GLOBAL FISHERIES AND LOCAL PROBLEMS: HOW ECOST MIGHT HELP AMELIORATE OVERFISHING IN THAILAND?

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ABSTRACT

A rapid increase in the Thai trawl and push net fisheries had led to over fishing and thus fishery resource degradation. Catch per unit effort decreased from over 300 kg/hr in the past 30 years to less than 20 kg/hr recently. The impact has placed a greater burden on coastal fishermen who have limited alternative fishing grounds. In response to the degradation of resources, Thai fishermen adjusted their fishing gears, turning to the "available" resources. Examples were anchovy fisheries in place of small trawl fisheries. Nevertheless such a response led to the degradation of another resource. Ecological, economic and social factors can explain such patterns of resource exploitation. Societal cost - a concept being developed within the ECOST project - includes ecological cost, economic cost, and social cost to form a measure that would better elaborate the value of Thai fisheries resources. The objective is to help improve fisheries management, to enhance the living conditions of the coastal poor and ensure the sustainability of Thai fisheries.

Keywords: Overfishing, Thai marine fisheries, ECOST

THAI FISHERIES

According to FAO fisheries statistics, Thailand ranked as the 9th top fish producing country in 2001. The production volume was 3,605,544 metric ton sharing 3% of the world production. Top fish producing countries in 2001 were China (34%), followed by Peru (6%), India (5%), Japan, the United States of America, and Indonesia (4% each), Chile, Russian Federation, and Thailand (3% each), and Norway (2%). In term of export volume Thailand ranked as the 6th sharing 4% of world export with an export of 167,195 metric ton. Nevertheless Thai export value was about 1% of world export value, ranked as 23rd indicating low price of Thai fish export. Most of export earning from Thai fisheries came from shrimp which was cultured. Due to fishery resource degradation in Thai waters as well as constraints on coastal environment, the increase in production as well as export was limited.

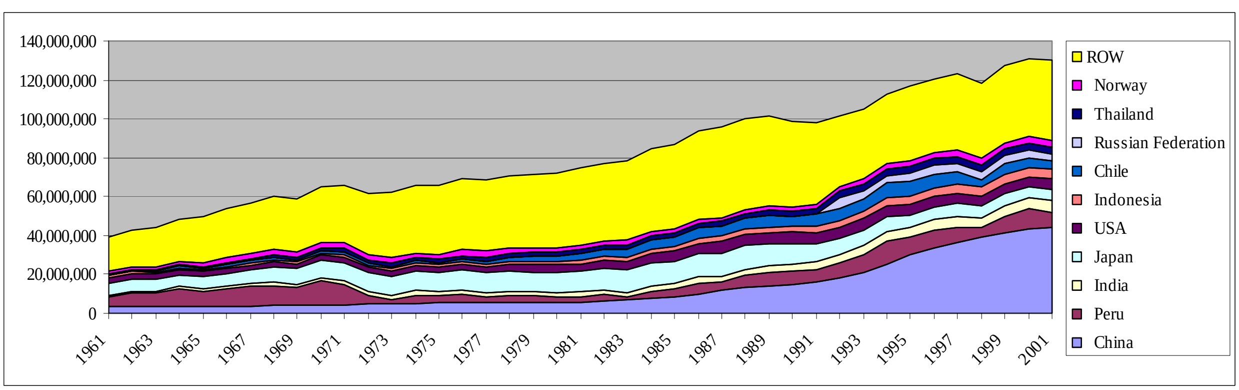
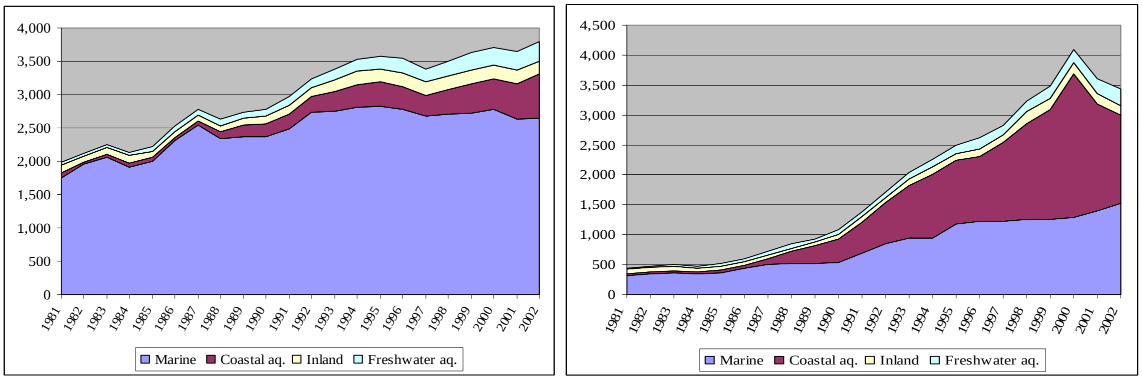


