ECOSYSTEM APPROACH AS A TOOL TO ANALYSE CONFLICTS BETWEEN SMALL SCALE AND INDUSTRIAL FISHERIES IN THE RED SEA

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As in many cases of resources exploitation, I have witnessed many conflicts between the small scale artisanal and the industrial fisheries in my research experiences in the Red Sea. During formal and informal interviews with fishermen of both categories and managers, I learned the details of the blames put by each group to the other. The artisanal fisheries blame the industrial for taking too much fish and a lot of discarding which they claim is the main cause for the decline in the resources, damage of their fishing gears and destroying the habitats the artisanal fisheries had fished for centuries before the industrial fisheries came. On the other hand, the industrial fisheries blame the artisanal for lack of efficiency and not contributing enough to the national economy, which they claim they could achieve. Talking to policy makers and managers, they acknowledge the pros and cons of each sector and their decisions are swayed based on specific circumstances, usually political. They use lack of knowledge of the ecosystem and data as an excuse for not making the most sustainable decisions. So, the objectives of this research are: to model the Red Sea ecosystem as a whole, starting from primary producers to top predators, including humans as part of the system, and their trophic interactions. Second, to objectively quantify the effects of each fishing sector on the ecosystem and on each other through trophic interactions of the organisms they target. The end product will be the resource map of the Red Sea ecosystem, which can be used in ecosystem based management. This research does not intend to give any final prescription to the debate between the sectors or the conflict between them due to habitat destruction. The latter is, relatively, well considered by the managers and almost every Red Sea country has regulations, at least in paper, to separate areas for artisanal and industrial sectors. For example, trawlers are not allowed to operate close to the shores and islands where coral reefs are abundant, the main fishing grounds for artisanal fisheries. However, the enforcement of this regulation is not strong.

The artisanal fisheries, which account for 70% of the total landing (52,700t/year) (Sheppard, 2000), are typical tropical fisheries, multi-gear and multi-species. Most of the fishery is done by wooden boats of size range between 5 – 18 meters, locally called ‘Sambuk’ and ‘Houris’. Sambuks are bigger in size and have inboard engines. Houris are smaller and use outboard engines. Both Sambuks and Houris use similar fishing gears namely hand-lining (targeting mainly coral reef fishes such as snappers, groupers and emperors) and gill net (for large pelagic fishes such as mackerels and tunas). The main differences in the operation of Sambuk and Houri are length of the fishing trip, crew size and capacity. Some fishers walk to the shore or use canoes for a day trip to catch fish in the shallow waters. The catch of artisanal fisheries is mainly for subsistence and local market. A small proportion is exported usually through merchants. The industrial fisheries operate trawlers for demersal fishes (with the main target being the lucrative shrimp), purse seines for schooling pelagic fishes and long lines. They are mainly owned by foreign companies and operate in a joint venture with economically and politically influential local businesses. Their market is almost exclusively for export.

The approach used to tackle the above objectives was ecological modelling integrated with local ecological knowledge (LEK). Ecopath with Ecosim (EwE), a modeling tool originally created by Polovina (1984) and later developed at the Fisheries Centre, University of British Columbia, was used. It is a system of accounting the energy transfers in an ecosystem. Its basic theory is that energy can be transferred from one group to another in an ecosystem, however the overall resultant energy is zero or close to zero in an arbitrary duration (Polovina, 1984; Christensen and Pauly, 1992).

Quantitative ecosystem models generally require a lot of data. Data for the Red Sea were collected from two, each a year long, field trips in 2004 and 2006, previous researches of the author in the area, published scientific papers, reports, dissertations, magazines, unpublished materials and anecdotal sources. Data depositories such as FishBase, FAO and Sea Around Us project (www.seaaroundus.com) were also used. Effort was made to collect data as much as possible from the Red Sea; however, when they were not available from the Red Sea, they were burrowed from similar ecosystems and explicitly described as such. These parameters are mainly life history data such as growth rate, consumption, maximum length, which are generally similar for the same species. Because EwE uses mass balanced equations (i.e. the net is zero), if one of the input parameters was missing, it was estimated by the model. Catch and effort data, including unreported catch, were reconstructed and entered to the model. The Red Sea can be categorized as a data poor area; however, a lot of information is available in people's memory. So interview was used to complement the data collection. Interview also helped to understand the perception of the fishers which can be an important tool in designing policy. 412 fishers, age range 12 – 83, were interviewed, using semi structured questionnaire, from Sudan, Eritrea and Yemen. A time series of catch per unit effort (CPUE in kg/day/crew) was calculated from the interviews and, changes in the species composition of catch and fishing grounds through many generations were also studied.

