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# Socioeconomic Assessment of the EPIC Mangrove Restoration Project in Thailand

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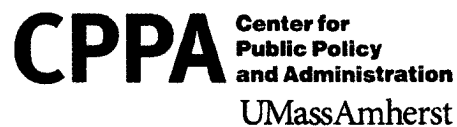
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## Socioeconomic Assessment of the EPIC Mangrove Restoration Project in Thailand

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June 1, 2015

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## I. Summary

Mangroves supply important services to tropical and subtropical communities around the world, but these delicate ecosystems have been degraded, sometimes destroyed, for development interests such as tourism, charcoal concessions, intensive aquaculture, and growing populations. The International Union for the Conservation of Nature (IUCN) is restoring mangroves at two sites on Koh Klang, an island in Krabi, Thailand. The process centers around teaching the surrounding community about the benefits of mangroves as food sources, fish nurseries, and in terms of disaster risk reduction, the ability of mangroves to protect nearby communities from floods, wind, salinization, and erosion. IUCN promotes the natural regeneration of mangroves, which involves attending to the hydrology and topography of the site to provide a habitat where seedlings can take root, and very limited mangrove planting. Silvofisheries are incorporated into the intervention to ensure a tangible economic benefit for site owners that can be used to garner community interest. Recording the successes of this process and using the results to educate the Thai government and other NGOs on the benefits of natural regeneration with silvofisheries is an integral part of the project. The intervention is in its very early stages so the benefits to-date are small, but through evaluation at multiple stages, a record of the project's socioeconomic impact will eventually provide evidence that the natural restoration of mangroves with silvofisheries is an ideal approach. After providing an analytical framework for assessment and potential measurement strategies, we conclude with recommendations for IUCN regarding up-scale and knowledge dissemination.

## II. Introduction

Since the 1960s, the area of mangroves in Thailand is estimated to have decreased from 2400 km<sup>2</sup> to as little as 1645 km<sup>2</sup> (Barbier, 2006). Aksornkoae *et al.* (2004) report that shrimp ponds alone may account for the loss of 50-65% of the country's mangroves. Because mangroves provide communities with a wealth of benefits including seafood and storm protection, the Thai government, NGOs, and community groups around Thailand have joined forces to restore this important ecosystem. The International Union for the Conservation of Nature (IUCN) partnered with Mangrove Action Project (MAP) to restore two former shrimp ponds on Koh Klang, an island in Krabi, Thailand. This restoration project — named EPIC for Ecosystems Protecting Infrastructure and Communities — is unique in its focus on community involvement and education, its efforts to educate local and national government officials and thereby affect policy, and most of all because of its emphasis on the natural restoration of mangroves. This report uses the findings of focus groups conducted on and around Koh Klang in March 2015 to provide an analytical framework that can be used to evaluate the socioeconomic impact

of EPIC on nearby communities, and compare EPIC's costs and benefits to other mangrove sites. We combine these findings with feedback from field staff and other stakeholders to make recommendations regarding measurement strategies, knowledge dissemination, and for IUCN to consider when planning and implementing future mangrove restoration projects.

### III. Motivation

April 2015 is Time 0 for the EPIC intervention. As EPIC moves forward, focus will shift from design and implementation to monitoring and evaluation. Assessing the socioeconomic impact of EPIC on surrounding communities is a critical component to ensure a thorough analysis of the intervention, and to fully inform future mangrove restoration projects at IUCN and elsewhere. Is natural restoration more cost-effective than replanting? Does the surrounding community gain disaster risk reduction benefits at a comparable degree and within a comparable timeframe? Who benefits from use and nonuse benefits of the mangroves? Does a shrimp pond restored to mangrove contribute to the food security, and improve the access to transportation, education, and health of many people or just a few people? Questions such as these abound, and EPIC is in a position to provide verifiable answers. A thorough socioeconomic assessment is necessary to provide the Thai government, NGOs, and private individuals with evidence that naturally restored mangroves provide a host of benefits that outweigh the costs. The analytical framework presented in this report is the first step in such an assessment.

### IV. Background

#### **The role of mangroves**

Mangroves play an important role along the coasts of tropical and subtropical regions of the world. Danielsen *et al.* find that mangroves reduce wave amplitude and intensity, protect the shore from storm damage, and enhance fisheries (2005). The degeneration or destruction of the mangrove ecosystem is linked to the undervaluation of the benefits they provide (Walton *et al.*, 2006). In 2002, Balmford *et al.* found that conversion of Thai mangrove to shrimp aquaculture provided significant short-term private benefits, but not long term. They find the total economic value of intact Thai mangroves is approximately \$60,400 USD per hectare, significantly greater value than shrimp farms, which have a total economic value of approximately \$16,700 USD per hectare (2002). Intensive shrimp ponds have a notoriously short lifespan due to self-pollution and disease, leading to a large number of abandoned ponds across the country; most intensive ponds have a lifespan of only 5-10 years (Moberg & Rönnbäck, 2003). The high value of an intact mangrove is due to benefits such as erosion control, storm and flood protection, nursery

and breeding ground, sediment trap, re-mineralization of organic matter, water catchment and groundwater recharge, tourism opportunities, and the provision of food and other products to local people (Moberg & Rönnbäck, 2003). Events such as the December 2004 tsunami brought the importance of the mangrove ecosystem to the forefront, and motivated the government as well as international organizations to restore it. “Conserving or replanting coastal mangroves and greenbelts should buffer communities from future tsunami events,” and can be established for \$150 to \$2000 USD per hectare (Danielsen *et al.*, 2005, p. 643).

Complicating factors include property ownership and rights to harvest in the mangrove. The Thai government officially owns mangrove areas, but in reality, they are open-access areas (Barbier, 2006). Over time, local communities developed informal rules to manage and share the resources of a mangrove, but with little or no legal control, the sites became vulnerable to wealthy outside investors, and illegal encroachment by everyone. Similar problems appear now during attempts to restore mangroves. Barbier (2006) finds that “the failure of present laws and democratic institutions to support local involvement in administrative decisions may deter villagers in coastal communities from participating in mangrove replanting efforts” (2006, p. 127). Yet most restoration efforts depend upon the participation of local communities in the planting and maintenance of the sites, while the shrimp pond owners (those most responsible for the destruction), are rarely called upon to replace the destroyed mangrove. Other complications involve the difficulty in physically establishing a successful restoration; replanting fails because of hydrology or type of species planted, and natural regeneration rarely occurs because the terrain is so drastically modified for the shrimp ponds it is no longer hospitable to mangroves (Barbier, 2006).

### **The seven landscapes**

To provide a rich analytical framework with which IUCN can evaluate the socioeconomic impact of the EPIC intervention, it is necessary to gain a thorough understanding of how EPIC impacts the environment in which it is located. To do so requires identifying a comprehensive series of landscapes that together paint a picture of what the EPIC sites may be in the future, and what the EPIC sites may have been had they not been selected by IUCN for this intervention. For example, one of the EPIC sites was an extensive pond and one was an abandoned pond before they became part of EPIC. In future, if EPIC succeeds, one of the sites will be a mature fringe mangrove, and the other a mature inland mangrove. So each of these landscapes provides valuable information against which to compare, and ultimately isolate, the socioeconomics of EPIC. The UMASS team identified six such landscapes, so there are a total of seven landscapes across which we compare various costs and benefits: abandoned pond, extensive pond, intensive pond, mature inland mangrove, mature fringe mangrove, MAP 2009, and the EPIC sites. A description and photograph of the seven landscapes follows.

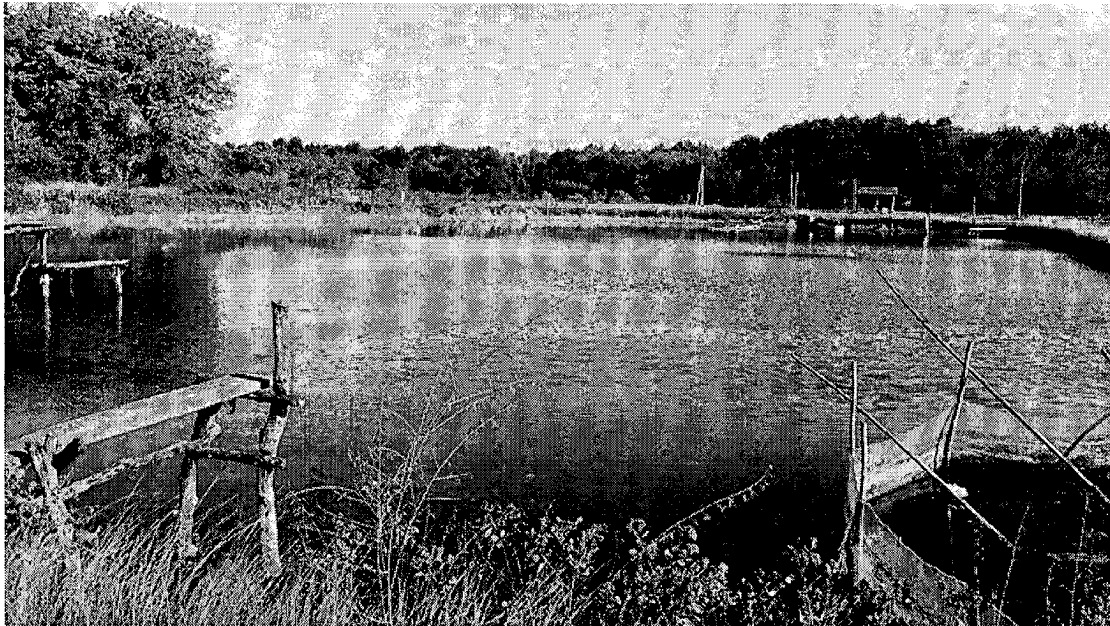


(1) *Intensive ponds* are highly regulated aquaculture sites in which private individuals grow and harvest great quantities of shrimp, or sometimes one fish species. These ponds are closed to outside tidal flushes and nutrients, and so farmers must use food, fertilizers, and antibiotics to maintain the shrimp. The ponds require a great deal of labor, and the upfront investment is especially significant because all mangroves are removed, the bottom smoothed, and the walls reinforced. Sometimes the entire pond is lined with plastic. There can be an economic windfall if a harvest is good, and thus the benefits of intensive farming can be great. Early success stories drew many Thais into shrimp farming in the 1990s, but disease spread quickly from pond to pond, and many people ultimately lost money.



Active intensive pond

(2) *Extensive ponds* use no or limited chemicals or feed to manage a rich polyculture. The tidal flush irrigates and carries food, mangrove seeds, and new larvae into the pond. Extensive ponds require far less labor than intensive ponds, and because of their biodiversity and better overall health, their harvests, though moderate, are more stable and predictable than an intensive pond harvest. Extensive ponds are not subject to the same debilitating diseases that cause so many intensive ponds to fail. Like intensive ponds, extensive ponds provide no storm protection.



Active extensive pond

(3) *Abandoned ponds* are failed intensive ponds. Intensive farming was profitable for a time in Thailand, but most profits went to wealthy nonlocal landowners who were able to fund the level of maintenance required to sustain an intensive pond. Ponds collapsed as disease spread and as other Asian countries flooded the market with cheap shrimp. Now many of the ponds stand abandoned, usually large pits with some standing water. Some have a few mangroves beginning to grow, but they are largely devoid of life due to the chemicals left behind. We saw many abandoned ponds on Koh Klang; such ponds are the baseline against which the remaining six landscapes are assessed.



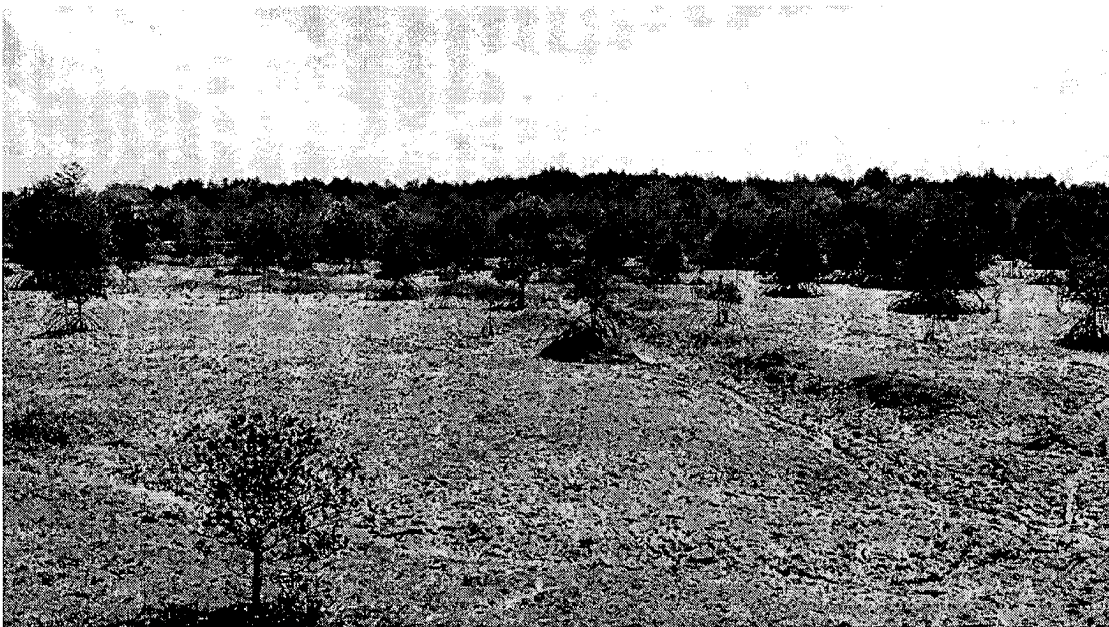
Abandoned pond

**(4 & 5) *Mature fringe and mature inland mangroves*** To discern mangroves set in a more protected location from those located adjacent to a large body of water or on a more seaward-facing edge (and thus receiving the brunt of a storm surge), Kovacs (2011), Cochard (2008), and Barbier (2006) use *inland* and *seaward fringe*. We will further distinguish *mature* from *young* mangroves to separate mangroves that are ten years and older from those less than ten years in age. This ten-year mark stems from input from MAP and from our visual assessment that a ten-year-old site is a healthy, productive environment. Note that such distinctions are relative for several reasons. Fringe and inland are relative terms because all mangroves are coastal, all mangroves grow in the intertidal zone, usually in calm estuaries or otherwise protected areas (Cochard, 2008). Mature and young are relative terms because very few mangroves in Thailand are part of a truly mature “virgin” ecosystem given the widespread destruction of mangroves since the 1970s.



Mature fringe mangrove along the canal

(6) **MAP 2009** was an abandoned shrimp pond in Ban Lang Da, a village on mainland Krabi, that MAP restored six years ago. Even at this young age the site exhibits healthy, naturally restored mangroves and provides benefits that abandoned ponds do not. MAP 2009 is roughly 2 km from the Andaman Sea, and is located on a canal inland from the sea and situated on the edge of a dense grove of mangroves that spread across an estuary.



MAP 2009 site

(7) **EPIC sites** IUCN has chosen two sites on Koh Klang for the EPIC intervention. Both sites are in their first year of restoration; officially, April 2015 is Time 0 because the hydrology has just been completed. Both will eventually contain silvofisheries to provide tangible benefits to the owners, and to increase the visibility and desirability of the site to the surrounding communities. EPIC employs CBEMR — Community-Based Ecological Mangrove Restoration — which emphasizes community involvement and education, and the natural restoration of mangroves rather than a large-scale planting initiative. MAP adapted CBEMR from the research of Robin Lewis and his ecological mangrove restoration program, which favors natural restoration to planting (Enright, 2015). The process allows various species of mangroves to take root and grow where the tidal flush and soil is right, and thus avoid a massive die-off as has happened at many planted sites. Depending on the topography and water flow of a site, EPIC requires varying degrees of preparation, and can still be labor intensive even though there is minimal planting. For example, EPIC Site 2 requires a sluice gate to maintain the proper water level for the silvofisheries, and a fence to keep goats from eating the juvenile plants. Both sites require ongoing labor to shape and maintain the irrigation canals and banks of the pond.

EPIC Site 1 is located in Village 3 on a former intensive shrimp pond that had been converted to an extensive fish pond. It is located approximately 60 m from the Andaman Sea and is labeled *fringe*. The site has some mangroves that are two meters tall ringed by a channel for silvofisheries.



EPIC Site 1 in Ban Klong Kum

EPIC Site 2 is an abandoned intensive shrimp pond and is located in Village 1 on a tidal channel, approximately 670 m from the Andaman Sea and approximately 450 m from the Krabi River, earning it the designation *inland*. The site has a few mangroves beginning to grow, and a few others that have been planted to provide support to the mud walls.



EPIC Site 2 in Ban Koh Klang

We will compare the costs and benefits of these seven landscapes against each other. We begin with a discussion of the socioeconomic variables we explored in the field.

## V. Methodology

### Focus group variables

In an effort to consider the array of costs and benefits that these seven landscapes can provide a community and individuals, we asked questions of people holding different roles within the communities affected by these landscapes. Our variables stem from efforts to thoroughly explore topics relevant to the socioeconomics of mangrove restoration and IUCN objectives involving scale-up and knowledge distribution: disaster risk reduction (DRR), socioeconomics, human capital such as education and health, the costs and benefits of mangroves, the costs and benefits of ponds, and community outreach and education. Examples of questions for each variable follow below. See Appendix A for a master copy of all the questions in our library.