Figure 1 World fish production 1961 – 2001 (mt)
Source: Calculated from FAO fisheries statistics

Dividing fisheries production into marine captures, coastal culture, inland capture, and freshwater culture; in 2002 of the total Thai fishery production of 3.8 million mt, 70% came from marine capture followed by coastal culture (17%), inland captures (5%) and freshwater culture (8%). Share of marine captures decreased through the years while those from coastal culture increased, so did the increase in freshwater culture. As compared to 1981 total production was 2.0 million mt with 88% marine captures, 3% coastal aquaculture, 6% inland captures and 3% freshwater culture. Marine captures tend to decrease while those from culture increase. In term of value, in 1981 fish production valued US$0.4 billion and increased to US$3.4 billion in 2002. In term of value, marine captures shared 72% in 1981 and decreased to 44% in 2002 while coastal culture share in 1981 was only 5% and increased to 43% in 2002. (Figure 2.)



(a) Volume (th mt) (b) Value (US$ million)

Figure 2 Volume and value composition of Thai fisheries 1981 – 2002

Source: Department of Fisheries, Thailand

Marine catch composition changed from 45% trash fish mainly caught by trawls and 33% fish followed by 8% shrimp, 6% mollusk, 5% squid, 2% crab, and 2% others in 1981 to 59% fish, 26% trash fish, 7% squid, 3% shrimp, 2% crab, 1% mollusk, and 1% others in 2002 (Figure 3 as calculated from the fisheries statistics reported by Department of Fisheries, Thailand.) Due to fishery resource degradation a number of fishing vessels had to left fishing in Thai fishing grounds, including trawlers, the main fishing gears, leading to less share of trash fish in marine catch composition.

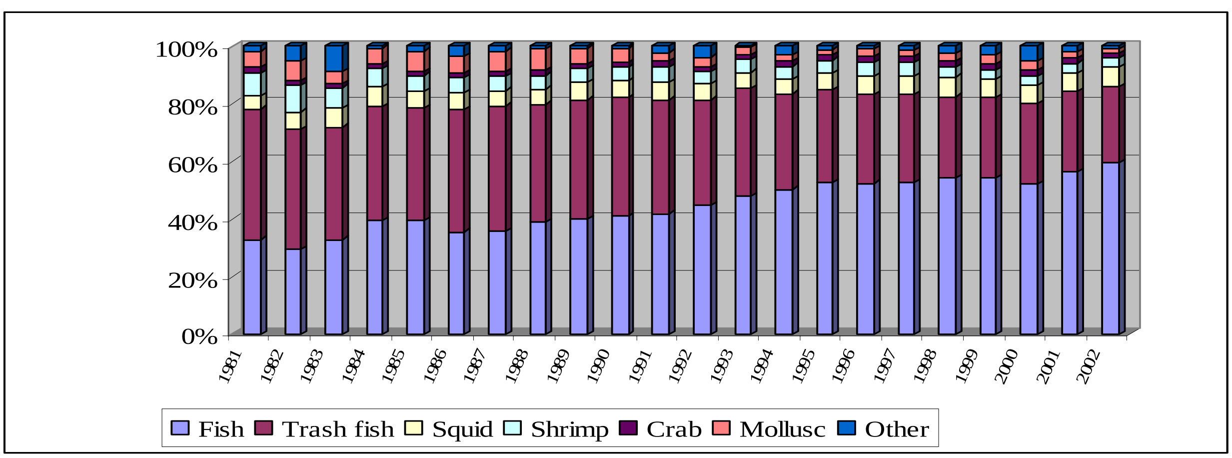


Figure 3 Share of catch composition of Thai marine captures 1981 – 2002 (% of total)

