequent increase in eggs and juveniles will increase the local fish density centrally and expand to the other zones as well. Due to this 'spill-over effect', the movement of larvae and adults to the Multiple-Use Zone (and beyond) will benefit the greater community relying on Cambodian fisheries.

**Local context:** In our case, the creation of such zones also aims to anticipate and conflict between subsistence fishing, small-scale commercial and IUU fishing which may occur without zoning. Indeed, trawling and rat tail traps are often reported as having tangled or caught the lines, hooks and weights of subsistence fishers causing the loss of their gear. Damage to, and even theft, of catch and equipment/traps can be anticipated and avoided by the use of Protected Zones to segregate vessels.

The priority in this area is to protect coral reefs and other sensitive habitats such as seagrass beds and mangroves, while still allowing for family-scale fishing, aquaculture developments and tourism. Therefore, in this zone, only trap and line fishing will be permitted, and ecotourism projects promoted.

### **Multi-Use Zone (red)**

**Total area:** [size to be determined on final draft via GIS]

The boundary of the Multi-Use Zone and in effect should extend at least 4 kilometres from each Conservation Zone. In effect, this means the boundary of the regulated portion of the MFMA will be 4 kilometres from each Conservation Zone, as immediately surrounding the Multi-Use Zone is the unregulated Buffer Zone.

#### **Minimum required size:**

The 4 kilometre size is an absolute necessity to protect the Conservation Zones from the adverse impacts of sedimentation, which lead to decline of tropical fisheries and the deterioration of coral reefs, seagrass beds and mangroves (Rogers 1990). Sedimentation is the process of sediment being disturbed from the seabed and subsequently abrading against and depositing on vulnerable coral reefs, seagrass meadows and marine species. From long-term observations of suspended marine sediment during surveys, MCC believes that a 4 kilometre distance is the minimum required to

ensure the protection of the vulnerable ecosystems and species that compose the Conservation Zones.

**Generalities:** The Multi-Use Zone is marked between the protected areas in the centre of the MFMA and the area outside, where fishing activities are unregulated. The Multi-Use Zone is a sustainable fishing and ecotourism zone. Carefully considered guidelines are necessary to avoid potential conflicts between commercial and subsistence fishers. Snorkelling is prohibited due to safety concerns regarding boat traffic, while scuba diving is still allowed at one's own risk to allow for either research or ecotourism.

**Local context:** Fishing activities are less limited than in the previously described zones. Small-scale legal Cambodian fishing practises are permitted within the Multi-Use Zone. All activities classed as illegal by fisheries law are strongly prohibited (including Trawling), allowing for local fishers to use legal methods to continue sustainable fishing in healthy areas of the coastal zone, without disrupting particularly vulnerable ecosystems. Additionally, with the development of tourism with Kep, this zone could be used as a key destination for scuba diving and recreational fishing.

### **Buffer Zone (orange)**

**Total area:** [size to be determined on final draft via GIS]

**Generalities:** The Buffer Zone aims to provide a transition space between the MFMA and open access fishing areas.

**Local context:** The Buffer Zone will be 1km surrounding the entire MFMA that allows for some flexibility at the border. Any vessels not adhering to the MFMA regulations can be warned of their proximity to a protected zone by means of surface buoys and thus can change course. Deployment of Anti Trawling Devices along the external borders and randomized distribution within the MFMA is essential to discourage trawler entry, this will also reduce costs associated with the need for less patrols to tackle illegal trawlers. These anti trawling devices are also known to serve as artificial habitats for fish and other marine life.

### **Special Purpose Zone (purple)**

**Total area:** [size to be determined on final draft via GIS]

**Generalities:** The Special Purpose Zone aims to provide an area for transportation facilities (piers) and all activities related to fishing (fisheries landings, boat fixing, etc.). Rules within the zone are decided on a case sensitive basis allowing vessels to moor and anchor in particular areas, even within conservation or protected zones.

**Local context:** Special Purpose Zones should be provided along the Kep coast and at Koh Pou. Passages for small-scale fishing boats can be mapped and marked with buoys to reduce damage

when vessels pass through seagrass beds and over reefs within the Conservation Zone, whilst still allowing access to surrounding Small-Scale Fishing and Multi-Use Zones.

**Table 2: Table stating proposed fishing regulations within specific MFMA zones, based on environmental and socio-economic data of the Kep Archipelago:**

ACTIVITY		Conservation Zone <i>Human activities strictly limited</i>	Small-scale Fishing Zone <i>A limited number of activities may be undertaken</i>	Multiple-Use Zone <i>A limited number of allowed activities can be undertaken</i>	Buffer Zone <i>Activities aside from destructive IUU fishing are unrestricted</i>
Squid lines (troll line)	Day time	✗	✓	✓	✓
	Night time	✗	✓	✓	✓
Traditional line fishing <sup>1</sup>		✗	✓	✓	✓
Long lines		✗	✗	✗	✓
Traps <sup>2</sup>	Fish traps	✗	✓	✓	✓
	Squid traps	✗	✓	✓	✓
	Crab traps <sup>8</sup>	✗	✓	✓	✓
Shell harvesting <sup>3</sup>		✗	✗	✓	✓
Bottom weighted net fishing <sup>4</sup>		✗	✗	✓	✓
Surface net fishing <sup>4</sup>		✗	✗	✓	✓
Anchoring <sup>5</sup>		✗	✓	✓	✓
Diving <sup>6</sup>		✗	✓	✓	✓
Snorkelling <sup>7</sup>		✗	✓	✓	✓
Research and scientific activities		✓	✓	✓	✓
Speed limit > 2 knots		✗	✗	✓	✓
Trawling		✗	✗	✗	✗

✓ : Allowed

✗ : Not Allowed

<sup>1</sup> Traditional line fishing stands for lines with hooks and baited.

<sup>2</sup> Regulation of trap size and number (per boat) should be employed.

<sup>3</sup> Excluding endangered species, which may not be fished.

<sup>4</sup> Regulation of net length and number (per boat) should be employed.

<sup>5</sup> On provided mooring buoys only. Exception made in case of emergency / safety reasons and in Special Purpose areas.

<sup>6</sup> Diving may be permitted in the Conservation zone for scientific activity only.

<sup>7</sup> Risk must be evaluated by the user/tourism operator, especially in area of important boat traffic; the FiA or local communities shall not be held responsible for any accident.

<sup>8</sup> Licenses for crab trap fishing within the Conservation Zone can be obtained through consent of the fishing authorities and MCC for catch monitoring purposes.



#### **d. Possible Zoning Schemes**

MCC lists a range of options available for the MFMA zoning scheme. This list is not exhaustive and other options or combinations may be negotiated. In general, 'No-Take' Conservation Zones focus on the ecologically significant yet threatened coral reef and seagrass habitats. Surrounding these are the Small-scale Family Fishing Zones, which occur at a distance of at least 1 kilometre from Conservation Zones. The Multiple Use zone is the outer-most regulated zone, being positioned at least 4 kilometres from Conservation Zones. The Buffer Zone encircles the MFMA at a radius of 1 kilometre. It should be noted that the eastern boundary of the MFMA is based on the limit of stage one seagrass mapping conducted by MCC, as to avoid crossing the international border with Vietnam.

### MAP A:

The 'No-Take' Fishery Conservation Zones encompass the majority of the shallow fringing reefs around Koh Seh, Koh Mak Prang, Koh Angkrong and Koh Pou, together with two extensive seagrass beds to the eastern side of Koh Seh and Koh Pou. Conserving such important habitats will lead to a 'spill-over' of marine species into the surrounding Small-Scale Family Fishing Zone and Multiple Use Zone, particularly where the Koh Pou seagrass bed extends, strongly benefitting fishers who utilise these zones. The initial implementation may seemingly reduce catch due to less area available for fishing, however protection against IUU fishing will very likely induce a rapid expansion of fish density and diversity into fishing zones, as Conservation Zones begin to recover within the first six months to a year.

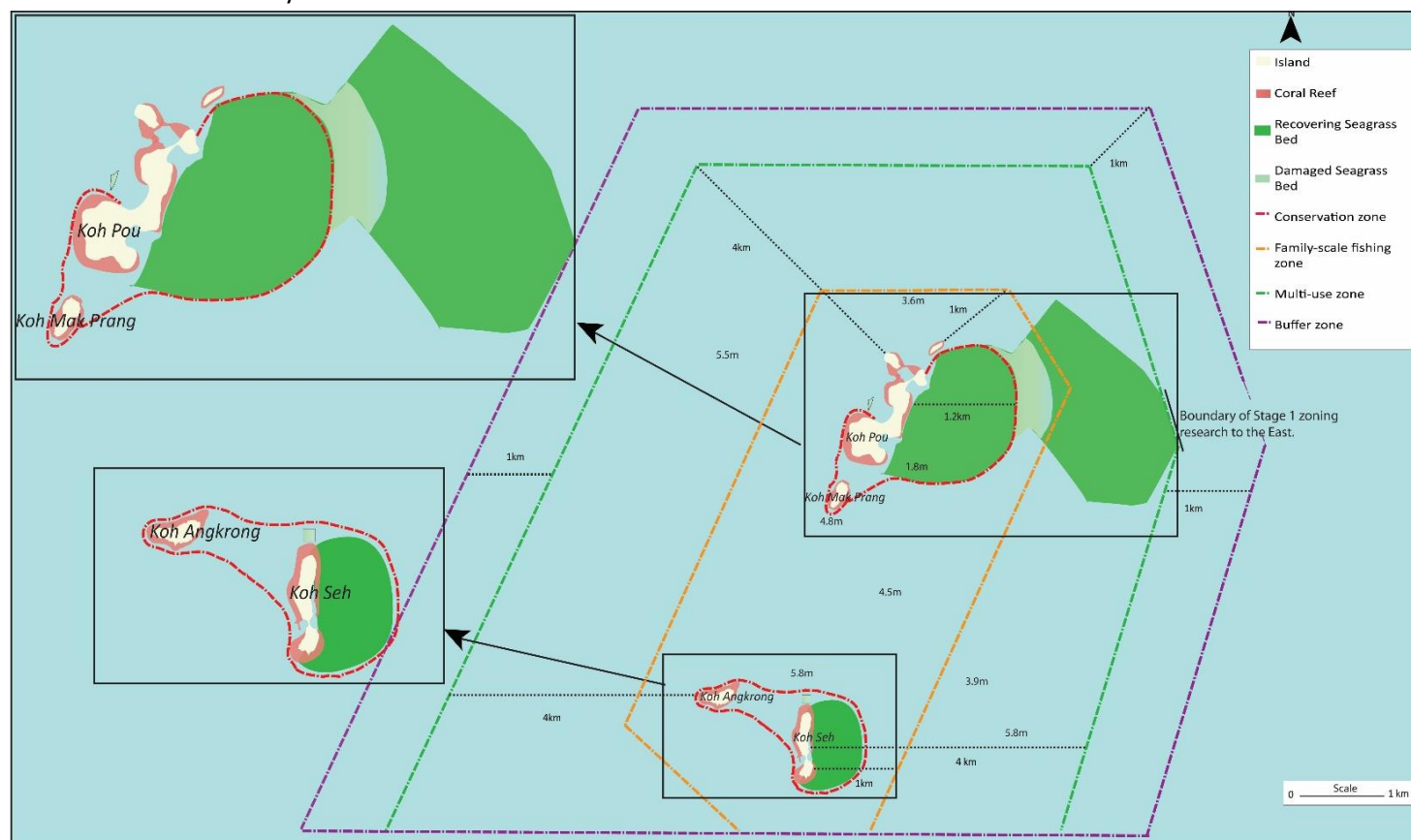


Figure 14: Map A showing the most preferable MFMA zoning plan.

[See 'Annex 7' for enlarged version.](#)

### MAP B:

The Conservation Zones in this zoning scheme once again include the bulk of shallow fringing reefs surrounding the relevant islands. Three reductions in Conservation Zone area have occurred; the eastern side of Koh Angkrong, the fringing reef of Koh Pou and the passage between Koh Pou and Koh Mak Prang are no longer of strict protection. This option will allow for high levels of recovery in sensitive areas, while offering greater fishing opportunities to local communities – particularly to subsistence fishers on the island of Koh Pou. In contrast, allowing any kind of fishing over coral reef ecosystems will undoubtedly slow the restoration of marine species and ecosystem at large, hindering the potential benefits of the ‘spill-over’ effect.

