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EFFECTIVENESS EVALUATION

OF A MARINE PROTECTED AREA IN VIETNAM

– THE CU LAO CHAM MPA CASE STUDY

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Abstract

Planning, implementing and managing MPA not only requires attentions to biological issues which influence the performance of MPA but also to social and economic aspects that can greatly affect the outcome of MPA implementation. This study used data from logbook program over 4 years and face-to-face interview to explore the effectiveness of Cu Lao Cham MPA which is one of 4 MPAs in Vietnam through the performance of ecological (CPUE), economic (income from fishing) and social (perception to the MPA objectives) indicators. Result of study has indicated linkages between ecological, socio and economic issues which often give an insight to direct and immediate feedbacks to MPA and despite the various of problems in management of Cu Lao Cham MPA such as poaching, poor and ineffective enforcement, sustainability…., the performance of ecological, economic and social indicators in this study showed that Cu Lao Cham MPA has achieved a significant amount of success and is one of the few well-managed marine protected areas in Vietnam. This study has also identified a number of indications that the coastal fishery of Cu Lao Cham could be on a transition towards becoming a viable, sustainable characteristic of better-established tropical marine protected areas.

Key words: Vietnam, MPA, CPUE, income, perception, effectiveness

Dedication

This work is dedicated to my parents, my husband who has greatly supported in my effort and two of my little daughters who are my future.

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Contents

Tables and Figures

Abbreviations

AIG	Alternative Income Generation
ALMRV	Assessment of the Living Marine Resources in Vietnam
ANOVA	Analysis of Variance
CBA	Cost-Benefit Analysis
CLC	Cu Lao Cham
CPUE	Catches Per Unit of Effort
GSO	General Statistics Office
HP	Horse Power
FAO	Agriculture Organization of the United Nations
LMPA	Sustainable Livelihoods in and around MPA
MPAs	Marine Protected Areas
Sp.	Species
VND	Vietnamese Dong

1. INTRODUCTION

Fisheries resources are considered as common resources that all people can get access to. It has been observed that most of the fisheries resources in marine waters have started to show a certain declining trend. According to the Food and Agriculture Organization of the United Nations (FAO), about one-quarter of stocks monitored by FAO are either overexploited, depleted or recovering from depletion (FAO 2006). Therefore, fisheries management issues have gradually been recognized as to their importance by the international fisheries society and the use of Marine Protected Areas (MPAs) is regarded as one instrument that can contribute to the conservation and management of the oceans as well as a tool of fisheries management. Worldwide the location and implementation of marine reserves, MPAs and ‘‘no-take zones” become increasingly important, as traditional fisheries management has failed to safeguard declining fish stocks (Stelzenmüller *et al.* 2008).

Many fishery scientists believe that MPAs may be one of few management tools that can ensure the sustainability of fish stocks and support the reef fisheries. The concept of MPAs is founded on the premise that fish population levels recover once fishing stops (Holland & Brazee 1996). Examples from researches conducted by McClanahan and Mangi 2000, and Bohnsack 1996 show that MPAs provide direct benefits through their contribution to the restoration of overfished stocks and serve as an alternative to conventional fisheries management tools such as gear regulations, closed seasons, closed areas, minimum allowable sizes for individual species, limit fishing effort by controlling the capacity of fleets and limiting time spent at sea …, especially when these tools can not be implemented effectively. McClanahan 2000 indicates that one of the most important roles of MPA is to enhance the local fishery through the “spillover effect” to the adjacent area of protected area. Enhancement might occur through dispersal of larvae from protected spawning grounds (Bohnsack 1998), migration of juveniles and adults (McClanahan and Mangi 2000). Many researches have been conducted on the “spillover effect” of MPAs and its result in enhancing the fisheries surrounding them. The popular theory of the “spillover effect” indicates that when fishing pressure from specific areas is removed and fisheries in the surrounding waters are regulated, the biomass will build up rapidly, and given the limited space within a marine reserve, fish will eventually ‘spill over’ into the areas surrounding the reserve, and thus contribute to fishable biomass in nearby fishing grounds and increase fish catches in the fishing zone neighboring the no-take zone (e.g. Polacheck 1990; Alcala 1998), thereby increasing catches per unit of effort (CPUE) in this zone. A case-study of a marine reserve in the Philippines, used by many authors, suggests the existence of a positive effect on

catches in adjacent fishing zones (Russ and Alcala 1996). Another study shows an increase in catches per unit of effort in the St-Lucia islands, by comparing the CPUE of artisanal fishermen before the creation of the reserve and 5 years later (Roberts *et al.* 2001). Other studies show encouraging results in Africa (McClanahan and Mangi 2000).

The enhancement of fisheries can also be understood in the context of the generation of positive economic rent or profits of managed fisheries by the fishermen (Guzman 2004). Research conducted by Guzman 2004 indicates that small fishery profit is being earned in the Baliangao Marine Reserve in Philippines. According to Pomeroy et al., 2006, the result from implementing an MPA is the increase in income, food security and materials assess in local community. This economic effect from MPAs is also demonstrated by increase in revenue when switching to a more valuable form of product and the changes in catch composition from smaller to larger fish are combined (Sanchirico *et al*. 2002). In case of optimal harvesting, resource rents could be still increased due to the high level of resilience toward negative shock created by marine reserves (Grafton *et al*. 2004).

The objectives of MPA include ecosystem preservation, fisheries management, and development of recreational non-extractive activities ("ecotourism") (Alban *et al*. 2008). Therefore, properly taking into account the many human dimensions of MPAs is critical to MPA success (Davis 2002; Pomeroy et al., 2004). In order to reduce fishing pressure on coral reefs, improved implementation and evaluation of incentive-based conservation strategies such as enforcement, conservation payments, and alternative income programs are needed (Bruner *et al.* 2001). MPAs could increase employment and improve livelihoods of coastal communities from tourism appearing after the establishment of MPAs (Ward et al. 2001). The effective results from livelihoods programs will create positive attitudes from local community to MPAs. Therefore the implementation of alternative livelihood projects will determine local people's attitudes to the MPAs. There is a significant linkage between local people's attitudes and their perceived benefits (Sekhar 2003; Hans 2003). McClanahan *et al*. 2005a, 2005b and Sesabo 2006 also show that positive attitudes and perceptions towards protected areas enhance compliance and management participation of local residents. Sanchirico *et al*., 2002 said that how fishermen respond to the management objectives of MPAs will have an influence in their effectiveness. However, many marine parks and other programs implemented to assist small scale fishers fail to achieve social objectives because of poor understanding about the complex livelihood strategies and socioeconomic conditions (Cinner *et al*.

2010) and support for livelihood activities can bring the negative impacts back to the fisheries resources and ecosystem. Walsh and Groves 2009 shows that agricultural subsidy increased fishing in some households in Kiribati but not decreased as expected. It is, thus, necessary to investigate whether alternative income generation programs implemented in MPA create inverse impacts to MPAs or not.

From these points of view, it is expected that the establishment of MPAs as a fisheries management tool will bring about socio-economic benefits to local communities by sustaining fish stocks and in order to know whether MPAs have a positive impact on the surrounding coastal fisheries we can use biological, economic and social indicators such as increased fish catch-per-unit of effort, income of local fishermen who fish in areas adjacent to the marine reserve and perception of local fishermen towards the alternative livelihood activities in MPA.

In Vietnam, activities relating to the establishment of MPA really started in 2000 with the assignment form the Government to the Ministry of Fisheries (former) in term of setting up the master plan for MPAs Network in Vietnam with a list of proposed 15 sites in the whole of the country and up to now four MPAs have been established in Vietnam which include Nha Trang Bay MPA, Phu Quoc MPA, Con Co MPA and Cu Lao Cham MPA. Cu Lao Cham MPA was established under the decision No 4680/QD-UBND dated 19/12/2005 of the Provincial People's Committee of Quang Nam with the support from the Danish Government through 2 projects which include project "Support to MPA Network in Vietnam" for the period from 2003 – 2006 and component "Sustainable Livelihoods in and around MPA (LMPA)" for the period from 2006-2010. The objectives of Cham Island MPA are to conserve marine biodiversity, protect and exploit effectively ecosystems, natural resources, environmental and cultural-historical values aimed at sustainable development and to improve livelihoods in and around MPA. These objectives of Cu Lao Cham MPA are a little different with the common purposes of MPA establishment summarized by Alban *et al*. 2008 in which biodiversity protection, sustainable fisheries management and the development of non-extractive values of the ecosystem are focused. Apart from ecosystem protection, the remaining objective of Cu Lao Cham MPA establishment has not focused on fisheries management which provides direct benefits by contributing to the restoration of overfished stocks (e.g. Bohnsack 1996a; McClanahan and Mangi 2000, decreases the risk of stock collapse (Fogarty *et al.* 2000), and provides an alternative to conventional fisheries management tools, especially when these tools cannot be implemented effectively (e.g. Agardy 1994) but focused on livelihoods improvement. The

livelihood improvement objective comes from the context that the livelihoods of the Cu Lao Cham community are heavily dependent upon declining fisheries resources, as such, the key objective is to improve the sustainability of their livelihoods by protecting the natural marine resources through the establishment of an MPA and to develop alternative sources of income in order to reduce pressure on fishery resources. These objectives seems to compete with the each other as implementation of livelihood activities may not support for ecosystem protection but bring inverse impacts to the ecosystem through pollution activities and induce pressure on fisheries resources due to an increase in income which may be used to invest on fishing activities. Therefore, biological, economic and social indicators would be seen as the main criteria to measure the success of Cu Lao Cham MPA. As MPA is a completely new field in Vietnam, an economic analysis of fisheries in the surrounding areas of the MPAs and effectiveness evaluation of MPAs are very essential, which would create critical data to serve for mangers to consider the appropriate management measures and actions applied in MPAs. However, up to now hardly any effective evaluation based on biological, economic and social indicators has been carried out in MPAs in Vietnam though valuation methodologies are available. This may come from the lack of historical and required data to make such an analysis. Therefore, in this context, I would like to make analysis of coastal fisheries in Cu Lao Cham MPA and its effectiveness evaluation as an initial basic for further study with the following objectives:

1. Define the status of existing coastal fishery in Cu Lao Cham MPA in term of economic analysis.
2. Evaluate if the establishment of Cu Lao Cham MPA can create economic profitability for the local fisheries communities.
3. Explore the perception of local people towards the alternative livelihood activities implemented in Cu Lao Cham MPA.

The study tries to address the following questions: What is the trend of fish production and CPUE in Cu Lao Cham MPA surrounding area after its establishment in 2005. Can Cu Lao Cham MPA with no-take zone help enhance the fish catch of the surrounding fishing grounds? Can Cu Lao Cham MPA generate intra-marginal profit? And whether or not alternative livelihood activities in Cu Lao Cham MPA serve for MPA objective and have lasting effects? In order to answer these questions, secondary data was obtained from Log Book program of Cu Lao Cham MPA which started in 2005

with participation of 80 households of the total 600 households in 2005 and 2006 and 40 households from 2007 up to now under the random basis. Primary data on investment and fixed costs and perception of local people toward livelihood activities were collected from face-to face semi-structured interview with more than 90 people of the total population of about 3000 people on Cham Island by random selection.

The study will include 5 chapters. The first chapter indicates the need of conducting economics assessment in Cu Lao Cham MPA and explains why biological, economic and social indicators such as increased fish catch-per-unit of effort and income of local fishermen from fishing and perception of local people towards livelihood activities are used to evaluate the success of Cu Lao Cham MPA. The second chapter gives a background description of the study site, Cu Lao Cham MPA, which includes a brief introduction of Cu Lao Cham MPA, status of socio – economic characteristics and fishing in Cu Lao Cham and set of management and livelihood activities taking place in Cu Lao Cham MPA. The Chapter three describes application of a part of Cost-Benefit Analysis (CBA) in economics assessment of MPA, the way of calculating CPUE and estimating income from fishing in the context of multi-species and multi-gears in fisheries. The chapter 4 refers to the results of the research which include a profile on fishing fleet, catch per unit effort of various fishing gears, annual fish production in coastal village, trend in CPUE from 2005 to 2008, fishing revenue-cost-income, and perception of local people towards the alternative livelihood activities implemented in Cu Lao Cham MPA. And the last chapter presents the discussions and implications from the study.

2. BACKGROUND

2.1 The overview of Cu Lao Cham Marine Protected Area.

Recognizing the importance of conservation of representative examples of globally significant coastal and marine biodiversity and ecologically sustainable use of renewable natural resources (e.g. fisheries), the Vietnamese Government has been taking step to conserve marine biodiversity, to effectively manage resources and to improve livelihood of local communities. With the support from the Danish Government through project "Support to Marine Protected Area Network in Vietnam" started in 2002, Cu Lao Cham MPA, considered as an initial step in this process, was recently established in Quang Nam Province, central-Vietnam in December 2005.

Cu Lao Cham is a small group of islands located in the central part of Vietnam which is 19km offshore from Hoi An town, situated at 15^0 52' - 16^0 00' N to 08^0 22' - 108^0 44' E in the eastern part of Quang Nam Province, central-Vietnam (See figure 2.1). The archipelago consists of 8 islands of which the largest is Hon Lao with total area of 1,317ha and one peak of 517m at the center and another at 326m to the west. Natural forest covers 532 ha or 35% of the total area while planting forest covers 30ha (Master Plan 2009). This area is of tropical monsoon climate. The temperature is stable with difference of 6-7^0C around the year.

Cu Lao Cham MPA site covers an area of 6,710 ha and contains both protected marine waters and an island nature reserve. The terrestrial area contains 595 ha of protected forest and 790 ha of rehabilitation forest. The marine component contains approximately 165 ha of coral reefs and 500 ha of seagrass beds. A large proportion of the proposed marine component is deeper than 20 m, although the waters around the islands are shallower (Birdlife International 2001).