Source: Department of Fisheries, Thailand

PROBLEMS IN THAI FISHERIES

Degraded fishery resources

Before trawl development in early 1960s most of marine captures were pelagic fish, mainly Indo Pacific mackerel caught by purse seines and bamboo stake traps in the Gulf of Thailand. The introduction of otter board trawl in early 1960s increased demersal catches. This fishing gear was rapidly adopted. Number of trawls and push nets increased significantly. Catch per unit effort of trawls in the Gulf of Thailand was 298 kg/hr in 1961 decreased continuously to 173 kg/hr in 1966. In 1968, large fishing vessels began to fish outside Thai waters. Small fishing vessels turned to squid fisheries. In response to decrease in catches, trawlers adapted their fishing gears to catch Indo Pacific mackerel, the main economic fish. Soon the catches decreased due to over fishing in this species.

In 1972 demersal resources in the Gulf of Thailand had already been over fished. CPUE decreased further to 63 kg/hr (Boonlerd Phasuk, 1987). Nevertheless, in the same year Thailand was ranked as one of the top ten fish producing country, with a total production of 1.7 mill mt. In 1973, light luring purse seine was adopted. In 1977, fish production reached 2 million mt for the first time and fluctuated since then. Economic pelagic species including Indo pacific mackerel, sardines and trevallies were over fished.

In early 1980s fishing grounds were limited by EEZ. Nevertheless, after 1981 a number of these vessels fished in neighboring fishing grounds and could lead to increase in marine catches. In 1983, CPUE decreased to 50 kg/hr but increased again in 1984 to 62 kg/hr. In 1989 CPUE in the Gulf of Thailand decreased to 20 kg/hr, and further decreased to 12 kg/hr in 2005.

In response to resource degradation Thai fishermen adapt their fishing in search of available resources. Examples include the fish attractive device purse seine and light luring anchovy purse seine targeted for pelagic species when demersal resources were degraded. Catch composition changed (Table 1) according to these adjustment which finally without effective control led to more degradation.

Degraded fishery resources in the Gulf of Thailand directly impacted on small scale fishermen who had to rely on coastal resources given limited capacity in leaving fisheries for the higher earning occupations. A number of commercial fishing vessels, especially the large vessel, turned to fish in non-Thai fishing grounds while some decided to quit fishing for the other better income occupations.

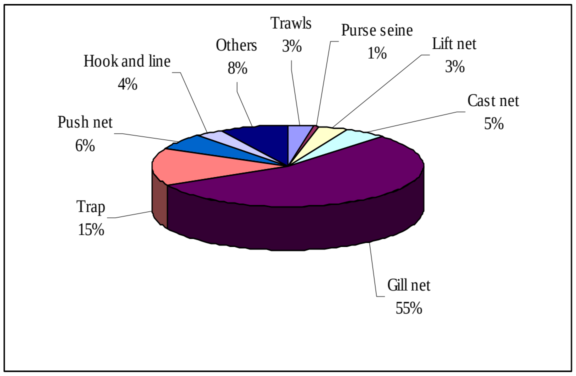
Duality in Thai fisheries

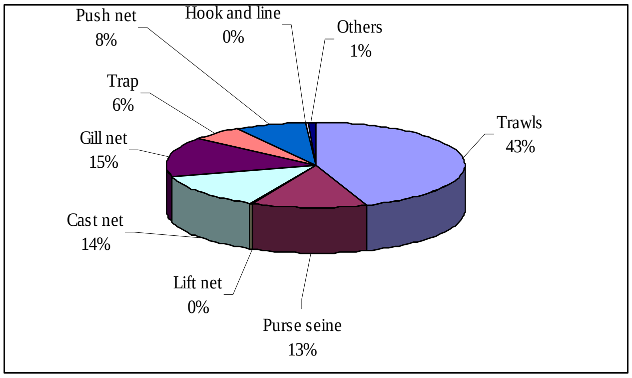
Thai fisheries can be divided into two main groups; small scale coastal fisheries and commercial fisheries. National Marine Census in 2000 reported that there were 57,801 fishing households; 92% were small scale while the rest 8% were commercial scale. Main fishing gears for small scale coastal fisheries are shrimp drift gill net and crab gill net. Other commonly found are mullet gill net and small push net. Small scale fishermen mainly used outboard engine vessels. In board engine vessel employed by small scale fishermen is usually less than 15 m long or less than 5 ton gross. Their fishing trips are daily, not too far from their village. For commercial scale fisheries main fishing gears are trawls. (Figure 4 and 5)