- **DRR** In the last year, how often has your roof been damaged by wind? Is there more or less damage than twenty years ago when there were mangroves between the house and the canal?
- **Socioeconomics** Was your family's income higher when you owned an intensive shrimp pond or now that you work as a fishmonger in Krabi Town?
- **Human capital (e.g. educational achievements)** Did your children ever miss school to work in the shrimp pond? Do they ever miss school now to harvest from the mangrove?
- **Non-use value of mangroves** Do you ever go into the mangroves to relax in the shade? Do you find the mangroves beautiful?
- **Health** Did you have any health problems such as rashes or breathing issues when you worked in an intensive shrimp pond?
- **Community capacity building** Why do you and the rest of the women's group help EPIC restore mangroves? Why is it important to restore mangroves?

We asked most questions across two frames of reference: (1) across various landscapes, i.e., Are there more species of shellfish in the mature inland mangrove or in the EPIC site? (2) across various timeframes, i.e., Are there more species of shellfish in the mangrove now compared to ten years ago?

### Focus group locations

The majority of the focus groups took place on Koh Klang, near an EPIC site (Focus groups 1 & 10) or near to the canal or coast. We travelled to the mainland to interview participants in MAP 2009 (Focus groups 2 & 20), to interview government officials (Focus Group 19), and to interview the owner of an active intensive shrimp pond (Focus Group 3). There are no intensive ponds still in operation on Koh Klang. Focus Group 4 took place at a site along the coast in Village 2 and is categorized as a mature fringe mangrove. This location is of interest because the community suffered severe erosion and flooding until it partnered with Raks Thai to restore 3 km of mangroves in the years after the 2004 tsunami. The government simultaneously built a concrete wall and a bamboo wall to prevent erosion. This Raks Thai site is now a fringe mangrove providing multiple benefits. See the map below for the location of each focus group and Appendix B for a closer satellite view of each location.





All twenty focus group locations

## Focus group participants

We identified and selected a cross-section of residents with various jobs and roles in the community, various relationships to fishing, intensive farming, and harvesting in mangroves, and people who live and work in areas affected by weather in various ways. So our focus groups include private households, business owners, cage fishers in the canal, open-sea fishers, tourism workers, mangrove harvesters, government officials, community leaders, elected representatives, religious leaders, teachers, healthcare workers, former pond workers, owners of active and inactive ponds, the EPIC site owners, private individuals whose homes suffer damage due to the loss of mangroves, members of a women's group, and members of a conservation group.

## Focus group protocol

In January and February, the UMASS team researched mangrove restoration in general, and the EPIC intervention in particular. Through this literature review and through consultation with IUCN, EPIC field staff, and our translator, we began to develop our data-collection framework. We obtained IRB certification and then followed the IRB recommendations of the U.S. National Institutes of Health to ensure the ethical treatment of our research participants. This required that we write a consent letter for our focus group participants, translate it to Thai, and then ask our translator to discuss the document with each participant before he or she signed it. We wrote a draft survey tool based on



feedback from stakeholders and after considering a wide-array of livelihood benefits. These became the foundation of our focus group questions, which encompass multiple variables, landscapes, timeframes, and types of participants in a library of over 400 questions. Once in the field on March 12th, we saw the landscapes and variables first-hand, and continued to refine our questions; it was a fluid and on-going process.

For the majority of the twenty focus groups, the owners of MAP connected us with members of the community with whom we wished to speak. Most focus groups contained only one or two people, but our largest contained ten individuals (five couples). See the table below for a breakdown of the details of each focus group. One member of the UMASS team would ask a question in English, which the translator would then ask the participant in Thai. Depending on the complexity of the question, an answer would be translated back to us intermittently or at the end of the participant's response. Occasionally the owners of MAP were present and would participate in the interview by asking questions or translating answers. The other UMASS team member typed what was said in English. Most interviews were conducted outside or in an open-air structure shielded from the sun, usually at the participant's home or place of work.

Upon return to Massachusetts, we transcribed interviews that we had not been able to type as they occurred, and then began to read through 130 pages of transcript searching for highlights, themes, and revelations.

### Table outlining focus groups

Below is a table outlining each focus group. (Note: Participant FG1\_2 is the second participant in Focus Group 1. Likewise, FG9\_3 is the third participant in Focus Group 9.)

Focus group	Date	Participant	Income/ Profession	Venue	Most defining landscape
1	3/13/15	FG1_1, F	Household, fisher, & mangrove harvester	Home	EPIC site 2
2	3/14/15	FG2_1, F FG2_2, M FG2_3, M	Retired, still mangrove harvester; Retired; Retired	Home	MAP 2009 site
3	3/14/15	FG3_1, M	Owner of active ponds	Home	Intensive pond
4	3/15/15	FG4_1, F FG4_2, F FG4_3, F	Shop worker; Tourism worker; Mangrove harvester	Home	Raks Thai 3 km restoration project
5	3/15/15	FG5_1, F FG5_2, M	Day-laborer & mangrove harvester; Fishmonger in Krabi	Home	Owners of abandoned ponds
6	3/16/15	FG6_1, F FG6_2, F	Local government officials	Gov't building	n/a

7	3/16/15	FG7_1, M	DMCR official from Krabi	Restaurant	n/a
8	3/16/15	FG8_1, M FG8_2, F	Community leaders	Home	EPIC site 2
9	3/16/15	FG9_1, M FG9_2, F FG9_3, M FG9_4, F FG9_5, M FG9_6, F FG9_7, M FG9_8, F FG9_9, M FG9_10, F	Sea fishers & ecotourism	Eco-lodge	Owners of potential future EPIC site; coastal with no mangroves
10	3/17/15	FG10_1, M	Boat rides for tourists & conservationist	Home	EPIC site 1; mature fringe
11	3/17/15	FG11_1, F FG11_2, M	Nurse; Community health worker	Health clinic	n/a
12	3/18/15	FG12_1, M FG12_2, M	Retired fisherman; Laborer	Cafe	n/a
13	3/18/15	FG13_1, F FG13_2, M	Cage fishers in canal	Home	Mature fringe mangrove
14	3/18/15	FG14_1, F	Seamstress	Home	EPIC site 1
15	3/18/15	FG15_1, M	Café-owner, retired international fishing captain	Cafe	n/a
16	3/19/15	FG16_1, M	Teacher	School	Mature inland mangrove
17	3/19/15	FG17_1 FG17_2 FG17_3 FG17_4 FG17_5 FG17_6 FG17_7	Fishers; minor mangrove harvesting	Home	Women's group –worked on EPIC and other conservation projects; mature inland mangrove
18	3/19/15	FG18_1, F FG18_2, M	Beauty salon manager; Restaurant owner	Home/ restaurant	On the canal, no mangroves
19	3/20/15	FG 19_1, M FG19_2, M FG19_3, M FG19_4, M	Sub-district government officials & involved with environment and Learning Center	Sub-district gov't building	n/a
20	3/20/15	FG20_1, M	Retired religious teacher	Shop in Village 6	MAP 2009 site

## VI. Findings

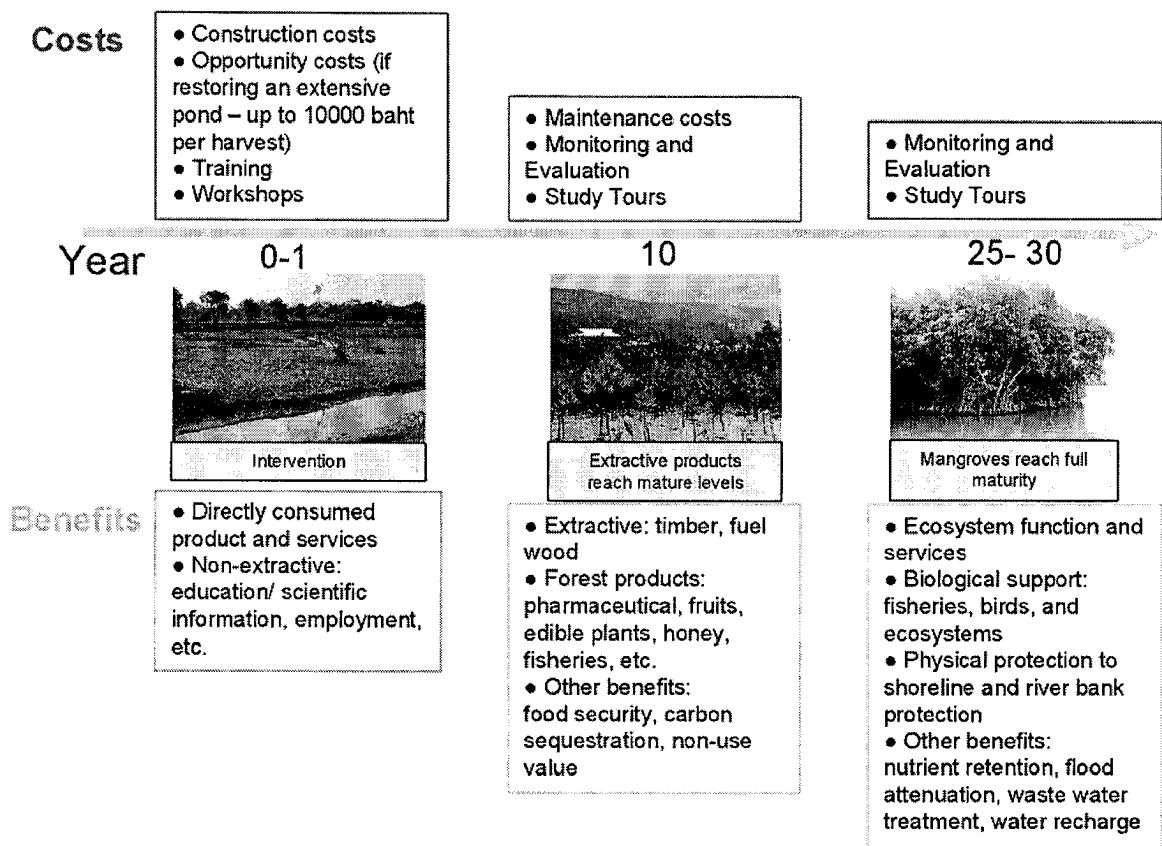
We begin the findings section with a description of our framework for analysis, detailed tables of which can be found in the appendices, and a timeline of the costs and benefits of restoration. Next, major findings are organized by variable with a box that contains translated focus group quotes for each. The section concludes with major findings regarding costs, property rights, and findings unique to EPIC.

### **Framework for analysis**

From the focus group transcripts we culled a unique and comprehensive view of the costs and benefits of mangrove restoration and pond farming. See Appendix C for a table of benefits across the seven landscapes, and Appendix D for a table of costs across the landscapes. For each cell in these tables, we evaluated the relative cost or benefit of that variable in that landscape. We populated cells using a system in which X represents a small cost or benefit, and XXX represents the maximum cost or benefit. A blank cell indicates no identifiable cost or benefit.

### **Costs and benefits timeline**

The costs and benefits of mangrove restoration appear on a timeline of many years. Early on, fish and crabs use the site as a nursery; DRR benefits appear later. Below is a 30-year timeline showing when costs and benefits are expected at the EPIC sites. With the exception of day-laborers employed during project implementation, benefits accumulate throughout the lifespan of the mangrove. So seafood harvests that appear in the very early years of restoration become more plentiful and grow in value throughout the remaining years depicted on the timeline.



Source: (IUCN 2003)

Above timeline: Costs and benefits of EPIC intervention over 30 years

## Findings by variable

### (1) Food security

Mangroves provide *supplementary* income and food, and only to those who have rights to harvest them. MAP 2009 benefits include accessible location, ease of harvest (minimal labor is required to stretch a net and wait as the tide ebbs, trapping seafood). Both the 3 km Raks Thai site and the MAP 2009 site have abundant seafood — a high quantity of animals and a high number of types of species. The success of the Raks Thai site initially caused conflict between villages (determining who has harvesting rights), but that conflict indicates that word of the available benefits have spread to a wider community. The harvests of both Raks Thai and MAP 2009 are accessible to a wider community of people than the EPIC sites, which are harvested only by the owners. Most people know that healthy mangroves provide a nursery or breeding ground for fish, but several open-sea fishermen did not recognize the relationship between the health of their fishery and that of the mangroves as nurseries. Finally, the food provided within the relative security of a mangrove may become increasingly necessary as the climate changes. One woman

reported a longer and more dangerous rainy season, and so a longer period during which her husband cannot fish at sea. She values the mangrove harvest as a secure supplement.

#### Focus group quotes regarding food security

Regarding the MAP 2009 site: *So she said that like before when she does harvest from outside it's a bit tiring. Because there is no specific place. She has to walk around. More work. But here after they start doing this, she knows the place to get the fish. They're less tired.* [FG2\_1]

On species richness of area behind 3 km site: *Variety. More species. Before reforestation just 2-3 species here. Now with mangrove here 4-5 kinds of species with the mangroves protecting this area.* [FG4\_3]

*When the mangrove were everywhere, it was better than intensive farms. You could go just outside your house and get fish and crabs. Now that there are chemicals, you have to go far to find a healthy mangrove to get food.* [FG8\_1]

*Along this canal, we have always had mangroves and there were always fish and crab. But if you go to any area without mangroves it is very difficult to find fish and crabs.* [FG12\_1]

On when there were mangroves right in front of house, along canal: *She collected seashells from in front of the pier. They just used their feet and found lots of seashell. Before it was waist high, now the shells are much deeper, (up to neck) so she can no longer reach them... In the past when they had forest here it was easy to collect fish and clams. They still have some, but they have to wait until the low tide. The push boats out there take all the small animals. Small long tail boats take some too... [She'd get] 200 baht a day, but she didn't do it every day. If she had a chance to sell—that's the maximum amount. Before it was easy to find. Now it is hard to find. Before they didn't have to pay. They just ate it. Nowadays, everything you have to spend money--200 or 300 baht a day...* [FG18\_1]

Official on sea fisher's incomes now that mangroves are gone: *They have to go 5-10 km deeper... They go deeper in the sea. They used to stay close to the mangrove forest. It's 20 years, so they've adjusted. Go to different villages. Not a large impact.* [FG19]

*After the tsunami a lot of organizations came to help and they encouraged them to grow mangroves. Now mangroves naturally grow back. Shellfish and crabs come in but only enough for food, not enough to sell.* [FG12\_2]

On changing climate: *Rainy season here lasts 6 months. The period of time is still the same but the amount of rainfall is increasing. Especially last year. ...And the problem is when the season storm gets worse, more severe, they cannot go out to sea in the same boat anymore. Normally in May it's the best season for harvesting shrimp from the sea but because of the monsoon, because of the storms they cannot go out. Although they know that there is plenty of shrimp for them to catch but they cannot go out.* [FG1\_1]

## **(2) Income**

A mangrove harvest provides a supplementary income of approximately 400 baht per day. The majority of people who harvest an inland mangrove such as MAP 2009 are retired, but it is unknown whether this is the population with time to harvest, whether they are a poorer group of people who harvest the mangrove because they need the income, or whether only this older population remembers and takes advantage of the mangrove. A second theme concerns the early years of a restoration and *loss* of income. A relative of the owner of EPIC site 1 had been using the site as an extensive pond, with a biannual harvest of between 4000 - 10,000 baht. When his extensive pond was drained to prepare it for EPIC mangroves, he was frustrated by the loss of at least two harvests. Income from an intensive pond can be great — as much as 50,000 baht — but disease and competition from other countries cause some years to be a net loss, and most focus group participants indicated that they had a net loss of income over the lifespan of their intensive pond. Abandoned ponds provide no income.

### **Focus group quotes regarding income**

On having lost two harvests from EPIC site 1: *But in the long term I think that the natural recovering forest would create better conditions once the ecosystem recovers. And the fishing would be the same as it was before.* [FG10\_1]

On intensive shrimp pond profit: *Some year he gained some money. But to compare across 5 years he lost 300,000 baht [\$10000 USD] overall. After that he finished. He didn't get any profit but lost overall.* [FG5\_2]

On the benefits of mangroves in abandoned shrimp pond: *She said that when the forest comes, the small animal will come, and she can earn a profit. She said it's natural. Let it grow and the small animal will come and then she can get it.* [FG5\_1]

On MAP 2009 site: *Only start to harvest, collect fish and sea shell. Those benefits started year 4, year 5. Each day he can benefit 400 – 500 baht. His daughter (20yo), his niece and nephew buy food, buy snacks [with the money].* [FG20\_1]

### **(3) Diet composition**

We found mixed results concerning overall diet. Health care workers think people ate better before, when they were employed in intensive farming on the island. Now that people go to Krabi Town for work, they eat fast food and junk food. Other people think they eat better now (post intensive farming) because income is steadier. And also because mangroves and extensive ponds provide a rich polyculture — mangroves provide plant species in addition to seafood — and the harvest is chemical-free. An intensive pond provides only one species, and it is latent with chemicals.