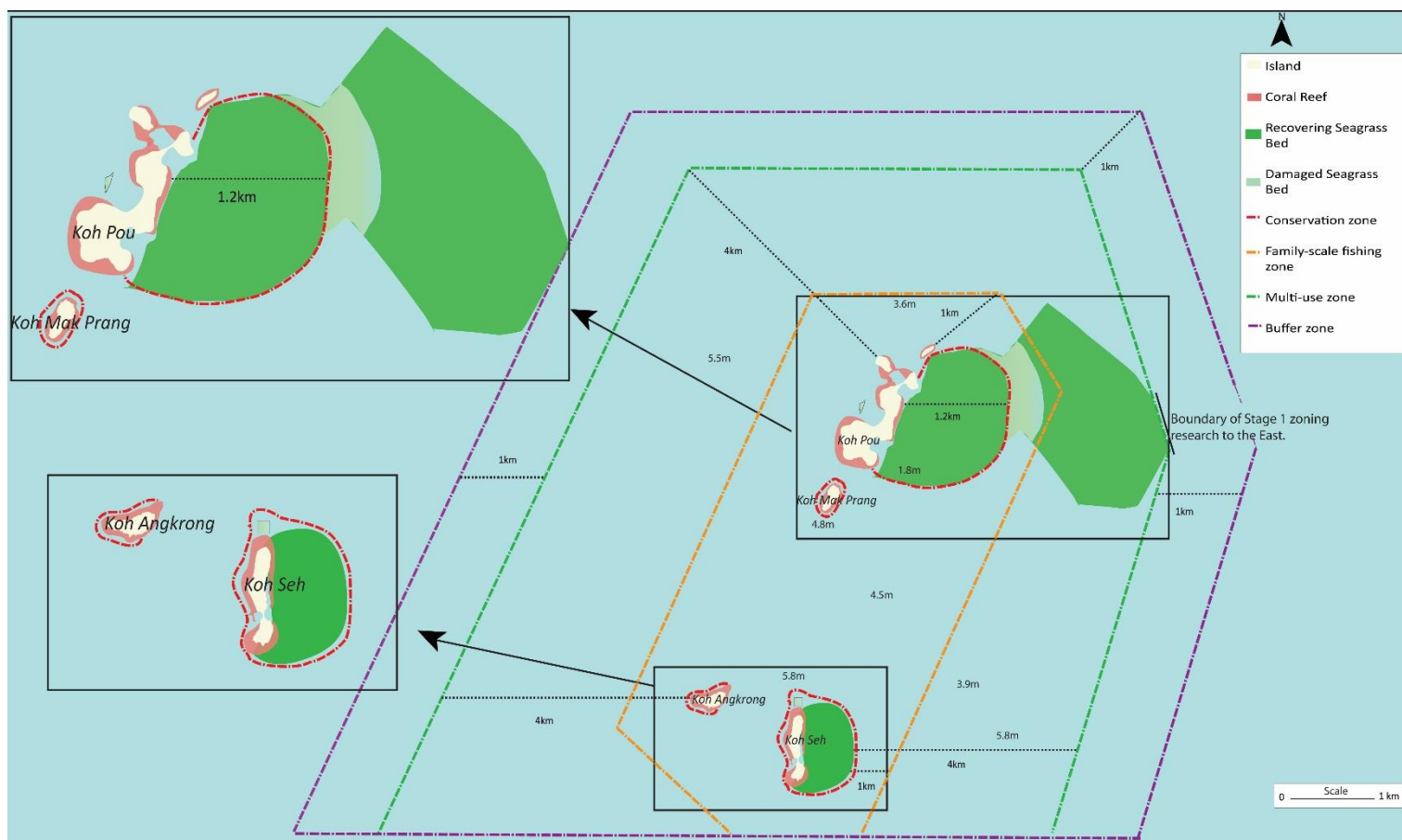


Figure 12: Map B showing the intermediate MFMA zoning plan.

[See 'Annex 8' for enlarged version.](#)

### MAP C:

The Conservation Zones in this zoning scheme include an additional two reductions, relative to Map B; the removal of the Conservation Zones from both the eastern side of Koh Pou and western side of Koh Seh. This incorporates a combination of seagrass and coral reef ecosystems, extends the Small-scale Family Fishing Zone into some of the most productive habitats in Kep Archipelago, and will undoubtedly benefit local fishers' livelihood in the short-term. Unfortunately, this option contains the least protection. This will result in the slowest recovery of critical habitat and marine species, and limited 'spill-over' of stocks as compared to former map options. Accordingly, Map C may appear to provide greater benefit in the short-term, however in the long-term Map A or B would heavily outweigh this option.

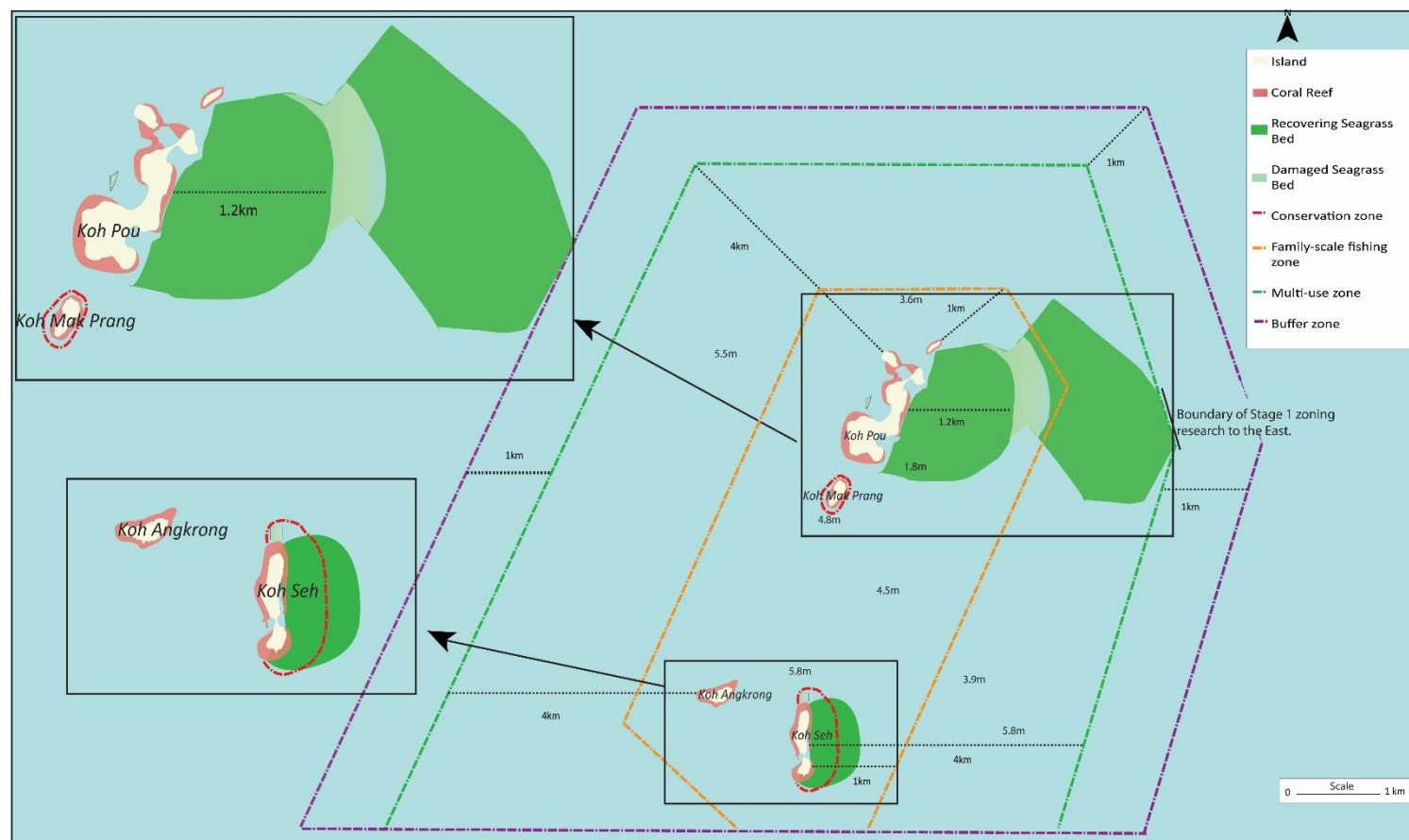


Figure 13: Map C showing the third MFMA zoning plan.

[See 'Annex 9' for enlarged version.](#)

## VIII. Monitoring and Evaluation

Effectiveness of the MFMA and results of its implementation will need to be closely monitored and evaluated. This will involve measuring the actual progress on activities and projects, and measuring the level of achievement against initial indicators set by relevant parties. Indicators can be realised via the action of implementation monitoring and effectiveness monitoring techniques, which will be described in this section. Implementation monitoring is used to evaluate management actions to determine whether they were implemented as proposed or comply with established standards (Bailey 2012). Implementation monitoring techniques include Monitoring Control and Surveillance (MCS), which in the future could be used with the guidelines detailed in the ASEAN Catch Documentation Scheme (ACDS) (SEAFDEC 2016). Additionally, patrols for IUU fishing activities and violating MFMA fishing regulations should form an important part of implementation monitoring. Effectiveness monitoring is used to determine if restoration actions had the desired effects on physical processes or habitat conditions (Bailey 2012). Effectiveness monitoring techniques include Marine Conservation Cambodia's (MCC's) marine surveys, which together with implementation monitoring practises, will form a comprehensive framework for monitoring and evaluation. Generally, effectiveness (step one) and implementation monitoring (step two) form a two-step process, in which effectiveness monitoring techniques are dependent upon implementation monitoring to enforce management regulations. Notably, FiA Monitoring and Evaluation Implementation is drafted in the Fisheries Annual Work Plan 2016 (FiA 2016), and thus this section contains significant information in regards to achieving this objective. It cannot be over emphasised that practising monitoring techniques and forming monitoring indicators are not worthwhile if the underlying issues of frequent and widespread IUU fishing remain.

A Monitoring Control and Surveillance (MCS) (see 'IUU, Threats & Resource-Use Conflicts', pp. 25) system is an effective tool in gathering monitoring information and forming compliance with conservation measures. Formulating an assessment of fishing capacity and establishing a catch monitoring system are two important goals of MCS. To assist with this, MCC recommends the use of official landing sites and catch per unit (CPU) monitoring within Kep Province. The use of official landing ports will ensure that catch monitoring and quotas are based upon and are leading to accurate fisheries data. If this is achieved, fish and other seafood catch can be quantified in line with quota schemes of the Regional Plan of Action (RPOA) for Managing Fishing Capacity (SEAFDEC 2016b). This monitoring technique should also assist in the degeneration of the IUU fishing industry by only accepting catch from registered vessels. CPU measurements would provide data on fluctuations in species diversity and abundance over time within local waters, leading to increasing information regarding areas of ecosystem recovery and fishing 'hot spots'. Training fisheries officers in the coastal provinces to consult and report on fisheries data and production is a vital step to establishing successful official landing ports and CPU data (FiA 2016). To re-iterate the point again, an MCS system would be highly advantageous to Kep Province, but nonetheless the great reduction of illegal and destructive fishing techniques within the region is a necessary action before this monitoring system can be effectively utilised.

The utilisation of the ASEAN Catch Documentation Scheme (ACDS) (SEAFDEC 2016) is a long-term goal for Kep Province fisheries. The ACDS seeks to improve the traceability and credibility of fishery products in Cambodia (SEAFDEC Secretariat 2016), thereby hindering IUU fish catch from entering markets. These guidelines are aligned with numerous international and regional policies, including

the FAO Code of Conduct for Responsible Fisheries, the Regional Code of Conduct for Responsible Fisheries for Southeast Asia, and the Regional Plan of Action (RPOA) to Promote Responsible Fishing Practises including Combating IUU Fishing in Southeast Asia. Importantly, these guidelines are also in accordance with the Food and Agriculture Organization of the United Nations (FAO) International Plan of Action regarding IUU, which prioritises strengthening controls such as catch documentation and effective monitoring control (Funge-Smith 2016). Clearly, following this scheme would provide benefits to Kep Province fishing authorities and fishers, however pervasive IUU activities need to be addressed before this scheme can be effectively installed. ACDS will also allow a quantitative monitoring of commercial and possibly non-commercial catch, thereby indicating the likely positive impact that the proposed MFMA is causing to fishery industries.

Given that patrols for illegal fishing activity are a key action taken to enforce Cambodian fisheries laws, documentation of these events should be formed as part of the implementation monitoring carried out as an activity of the proposed MFMA. Details of the encounter should be recorded, such as the time, date, area, type of illegal fishing technique/vessel, registration number of vessels (if present), nationality of crew etc. This information would provide crucial feedback on the frequency and intensity of IUU activities, thereby indicating how successful law enforcement is in mitigating IUU fishing, as well as shedding light on where, when and by whom these destructive fishing techniques are occurring.

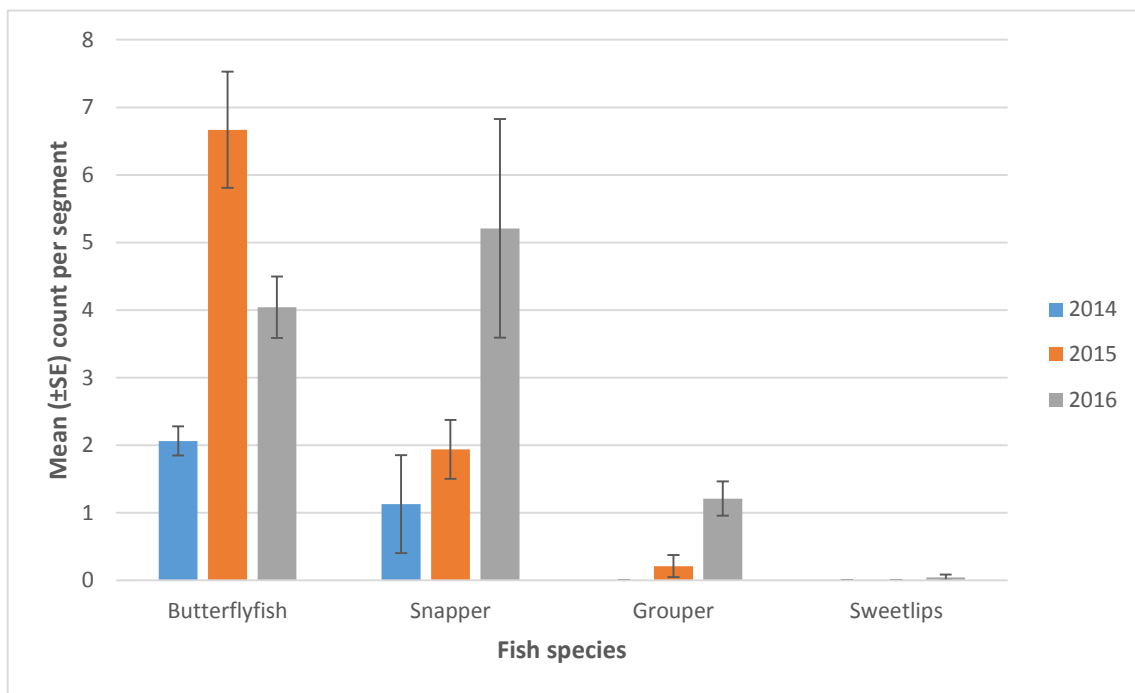
In addition to this, patrols for vessels disobeying MFMA regulations should be conducted regularly. These issues could be personally addressed with the fishers or other involved parties, with any misunderstandings resolved.