Table 1 Thai marine fisheries catch composition 1982,1992, 2002

1982			1992			2002		
Catch	**Volume(th mt)**	**%**	**Catch**	**Volume(th mt)**	**%**	**Catch**	**Volume(th mt)**	**%**
Total	**1,986.60**	***100***	**Total**	**2,965.70**	***100***	**Total**	**3,303.80**	***100***
Pelagic	**395.5**	***19.9***	**Pelagic**	**841.2**	***28.4***	**Pelagic**	**833**	***25.2***
sardinella	116.9	*5.9*	sardinella	163.5	*5.5*	anchovy	151.7	*4.6*
Indo Pacific mackerel	86.1	*4.3*	anchovy	159.9	*5.4*	Indo Pacific mackerel	146.4	*4.4*
scad	35.8	*1.8*	Indo Pacific mackerel	129.6	*4.4*	sardinella	128.9	*3.9*
eastern little tuna	25.9	*1.3*	eastern little tuna	94.6	*3.2*	scad	104	*3.1*
anchovy	24.6	*1.2*	longtail tuna	74.4	*2.5*	longtail tuna	62.6	*1.9*
other pelagic	106.2	*5.3*	other pelagic	219.2	*7.4*	other pelagic	239.4	*7.2*
Demersal fish	**99.2**	***5***	**Demersal fish**	**223.4**	***7.5***	**Demersal fish**	**509**	***15.4***
threadfin bream	17.3	*0.9*	threadfin bream	65.4	*2.2*	threadfin bream	121.4	*3.7*
crocker	11	*0.6*	bigeye	44.6	*1.5*	bigeye	103.6	*3.1*
bigeye	9.6	*0.5*	lizard fish	38.3	*1.3*	lizard fish	79.1	*2.4*
lizard fish	8.6	*0.4*	crocker	18.5	*0.6*	crocker	51.7	*1.6*
flatfish	6.8	*0.3*	flatfish	7.7	*0.3*	hair tail	19.9	*0.6*
other demersal fish	45.8	*2.3*	other demersal fish	48.9	*1.6*	other demersal fish	133.3	*4*
Food fish	**84.5**	***4.3***	**Food fish**	**164.7**	***5.6***	**Food fish**	**241.3**	***7.3***
Trash fish	**812.8**	***40.9***	**Trash fish**	**1,001.4**	***33.8***	**Trash fish**	**696.6**	***21.1***
Squid & cuttlefish	**116.6**	***5.9***	**Squid & cuttlefish**	**150.3**	***5.1***	**Squid & cuttlefish**	**184.8**	***5.6***
squid	70.6	*3.6*	cuttlefish	65	*2.2*	squid	89.5	*2.7*
cuttlefish	39	*2*	squid	64.8	*2.2*	cuttlefish	73.2	*2.2*
others	7	*0.4*	others	20.5	*0.7*	others	22.1	*0.7*
Shrimp	**188.6**	***9.5***	**Shrimp**	**301.6**	***10.2***	**Shrimp**	**350.5**	***10.6***
banana shrimp	19	*1*	black tiger shrimp	179.7	*6.1*	black tiger shrimp	262.4	*7.9*
school prawn	15.7	*0.8*	banana shrimp	15.9	*0.5*	banana shrimp	21.1	*0.6*
other shrimp	153.9	*7.7*	other shrimp	106	*3.6*	other shrimp	67	*2*
Crab	**29.9**	***1.5***	**Crab**	**44.5**	***1.5***	**Crab**	**42.1**	***1.3***
swimming crab	25	*1.3*	swimming crab	36.3	*1.2*	swimming crab	28.9	*0.9*
other crabs	4.9	*0.2*	other crabs	8.2	*0.3*	other crabs	13.2	*0.4*
Mollusk	**157.2**	***7.9***	**Mollusk**	**135.4**	***4.6***	**Mollusk**	**417.2**	***12.6***
green mussel	65.5	*3.3*	shortnecked clam	70.6	*2.4*	green mussel	291	*8.8*
other mollusk	91.7	*4.6*	other mollusk	64.8	*2.2*	other mollusk	126.2	*3.8*
Others	**102.3**	***5.1***	**Others**	**103.2**	***3.5***	**Others**	**29.3**	***0.9***