Cu Lao Cham archipelago comprises 8 islands but only the main island Hon Lao is inhabited. The population of Cu Lao Cham is about 3,000 in 600 households, clustering in Hon Lao island (Hien, *et al*. 2006). Cu Lao Cham is a commune named Tan Hiep under Hoi An town. The commune consists of 4 villages: Bai Lang, Thon Cam, Bai Ong and Bai Huong of which Bai Lang and Bai Huong have the most population density. The inhabitants on Cu Lao Cham are incredibly vulnerable as their only source of income comes from the natural (mostly marine) resources. More than 85% of the

households earn their living directly from the marine resources or providing services to the marine exploitation activities (McEwin 2006). In the households the husbands are fishermen while the wives sell their products at local markets.

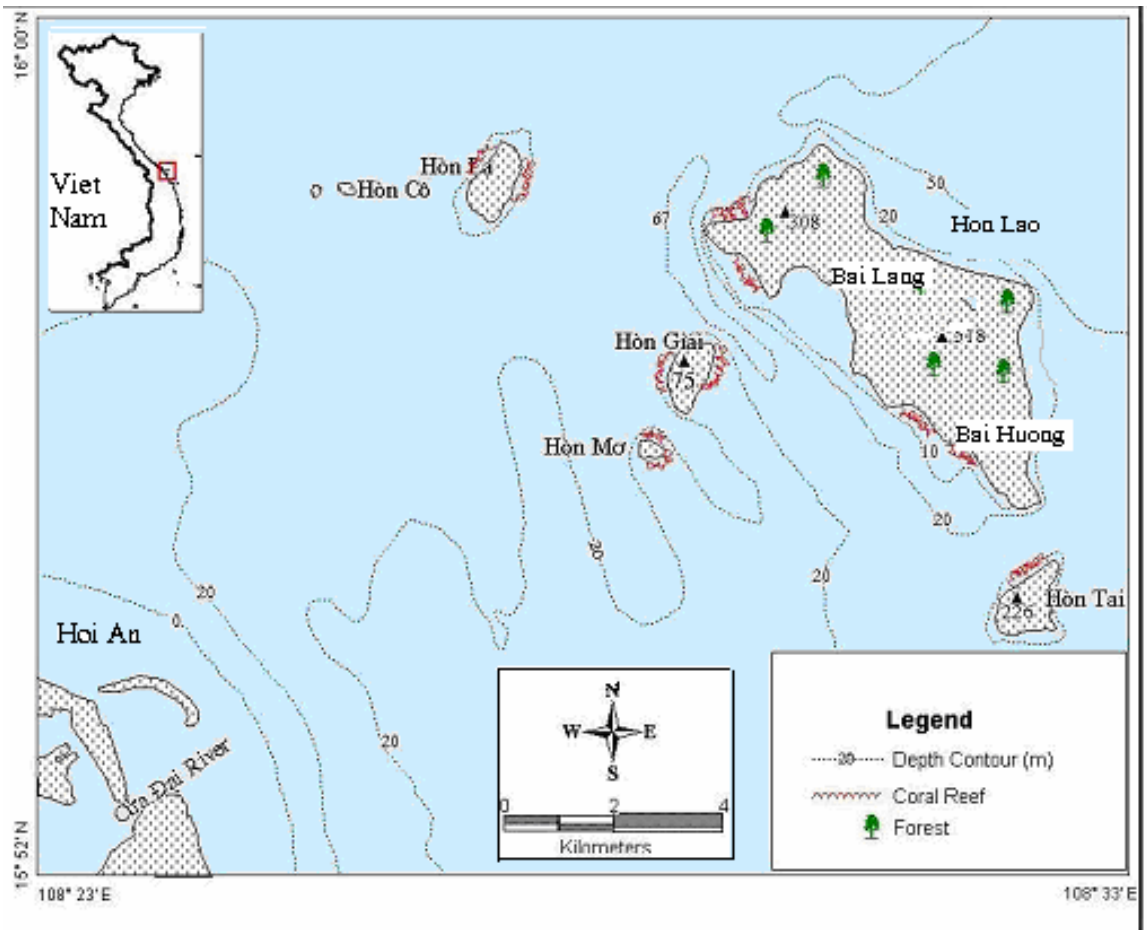

Figure 2.1: Cu Lao Cham archipelago, Quang Nam Province, Central Vietnam
Source: Map cited from Tuan et al 2004

The commune's infrastructure has been improved. One road running along the North South direction is constructed. Fresh water supply is sufficient to meet the demand of local residents and tourists up to 10,000 people (Thanh *et al*. 2008). Hon Lao has not been connected to national electrical network; electricity is supplied by a generator from 6pm to 10pm everyday.

Each village has its own primary school, but there is only one secondary school in Bai Lang. Most of the residents only finish primary school, however there are many young people finish high school now (Hien, *et al*. 2006 and Thanh *et al*. 2008).

2.2. Biodiversity in Cu Lao Cham

Coral reefs, seagrass beds, rocky shore, sandy bottom are the important habitats in the waters around Cu Lao Cham islands. Of which, coral reefs and seagrass beds are considered as the most productive ecosystems. The studies on biodiversity, resource utilization and conservation potential have defined and proposed Cu Lao Cham islands as a Marine Protected Area in Vietnam, based on its diversity of habitats, marine organisms and the importance of fishing grounds. The biodiversity value of Cu Lao Cham MPA is assessed as follows:

Coral reef

Coral reefs are the most common and important habitat in Cu Lao Cham MPA waters. Coral reefs are widely distributed in the shallow waters with the morphology and profile varying considerably. Coral reef communities occur in patches around most of the islands. Fringing coral reefs mainly occurred on the west and southwestern part of Cu Lao Cham and most of the smaller islets. In overall, some 261 species of 59 genera of 15 families of scleractinian corals, 15 species of 11 genera of 6 families of soft corals, 3 species of fire corals (*Milleporidae*), 1 species of blue coral (*Helioporidae*) and 2 species of horny corals (*Order Antipatharia*) were recorded in Cu Lao Cham MPA waters (Tuan *et al.* 2004).

Algae

A total of 47 species in 26 genera of reef-associated macro-algae found on rock, gravel and dead coral, were recorded in Cu Lao Cham waters (Completion Report 2006). *Colpomenia bullosa, Colpomenia sinuosa, Sargassum spp., Padina spp., Rosenvingea spp. and Dictyota spp.* were common species (Tuan *et al.* 2004).

Marinegrass

Marinegrass beds in Cu Lao Cham waters supported 4 species including *Halophila decipiens, Halophila ovalis, Halodule pinifolia* and *Cymodecea rotundata* (Tuan *et al.* 2004). *Cymodecea rotundata* was narrowly distributed in the shallow waters of less than 5 m deep and this species was

only found on Bai Bac. The other three species of *Halophila* were recorded at all of marinegrass beds. *Halodule pinifolia* and *Halophila ovalis* were abundant in the waters of 2 – 6 m depth while *Halophila decipiens* was distributed in deeper waters of 5 – 10 m (Tuan *et al.* 2004).

Mollusc

The area supports some 66 species of reef-associated molluscs, in 43 genera from 28 families (Completion Report 2006). *Trochus maculatus, Drupa sp., Pedum spondyloideum, Atrina vexillum, Pinctada margaritifera* and *Tridacna squamosa* were the most common species and observed at most of study reefs (Tuan *et al.* 2004). *Tridacna squamosa* was common on shallow reefs while *Pinctada margaritifera* was abundant in deep reefs.

Crustaceans

There were four species of lobsters, *Panulirus longipes, P. ornatus, P. stimpsoni* and *P. versicolor* and one species of crab *Charybdis feriata* found on coral reefs in Cu Lao Cham MPA waters (Tuan *et al.* 2004). These species are of great economic importance to the local fishermen, of which ornate lobster *Panulirus ornatus* is considered as a commercial species because of food and aquaculture demand.

Echinoderms

Some 16 species belonging to 9 genera and 8 families of echinoderms were recorded in Cu Lao Cham MPA waters (Completion Report 2006). *Diadema setosum, Acanthaster planci, Holothuria edulis* and *Holothuria atra* were common species found on most of the reefs. Crown-of-thorn marinestar *Acanthaster planci* and marine urchin *Diadem*a were recorded at high number on some reefs (Tuan *et al.* 2004).

Coral reef fish

Some 200 species of reef-associated fishes, in 85 genera from 36 families, were recorded in CLC and adjacent islands (Tuan *et al.* 2004). The families *Pomacentridae* (39 species) and *Labridae* (33 species) were both well represented, as was the *Chaetodontidae*, with 19 species of butterfly fishes

(Tuan *et al.* 2004). Some other common species families were *Acanthuridae* (12), *Scaridae* (12), *Siganidae* (6), *Serranidae* (6) and *Lutjanidae* (5) (Tuan *et al.* 2004). Among them, some species including *Labroides dimidiatus*, *Thalassoma lunare, Halichoeres marginatus, H. melanochir, Gomphosus varius (Labridae), Abudefduf sexfasciatus, Neoglyphidodon melas, Hemiglyphidodon plagiometopon, Pomacentrus chrysurus (Pomacentridae), Chaetodon kleinii, C. trifascialis, C. trifasciatus (Chaetodontidae), Parupeneus multifasciatus (Mullidae), Acanthurus nigrofuscus (Acanthuridae)* and *Sufflamen chrysoptera (Balistidae)* appeared commonly at almost reefs (Tuan *et al.* 2004, Completion Report 2006 and Long 2008). Several commercially important species were found including nine siganids, six serranids, six lutjanids, two lethrinids and one Haemulids (Tuan *et al.* 2004). Most of the targeted fish families collected for food and aquarium trades were either scarce or absent (Hien, *et al*. 2006).

2.3. Fishing Activities in Cu Lao Cham

Fishing is by far the most important socio-economic activity on Cu Lao Cham. Over two thirds of households in Bai lang community and approximately 87% in Bai Huong, regard fishing as their main occupation, while approximately 90% of all Cu Lao Cham households have some fishing income (McEwin 2006). Over half of the fishing households on Cu Lao Cham own boats with engines (McEwin 2006). The fishing vessels are very small in general with horsepower smaller than 5 HP, the rest have a horsepower capacity ranging from 6 to 20 HP and only two vessels exist with 125 and 150 HP, respectively (Tilde 2005). The average engine size of the boats is relatively low at 10Hp (McEwin 2006). This small engine fishing fleet restricts the available fishing areas to distances of about 20 to 30 km from the villages within a few hours travelling time from the villages. The length of the fishing trips vary between fleets but most boats go to sea in the late afternoon and return at dawn the next morning. Each boat has an average of 2 to 3 crew comprising family member and hired laborers from other households.

Fishermen communities in Cu Lao Cham operate fishing activities in coastal areas with various types of gear which can be divided into three main gear group including driftnet, long-line and lift-net. Driftnets are the most commonly used in the community with different types of gear targeted to different species. Fishermen have classified driftnet based on the size of net mesh and targeted species. Under the mesh size driftnet are classified as small mesh net with mesh size of about 17 mm

(for anchovy), size 3 net and size 2 net and with mesh size of 20 mm and 40 mm respectively. Bi net and Di net are driftnets with mesh size from 20mm to 40mm but the catching practices are different from size 3 net and size 2 net in term of using a tool to stir the water so that the fish move towards the net. Under the target species driftnets are classified as Sardine net, Nhoi net, Rabit Fish net and Squid net in which Nhoi net, Rabit Fish net and Squid net are the driftnets with three layers (trammel net). Long-line is targeted to export fish. Lift-net is one kind of purse seine targeting to pelagic fish.

The captains of the fishing boats each adopt different strategies; they use different combinations of gear, target different species, and go to different fishing grounds throughout the year. The weather conditions have a large influence on the fishing pattern. Fishing activities are operated all year round but are greatly reduced during the monsoon months of October to February due to bad weather and rough seas. It is common practice to shift gear and vessels between seasons, e.g. from 3-layer nets used in the summer season which last from March to October to size 2 net or size 3 net used in the winter season which last from November to March and change from a "big engine" boat in the summer to a small round basket boats in the winter season. Coracles without engines cannot access areas further from shore. For some households, fishing from coracles is a full-time occupation, but for many more households, it is a part-time occupation in periods of no other employment of when the weather is too rough to allow fishing from larger boats. The fishermen tend to concentrate their fishing effort on the fishing grounds nearest their respective community, so there is some distinction between the fishing grounds of Bai Lang and Bai Huong (Trinh 2006). The marine resources are open to all and the seas around Cu Lao Cham are also fished by boats from Hoi An District and other provinces.

2.4. Management Measures of Cu Lao Cham MPA

In order to manage Cu Lao Cham MPA, the MPA zoning plan and management regulations were discussed with the local people. The community based process was lasting for over one year from 10/2004 to 12/2005 before zoning plan and regulations were officially approved by the Quang Nam People's Committee. There are more than 50% of the total number of households living in the commune participated in discussion and recommendation for these plan and regulations (Trinh 2006). Cu Lao Cham MPA Zoning Plan and Management Regulation were issued by the Decision No 88/2005/QD-UBND dated 20/12/2005 by the Provincial People's Committee of Quang Nam.