Following successful implementation monitoring, effectiveness monitoring is the next step in tracking the likely marine environmental benefits to Kep Province. An effectiveness monitoring method within the MFMA would be through the continuation of marine surveys currently carried out in the region by MCC (see 'Marine survey data collection' pp. 44). MCC is currently or has conducted surveys of coral reefs, seahorse and habitat distribution within the Kep Archipelago. Collection of such data allows for conclusions to be formed regarding the potential recovery and expansion of habitats and populations found in this region. For example, MCC could conduct biannual surveys of seagrass range to monitor the growth of this ecologically significant habitat, as well as coral reef surveys to monitor the abundance of important fish, invertebrates and substrates. There is a high likelihood that this data will show a steady regeneration of seagrass and coral reef habitats, and thus this will potentially greatten the density and biodiversity of marine organisms. Conservation Zones should be the hotspots of ecosystem recovery but, with high probability, the 'spill-over' effect (see 'Spill-Over' effect pp. 49) should occur, leading to the expansion of species biodiversity and abundance throughout the surrounding marine environment. This in turn will boost ecosystem productivity in the fishing zones of the MFMA for the fishing communities and potential tourism industries. Given the likely potentiality of this scenario, Conservation Zones and the surrounding zones would require monitoring via marine surveys to track the changes in fish, invertebrate and substrate diversity and density.

Indicator species are those used to monitor environmental changes, assess the efficacy of management, and provide warning signals for impending ecological shifts (Siddig *et al.* 2016). Numerous indicator species are recorded during MCC's reef surveys, for example butterflyfish, the density and richness of which can symbolize the quality of coral substrate (Crosby & Reese 1996), and seahorses, which show particular susceptibility to habitat degradation (Lourie *et al.* 2004).

Clearly, the monitoring of indicator species will be an important component of monitoring the rehabilitation of marine ecosystems in the Kep Archipelago. Greatening population numbers of indicator species would strongly suggest that the MFMA implementation and enforcement of protection by relevant authorities is succeeding in fuelling the restoration of Kep’s ocean.

The simultaneous use of implementation monitoring and effectiveness monitoring techniques, for instance following the ACDS, establishing MCS and performing marine survey techniques, should produce a comprehensive assessment of environmental and management actions in Kep Province. Following establishment of the MFMA, monitoring of Kep’s marine environment will provide baseline data which can be used to form indicators of progress relative to objectives for the region. As an example, increases in coral and seagrass habitat, commercial and non-commercial fish density and diversity, and catch quantity should be primary environmental indicators. Objectives should state more specific levels of increases, and when reached, these objectives will demonstrate that positive advancement has been made, after which new objectives can be formed relative to the indicators. MCC has collected data that demonstrates trends in population growth in fish species from March 2014 to March 2016 (refer to figure 14). During this period of time within eastern Koh Seh reef, butterflyfish (196%,  $p=0.006$ ) and snapper (463%,  $p=0.06$ ) increased dramatically, whilst grouper numbers greatened significantly (580%,  $p<0.01$ ) between 2015 and 2016, and sweetlips were recorded only in 2016 (refer to Annex 10 for all averages, measures of error and t-test results).



**Figure 14: 2014, 2015 and 2016 mean count ( $\pm$ SE) of fish species per 20 metre segment of MCC’s reef surveys on eastern Koh Seh reef.**

These numbers could be used as rough estimates for objectives for Conservation Zones, however caution is advised given the variability in the environmental conditions, socio-demographic context and IUU fishing intensity across different ecosystems in the Kep Archipelago. These figures do indicate the substantial growth in key fish populations possible over a two-year period of protection against illegal and destructive fishing techniques.

Monitoring and evaluation is a vital part of any MFMA scheme. Continuing to assess both environmental health, socio-economic changes for local communities, and effectiveness of imposed regulations ensures that the plan is working to benefit the region in the greatest way possible. MCC would recommend annual meetings between all stakeholders in which these considerations can be discussed and any adjustments to the management plan, made. This gives the opportunity for numerous MFMA aspects, such as zone boundaries and catch limits quotas, to be enlarged or reduced in accordance with changes in the previous year.



## IX. Conclusion

With all necessary data now collected, the creation of the Marine Fisheries Management Area and associated Zoning Plan can be finalised to efficiently protect the fragile habitats and fisheries resources surrounding the islands of Koh Seh, Koh Pou, Koh Mak Prang and Koh Angkrong. Encouraging results of reef surveys around Koh Seh each year since MCC began its project on the island indicate that within one year of protection, fish stocks (particularly predatory species) and other populations can increase dramatically – a positive outlook for the implementation of the MFMA. Accordingly, key ecosystems of relatively denser marine stocks, such as degraded and susceptible coral reefs and seagrass beds, have been identified for more intense protection. The four kilometre distance from the Conservation Zones to the Multi-Use Zone will enhance the level of protection, by safeguarding vulnerable ecosystems against the adverse impacts of sedimentation.

Local communities who depend on fisheries for their livelihoods shall be involved in both the planning and management of the MFMA. Conservation Zones are the highest priority zone in this draft, however a large amount of area is available for small-scale family fishing. MCC anticipates the support of such communities as for a number of years many locals have acted alongside the organisation to attempt to deal with IUU and overfishing.

The significance of an MFMA in the Kep Archipelago will be shown in resultant biological and economic improvement in the region. Protection from IUU, destructive catch methods and overfishing will allow for undisturbed environmental rejuvenation within the Protected Zones. In turn, a great 'spill-over' of marine resources into surrounding waters will increase catch over time for local fishers (see 'Spill-Over' effect pp. 49), allowing them to improve their economic standing using fishing techniques which can be sustained for many years to come. In order to ensure the progress is continual, MFMA plans will be adaptable and accessible for change each year over a meeting including all stakeholders and researchers.

Currently the primary recommendation for the MFMA proposes an area of protected coral reefs and seagrass beds. This would be the ideal mapping of management areas as it allows for greatest ecosystem recovery within the Kep Archipelago. Through the rejuvenation of trophic levels – from primary producers through to predatory fish and mammals – 'spill-over' of stocks into fishing zones will bring long term benefits to local communities. With prolonged management and correct law enforcement, stocks will rise to a level where they can be sustainably fished by generations to come whilst maintaining a healthy biodiversity and attracting marine ecotourism.

## References:

- Ahmed, A & Chanthana, Y 2015, *Environmental Impacts Assessment of Marine Fisheries Related Activities in Cambodia*, presented at: Study Validation Workshop, Phnom Penh, Cambodia.
- Andrew, N & Evans, L 2009, Approaches and frameworks for management and research in small-scale fisheries in the developing world, WorldFish.
- Asian Development Bank 1999, 'Draft strategic plan for coastal marine and environmental management', *Coastal and marine management in the South China Sea*, Asian Development Bank.
- Bailey, S 2012, *Effectiveness Monitoring Program: Plan and Protocols*, Tillamook Estuaries Partnership, Oregon, U.S.A.
- Bangkok Post 2009, '(Koh Kong fishing) Ban reflects decline in stocks', *Bangkok Post*, Bangkok, Thailand.
- Bergh, P & Davies, S 2002, 'Chapter 8: Fishery Monitoring, Control and Surveillance', In: Cochrane, K 2002, *A Fishery Manager's Guidebook – Management Measures and Their Application*, Fisheries and Aquaculture Department, FAO, Rome, <[www.fao.org/docrep/005/y3427e/y3427e0a.htm](http://www.fao.org/docrep/005/y3427e/y3427e0a.htm)>
- Burke, L, Selig, L & Spalding, M 2002, 'Reefs at Risk in Southeast Asia', Washington DC: World Resources Institute.
- Bustamante, G, Purificacion, C, Di Cario, G, Gomei, M, Romani, M, Souan, H & Vanzella-Khoury, A 2014, 'Marine protected areas management in the Caribbean and Mediterranean seas: making them more than paper parks', *Aquatic Conservation: Marine and Freshwater Ecosystems*, vol. 24, no. 2.
- Cesar, H, Bourke, L & Pet-Soede, L 2003, *The Economics of World Wide Coral Reef Degradation*, Cesar Environmental Economics Consulting, Arnhem, WWF Netherlands, Zeist, Netherlands, pp. 23, online at: <<http://assets.panda.org/downloads/cesardegradationreport/100203.pdf>>
- Chevillard, J 2014, Phnom Penh Post, Phnom Penh.
- Churchill, J 1989, 'The effect of commercial trawling on sediment resuspension and transport over the Middle Atlantic Bight continental shelf', *Continental Shelf Research*, vol. 9, no. 9, pp. 841 – 865.
- Clark S & Kirkman H 1989, 'Biology of sea-grasses', *A treatise on the biology of seagrasses with special reference to the Australian region Elsevier*, Amsterdam, pp. 304-335.
- Crosby, M & Reese, E 1996, *A manual for monitoring coral reefs with indicator species: Butterflyfishes as Indicators of Change on Indo-Pacific Reefs*, Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration, Silver Spring, MD.
- Director General of Fisheries Administration 2007, Fisheries Administration, Ministry of Agriculture Forestry and Fisheries Phnom Penh, <[http://www.fia.gov.kh/english/index.php?page=director\\_general](http://www.fia.gov.kh/english/index.php?page=director_general)>
- Duplain, D & Haisoune, A 2015, 'The mysterious life of Mister K: a seahorse life history study in Cambodia', *National Geographic Voices – Ideas and Insight from Explorers*,

[voices.nationalgeographic.com/2015/03/the-mysterious-life-of-mister-k-a-seahorse-life-history-study-in-cambodia](http://voices.nationalgeographic.com/2015/03/the-mysterious-life-of-mister-k-a-seahorse-life-history-study-in-cambodia)>

Diamond, J, Blanco, V & Duncan, R 2012, 'Knowing sea turtles: local communities informing conservation in Koh Rong Archipelago, Cambodia', *Cambodian Journal of Natural History*, vol. 2012, no.2, pp. 131 – 140.

European Commission 2015, *European Commission – Fact Sheet*, Brussels, Belgium, <[www.europa.eu](http://www.europa.eu)>

European Union (EU) 2014, 'MIP 2014-2020 – Cambodia Summary', <[ec.europa.eu/transparency/regcomitology/index.cfm?do=Search.getPDF&NDEkks+7lpDt1lp74nJq6lqBB7fl4EnisQ1BdEUO8vCyEZEdggz=n4JOVUqYppXe7kGvLzo2Pu5uyjPyPE0HGhn1Yyu8a5hceFqN5ixnqYi=>](http://ec.europa.eu/transparency/regcomitology/index.cfm?do=Search.getPDF&NDEkks+7lpDt1lp74nJq6lqBB7fl4EnisQ1BdEUO8vCyEZEdggz=n4JOVUqYppXe7kGvLzo2Pu5uyjPyPE0HGhn1Yyu8a5hceFqN5ixnqYi=>)>

Fisheries Administration 2011, *The Strategic Planning Framework of Fisheries: 2010 – 2019*, Ministry of Agriculture, Forestry and Fisheries, Phnom Penh, Kingdom of Cambodia.

Fisheries and Aquaculture Department 2011, *Fisheries & Aquaculture Country Profiles: The Kingdom of Cambodia*, Food and Agriculture Organization of the United Nations, United Nations, Rome.

FAO 1981, *Report on an expert consultation on monitoring, control and surveillance systems for fisheries management*, Rome, pp. 115.

Fisheries Administration 2016, *Senior expert to support FiA in developing Cambodia's National Plan of Action (NPOA) to prevent, deter and combat Illegal, Unreported and Unregulated (IUU) fishing and to manage Cambodia's fishing capacity in the Cambodian EEZ and in the High Seas*, Phnom Penh, Cambodia.

Fisheries Administration 2006, *National Action Plan for Coral Reef and Seagrass Management in Cambodia 2006-2015*, Phnom Penh.

2016, *Fishing Vessel Registration, Licensing and Regional Fishing Vessels Record (RFVR)*, presented at: The Stakeholders Consultation on Regional Cooperation in Sustainable Fisheries Development Towards the ASEAN Economic Community, Bangkok.

Fuller, K, Kling, D, Kroetz, K, Ross, N & Sanchirico, J 2013, 'Economic and Ecology of Open-Access Fisheries', In: Shogren, J, (ed.) *Encyclopaedia of Energy, Natural Resource, and Environmental Economics*, Vol. 2 *Encyclopaedia of Energy, Natural Resource, and Environmental Economics*, pp.39-49, Elsevier, Amsterdam.

