Yellow Sea Large Marine Ecosystem Project

Activity Title:	Multi-factor management of Fisheries, Mariculture & Pollution Discharge
Lead Organisations:	Yellow Sea Fisheries Research Institute (YSFRI), China West Sea Fisheries Research Institute (WSFRI) & West Sea Mariculture Research Center (WSMRC)

State of the Yellow Sea Fisheries

The over-capacity in the Yellow Sea fishing fleets and the resulting over-exploitation of fish stocks is reported in the Yellow Sea Large Marine Ecosystem (YSLME) project's Transboundary Diagnostic Analysis (TDA) and supported by the scientific literature. The impacts of over-exploitation are reflected in: the change in fish catch composition from large, valuable demersal fish to small, cheap pelagics (Fig.1); the simplification of the age structure of exploited species with the majority of the catch being 1 year old or less so that catches are dependent on that years recruitment; reduction in the trophic level of some species; the 40% decline in biomass between the 1960's and 1980's; and reduction in the mean size at maturity.

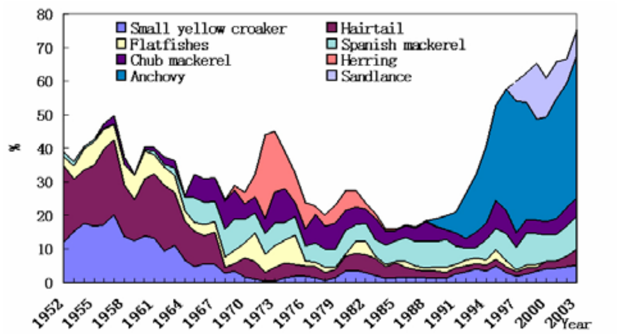

Fig. 1: Yield (%) of 8 commercially important fish species.

Ecosystem-based management and the SAP

However, fish stocks are also impacted by changes to the ecosystem that influence food supplies, water condition, habitat for spawning and nursery, and water temperature. Increases in pollution, coastal eutrophication and degradation of coastal habitats, reclamation and conversion of coastal areas (identified by WWF as critical for biodiversity conservation) and climate change are all impacting the ecosystem.

This is why the YSLME project's Strategic Action Programme (SAP) is promoting a science-driven ecosystem-based approach to managing the environmental problems. The SAP's primary objective is to protect the ecosystem services (provisioning, regulating, cultural and supporting services) in order to maintain standards of living for the huge coastal population.

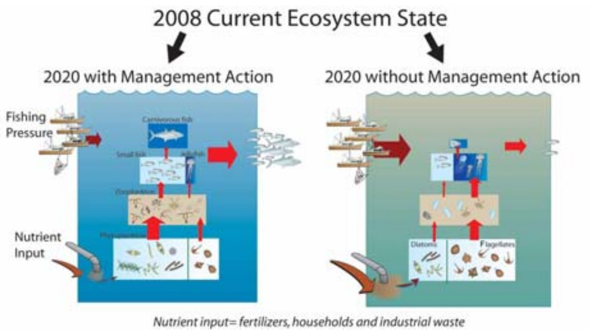

Fig. 2: Simplified state of ecosystem with & without management actions.

Therefore, to protect fish stocks the SAP also has targets to reduce in pollution and habitat reclamation, as well as aiming for a 25-30% reduction in the Yellow Sea fishing fleets (Fig. 2). Both China and R. Korea have made enormous progress and millions of dollars have been spent in boat buy-back programmes.

However, this reduction in fishing effort may impact fish catches at least in the short term until stocks recover, leading to a potential shortfall in fish protein. To compensate and ensure food security, mariculture will have to increase production. In addition, the growth in population and increase in wealth is expected to swell demand and the YSFRI recently suggested that mariculture needs to almost double production to

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25 million tonnes by the year 2020 (Fig. 3).

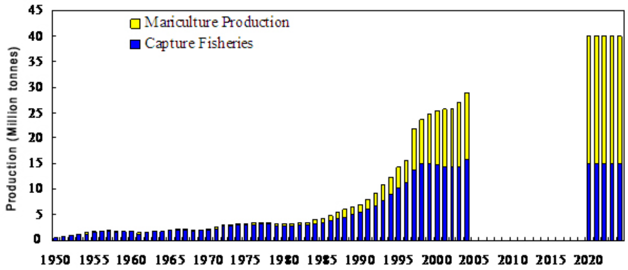

Fig. 3: Projected Chinese mariculture and fisheries production (Wang Q. 2nd Regional Mariculture conference).