This decision regulated activities prohibited to the entire Cu Lao Cham MPA, which include: Activities disturbing the environment and landscapes, destroying substratum rock, coral reefs, flora beds and other ecosystems, and negatively impacting the marine species community, habitat, breeding and growing areas; Fishing activities by dynamite, chemicals, electricity, poisonous and other destroyed methods; Hunting activities on fauna and flora species which are named on the protected list; Exploiting activities on marine resources species which are named on the banned list including seasonal ban, except for research purposes permitted by the Government; Exploitation of marine animals with size smaller than specified sizes, except for allowed catches for aquaculture purposes; Industrial scale aquaculture; Any kind of mining; Activities that cause beach erosion around islands; Activities converting land and water use illegally; Activities that introduce exotic flora and fauna species that might cause damages to the environment, natural ecosystems and biodiversity in the MPA; Activities that pollute the environment including noise and vibration with the intensity greater than permitted limit.

Moreover, according to Decision 88/2005, the functional zones (see the figure 2.2) and activities for specific zone are regulated as follows:

-Extremely protected zone (Core zone) is a zone which is specified by coral reef ecosystem and marine biodiversity. This zone is totally conserved, managed and protected carefully, maximum restricted from negative impacts on habitats, and capable for scientific research, training and education. Besides activities prohibited to the entire Cu Lao Cham MPA, activities are prohibited in this zone include: Collecting mineral specimen, coral, wild animals, aquatic fauna and flora, microbiological samples; and any kinds of visiting or excursion, touring, swimming, snorkeling, diving.

-Ecological rehabilitation zone is a zone which is managed, protected and well organized with activities for recovering ecological habitats, biodiversity and natural marine resources in order to economically benefit communities. Some areas in this zone might be added into the extremely protected zone in the future. In this zone more additional activities are prohibited such as construction, housing, anchoring in coral reef areas; and any kinds of exploitation of forestry or aquatic products.

-Controlled development zone includes the following zones:

Tourism development zone is a zone concentrating on all tourism activities which are available to generate income for the local people. These tourism activities are under controlled by the Management Board of MPA such as scuba diving, visiting, coral reefs watching by glass bottomed boat, surfing, sailing, swimming, research, education, training, and community entertainment.

Community development zone is located on lands where people live including Bai Lang, Thon Cam, Bai Ong, and Bai Huong villages of Cham islands.

Reasonable fishing zone is reserved for organizing reasonable marine resources exploitation, developing relevant activities (fishing, aquaculture and other suitable gears) in order to increase income, improve living standards and generate alternative income for MPA communities.

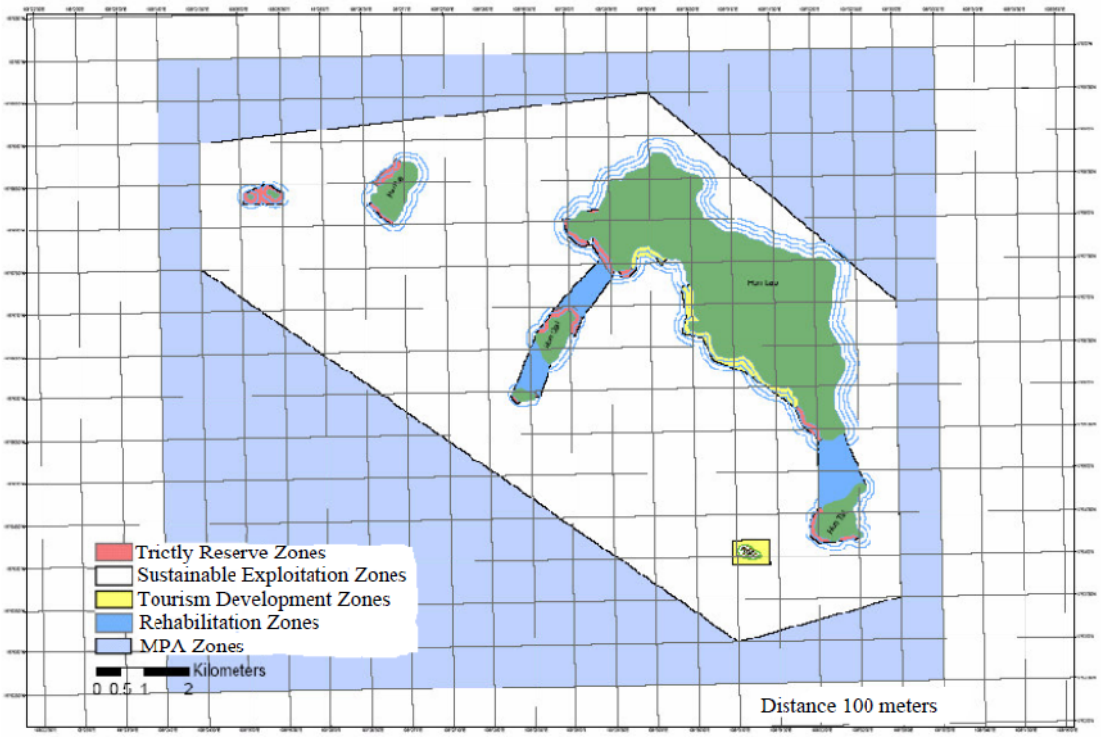

Figure 2.2: Cu Lao Cham MPA zoning plan map (issued by the Decision N088/2005/QD-UBND dated on 20/12/2005 by the Quang Nam PPC)
Source: Map cited from Completion Report 2006

2.5. Livelihood activities implemented in Cu Lao Cham MPA.

Tidle 2005 shows that the households on Cu Lao Cham are extremely vulnerable as they do not have access to alternative sources of income and if the MPA project do not provide for this, the fishermen will be forced to continue exploiting the protected areas in order to survive. This will either cause the collapse of the MPA project or extreme poverty for the total community living on Cu Lao Cham. Therefore, one of purpose on Cu Lao Cham MPA establishment is to improve livelihoods for local community on island and in consistence with it, livelihood interventions have been conducted with a view to reducing the fishing pressure in Cu Lao Cham MPA and increase income for local community. According to Thanh et al. 2008, livelihood interventions on Cham Island can be grouped as follows:

Group 1: Environmental quality improvement

Improving the environmental quality would help to protect resources for livelihoods of households and the community. Therefore under the LMPA component, two objectives are targeted, which are (i) improving the living environment and (ii) giving more opportunities for new livelihood development (Completion Report 2006). Under this group, one of the activities is the establishment of solid waste treatment system in Cu Lao Cham. Solid waste from households remains unsolved problem in most of MPAs in general and Cu Lao Cham in particular (Hien *et al*. 2006). Thus, a project under the LMPA component has established and operated a waste treatment system in Cu Lao Cham aimed at managing the waste in Cu Lao Cham, and improving the environmental quality for local residents and to reduce negative impacts of people on marine ecosystem.

The project encourages initial classification of waste at household level into two categories: organic waste and non-organic waste. Organic waste will be treated by composting technology at the site. It is expected that 47 composting basin will be constructed in 4 villages which include Bai Huong, Thon Cam, Bai Lang and Bai Ong (Completion Report 2006). The products will be used for agriculture. Non-organic waste will be compressed into small blocks and transported to the land. Waste compressing system will be installed in Bai Lang and Bai Huong with capacity of 200kg waster per day (Thanh *et al*. 2008). Local residents will be trained to separate the waste. Non-organic waste will be treated with capacity of 450kg per day and after being compressed the waste

will be in form of a small block with the volume of 0,5 m^3 per day (Thanh *et al*. 2008). Hoi An Public Works Company will be responsible for non-organic waste treatment.

Group 2: Tourism development

Tourism has a great potential for sustainable livelihood strategy *(*Tao *et al.* 2009*)*. As the tourism industry is rapidly growing in Vietnam, one opportunity to alternative sources of income could obviously be developing the tourism industry on Cu Lao Cham. Tourism development will help to reduce the pressure of natural resource exploitation in the MPAs and in the long term and would be the most important industry in these areas as a sustainable livelihood for local residents (Thanh *et al*. 2008). In order to reduce the catching activities in core zone of MPAs and find alternative livelihoods for local communities in Cu Lao Cham, LMPA component has supported tourism development in Cu Lao Cham by funding young people to attend training course of tourism services in Hoa Sua vocational school in Hanoi in two years and developing home-stay service in Cu Lao Cham. A communication network has been set up with hotel systems in Hoi An to help learners to find jobs when they finish Hoa Sua school. To support for the promotion of home-stay service, training courses on skills of running business and communication with customers have been conducted and financial source to upgrade the rooms and furniture for tourists has been provided for some households selected. In 2009, 6 households were selected to participate in the project and the approved budget for this activity is 63.325.000 VND (LMPA Source).

Group 3: Fish sauce and dried fish production

As Cu Lao Cham islands are affected by moon-soon weather, the main harvesting season lasts from March to October while fishing activities are dramatically reduced from October to February due to rough see. During harvesting season, the price of fish are not high because of high production, therefore fish sauce and dried fish production are considered to be potential alternative livelihoods in Cu Lao Cham MPA which can create income during the whole year. With the support from LMPA Component, 20 women were sent to training course on fish sauce production 14 of which have started production, mainly in Bai Huong and 9 households have been supported with running business in dried fish production (Thanh *et al*. 2008). The products are made from different kinds of fishes and other marine species such as cuttle-fish which will be expanded to markets in Hoi An and Da Nang. To support for dried fish production a plan to send these households to visit Nui Thanh,

Quang Nam province to study the production model and trademark building experience is set up and some training courses to enhance production technology will also be organized. An association will be founded to help the producers to cooperate for future development.

Group 4: Handicraft production

Other handicraft production such as fish-net knitting, bag knitting, souvenir making, rattan are encouraged in Cu Lao Cham MPA. However there are difficulties in accessing the market, covering high cost of transportation and lack of distribution channels (Thanh *et al*. 2008).

Group 5: Agriculture development

In Cu Lao Cham, in the first stage 29 households were selected to be supported both financially and technically (Completion Report 2006). These households can borrow money for husbandry and culturing safe vegetable. In 2009, there are 2 households with total of 4 people participating in project. The total approved budget for this activity is 63.000.000 VND, in which investment for production is 32.000.000 VND. The spent budget up to June 2009 is 9.452.000 VND (LMPA Source).

Group 6: Public awareness raising activities

Increasing awareness of community is a very important activity in performing marine reserve in the locality, which strongly supports for sustainability of livelihood improvement in MPA. Recognizing this importance, LMPA Component has conducted many activities such as studying sightseeing, conferences and meetings, as well as environment education and natural resource in schools. According to the Completion Report 2006, from 2003 to 2006 two third of the total number of residents on Cham island attended in the education activities of MPA in which there were over 1868 adults (50% women) and 606 children.

3. METHODOLOGY

3.1. Application of Cost – Benefit – Analysis for MPA

From economic point of view, assessing the consequences of a public project such as MPA establishment should take consideration of efficiency and equity (Squires and Van der Tak, 1985). In term of efficiency, it is necessary to address the question *"what is the global surplus generated by the project, i.e. the net additional wealth that one may expect it will generate for society ?"* and in term of equity, it is necessary to address the question *"how will costs and benefits related to the project be shared between social groups, and what type of compensatory measures might be set in order to compensate the groups that might suffer from the project ?"* .

The classical approach to assess the global surplus generated by a public project and its distribution within society is called cost-benefit analysis (CBA). There is a wide scope for the use of CBA in the field of environmental economics (Hanley and Spash 1993) and the creation of a MPA typically falls within this scope (Hoagland *et al*. 1995; Carter 2003). When defining the use values of MPA, costs and benefits to fishing and ecotourism are considered. For fishing, valuing costs and benefits generated by the MPA will take consideration of the fact that when fishing is banned, biomass in the no-take part of the MPA will be increase, which is likely to induce a net transfer from the no-take zone to the fishing zone (spillover effect), thereby increasing the catch per unit of effort (CPUE) in this zone (Alban *et al*. 2008).

3.2. Field Methods

3.2.1. Economic Assessment of Coastal Fishery in MPA

In order to demonstrate that Cu Lao Cham MPA has a positive impact on the surrounding coastal fishery we can investigate fish catch-per-unit of effort (Alcala & Russ 1998) and income of municipal fishermen who fish in areas adjacent to the marine reserve (Guzman 2004). Past information, such as amounts of fish catch of selected fishing gears, fishing effort levels, prices of fish, and types of target species were obtained as secondary data from Log-Book program implemented in Cu Lao Cham. Supplemental information relating the fixed cost, investment cost and life age of fishing vessels was also generated from interviews with local households.

Fish Catch and Fishing Effort

Cu Lao Cham Fisheries are multi-species and multi-gears fisheries therefore in order to estimate the fish catch and CPUE in Cu Lao Cham, categorization into the main fleets is applied. According to Manual of ALMRV 1996, a fleet is a group of fairly uniform boats, that is, they have approximately the same construction. In addition, the main fishing fleets are characterized by their fishing strategy such as the fishing grounds exploited and the fishing gears used. In Cu Lao Cham, the different strategies with using different combinations of gear, targeting different species, and going to different fishing grounds throughout the year are adopted by the captains of the fishing boats. There are at least 14 main types of gear and thus many different combinations of gear are possible. They use the same type of gear and fishing techniques and most often they also share the same fishing ground. As most of fishing boats in Cu Lao Cham are small with horse power smaller than 20 HP, therefore based on the type of fishing gear and the way of combining gear in Cu Lao Cham, the boats with engine in Cu Lao Cham can be grouped into 4 main fleets defined as driftnet, lift-net, long-line and diving for economic analysis (Table 3.1).