Funge-Smith, S 2016 (former Senior Fishery Officer FAO RAP and former Secretary AFIC), *International fight against IUU fishing*, present at: Fisheries Administration of Cambodia Consultation on IUU, Phnom Penh, Cambodia.

Gillet, R 2004, *The marine fisheries of Cambodia*, FAO, Rome.

Guidetti, P 2006, 'Marine Reserves Re-established, Lost Predatory Interactions and Cause Community Changes in Rocky Reefs', *Ecological Applications*, vol. 16, no. 3, pp. 963-976.

Hodgeson, G 1990, 'Sediment and the Settlement of Larvae of the Reef Coral *Pocillopoardamicornis*', *Coral Reefs*, vol. 9, no. 1, pp. 41-43.

ICEM - International Centre for Environmental Management 2003, Cambodia National Report on Protected Areas and Development, ICEM, Indooroopilly, Australia.

*IUU in Cambodia*, January 2016, Kampongsom, Sihanouk Province, Cambodia.

Liger Learning Centre 2016, *Proposal for a Feasibility Study of Algal Farming as an Alternative Livelihood for Cambodian Fishermen*, Liger Learning Centre, Ta Khmau, Phnom Penh, Cambodia.

Lourie, S, Foster, S, Cooper, E & Vincent, A 2004, *A Guide to the Identification of Seahorses*, Project Seahorse and TRAFFIC North America, Washington D.C.: University of British Columbia and World Wildlife Fund.

Mam, K 2002, 'Coral Reef and Seagrass in Cambodia', *Wetland Science and Practice*, vol. 19, no. 1, pp. 18 - 21.

Hutchinson, J, Manica, A, Swetnan, R, Balmford, A & Spalding, M 2013, 'Predicting Global Patterns in Mangrove Forest Biomass', *Conservation Letters*, vol. 7, no. 3, pp. 233 – 240.

MCC 2015, 'Strategic environmental assessment of the proposed marine protected area, Kep Archipelago, Cambodia', Kep Province, Cambodia.

MCC 2014, 'Initial environmental assessment of three islands in the Kep Archipelago, Cambodia, and recommendations for future sustainable use of the area', Kep Province, Cambodia.

Monyneath, V 2001, *The status of Cambodia's coastal and marine environments; emerging policies and management strategies*, presented at: International Symposium on Protection and Management of Coastal Marine Ecosystems.

MRAG 2009, *Illegal, Unreported and Unregulated Fishing*, Policy brief 8, <[www.mrag.co.uk/Documents/PolicyBrief8\\_IUU.pdf](http://www.mrag.co.uk/Documents/PolicyBrief8_IUU.pdf)>

National FiA 2016, *Expert Consultation Workshop on Cambodia Marine Fishing Capacity and Illegal Unreported and Unregulated (IU) Fishing*, Kampongsom, Sihanouk Province, Cambodia.

O'Leary, J & McClanahan T 2010, 'Trophic cascades result in large scale coralline algae loss through differential grazers', *Ecology*, vol. 91, no. 12, pp. 3584 – 3597.

Orth, R, Carruthers, T, Dennison, W, Duarte, C, Fourqurean, J, Heck Jr., K, Hughes, A, Kendrick, G, Kenworthy, W, Olyarnik, S, Short, F, Waycott, M & Williams, S 2006, 'A Global Crisis for Seagrass Ecosystems', *BioScience*, vol. 56, no. 12, pp. 987.

Poiner, I, Walker, D & Coles, R 1989, 'Regional studies seagrasses of tropical Australia', In: *Biology of Seagrasses* (eds. A W D Larkum, A J McComb & S A Shepherd), Elsevier, Amsterdam, pp. 279-303.

Preen, A, Marsh, H, Lawler, I, Prince, R & Shepherd, R 1997, 'Distribution and Abundance of Dugongs, Turtles, Dolphins and other Megafauna in Shark Bay, Ningaloo Reef and Exmouth Gulf, Western Australia', *Wildlife Research*, vol. 24, pp. 185–208.

- Rizvi & Singer 2011, 'Cambodia Coastal Situation Analysis', *Coastal Southeast Asia no.6*, IUCN.
- Rogers, C 1990, 'Responses of coral reefs and reef organisms to sedimentation', *Marine Ecology Progress Series*, vol. 62, pp. 185 – 202.
- Royal Government of Cambodia Fisheries Administration 2016, *Fisheries Annual Work Plan 2016*, Phnom Penh.
- RPOA-IUU 2016, *Welcome to RPOA-IUU Website*, Jakarta, Indonesia, <  
<http://rpoaiuu.org/index.php/en/>>
- Russ, G & Alcala, A 2001, 'Enhanced Biodiversity Beyond Marine Boundaries; The Cup Spillith Over', *Ecology Applications*, vol. 21, no. 1, pp. 241-250.
- Sale, P, Cowen, R, Danilowicz, B, Jones, G, Kritzer, J, Lindeman, K, Planes, S, Polunin, N, Russ, G, Sadovy, Y & Steneck, R 2005, 'Critical science gaps impede the use of no-take fishery reserves', *Trends in Ecology and Evolution*, vol. 20, no. 2, pp. 74- 80.
- SEAFDEC 2016a, *Combating IUU Fishing and Enhancing the Competitiveness of ASEAN Fish and Fishery Products*, presented at: The Stakeholders Consultation on Regional Cooperation in Sustainable Fisheries Development Towards the ASEAN Economic Community, Bangkok, Thailand.
- SEAFDEC 2016b, *Recommendations on the Practical Steps Towards the Issues for Combating IUU Fishing and Enhancing the Competitiveness of ASEAN Fish and Fishery Products*, presented at: The Stakeholders Consultation on Regional Cooperation in Sustainable Fisheries Development Towards the ASEAN Economic Community, Bangkok, Thailand.
- SEAFDEC 2016c, *Fishing Vessel Registration, Licensing, and Regional Fishing Vessels Record (RFVR)*, presented at: The Stakeholders Consultation on Regional Cooperation in Sustainable Fisheries Development Towards the ASEAN Economic Community, Bangkok, Thailand.
- SEAFDEC Secretariat 2016, *SEAFDEC initiatives in combating IUU fishing in ASEAN region*, Expert Consultation on Cambodia Marine Fishing Capacity and Illegal, Unreported and Unregulated (IUU) Fishing, Kampong Som, Sihanouk Province, Cambodia.
- Siddig, A, Ellison, A, Ochs, A, Villar-Leeman, C & Lau, M 2016, 'How do ecologists select and use indicator species to monitor ecological change? Insights from 14 years of publication in *Ecological Indicators*', *Ecological Indicators*, vol. 60, pp. 223 – 230.
- Siriraksophon, S 2016, *Managing Fishing Capacity and Improving Fishing Licensing through E-System for FiA Cambodia*, Expert Consultation on Cambodia Marine Fishing Capacity and Illegal, Unreported and Unregulated (IUU) Fishing, Kampong Som, Sihanouk Province, Cambodia.
- Styllis, G & Sothear, K 2014, 'Vietnam's Fish Industry Dominates in Cambodia', *The Cambodia Daily*, Phnom Penh, Cambodia.
- Treml, E, Ford, J, Black, K & Swearer, S 2015, 'Identifying the key biophysical drivers, connectivity outcomes, and meta-population consequences of larval dispersal in the sea', *Movement Ecology*, vol. 3, no. 1, pp. 17.

Trono Jr., G 1998, 'Seaweeds', *The Living Marine Resource of the Western Central Pacific, Volume 1: Seaweeds, corals, bivalves and gastropods*, Food and Agricultural Organization of the United Nations, Rome.

United Nations Industrial Development Organisation 2015, *Cambodia Export Diversification and Expansion Program – Marine Fisheries Component*, 'Value Chain Assessment of Marine Fisheries Sector and Roadmap for Development', United Nations, Vienna, Austria.

Vuth, CS 2008, 'Message by Governor of Kampot Province', *Seagrass Management Plan for Kampot Province, Kingdom of Cambodia (2006-2015)*, Kampot Province, Cambodia.

Wheeler, M, McNamee, PJ & Kosal M 2000, *Objectives off ADB5712REG Coastal and Marine Environmental Management in the South China Seas, PHASE II- CAMBODIA COMPONENT*, presented at: 'International Symposium on Protection and Management of Coastal Marine Ecosystem'.

## Annex 1: Questionnaire used in fishing community interviews.

### PART 1 – SOCIO-ECONOMIC & DEMOGRAPHICS

ផ្នែកទី១ សង្គមសេដ្ឋកិច្ច និងប្រជាសាស្ត្រ

H1. Family name ឈ្មោះអ្នកផ្តល់សម្ភាសន៍: \_\_\_\_\_

\_\_\_\_\_

H2. When did you arrive in the village (year)? តើអ្នកមករស់នៅទីនេះតាំងពីពេលណា? \_\_\_\_\_

\_\_\_\_\_

H2.1 From where (what is your home land)? មកពីទីណា (ស្រុកកំណើតអ្នកនៅទីណា?) \_\_\_\_\_

\_\_\_\_\_

H2.2 why did you leave your home land? ហេតុអ្វីអ្នកចាកចេញពីស្រុកកំណើត? \_\_\_\_\_

\_\_\_\_\_

H2.3 Since you moved here, have more people moved to the village? If yes, how many? \_\_\_\_\_

\_\_\_\_\_

H2.4 If more people have moved here, are they fishermen? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

H3. How many family members do you have and live near you nowadays?

តើអ្នកមានសមាជិកដែលរស់នៅជាមួយអ្នកប៉ុន្មាននាក់? \_\_\_\_\_

\_\_\_\_\_

Name	Age	Gender (M/F)	Ethnicity ជនជាតិ (Khmer ខ្មែរ, Cham ចាម, other	Religion សាសនា: Buddhist ព្រះពុទ្ធ (B), Muslim មូស្លីម (M), other	Language ភាសា	Education ការអប់រំ (Read/write អាន/សរ សេរ, Number of	Occupation 1 មុខរបរទី១ (\$\$\$\$\$) & where do you sell?	Occupation 2 មុខរបរទី២ (\$\$\$\$\$) & where do you sell?	Occupation 3 មុខរបរទី៣ (\$\$\$\$\$) & where do you sell?
ឈ្មោះ	អាយុ	ភេទ							

			ផ្សេងៗ .....)				ផ្សេងៗ (O)				year ថ្នាក់ (.....)		តើអ្នកលក់ ផលិតផល នៅទីណា?	តើអ្នកលក់ ផលិតផលនៅទី ណា?	តើអ្នកលក់ ផលិតផលនៅទី ណា?
		M	F	K	C		B	M	O		R	W			
		M	F	K	C		B	M	O		R	W			
		M	F	K	C		B	M	O		R	W			
		M	F	K	C		B	M	O		R	W			
		M	F	K	C		B	M	O		R	W			

- ❖ Where do you sell? តើអ្នកលក់ផលិតផលនៅទីណា?
- Product is use by the family only: write “family” ផលិតផលប្រើសំរាប់តែគ្រួសារ: សរសេរ “គ្រួសារ”
  - Product is sent and sold not too far (other island, in province): write the name of place ផលិតផលលក់នៅទីកន្លែងមិនឆ្ងាយ (តាមកោះផ្សេងៗ....., នៅក្នុងខេត្ត) សរសេរឈ្មោះទីកន្លែង
  - Product is sent and sold in other province or in Phnom Penh: write the name of the province or Phnom Penh ផលិតផលលក់ទៅខេត្តផ្សេងៗ រឺរាជធានីភ្នំពេញ: សរសេរឈ្មោះខេត្ត រឺរាជធានីភ្នំពេញ
  - Product is sent and sold to another country: write the name of the country ផលិតផលលក់ទៅក្រៅប្រទេស: សរសេរឈ្មោះប្រទេស
- Do you want your children to become fishermen or attend to high education?.....
- .....
- .....
- .....
- .....
- Do you think that children should learn about marine conservation? Why? .....
- .....
- .....
- .....
- .....
- Have you ever talk to your children or family about marine conservation? Yes No



## PART 2 – FISHING PRATICES

### ផ្នែកទី២ សកម្មភាពនេសាទ

**F1.** Are you or member of your family is a fisherman? តើអ្នក

រឺសមាជិកគ្រួសាររបស់អ្នកជាគ្រួសារដែលនេសាទមែនទេ? ☐Yes បាទ/ចាស

☐No ទេ

**IF NO បើទេ:** F.1.1 Were you or a member of your family is a fisherman before? តើអ្នក

រឺសមាជិកគ្រួសាររបស់អ្នកជាគ្រួសារដែលនេសាទកាលពីមុនរឺទេ? ☐Yes បាទ/ចាស

☐No ទេ

**IF F.1.1: NO ទេ Skip all in questionnaire បញ្ចប់ការសួរ**

**IF F.1.1: YES បើបាទ:** F.1.2.1 Are you still fishing nowadays? តើសព្វថ្ងៃអ្នកនៅនេសាទរឺទេ? ☐Yes

បាទ/ចាស ☐No ទេ

**IF F.1.2.1: NO បើទេ:** F.1.2.2 when and why did you stop? តើឈប់នេសាទតាំងពីពេលណា

ហើយហេតុអ្វីបានជាឈប់នេសាទ? \_\_\_\_\_

\_\_\_\_\_

**F2.** What are the fishing gears that you use nowadays? តើសព្វថ្ងៃអ្នកប្រើប្រាស់ឧបករណ៍អ្វី?

\_\_\_\_\_

**F3.** How long that you use this gears? តើអ្នកប្រើឧបករណ៍ដែលអ្នកប្រើរាល់រយៈពេលប៉ុន្មានហើយ?

\_\_\_\_\_

\_\_\_\_\_

**F4.** What is the gear that you use before? When and why you stop that last gears?

តើកាលពីមុនអ្នកប្រើឧបករណ៍អ្វី? ពេលណា និងមូលហេតុអ្វីបានជាអ្នកឈប់?

