SPEAR

Sustainable options for people, catchment and aquatic resources

The Challenge

The impact of fish farming on the environment has been the subject of a large number of studies during the past two decades. Many of the negative environmental impacts have been reduced as a result of better farming practices, improved feeds and the location of fish farms in more exposed areas. Furthermore, a number of precautions have been taken to manage the environmental impact, including assessment through standardised monitoring programmes and the use of simulation models. China is the largest aquaculture producer in the world –two thirds of all aquaculture products in the world originate from China – however, most of this aquaculture is not sustainable.

Two contrasting aquaculture systems in China were studied: Sanggou Bay, part of a rural watershed, and Huangdun Bay, located in an industrialised area south of Shanghai. In both systems, large-scale cultivation of seaweeds, shellfish and finfish are important for community income and livelihoods.

Project Objective

SPEAR aimed to develop and test web-based modelling tools to assist aquaculture producers make their products more sustainable. This integrated framework will take into account watershed interactions, the ecological structure and human activities in the catchment. An interdisciplinary approach combines natural and social sciences, and addresses the complex scaling issues inherent in integrated management.

Key Points

When the models are combined they can be used to assist the aquaculture manager in decision making with regard to

- positioning of an aquaculture system
- optimum density and stocking required
- day-to-day management of the facility.

The models take into account all the physical, hydrological, biological and chemical elements in the ecosystem and can be used in the development of catchment management plans to ensure responsible and sustainable aquaculture.

Aquainnova

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EATiP *Thematic Area of Relevance*

TA1: Product Quality, Consumer Safety and Health
TA2: Technology and Systems
TA3: Managing the Biological Lifecycle
TA4: Sustainable Feed Production
TA5: Integration with the Environment
TA6: Knowledge Management
TA7: Aquatic Animal Health and Welfare
TA8: Socio-Economics and Management

Key Words

Shellfish, Aquacutlure, model, monitoring, production, sustainable, Catchment management.

Project Information

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Output Highlights

New technology
Three software modelling tools were developed and are as follows.

- MARKET Model - Modelling approach to resource economics decision making in eco-aquaculture
- FARM model - Farm Aquaculture Resource model that simulates processes at the farm-scale
- MOM model - Modelling - Ongrowing fish farm - Modelling

MARKET Model
A modelling approach to resource economics decision making in eco-aquaculture or MARKET model. The MARKET model was developed as a scenario-testing tool to provide insights on the ecological and economic interactions, which is a critical issue for sustainable aquaculture management.

FARM Model
The FARM model simulates processes at the fish farm-scale, by integrating a combination of physical and biogeochemical models, shellfish and finfish growth models and screening models for determining optimal production, income and expenditure. The model also incorporates a eutrophication assessment and a nutrient emissions trading by means of a mass balance analysis.

MOM model
Model simulations and monitoring are both essential parts of a management system called Modelling—Ongrowing fish farms—Monitoring (MOM), which can be used to regulate the environmental impact of fish farming. This model estimates the holding capacity of fish farming sites and is expressed in terms of maximum fish production per month.

The Full Report:
For a comprehensive description of the research project and for a copy of the final report, visit http://www.biaoqiang.org/

Next Steps – Suggested Actions/Follow On

RTD

- The MARKET model can be widely applied, provided that case specific information exists on shellfish demand, price, income production functions, physical area available for cultivation, and environmental conditions that have an effect on the growth of aquatic resources and are affected by its production. It is recommended that future MARKET model developments include: (i) an improvement of the decision model, in particular for decisions by farmers about changes of production level, (ii) explicit dynamic coupling with an ecosystem model, and (iii) implementation for other aquaculture species and culture practices, especially those that normally raise more concerns related with environmental management, such as finfish monoculture.

Policy

- Outputs of FARM may be used to analyse the farm production potential and profit maximization according to seeding densities and/or spatial distribution. FARM results may be used by farmers to analyse farm production potential and by managers for environmental assessment of farm-related water quality impacts, whether positive or negative. It is a useful tool for all stakeholders for the valuation of nitrogen credits and ultimately the development of integrated catchment management plans.

RTD/Policy

- The MARKET model allows for an integrated dynamic analysis of (i) the demand for mariculture products, (ii) economic production and cost limiting factors, (iii) the biological growth of aquatic resources, (iv) interactions with the environmental conditions and (iv) the spatial limitations of culture in coastal ecosystems. This approach can contribute to mariculture management and assist in the implementation of an ecosystem approach to aquaculture (EAA).

Environment

- The MOM model provides the farm manager with a mean of regulating the impact the fish farm has on the environment. The holding capacity of a site is estimated while ensuring that three basic envi-

ronmental requirements are met:

(i) benthic fauna must not disappear as a result of accumulation of organic material;

(ii) water quality in the net pens must be kept high;

(iii) water quality in the surrounding areas surrounding must not deteriorate.

All these requirements must be fulfilled, and the holding capacity is determined by the lowest of the three estimates. The fulfilment of requirements (i) and (ii) depends on local environmental properties such as water depth, the annual temperature cycle and the vertical distribution of current properties, and concentrations of oxygen and ammonium. It also depends on the maximum fish density per unit area, so the physical configuration of the farm is of importance. All these factors as well as feeding rate and feed composition are taken into account in the model.

- Simulation models are needed for rational coastal zone planning and for estimating the holding capacity of sites for fish farming. They are useful tools for maintaining high water quality in net pens and for evaluating how changes in farm management are likely to affect surrounding areas. By deciding which fish to choose, when, how much and what to feed them farmers can ensure that water quality is not negatively affected and production is sustainable in the long term.

Related Publications/Projects

A comprehensive list of publications can be downloaded from the project website http://www.biaoqiang.org/