Source: Department of Fisheries, Thailand

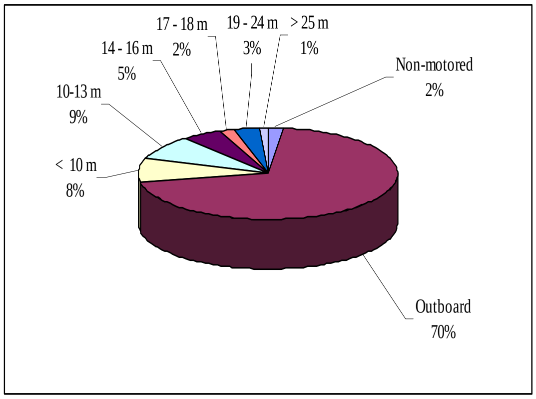




(a) Small scale fishing gears (b) Commercial scale fishing gears

Figure 4 Share of fishing gears of small scale and commercial scale Thai fisheries, 2000

Source: Marine Fisheries Census, National Statistics Office



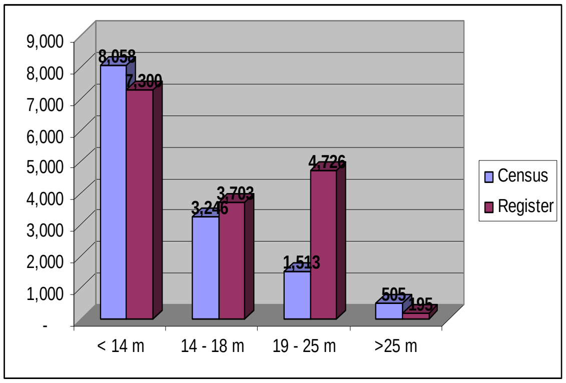


Figure 5 Composition of Thai fishing vessels **Figure 6 Number of inboard engine vessels**

Source: Marine Fisheries Census, National Statistics Office and Department of Fisheries

While about 80% of marine captures are from commercial fishing, number of commercial vessels shares only about 20% of the total fishing vessels in Thailand. By number of vessels, 70% are small scale outboard engine; numerous and scatter among coastal fishing villages. These outboard engine vessels were belonged to small scale fishermen, fishing in coastal zone. These small fishing vessels had to continue fishing in spite of the lower income due to degraded fishery resources.

About 30% inboard engine fishing vessels are required to register, 24% are those up to 18 m long vessels mainly fished in Thai fishing grounds. Capacity reduction can be targeted on this group while controlling the coming back of larger vessels from outside Thai waters. (Figure 6)

Conflicts among fishing gears

Within Thai fishing grounds there were also conflicts in fishing gears. Examples were conflicts between drift gill nets which were main fishing gears for small scale fisheries and trawls and push nets. While gill nets were often damaged by trawls and push nets, they were blamed as blocking trawl and push net sails.

Nevertheless trawls were banned, by regulation, within 3 km from shore and push nets were not legally allowed since they were destructive gears. Trawls and push nets usually used fine mesh size thus caught juvenile economic species as trash fish. Such regulations had never been adequately effective.

There was also conflict between light luring anchovy purse seine and coastal fisheries. Since this anchovy fishing had to use fine mesh size, juvenile economic species were caught as by catch leading to fishery resource degradation. (Details in Ruangrai Tokrisna, 2000.)

Lack of efficient management and control

Over capacity in Thai fishing grounds have to be reduced. Number of fishing vessels should be decreased and effectively controlled to renew resource abundance, thus reduce fishing cost and increase fishing income especially among coastal fishermen. More information are required for an effective management planning including the number and type of existing vessels and those to be reduced as well as capacity reduction process. To determine optimum number of vessels, economic data on cost and return and biological data on fishery resource are required. Once the capacity reduction can be determined, effective control on the optimum level is necessary.