The Red Sea, a subtropical system, has high diversity. There are more than 1000 species of only fish (Froese and Pauly, 2010). It is not practical for each species to be represented by itself in the model; hence grouping of similar species was necessary. To do the grouping objectively, cluster analysis was done using parameters which affect the energy flow: trophic level, size (asymptotic weight, log W_{∞}), habitat, and von-Bertallanfy growth parameter (K). Once the organisms were grouped by cluster analysis, special consideration was given to the economically important species, which appear often in catch. In order to be able to see the changes to them due to fishing, they were put as separate groups by gear type, which were 4 species for gill net, 10 for hook gears, 8 for seines and 4 for trawlers. These species accounted for more than 75% of the retained catch.

Ecopath gave a snapshot of the Red Sea ecosystem at one fixed time. Ecosim (Walters et al., 1997) on the other hand, is time dynamic and can be used in prediction and policy exploration. A mass-balanced Ecopath model (i.e. a model which fulfilled the basic principles of ecology) of the Red Sea was used for Ecosim runs driven by fishing mortality. Biomass of the major species fished predicted by the model was fitted to the time series of CPUE reconstructed to validate how close the model could imitate the reality. The model which had the least sum of squares was used to predict the consequences of different objectives and scenarios. The four major policy exploration facility in EwE are: maximize fisheries rent (economic), social benefits (such as employment and food security), mandated rebuilding of species and ecosystem structure or "health" (Christensen et al., 2000). These policy objectives were explored separately and their combinations by assigning different weights. The optimal scenarios for the objectives were studied by allowing a range of fishing possibilities from open access to complete closure of fisheries and different combinations of the various fishing sectors. The simulation exercises also showed the trade offs during changes in the policy objectives or the fishing sectors.

The model simulation results showed the current level of fishing mortality by the different gears in relation to the effort level for maximum sustainable yield (Fmsy) as calculated by the model. The model did not show any evidence for the decline of artisanal fisheries catch due to increase in industrial fishery effort and trophic interactions of the species targeted by each sector (Figure 1). However, caution should be made that this model did not investigate the spatial habitat destruction by the fishing activities.