Driftnet fleet is classified as the main fleet in Cu Lao Cham occupying the largest proportion (56%) with about 120 fishing boats. While the average size of engines is very similar across all fleets, the long-line fleet, taking for 25 % of the total boats with slightly higher average engine power than other groups of fleet because they access fishing grounds further from shore. In driftnet fleet group Di net, Rabbit fish net and squid net small mesh net and size 3 net are operated around the year. Long-line fleet goes the furthest from the shore in Cu Lao Cham, from 50 metres to several kilometers with fishing season from February to November. They go fishing all around the year with high value fish for export markets such as ribbon fish, shark, grouper, indian pike conger, etc…. Lift-net fleet also has a higher average engine size (12 Hp) occupying about 15 % of the total fishing boats with engine. Diving fleet, commercial scuba divers, dive around the coral reefs for coral-related fish. They use compressed air supplied through compressors on the boats. These boats almost always also use other types of fishing gear some of the time, such as sardine net. They go fishing from February to September to catch lobster, sea snails, rabbit fish and others. This occupation is quite dangerous due to the reliance on good equipment and knowledge. Diving to deeper depths is now rarely done due to serious accidents that occurred previously in Cu Lao Cham. The lift-net fleet is operated from January to November in a year.

Table 3.1: Number of fishing fleets with engine in Cu Lao Cham 2003-2007

Fleet	Gear	Villages				
		Bai Ong	Thon Cam	Bai Lang	Bai Huong	Total
A	**Driftnet**	**31**	**22**	**23**	**44**	**120**
	Sardine net	2	1	0	0	3
	Small mesh net	2	2	5	0	9
	Size 2 net	0	2	0	0	2
	Size 3 net	18	2	12	0	32
	Bi Net	1	0	0	1	2
	Nhoi Net	0	0	1	0	1
	Di net	1	0	0	0	1
	Rabbit Fish net	0	0	1	0	1
	Squid net	7	15	4	43	69
B	**Lift-net**	**1**	**7**	**15**	**8**	**33**
C	**Long-Line**	**18**	**0**	**36**	**0**	**54**
	Long- line	17	0	33	0	50
	Handle-line	1	0	3	0	4
D	**Diving**	**1**	**3**	**3**	**0**	**7**
E	**Other**	**2**	**0**	**1**	**0**	**3**
	Total	**53**	**32**	**78**	**52**	**215**

Source: LMPA Component

"Fishing effort" can be measured in many different ways such as "number of trawling hours" for trawlers, "number of hooks per night" for long-lines, "number of driftnets per night" for driftnets etc….However, what is can actually be used as measure for fishing effort, of course, depends on which data on the fishing are available. In Vietnam, it may currently be difficult to get very detailed fishing effort data, therefore "Boat-Fishing-Days" as effort unit has to be used because this information seems to be available (ALMRV, 1996). Therefore "Boat-Fishing-Days" as effort unit is used to calculate catch-per-unit-effort (CPUE) in this research. CPUE was calculated for each fleet in year 2005, 2006, 2007 and 2008 through the following formula:

(1)
$$CPUE = \frac{H_{(ij)}}{E_{(ij)}}$$

Where

CPUE	Catch per unit of effort to be measured by kg/day
H_{ij}	The total catch by specific gear in the fleet in year i with the sample size j of log-book program.
E_{ij}	Fishing effort measured by "Boat-Fishing-Days" in year i with the sample size j of log-book program. E_i = D(end) – D(start) + 1

Raising factor was used to calculate the annual catch. According to ALMRV, 1996, the "raising" is to multiply the average result for a sample with the total number in the population. This is procedure of "raising of samples to total". Based on this, the annual catch of specific fleet was obtained by multiplying the mean CPUE of that fleet with total fishing effort which is measured as "fishing-days" in a year and the number of boats of respective fleet. The annual catch of the fleet is described by following equation:

(2)
$$H = MeanCPUE * e * n$$

Where

H	Annual Catch by specific fleet to be measured in kg
Mean CPUE:	Average CPUE of the fleet in a year to be measured in kg/day. $MeanCPUE = \frac{\sum_{t=1}^{k} CPUE}{k}$ (*where* k ≥5 is number of observations in a year - the total times of CPUE calculation of certain fleet by samples in a year)
e:	Total number of fishing days of the fleet in a year
n:	Total number of fishing boats of that fleet

Fishing Revenue

Gross daily revenues are a function of the amount of catch and its corresponding value or price per unit weight. In this research, revenue per unit of effort was used to estimate the total annual revenue of each fleet. The calculated process of the annual revenue of each fleet is described by following equations:

(3) $$R_{pue} = \frac{R_{(ij)}}{E_{(ij)}}$$

Where

R_{pue} Revenue per unit of effort to be measured in VND

R_{ij} the total Revenue by specific fleet in year i with the sample size j of log-book program.

E_{ij} fishing effort measured by "Boat-Fishing-Days" in Year i with the sample size j of log-book program.

(4) $$R = MeanR_{pue} * e * n$$

Where

R: Annual revenue by specific fleet to be measured in VND

Mean R_{pue}: Average of Revenue per unit of effort of the fleet in a year to be measured in VND/day

$$MeanRpue = \frac{\sum_{t=1}^{k} Rpue}{k}$$

(where k ≥5 is number of observations in a year - the total times of Rpue calculation of certain fleet by samples in a year)

e: Total number of fishing days of that fleet in a year

n: Total number of fishing boats of that fleet

Fishing cost

Variable cost

Variable costs or operating costs include running costs (fuel, oil, ice, food and other miscellaneous expenses) except labor cost as most of fishing boats in Cu Lao Cham are small which require only family members working on boat. Fuel oil is the major variable cost item, followed by bait, food and ice.

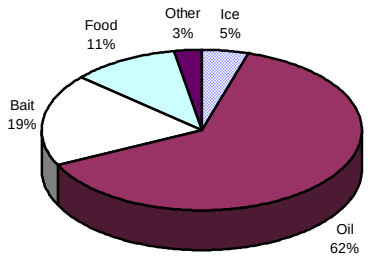

Figure 3.1: Annual Variable Cost Items
Source: Cited from McEwin 2006

Annual variable cost was calculated based on the following equations:

(5) $$C_{pue} = \frac{C_{(ij)}}{E_{(ij)}}$$

Where

Cpue	Cost per unit of effort to be measured in VND
Cij	the total cost by specific fleet in year i with the sample size j of log-book program.
E_{ij}	fishing effort measured by "Boat-Fishing-Days" in Year i with the sample size j of log-book program

(6) $$C = MeanC_{pue} * e * n$$

Where

C: Annual variable cost by specific fleet to be measured in VND

Mean C_{pue}: Average of Cost per unit of effort of the fleet in a year to be measured in VND/day

$$MeanCpue = \frac{\sum_{t=1}^{k} Cpue}{k}$$

(where k ≥5 is number of observations in a year - the total times of Cpue calculation of certain fleet by samples in a year)

e: Total number of fishing days of that fleet in a year

n: Total number of fishing boats of that fleet

Fixed cost

According Trinidad et al. 1993, fixed costs incurred by the fishing boat owners include tax and insurance, the costs of repairing and maintaining the boat, engines and other equipment, and depreciation. Fixed costs are often only paid for once or twice a year or even less.

Investment Cost

Investment costs include capital costs of the boat, engine, and gears, winch and mechanical equipments, electronic equipments, storage equipment (boxes, containers, etc) (Trinidad et al. 1993). Investment cost was collected under the categorized fishing fleet.

Depreciation costs

Depreciation costs are the costs of replacing equipment after it has reached the end of its economic life and can no longer be used. These costs are not incurred every year but are real and must be included in any analysis of long-term and overall profitability of fishing fleets. The boat-owner must earn and save enough money to be able to replace old equipment when needed. This means

that a proportion of his operating profits must be allocated to meeting these depreciation costs – the depreciation of value in equipment. Annual depreciation costs are calculated here as the total cost of the equipment item, such as the vessel or engine, divided by the total number of years that the item can be used (the total economic life of the item).

Fishing income

Annual fishing income by main fleet was estimated by subtracting the sum of annual variable cost, investment cost and fixed cost from annual revenues, which equivalent to (4) – (6) - (investment cost + fixed cost).

3.2.2. Perception of the local community on livelihood issues

How fishermen respond to the management objectives of MPAs will have an influence on the effectiveness of MPAs (Sanchirico *et al*. 2002). Alban *et al*. 2008 sumarised the objectives of MPA creation as (i) ecosystem preservation, (ii) fisheries management, and (iii) development of recreational non-extractive activities ("ecotourism"). Many surveys were conducted on the perceptions of stakeholders towards objective of MPAs. Mangi 2008 conducted a survey on the perceptions of stakeholders towards objectives of MPAs in Southern Europe by ranking the importance of MPAs' objectives. Most of reasons of MPAs establishment in Vietnam concentrated on conservation and livelihood improvement. It is expected that livelihood improvement will support for conservation objective and reduce the pressure on fishing in MPA. Therefore, in the framework of this study a questionnaire was developed to assess the perceptions of local people on the importance of livelihoods improvement objective among Cu Lao Cham MPA objectives. The questionnaire was designed to elicit the respondents' perceptions of the objective of livelihood improvement when establishing Cu Lao Cham MPA, and explore the perception of local people towards alternative livelihoods activities. Before asking questions regarding the objectives of MPA creation, general information about respondents were obtained such as education background and occupation. The survey employed Likert scale survey techniques (Pomeroy et al. 1997; Shafer & Benzaken, 1998; Suman et al. 1999) to quantify responses on attitudes and perceptions of local people. Questions concerning objectives of marine protection provided the respondent with a list of 5 specific objectives. These included whether MPAs protect marine biodiversity from damaging

activities, prevent over-exploitation of species, improve or sustain yields in adjacent areas, promote the development of tourist and improve livelihoods for local community. Each respondent was asked to rank how they perceive the importance of the objectives of Cu Lao Cham using 9 for the most important objective, 8 for second most important and 1 for least important. Besides, a few questions were used to explore the perception of local people to the values of Cu Lao Cham MPA and the effectiveness of Cu Lao Cham MPA by themselves.

Walsh and Groves 2009 shows that agricultural subsidy increased fishing in some households in Kiribati but not decreased as expected. Therefore in order to explore the perception of local people and define whether livelihood activities have lasting effect, there is one section of the questionnaire focused on specific issues such as *"Do you believe successful livelihood activities will reduce fishing activities in CLC MPA", "If alternative livelihoods create more income for your family, what of the following activities will you invest on?", "What kind of the following activities are you involved in?".*

3.2.3. Data and analysis

Information from 2005 to the end of 2008, such as amounts of fish catch of selected fishing gears, starting and ending day of the trip, fishing effort levels, prices of fish, types of target species, variable cost for each trip and other pertinent data on Cu Lao Cham MPA were obtained from Log Book system of Cu Lao Cham MPA's project as secondary data for the study. Log Book program started in Cu Lao Cham, Quang Nam province in 2005 including information of the name of boat owner, horse power, fishing gear, variable cost for a trip, starting day and ending day of the trip, fishing ground, depth, production, catch species, quantity in kg and selling price. Log-books were provided for 80 households of the total 600 households in 2005 and 2006 and reduced to 40 households from 2007 up to now. The samples were distributed randomly for fishing fleets which have the same gear and horse power. Log-books were collected monthly and afterwards data were updated in database running in ACCESS- a part of the Microsoft Office Package.

More additional survey of investment costs and fixed cost of categorized fishing fleet on Cham island, its economic life and its total of fishing days was implemented in 50 households of which 40 households had been selected as samples for log-book program and 10 households living in Cu Lao Cham was selected on random basis

Semi-structured and key informant interviews were implemented with 90 households of the total of 600 households on Cham Island in which 40 households involved in log-book program to explore the perception of local community on alternative livelihoods issues. 90 households was the sample size when Alpha Level selected is 0.1 and the Acceptable Margin of Error of .03 for continuous data (Bartlett et al, 2001). The survey was done by random selection.

A questionnaire was developed to assess the perceptions of local people of the importance of MPAs which focused on eliciting the respondents' perceptions of the objectives of establishing MPAs. The questionnaire was translated into Vietnamese and each respondent questioned using a face-to-face interview. Questionnaires were presented to local people in the late of morning and in the afternoon as that time they were at home after their trip at sea. All data collection took place in the late weeks of March, 2010 in 4 villages of Cham Islands which include Bai Lang, Thon Cam, Bai Ong and Bai Huong. All local people were asked the same questions and the results were compared. The questionnaires are appeared as Appendix 1.

Data analysis was analyzed by EXCEL because of their reputation for user-friendliness. Analysis of variance (ANOVA) was used to determine differences in mean values for CPUE and mean scores for objectives of Cu Lao Cham MPA.

4. RESULTS

4.1. Catch-per-unit-effort (CPUE)

The annual catch per unit of effort for each main gear fleet was calculated by dividing the total catch of that gear by the total operating days at sea obtained from all samples in a year. Statistics calculated form equation (1) in part 3 show that annual average CPUE are different between main fleets. The widest range in mean CPUE values each year was observed in lift-net fleet (from 99.02 kg/day in 2007 to 42.80 kg/day in 2008) while the narrowest gap in daily catch was observed in driftnet fleet (from the highest level 8.90 kg/day in 2005 to 6.80 kg/day in 2006). In long-line fleet CPUE changed from 13.38 kg/day to 30.53 kg/day. Of the major gear types operating outside Cu Lao Cham MPA, lift-nets exhibited the largest mean catch-per-unit-effort rate or CPUE (67.97 kg/day) values, followed by long-line (21.88 kg/day), diving (11.72 kg/day) and drift net (7.92kg/day) for the period 2005-2008 (Table 4.1).