Number of vessels in coastal small scale fisheries is numerous which makes them difficult to be controlled by limited number of official personnel on monitoring and control. For small scale fisheries, community based fishery management/co-management can be more appropriate. However key of success is the capability in coastal fishery management among community organizations. Capacity strengthening and support on legislation framework and enforcement should be the priories.

For commercial scale fishery, Thai government put the priority on capacity reduction, with the emphasis on trawls and push net. Effective control on number of vessels and their fishing effort is the key of success. Nevertheless capacity reduction through buy back program is costly. Effectiveness of the program should be carefully reviewed first.

EMPIRICAL EVIDENCE

Cost of over fishing in the Gulf of Thailand

Panayotou and Jetanavanich (1987) determined the optimum level of fishing effort in the Gulf of Thailand using bio-economic variable price model to estimate sustainable function.

$$
\begin{aligned}
&Y = f(E)\\
&AR = g(Y) \rightarrow TR = AR * Y \rightarrow MR = h(Y)\\
&TC = cE = j(Y) \rightarrow AC = TC / Y, MC = k(Y)\\
&MEY : AR = MC; OA : AR = AC
\end{aligned}
$$

Having Y = catch (thousand mt), E = fishing effort (million standard fishing hour), AR = average revenue, TR = total revenue, MR = marginal revenue, TC = total cost, c = cost per unit of fishing effort, AC = average cost, MC = marginal cost, and MEY = maximum economic yield. The study revealed that in 1982, the actual fishing effort was 19.2 million standard fishing hours higher than the effort at maximum economic yield (MEY) which was 11.8 million standard hours as well as higher than the effort at maximum sustainable yield (MSY) of 15.7 million standard fishing hour. At MEY total benefit accrued to the society would be 23% higher than the actual catch, thus a loss of US$95.6 million in 1982, in term of resource rent and consumer surplus.

In 1997, based on Gordon-Schaefer fixed price model, estimated MEY was 14.5 million hours while the actual effort was 29.9 million hours indicating over fishing at a loss of US$21 million in term of resource rent. (FAO, 2001)

Cost of juvenile economic species by catch in trawls and push net

The loss of juvenile economic species by catches in trawls and push net can be estimated from the weight-length relationship (Sparre 1986).

$W_{tn} = aL_{tn}^{b}$, N_{tn}= (total weight of juvenile economic species)/W_{tn}, $N_{tp} = N_{tn}e^{-z\Delta t}$, $L_t = L_{\alpha}^{-K(t_t - t_0)}$, $W_m = aL_m^{\ b}$, cost of juvenile by catch= $p*W_m$

Having W_{tn} = juvenile weight (gm/fish), L_{tn} = length of juvenile (cm), N_{tn} = number of juvenile by catch, N_{tp} = number of survival, z = mortality rate, Δt = growth period up to marketable size, L_t = length of economic species at age t (cm), L_{α} =maximum length (cm), t_0 = time of hatching , t_t = age of fish, W_m = marketable weight of economic species, L_m = marketable length of economic species, and p = price of economic species.

Sumana Sutheemechaikul (1992) estimated that in the loss of juvenile by catch was fifteen times of the value of trash fish caught by push net in the upper south while the losses were 6.7 times and 5.1 times for small otter board trawl and beam trawl respectively. Waraporn Dechboon (1998) used the same methodology and found that the loss was about one-fifth of the total revenue for large push net in lower south. Ruangrai Tokrisna (2000) estimated the loss of juvenile by catch in light luring anchovy purse seine and found that the loss varied by gear, location and fishing season from almost half to seven times of the return from anchovy in critical area in lower south while varied from numerous to almost twice of the total return from anchovy in upper south. These losses should be taken into account for decision making in investment on fishing capacity reduction.