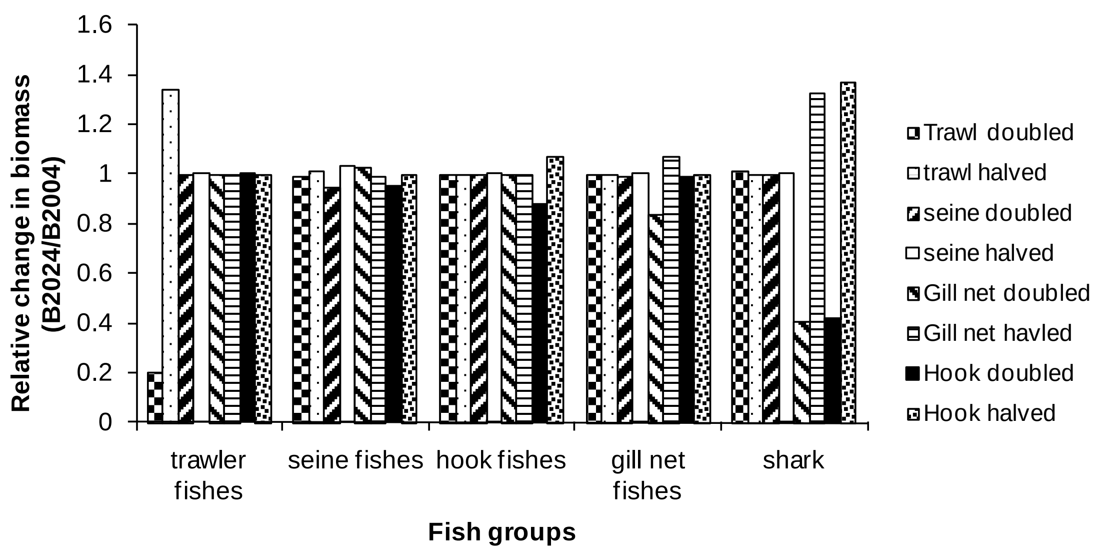

Figure 1: Change in the biomass of different groups of economically important species due to change in the effort of the various fishing gears.

Figure (2) shows what will happen to the biomass of fish groups targeted by different gears if a weight of 2 is given to social objectives, 1 for economic and 1 for ecological. This combination of weight to different objectives is very realistic for the area, i.e., this will reflect if the policy is to maintain the statuesque. This result is in line with the results obtained from interviews where shark fishery was the one that experienced the highest rate of decline based on knowledge from the fishers.

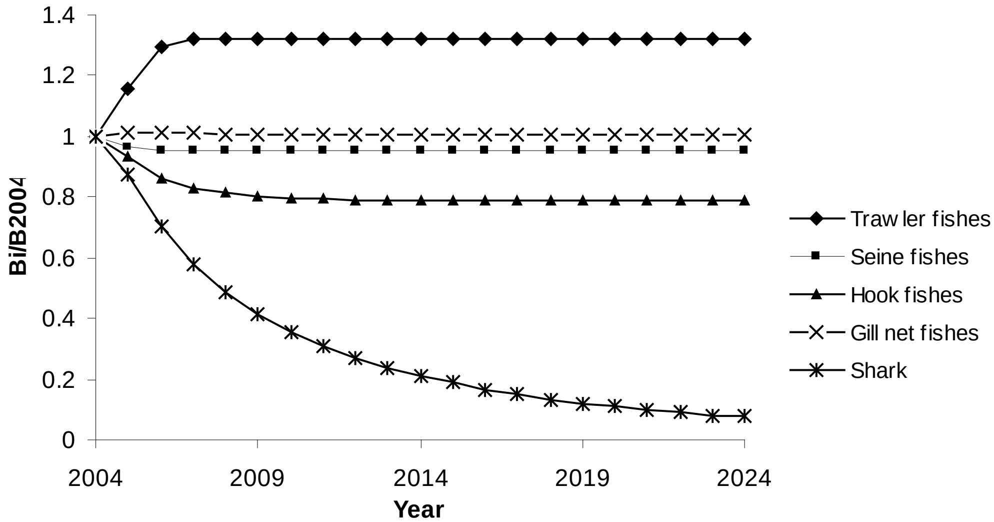

Figure 2: Relative change in biomass as a proportion of 2004 due to fishing policy where social is given the weight of 2, economic 1 and ecological 1.

The main results of the interviews can be summarized as more than 75% of artisanal fishers blame industrial fisheries for the decline in their catch. A significant decline in catch rate of all the fishing gears; proportionally the decline in the shark fishery was the highest. It also revealed that 39% of the actual catch is not reported at all. The majority of the unreported catch is the amount taken by the crew to their families and given to friends before landing. This amount could not be captured by any kind of data recording system put in place by the fishery administrations of the countries. In addition, the interviews clearly showed the decline in the number of species, usually top predators, which were dominant in the catch over time; and the decline in the abundance of fish in the fishing grounds near the fishing ports and the continuous displacement from nearby fishing grounds to further and further grounds. The perception of this change varies through different generations of fishing communities, which is a clear indicator of the shifting baseline syndrome (Pauly, 1995).

The ecological model together with the local ecological knowledge was able to clearly show what will happen to the sustainability and diversity of the Red Sea ecosystem and the livelihood of the communities under different scenarios. Most of this knowledge may not be completely new; however, in this research I was able to quantify the tradeoffs with explicit uncertainty values. The results can be used to guide the policy in ecosystem based management in the presence of political will to make informed decision.

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