Table 6.9 Optimizing for value of the landings in the Gulf of Thailand, taking the 1973 situation as starting point and applying a constant effort for each of the six fleets for 1973-1993. The effort column gives the effort by fleet in 1993 relative to the effort in 1973.

	Value	Cost	Rent	Effort (1993/1973)
	thousand Baht/km^{-2} /year			
Otterboard trawls	9.82	10.8	-1.01	0.832
Pair trawls	15.5	21.7	-6.18	2.556
Beam trawls	0.955	1.05	-0.097	1.111
Pushnets	0.869	0.934	-0.065	0.419
Purse seines	2.01	3.39	-1.39	1.681
Other gears	78.0	84.5	-6.45	3.672
Total	107	122	-15.2	

Additional simulations could be run to address several of the other workshop objectives as discussed earlier, but time did not allow this during the workshop. Also, the simulations presented here are very preliminary and would need considerable more effort allocated to be done in a more satisfactory manner. Yet, we conclude that ecosystem-based modelling is a feasible approach to explore fisheries management issues in the Gulf of Thailand.

7 COMPARISON OF MODELLING FINDINGS BY THE THREE GROUPS

The intended scope of the workshop was to analyse the effects of the following management measures:

a) **Complete ban on pushnet fisheries within 3 years;**

b) Expansion of the non-trawl and non-pushnet zones from 1.6 nm (3 km) to 3 nm;

c) The impact of current regulations concerning closed seasons and areas;

d) Increase the minimum mesh size of shrimp trawl gear to 2.5 cm and finfish trawl gear to 3 cm;

e) **Reduction of the numbers of various categories of trawlers;**

f) Increase fishing licence fees.

Due to data constraints and limited time, not all of these measures could be subjected to a detailed analysis. Data constraints prevented an analysis of an expansion of the non-trawl and pushnet zones from 1.6 to 3 nm and of current regulations concerning closed areas and seasons. Only management measures (a) and (e) could be subjected to a more detailed analysis.

The **Gordon-Schaefer/Fox working group** accomplished a fairly complete analysis, within the limitations of surplus production modelling. The use of a single-species surplus production model for the multi-fleet and multi-species fisheries of the Gulf of Thailand allows only for rough estimates of optimal fleet sizes and fishing effort. The availability of long time series of data on catch and effort and independent resources abundance estimates through regular trawling assessment surveys favoured this modelling approach.

The findings of this working group indicated that current (1997) fishing effort in the demersal trawl and pushnet fisheries is more than double the level of fishing effort required to maximize resource rent. The working group estimated the potential annual resource rent to be in the order of Baht 7,200 million (approximately US $ 192 million) against a current **negative** rent of Baht 800 million. A reduction in fishing effort and fleet size of that magnitude would result in a dramatic drop in employment in the fisheries of more than 40,000 fishermen, many of whom are immigrants from Myanmar. The findings of this working group are in line with those of a mid-1980 bio-economic analysis using the same model and tally broadly with the results of the other two working groups.

Much time of the **BEAM 5 working group** was spent on compiling and estimating the input data to allow for a complex modelling exercise involving nine species, all representing a major species group), eight fleets and two areas (i.e. inshore in a depth range of <20 m and offshore >20 m). The model simulations produced valuable insights into the effects of a ban of the pushnet fisheries and a reduction in trawling effort.

The results (see Table 5.30) indicated that the complete withdrawal of pushnetters from the demersal fisheries would increase annual net economic benefits by about Baht 410 million (US $ 11 million). Additional gains would occur from a reduction of excessive and wasteful trawling effort to as low as one half of the current level. The simulation results indicate that this would increase the annual net economic benefit by an additional Baht 1.8 billion (US $ 48 million).

In comparison with the Gordon-Schaefer model, the estimated economic gain from a fleet reduction was less in the case of the BEAM 5 simulation for two reasons. Firstly, in the BEAM 5 simulation, fishing costs were proportioned in accordance with the ratio between the simulated and the actually observed catch. Secondly, the implicit fishing mortality value (F) used in a Gordon-Schaefer assessment is always smaller than 1 and thus much lower than the Fs used in the BEAM 5 application. As a consequence of the high F and M values, BEAM 5 may considerably underestimate the gains from a reduction of fishing effort. The validity of the high F and M values should be subjected to future detailed assessments. Depending on the outcome of such assessments, the BEAM 5 exercise should be repeated and further refined.

The **ECOPATH working group** made the most extensive use of the available long time series of data on catch and effort and of ecological information. ECOPATH (with ECOSIM) simulates predator-prey relationships through a mass balance approach. An ECOPATH model was constructed to represent 1973, the first year for which there was a fairly complete coverage of standardized trawl surveys, landings and effort data. Changes in relative effort for each of the six fleets considered during the period 1973-1993 were then used to drive the model over the time period. The tuning of the model to fit the observed data set suggested that mortality rates are probably lower than those estimated for the BEAM 5 application.

The ECOPATH/ECOSIM modelling results indicated that a complete ban of pushnet fishing would have minor effects on biomass, catches and profits. This can be assumed to reflect the overall very low catch level represented by the pushnet fleet. Banning a marginal activity cannot be expected to have major overall effects.

Avoiding the harvest of juveniles by banning all small mesh sizes would lead to a marked decrease in overall catch level (to 50%), while the value of the catch would only decrease marginally (4%). Overall the reduced catches of small fish would not lead to any marked improvement in the state of the system, indicating that such a measure is inadequate to change the gross overfishing in the Gulf of Thailand. Time constraints did not allow the use of ECOSPACE to analyse some of the other proposed management measures, such as an expansion of the non-trawl zone.

The results of the ECOPATH analyses tally broadly with those of the Gordon-Schaefer and BEAM 5 models and indicate gains from a reduction in fishing effort. Indeed, all models indicated a severe over fishing of the demersal resources in the Gulf of Thailand.

This has been the first time that concurrently three different modelling approaches were applied to the Thai demersal fisheries in the Gulf of Thailand (and perhaps to any other fishery). The outcome has proven the worth of such a combined effort. However, in a future similar exercise, greater care should be taken in ensuring the consistency of data sets applied in all three modelling exercises. This would certainly require the allocation of more preparation and workshop time to do justice to the complexity of the task.

It should also be noted that one of the objectives of the workshop was to train the participants in the use of the different models. It was also the first application of BEAM 5 in the tropics. Therefore, it is likely that a re-assessment and a revision of the results of this workshop will be required in the near future. Following the practice in other large management areas, such revisions should preferably be undertaken annually or bi-annually, taking into account new data and information and making better use of the new knowledge gained by the participants.