Table 4.1: Annual Average CPUE estimated for the main gear fleet in Cu Lao Cham from the year 2005 - 2008

Unit: kg/day

Year	Long-line	Diving	Lift-net	Driftnet	Others
2005	21.97	16.25	59.35	8.90	3.26
2006	13.38	10.57	70.69	6.80	7.97
2007	21.62	8.34	99.02	7.38	
2008	30.53		42.80	8.58	
Average	**21.88**	**11.72**	**67.97**	**7.92**	**5.61**

Source: Cu Lao Cham Logbook data

Analysis of variance (ANOVA) for Single Factor indicates that CPUE values in annual average of each main fleet through the years are statistically different (P values for driftnet, lift-net and long-line are equal to 2.66E-40, 1.89E-08 and 4.3E-13 respectively). This means that the annual average CPUE values of each fleet are different between years (Fig. 4.1; Appendix 2), in which there is a large variation in lift-net fleet reaching a peak of 99.02 kg/day in 2007 and dropping to 42.80 kg/day in 2008 although its CPUE was increasing from 2005 to 2007. The reason for great change in CPUE for lift-net fleet between 2007 and 2008 may come from the fact that lift-nets in Cu Lao Cham are targeting to migrating pelagic species such as anchovy and fishermen in Cu Lao Cham lost their harvesting season of migrating pelagic fish in 2008. The annual average CPUE for long-line fleet

showed a decline from 21.97 kg/day in 2005 to 13.38kg/day in 2006, followed by a progressive increase toward 2008 reaching a peak of 30.53kg/day. There is a slight variation in annual average CPUE of driftnet fleet with a slight increase in the period from 2006 to 2008. Diving activities are the most affected when MPA is established as these activities normally take place near the coral reefs, which was reflected in the reduction of its annual average CPUE. In general, except lift-net yields, the annual average CPUE of the main fleets such as long-line and drift net was decreasing in the period 2005-2006 right after Cu Lao Cham MPA was established in December 2005 and increasing afterwards.

Figure 4.1: Mean CPUE of main gear fleets in CLC (2005-2008)
Source: Cu Lao Cham Logbook data

4.2. Annual Fish Production of main gear fleets

In this study, the total annual fish catch by main gear fleets (long-line, lift-net and driftnet), was calculated by multiplying annual average catch per day which took the mean over all the samples (the trips) by the total number of fishing boats and total fishing days in a year for that fleet. As a result, the table 4.2 obtained from equation (2) in 3 shows the annual fish catch of main fleets for 4 years from 2005 to 2008. This table also indicates that the total annual average fish catch of driftnet, lift-net and long-line fleet in 4 years amounted to about 221 tonnes, 448 tonnes and 205 tonnes respectively. Dividing this total number by the total bay water area (5320 ha or 53.2 km^2) results in an annual fish yield per km^2 of 16.9 $t/km^2/yr$.

Table 4.2: Estimated annual total fish catch of main fleets in Cu Lao Cham obtained by raising recorded annual catch per unit of effort to the total number of fishing boats and total fishing days in a year of that fleet (2005-2008)

Unit: kg

Year	Long-line	Lift-net	Driftnet
2005	221893.6	417151.7	230616.6
2006	135152.4	496878.7	176267.0
2007	218329.3	696023.8	191382.3
2008	308279.5	300871.8	222396.7
Average	220913.7	477731.5	205165.7

Source: Cu Lao Cham Logbook data

The annual total fish catch from use of long-line and driftnet showed a significant decline in 2006, followed by a remarkable increase towards 2008 while there is a great fluctuation in annual total fish catch of lift-net use (Figure 4.2). In long-line fleet the annual total fish catch reached the highest level of about 308 tonnes in 2008 and the lowest level of about 135 tonnes in 2006. The annual total fish catch of lift-net fleet dropped to the lowest level of about 301 tonnes in comparison with 696 tonnes in 2007. There is a stable increase in annual total fish catch from driftnet use from 2006 to 2008.

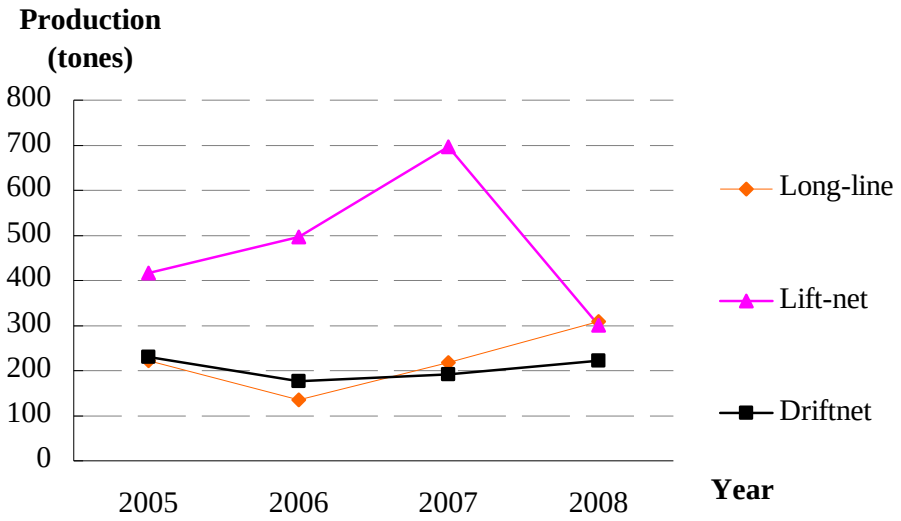

Figure 4.2: Annual Fish Catch by main gear fleets in CLC (2005-2008)
Source: Cu Lao Cham Logbook data

4.3. Fishing Revenues, Costs and Income

Gross daily revenues are a function of the amount of catch and its corresponding value or price per unit weight. The results in table 4.3 derived from equation (3) of part 3 show the mean values of revenue of driftnet, lift-net and long-line gear use over 4 years from 2005 to 2008. It can be seen from this table that the average revenues per day of main fleets are quite different in which the average revenue per day of lift-net is the highest (VND 781073) while the average revenue per day of driftnet is the lowest (VND 142618). The average revenue per day of long-line is VND 579551.

Table 4.3: Mean revenue per day of main fleets from 2005 -2008

Unit: VND 1000 ($US 1 =VND19,000)

Year	Long-line	Lift-net	Driftnet
2005	416.487	313.673	115.523
2006	331.095	2032.567	153.534
2007	517.604	468.633	135.653
2008	1053.019	309.417	165.760
Average	579.551	781.073	142.618

Source: Cu Lao Cham Logbook data

Analysis of variance (ANOVA) for Single Factor indicates that mean revenues per day from driftnet and long-line use are statistically different through years (P values for driftnet, and long-line are equal to 3.49E-32 and 9.22E-26 respectively) while there is no significant difference in mean revenue per day for lift-net (P value = 0.654385) (Appendix 3). Figure 4.3 shows that mean revenue per day for long-line started increasing from 2006 reaching a peak of 1053 thousand VND in 2008 and mean revenue per day of driftnet fleet was rather stable with a slight reduction in 2007 while there was great fluctuation in mean revenue per unit of lift-net although ANOVA analysis indicated no significant difference. The reasons why the catch in 2006 of lift-net fleet did not reach a peak in comparison with 2007, but its revenue was the highest can be explained by two factors as follows: Firstly, there was a great fluctuation in price of catch from lift-net fleet between 2006 and 2007. Data from the logbook showed that the average price in 2005, 2006, 2007 and 2008 was VND 7885, VND 14510, VND 7605 and VND 8577 per kg respectively, in which the price in 2006 was nearly doubled than the price 2007 (Table 4.4). Secondly, the species composition of catch from lift-net fleet in 2007 was mainly anchovy the price of which was very low ranking from VND 2000 to VND 4000 while there was a large proportion of squid and cuttle-fish during March, April and May in

2006 occupying from 23%-70% of each catch. Observations from log book showed that the average prices in March, April and May in 2006 were VND 18240, VND 17130 and 13640 VND respectively.

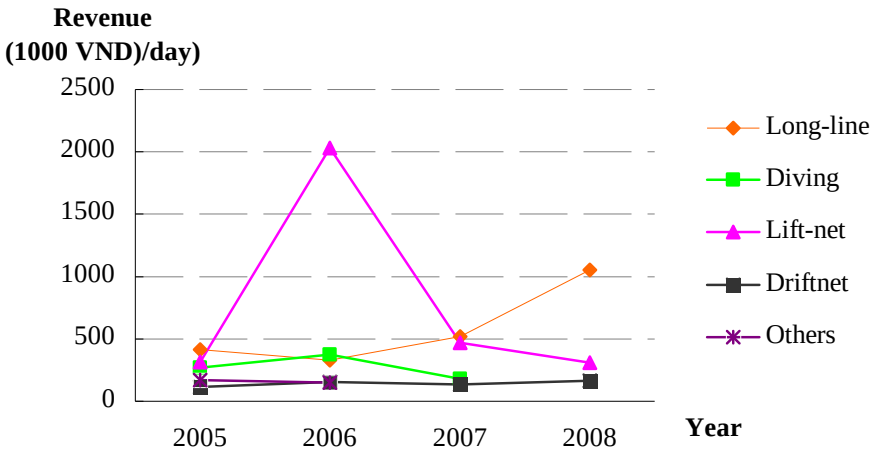

Figure 4.3: Mean revenue per day of main fleets from 2005-2008
Source: Cu Lao Cham Logbook data

Table 4.4: Summary of Average Catch Price of Lift-net fleet (2005 -2008)

Groups	*Count*	*Sum*	*Average (VND 1000)*	*Variance*
2005	896	7064.782	7.884802	66.65116
2006	532	7719.531	14.5104	7452.276
2007	207	1574.162	7.604645	53.18485
2008	115	986.2502	8.576089	31.49836

Source: Cu Lao Cham Logbook data

The variable cost calculated by putting all operating costs per trip such as fuel, oil, ice, food, bait…(not including crew wage) for mean gear fleets has been increasing since 2006, which was reflected in increasing trend of mean cost per day values. Analysis of variance (ANOVA) for Single Factor indicates that mean cost per day values for driftnet, lift-net and long-line use are statistically different through years (P values for driftnet, lift-net and long-line are equal to 0.001457, 4.98E-57 and 1.9E-169 respectively) (Appendix 4). Results obtained from equation (5) part 3 (figure 4.4) show that cost per day for long-line use remarkably increased from 2006 towards 2008 while there was a slight increase in mean cost per day for driftnet use during this period. Mean cost per day for lift-net had a large variation with a great increase for the duration of 2006 and 2007, but after that there was a very slight increase in the mean cost per day.

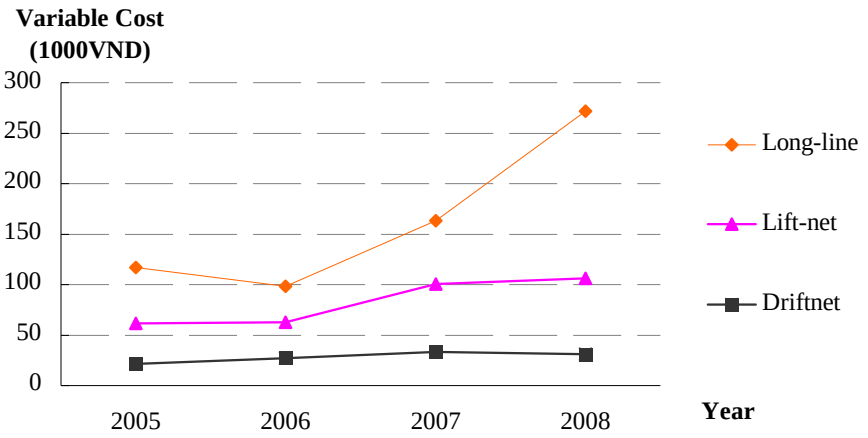

Figure 4.4: Mean cost per day of main fleets from 2005-2008
Source: Cu Lao Cham Logbook data

As almost all fishing boats in Cu Lao Cham are small, investment cost can not be separated for vessel, engine and gear by the fishermen. The fishermen in Cu Lao Cham can separate investment cost on gear and vessel with engine for lift-net fleet but only remember the total initial investment costs for driftnet and long-line use. Table 4.5 indicates that investment costs varied greatly between the main gear fleets, in which the average investment cost for long-line use was the highest of about VND 39.5 million equivalent to the fact that the average horse power of this fleet was the highest among the main gear fleets (about 16HP). Driftnet use had the lowest average investment cost of VND 12.25 million respectively to the lowest average horse power (10 HP). The average investment cost of lift-net fleet was rather high (about VND 36 million) as the investment on gear of this gear type occupied about 32 % (Appendix 5.b). The average economic life of drift net, lift-net and long-line fleets is 23.67, 23.75 and 28 years respectively.

Table 4.5: Average investment cost, fixed cost and horse power of main gear fleets

	Investment (Vessels+ engine) *(VND)*	**Economic life of boat *(Year)***	**Operating day at sea *(day/year)***	**Horse power (HP)**
Driftnet fleet	12255882	23.67	216.48	10.47
Lift-net fleet	35875000	23.75	212.50	12.00
Long-line fleet	39500000	28	187.64	15.75

Source: From investment cost and fixed cost survey (number of boats: 50)

Table 4.6 shows the cost composition of total fixed cost including cost of maintenance and repair of boat, engine, gear, depreciation and license fee (detailed data of fixed costs of main gear fleet is shown as Appendix 5) and total variable cost of 3 main gear types over 4 years from 2005 to 2008 derived from the equation (6) in part 3. The total average costs of driftnet use in 2005, 2006, 2007 and 2008 was VND 1.28, VND 1.42, VND 1.57 and VND 1.53 billion respectively with less than 50% of which was made up variable costs in 2005 and 2006 and more than 50% of which made up fixed costs in 2007 and 2008. The variable cost of lift-net use occupied more than 55% of the total cost in 2005 and 2006, and increased to 67% and 68% of the total cost in 2007 and 2008 respectively. The annual total cost of lift-net use ranged from VND 785 million to VND 1.1 billion. In 2007 and 2008 the variable costs of long-line use took a part of 60% and 72 % while in 2005 and 2006 this figures stood at 52% and 48% respectively.