\_\_\_\_\_

\_\_\_\_\_

**F5: Detail on boat and fishing gears** ភាពលំអិតលើទូក និងឧបករណ៍នេសាទ

Type of boat ប្រភេទទូក	Number of boat លេខទូក	Number of engine and power (horsepower HP) លេខម៉ាស៊ីនកំលាំងម៉ាស៊ីន	Are you: តើអ្នក: Owner of the boat ជាម្ចាស់ទូក (o) and/or captain រឺជាអ្នកបើកទូក (C) or crew member រឺជាកូនដៃទូក (CM)?			Type of fishing gear: ប្រភេទឧបករណ៍នេសាទ: line សន្ទូចរនង (L), trap លប (T) or nets សំណាញ់ (N)			Species you want to catch: ប្រភេទដែលចាប់បាន fish ត្រី (F), shrimp បង្កា (S), crab ក្អាម (C), octopus មីក (O) other ផ្សេងៗ .....					Your fish for: ផលនេសាទ អ្នកសំរាប់: family គ្រួសារ (F) or to sell លក់ (M)?	
Paddle-boat ទូកថ្នោល			O	C	CM	L	T	N	F	S	C	O		F	M
Long-tail boat ទូកកន្ទុយវែង			O	C	CM	L	T	N	F	S	C	O		F	M
Trawling boat ទូកអូស			O	C	CM	L	T	N	F	S	C	O		F	M
Other boat (precise) ទូកផ្សេងៗ(បញ្ជាក់) .....			O	C	CM	L	T	N	F	S	C	O		F	M

**F5.1** If you sell your products to somebody outside the island, do they sell them to other people? If so, where are the products sold?

\_\_\_\_\_

**F5.2** Do you use the fishing gear “only one gears for full of the year or more gears for your fishing trip for full gear or changing the gear by the season of the highly of catch for each species or what other .....”? \_\_\_\_\_

\_\_\_\_\_

តើអ្នកប្រើប្រាស់ឧបករណ៍នេសាទ “តែមួយប្រភេទពេញៗឆ្នាំ

រីចេញនេសាទម្តងមានឧបករណ៍នេសាទច្រើន

វិធីសាស្ត្រឧបករណ៍នេសាទទៅតាមរដូវដែលផលនេសាទប្រភេទណាមួយសំបូរ?”

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---

**F5.3      How      many      people      work      on      the      fishing      boat?**

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**F5.4 If you are the owner/captain, how many people work for you? Are they relatives?**

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**F5.5      Where      do      you      get      your      bait?      What      is      the      bait?**

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**F6: Detail on fishing gears លំអិតលើឧបករណ៍នេសាទ**

**F6.1 if fishing with line: បើអ្នកនេសាទប្រើសន្លូចរនង**

Type of line ប្រភេទសន្លូចរនង (squid line, octopus line សន្លូចរនងខ្យង, long line សន្លូចរនងវែង.....)	Number of line  ចំនួនរនង	Number and size hooks  ចំនួន ផ្លែ និងទំហំ	How long do you go fishing when you use lines?  តើអ្នកប្រើរយៈពេលប៉ុន្មានក្នុងការ នេសាទ?					If you leave the line and pick it up later (octopus line for example), how long do you line in the water?  ប្រសិនបើអ្នកទំលាក់រនងចោល តើរយៈពេលប៉ុន្មានទើបទៅសារវិញ?					
			1-2 hours  ១ ទៅ ២ថ្ងៃ	2-3 hours  ២ ទៅ ៣ថ្ងៃ	4-5 hours  ៤ទៅ ៥ថ្ងៃ	5-6 hours  ៥ទៅ ៦ថ្ងៃ	6-7 hours  ៦ទៅ ៧ថ្ងៃ	7-8 hours  ៧ ទៅ ៨ថ្ងៃ	8-9 hours  ៨ ទៅ ៩ថ្ងៃ	½ day  ½ ថ្ងៃ	1 day  ១ ថ្ងៃ	1-2 days  ១ទៅ ២ថ្ងៃ	>2 days  លើ សពី ២ថ្ងៃ
			1-2 hours  ១ ទៅ ២ថ្ងៃ	2-3 hours  ២ ទៅ ៣ថ្ងៃ	4-5 hours  ៤ទៅ ៥ថ្ងៃ	5- 6 hours  ៥ទៅ ៦ថ្ងៃ	6-7 hours  ៦ទៅ ៧ថ្ងៃ	7-8 hours  ៧ ទៅ ៨ថ្ងៃ	8-9 hours  ៨ ទៅ ៩ថ្ងៃ	½ day  ½ ថ្ងៃ	1 day  ១ ថ្ងៃ	1-2 days  ១ទៅ ២ថ្ងៃ	>2 days  លើ សពី ២ថ្ងៃ

**F6.2 if fishing with traps: បើអ្នកនេសាទប្រើលប**

Type of traps ប្រភេទលប (fish traps លបគ្រី, crap traps-wood or metal លបក្តាម-ឈើ រីដេក, squid traps.....)	Number of traps ចំនួនលប	If you leave the line and pick it up later (octopus line for example), how long do you line in the water? ប្រសិនបើអ្នកទំលាក់, តើរយៈពេលប៉ុន្មានទើបទៅសារវិញ?			
		½day ½ ថ្ងៃ	1 day ១ ថ្ងៃ	1 to 2 days ១ទៅ២ថ្ងៃ	More than 2 dayលើសពី២ថ្ងៃ
		½day ½ ថ្ងៃ	1 day ១ ថ្ងៃ	1 to 2 days ១ទៅ២ថ្ងៃ	More than 2 days លើសពី២ថ្ងៃ

**F6.2** if fishing with net បើអ្នកនេសាទប្រើមង

Type of nets ប្រភេទមង (fish nets មងត្រី, crab nets មងក្តាម, trawl net) អ្នកអូស ....)	Bottom (B) or surface (s) net? ស្រទាប់បាត វិផ្ទៃលើ?		Number of nets ចំនួនមង	Length of each nets (meters or kilometers) ប្រវែងសំណាញ់ មួយៗ (ម៉ែត្រ វិគីឡូម៉ែត្រ)	Size of mesh ទំហំក្រឡា	If you leave the line and pick it up later (octopus line for example), how long do you line in the water?  ប្រសិនបើអ្នកទំលាក់, តើរយៈពេលប៉ុន្មានទើបទៅសារវិញ?			
	B បាត	S ផ្ទៃលើ				½day ½ ថ្ងៃ	1 day ១ ថ្ងៃ	1 to 2 days ១ទៅ២ ថ្ងៃ	More than 2 days លើសពី២ ថ្ងៃ
	B បាត	S ផ្ទៃលើ				½day ½ ថ្ងៃ	1 day ១ ថ្ងៃ	1 to 2 days ១ទៅ២ ថ្ងៃ	More than 2 days លើសពី២ ថ្ងៃ

**F7.** How much do you catch per fishing trip?

តើពេលចេញនេសាទមួយដងអ្នកបានផលនេសាទប៉ុន្មាន?

**F7.1 if fishing with line បើនេសាទដោយប្រើសន្លឺចរនដ**

Type of line # 1  ប្រភេទសន្លឺចរនដ #១	Species you catch the most  ប្រភេទដែលអ្នកតែងតែចាប់បាន	How much do you usually catch (kilograms)?  តើជាធម្មតាអ្នកចាប់ប៉ុន្មានគីឡូក្រាម?	The month that highly catch. How much you can catch?  តើខែណាដែលប្រភេទនេះសំបូរហើយចេញនេសាទម្តងបានប៉ុន្មានគីឡូក្រាម?		The month that lower catch. How much you can catch?  តើខែណាដែលប្រភេទនេះខ្សត់ហើយចេញនេសាទម្តងបានប៉ុន្មានគីឡូក្រាម?		Do you catch: less than before or more than before? Why? តើអ្នកចាប់បានច្រើនជាងមុន ឬតិចជាងមុន?	
	Species 1: ប្រភេទ ១:		Month  ខែ		Month  ខែ		Less តិច	More ច្រើន
	Species 2: ប្រភេទ ២:		Amount បរិមាណ		Amount បរិមាណ		Reason មូលហេតុ ..... .....  ..... ..... .....	

Type of line # 2  ប្រភេទសន្លូតរនង #១	Species you catch the most  ប្រភេទដែលអ្នកតែងតែចាប់បាន	How much do you usually catch (kilograms)?  តើជាធម្មតាអ្នកចាប់ប៉ុន្មានគីឡូក្រាម?	The month that highly catch. How much you can catch?  តើខែណាដែលប្រភេទនេះសំបូរហើយចេញនេសាទម្តងបានប៉ុន្មានគីឡូក្រាម?		The month that lower catch. How much you can catch?  តើខែណាដែលប្រភេទនេះខ្សត់ហើយចេញនេសាទម្តងបានប៉ុន្មានគីឡូក្រាម?		Do you catch: less than before or more than before? Why?  តើអ្នកចាប់បានច្រើនជាងមុន ឬតិចជាងមុន?	
	Species 1: ប្រភេទ ១:		Month ខែ		Month ខែ		Less តិច	More ច្រើន
	Species 2: ប្រភេទ ២:		Amount បរិមាណ		Amount បរិមាណ		Reason មូលហេតុ ..... .....  ..... ..... .....	

**F7.2** if fishing with traps បើនេសាទដោយប្រើឈប

<p>Species you catch the most</p> <p>ប្រភេទដែលអ្នកតែងតែចាប់បាន</p>	<p>How much do you usually catch (kilogram)?</p> <p>តើជាធម្មតាអ្នកចាប់ប៉ុន្មានគីឡូក្រាម?</p>	<p>The month that highly catch. How much you can catch?</p> <p>តើខែណាដែលប្រភេទនេះសំបូរ ហើយចេញនេសាទម្តងបានប៉ុន្មានគីឡូក្រាម?</p>	<p>The month that lower catch. How much you can catch?</p> <p>តើខែណាដែលប្រភេទនេះខ្វះខាត ហើយចេញនេសាទម្តងបានប៉ុន្មានគីឡូក្រាម?</p>	<p>Do you catch: less than before or more than before? Why?</p> <p>តើអ្នកចាប់បានច្រើនជាងមុន រឺតិចជាងមុន?</p>			
<p>Species 1:</p> <p>ប្រភេទ ១:</p>		<p>Month</p> <p>ខែ</p>		<p>Month</p> <p>ខែ</p>		<p>Less តិច</p>	<p>More ច្រើន</p>
<p>Species 2:</p> <p>ប្រភេទ ២:</p>		<p>Amount</p> <p>បរិមាណ</p>		<p>Amount</p> <p>បរិមាណ</p>		<p>Reason</p> <p>មូលហេតុ.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>...</p>	



**F.7.3** if fishing with nets បើនេសាទដោយប្រើមង

Type of net #1 ប្រភេទមង #១	Species you catch you catch the most ប្រភេទដែលអ្នក តែងតែចាប់បាន ន	How much do you usually catch (kilogram)? តើជាធម្មតាអ្នក ចាប់ប៉ុន្មានគីឡូ ក្រាម?	The month that highly catch. How much you can catch? តើខែណាដែលប្រភេទ នេះសំបូរ ហើយចេញនេសាទ ម្តងបានប៉ុន្មានគី ឡូក្រាម?		The month that lower catch. How much you can catch? តើខែណាដែលប្រភេទ នេះខ្សត់ ហើយចេញនេសាទ ម្តងបានប៉ុន្មានគី ឡូក្រាម?		Do you catch: less than before or more than before? Why? តើអ្នកចាប់បានច្រើន ជាងមុន វិចិត្រជាងមុន?	
	Species 1: ប្រភេទ ១:		Month ខែ		Month ខែ		Less តិច	More ច្រើន
	Species 2: ប្រភេទ ២:		Amount បរិមាណ		Amount បរិមាណ		Reason មូលហេតុ ..... .....  ..... ..... ...	

Type of net #2 ប្រភេទមង #១	Species you catch you catch the most ប្រភេទដែលអ្នក តែងតែចាប់បាន	How much do you usually catch (kilogram)? តើជាធម្មតាអ្នក ចាប់ប៉ុន្មានគីឡូ ក្រាម?	The month that highly catch. How much you can catch? តើខែណាដែលប្រភេទ នេះសំបូរ ហើយចេញនេសាទ ម្តងបានប៉ុន្មានគី ឡូក្រាម?		The month that lower catch. How much you can catch? តើខែណាដែលប្រភេទ នេះខ្វះខាត ហើយចេញនេសាទ ម្តងបានប៉ុន្មានគី ឡូក្រាម?		Do you catch: less than before or more than before? Why? តើអ្នកចាប់បានច្រើន ជាងមុន រឺតិចជាងមុន?	
	Species 1: ប្រភេទ ១:		Month ខែ		Month ខែ		Less តិច	More ច្រើន
	Species 2: ប្រភេទ ២:		Amount បរិមាណ		Amount បរិមាណ		Reason មូលហេតុ ..... ..... ..... ..... ...	