#### **Focus group quotes regarding diet**

*Nowadays they have much better diet because now they change their job from shrimp pond owner, they become a vendor and have more certain income. Better quality of life so they eat more variety more amount. Same for her, when she worked in the shrimp pond, she said, Shrimp eats lots of food but the owner has nothing to eat!* [FG5]

*They see the change of the diet when they do the shrimp pond. Most of them stayed in the island when they worked the ponds. They had better diet. When they stopped working on shrimp pond they go to work in town and had worse diet because they eat junk food and don't have time to prepare good food like before.* [FG11]

### **(4) Disaster risk reduction and erosion**

DRR and erosion are both caused by extreme events while erosion can also be a slow, chronic condition. By restoring inland abandoned shrimp ponds today, EPIC provides what will be a healthy ecosystem in thirty years, when erosion and climate change have possibly caused mangroves that are inland now to become fringe.

Ponds provide no disaster protection, no shield from wind, waves, or erosion. As mangroves mature, their fronds, roots, and trunks provide increasingly significant protection. Most residents of Koh Klang are not terribly affected by wind, floods, or

erosion problems. Flooding especially seems to be a nonissue. Annual spring tides or monsoon related floods are expected and part of island life; work and school are never affected for more than a few hours. Some focus group participants have a limited understanding of the DRR benefits of mangroves. Interest in the restoration of mangroves for their DRR benefits is very high among the population currently affected by erosion, floods, or storms, but low among the population not directly affected by these events.

When pressed (Why do you want more mangroves?) people expressed interest in the fish, and provided answers such as “We’re proud to help the government and environment.” It is worth noting that people are often paid for their labor when they participate in hydrology and planting efforts. It seems that if floods, coastal erosion, wind, and salinization were significant worries, members of the women’s group would list these reasons when asked why their group is involved in mangroves. It is possible, however, that floods, wind, erosion, and salinization ARE important issues, but people just do not connect those problems to the services mangroves provide. The most satisfactory answer came from an elected official who said, It is more than these small things you list [erosion, floods, more food], mangroves are part of Thailand.

#### Focus group quotes regarding disaster risk reduction

*For example this house does not have a permanent roof. So when the strong winds come in this direction it's gone because there are no trees to protect her house. [FG1\_1]*

*It's different now here with the changing of the weather. The strong winds have come recently. In the past when they didn't have the forest to protect them. It was ok. It was natural. Strong but not that strong. But they knew how to cope with the weather. The global weather is changing. [FG2\_3]*

*The limited knowledge of government officials regarding DRR: They used to hear that before the homes would not be as damaged [by wind] as they are nowadays. Their grandparents and parents said they had thicker, healthier mangroves that might have helped protect them but they had never made that connection until now. [FG6]*

*On storms: Tropical storms in November so we have to change the roof every year. Because in the past it was nypa thatch roof so we had to fix it during monsoons, but no cost. It's normal. Normal to repair after monsoon season. [FG9]*



On mangrove protection: *Easy example, out the window. There is a forest over there. The roof used to go every year, but now it is okay. They had mangrove there in 2001, not that high so the wind blew and second [floor] had roof damage. Now the mangroves are higher and higher.* [FG11]

On mangroves and wind: *They don't see any connection, it doesn't matter if the mangroves come back or not. The season, the storm season comes every year anyway. It is the direction of the monsoon. The monsoon comes from the opposite direction (across the village) so there is no way the mangroves across the canal would provide protection from the monsoon wind.* [FG13]

*He noticed that mangrove forests help to lessen the energy of tidal waves during the monsoon time. He notices by looking at the different areas. He noticed the erosion problem because there is no natural fence to stop the storm surge and energy through the canal.* [FG1\_2]

On the Raks Thai 3 km strip of mangroves: *The old house was over there and moved inland more and more... Many km [of houses] along the coast had to move in... But after they got that it happens a little bit less. The bamboo fence and forest slow down the stream and the storm.* [FG4\_2]

*He thinks maybe roots of tree can slow down the erosion.* [FG9]

At house on canal, with no mangroves: *So when they had mangroves, the soil did not erode. But when the mangroves were gone, the erosion makes the ground level go down. The water comes higher. They don't know if it's because the erosion makes the porch lower or the floods are higher... The effect of the government wanting to make the canal deeper –dredging. So sucked mud, then the mangrove dirt fell in, then the mangroves fell down. The mud is gone, then the mud at the forest eroded. Then the trees died.* [FG18]

*During the tsunami, around Village 4 and 3 has thick mangrove forest so it was a wave break... And they can protect from the wind. Also at the river area, to protect the erosion along the canal and the water. So there's nothing harmed or damaged at all.* [FG19\_2]

On women's group charity work: *People don't need help from floods. Because the floods come and go. No need for help.* [FG17]

### **(5) Salinization**

When water becomes salty, known as salinization, water for crops and drinking water may become unusable. Salinization and the purchase of drinking water on Koh Klang may be dated to the expansion of intensive farming or to the charcoal concession. As mangroves restore, salinization decreases and new areas become hospitable to crops such as rice because mangroves limit the salt reaching these now protected paddies. Simultaneously, fewer people need to purchase water.

#### **Focus group quotes regarding salinization**

*On buying water: Started five years ago. Water started to have a different taste. Quantity of water started to decrease... Not just the shrimp pond but also the sea level rise might have washed into it. The water was salty. [FG6]*

*Before the tsunami the rice paddy field was very large. After the tsunami they couldn't grow rice on over half the field. Someone from Land Development came to help them. [FG6]*

*On connecting water source to mangroves (they live in Village 2 and have to buy water due to salty taste and drought): The mosque well is close to the mangrove forest. It is for everyone to drink... The roots can help can make the water clean. [FG17]*

### **(6) Physical and mental health**

Intensive ponds provide few long-term benefits for the local community, while costs include rashes, breathing problems, fatigue, and possibly some other more serious diseases. Chemicals wash into the waterways and pollute the natural fishery. More mosquitos are linked to the use of fertilizer, and the mosquitos make the environment uncomfortable and may even lead to increased cases of dengue fever. Rice paddy work now carries some of the rashes and breathing problems previously associated with intensive farming.

Some of the major costs of intensive ponds are the constant labor required and resulting stress and fatigue. For this reason, some owners of abandoned ponds say they will not return to intensive farming even if it becomes lucrative again. Quality of life and income security are better now, because people are less dependent on the boom or bust of an intensive pond. Intensive farming is very stressful due to this insecurity and because of the constant care (antibiotics, fertilizer, food) the ponds require.

### Focus group quotes regarding physical and mental health

On “easy work” at Raks Thai site: *When she comes to collect the clams here 300-400 baht a day, easy income. To compare to when she had shrimp pond, she was very tired and worried, she could not stop working, stressful and hard work. More hard work than going out to catch the fish.* [FG4\_3]

Comparing income during intensive pond days versus today’s fishery: *It’s hard to compare exactly. You get money from shrimp pond, but it’s not a certain amount and it’s hard. First time you can get good profit, but later, many people had shrimp pond as well so the price went down. And if your pond had disease, it’s very hard to tell, the income is not constant... But to compare now, she goes out for husband’s fishery she know how much she will get. And she is more happy with the income.* [FG4\_3]

*The community only gets the pollution side of the shrimp pond operation. And usually they don’t even use local labor. Usually, quite often, most shrimp farmers use Burmese or people from the northeast. They have no attachment to the local community. So it’s easier for them to control.* [Jim Enright of MAP]

*Yes--skin disease, rash, allergic. 1998-1999 at that time, they have lots of chemicals and sometimes too much. And he used the chemical but tried to be very, very careful, not touch them. Breathing problems... Tired, don’t know what happened, very tired, could not breathe well.* [FG3\_1]

*[She] could not breathe well, for 3 years. Short of breath.* [FG4\_3]

### **(7) Health of the island ecosystem**

Ponds fragment the ecosystem and weaken the system for species diversity and health. By increasing mangrove coverage and density, whether fringe or inland, the ecosystem becomes healthier. The strength of the system improves. Fringe mangroves provide direct protection from storms, however, mangroves that are inland and not adjacent to large bodies of water are also key in disaster risk reduction.

#### Focus group quotes regarding the health of the island ecosystem

On importance of mangroves: *It's very important. The mangrove forest can bring more rain. If they have enough rain, the fish and the crab in the rain can be in a good amount. If they don't have enough rain, the sea dries out, no fish.* [FG13]

On benefits of Raks Thai site: *In the good years she has more income, not just because they sell the fish and the crabs but because the whole thing connects together. Now that they have more mangroves here, the tourists and more species come and they can collect more. And the prices are higher because they can sell to the tourist. So it makes it better, not just because there are more shellfish, but because many things are going on after they got the mangrove.* [FG4\_3]

#### **(8) Non-use value of the ecosystem**

Local residents identify mangroves as part of their culture. Mangroves provide benefits that cannot be measured such as relaxation, shade, and beauty. They provide resting places for fishers, which may also have positive mental and physical health implications.

#### Focus group quotes regarding non-use value of the ecosystem

*Mangrove forest is a part of their livelihood and income generation. But that's a part of the culture. The people live with and off them.* [FG1\_1]

*It is beautiful. It grows and they see all the green. Yes it is fun [to go into the mangroves]. The wind blows and it is comfortable. He makes a hammock in the trees and sleeps very well.* [FG2\_3]

### (9) Tourism

A healthy mangrove ecosystem attracts birds, which feed in tidal mudflats. Birders come to see birds wintering in Thailand, and other ecotourists pay for boat rides through the mazes of healthy mature mangroves. The monkeys are a draw too.

#### Focus group quotes regarding tourism

*Then tourists came and asked him to take them around to see mangroves, mountains, and caves. Now he takes tourist through the mangroves forest to the caves in the mountains... He gets 300 baht per hour per person. [FG10]*

### (10) Empowering women

There are a number of women involved in EPIC. Some are volunteer conservationists, others are members of a women's group that does charity work on the island. They discussed feeling proud, and cited opportunities to go off-island for training and to visit other restored mangrove sites.

#### Focus group quotes regarding empowerment of women

*On why women's group plants mangroves (sometimes paid): The government – mangrove unit – came and approached them to work to reforest mangroves together... They're proud. Friendships, relationships among community members. Build relationships. They're proud of their work together. Sometimes the government cut mangroves for wood so they're replanting so that the community will have more fish. They cut to use them and [the women] replant them. [FG17]*

*She was helping with this land, she's a woman's representative so she's always going out for meetings and sharing what's going on here and knows lots of NGOs and people outside. So when they start this meeting on adaptation and climate change, when they go out or are sharing the knowledge of the community on adaptation she knows a lot. The people start to get to know the strength of this community, and it became the learning center. At first the NGO brought the other communities here: "Oh, this is very nice community, they do quite a lot on reforestation!" And many people start to come. [FG4\_2]*

## Costs across landscapes

The costs associated with the seven landscapes are described in Appendix D. Any quantities provided are approximations as most costs vary depending on the characteristics of a given site.

Our focus groups reveal that stakeholders perceive decreased seafood harvests and the loss of biodiversity and ecological services as the main consequences of mangrove degeneration. The rise and fall of shrimp aquaculture left many abandoned ponds on Koh Klang and decreased the island's resource base. Disease, soil pollutants, and rising input costs forced shrimp farmers to abandon their ponds, leaving many people with debt. Furthermore, ponds are often owned by outside investors who hire migrant workers from northeast Thailand or Myanmar, so local laborers often do not directly reap the economic benefits. But local communities do suffer the ecological costs of degraded mangroves.

Intensive ponds require intensive labor to feed and care for the densely stocked shrimp, and to maximize yield, they require clean, aerated water (Rosenberry, 1995). **Construction costs** for such a system range from \$25,000 to \$250,000 per hectare. **Production costs** range from \$4.00 to \$8.00 per kilogram of live shrimp (Rosenberry, 1995). Extensive ponds require less labor and carry fewer production costs than intensive ponds because they use tides to stock and flush the ponds, and thus use minimal feed and fertilizer. Harvesting wood to clear areas for aquaculture generates additional **labor costs** associated with both types of ponds.

The **ecological costs** associated with shrimp farming include increased soil erosion, water pollution, salinization of groundwater and agricultural land, and decreased coastal protection and seafood larvae populations (Quarto, 2012). Selective harvesting of shrimp larvae has a high by-catch rate — as much as twenty pounds of fish lost for each pound of shrimp larvae — so the ponds affect the fishing industry and island food security as well (Quarto *et al.*, 1996). Clearing mangroves to form ponds increases fragmentation and thus weakens the remaining mangrove forest. Clearing mangroves also increases nutrient and sediment runoff and so reduces biodiversity and seafood harvests. Quantifying these ecological costs is difficult.

Chemicals used in intensive ponds alter water chemistry and increase toxins. This impacts **human health**, and can result in a loss in worker productivity and a loss of individual benefits related to health outcomes.

Restoring abandoned ponds requires the environmental **remediation of acidic soils** that remain years after abandonment; the change in pH shifts flora and fauna away from the natural mangrove ecosystem toward acid-tolerant species (Sammut, *et al.*, 1996). This

altered landscape inhibits the natural restoration of mangroves even when an owner or community is eager for restoration because of the cost of restoring soil pH.

## Property rights

The focus groups reveal the complexity of property ownership in Thailand, and the fact that this murkiness affects both the ability of NGOs to find areas to restore to mangrove as well as the willingness of individuals to restore their abandoned ponds.

It is difficult to find an appropriate site for natural restoration. The best sites are along a mangrove trail where the new trees would bolster the strength of the overall forest. But owners are often reluctant, or are not local and are unresponsive, or are wealthy and have little interest in the pond. Some owners are waiting for shrimp farming to become economically viable again and cut mangroves to keep their pond ready for that time.

Fear of government appropriation prevents many people from allowing mangroves to naturally rejuvenate. One young man described how he learned about the benefits of mangroves in school and understood their importance, and so does allow mangroves to grow in his abandoned pond, but he feels he must thin them occasionally to prevent a full mangrove ecosystem from taking hold. He fears that the government would take control of his land if it returned to mature mangrove. Meanwhile, government officials claim the government would never appropriate a restored mangrove that is privately [and legally] owned, and claims that the real problem is that people illegally encroached upon government land to make their intensive shrimp pond, and it is only these areas to which the government now lays claim. Property rights are further discussed in the recommendations section of this report.

### Focus group quotes regarding property ownership

Government officials on inland mangroves: *Inland is more about the fish, crabs, and nurseries. The inland forest cannot expand more because there is more population that needs more area. And the investors come and cut so [the government] cannot make a lot of mangrove forest inland.* [FG19]

Resident on whether government appropriation of land occurs: *There is some area but not around here. Some other area where the DMCR find out that this shrimp pond should not be private land so they take it back... It's real. He can tell an occupied area runs through a place where DMCR take back the land the mangroves rejuvenate quickly the people have to leave... Here, the DMCR could not take it because the land belongs to him. But the story is about an area that is not private land.* [FG3\_1]

Abandoned pond owner worries about government appropriation: *Yes, they worry. He said there are some shrimp pond owner who when the mangrove come they cut the mangroves because they are afraid. If some owner has paper or ownership they don't care. If some owner does not have paper they feel uncertain if the forest come back... Yes, he knows one person in Village 3 [to whom this happened]. And some people who encroach into the area of the government, they know that "okay, the government will take back."* [FG5\_2]

### **EPIC findings**

The EPIC sites already have a few mangroves starting to naturally regenerate, some several meters tall. Other mangroves have been planted, mainly along the banks to reinforce the mud walls. But it is too early to measure significant economic or DRR benefits at the EPIC sites. It is likely that labor will continue in order to form a cement support for the sluice gate in EPIC site 2, which has a strong water flow causing the gate to require additional support. So day laborers will continue to receive pay. Fish and other animals are populating the ponds, and owners are using the silvofishery as a place to deposit young fish for harvest at a later time, so food-related benefits are small but already measureable.

The ponds are approximately one hectare in size and are privately harvested by the owners, so they will not provide community-wide food or DRR. However, there are a few houses that *will* directly benefit when a mature EPIC mangrove provides a wind-break. These households will also benefit when a mature EPIC site absorbs water during a flood surge in the channel, and decreases or prevents the salinization of the surrounding water table.

The EPIC sites will eventually provide benefits on par with the MAP 2009 site. However, one significant difference between EPIC and MAP 2009 concerns access to the mangroves and who reaps the harvest. MAP 2009 is currently harvested by individuals who live in the surrounding area; its wealthy and largely absent owner allows this. But the EPIC program-design earmarks the harvest specifically for the owners. In addition to being the preference of each owner, it is a necessary stipulation to enable IUCN to accurately measure the benefits of the mangrove in coming years. Thus EPIC mostly benefits site-owners whereas MAP 2009 benefits the wider community.



### Focus group quotes regarding EPIC: Part 1

*On EPIC benefits: Yes, the villagers know the benefits better than me. They have heard from their mothers and fathers what the mangroves provided for them. But we need to do more to help the people better understand and protect the mangrove forest. The Thai error is that people think the government has to do it but we need to do it together. [FG6\_2]*

*Species and quantity are not the same when the mangroves are only recovering. Need to wait until the mangroves and ecosystem becomes healthy... It took 10 years for an abandoned shrimp farm near her office to grow back and recover. But in some areas the recovery rate is a lot slower. [FG8\_2]*

*Whenever the community members can capture the small larvae of sea bass from nature they will stock the ponds. They do not intentionally stock it for farming or their main source of income. Basically it's only for their own consumption but if they have more they might harvest it for sale. [FG1\_1]*

CBEMR with silvofisheries is a wise choice for an IUCN intervention. It is necessary to involve the community to sustain the project, and natural restoration is more cost-effective than planting, which has a high fail-rate. Silvofisheries will provide a more immediate benefit than waiting for the mangrove to provide DRR benefits. Without the silvofisheries, it is unlikely people would allow their ponds to regenerate.