Table 4.6: Cost composition in average of main gear use in 4 years from 2005 -2008

Unit: VND 1000 ($US 1 =VND19,000)

Criteria	**Driftnet**		**Lift-net**		**Long-line**	
Year 2005	Volume	Percentage	Volume	Percentage	Volume	Percentage
Variable cost	561252	44%	430927	55%	1183513	52%
Fixed cost	717898	56%	354238	45%	1092372	48%
Total	1279151	100%	785165	100%	2275885	100%
Year 2006	Volume	Percentage	Volume	Percentage	Volume	Percentage
Variable cost	697875	49%	441226	56%	994319	48%
Fixed cost	717898	51%	354238	44%	1092372	52%
Total	1415773	100%	795464	100%	2086691	100%
Year 2007	Volume	Percentage	Volume	Percentage	Volume	Percentage
Variable cost	856972	54%	705005	67%	1646731	60%
Fixed cost	717898	46%	354238	33%	1092372	40%
Total	1574870	100%	1059243	100%	2739103	100%
Year 2008	Volume	Percentage	Volume	Percentage	Volume	Percentage
Variable cost	809659	53%	745991	68%	2744597	72%
Fixed cost	717898	47%	354238	32%	1092372	28%
Total	1527558	100%	1100229	100%	3836969	100%

Source: From investment cost and fixed cost survey (number of boats: 50)

Annual gross revenues from fishing were calculated for each main fleet using equation (4) part 3. The mean values of annual gross revenues for each main fleet through the years are presented in Table 4.7, together with total fishing (fixed and variable) costs obtained from the fishing cost survey. Capital costs had been amortized according to the life or longevity of the capital asset such as boat or gear. The average annual depreciation cost of the vessel was highest for the long-life boat (VND1.7 million), followed by lift-net boat (VND 1.5 million) and the lowest for driftnet fleet boat (about VND 518 thousand). The repair and maintenance costs for a boat in driftnet, lift-net and long-line fleets were VND 5.3 million, VND 5.2 million and VND 17 million. Each fishing boat had to pay VND 75 thousand per year for fishing fee. Data on economic life of the boats, investment costs, repair and maintenance are appeared in Appendix 5.

Table 4.7: Estimated average incomes among main gear fleets 2005-2008

Unit: VND 1000 ($US 1 =VND19,000)

Year	Total Revenue (1)	Total Annual Variable Cost (2)	Operational profitability (3)=(1)-(2)	Total Annual Fixed Cost			Net Profit =(3)-(4)-(5)-(6)
				Total Annual Repair & Maintenance (4))	Tax and insurance (5)	Total Depre-ion (6)	
Driftnet							
2005	2994350	561252	2433098	646756	9000	62143	**1715200**
2006	3979604	697875	3281730	646756	9000	62143	**2563831**
2007	3516138	856972	2659166	646756	9000	62143	**1941267**
2008	4296499	809659	3486839	646756	9001	62143	**2768940**
Lift-net							
2005	2204807	430927	1773880	170500	2475	181263	**1419642**
2006	14286916	441226	13845690	170500	2475	181263	**13491452**
2007	3294020	705005	2589015	170500	2475	181263	**2234777**
2008	2174895	745991	1428904	170500	2475	181263	**1074666**
Long-line							
2005	4205684	1183513	3022171	919036	4050	169286	**1929799**
2006	3343396	994319	2349077	919036	4050	169286	**1256705**
2007	5226768	1646731	3580037	919036	4050	169286	**2487665**
2008	10633381	2744597	7888784	919036	4050	169286	**6796412**

Source: From logbook data; and investment cost and fixed cost survey

Operational profitability is calculated as the total annual revenue earned less the variable costs (not including labor cost), such as fuel and ice. In the short-term, fishing boats are profitable if their income is greater than their variable costs incurred. However, in the longer-term, fixed costs, such as

repairs and maintenance and the costs of replacing old equipment, must be met. Therefore, a boat is profitable if its total annual income is greater than both variable costs and fixed costs. Estimates of gross revenues and net incomes (Table 4.7) suggest that all main fleets are profitable and there is a fleet more profitable than others. Long-line use obtained the highest gross annual average revenues (about VND 5.9 billion) but ranked the second in terms of net income (about VND 5.1 billion). The gross revenue and net income of driftnet is the lowest which are equivalent to VND 3.7 billion and VND 2.2 billion respectively.

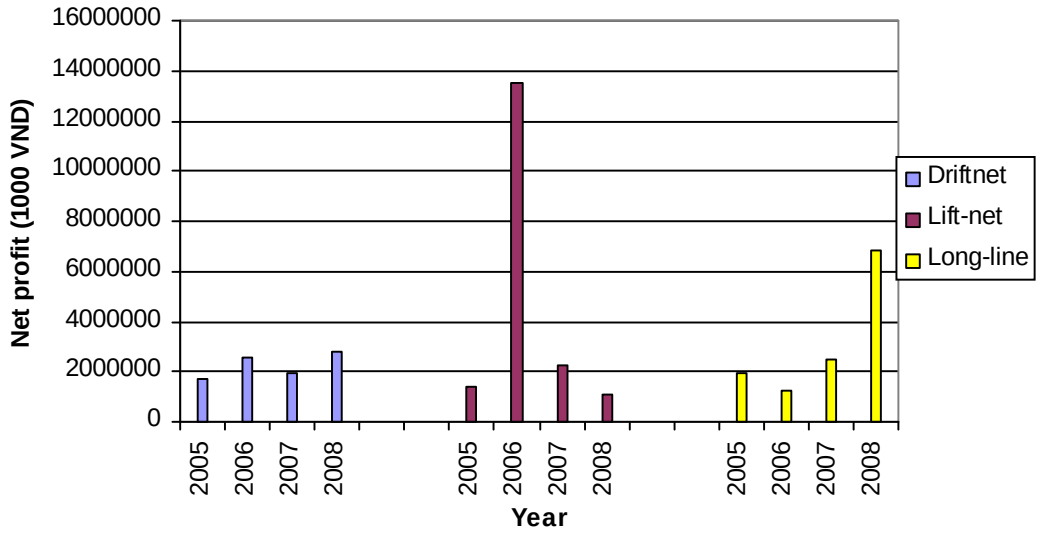

Figure 4.5: Total annual net profit of main fleets through years 2005-2008
Source: From survey (number of boats:50) and logbook program

Figure 4.5 shows the trend of net profit of main fleet in which there is great fluctuation in profit value of lift-net. Although the catch fish of lift-net was not highest in 2006, its net profit was the highest in this year. It was surprising that the fish catch of this fleet increased dramatically in 2007 but its net profit dramatically reduced in 2007 (more than 6 times). This may come from the factors that the variable cost of lift-net significantly increased in 2007 due to the increase in oil price (GSO 2006, 2007), and the price of anchovy (target species of lift-net) dramatically reduced in 2007. Besides, a large proportion of economic-valued species such as squid and cuttle-fish in the catch composition of lift-net fleet in 2006 in comparison with anchovy as the main catch in 2007 made profit of that fleet in 2006 highest. In 2008 the fishermen in Cu Lao Cham lost the pelagic crop, therefore the net profit was the lowest in this year. The net profit of long-line use had increasing trend reaching a peak in 2008 from 2006 to 20008 which coincided with its CPUE trend and annual

fish catch trend. The net profit of driftnet use was mainly stable with a small reduction in 2007, but when compared with the year 2005, the net profit of driftnet use had an increasing trend. Profits from fishing activities go directly to the owners as most of fishing boats in Cu Lao Cham are small, which require only family members working on boat.

The only source of income of inhabitants on Cu Lao Cham comes from the natural (mostly marine) resources with more than 85% of the households earning their living directly from the marine resources or providing services to the marine exploitation activities (Tilde 2005 and McEwin 2006). With the total population of 3000 people in Cu Lao Cham (Hien, *et al*. 2006), the average income per month per person whose life (about 2550 persons) depend on marine resources can be roughly estimated to be about VND 165000, VND 565000, VND 217000 and VND 347000 in 2005, 2006, 2007 and 2008 respectively (Table 4.8).

Table 4.8: Monthly average incomes per person from fishing activities (2005-2008)

Unit: VND 1000 ($US 1 =VND19,000)

Year	Driftnet fleet	Lift-net fleet	Long-line fleet	Total	Monthly income per person
2005	1715199.6	1419642.3	1929799.0	5064641	**165.5**
2006	2563831.3	13491451.6	1256704.9	17311988	**565.8**
2007	1941267.3	2234776.8	2487664.9	6663709	**217.8**
2008	2768939.9	1074665.8	6796412.1	10640018	**347.7**

4.4. Perceptions of local people towards objectives of Cu Lao Cham MPA and livelihoods.

The age of the respondents ranged from 19 to 54 with a mean of 39.05 years. More than 80% of respondents are fishermen. The most common education background of respondents was secondary school (50%), followed by primary school (40%), and illiteracy (10%). Of the respondents, four (4.4 %) involved in livelihood activities of tourism, seven (7.8%) conducted in fish sauce production, three (3.3 %) produced dried fish production, six (6.7 %) had children sent to vocational school and one (1.1%) involved in agriculture activity.

Table 4.9 shows the responses of local people towards Cu Lao Cham MPA objectives which ranked in average. There was significant difference in the scoring of different objectives of MPA

(ANOVA, *F*-value = 27.97, *p*-value = 9.63E-21) among all respondents (Appendix 6). Biodiversity protection was ranked the second important objective of establishing a MPA, giving it a mean score of 7.01 out of 9, while livelihoods improvement was ranked as less important with a mean score of 5.6. Tourism development objective was highest scored with mean of 7.19. The scores given by local people for over-exploitation prevention and yield improvement were lower important (mean were 5.8 and 5.5 respectively), which is a little higher than normal level (Figure 4.6).

Table 4.9: Importance weight of Cu Lao Cham MPA objectives by local people

SUMMARY

Groups	*Count*	*Sum*	***Average***	*Variance*	*StD*
Tourism development	90	647	**7.19**	1.952684	1.40
Biodiversity protection	90	631	**7.01**	2.595381	1.61
Over-exploitation prevention	90	529	**5.88**	2.265793	1.51
Livelihoods improvement	90	504	**5.60**	1.411236	1.19
Yield improvement	90	495	**5.50**	2.162921	1.47

Source: From perception survey (number of households: 90)

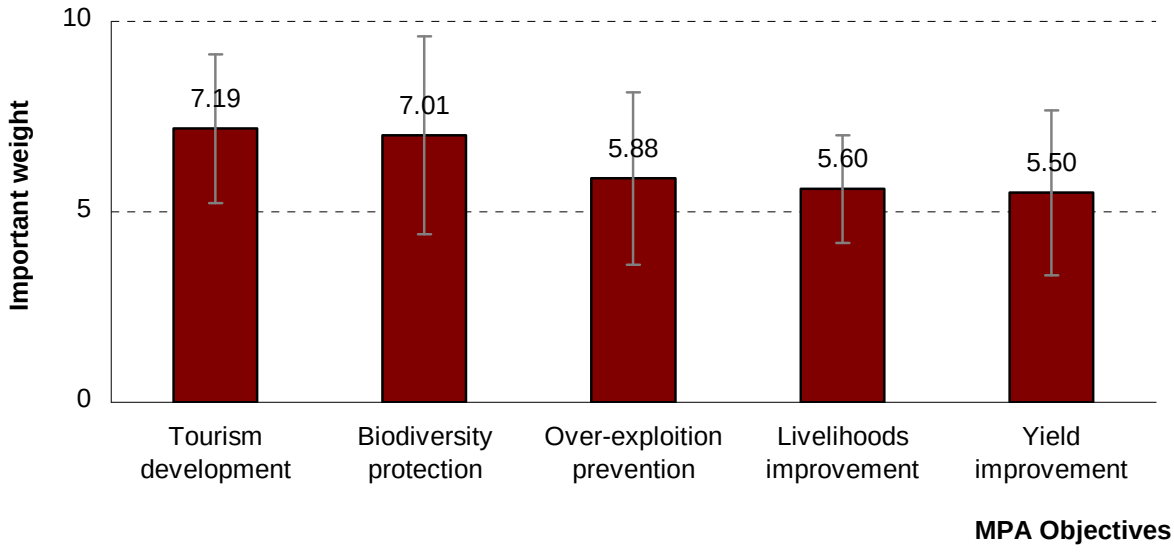

Figure 4.6: The important weight of CLC-MPA objectives compared with normal level of 5 score

Source: From perception survey (number of households: 90)

In response to the evaluation of the effectiveness of Cu Lao Cham MPA, almost local people agreed that Cu Lao Cham MPA was effective in which about 9% of local respondents thought that the effectiveness of Cu Lao Cham MPA was very good, 65% ranked "good" for Cu Lao Cham MPA, and 26% considered that the effectiveness of Cu Lao Cham was at normal level. When asking about the success of Cu Lao Cham MPA, only 4,4% agreed with the livelihood improvement as the main success of Cu Lao Cham MPA while 57% and 27% of respondents agreed that Cu Lao Cham MPA establishment brought about a stream of benefits for them in terms of increased tourism value and fish yield improvement respectively (Figure 4.7). And when asking about the factors to the success of Cu Lao Cham MPA in the future through the question "*What kind of the following activities will increase the most effectiveness of CLA MPA?"* followed by training and alternative income generation with 20% of respondents supporting for each. Credit was considered the least important factor to the effectiveness of Cu Lao Cham MPA with only 7% of supporting respondents (Figure 4.8). In consistence with the above result, almost all the local people in Cu Lao Cham were aware of the values of coral reef protection, environment improvement and tourism development that Cu Lao Cham MPA brought back to the local people when they were being asked with the questions to explore the perception by themselves on the values of Cu Lao Cham MPA.