**PART 3 – EDUCATION OF PEOPLE ON THE ADVANTAGE OF FISHERY RESOURCE**

ផ្នែកទី ៣ ចំនេះដឹងរបស់ប្រជាជនទៅលើសារៈប្រយោជន៍នៃធនធានជលផល

**F7. If you go fishing: Do you think that because of making the Community Fishing Area, Conservation Area, so there more fish/crabs/squids than before?** ☐ Yes ☐ No ☐ Same

ប្រសិនបើអ្នកទៅនេសាទ: អ្នកគិតថាមកពីការបង្កើតសហគមន៍នេសាទ, តំបន់អភិរក្សផ្សេងៗ ដែលធ្វើអោយសំបូរ ត្រី ក្តាម ជាងពីមុន? ☐ បាទ/ចាស ☐ ទេ ☐ ដូចគ្នា

**F8. How many days per week do you go fishing (average)?** ☐ 1 to 3 days ☐ 3 to 5 days ☐ 5 to 7 days

ក្នុងមួយសប្តាហ៍តើអ្នកនេសាទប៉ុន្មានថ្ងៃ (ជាមធ្យម)? ☐ ១ ទៅ ៣ ថ្ងៃ ☐ ៣ ទៅ ៥ ថ្ងៃ ☐ ៥ ទៅ ៧ ថ្ងៃ

**F9. What do you think are the main problem in the area of sea?**

តើអ្នកគិតថាបញ្ហាសំខាន់អ្វីខ្លះដែលកើតមាននៅតំបន់សមុទ្រ?

☐ Destructive fishing techniques ការបំផ្លាញដោយបច្ចេកទេសនេសាទ

☐ Foreign illegal fishing and poaching (poaching: Vietnamese boats)

ការនេសាទខុសច្បាប់ពីបរទេស និងការចូលមកដោយខុសច្បាប់ (នេសាទខុសច្បាប់: ទូកវៀតណាម)

☐ Anchoring on the coral reef: destroy where the fish can reproduce

ការបោះយុទ្ធការលើផ្កាថ្ម: បំផ្លាញតំបន់ដែលត្រីរស់នៅ

☐ Conflict between fishing boat and tourist boat ជំលោះរវាងទូកនេសាទ

និងទូកទេសចរណ៍

☐ Conflict between small fishing boat and big fishing boat, Example: traps are broken or destroy by bigger fishing boat with big fishing gears like trawl ....

ជំលោះរវាងទូកនេសាទតូចៗ និងទូកនេសាទធំៗ ឧទាហរណ៍ លបត្រូវបំផ្លាញ និងបាត់ដោយសារទូកនេសាទធំៗ ហើយមានឧបករណ៍ធំៗ ដូចជា ទូកអូសជាដើម

☐ Pollution, Example: garbage thrown at sea, dirty water.... ការបំពុល: សំរាម ទឹកខ្វក់

☐ The Fisheries law is not well enforced / the police does not control often enough

ការអនុវត្តច្បាប់ជលផលនៅមានកំរិត / ប៉ូលីសដឹងទឹកមិនបានល្អាតពេញលេញ

☐ Climate change បំប្លែងអាកាសធាតុ

**F10.** Is there any illegal fishing in you village or fishing community or another area of KEP's sea? ☐

Yes ☐ No

តើមានបទល្មើសនេសាទនៅក្នុង ភូមិ សហគមន៍នេសាទ

រឺក៏តំបន់ណាមួយនៅក្នុងសមុទ្រខេត្តកែបរឺទេ? ☐ បាទ/ចាស ☐ ទេ

**F11.** What is the illegal fishing that occurring in you village or fishing community or another area of KEP's sea?

តើមានបទល្មើសនេសាទអ្វីដែលមាននៅក្នុង ភូមិ សហគមន៍នេសាទ

រឺក៏តំបន់ណាមួយនៅក្នុងសមុទ្រខេត្តកែប?

☐ Trawl in the shallow water ទូកអូសទឹករាក់ ☐ Small mesh net មងក្រឡាតូច ☐

Electricity ការប្រើអគ្គិសនី (ឆក់) ☐ Long trap that have small mesh (look like mouse tail)

លបកន្តយកន្តរ

☐ Other ផ្សេងៗ .....

**F12.** How often that the illegal fishing occurring in you village or fishing community or another area of KEP's sea? (Days in week or month)

តើមានបទល្មើសនេសាទមាននៅក្នុង ភូមិ សហគមន៍នេសាទ  
 រីកតំបន់ណាមួយនៅក្នុងសមុទ្រខេត្តកែប កំរិតណា? (ថ្ងៃក្នុង១សប្តាហ៍)

☐ Trawl in the shallow water ទូកអូសទឹករាក់ \_\_\_\_\_  
 \_\_\_\_\_

☐ Small mesh net មងក្រឡាតូច \_\_\_\_\_  
 \_\_\_\_\_

☐ Electricity ការប្រើអគ្គិសនី (ឆក់) \_\_\_\_\_  
 \_\_\_\_\_

☐ Long trap that have small mesh (look like mouse tail) ឈបកន្ទុយកន្ទុរ \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

☐ Other ផ្សេងៗ ..... \_\_\_\_\_  
 \_\_\_\_\_

**F13. F13.** Having a conservation areas for.....(fill in the blanks below)  
 តើអ្នកដឹងទេថា ហេតុអ្វីបង្កើតអោយមានតំបន់អភិរក្ស ដូចជា ស្មៅសមុទ្រ ផ្កាថ្ម និង  
 ព្រៃកោងកាង?

**F13.1** ...seagrasses are ☐Beneficial ☐Not Beneficial ☐Don't Know

**Explain:**

\_\_\_\_\_  
 \_\_\_\_\_

**F13.2** ...coral reefs are ☐Beneficial ☐Not Beneficial ☐Don't Know

**Explain:**

\_\_\_\_\_  
 \_\_\_\_\_

**F13.3** ...mangroves are ☐Beneficial ☐Not Beneficial ☐Don't Know

**Explain:** As long as electric gear is allowed everything would stay the same

**F14.** Do you need to have conservation area like sea grass, coral reef and also mangrove area?

តើអ្នកចង់បង្កើតអោយមានតំបន់អភិរក្ស ដូចជា ស្មៅសមុទ្រ ផ្កាថ្ម និងព្រៃកោងកាង? ☐ Yes

បាទ/ចាស ☐ No ទេ

**F15.** Is there any conservation area of sea grass in you village or fishing community or another area of KEP's sea? ☐ Yes ☐ No

តើមានការអភិរក្សស្មៅសមុទ្រនៅក្នុង ភូមិ សហគមន៍នេសាទ

រឺក៏តំបន់ផ្សេងៗនៅក្នុងខេត្តកែបរឺទេ? ☐ បាទ/ចាស ☐ ទេ

If yes, where is it: បើបាទ តើនៅទីណា? \_\_\_\_\_

\_\_\_\_\_

**F16.** If have, is there any anti trawling block that drop in the sea grass area in you village or fishing community or another area of KEP's sea? ☐ Yes ☐ No

បើមាន តើមានការទំលាក់ប្រអប់សុវត្ថិភាពនៅតំបន់ស្មៅសមុទ្រនៅក្នុង ភូមិ សហគមន៍នេសាទ

រឺក៏តំបន់ផ្សេងៗនៅក្នុងខេត្តកែបរឺទេ? ☐ បាទ/ចាស ☐ ទេ

**F17.** Do you know how the statuses of sea grass in you are village or fishing community or another area of KEP's sea? ☐ Better ☐ Good ☐ Small destruction ☐ Big destruction

តើអ្នកដឹងទេថា តើស្ថានភាពតំបន់ស្មៅសមុទ្រនៅក្នុង ភូមិ សហគមន៍នេសាទ

រឺក៏នៅក្នុងតំបន់ផ្សេងៗនៅក្នុងខេត្តកែបមានសភាពដូចម្តេចដែរ?

☐ ល្អប្រសើរ ☐ ល្អ ☐ មានការបំផ្លាញតិចតួច ☐ មានការបំផ្លាញធ្ងន់ធ្ងរ

**F17.** How much do you understand about the advantage of sea grass to your fishing? ☐ Better

☐ Good ☐ Medium ☐ Poor ☐ Very poor

តើអ្នកមានការយល់ដឹងកំរិតណាអំពីសារៈប្រយោជន៍នៃតំបន់ស្មៅសមុទ្រចំពោះការនេសាទរបស់អ្នក? ☐ ល្អប្រសើរ ☐ ល្អ ☐ មធ្យម ☐ ខ្សោយ ☐ ខ្សោយខ្លាំងណាស់

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**F18.** Do you know where is the coral reef area in KEP's sea? អ្នកដឹងទេថា

តើតំបន់ផ្កាថ្មនៅក្នុងខេត្តកែបមាននៅទីណា? ☐ Yes បាទ/ចាស ☐ No ទេ

If yes where is it: បើបាទ តើនៅទីណា 

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**F19.** How much do you understand about the advantage of coral reef to your fishing? ☐ Better

☐ Good ☐ Medium ☐ Poor ☐ Very poor

តើអ្នកមានការយល់ដឹងកំរិតណាអំពីសារៈប្រយោជន៍នៃតំបន់ផ្កាថ្មចំពោះការនេសាទរបស់អ្នក? ☐

ល្អប្រសើរ ☐ ល្អ ☐ មធ្យម ☐ ខ្សោយ ☐ ខ្សោយខ្លាំងណាស់

**F20.** Have you ever known about the status of coral reef that how is it? ☐ Better ☐ Good ☐

Medium ☐ Poor ☐ Very poor

តើអ្នកដឹងទេថា តើស្ថានភាពតំបន់ផ្កាថ្ម នៅក្នុងខេត្តកែបមានសភាពដូចម្តេចដែរ?

☐ ល្អប្រសើរ ☐ good ល្អ ☐ មានការបំផ្លាញតិចតួច ☐ មានការបំផ្លាញធ្ងន់ធ្ងរ

**F21.** Is there any conservation area of mangrove forest in you village or fishing community or another area of KEP's sea? ☐ Yes ☐ No

តើមានការអភិរក្សតំបន់ព្រៃកោងកាងនៅក្នុង ភូមិ សហគមន៍នេសាទ

រីកនៅក្នុងតំបន់ផ្សេងៗនៅក្នុងខេត្តកែបរឺទេ? ☐ បាទ/ចាស ☐ ទេ

If yes where is it:បើបាទ តើនៅទីណា \_\_\_\_\_  
\_\_\_\_\_

**F22.** How much do you understand about the advantage of mangrove forest to your fishing? ☐

Better ☐ Good ☐ Medium ☐ Poor ☐ Very poor

តើអ្នកមានការយល់ដឹងកំរិតណាអំពីសារៈប្រយោជន៍នៃតំបន់ព្រៃកោងកាងចំពោះការនេសាទរបស់អ្នក? ☐ ល្អប្រសើរ ☐ ល្អ ☐ មធ្យម ☐ ខ្សោយ ☐ ខ្សោយខ្លាំងណាស់

**F23.** Do you know, what is status of mangrove area in you village or fishing community or another area of KEP's sea? ☐ Better ☐ Good ☐ Medium ☐ Poor ☐ Very poor

តើអ្នកដឹងទេថា តើស្ថានភាពព្រៃកោងកាងតំបន់នៅក្នុង ភូមិ សហគមន៍នេសាទ

រីកនៅក្នុងតំបន់ផ្សេងៗនៅក្នុងខេត្តកែបមានសភាពដូចម្តេចដែរ?

☐ ល្អប្រសើរ ☐ good ល្អ ☐ មានការបំផ្លាញតិចតួច ☐ មានការបំផ្លាញធ្ងន់ធ្ងរ

**F24.** Have you ever heard about the crab bank? តើអ្នកធ្លាប់ឮពីការបង្កើតធនាគារក្តាមរឺទេ? ☐

Yes បាទ/ចាស ☐ No ទេ

**F25.** If yes, is there crab bank in your village or in your community? បើបាទ

តើមានធនាគារក្តាមនៅក្នុងសហគមន៍អ្នករឺទេ? ☐ Yes បាទ/ចាស ☐ No ទេ



**F26.** How can we processing it? តើគេដំនើរការវាដូចម្តេច?

This image shows a blank sheet of white paper with horizontal blue ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

**F27.** Do you know, what is the advantage of crab bank?

តើអ្នកដឹងពីសារៈប្រយោជន៍នៃធនាគារក្លាមរឺទេ?

[illegible]

**F28.** Do you know what aquaculture is? តើអ្នកធ្លាប់ដឹង រឺលឺទេថាអ្វីជាវារីប្បកម្ម

(ការចិញ្ចឹមនៅក្នុងទឹក)? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**F29.** Do you want to have and participation in crab bank in your village or community?

តើអ្នកចង់អោយមាន និងចូលរួមក្នុងធនាគារក្តាមរឺទេ? ☐ Yes បាទ/ចាស ☐

No ទេ

**F30.** Do you have any relatives working in aquaculture farms?

តើអ្នកធ្លាប់ធ្វើការដែលទាក់ទងនឹងវារីប្បកម្ម (ការចិញ្ចឹមនៅក្នុងទឹក) រឺទេ? ☐ Yes បាទ/ចាស

☐ No ទេ

Yes: where? What culture? បើបាទ/ចាស: តើនៅកន្លែងណា? ហើយចិញ្ចឹមអ្វី? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**F31.** Would you like to know more about aquaculture? តើអ្នកចង់ដឹងអ្វីបន្ថែមវារីប្បកម្ម

(ការចិញ្ចឹមនៅក្នុងទឹក)? ☐ Yes បាទ/ចាស ☐ No ទេ

**F32.** Would you like to work in an aquaculture facility instead of fishing?

តើអ្នកចង់មានការងារដែលទាក់ទងនឹងវារីប្បកម្ម (ការចិញ្ចឹមនៅក្នុងទឹក) ដែលជាភាពងាយស្រួល ជំនួសអោយការនេសាទ?