### Focus group quotes regarding EPIC: Part 3

*Natural growth is better than replanting. The soil and nutrients would be better in natural growth. The planted mangroves might not grow because the shrimp ponds ruined the soil. [FG15\_1]*

*On EPIC methods: In the EPIC site, they are very careful about what should be grown and how the water should flow. [FG8\_2]*

*There are activities from the schools to plant mangrove on abandoned shrimp ponds but the trees did not grow well. The mangroves that grow naturally are much better. Mangroves that grow naturally are much healthier. Believes it might be related to chemicals that were used during intensive shrimp farms. [FG6\_1]*

On letting her pond become EPIC site 1: *The pond will naturally come back. Water flow. There was nothing happening from that pond but if you do something, that might be good... If more trees come there might be more fish and crabs.* [FG14]

Another important goal of the EPIC program is to demonstrate and promote the technique — to show communities, NGOs, and government officials that natural restoration is more reliable than large-scale plantings for which the appropriate mangrove species are not carefully chosen. In April 2015, the IUCN team brought government officials from Bangkok to witness the start of the EPIC restoration. This is a tremendous step in EPIC efforts to draw the Thai government's focus to the benefits of CBEMR. Potential roadblocks involve the long-term nature of a CBEMR intervention versus the faster results of planting; government officials in our focus groups were interested in natural regeneration, but worried the timeframe would not work for a government project.

Before and during the EPIC restoration, IUCN/MAP held community meetings and conducted workshops in which interested people could learn about the benefits of mangroves and the CBEMR technique. At one of these meetings, silvofisheries became part of the intervention. Throughout the implementation process, EPIC relied upon local labor, so additional training occurred on-site as the team encountered each new challenge and found its solution together.

The government's own environmental educational efforts include a sub-district Learning Center that partners with communities to teach climate change and mangrove restoration. And public schools have an environmental unit in which students learn about the importance of the ecosystem and plant mangroves. EPIC might connect with either of these networks to expand knowledge of CBEMR.

#### **Focus group quotes regarding EPIC: Part 2**

*When they started the project for the first time they didn't understand why they were doing it here because that abandoned shrimp pond is private, it belongs to the Imam. And why the other community member had to work there. But they got paid so they went to help. Later Jim and Ning took them to study more about reforestation and ecosystem so they understood more about what they were doing. And they saw a change. They started in 2013, and not only they see the change. Everyone in the community sees the change--trees coming up, the water flow, and they hope that they might have fish and crabs starting to come. And not only them, the other shrimp pond owner wants them to do the same. They hope for something better, now they understand.* [FG4]

Teacher on why school children replant: *The older person tells the story or teaches the kids that “Oh before, when we cook for food, we just took the vegetable from the house. And just go and get fish or shrimp from the sea in 30 minutes. Now it takes longer time to find fish or shrimp. So the school has this project to teach students that the mangrove is very important as the nursery for the fish. To teach students the connection between the forest and their lives, their food.* [FG16\_1]

Describing EPIC: *It is a project that is trying to reforest the pond back to its natural state. With the water. Let the water in and out. It might take time but it will change through natural ways. And when it comes back people will benefit.* [FG6\_2]

Government official after EPIC meeting, on scaling-up EPIC methodology: *It’s a very good idea, and he thinks that as a government representative it’s very interesting and a very good way to do it. He can see very good things from the EPIC start. They use the community, local wisdom, and get participation from the community. That’s why they have community involvement at the start. Even if it takes long, they learn. Then people learn and everyone can gain benefits. It takes a long time. It might be difficult for government to get involved in such a long project, 3-4 years. At the policy level, the technical level, it is a different way to see things. The policy would like to see something fast. ... Time is why the government could not do something like what the NGOs do. But they’re interested and would like to support. That’s why they send him to the meetings, as a representative, they are interested in this project.* [FG7]

On EPIC: *Everyone looks at the project and is impressed by how it looks. They want to see the results. They would like to see the results. If the results turn out well they would all like to do it. They think it might cost them 10000 baht [to prep an abandoned pond] but if they work together and help each other out they can make it happen.* [FG8\_1]

On cutting mangroves from abandoned pond: *Sometimes the lack of knowledge. Some of them have seen the mangrove trees come up, but the lack of knowledge so they don’t want them to come. They don’t want other things to come with the tree. They don’t know so they just cut it because some plots they still use it. The benefits from the plot. The tree comes but they cut it. If the EPIC site shows result, they will learn and it might be good for them.* [FG9]

On why he doesn’t think the EPIC approach will work, an approach that he just learned about from us: *In here, he also grows and let the natural growth and the trees never come. The clams eat the trees. So around this area, they do both [natural regeneration and planting], but the clams eat the baby trees.* [FG16\_1]

EPIC Thailand offers a cost-effective approach that combines social and environmental forces to protect infrastructure and communities (Cheong *et al.*, 2013). Many different factors affect an EPIC mangrove restoration so it is important to note that costs can vary greatly — five- to ten-fold. Factors include location, size, and security of the site; the amount of hydrological correction needed; who performs the labor over what timeframe; and the level of training needed. Based on MAP's experience to-date, costs range from \$5000 to \$30,000 per hectare. Long term, costs also depend on the level of monitoring and follow-up that donors and implementing agencies require; a basic level requires an additional \$700 per year (Enright, 2015b). Below is a brief description of EPIC costs; the complete budget developed with MAP is presented in Appendix E. It provides an estimation of the costs of the two sites.

Potential construction costs	EPIC implementation (from Enright, 2015b)
Break dikes and open sluice gates to restore tidal flow	The sluice gate at EPIC 2 had to be rebuilt several times because of strong water pressure
Install culverts to prevent drainage into the coastal belt	Two PVC culverts required at each site plus backhoe
Remove natural or man-made blockages	Paid community members and free labor from student volunteers; manual digging is on-going
Establish silvofishery for community	Required backhoe, otherwise minimal cost because both sites are former ponds

## VII. Recommendations

### Measurement strategies

This section explores data collection methodologies for costs and benefits associated to the program evaluation methodology. Areas to evaluate include quantity and type of food and other products harvested in mangroves; salinity and quantity of water; the presence of eco-tourists, especially birders; the value people place on mangroves for their cool, relaxing beauty; the effect of EPIC on health and education; the degree and successfulness of community and government outreach and education; and the protection mangroves provide from wind, flood, and erosion. Recommended measurement strategies are highlighted below, and a more comprehensive discussion follows the table.

	Measurable					Non-Measurable	
Cost benefit	Food and product	DRR	Tourism	Education	Health	Outreach	Non-use
Sample	EPIC site owners & families	EPIC site neighbors, Sediment-ologist	tourism workers, gov't officials, conservation groups, volunteer NGOs	EPIC families, teachers	EPIC families, neighbors, and day-laborers, healthcare workers	EPIC participants, local community, abandoned pond owners, government officials, NGOs	EPIC site owners & families
Data collection strategy	Household survey	Household survey, erosion & salinity tests	Survey	Household survey, test results	Survey	tally of training hours, number of participants, blogs, tweets, articles; survey of participants	Household survey
Frequency of data collection	0, 1, 5, 10, 25 years	0, 10, 25 years	0, 1, 5, 10, 25 years	0, 10, 25 years	0, 10, 25 years	0, 1, 5, 10, 25 years	0, 10, 25 years

### ***Measureable benefits***

***Food and products*** Surveys of EPIC site owners and their family members across time will be most useful to obtain accurate information about exactly what has been harvested from the sites, and to obtain estimations of the economic value of that harvest. Questions should range from quantities and species of shrimp, clams, fish, and crabs, to palm fronds, wood, medicines, and teas. How have the sites affected income and food security? To secure the most accurate account, it is imperative that the EPIC sites remain available to only a closed set of individuals; if the sites become available to the community, it will be far more difficult to accurately assess the economics of the harvest. Additionally community access might cause the harvest to be depleted and the site to become less productive than a privately-owned, well-managed site — the tragedy of the commons. This would skew the estimation of the yield for a mangrove of a given age.

***Disaster risk reduction*** Surveys of people living in close proximity to the EPIC sites will be most useful to ascertain whether the sites have provided DRR across time. Lines of inquiry should include amounts spent to fix roofs, replace vegetation, repair walls, replace floor boards, build fences, and to repair the topography or hydrology of the EPIC sites themselves. A sedimentologist may conduct erosion and soil tests along affected banks and property, and in neighboring agricultural fields. Water can be tested for salinity across time, and nearby farmers asked about the water available for their fields — whether they can now grow a different variety of species or quantity. Household representatives can answer questions about drinking water, and whether and how much money is spent on water, and in what seasons it is necessary. Time spent traveling to the Imam's well for water could also be measured.

***Tourism*** Workers at hotels, restaurants, cafes, and tourism agencies, as well as government officials, can answer questions about eco-tourists interested in mangroves. The boatman we interviewed draws a substantial portion of his income from bringing tourists into dense fringe mangroves and along the canal to see monkeys who live in the mangroves. Birders may also be increasingly drawn to the area as biodiversity increases. Researchers, conservationists, and NGO volunteers and workers are not exactly tourists, but their presence does increase the visibility of mangroves, and they do spend money on Koh Klang. Thus these groups (especially NGOs targeting “gap-year” youths) can provide an estimate regarding their numbers and economic benefit to the island.

***Education*** Students living in areas protected by mature EPIC sites may be less likely to miss school after an extreme event due to reduced damages to their home or route to school than that suffered by their nonEPIC peers. Teachers and parents may provide information regarding whether students have missed school to work in an EPIC site, or if students from families involved in EPIC have a more sophisticated understanding of mangrove ecology, community-based work, climate change, or DRR than their peers.

Over time, teachers may notice that students involved in EPIC gain a broader understanding of the environment, ecosystems, and Thailand's role in the world, and it may affect the percentage of students who go on to higher education. So an analysis of these statistics over time may provide further information about the benefits of EPIC.

**Health** Individuals involved with EPIC or living near it, as well as healthcare workers, can be surveyed regarding the health effects of the sites: have there been any accidents, injuries, or deaths during maintenance of the EPIC sites, or as a result of floods, erosion, or wind? Several focus group participants spoke of stress and depression related to storms and damage to property, so mental health workers should be surveyed as well. Community health volunteers visit the home of anyone who suffers damage or injury from a storm, so these individuals will provide valuable information. Hopefully the need for such visits will decrease as mangroves are restored.

### ***Non-measurable benefits***

The benefits below are not economically quantifiable, however, we provide some suggestions to measure them.

***Provision of cool, relaxing, & peaceful environment*** Mangroves provide a cool and relaxing place to rest and get out of the sun. To measure this service, survey individuals regarding their use of mangroves for these purposes. Asking fishers if they take naps in the mangroves uncovered some fun answers. It may be productive to advance the economic evaluation of this benefit by determining whether an expense such as electricity for a fan is *avoided* because the mangroves provide a relaxing and cool environment.

***Community and government outreach*** Individuals involved in EPIC, government officials such as those involved in the Mangrove Learning Center, community leaders, and conservation group members, will be valuable resources when assessing the educational successes of EPIC across time. A tally of IUCN/MAP hours spent communicating with and teaching EPIC participants in meetings, training sessions, and in the field will provide a quantitative number of education-hours. A control group of random Koh Klang residents can provide a baseline of how much a typical resident knows about climate change, mangrove restoration (planting and natural), DRR, and ecosystems to compare against EPIC participants.

There was a surprising range of environmental knowledge among government officials. For this reason, the officials should be assessed from two angles: as subjects and as observers. What do they personally understand, and what do they observe the community understands? Special attention should be paid government officials from departments concerning property rights and management because this group is critical to the long-term success of EPIC. Do these individuals understand the connection between mangroves,

shrimp ponds, and Thai property rights? Have they made moves to reform the relevant policy? Is there national attention on the issue, in heavily-circulated newspapers, for example? Are people who are running for elected office discussing property rights, and encouraging mangrove regeneration on private land? Changes in the public discussion regarding property rights or perhaps even the public discussion of the value of natural restoration over massive planting efforts should be evaluated to measure these goals of EPIC. The prevalence of related blogs or websites can be tallied, the number of hits on these sites tallied, and the number of related internet searches tallied to uncover the array of public discussion and knowledge involving property rights, mangrove ecosystems, DRR, and natural restoration. Do people Tweet about Thai property rights issues?

## **Knowledge dissemination**

***Continue education of the community*** IUCN should continue to fund workshops that teach about climate change, ecosystems, and the role of mangroves, as well as the techniques required for successful natural restoration. Since the seafood and product harvest available in a mature mangrove is only supplementary to most people's income, a broader knowledge about DRR and other ecological benefits of mangroves is required to maintain community participation and interest after IUCN withdraws. [At least some] local schools already have an environmental unit that teaches the importance of the mangrove ecosystem. IUCN might propose that EPIC be used as a case study for students, so that the natural restoration process can be highlighted.

***Continue education of the government*** Most government officials [in relevant fields] understand the ecological benefits of mangroves. Further educating them involves the need to modify policies and practices governing the property rights of mangroves. IUCN should work with other NGOs to educate the Thai government regarding the need to enact changes so that private individuals are willing to allow mangroves to naturally regenerate on their abandoned ponds. A policy involving a government subsidy per hectare of restored mangrove may be an incentive; it could cover costs of any hydrology work, but also reimburse some of the cost incurred to create the flat-bottomed, treeless environment required for an intensive shrimp pond. Many people are preserving the walls and hydrology of their intensive pond because it was a substantial investment, and they see mangrove restoration as a loss of that investment. The government could pay pond owners to allow the mangroves to return.

***Wrap restoration in broader environmental efforts*** Most focus group participants described garbage or education as the primary problem facing their community. Garbage piles up on the island and they have to pay for a barge. Fishers who are otherwise happy with their lifestyle are concerned that the job will not exist for their children because of



trawlers and climate change, and so want their children to receive a good education. Perhaps mangrove restoration can be linked to waste management education and information about the fishing industry within a broader “humans and the Earth” framework, and an official program implemented in schools. Students could learn about climate change, and other impacts humans have on the environment in other ecosystems around the world. Expanding the curriculum to a global view may broaden horizons and encourage more students to pursue higher education.

***Reach out to and train pond owners*** IUCN should reach out to abandoned pond owners and managers. Educational sessions and a sales pitch might entice such owners to try natural restoration. Some owners need only be convinced to stop thinning or cutting the mangroves that are already growing back. Others will have to be taught about topography, hydrology, and the need to ensure the tidal flush appropriately feeds the site for a variety of fish and mangrove species to take root.

***Increase partnership with the Thai government*** A future IUCN project should more closely involve the government. Once the successful restoration of the EPIC sites is reported, government officials might be willing to try CBEMR on government-owned land. This would provide an opportunity for IUCN to work along a canal or sea edge, and thus test CBEMR on a fringe mangrove. Government officials have access to these areas, but not to privately owned shrimp ponds. IUCN, meanwhile, is able to access privately owned shrimp ponds by working closely with a community. Together, the government and IUCN could embark upon a large restoration involving government land and privately owned ponds along the same mangrove trail.

***Disburse knowledge, lessons learned*** The successes, benefits, and difficulties of CBEMR, once evident in the MAP 2009 and EPIC sites, should be widely distributed to the academic community, NGOs, and local and national officials and educators. Local schools could incorporate lessons about the benefits of mangroves and natural restoration, and the Learning Center could likewise teach about the benefits of the system. A thorough curriculum might include Webexs, training sessions, and site visits. IUCN staff involved in EPIC might brainstorm ways to disseminate information generated by all six EPIC sites to academics and local and international NGOs.

***Implement a certificate program*** More than one person mentioned the typical flow of information from the minds of Koh Klang residents to the minds of visiting graduate students. It is unfair that we take people’s time and information and turn it into a degree. At least one international agency has a certificate program to address this issue. Perhaps IUCN could implement a program after the completion of which participants receive a certificate from IUCN that indicates he or she has *genuine* knowledge of the conservation program in question, as well as of ecosystems and climate change in general.

## Future expansion of EPIC methodology

***Property rights reform*** As discussed in the knowledge dissemination section, it is imperative that IUCN work with NGOs and other stakeholders to ensure that the Thai government understands the connection between property rights and mangrove restoration, and moves to reform the structure. Citizens must be guaranteed that if they allow mangrove restoration on a pond on which they now have harvesting rights, they will maintain those rights after the mangroves return. Once there is comprehensive reform that is well-publicized throughout the country, citizens will allow their ponds to restore to mangroves without fear of government appropriation.

***Continue involvement*** IUCN's goal is to promote an expansion of the CBEMR methodology. Since each pond is different, the process cannot be precisely duplicated. A new site will have a new set of problems that will require knowledge of hydrology and basic engineering that the average person does not possess. Duplicating an EPIC project on another pond will also require legal understanding, as well as a degree of organization and labor that will likely need to be at least partially paid. It is therefore probable that the community will need continued support and funding from IUCN.

***Remain flexible*** EPIC is designed as a flexible program, which is wise and necessary given the vagaries of nature and of a community of people with complicated interests. Silvofisheries were a wise addition to the program-plan because they directly answered the community's request for tangible benefits. Similarly, it is necessary to remain flexible with respect to the restoration itself; natural restoration is preferable, but supplementary planting is helpful and speeds the restoration along. Experiments combining the two, while always treating each pond as a unique ecosystem, will be the most successful interventions with the most enlightening results for the EPIC demonstration.