However, unless the expansion is carefully managed, mariculture can have a number of environmental impacts such as eutrophication and spread of diseases. To this effect the YSLME project is demonstrating two mariculture techniques that can be used to boost production at the same time as decreasing impacts.

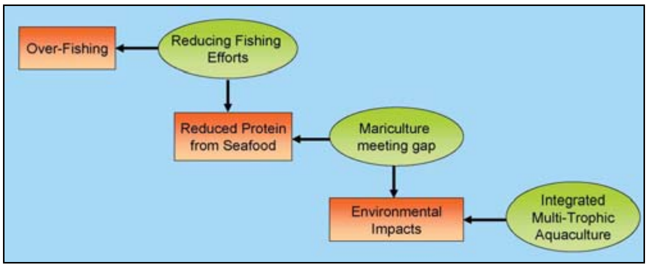

Fig. 4: Adaptive management in the fisheries sector.

So, to rephrase, to solve overfishing, the SAP proposes a reduction in fishing effort, this may cause a temporary shortfall in seafood, the demand for which mariculture will have to meet, but unsustainable production causes many environmental impacts, therefore two sustainable systems are demonstrated (Fig. 4).

Demonstration Activities

Integrated Multi-Trophic Aquaculture (IMTA)

IMTA is a type of polyculture that maximises production by culturing species from different trophic levels together so that the waste products of one species are utilised by another, and by using the 3 dimensional space. In Fig. 5 the suspended particulate organic material from the fish culture is removed by the filter feeding mussels, the dissolved inorganics are used by the macro/micro-algae that produces oxygen and any material that settles on the bottom can be utilised by the detritivores, eg. sea cucumber. In different areas of Sanggou Bay in Shandong Province, a number of different IMTA systems are being trialled by YSFRI to increase sustainable production. Carrying capacity models are also being used to optimise culture densities to the available resources (eg matching density of filter feeders to the available food) this significantly enhances production as growth and survival are improved while reducing impacts.

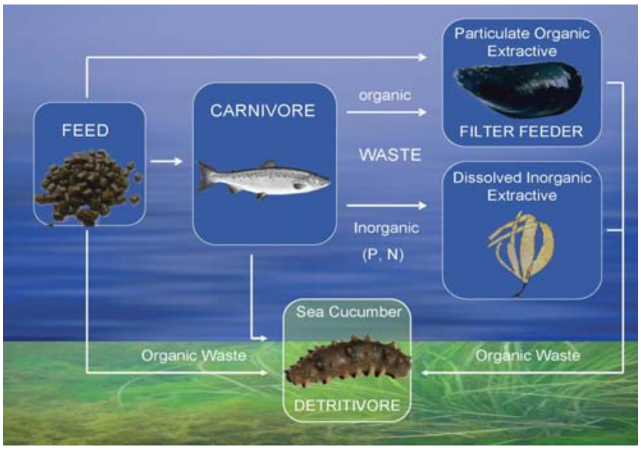

Fig. 5: Integrated multi-trophic aquaculture concept.

Heterotrophic Shrimp Culture

Even with the bad reputation of shrimp culture, due to the destruction of coastal habitats and the release of nutrients, chemicals and pathogens into the wild, the demand continues to grow. In contrast to the normal semi-intensive culture systems, heterotrophic culture offers a highly productive environmentally friendly alternative. The WSMRC is trialling zero water exchange systems, heterotrophic bacteria are used to recycle shrimp waste and excess food, these bacteria form flocs, kept in suspension by high aeration, that are eaten by the shrimp. This has many advantages: no nutrients, pathogens or chemicals are released; water quality is more stable than the semi-intensive algae dominated systems; the recycling of nitrogen by the bacterial flocs means there are high feed conversion ratios therefore less fishmeal is required for feeding; the high density and high survival means that production can be more than 70 times that of average shrimp ponds in R. Korea.

Future

These culture systems may not suitable for all areas, but through workshops and conferences the YSLME project is promoting the exchange of ideas that will ensure increased sustainable production through advances in disease control, dietary improvements, selection for disease resistance and growth characteristics and offshore culture.

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