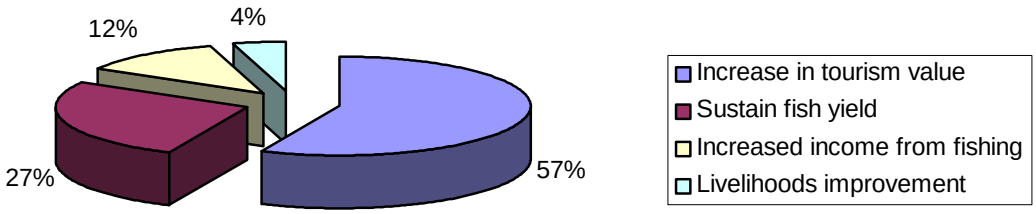

Figure 4.7: Success of CLC MPA by the perception of local people
Source: From perception survey (number of households: 90)

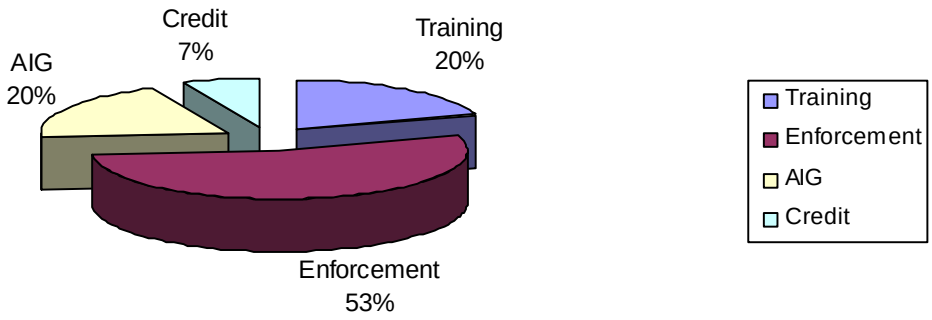

Figure 4.8: Important factors to the effectiveness of Cu Lao Cham MPA by the perception of local people
Source: From perception survey (number of households: 90)

Interestingly, 27% of respondents will invest on fishing if alternative livelihoods create more income for their family. About 40% and 29% of respondents supported for investment on higher education for their children/or send children to vocational school and alternative livelihood activity respectively. Only 4% liked to save money. Among the respondents, 63% agreed that livelihood activities may reduce pressure on fishing but almost all respondent had no idea about what kind of livelihood activities they would like to involve in.

5. DISCUSSIONS AND CONCLUSION

The present study does not capture the spillover of individual species, or whole assemblages, from and to the MPA, a factor often considered in the planning of reserves, but the increase in mean CPUE (in the context of no variation in fishing capacity for the duration 2007-2010) of long-line and driftnet fleets from 2006 to 2008, especially the increase in mean CPUE of long-line use from 21.97 kg/day in 2005 (before Cu Lao Cham MPA establishment) to 30.53 kg/day in 2008 obtained in this study suggest that fish coral catch may be improving slightly in Cu Lao Cham, which is possibly as a result of improvement to the increased availability of juvenile and adult fish, presumably from improved recruitment resulting from protection of the spawning stock in the MPA. This result is coincided with some researches on the trend of CPUE in MPA as the research conducted by Galal, 1999 showed that increased CPUE at fished sites within Nabq Managed Resource Protected Area, South Sinai, Egyptian Red Sea was seen two years after establishment of No Take Zone and was statistically significant after five years, suggesting the No Take Zones may be benefiting the fishery through spillover (Ashworth *et all*. 2005).

The annual fish yield per km^2 of Cu Lao Cham estimated in this study is 16.9 $t/km^2/yr$. There has been no research on figure of the annual fish yield per km^2 in MPAs in Vietnam but many researches conducted in marine reserves in the Philippines which had the similar tropical fisheries features with Vietnam suggested that Apo Island, one of the first marine reserves in the Philippines, was reported to fish yield of 15 to 30 $t/km^2/yr$ (Alcala 2001); Sumilon Island (Southern Cebu) could sustain yield fish between 14 and 37 $t/km^2/yr$ (White & Trinidad 1998), and yield values from other marine reserves in the Philippines such as Selinog Island, Pamilacan Island and San Salvador were reported to be 6.0 $t/km^2/yr$, 10.7 $t/km^2/yr$ and 14.0 $t/km^2/yr$ respectively (Guzman 2004). This figures indicated that the estimated fish yield by main fleets in Cu Lao Cham is a little higher than lower limit of Apo Island's and Sumilon Island's fish yields and much higher than yield values of other marine reserves in Philippines. No reliable data existed for measuring the change in the abundance of fishery resources around CLC prior to the MPA implementation, but compared with the conclusion made by Tuan 2004 that Cu Lao Cham waters were heavily over-exploited by local villagers and by 'outside' fishermen, marine resources on coral reefs were also heavily exploited and many of commercially species had been extended to rare, endangered and critically endangered levels which was supported by results from survey conducted by McEwin 2006 that the amount of fish caught had been declining for several years and some species had disappeared completely with

86% of fishermen reporting that there had been a decline in fish catch in the last 5 years with most estimating a 30-50% decline, the increase in annual CPUE of long-line fleet and driftnet fleet from 2006 to 2008 in the context of no variation in fishing capacity obtained from this research combined with comparison the annual fish yield per km^2 in Cu Lao Cham with other marine reserves in Philippines reflects that the coastal fisheries of Cu Lao Cham may be on a transition toward becoming a viable, sustainable characteristic of better-established tropical marine protected areas.

Vietnamese fisheries has characteristics of open-access fisheries with no entry limitation regulation to the fisheries, therefore the positive net profits from fishing in Cu Lao Cham from 2005 to 2008 were interesting. There are some reasonable explanations for this. First, with a great support from Vietnamese Government and Danish Government through project "Support to MPA Network in Vietnam" started in 2003 before the establishment of Cu Lao Cham MPA in 2005, many activities relating to awareness raising and communities development were implemented very well in Cu Lao Cham (Trinh 2006). Besides, the local people can develop other alternative income generation like tourism development which was reflected clearly in the perception survey with the highest scored of 7.19 for tourism development objective. Therefore, the entry by new fishing boats to the fisheries in Cu Lao Cham is actually not increased for the period 2005-2010 with the observation from survey that the oldest fishing boats was built in 1990 and the newest was built in 2005. Second, the positive net profit of an average of main fleets in Cu Lao Cham through years may also be explained by the concept of intra-marginal rent in an open-access fisheries. This concept comes from the fact that an average vessel, in a group of heterogeneous vessels, has higher fishing efficiency than that of a marginal vessel with zero-profit (Long, *et all*. 2008). Thus, the net profit of average driftnet, lift-net and long-line may be positive without contradicting the theory of open-access fisheries (Copes 1972). These positive incomes from fishing activities attached with the high perception of local people in Cu Lao Cham on the tourism values that Cu Lao Cham MPA brought back to local community when establishing MPA make local people believe in the effectiveness of Cu Lao Cham MPA. This was reflected in the survey that about 75% local people agreed that Cu Lao Cham MPA was effective in which about 9% of local respondents thought that the effectiveness of Cu Lao Cham MPA was very good, 66% ranked "good" for Cu Lao Cham MPA. This was in line with confirmation by Sekhar (2003) and Hans (2003) that attitudes were significantly related to perceived benefits of local people.

With more than 85 percent of 3000 people living in Cu Lao Cham depending on fishing activities, the rough average monthly incomes from fishing of all gears per person was about VND 165000 in 2005, VND 565000 in 2006, VND 217000 in 2007 and VND 347000 in 2008 in which the monthly income in 2005 and 2007 were under the poverty threshold of VND 200000 and VND 260000 respectively and monthly income in 2008 was a little higher than the poverty threshold of VND 300000 for rural communities in Vietnam. Although monthly income in 2006 was doubled higher than poverty threshold, this income was not stable over the years. This indicated that although MPA has been established monthly income of people whose life depend on fisheries were still small, which completely coincided with low perception of local people of Cham Island on the MPA objectives of over exploitation prevention and fisheries resources improvement. This was also reflected clearly in the results from the perception survey that only 27% of respondents considered that Cu Lao Cham had benefit of fish yield improvement and 12 % thought that increased income from fishing is the main success of Cu Lao Cham. The low net profit can be explained in the light that the CPUE is still low, the fisheries is still in open access and the problems of inefficient monitoring and enforcement of boundary regulations, continued poaching and entry from other neighboring regions are still existed in Cu Lao Cham. In consistence with it, 53% of respondents considered that enforcement and control would be the most important factors to more effectiveness of MPA. These issues are just a few of the many challenges confronting the management of Cu Lao Cham MPA.

The result on weighting importance of Cu Lao Cham MPA's objectives is surprising, since the objectives of Cu Lao Cham MPA establishment targeted to biodiversity conservation and livelihood improvement, however the local people give high rank to the biodiversity conservation as a major objective of establishing MPA but not to the livelihood improvement. This reality may come from the fact that the community development activities attached with awareness raising programs have been implemented strongly in Cu Lao Cham (Trinh 2006) with two third of the total number of residents on Cham island attended in the education activities of MPA (Completion Report 2006). Thus all almost local people in Cu Lao Cham are clearly aware of the role of MPA in biodiversity conservation owning to their high awareness level, which was reaffirmed by about 53% of respondents considering that enforcement and control are the most important factors to more effectiveness of MPA, while only 20% of respondents thought that alternative income generation was the main factor of MPA effectiveness. In consistence with this result when asking about the

success of Cu Lao Cham MPA, only 4,4% agreed with the livelihood improvement as the main success of Cu Lao Cham MPA while 57% and 27% of respondents agreed that Cu Lao Cham MPA establishment would bring about a stream of benefits for them in terms of increased tourism value and fish yield improvement respectively. With more than 80% of fishers respondents, the result on the perception of local people to MPA objectives in this study is in contrary with the result obtained from research conducted on perception of stakeholders towards objectives and zoning of marine-protected areas in Southern Europe which indicated that fishers in Europe ranked fisheries management including over-exploitation prevention and yield improvement in adjacent areas as the most important objective of MPA establishment (Mangi 2008). This difference may come from the fact that the approach of MPA establishment in term of objectives in Vietnam has focused on biodiversity protection and livelihood improvement but not focused on fisheries management which provides direct benefits by preventing over exploitation of fisheries resources and sustaining or improving the fish yield. Although livelihood improvement is defined as one of two objectives of Cu Lao Cham MPA establishment, the result from the survey on Cu Lao Cham showed that the perception of local people towards livelihood objective was very low, besides it seems that local people on Cham Island have no idea about what kind of livelihood activities they would like to involve, especially they seem to have no thought to consider fishing itself as a sustainable livelihood. This should be of a concern for MPA management in Vietnam as the success of MPA establishment largely depends on its objectives, and the perception of people towards the objectives of MPA is defined as an important indicator to measure the success of MPA. Besides, what 27% of respondents will invest on fishing if alternative livelihoods create more income for their family indicates that supporting for livelihood activities may not bring back positive impacts on the fisheries resources improvement. These issues may raise a question whether the objective of fisheries management left behind when establishing MPA in Vietnam was a right approach or not as MPAs are supposed to help fisheries management in terms of providing direct benefits by contributing to the restoration of overfished stocks (e.g. Bohnsack 1996a; McClanahan and Mangi 2000), decreasing the risk of stock collapse (Fogarty *et al.* 2000), and providing an alternative to conventional fisheries management tools, which are closely related to the benefits of ecosystem protection. Besides, fishing may become a sustainable livelihood when it is put under well management. In fact many researches indicated the role of MPA and fisheries management in increasing yields in adjacent fishing zones such as an increase in stock recovery and improved financial returns for artisanal fishers from a trawl ban introduced in the Gulf of Castellammare, northwest Sicily (Whitmarsh *et al*. 2002).

In summary, despite the various of problems in management of Cu Lao Cham MPA such as poaching, poor and ineffective enforcement, sustainability…., the performance of ecological (CPUE), economic (income from fishing) and social (perception to the MPA objectives) indicators in this study showed that Cu Lao Cham MPA has achieved a significant amount of success and much of this success is attributed to the support of local authority, effort of MPA Management Board and involvement of a large sector of the community in Cu Lao Cham MPA. This study has also identified a number of indications that the coastal fishery of Cu Lao Cham could be on a transition towards becoming a viable, sustainable characteristic of better-established tropical marine protected areas.

This study has showed the linkages between ecological, socio and economic issues which often give an insight to direct and immediate feedbacks to MPA (Brown et al., 2001), the results is limited with general view within the fisheries sector in MPA though. In order to evaluate the effectiveness of MPA, study by species or by taxa in framework of ecological indicator is important, besides studies on MPA also have to be more and more multidisciplinary (Jameson *et al.* 2002; Fazey *et al.* 2005) with clear planning, monitoring, evaluation and links with policy and management of the MPA (Dung 2007).

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APPENDIXES

Appendix 1:

a, Questionnaire towards people perception on MPA objectives and Livelihoods in Cu Lao Cham

Section 1: General information from interviewees. (Question 1 to 4)

1. ***What is your occupation****?*.....

2. ***Which level of education level you have gotten?***

Elementary ☐ Middle school ☐ High school ☐ Other ☐

3. ***How old are you***?.....