***Silvofisheries as a "fish bank"*** The fish bank concept is adapted from Indonesia, where an individual used a pond to hold fish for neighbors who did not otherwise have access to a pond. It can serve as a nursery. IUCN might adapt this concept on Koh Klang to provide an additional community benefit of restoration with silvofishery. Such an addition is inappropriate for the first two EPIC sites, but the owner of a future restoration could implement a banking system after the mangrove is sufficiently stable.

***Geographic Information System (GIS)*** A variety of open source maps and satellite images are available now. GIS would provide IUCN scientists with a tool to identify ideal locations for future EPIC restorations. Ideally, a mangrove trail leads to the potential site, and topography maps may be an excellent way to analyze hydrology. Since the Thai government owns a pre-determined strip of mangrove forest along coasts, GIS would provide a way to set buffers to clearly identify these areas.

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## Appendix A: Thailand Focus Group Questionnaire

<b>Site Description</b>
Site 1: community with active pond
Site 2: community with abandoned pond
Site 3: community with mature mangroves
Site 4: community with EPIC mangrove restoration
Site 5: community with more mature non-EPIC mangrove planting (6+ years)
Site 6: community with government monoculture mangrove planting
Site 7: neighboring community, not immediately affected by mangrove restoration, but perhaps tangentially

<b>Group Description</b>	<b>Contact Method</b>
Local Households (MALE head of household) of different socioeconomic status and ideally with income derived from different activities representative of the community, including fishers, shell fishers, shrimpers, farmers, business, day-laborers	Field Staff, Meeting people on the street or in other interviews, friends/relatives of contacts
Local households (FEMALE head of household) of different socioeconomic status and ideally with income derived from different activities representative of the community, including fishers, shell fishers, shrimpers, farmers, business, day-laborers	Field Staff, Meeting people on the street or in other interviews, friends/relatives of contacts
Community leaders, including Imam	Field Staff, Meeting people on the street or in other interviews, friends/relatives of contacts
Children/youth of different socioeconomic status	Field Staff, Schools, Meeting people on the street or in other interviews, friends/relatives of contacts
Local doctor/health clinic workers	Field Staff, Meeting people on the street or in other interviews, friends/relatives of contacts, email/internet
Local teachers/school officials	Field Staff, Meeting people on the street or in other interviews, friends/relatives of contacts, email/internet

Local government officials	Field Staff, Meeting people on the street or in other interviews, friends/relatives of contacts, email/internet
Local merchants, including tourism	Field Staff, Meeting people on the street or in other interviews, friends/relatives of contacts
Mangrove maintenance & IUCN project employees	Field Staff, Meeting people on the street or in other interviews, friends/relatives of contacts, email/internet

<b>SHRIMP PONDS (questions to identify type of community)</b>	
Code	Questions
1_1	Are there active shrimp ponds in or around your community?
1_2	Do you know many?
1_3	Do you know who owns them?
1_4	Do you know anybody who works there?
2_1	Are there non-active shrimp ponds in or around your community?
2_2	Do you know many?
2_3	Do you know who owns them?
2_4	Do you know anybody who used to work there?
3_1	Are there non-active shrimp ponds that are being replanted as mangroves?
3_2	Do you know many?
3_3	Do you know who owns them?
4_1	Are there non-active shrimp ponds that are being naturally replaced by mangroves?
4_2	Do you know many?
4_3	Do you know who owns them?
<b>MANGROVE FORESTS (to identify type of community)</b>	
5_1	Are there mangrove forests in or around your community?
6_1	Does your community have virgin/ mature mangrove forests?
7_1	Does your community have new mangrove plantings (1 to 5 years)?

7_2	How old are these new mangroves?
7_3	Are the plants part of a natural restoration project? (natural growth no planting)
7_4	If someone planted them, who planted them? (Privates, NGOs, government...)
7_5	Did they replace shrimp ponds?
8_1	Does your community have older mangrove plantings (6 to 10 years)?
8_2	How old are the mangroves?
8_3	Are the plants part of a natural restoration project? (natural growth no planting)
8_4	If someone planted them, who planted them? (Privates, NGOs, government...)
8_5	Did they replace shrimp ponds?
9_1	Does anyone take care of the mangroves (monitoring their growth, protecting the mangrove, <i>etc.</i> )?
9_2	Who? (prompt: local government, local organizations, private citizens)
9_3	What do they do? (monitoring their growth, protecting the mangrove, <i>etc.</i> )
10_1	Can you describe the difference between mangroves in a government monoculture and an ecosystem reconstruction?
11_1	Can you describe what the government program does? (prompt: does the government cut mangroves, keep all the plants the same kind of mangrove)
12_1	Is the mangrove in your community healthy?
12_2	How can you tell?
<b>Property rights and land ownership</b>	
11_1	Who has ownership of the shrimp ponds?
11_2	Private individuals living in community?
11_3	Private individuals not living in community?
11_4	Local cooperatives?
11_5	Private companies?
11_6	Local or central government?
12_1	Who has ownership of the mangrove plots?
12_2	Private individuals living in community?
12_3	Private individuals not living in community?
12_4	Local cooperatives?
12_5	Private companies?

12_6	Local or central government?
13_1	How do plot owners manage their land?
13_2	Owners rent to local farmers?
13_3	Owners lend to locals in exchange for percentage of profits?
13_4	Others?
14_1	Does the government ever expropriate plots?
14_2	If so, are mangrove more likely to be expropriated than active shrimp ponds?
14_3	If so, are mangrove more likely to be expropriated than NON-active shrimp ponds?
<b>Economics: challenges and services</b>	
15_1	What are the main economic activities in this community?
15_2	Agriculture? (explain)
15_3	Fishing?
15_4	Shrimp ponds?
15_5	Factory?
15_6	Commerce (including tourism)?
15_7	Other?
16_1	Of the last 5 years, what was the best year for household income?
16_2	Because more people worked?
16_3	Children began to work?
16_4	Household grew?
16_5	Good weather?
16_6	Good crops?
16_7	Good fishing?
16_8	Someone had a job with wages?
16_9	Mangroves were healthy?
16_10	Extra income was earned from an activity?
16_11	Something else?
17_1	Of the last 5 years, what was the worst year for household income?
17_2	Death of a family member?



17_3	Sickness and injuries?
17_4	Weather shocks and weather extremes (floods, storms, erosion...)?
17_5	Loss of harvest?
17_6	Loss of business (commerce)?
17_7	Bad fishing?
17_8	Failure of shrimp pond activities?
17_9	Cutting down of mangroves?
17_10	Land expropriation from government?
17_11	School expenses?
17_12	Health expenses?
17_13	Other expenses?
17_14	Retirement?
17_15	Something else?
18_1	In the past year how often have flooding or weather-related accidents occurred?
	How often do they
19_1	Cause illness?
19_2	Cause injury?
19_3	Cause death?
19_4	Damage infrastructure? (homes, road, structures, public buildings)
19_5	Damage harvest?
19_6	Damage land?
19_7	Damage cars, trucks, agricultural equipment?
19_8	Prevent people from working?
19_9	Prevent people from traveling/ moving around?
19_10	Prevent kids and teachers from going to school?
19_11	Affect tourism?
19_12	Increase coastal erosion?
20_1	What is the main source of concern for your family? (indicate if the following are important or not so important)
20_2	Death of a family member?

20_3	Sickness and injuries?
20_4	Weather shocks and weather extremes (floods, storms...)?
20_5	Loss of harvest?
20_6	Loss of business (commerce)?
20_7	Bad fishing?
20_8	Failure of shrimp pond activities?
20_9	Cutting down of mangroves?
20_10	Land expropriation from government?
20_11	School expenses?
20_12	Health expenses?
20_13	Other expenses?
20_14	Retirement?
20_15	Something else?
21_1	Are there schools in this community?
21_2	How close is the closest primary school?
21_3	How do kids go there?
21_4	How close is the closest secondary school?
21_5	How do kids go there? (on foot, public transportation)
21_6	Do schools ever close because of flooding? (staff or students unable to reach school)
21_7	Do mangroves help prevent flooding?
21_8	How close is the closest secondary school?
22_1	Is there a health clinic in this community?
22_2	How close is the closest clinic?
22_3	How often is it open?
22_4	How long does it take to go there?
22_5	Does the clinic ever close because of flooding? (staff or patients ever unable to reach the clinic)
22_6	Do mangroves help prevent flooding?
23_1	What services are provided at the clinic?
23_2	Vaccinations?

23_3	Regular prenatal check-ups?
23_4	Regular pediatric visits for small children?

<b>SHRIMP PONDS</b>	
<b>For current and former shrimp pond owners or workers</b>	
24_1	Do you own or harvest a shrimp pond (for adult shrimp) that generates income?
24_2	How many shrimp ponds?
24_3	How old is/are the shrimp pond(s)?
24_4	What portion of your income derives from the pond(s)?
25_1	Did you harvest a shrimp pond in the past that is now replanted with a mangrove?
24_2	How many?
25_3	What do you do now? (How have you replaced the shrimp pond activity?)
25_4	What portion of your income did you derive from the pond when it was a shrimp pond?
25_5	What portion of your income do you derive from the pond now that it is not a shrimp pond?
<b>For anybody who is familiar with active shrimp ponds</b>	
26_1	Do you observe more frequently health problems for people <u>working in active</u> shrimp ponds?
26_2	Skin diseases?
26_3	Stomach upsets?
26_4	Infections?
26_5	Parasites?
26_6	Bacteria?
26_7	Fungus?
26_8	Other?
27_1	Do communities with <u>active shrimp ponds</u> experience more frequently the following problems?
27_2	Quality of drinking water?
27_3	Amount of clean water?
27_4	Less food grown for the community?

27_5	Other?
28_1	Does the presence or absence of shrimp ponds change the type of plants people grow in their other fields?
29_1	Does the presence or absence of shrimp ponds change local diet? (what people eat)
30_1	Do kids work in shrimp ponds?
31_1	Can shrimp ponds affect the amount of education children receive? If yes, how?
31_2	Kids skip school to work?
31_3	Kids are often sick?
31_1	Do you think communities with active shrimp ponds are more vulnerable to weather shocks (have higher risk)?
31_2	Storm surges?
31_3	Floods?
31_4	Disease epidemics?
31_5	Ask in detail how?
<b>For anybody who is familiar with NON-active shrimp ponds</b>	
32_1	Do you observe more frequently health problems for people living in communities with non-active shrimp ponds?
32_2	Skin diseases?
32_3	Stomach upsets?
32_4	Infections?
32_5	Parasites?
32_6	Bacteria?
32_7	Fungus?
32_8	Other?
<b>Mangrove Goods and Services</b>	
For people living in communities with or surrounded by mangroves	
33_1	Have mangroves in this community changed over time?
33_2	More healthy (less healthy)?
33_3	More dense (less dense)?
33_4	More (less) types of plants?
35_1	Has the mangrove changed its production over time?
35_2	Type or amount of fish?

35_3	Type or amount of wood?
35_4	Type or amount of fruits/food?
36_1	Do you or members of your household harvest any plants/fruits from the mangrove?
36_2	What?
36_3	What do you use it for?
36_4	Do you sell it?
37_1	Do you or members of your household harvest any medicine from the mangrove?
37_2	What?
37_3	What do you use it for?
37_4	Do you sell it?
38_1	Do you or members of your household harvest any wood from the mangrove?
38_2	What?
38_3	What do you use it for?
38_4	Do you sell it?
39_1	Do you or members of your household collect any other products from the mangrove?
39_2	What products?
39_3	What do you use them for?
39_4	Are the products to sell?
40_1	Do the women, children, or elderly in the household collect any of the above products from the mangrove?
41_1	Are there any products that you or your neighbors USED TO collect from the mangrove, but are no longer available?
41_2	What? And what were they used for?
41_3	When did they disappear?
41_4	Why?
	We want to better understand the possible benefits of more mature mangroves compared to younger mangroves, Let's now compare the <u>different types of mangroves</u> you know:
42_1	Are there any products that you can collect only in the most mature mangroves?
42_2	Is the <u>quality</u> of drinking water better in areas with more mature mangroves?
42_3	Is the <u>quantity</u> of drinking water better in areas with more mature mangroves?

42_4	Is the <u>quality</u> of water used for agriculture (in fields close to mangroves) better in areas with more mature mangroves? (Less salty, etc.)
42_5	Is the <u>quantity</u> of water used for agriculture (in fields close to mangroves) better in areas with more mature mangroves?
42_6	How does the <u>variety</u> of fish differ in mangrove forests of different ages?
42_7	How does the <u>quantity</u> of fish differ in mangrove forests of different ages?
42_8	How does the <u>variety</u> of shellfish differ in mangrove forests of different ages?
42_9	How does the <u>quantity</u> of shellfish differ in mangrove forests of different ages?
	We want to better understand the possible benefits of <u>mangroves compared to active and non-active shrimp-ponds</u> . Let's now compare resources associated to mangroves with resources associated to active and non-active shrimp ponds:
43_1	Are there any products that you can collect only in mangroves and not in non-active shrimp ponds?
43_2	Is the <u>quality</u> of drinking water better in areas with more mangroves than shrimp ponds?
43_3	Is the <u>quantity</u> of drinking water better in areas with more mangroves than shrimp ponds?
43_4	Is the <u>quality</u> of water used for agriculture (in fields close to mangroves) better in areas with more mangroves than shrimp ponds? (less salty, etc.)
43_5	Is the <u>quantity</u> of water used for agriculture (in fields close to mangroves) better in areas with more mangroves than shrimp ponds?
43_6	How does the <u>variety</u> of fish differ in mangrove areas compared to abandoned shrimp ponds?
43_7	How does the <u>quantity</u> of fish differ in mangrove areas compared to abandoned shrimp ponds?
43_8	How does the <u>variety</u> of shellfish differ in mangrove areas compared to abandoned shrimp ponds?
43_9	How does the <u>quantity</u> of shellfish differ in mangrove areas compared to abandoned shrimp ponds?
<b>RESILIENCE</b>	
ASK ANYBODY - not only people living in communities with or surrounded by mangroves	
	We want to better understand the possible benefits of <u>mangroves compared to active and non-active shrimp ponds</u> . Let's now compare resilience and risk mitigation associated to mangroves and resilience associated to active and non-active shrimp ponds:
44_1	Do mangroves protect communities from floods more than active and non-active shrimp ponds?
44_2	Do you have any knowledge of villages that got flooded because mangroves were cut?
44_3	Is <u>flooding more frequent</u> in areas where mangroves have been replaced by shrimp ponds?
44_4	Is <u>flooding more abundant and dangerous</u> in areas where mangroves have been

	replaced by shrimp ponds?
44_5	Is <u>coastal erosion</u> more severe in areas where mangroves have been replaced by shrimp ponds?
44_6	Are <u>homes</u> more frequently flooded in areas where mangroves have been replaced by shrimp ponds?
44_7	Is <u>harvest</u> more frequently flooded (damaged/lost) in areas where mangroves have been replaced by shrimp ponds?
44_8	Is <u>infrastructure</u> (schools, health clinics, religious buildings) more frequently flooded (damaged) in areas where mangroves have been replaced by shrimp ponds?
44_9	Are <u>roads</u> more frequently flooded in areas where mangroves have been replaced by shrimp ponds?
44_10	Are <u>stores</u> more frequently flooded in areas where mangroves have been replaced by shrimp ponds?
44_11	Are <u>people more likely to be injured</u> due to floods in areas where mangroves have been replaced by shrimp ponds?
44_12	Are <u>students</u> more likely to miss schools due to floods in areas where mangroves have been replaced by shrimp ponds?
44_13	Is <u>tourism</u> more likely to be impacted due to floods in areas where mangroves have been replaced by shrimp ponds?
	We want to better understand the possible benefits of <u>mature mangroves</u> . Let's now compare resilience and risk mitigation associated to mangroves of different levels of maturity (young mangroves compared to mature mangroves):
45_1	Are mature mangroves more effective in protecting communities against floods (compared with young mangroves)?
45_2	How old should mangrove forests be to be effective in protecting communities against floods and coastal erosion?
45_3	Is <u>flooding less frequent</u> in areas where mangroves are more mature?
45_4	Is <u>flooding less abundant and dangerous</u> in areas where mangroves are more mature?
45_5	Is <u>coastal erosion</u> less severe in areas where mangroves are more mature?
45_6	Are <u>homes</u> less frequently flooded in areas where mangroves are more mature?
45_7	Is <u>harvest</u> less frequently flooded (damaged/lost) in areas where mangroves are more mature?
45_8	Is <u>infrastructure</u> (schools, health clinics, religious buildings) less frequently flooded (damaged) in areas where mangroves are more mature?
45_9	Are <u>roads</u> less frequently flooded in areas where mangroves are more mature?