BEAM 5 was developed in collaboration between Per Sparre from Danish Institute for Fishery Research and Rolf Willmann from FAO. It is multi-species, multi-fleet dynamic software for bio-economic stochastic simulation model. It can be employed for the analysis on bio-economic and socio-economic effects of the transition from poorly managed fishery with excessive fleet capacity with depleting stock and low return or loss to a well managed fishery with stock recovering and adjusted fleet capacity. Application in case of demersal fisheries in the Gulf of Thailand indicated that the net economic benefit would increas 7.9% if push net was totally banned and could increase up to as high as 34.8% if push net was banned and trawl was reduced by half. (FAO, 2001)

Applying EwE (ECOPATH with ECOSIM), for optimum rent the effort ratios 1993 fishing efforts in otter board trawl, pair trawl, beam trawl, push net, purse seine, and other gears should be reduced by 0.4, 1.4, 0.4, 0.3, 0.4, and 1.6 of the effort level in 1973 accordingly, indicating that fishing efforts should be reduced by more than half in case of otter board trawl, beam trawl, push net and purse seine while they could be increased in cases of pair trawl and other gears. (FAO, 2001)

ECOST AND AMELIORATION OF OVERFISHING IN THAILAND

Evidences from bio-economic model indicated that there had been over fishing in Thai fisheries, especially in the Gulf of Thailand. Reducing fishing capacity in trawl, especially otter board trawl and beam trawl, as well as push net could improve the situation. Through the EwE, it was recommended that purse seine should also be reduced.

Managing Thai fisheries is difficult due to its being multi-species and multi-gears. Otter board trawl, the main fishing gear, and push net are destructive gears since they are non-selective fishing caught mainly trash fish. Parts of these trash fish are by catches of juvenile economic species, thus resulting in more fishery resource degradation.

Due to resource degradation in Thai fishing grounds, a number of large fishing vessels either quit or fish in non-Thai fishing grounds. Renewal fishery resource abundance in Thai waters could bring back these fishing vessels, thus again increasing fishing capacity in Thai waters. It is necessary to ensure that number of fishing vessels in Thai waters could be effectively controlled.

Capacity reduction requires effective control on fishing effort, starting from number of fishing vessels. The long coast lines plus limited personnel and budget on monitoring, control and surveillance constrained effective management.

Fisheries management in Thailand can be divided into two parts, one on commercial scale fisheries and the other one on small scale coastal fisheries. For commercial fisheries, number of fishing vessels tends to decrease due to degraded fishery resources, high cost of fishing, thus low return. Department of Fisheries is seeking the possibility of buy back program, especially for trawls and push net which are considered destructive fishing gears. One important key of success is the effective control of the effort which can be difficult in lack of information on the actual number of fishing vessels and compliance among the fishermen. Collaboration from commercial fishermen, perhaps through Fisherman Associations, can enhance the chance of success.[i]

For small scale coastal fisheries, community based fishery management/co-management (CBFM/CM) can be adopted. Nevertheless, community capacity in fishery management should be strengthen. Capable community organization is one of the keys of success. Indigenous knowledge on fishery resources and fishing behaviors among the local community are useful for effective local fishery management planning. Fishing right system can be adopted. There should also be legislation framework in support of CBFM/CM. [ii]

Ecological factors, the scientific information, on fishery resources are required for fishery management planning. For multi-species fisheries ecological factors are important in explaining fish stock dynamic and relation among the stocks. Understanding on the stock, fishing, fishing effort, predator and prey is possible using the ECOPATH, ECOSIM, ECOSPACE, and EwE. ECOST work packages in responsible for this part include

- WP 4: Development and application of an ecological model to the Gulf of Thailand
- WP 5: Production of ECOST model
- WP 6: Calibration and application of ECOST method to fisheries in the Gulf of Thailand
- WP 7: Eco-region comparative analysis of societal costs according to the Gulf of Thailand ecosystems, methods of fishing and fishing policies
- WP 9: Elaboration of a generic version of ECOST model for the Gulf of Thailand.

Economic factors explain the incentive in fishing and the fishing effort, thus fishing behavior. Economic valuation is important in specifying the fishery resource value as well as the benefit from investment on fishery management. Factors to be considered in this part are fishing cost, management cost, prices, opportunity cost in term of forgone resource rent and consumer surplus, net social benefit from optimum sustainable fisheries in the Gulf of Thailand. BEAM 5 can be the useful package for the analysis in this part. It is expected that information from both EwE and BEAM 5 will be useful for effective fisheries management planning. ECOST work packages in responsible for this part include

- WP 3b: Development of a method for economic valuation for fisheries in the Gulf of Thailand
- WP 9: Elaboration of a generic version of ECOST model for the Gulf of Thailand.