Section 2: Perceptions of local people towards objectives of MPA

Question 4 to 8

Please rank the importance of Cu Lao Cham MPA

1 = No importance 2 = low 3 = Medium 4. highly 5. Very highly					
4. Protect marine biodiversity from damaging activities	1	2	3	4	5
5. Prevent over-exploitation of species	1	2	3	4	5
6***. Improve or sustain yields in adjacent areas***	1	2	3	4	5
7. Promote the development of tourist	1	2	3	4	5
8. Improve livelihood activities for local community	1	2	3	4	5

9. In your opinion, which values of CLC MPA are you aware of?

……

10. In your opinion, what kind of the following activities will increase the most effectiveness of CLA MPA?

a, capacity building b, enforcement & control activities

c, alternative income generations

d, cultural information e, credit d, other

11. Consider the effectiveness of MPA management, how do you rank?

Very Bad	Bad	Normal	Good	Very Good

12. In your opinion, which one of the followings is the success of CLC MPA?

a. Increased income from fishing activities b. Increase in fish catch

c. Increase in tourism values

d. Increased income from alternative income generations e. other

Section 3: Explore the perception of local people towards livelihood activities

13. Have you participated in livelihoods activities implemented by CLC MPA ?

Yes ☐ No ☐

If YES, go to question 14

If NO, go to question 15

14. What kind of the following activities are you involved in? And how do you use income from this activity?

- Environmental quality improvement	
- Tourism development	
- Fish sauce production	
- Dried fish production	
- Handicraft production	
- Agriculture development	

15. What kind of livelihood activities do you expect to be involved in?

16. If alternative livelihoods create more income for your family, what of the following activities will you invest on?

- Higher education for your children/or send children to vocational school	
- Fishing	
- Continue to invest on ongoing alternative livelihood activity	
- Aquaculture	
- Any other ?	

17. Do you think alternative livelihood activities create pollution to CLC MPA? Why?

18. Do you believe successful livelihood activities will reduce fishing activities in CLC MPA?

b. Questionnaire on fixed and investment cost (*Survey in Cu Lao Cham MPA)*

1. Operating days in year

Gear	Months operating	Total operation days in a year
Gill Net		
Sardine net		
Small mesh net		
Size 2 net		
Size 3 net		
Bi Net		
Three Layers Gill Net		
Di net		
Rabit Fish net		
Squid net		
Lift-net		
Lift-net with light		
Squid lift net		
Line		
Long- line		
Handle-line		
Diving		
Other		

2. Fishing equipment investments and economic life

Equipment	Cost (VnD mill)	Economic Life	Number of years left
Vessel			
Winch and mechanical equipments			
Electronic equipments			
Fishing gears including wires/ ropes			
Storage equipment (boxes, containers, etc)			
Other (specify)			
Engine			

3. Repair and maintenance costs by item, Cu Lao Cham

	Vessel	Mechanical equip.	Electronic equip.	Gears	Other	Engine
Maintenance						
Repair						

4. How much tax and insurance do you pay per fishing boat per year?

Appendix 2: ANOVA Single Factor results for Annual Average CPUE of Main fleets

a.*Driftnet Fleet*

SUMMARY

Groups	*Count*	*Sum*	***Average***	*Variance*
2005	2696	23986.98	**8.897246**	137.5486
2006	2537	17252.68	**6.800426**	121.9806
2007	1635	12072.15	**7.383578**	79.53124
2008	3442	29532.77	**8.580118**	148.308

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	21009.72	4	5252.429	48.20263	2.66E-40	2.372624
Within Groups	1399336	12842	108.9656			
Total	*1420346*	*12846*				

Df = 12846 of n = 12848 satisfying normal distribution

b. Lift-net fleet

SUMMARY

Groups	*Count*	*Sum*	***Average***	*Variance*
2005	957	56795.3	**59.34723**	7062.699
2006	535	37819.05	**70.68981**	17514.83
2007	207	20497.5	**99.02174**	13471.48
2008	115	4922.5	**42.80435**	1445.047

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	429838.1	4	107459.5	10.54399	1.89E-08	2.376616
Within Groups	19343542	1898	10191.54			
Total	19773380	1902				

Df=1902 of n =1904 satisfying normal distribution

c. Long-line fleet

SUMMARY

Groups	*Count*	*Sum*	***Average***	*Variance*
2005	485	10657.4	**21.97402**	818.8603
2006	396	5300.095	**13.38408**	665.3787
2007	449	9707.85	**21.62105**	1713.644
2008	642	19599.47	**30.52876**	2053.86

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	75498.62	4	18874.66	16.18965	4.3E-13	2.375567
Within Groups	2850496	2445	1165.847			
Total	2925995	2449				

Df= 2449 of n = 2451 satisfying normal distribution

Appendix 3: ANOVA results for Annual Average Revenue per day of main fleets

a. Driftnet fleet

SUMMARY

Groups	*Count*	*Sum*	***Average***	*Variance*
2005	2535	292850.2	**115.5228**	17525.98
2006	2465	378461.6	**153.5341**	38100.97
2007	1635	221793.4	**135.6535**	26695.08
2008	3279	543527	**165.76**	79748.9

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6717632	4	1679408	38.62755	3.49E-32	2.372646
Within Groups	5.41E+08	12446	43476.94			
Total	5.48E+08	12450				

n=12609

b. Lift-net fleet

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
2005	896	281051	**313.673**	204848.4
2006	532	1081326	**2032.567**	1.52E+09
2007	207	97007	**468.6329**	232034.6
2008	115	35583	**309.4174**	61122.35

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.08E+09	4	2.7E+08	0.611499	0.654385	2.37678
Within Groups	8.08E+11	1834	4.41E+08			
Total	8.1E+11	1838				

n=1840

c. Long-line fleet

SUMMARY

Groups	*Count*	*Sum*	***Average***	*Variance*
2005	464	193249.9	**416.4869**	224073.4
2006	390	129127	**331.0949**	396963.3
2007	447	231369.1	**517.6043**	562150.9
2008	642	676037.9	**1053.019**	4739270

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	193600086.8	4	48400022	31.68327	9.22E-26	2.375611
Within Groups	3690732318	2416	1527621			
Total	3884332405	2420				

n=2422

Appendix 4: ANOVA results for Annual Average Variable Cost per day of main fleets

a. Driftnet fleet

SUMMARY

Groups	*Count*	*Sum*	***Average***	*Variance*
2005	2522	54609.5	**21.65325**	323.5194
2006	2408	64833.42	**26.92418**	7553.019
2007	1600	52899.5	**33.06219**	61859.92
2008	3279	102425.7	**31.23686**	1867.367

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	182254	4	45563.5	4.410329	0.001457	2.372658
Within Groups	1.26E+08	12244	10331.09			
Total	1.27E+08	12248				

n = 12250

b. Lift-net fleet

Groups	*Count*	*Sum*	*Average*	*Variance*
2005	956	58609.5	**61.30701**	602.7829
2006	535	33583.17	**62.77227**	763.1235
2007	207	20762	**100.2995**	2309.424
2008	115	12205	**106.1304**	1071.957

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	559354.7	4	139838.7	72.24035	4.98E-57	2.376619
Within Groups	3672103	1897	1935.742			
Total	4231457	1901				

n=1903

c. Long-line fleet

SUMMARY

Groups	*Count*	*Sum*	***Average***	*Variance*
2005	485	56843.33	**117.2027**	11265.04
2006	358	35251.17	**98.46695**	14898.88
2007	447	72894.5	**163.0749**	15658.57
2008	627	170416.2	**271.7961**	22183.23

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	17384576	4	4346144	233.5834	1.9E-169	2.375651
Within Groups	44469271	2390	18606.39			
Total	61853847	2394				

n=2396

Appendix 5: Data on economic life, investment cost, total annual depreciation and total annual repair and maintenance of main fleets with descriptive statistics

Fleet	Investment cost (1)	Economic life (2)	Depreciation = (1)/(2) (3)	Total Depreciation = (3) x total number of boats	Annual Repair & Maintenance (4)	Total Annual Repair & Maintenance = (4) x total boats
Driftnet Fleet	12255882	23.667	517854.184	62142502.1	5389632.35	646755882
Lift-net fleet	35875000	23.750	1510526.32	181263157.9	5166667.00	170500011
Long-line Fleet	39500000	28.000	1410714.29	169285714.3	17019192.00	919036368

a. Descriptive statistics of driftnet fleet

	Investment (Vessels+ engine)	*Vessel (fixed cost)*	*Engine (fixed cost)*	*Gear(fixed cost)*	*Economic life*	*Operating day/year*	*Horse power*
Mean	**12255882.35**	**1405882.35**	**743750.00**	**3240000.00**	**23.67**	**216.48**	**10.47**
Standard Error	1094543.19	197576.28	112404.75	403236.90	1.22	5.48	0.45
Median	12000000.00	1000000.00	500000.00	3000000.00	24.50	220.00	9.00
Mode	15000000.00	1200000.00	300000.00	3000000.00	20.00	240.00	8.00
Standard Deviation	**6382228.70**	**1152057.76**	**635857.31**	**2016184.52**	**6.69**	**31.49**	**2.62**
Sample Variance	4.07328E+13	1.3272E+12	4.04315E+11	4.065E+12	44.78	991.51	6.86
Kurtosis	-0.69	8.50	4.36	-0.60	-0.59	0.47	-0.97
Skewness	0.41	2.90	1.99	0.61	0.03	-0.67	0.71
Range	22600000.00	4900000.00	2800000.00	6500000.00	27.00	140.00	7.00
Minimum	2400000.00	600000.00	200000.00	500000.00	12.00	130.00	8.00
Maximum	25000000.00	5500000.00	3000000.00	7000000.00	39.00	270.00	15.00
Sum	416700000.00	47800000.00	23800000.00	81000000.00	710.00	7144.00	356.00
Count	34.00	34.00	32.00	25.00	30.00	33.00	34.00
Confidence Level(99.0%)	**2991689.337**	**540030.618**	**308443.3555**	**1127829.22**	**3.3676678**	**15.010697**	**0.91**

b. Descriptive statistics of lift-net fleet

	Investment (Vessels+ engine)	*Gear*	*Vessel (fixed cost)*	*Engine (fixed cost)*	*Gear (fixed cost)*	*Economic life*	*Operating days*	*Horse power*
Mean	**24375000**	**11500000**	**3775000**	**825000**	**566666.667**	**23.75**	**212.5**	**12.00**
Standard Error	5899770.48	2629955.6	469707.355	118145.391	66666.667	3.11916	9.46485	1.41
Median	28500000	12000000	4100000	900000	500000	21	205	11.00
Standard Deviation	**11799541**	**5259911.3**	**939414.711**	**236290.781**	**115470.054**	**6.23832**	**18.9297**	**2.83**
Sample Variance	1.3923E+14	2.767E+13	8.825E+11	5.5833E+10	13333333333	38.9167	358.333	8.00
Kurtosis	1.9770908	-5.290173	3.13200491	0.43573179	#DIV/0!	3.50406	2.61547	1.50
Skewness	-1.5096758	-0.123691	-1.7131395	-1.1938238	1.732050808	1.86902	1.65852	1.41
Range	25500000	10000000	2100000	500000	200000	13	40	6.00
Minimum	7500000	6000000	2400000	500000	500000	20	200	10.00
Maximum	33000000	16000000	4500000	1000000	700000	33	240	16.00
Sum	97500000	46000000	15100000	3300000	1700000	95	850	48.00
Count	4	4	4	4	3	4	4	4.00
Confidence Level(99.0%)	**34460024.3**	**15361332**	**2743518.07**	**690076.512**	**661656.213**	**18.2187**	**55.2833**	**4.50**

c. Descriptive statistics of long-line fleet

	Investment (Vessels+ engine)	*Vessel (Fixed Cost)*	*Engine (Fixed Cost)*	*Gear (Fixed Cost)*	*Economic life*	*Operating day*	*Horse power*
Mean	**39500000**	**4750000**	**2713636.364**	**9555555.6**	**28**	**187.6363636**	**15.75**
Standard Error	5594234.045	583939.0794	516724.4258	1143958.9	4.0620192	13.52927649	1.39
Median	37500000	4750000	2000000	10000000	30	190	15.00
Mode	30000000	6000000	2000000	10000000	30	180	15.00
Standard Deviation	**19378995.19**	**2022824.308**	**1713781.04**	**3431876.7**	**9.0829511**	**44.8715338**	**4.83**
Sample Variance	3.75545E+14	4.09182E+12	2.93705E+12	1.178E+13	82.5	2013.454545	23.30
Kurtosis	-0.309123061	-0.110166867	-0.139120621	1.0778556	1.0743802	5.179427244	-0.75
Skewness	0.380620088	-0.463288749	0.69217201	-0.5867967	-0.2669003	-1.805109086	0.27
Range	67000000	6700000	5650000	12000000	25	170	16.00
Minimum	8000000	800000	350000	3000000	15	70	8.00
Maximum	75000000	7500000	6000000	15000000	40	240	24.00
Sum	474000000	57000000	29850000	86000000	140	2064	189.00
Count	12	12	11	9	5	11	12.00
Confidence Level(99.0%)	**17374608.53**	**1813601.796**	**1637640.601**	**3838425.2**	**18.701922**	**42.87796624**	**3.07**

Appendix 6: ANOVA results for Weight Average of Cu Lao Cham MPA objectives by local people

ANOVA Single Factor

SUMMARY

Groups	*Count*	*Sum*	***Average***	*Variance*	*StD*
Biodiversity protection	90	631	**7.01**	2.595381	1.61
Over-exploitation prevention	90	529	**5.88**	2.265793	1.51
Yield improvement	90	495	**5.50**	2.162921	1.47
Tourism development	90	647	**7.19**	1.952684	1.40
Livelihoods improvement	90	504	**5.60**	1.411236	1.19

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	232.4978	4	58.12444	27.97668	9.63E-21	2.391982
Within Groups	924.5333	445	2.077603			
Total	1157.031	449				