45_10	Are <u>stores</u> less frequently flooded in areas where mangroves are more mature?
45_11	Are <u>people</u> less likely to be <u>injured</u> due to floods in areas where mangroves are more mature?
45_12	Are students less likely to miss school due to floods in areas where mangroves are more mature?
45_13	Is <u>tourism</u> less likely to be impacted due to floods in areas with more mature mangroves?
<b>Mobility Related to Mangroves</b>	
	We want to better understand the possible benefits of <u>mangroves</u> compared to <u>active and non-active shrimp ponds</u> . Let's now compare mobility and risk mitigation associated to mangroves and resilience associated to active and non-active shrimp ponds:
46_1	Do mangroves protect roads from floods more than active and non-active shrimp ponds?
46_2	Do you have any knowledge of roads that get flooded regularly because mangroves were cut?
46_3	Is access to <u>roads</u> more limited due to floods in areas where mangroves have been replaced by shrimp ponds?
46_4	Is <u>access to roads</u> <u>safer</u> in areas protected by mangroves compared to areas close to shrimp ponds?
46_5	Is <u>access to roads</u> particularly difficult for kids and elderly people due to floods in areas where mangroves have been replaced by shrimp ponds?
46_6	Is the <u>quality</u> of roads worse due to floods in areas where mangroves have been replaced by shrimp ponds?
46_7	Are <u>students</u> less likely to miss school because the roads are better in areas protected by mangroves?
46_8	Are <u>tourism and commerce</u> affected by bad roads (easily flooded) in areas where mangroves have been replaced by shrimp ponds?
	In areas where mangroves have been cut, are roads more prone to be flooded and therefore it is harder to:
47_1	Reach health clinics?
47_2	Enjoy public spaces within the community (flooded)?
47_3	Go to work in nearby towns?
47_4	Go to work in the fields?
47_5	Access public transportation (taxis, buses, boats)?
47_6	Access boats to reach Krabi?
<b>Health Related to Mangroves</b>	
48_1	Are shrimp pond workers more exposed to certain medical conditions?
48_2	Skin diseases?
48_3	Gastroenteritis (stomach bugs)?



48_4	Fever(s)?
48_5	Infections?
48_6	Parasites?
48_7	Fungal diseases?
48_8	Injuries from animals that live in/around shrimp ponds?
48_9	Intoxication due to chemicals in shrimp ponds?
48_10	More miscarriages due to toxic substances or diseases associated to shrimp ponds?
48_11	Injuries and deaths from floods?
48_12	More mosquitos?
49_1	Do you think people's health is affected positively by the presence of mangroves? In areas where there are no mangroves to give space to (active or non-active) shrimp ponds do you observe more frequently:
49_2	Skin diseases
49_3	Gastroenteritis (stomach bugs)?
49_4	Fever(s)?
49_5	Infections?
49_6	Parasites?
49_7	Fungal diseases?
49_8	Injuries from animals that live around shrimp ponds?
49_9	Intoxication due to chemicals in shrimp ponds?
49_10	More miscarriages due to toxic substances or diseases associated to shrimp ponds?
49_11	Injuries and deaths from floods?
49_12	Other?
50_1	Do you think that mangroves have beneficial effects for the health of agricultural fields? For instance:
50_2	Are there less pests when there are mangroves (and not shrimp ponds) nearby?
50_3	Is the soil more fertile when there are mangroves (and not shrimp ponds) nearby?
50_4	Is irrigation water less salty, more abundant when there are mangroves (and not shrimp ponds) nearby?
51_1	Do you think that mangroves have beneficial effects for the health of animals in farms? For instance:
51_2	Are there less pests when there are mangroves (and not shrimp ponds) nearby?
51_3	Is water for animals more abundant and healthier when there are mangroves (and not shrimp ponds) nearby?
51_4	Are animals less likely to be killed by floods?
51_5	Other?
52_1	Do you think the mangroves are more dangerous than the shrimp pond?
<b>Mangrove Non-use Value</b>	
53_1	Do mangroves hold an important place in local culture? How?
54_1	Is there any relationship between religion and mangroves?
55_1	Are the mangroves a source of peaceful relaxation for you?

55_2	Do you ever go to the mangroves to relax?
<b>Children, Education and Labor</b>	
56_1	Do students miss school because of weather, such as storms or floods?
56_2	Are they more likely to skip school in areas where the coast is not protected by mangroves? (due to floods)
57_1	Do students miss school because they have to work at certain times of year?
58_1	Do children work after going to school?
58_2	What type of activities do they do? (distinguish between boys and girls)
58_3	Are any of the activities indicated related to mangroves or shrimp ponds?
58_4	Do boys work more (are absent from school more) than girls?
59_1	In areas where there is an EPIC or other type of mangrove project: Can you see any ways the mangrove project has affected education or the school in the community?
59_2	Increased school attendance?
59_3	Increased school attendance for kids whose parents do specific jobs?
59_4	Kids get sick less frequently than they did before?
59_5	Families experience less floods and kids do not skip school to help their families?
59_6	More (or less) resources for education at the household level?
59_7	Other?
<b>Mangroves and Business</b>	
Questions for business owners or people working in local businesses (commerce, tourism, transportation)	
60_1	Do mangroves affect your business in any way?
60_2	How? (Less floods, better transportation, less diseases, more tourism...)
61_1	Do shrimp ponds affect your business in anyway?
61_2	How?
62_1	To your knowledge, do changes in the extension of mangrove forest affect the number of customers?
62_2	How?
63_1	To your knowledge, do changes in the extension of mangrove forest affect your revenues?
63_2	How?
64_1	Do you think mangroves help tourism?
65_1	Are you familiar with mangrove regeneration projects?
65_2	To your knowledge, have these projects affected other businesses in the community? (Prompt: certain kinds of stores, farmers, fishers, women, <i>etc.</i> ?)
65_3	How?

<b>SOCIOECONOMIC COMMUNITY STRUCTURE</b>	
IUCN EPIC Project	
Only for communities close to EPIC Project or other MAP projects	
66_1	What do you know about the EPIC mangrove project?
67_1	Have you (or your family) participated in the EPIC project in any way?
67_2	How?
68_1	Can you see any ways the EPIC project has affected people in the community? (Including their income, health and general level of happiness)
68_2	Farmers cultivating rice?
68_3	Farmers not cultivating rice?
68_4	Fishermen?
68_5	Businesses?
68_6	Tourism?
68_7	Shrimp pond owners/workers?
68_8	Former shrimp pond owners or workers?
68_9	Women?
68_10	Children?
68_11	Elderly?
68_12	Health?
68_13	Education?
68_14	Religious practices?
68_15	How?
69_1	Do mangroves affect the number of floods the community experiences?
69_2	Has the frequency of flooding and accidents decreased since the beginning of the project?
70_1	Are the communities with mangrove rejuvenation or mature mangroves doing better economically than the communities with no mangroves?
70_2	Do you think mangroves affect the activities of the community?
71_1	Do fewer floods mean that markets can open more regularly, throughout the year?
72_1	Are public religious celebrations or holidays affected by floods?
72_2	How?
73_1	Do you notice any changes associated with the restoration of mangroves in:
73_2	Women's labor or activities?
73_3	Child labor?
73_4	General health of the population?
73_5	Health of children?
73_6	Health of plants (agricultural activities)?
73_7	Health of animals?
73_8	Clean/drinking water availability and quality?
73_9	Harvest levels?
73_10	Has the mangrove changed who is the wealthy family in this community?

73_11	Has the mangrove changed who is a leader in this community?
74_1	Do you know of instances of families who have experienced material losses or material gains as a result of changes in the presence or health of the mangroves?
75_1	Does the community have community work periods when everyone comes together to fix a mangrove or shrimp pond or rice paddy?
76_1	Does the community have an emergency fund to pay to fix the mangroves or shrimp pond or rice paddy when they get damaged?
77_1	Do you know of another community/village that is affected by mangroves more than this community?
77_2	Which community?
77_3	How is it affected?
<b>Mangrove Related Economic Activities</b>	
78_1	Does the mangrove project have a direct impact on your income? (Do you do any activity that would not be possible if the mangrove was gone?)
78_2	What?
79_1	Do you benefit from the mangrove project in any way?
79_2	How?
80_1	Do your two closest neighbors, friends, or members of the community benefit from this mangrove project in any way?
80_2	How?
81_1	Do you think the mangrove project has changed anything for you or your village in any way?
81_2	How?
82_1	Do you think the mangrove project has changed anything for women, children, or the elderly in any way?
82_2	How?
<b>Maintenance of Mangroves</b>	
83_1	When did the mangrove restoration project start?
84_1	Can you describe the project?
85_1	How many people are permanently assigned to work on the mangrove site?
85_2	Do they perform maintenance?
85_3	Are they members of the community?
85_4	Have they been trained?
85_5	What is their salary?
86_1	Are there temporary workers involved in the project?
86_2	What are they paid?
86_3	How often do they work?
86_4	Who works? (Prompt: women, men, leaders, elderly, children, fishers, everybody)
87_1	Do they do it on a voluntary basis or are they paid?
88_1	How much pay?
89_1	What are the costs (materials and administrative) associated with the project?

89_2	Initial costs?
89_3	Administrative costs?
89_4	Maintenance costs?

Income-Livelihood	
90_1	Who lives in the house?
90_2	What are their ages?
90_3	Who is the head/heads of household?
91_1	How many people in the household work?
91_2	In which jobs?
92_1	Do you work for the household, or for someone else?
92_2	Is the work permanent or temporary?
93_1	How many people work in the home? (Babysitting, housekeeping, cooking)
94_1	Do you trade products?
95_1	What is your religion?
96_1	Who decides what the family eats?
96_2	Where do you get your food?
96_3	Who pays for your food?
97_1	What are the items you need to cook?
97_2	How do you get them?
97_3	What are the essential food items that you buy most frequently?
98_1	How do you cook your food?
98_2	Where does your fuel come from?
99_1	What are the biggest challenges faced by your household?
	Which of these challenges affect you:
100_1	Disease?
100_2	Weather?
100_3	Distance from town?
100_4	Lack of food?
Agro-Forestry	
101_1	Do you own land?
101_2	How much?
101_3	What kind?
102_1	Do you cultivate crops?
102_2	What kinds?

102_3	How much do you cultivate?
102_4	Do you sell what you cultivate?
102_5	What percent?
102_6	Are your crops rain-fed?
102_7	Are your crops fed by water surge/tide?
103_1	Do you rely on the mangrove for food or fish?
104_1	Do you rely on a shrimp pond for food or income?
105_1	Do you fish (for fish or shellfish) for food or do you catch and sell fish?
105_2	Where do you fish or shellfish?
106_1	Is this your main source of income?
107_1	Do you own animals?
107_2	How many?
107_3	What kind?
107_4	Do you ever sell your animals?
107_5	Or animal by-products (e.g. eggs, meat, milk)?
108_1	Do you collect any products from the mangrove?
108_2	If yes, what products?
108_3	What do you use them for?
109_1	Do you sell any of the products from the mangroves?
109_2	If yes, how much of what you collect?
109_3	Where do you sell your products?
110_1	What is the role of women and children?
111_1	Do the women or children in the household help with cultivation?
111_2	Collection?
111_3	Sales?
112_1	Do women in the household produce any crafts to sell?
112_2	Do children?
113_1	Do children contribute to the family's income by helping to cultivate?
113_2	By fishing or shrimping?
113_3	For how many hours per day?
<b>Migration</b>	
114_1	Are any of the household members away for work? Who (relation)?
114_2	If yes, who (relation)?

114_3	Where did they go?
114_4	How long have they been gone?
114_5	Is it temporary or is it permanent?
114_6	Do you plan to follow them?
114_7	Do they send any remittances?
115_1	What portion of your income is remittance?
115_2	How are remittances used?
	How much of the remittances goes to:
116_1	Food?
116_2	Education?
116_3	Agricultural materials?
116_4	Emergencies?
117_1	Do you know if there are other people who migrated from this village?
117_2	If yes, who? (relation)
<b>Financial Accessibility</b>	
118_1	Who makes decisions on how money is spent or saved?
119_1	Do you have a bank account?
120_1	Do you know anybody who has a bank account?
121_1	Is it easy to open a bank account?
122_1	Do you have any savings?
122_2	How much?
123_1	Do you have access to loans/micro-credit?
123_2	From which sources?
124_1	Do you have any kind of insurance?
124_2	What?
124_3	Is it easy to get insurance?
125_1	Do you have any debt?
125_2	How much?
125_3	Is having debt something that worries you?
<b>Assets</b>	
126_1	Do you own your home?
126_2	If not, who does? [Visual check of construction and flooring materials, presence of garden]
127_1	Do you have electricity?

128_1	Do you have a refrigerator?
128_1	Do you have an air conditioner?
129_1	Do you have television?
130_1	Do you have a phone?
130_2	Cellphone?
130_3	How many in the household?
131_1	Do you have a computer?
132_1	Do you have access to the internet?
132_2	Do you have an e-mail account?
133_1	Is your house in an area vulnerable to floods?
133_2	Have floods affected your house before?
133_3	Is your house in an area vulnerable to floods aggravated by the mangrove?
134_1	What is your preferred mode of transportation?
135_1	What do members of the household do to travel?
136_1	Do you have a bicycle?
137_1	Do you have a moped?
138_1	Do you have a car?
139_1	Do you have a boat?
139_2	What kind?
140_1	Do you have a fertilizer or seeding machine for farming?
141_1	Do you have a rice mill?
<b>Education</b>	
142_1	Do any of your children go to school?
142_2	Which ones (ages and genders)?
142_3	Who decides whether children go to school?
143_1	Do you pay for your children's school?
143_1	How much does it cost?
144_1	What are the reasons that your kids might miss school?
	Do your kids ever miss school to help with:
145_1	Work?
145_2	Harvest?
145_3	Property repairs during floods?
146_1	What do your kids do when they are not at school?
147_1	For how long do you expect your children to stay in school?
148_1	When do you expect your children to get married?



<b>Health</b>	
149_1	Where do you access health care?
149_2	How do you get there?
150_1	When are you able to access health care?
150_2	Is it reliably open and accessible?
151_1	How often do you see a doctor for any reason?
152_1	Are there any mobile clinics that visit your area?
153_1	What do you go to the clinic for?
154_1	What would you do if you needed help that you could not get in the clinic (i.e. surgery)?
154_2	Would you go somewhere else?
154_3	How would you get there?
155_1	If you needed medicine, where would you go to get it?
156_1	Are you aware of vaccinations for your children?
156_2	Do you have access to these?
157_1	How much do you spend on health related expenses?
<b>Community Leaders</b>	
158_1	What are the main activities that support livelihoods in the area?
159_1	What are the main sources of income?
160_1	What services does your community have?
160_2	Electricity?
160_3	Running water?
160_4	Sewage?
160_5	Public transportation?
160_6	Law enforcement?
161_1	Where does the water for public consumption come from?
162_1	What are the most important problems in your community?
163_1	Has the presence [or absence] of the mangrove changed people's activities?
163_2	How?
164_1	Has the presence [or absence] of the shrimp pond changed people's activities?
164_2	How?
165_1	In which ways has the mangrove improved living conditions in the area?
165_2	In which ways has it harmed living conditions?
166_1	What products are extracted from the mangroves?
166_2	Fish?

166_3	Shellfish?
166_4	Birds?
166_5	Wood?
166_6	Fruit?
166_7	Medicine?
167_1	Has the amount of flooding or droughts changed as a result of the mangrove?
168_1	Do the mangrove facilitate access to health care?
168_2	Are roads more easily passable because of less flooding?
168_3	Are clinics more easily accessible?
168_4	Do traveling clinics come to town now?
168_5	Is there easier access to medications, vaccinations?
169_1	Does the mangrove facilitate access to schooling?
169_2	Do families have more time or money to allow the children to go to school because of the products from the mangrove?
170_1	Does the mangrove facilitate participation in the market?
170_2	Do people sell products to other villages?
171_1	What impact does the mangrove have on migration?
171_2	Have more people left since the mangrove was restored?
171_3	Do more stay here now?
171_4	Are migrations mostly temporary or permanent?
171_5	Has this changed because of the mangrove?
172_1	Is there any advantage of a government monoculture mangrove versus EPIC restored mangrove?
173_1	Do people collaborate on community projects like mangrove restoration or care?
174_1	Does the community have an emergency fund to fix the mangrove or road behind the mangrove when they get damaged?
175_1	Can the community access public funds to improve the mangrove as the eco-engineering project teaches?
176_1	Are there families or communities that became troubled as a result of shrimp pond collapse?
176_2	Of mangrove collapse?
177_1	If families or communities become troubled as a result of shrimp or mangrove collapse, who helps them?
177_2	Family?
177_3	Neighbors?
178_1	How close are the mangroves to rice paddies or other fields?
178_2	Does the presence or absence of the mangrove affect these fields?

179_3	How? (i.e. number of fields fit for farming, fields now better for different crop, fields in new area of village due to change in water flow, <i>etc.</i> )
<b>Healthcare Workers</b>	
180_1	What is the extent of the “catchment” service area of the hospital/health facility? (show on map)
181_1	Which health services are provided regularly?
181_2	Are medications available here?
182_1	How do most people reach this health facility?
182_2	Where do most patients come from?
183_1	What is the average age of the patients?
184_1	What is the most common reason for their visits?
185_1	Are there mobile clinics?
185_2	For which services?
185_3	Frequency in each community?
185_4	If there are mobile clinics, are they more reliable when traveling on green roads?
186_1	What happens if a patient needs care that you are not able to provide?
186_2	Where do they go?
186_3	How do they go there?
187_1	If someone must travel far for care (e.g. surgery), how do they get there?
187_2	What support services exist?
188_1	Do people from communities without mangroves come to the clinic to be treated for different reasons than people from communities with a mangrove?
188_2	If so, what are the different reasons?
189_1	Do people from communities without mangroves tend to have the same health problems as each other?
189_2	Are these different than the health problems of people in communities with mangroves?
190_1	Are there differences in the health problems of people from communities with a mature mangrove versus a young mangrove?
191_1	Do people who work in shrimp ponds have certain health conditions or problems?
191_2	What?
192_1	Do people who work in mangroves have certain health conditions or problems?
192_2	What?
193_1	Does the absence of a mangrove increase mortality?
193_2	Why?
194_1	Is the clinic personnel local?