Collaboration and compliance from the fishermen influence the success in fishery management. Social factors explain behavior of stakeholders which are important in effective planning on fishery management. Political environment and administrative management regime are also important for successful planning. Social factors will include understanding on the fishermen, their livelihood, fishing community, fishery legislation, fisherman compliance to fishery rules and regulation, fishery politics, and fishery administration. ECOST work packages in responsible for this part include

- WP 3a: Development of a method for sociological valuation for fisheries in the Gulf of Thailand
- WP 9: Elaboration of a generic version of ECOST model for the Gulf of Thailand.
- WP 10: Public and fishery policy analysis
- WP 11: Definition of public policy options toward a better integration of societal cost in public and private decision making.

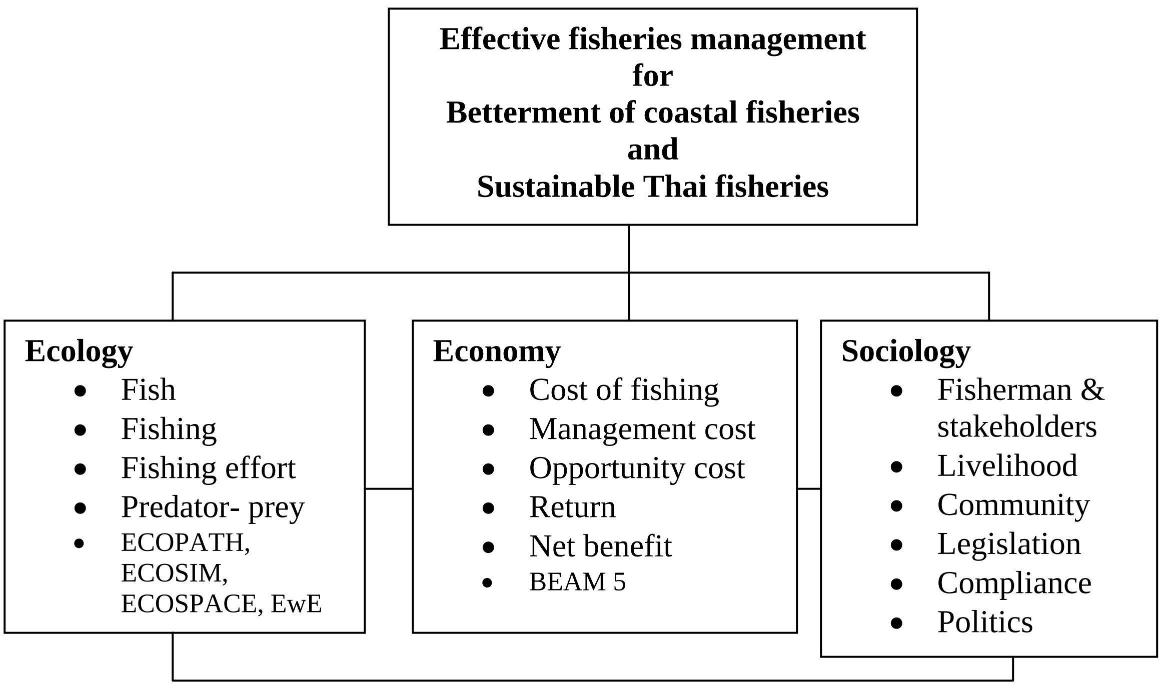


Figure 7 Societal cost for effective fisheries management

Beside aforementioned work packages ECOST has started from WP 1: to study the present relevance of available tools and models for impact assessments on ecosystems and monetary valuation to develop links between ecology, economics and sociology. There is also WP2: for development of platform data and information. Approaching the final stage there is WP 12 for dissemination of knowledge, tools and results of the studies.

Ecological, economic and social factors can explain such patterns of resource exploitation. Societal cost - a concept being developed within the ECOST project - includes ecological cost, economic cost, and social cost to form a measure that would better elaborate the value of Thai fisheries resources. The objective is to help improve fisheries management, to enhance the living conditions of the coastal poor and ensure the sustainability of Thai fisheries.

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ENDNOTES

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[i] Details in Ruangrai Tokrisna (2004).
[ii] Example is the Japanese fishing right system. Details are available in Ruangrai Tokrisna and Seiichi Fukui (2004).