☐ Yes បាទ/ចាស ☐ No ទេ

**F33.** What aquaculture would be interested in? តើវារីប្បកម្ម (ការចិញ្ចឹមនៅក្នុងទឹក)

អ្វីដែលដែលអ្នកចាប់អារម្មណ៍? \_\_\_\_\_

\_\_\_\_\_



[illegible]

Do you sometimes go swimming? yes

YES: Do you wear a mask? no

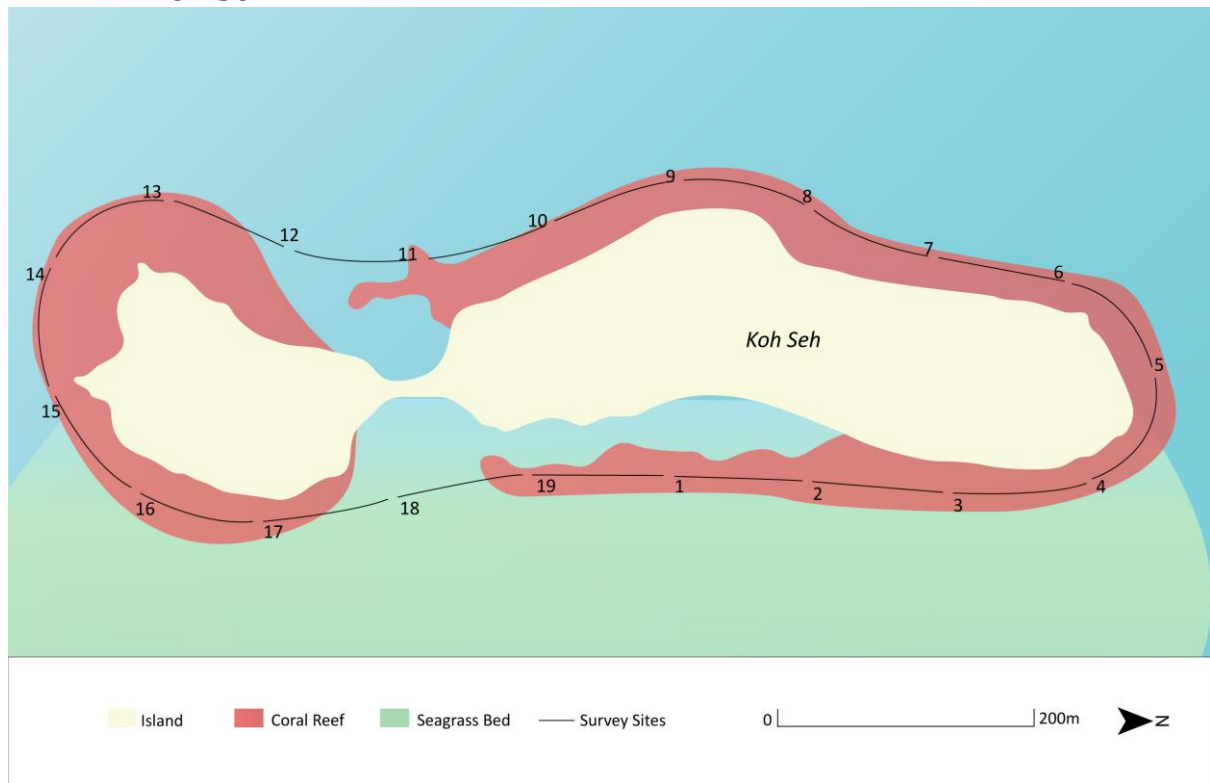
YES: Have you ever seen the coral, fish and crabs underwater? yes

NO: Would you like to? \_\_\_\_\_

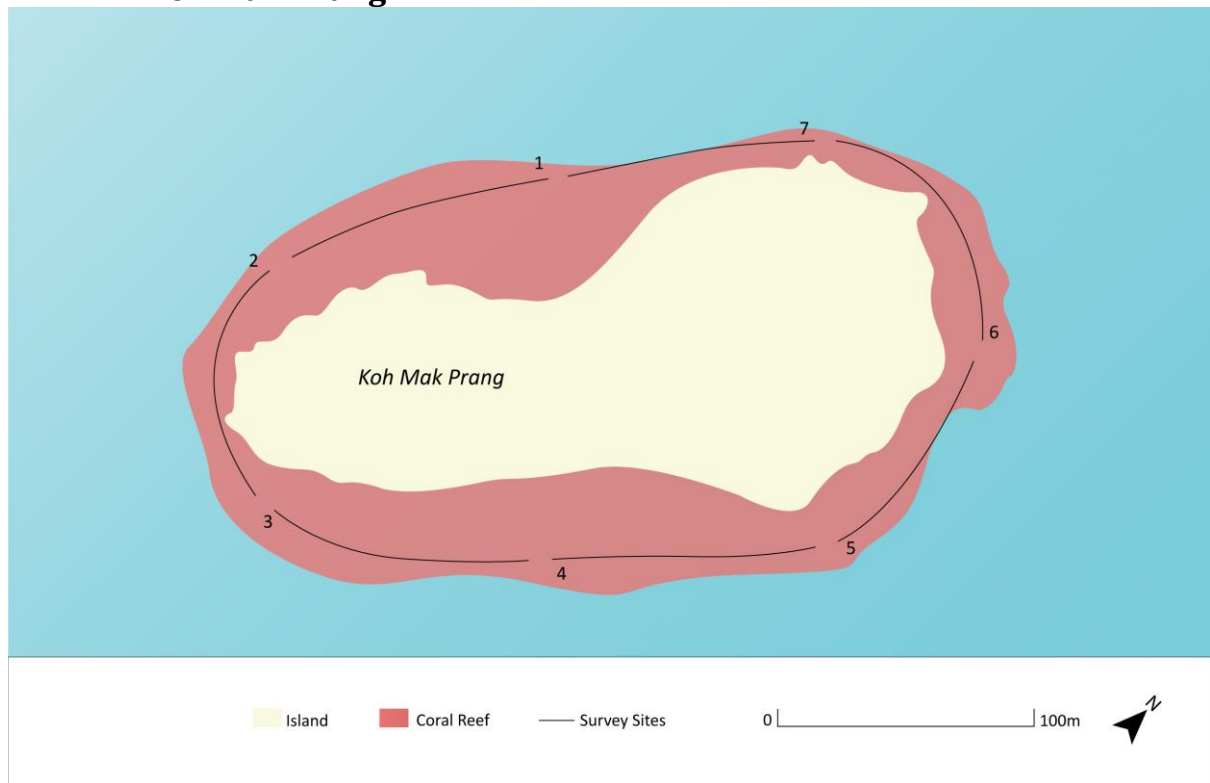
NO: Are you comfortable in the water? \_\_\_\_\_

YES: Would you like to see the coral, fish and crabs underwater? \_\_\_\_\_

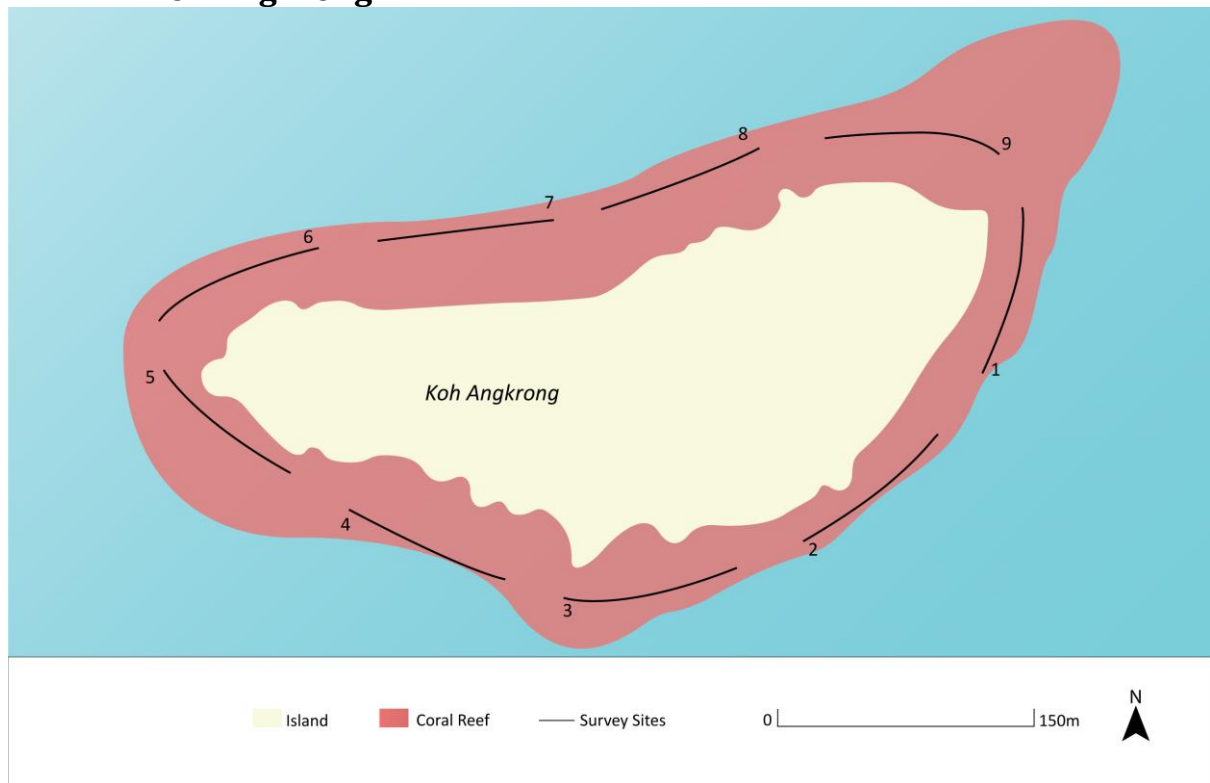
**Annex 2: Survey sites from MCC's research (MCC 2014; 2015) around Koh Seh.**



**Annex 3: Survey sites from MCC's research (MCC 2014; 2015) around Koh Mak Prang.**



**Annex 4: Survey sites from MCC's research (MCC 2014; 2015) around Koh Angkrong.**



## Annex 5: 2015 and 2016 mean fish abundance for eastern Koh Seh reef:

Mean values are the average number of fish recorded per 20m segment of the survey transect line. RES = Reef Edge South, REN = Reef Edge North, RE = Reef Edge.

FISH:	2015	2015	2016	2016	2015	2016
	MEAN RES:	MEAN REN:	MEAN RES:	MEAN REN:	MEAN RE:	MEAN RE:
Eight Banded Butterflyfish	0.33	0.42	0.58	0.33	0.38	0.46
Long-Beaked Coral Fish	7.50	4.08	2.42	2.33	5.79	2.38
Other Butterflyfish	0.42	0.58	1.00	1.42	0.50	1.21
Butterflyfish total	8.25	5.08	4.00	4.08	6.67	4.04
Golden Rabbitfish	0.00	0.00	0.00	1.75	0.00	0.88
Virgate Rabbitfish	0.17	0.17	1.42	28.50	0.17	14.96
Java Rabbitfish	18.50	13.42	2.00	20.08	15.96	11.04
Rabbitfish total	18.67	13.75	3.42	49.33	16.21	26.38
Scatfish	0.00	0.00	0.83	1.58	0.00	1.21
Sergeant Fish sp.	15.00	10.92	20.75	19.92	12.96	20.33
Spanish Flag Snapper	0.00	0.00	1.92	2.58	0.00	2.25
Black-Spot Snapper	0.00	0.00	0.67	5.25	0.00	2.96
Other Snapper	1.58	1.42	0.00	0.00	1.50	0.00
Snapper total	1.58	1.42	2.58	7.83	1.50	5.21
Monogram Monocle Bream	0.00	0.00	1.17	1.25	0.00	1.21



Whitecheek Monocle Bream	0.00	0.00	0.00	0.33	0.00	0.17
Bream Total	0.00	0.00	0.83	1.58	0.00	1.21
Emperor	0.00	0.00	0.25	0.58	0.00	0.42
Trevally	0.00	0.08	0.00	0.00	0.04	0.00
Jacks	0.00	0.00	1.33	1.33	0.00	1.33
Mullet	0.00	0.00	0.75	2.75	0.00	1.75
Orange- Spotted Grouper	0.00	0.00	0.08	0.17	0.00	0.13
Blue-Lined Grouper	0.08	0.00	0.50	0.42	0.04	0.46
Chocolate Grouper	0.00	0.00	0.42	0.75	0.00	0.58
Honeycomb Grouper	0.00	0.00	0.00	0.08	0.00	0.04
Other Grouper	0.08	0.00	0.00	0.00	0.04	0.00
Grouper 10-20cm	0.00	0.00	0.42	0.75	0.00	0.58
Grouper 20-30cm	0.00	0.00	0.50	0.50	0.00	0.50
Grouper 30-40 cm	0.08	0.00	0.00	0.08	0.04	0.04
Grouper 40-50 cm	0.00	0.00	0.08	0.08	0.00	0.08
Grouper >50 cm	0.08	0.00	0.00	0.00	0.04	0.00
Grouper total	0.42	0.00	1.00	1.42	0.21	1.21
Sweetlips	0.00	0.00	0.00	0.08	0.00	0.04
Cleaner Wrasse	0.00	0.00	2.92	1.25	0.00	2.08
Weedy Surge Wrasse	0.00	0.00	5.08	4.17	0.00	4.63
Other Wrasse	0.00	0.00	1.75	2.50	0.00	2.13

Wrasse total	0.00	0.00	9.75	7.92	0.00	8.83
Sweeper	23.33	7.00	91.50	44.67	15.17	68.08
Cardinalfish	52.25	42.83	74.50	62.33	47.54	68.42
Toadfish	0.00	0.00	0.00	0.08	0.00	0.04
Catfish	0.00	0.00	0.00	0.08	0.00	0.04
Seahorse	0.02	0.00	0.00	0.08	0.01	0.04
Needlefish	0.00	0.00	16.42	0.42	0.00	8.42
Boxfish	0.00	0.00	0.00	0.08	0.00	0.04
Filefish	1.50	0.33	1.42	0.58	0.92	1.00
Carpet Blenny Eel	0.00	0.00	1.08	0.92	0.00	1.00

## Annex 6: 2015 and 2016 T-test results for fish species within eastern Koh Seh reef:

Significant differences are highlighted in yellow (increase 2015 – 2016) or green (decrease 2015 – 2016). RES = Reef Edge South, REN = Reef Edge North, RE = Reef Edge.