195_1	Does the clinic ever close because of flooding?
195_2	Are staff or patients ever unable to reach the clinic?
195_3	Why?
195_4	Is this different in communities with mangroves of different ages?
196_1	What kind of care is available for pregnant women?
196_2	Children?
197_1	How often are children seen?
198_1	Are vaccines available for children?
198_2	How are these administered?
198_3	Do people come to the clinic for these, or must you travel to them?
198_4	Are communities aware of these vaccines?
199_1	Are there nutritional supplements for kids or pregnant-nursing mothers?
199_2	If so, where can these be accessed?
200_1	How varied are the diets in this region?
201_1	Are the diets of people from communities with mangroves different from the diets of people from communities with no mangrove?
201_2	How?
202_1	Are the diets of people from communities with shrimp ponds different from the diets of people from communities without shrimp ponds?
202_2	How?
203_1	Does the presence of the mangrove improve diet diversity?
204_1	Are there problems of malnutrition/stunting in the area?
204_2	What could be done to combat this?
205_1	How often do flooding-related accidents occur?
206_1	Are there diseases or infections related to flooding?
207_1	Do these flooding related accidents, diseases, or infections occur more or less in communities with mangroves or communities without mangroves?
207_2	How serious are these?
207_3	Do people in communities with flooding, erosion, or storm damage suffer mental health problems such as stress or depression more than people with no flooding or erosion problems?
207_4	Do people working in or near active intensive ponds have more diseases related to mosquitoes than people not working in or near intensive ponds?

Education Workers	
208_1	Where do you live?
209_1	For how long have you been a teacher here?
210_1	What are the main challenges that teachers face in this area?
211_1	What is the teacher turnover (or how often are teachers replaced)?
211_2	Why?
212_1	What is the student-to-teacher ratio?
213_1	Until which age do boys attend school in this area?
213_2	And girls?
213_3	Why?
214_1	How much does it cost to attend school?
214_2	Books?
214_3	Materials?
214_4	Where do students get this?
215_1	What are the reasons why students miss school?
216_1	How often do older students miss school to help with work related activities?
217_1	Do kids miss school during harvest?
217_2	Girls or boys or both?
217_3	What are other reasons girls might miss school? (i.e. babysitting, period, <i>etc.</i> )
218_1	Where is the closest secondary school?
218_2	Do you know what percentage of students go on to secondary school?
218_3	Girls versus boys?
219_1	Where is the closest college/university?
219_2	What percent of people in the community have any college/university education?
220_1	Do you know of instances of families who have suffered material losses as a consequence of mangroves or shrimp ponds?
221_1	Has the school schedule been affected by floods?
221_2	Is the school schedule more reliable with the mangrove?

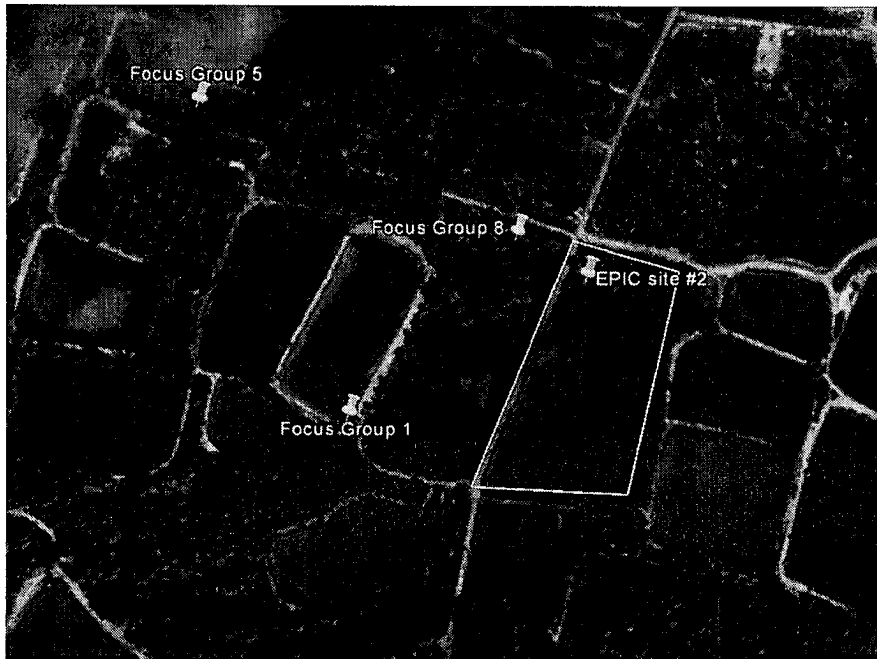
222_1	What do you know about the IUCN mangrove project?
222_2	In which ways is it positive?
222_3	In which ways is it negative?
223_1	In your opinion, in which ways does the presence of mangroves help the community?
223_2	In your opinion, in which ways does the presence of mangroves improve the education of students?

<b>Local Merchants, including Tourism</b>	
224_1	Has your business been affected by the shrimp ponds?
224_2	How? (Certain equipment needed or not needed anymore, people have more or less spending money, <i>etc.</i> )
225_1	Has your business been affected by the mangrove restoration?
225_2	How? (Certain equipment needed or not needed anymore, people have more or less spending money, <i>etc.</i> )
226_1	Do different people have money to spend now?
227_1	Have the number of visitors/tourists changed?
227_2	How?

<b>Mangrove Restoration and Maintenance Workers</b>	
228_1	How many people are permanently assigned to work on the mangrove project?
228_2	Salary?
229_1	Are there temporary workers involved during certain times of year?
229_2	Why?
230_1	How many people are regularly involved in maintenance activities related to the mangrove project?
230_2	Do they do it on a voluntary basis or are they paid?
230_3	How much?
231_1	What other costs are associated with the project?
231_2	Materials?
231_3	Administrative?
232_1	How long does it take to repair the mangrove ecosystem?
232_2	Does this take more or less time as the mangroves matures?
232_3	Can you compare this to a government/conventional mangrove planting?

233_1	Who owns the land where the mangroves are restored?
233_2	The community?
233_3	Private owners?
233_4	The government?
234_1	Who owned the shrimp pond that used to be there?
234_2	The community?
234_3	Private owners?
234_4	The government?
<b>Following to be asked of IUCN Project Employees, IN ADDITION to above</b>	
235_1	What are the long-term plans for the mangrove when IUCN is no longer involved?
236_1	What do you think is the community perception of the IUCN project?
237_1	How do people know about it?
237_2	Do they think it helps in any way?
238_1	Have any community members participated in the IUCN project in any way?
238_2	How?
239_1	Does the project have any technology transfer/education/community empowerment component?
240_1	Could any direct benefit be extracted from the eco-engineering treatments? (i.e. fruit trees, timber)
241_1	What trainings have IUCN/MAP conducted to teach people about the CBEMR methodology?
242_1	What meetings and outreach structure is in place to teach people about EPIC, the benefits of mangroves, and the benefits of CBEMR over planting?

## Appendix B: Focus group locations



Picture 1: Focus groups 1 and 8 were with the family who owns EPIC site 2. Focus Group 5 participants own abandoned shrimp ponds.

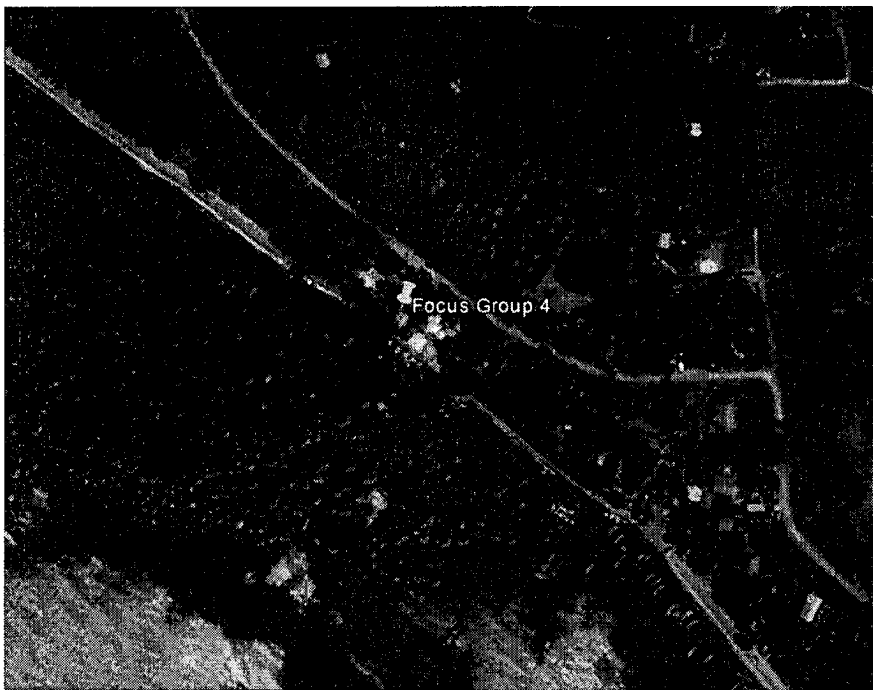


Picture 2: Focus Group 2 participants were mangrove harvesters at MAP 2009. Focus Group 20 was with a conservation and religious leader near MAP 2009.

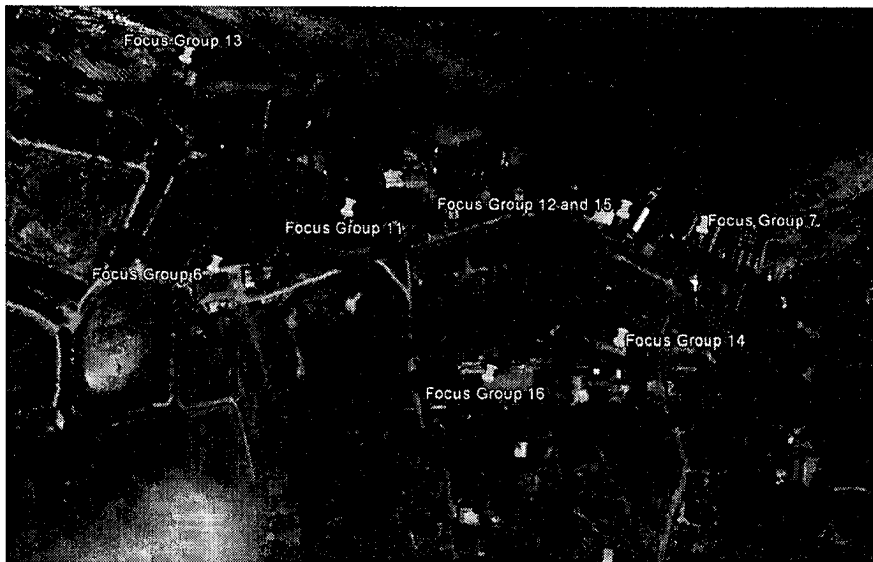




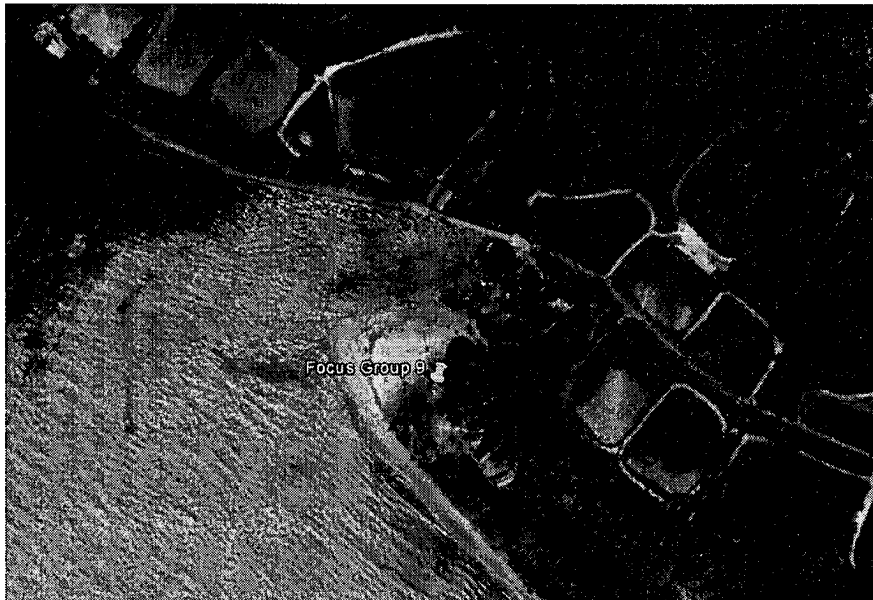
Picture 3: Focus Group 3 was at the home and business of an active intensive and extensive shrimp pond owner.



Picture 4: Focus Group 4 participants were conservation leaders. One of the participants worked on EPIC site 2 and lives behind the 3 km Raks Thai mangroves. Another used to work in an intensive pond.



Picture 5: Focus Group 6 participants were local government officials at their place of work. Focus Group 7 was with a government official from DMCR. Focus Group 11 participants were health care workers at an island health clinic. Focus group 12 and 15 participants were the customers and owner of a shop near the canal pier. Focus Group 13 participants were cage fishers living in the canal on a floating house. Focus Group 14 was with the owner of EPIC site 1 at her home. Focus Group 16 was with a teacher at a school in Village 1.



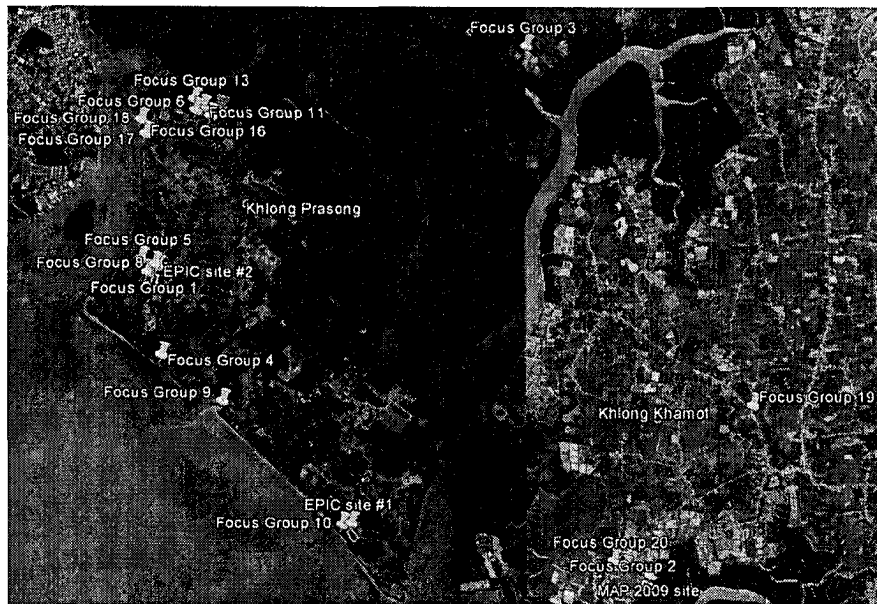
Picture 6: Focus Group 9 participants were fishers and owners of the Koh Klang Homestay.



Picture 7: Focus Group 10 was with a conservation leader who brings tourists on boat rides in the mangroves, and also manages EPIC Site 1.



Picture 8: Focus Group 19 participants were government officials at the sub-district government office on the mainland.



Picture 9: All 20 focus group site locations

## Appendix C: Analytical framework of benefits

CATEGORY	BENEFIT	LANDSCAPE						
		Intensive pond	Abandoned pond	Extensive pond	EPIC	MAP 2009	Mature inland mangrove	Mature fringe mangrove
<b>Food Source</b>	increase in harvest for personal consumption		X	XX	X	XX	XXX	XXX
	increase in harvest generating household income			XX		X	XX	XXX
	harvest value (household consumption+income generated from sales)	two harvest per year, hit or miss, 50000 baht	0 baht	occasional harvest, 4000 - 10000 baht per harvest	small number of crabs, fish already harvested; 6 mud crabs (600 baht)	modest income and food, 400 baht per day (1 kilo = 100 baht)	modest income and food, 400 baht per day (1 kilo = 100 baht)	modest income and food
	variety of species: fish, mud crab, shrimp, various clam species	X		XXX	X	XX	XXX	XXX
	chemical-free food			X	XX	XX	XXX	XXX
	more abundant	X varies widely		XXX	X	XX	XXX	XXX
	more accessible than sea fishing	XXX	XXX	XXX	XXX	XXX	XXX	XX
<b>Products</b>	fronds for roof				X	XX	XXX	XXX
	cigarette wrappers				X	XX	XXX	XXX



CATEGORY	BENEFIT	LANDSCAPE						
		Intensive pond	Abandoned pond	Extensive pond	EPIC	MAP 2009	Mature inland mangrove	Mature fringe mangrove
	medicinal leaves and roots				X	XX	XXX	XXX
	heart of palm				X	XX	XXX	XXX
	wood	wood from initial clearing	wood from initial clearing	wood from initial clearing	X	X	X	X
<b>Tourism/NGO presence</b>	ecotourism (birders, etc.)					X	XX	XXX
	tours of mangroves						X	XXX
	draw for NGO volunteer groups				XXX	XX	X	X
	higher price for fish with increased tourism				X	X	XX	XXX
<b>Supplementary food/income when needed</b>	provide backup for rainy season when no sea fishing due to storms (Climate change adaptation as storms increase)	XX		XX	XX		XX	XX
<b>Fish nursery</b>	provide fishers with place to deposit sea-caught young fish to harvest later, when mature			X	X	X	X	
	natural nursery for sea creatures			XX	X	XX	XXX	XXX
<b>Wind</b>	DRR-prevent storm damage to roofs and other structures					X	XX	XX

CATEGORY	BENEFIT	LANDSCAPE						
		Intensive pond	Abandoned pond	Extensive pond	EPIC	MAP 2009	Mature inland mangrove	Mature fringe mangrove
Erosion	DRR-prevent storm damage to homes, other structures, land, vegetation						XX	XXX
	decrease damage to fishing habitat- thicker mangroves prevent damage to more inland mangroves, and their nurseries					X	XX	XXX
	decrease chronic erosion					X	XX	XXX
Floods	DRR-reduces flood frequency					X	XX	XXX
	DRR-reduces impact of flood					X	XX	XXX
Salinization	decrease or prevent salinization of drinking and irrigation water					XX	XX	XX
Health of ecosystem	increase biodiversity—bird, fish, shellfish, monkeys, snakes, plants			X	X	XX	XXX	XXX
	restore mangroves to locations where they belong				X	X	X	X
	provide better DRR as effects of climate change magnify					X	XXX	XXX



CATEGORY	BENEFIT	LANDSCAPE						
		Intensive pond	Abandoned pond	Extensive pond	EPIC	MAP 2009	Mature inland mangrove	Mature fringe mangrove
Community education and involvement	community learns by doing, showcases technique	XX		XX	XXX	XXX		
	day-labor pay to plant mangroves or dig/mold irrigation channels				XX	XX	XX	XX
	day-laborer pay to feed or harvest shrimp or fish	XXX						
	training sessions to learn about ecosystems, climate change and risk reduction, role of mangroves				XXX	XXX		
	travel to other sites, other villages for training				XXX	XXX		
	networking				XXX	XXX		
	contact with NGO workers and volunteers				XXX	XXX		
Empowering women	travel, networking, education of women's group				XXX	XXX		
Cultural value	"Thailand equals mangroves"					XX	XX	XX
Shade, relaxation	coolness, beauty, naps					XX	XX	XX
Health	decreased occurrence of rashes		XX	XX	XX	XX	XX	XX
	decreased occurrence of breathing problems		XX	XX	XX	XX	XX	XX



CATEGORY	BENEFIT	LANDSCAPE						
		Intensive pond	Abandoned pond	Extensive pond	EPIC	MAP 2009	Mature inland mangrove	Mature fringe mangrove
	decreased occurrence of pregnancy and birth complications		XX	XX	XX	XX	XX	XX
	decreased occurrence of fatigue		XX	XX	XX	XX	XX	XX
	decreased stress levels		XX	XX	XX	XX	XX	XX
	decreased presence of mosquitos		XX	X	XX	XX	XX	XX
	improved diet (reports vary, some claim diet better with mangroves; others claim better when people were employed on the island by ponds, less "fast-food")	XX		XX		X	X	XX
	decreased contamination of nearby waterways (runoff/tidal flush of chemicals)				X	X	X	X
Higher or more stable income	income throughout year			X	X	X	X	X
	income more reliable			X	X	X	X	X
	income higher	varies massively		X		X	X	X
Benefits to community, not outsiders	community access to open water (boats)						X	X
	storm protection					X	X	XX
	healthier ecosystem			X	X	XX	XXX	XXX

CATEGORY	BENEFIT	LANDSCAPE						
		Intensive pond	Abandoned pond	Extensive pond	EPIC	MAP 2009	Mature inland mangrove	Mature fringe mangrove
	nursery for fish/crab			XX	XX	XX	XX	XX
	day-laborer pay (during restoration)				X	X		
	day-laborer pay (during harvest)	XX (but often to migrant workers)						
	decrease contamination of community drinking water & waterway			X	XX	XX	XX	XX

## Appendix D: Analytical framework of costs

CATEGORY	COSTS	LANDSCAPES							SUGGESTED MEASUREMENT STRATEGIES	
		Cost associated to Intensive shrimp or fish pond	Cost associated to Extensive pond	Cost associated to Abandoned pond	Cost associated to EPIC (inland mangrove restoration w/ silvofisheries, 1 year old)	Cost associated to MAP 2009 (inland mangrove, 6 years old)	Cost associated to Healthy inland mangrove	Cost associated to Healthy coastal mangrove	Measurement strategy for community based large scale project	Measurement for small scale EPIC site
Implementation Costs		XXX (Cost of soil sampling, leaching, pond drying, tilling, initial control of undesired species, liming, and fertilization)	XXX		XX (See EPIC itemized cost table)	X (cost of correcting hydrology and topography)			Survey site owners, managers	Survey site owners, managers
Maintenance Costs	reinforcing sluice gate	XXX	XXX		XXX				Survey site owners, managers	Survey site owners, managers
	Control of undesirable species	XXX	XXX	X (thinning naturally rejuvenated)					Survey site owners, managers	Survey site owners, managers
	feeding	XXX	XX						Survey site owners, managers	Survey site owners, managers
	fertilization	XXX							Survey site owners, managers	Survey site owners, managers
Upscale Costs		XXX	XXX		XX	X				
Negative effects associated to Health	increase occurrence of rashes	XX							Survey health care workers, shrimp pond workers	Survey health care workers, shrimp pond workers
	increase occurrence of breathing problems	XX							Survey health care workers, shrimp pond workers	Survey health care workers, shrimp pond workers
	increase occurrence of pregnancy and birth complications	X							Survey health care workers, shrimp pond workers	Survey health care workers, shrimp pond workers
	increase occurrence of fatigue	XX							Survey health care workers, shrimp pond workers	Survey health care workers, shrimp pond workers
	increase stress levels	XX	X						Survey health care workers, shrimp pond workers	Survey health care workers, shrimp pond workers
	increase presence of vectors and parasites	XX							Survey health care workers, shrimp pond workers communities near shrimp ponds	Survey health care workers, shrimp pond workers
	decrease in diet quality (reports vary, some claim diet better with mangroves, more local seafood; others claim better when people were employed on the island by ponds, because less "fast-food" poor quality food grabbed while working in Krabi Town)	XX	XX	XX	X					Measurement will have to consider what people eat when working in Krabi versus on island; what people consume from mangroves or extensive pond that they couldn't consume
	increase contamination of nearby waterways (runoff/tidal flush of chemicals)	XXX							Survey government officials, and communities near sites	

CATEGORY	COSTS	LANDSCAPES							SUGGESTED MEASUREMENT STRATEGIES	
		Cost associated to Intensive shrimp or fish pond	Cost associated to Extensive pond	Cost associated to Abandoned pond	Cost associated to EPIC (inland mangrove restoration w/ silvofisheries, 1 year old)	Cost associated to MAP 2009 (inland mangrove, 6 years old)	Cost associated to Healthy inland mangrove	Cost associated to Healthy coastal mangrove	Measurement strategy for community based large scale project	Measurement for small scale EPIC site
Negative effects associated to food source	decrease in harvest for personal consumption	XXX							income from sales plus monetary worth of seafood consumed by communities	income from sales plus monetary worth of seafood consumed by owners
	decrease in harvest generating household income	XXX	XXX	X					survey households	survey households
	loss of species variety: fish, mud crabs, shrimp, various clam species	XXX	XXX	XXX					survey harvesters for list of species	survey owners for list of species
	less abundance	XXX	XXX	XXX	X	X			survey harvesters re quantity of catch	survey harvesters re quantity of catch
Negative effects associated to Products	less fronds for roof	XXX	XXX	XXX	X	X			survey harvesters re quantity	survey harvesters re quantity
	less cigarette wrappers	XXX	XXX	XXX					survey harvesters re quantity	survey harvesters re quantity
	less medicinal leaves and roots	XXX	XXX	XXX	X	X			survey harvesters re quantity and species	survey harvesters re quantity and species
	less heart of palm	XXX	XXX	XXX	X	X			survey harvesters re quantity and species	survey harvesters re quantity and species
	less wood	XXX	XXX	XXX	X	X			survey harvesters re quantity and species	survey harvesters re quantity and species
Negative effects associated to Tourism/NGO presence	less ecotourism (birders, etc.)	XXX	XXX	XXX	X	X			survey tour guides and others in industry; tourists/birders; international birding groups	survey tour guides and others in industry; tourists/birders; international birding groups
	less mangrove tours	XXX	XXX	XXX	X	X			survey tour guides and others in industry; tourists/birders; international birding	survey tour guides and others in industry; tourists/birders; international birding
Negative effects associated to Supplementary food/income when needed	less backup for rainy season when no sea fishing due to storms (Climate change adaptation as storms increase)	XXX	XXX	XXX					survey harvesters	survey harvesters
Negative effects associated to Fish nursery	natural nursery loss for sea creatures	XXX	XXX	XXX					survey fishers	survey fishers
Negative effects associated to Wind	storm damage to roofs and other structures	XX	XX	XX					survey home owners, business owners	survey home owners, business owners
Negative effects associated to Erosion	storm damage to homes, other structures, land, vegetation	XX	XX	XX					survey home owners, business owners, farmers, fishers; hydrologists and sedimentologists conduct study	survey home owners, business owners, farmers, fishers

CATEGORY	COSTS	LANDSCAPES							SUGGESTED MEASUREMENT STRATEGIES	
		Cost associated to Intensive shrimp or fish pond	Cost associated to Extensive pond	Cost associated to Abandoned pond	Cost associated to EPIC (inland mangrove restoration w/ silvofisheries, 1 year old)	Cost associated to MAP 2009 (inland mangrove, 6 years old)	Cost associated to Healthy inland mangrove	Cost associated to Healthy coastal mangrove	Measurement strategy for community based large scale project	Measurement for small scale EPIC site
	damage to fishing habitat—thicker mangroves prevent damage to more inland mangroves, and their nurseries	XX	XX	XX					survey harvesters and fishers	survey harvesters and fishers
	decrease chronic erosion	XX	XX	XX					survey home owners, business owners, farmers, fishers	survey home owners, business owners, farmers, fishers
Negative effects associated to Floods	flood frequency	XX	XX	XX					survey home owners, business owners, farmers, fishers	survey home owners, business owners, farmers, fishers
	impact of flood	XX	XX	XX						
Negative effects associated to salinization	salinization of drinking and irrigation water	XX	XX	XX					survey community regarding water sources, farmers re irrigation	survey community regarding water sources, farmers re irrigation
Negative effects associated health of ecosystem	decrease biodiversity—bird, fish, shellfish, monkeys, snakes, plants	XXX	XXX	XXX					survey harvesters and fishers, tourist guides, environmentalists	survey harvesters and fishers, tourist guides, environmentalists
	natural mangrove habitat loss	XXX	XXX	XXX					survey environmentalists, mangrove-knowledgeable	survey environmentalists, mangrove-knowledgeable
	loss of DRR as effects of climate change magnify	XX	XX	XX					survey community and environmentalists	survey community and environmentalists
Negative impact on Thai culture	"Thailand equals mangroves"									
Loss of mangrove no-use benefits	coolness, beauty, naps								survey community	survey community
	mangrove value lost per hectare	\$9990 per hectare per year (1997 dollars)	\$9990 per hectare per year (1997 dollars)							
Lower or less stable income	income throughout year								Comparison of month-to-month income across multiple years	
	less reliable income									
	lower income	varies massively								
Costs to community, not outsiders	risk from storm surges and coastal hazards	XXX	XXX	XXX						
	weaker ecosystem	XXX	XXX	XXX						
	loss of fish/crab nurseries	XXX	XXX	XXX						
	increase contamination of community drinking water & waterway	XX								



## Appendix E: EPIC Thailand Project Costs

### Overall itemized budget:

Description of budget item (include unit costs where appropriate)	Exchange rate applied: 1 USD = 34 Thai Baht	
	(Thai Baht)	(USD)
<b>1. SALARIES / WAGES /CONSULTANCY COSTS</b>		
1.1 Supervisory Staff on Demonstration site 1 person x (50 % of 50,000B for 12 months)	266,667	8,333
1.2 Consultants / Experts: 1 person x 3000B x 20 days	80,000	2,500
1.3 Field Staff / Equipment operators		
1.3.1 MAP field staff (1 person 60% time ) x 30,000B x 12 month	240,000	7,500
1.3.2 MAP field staff Insurance (18,000B per year)	24,000	750
1.4 Internship Master Student (fulltime): Perdeim for food & lodging 4500B x 5 months	0	0
1.5 Office Staff: Book keeping accounting 1 person x (1500B per day) x 12 days	6,000	188
1.6 Daily workers No. of persons & duration of employment on this project: villager's wage (300B x 100 person/day)	40,000	1,250
<b>SUB-TOTAL:</b>	<b>656,667</b>	<b>20,521</b>
<b>2. TRAVEL &amp; ACCOMMODATION COSTS</b>		
2.1 Travel costs Trang to Koh Klang: 1 trip x 3,000B x 12 months	48,000	1,500
2.2 Accommodation: 1 trips x 2,000B x 12 months	32,000	1,000
2.3 Meals: 3 person x 300B x 4 days x 12 months	57,600	1,800
<b>SUB-TOTAL:</b>	<b>137,600</b>	<b>4,300</b>
<b>3. EQUIPMENT: PURCHASE, HIRE &amp; RUNNING COSTS</b>		
3.1 Hiring a pick up truck (1500B x 3 days x 8 months)	48,000	1,500
3.2 Fuel & maintenance: 1500B x 1 trip x 12 months	24,000	750
3.3 Hiring equipment (Rent of earth digger for hydrological channel)	53,333	1,667
3.4 Purchase of equipment (1 digital camera for documentation and time lapse monitoring)	0	0

3.4.1 Site work equipment: tools, transect tapes, buckets, shovels, guide ropes, auto-level rental	12,000	375
3.4.2 Fence materials (rolls of nylon weave, steel rods) and instillation. Regular inspection and repair.	13,333	417
3.5 Channel maintenance: Digging and correcting of channels dug onsite	24,000	750
3.6 Establish demonstration livelihoods (subject to the needs of the community.(i.e. Nypa Palm products, tea making from Acanthus etc)	40,000	1,250
<b>SUB-TOTAL:</b>	<b>214,666</b>	<b>6,708</b>
<b>4. OFFICE RUNNING COSTS</b>	<b>0</b>	
4.1 Computer costs: Laptop rental and computer maintenance (1,000B x 12 months)	8,000	250
4.2 Telephone & fax & Internet: 800B x 12 months	6,400	200
4.3 Office supplies: 2,000B x 12 months	16,000	500
<b>SUB-TOTAL:</b>	<b>30,400</b>	<b>950</b>
<b>5. COST OF PUBLICATIONS, VIDEOS/DVDs, CDs etc.</b>	<b>0</b>	
5.1 Preparation: CBEMR manual booklet and poster (Copywriting, typesetting and layout, photography, printing, distribution)	20,000	625
5.2 Printing / reproduction : Report Production for external publication (EMR manual booklet and Poster)	10,667	333
<b>SUB-TOTAL:</b>	<b>30,667</b>	<b>958</b>
<b>6. COST OF WORKSHOP(S)/ TRAINING COURSE(S)</b>	<b>0</b>	
<i>Dates of workshop(s)/ course(s):</i>		0
6.1 Stakeholder workshop to review project & provide input (1 day/ 25 participants)	10,667	333
6.2 CBEMR training: 3 days/ 20 participants		0
6.2.1 Transportation (12 person x 500B)	8,000	250
6.2.2 Accommodation and meals (12 person x 700B x 3 days)	20,267	633
6.3 Organizing training course		0
6.3.1 Fee for resource person (2,500B x 4 days)	13,333	417
6.3.2 Training materials	6,667	208
6.3.3 Training venue	4,000	125
6.4 Community capacity building field study trip (2 days) (Minivan hire, boat, accomodation and meals)	0	0

<b>SUB-TOTAL:</b>	<b>62,934</b>	<b>1,967</b>
<b>7. MONITORING, EVALUATION, DOCUMENTATION AND REPORT</b>	<b>0</b>	
7.1 Monitoring of progress and quadrants, photography etc. On-going	6,667	208
7.2 CBEMR Video documentation	40,000	1,250
7.3 Production of final report	6,667	208
<b>SUB-TOTAL:</b>	<b>53,334</b>	<b>1,667</b>
<b>TOTAL:</b>	<b>1,186,268</b>	<b>37,071</b>
<b>8. MISCELLANEOUS</b>	<b>0</b>	
MAP overhead 6% of Total budget (813,700 Baht)	94,901	2,966
<b>SUB-TOTAL:</b>	<b>94,901</b>	<b>2,966</b>
<b>GRAND TOTAL</b>	<b>1,281,169</b>	<b>40,037</b>