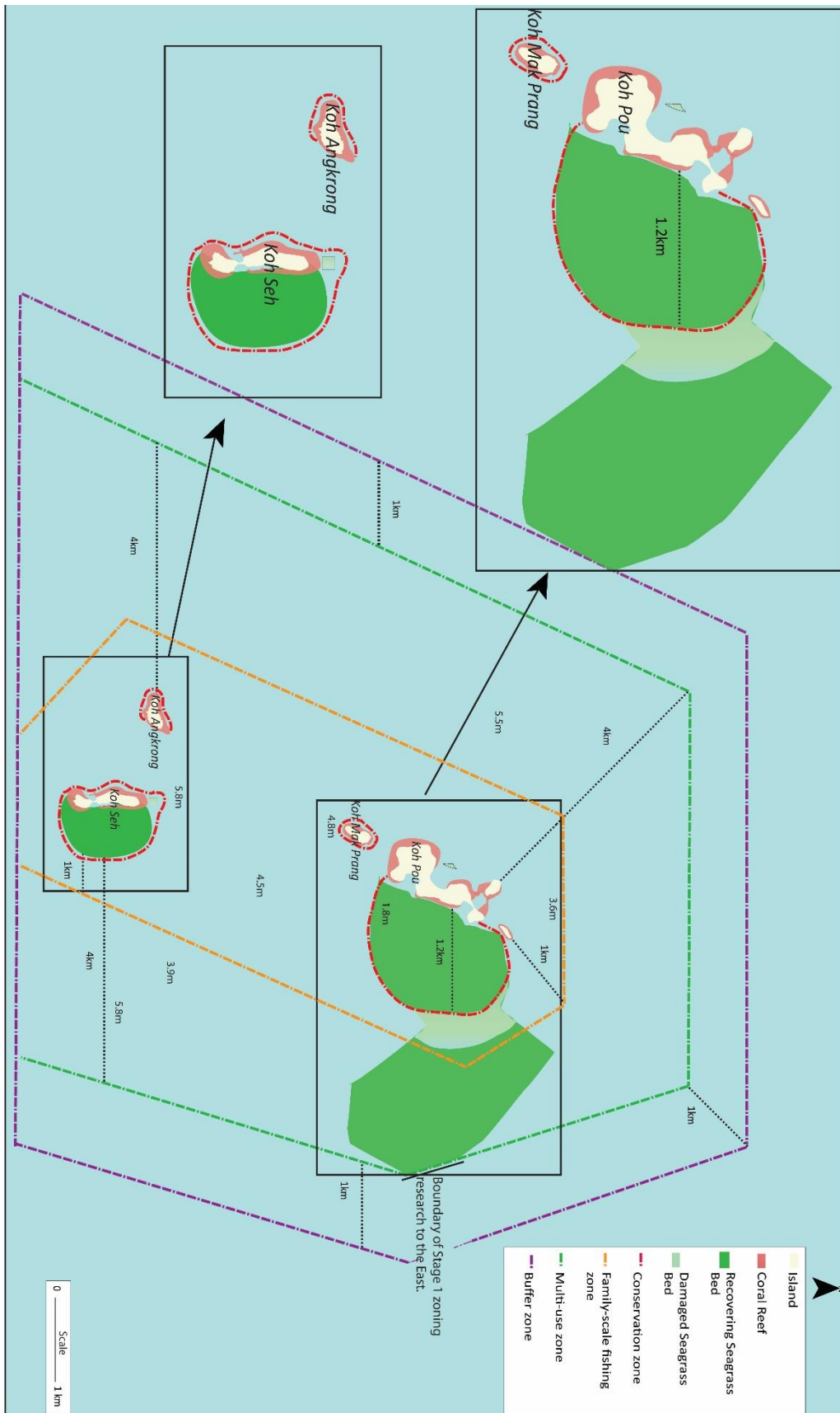
FISH:	2015 - 2016 RES:	2015 - 2016 REN:	2015 - 2016 RE:
Eight Banded Butterflyfish	0.728690044	0.868273624	0.82714
Long-Beaked Coral Fish	0.012089171	0.078698157	0.005983
Other Butterflyfish	0.398675595	0.341575084	0.149583
Butterflyfish total	0.017035009	0.385504929	0.022366
Golden Rabbitfish	#DIV/0!	0.113403916	0.143084
Virgate Rabbitfish	0.209837682	0.006947902	0.047654
Java Rabbitfish	0.052720344	0.666540978	0.559112
Rabbitfish total	0.065547676	0.015671595	0.392676
Scatfish	0.116116524	0.147035139	0.027155
Sergeant Fish sp.	0.179774805	0.175771663	0.036804
Spanish Flag Snapper	0.019416074	0.000303459	1.48E-05
Black-Spot Snapper	0.373900966	0.10406269	0.084892
Other Snapper	0.012072544	0.201555456	0.007315
Snapper total	0.348641139	0.062948401	0.051656
Monogram Monocle Bream	0.00219213	0.074201482	0.000596
Whitecheek Monocle Bream	#DIV/0!	0.01613009	0.073388
Bream Total	0.131777567	0.02696532	0.004521

Emperor	0.158302423	0.057235231	0.013618
Trevally	#DIV/0!	0.373900966	0.340893
Jacks	0.190034125	0.116116524	0.019838
Mullet	0.373900966	0.313080396	0.176792
Orange-Spotted Grouper	0.373900966	0.116116524	0.049332
Blue-Lined Grouper	0.066766545	0.066766545	0.003293
Chocolate Grouper	0.007490434	0.060169847	0.003507
Honeycomb Grouper	#DIV/0!	0.373900966	0.340893
Other Grouper	0.373900966	#DIV/0!	0.340893
Grouper 10-20cm	0.007490434	0.060169847	0.003507
Grouper 20-30cm	0.025721421	0.025721421	0.00027
Grouper 30-40 cm	0.373900966	0.373900966	1
Grouper 40-50 cm	0.373900966	0.373900966	0.144928
Grouper >50 cm	0.373900966	#DIV/0!	0.340893
Grouper total	0.155016211	0.049071933	0.007807
Sweetlips	#DIV/0!	0.373900966	0.340893
Cleaner Wrasse	0.00327091	0.044708587	0.00124
Weedy Surge Wrasse	0.000955054	0.000156765	1.45E-07
Other Wrasse	0.028234289	0.06862504	0.002642
Wrasse total	0.001686149	0.002462454	1.57E-06
Sweeper	0.043618571	0.006272329	0.006826
Cardinalfish	0.336402711	0.021049037	0.063992
Toadfish	0.373900966	#DIV/0!	0.340893

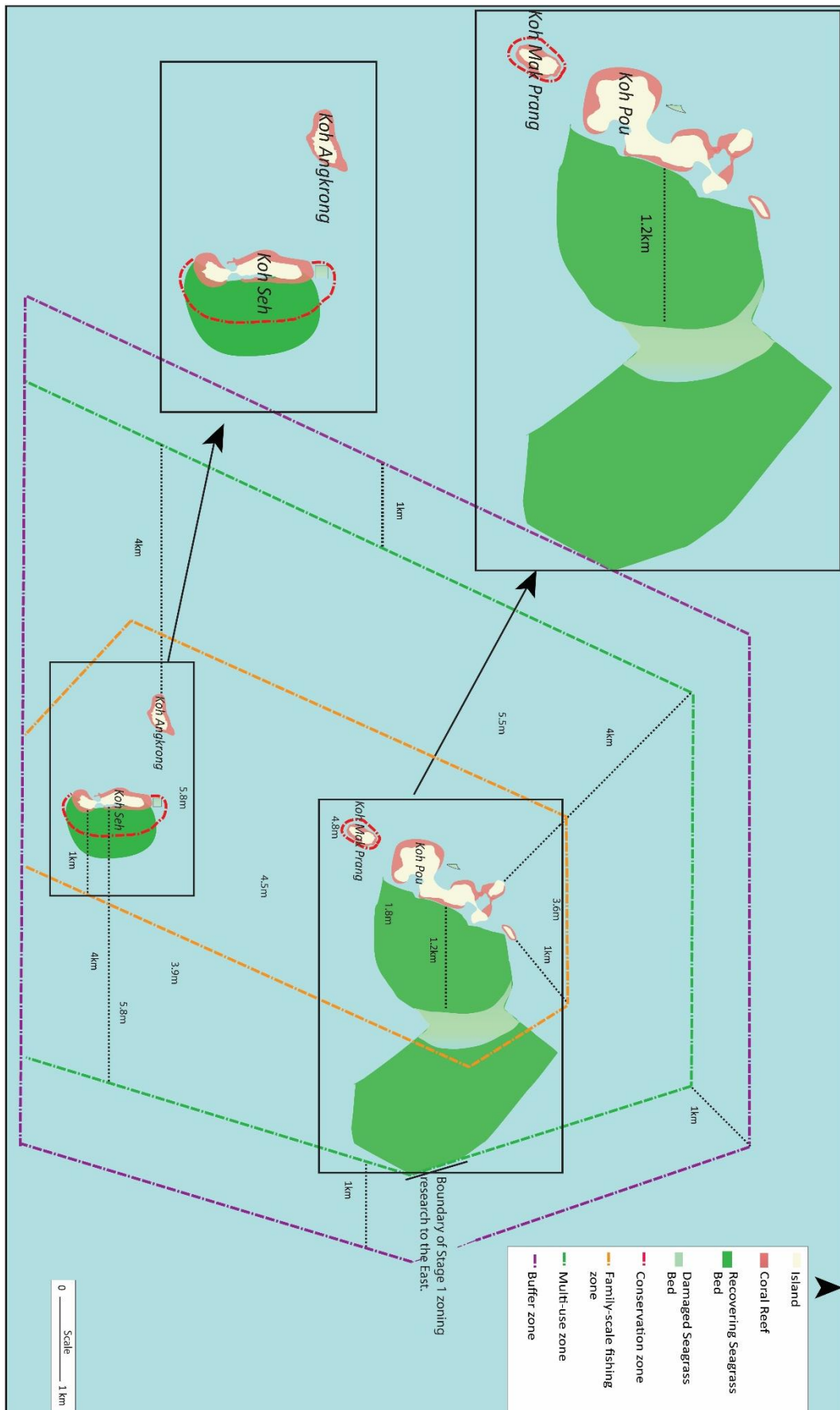
Catfish	#DIV/0!	0.373900966	0.340893
Seahorse	#DIV/0!	0.373900966	0.340893
Needlefish	0.199578683	0.131777567	0.189182
Boxfish	#DIV/0!	0.373900966	0.340893
Filefish	0.931078531	0.25081536	0.876594
Carpet Blenny Eel	0.00020204	0.191179987	0.003738

[illegible]

**Annex 8: Map B showing the intermediate MFMA zoning plan.**



Annex 9: Map C showing the third MFMA zoning plan.





**Annex 10: Mean fish abundance, error measures and t-test results for  
Koh Seh eastern reef 2014 – 2015 – 2016.**

Species	2014 MEAN	2015 MEAN	2016 MEAN
Butterflyfish	2.0625	6.66666667	4.0416667
Snapper	1.125	1.9375	5.2083333
Grouper	0	0.20833333	1.2083333
Sweetlips	0	0	0.0416667

Species	2014 STDEV	2014 SE	2015 STDEV	2015 SE	2016 STDEV	2016 SE
Butterflyfish	0.42695628	0.213478	2.1075262	0.860393967	1.11149299	0.453765
Snapper	1.4505746	0.725287	1.06800047	0.436009365	3.9636368	1.618148
Grouper	0	0	0.40052049	0.163511807	0.62081935	0.253448
Sweetlips	0	0	0	0	0.10206207	0.041667

Species	T-test 2014 vs. 2015	T-test 2014 vs. 2016	T-test 2015 vs. 2016
Butterflyfish	0.002496037	0.005725654	0.022366151
Snapper	0.401758912	0.056083397	0.152087565
Grouper	0.25862864	0.005025605	0.00780686
Sweetlips	#DIV/0!	0.363217468	0.340893132