Cover: Haiko, Pingtung, Chinese Taipei.
Photo: W.Y. Chiau

APEC Bulletin on Marine Resource Conservation and Fisheries
November 2004 VOL. VI No. 4

Publisher
Dr. Juu-en Chang, Minister
Environmental Protection Administration
Chinese Taipei

Supervisor
Dr. Gwo-Dong Roam, Director General
Office of Science and Technology Advisors
Environmental Protection Administration
Chinese Taipei

Editor-in-Chief
Dr. Wen-Yan Chiau
Department of Marine Environment and Engineering
National Sun Yat-sen University
Chinese Taipei

Assistant to the Editor
Yu-Yang Lin,
The Foundation of Ocean Taiwan
Chinese Taipei

This Bulletin on APEC MRC and Fisheries is available on the Website,
http://enix.epa.gov.tw/aboutvc.htm
For inquiries or subscriptions to the printed or the CD Version,
please contact:

APEC Bulletin on Marine Resource Conservation and Fisheries
Environmental Protection Administration
Office of Science and Technology Advisors
41, Sec.1, Chung-Hwa Road, Taipei, Taiwan
Tel: 886-2-2311-7722 ext. 2203
Fax: 886-2-2311-5486
Email: shiuan@sun.epa.gov.tw

Printed By
The Foundation of Ocean Taiwan
301-1 Pei-Ning Road, Keelung 202
Taiwan
Tel: +886-7-525-5166
Fax:+886-7-525-5167
Email: chiauyw@mail.nsysu.edu.tw

Status of Marine Aquaculture in Chinese Taipei and An APEC Pilot Study for Assessment of Environmental Carrying Capacity and Development of Risk Assessment Methodologies and Guidelines for Use in Sustainable Marine Aquaculture

Wen-Yan CHIAU[1], Chiu L. CHOU[2], and Yi-Che SHIH[1]

[1] Department of Marine Environment and Engineering,
National Sun Yat-sen University, Kaohsiung 804, Chinese Taipei

[2] Bedford Institute of Oceanography, Marine Environmental Sciences Division,
Department of Fisheries and Oceans,
P.O.Box 1006, Dartmouth, Nova Scotia, Canada B2Y 4A2

Status of Marine Aquaculture in Chinese Taipei

The total length of coastline of the Chinese Taipei Area is about 1,600 km, while the total area of shallow seas less than 30 m deep and adequately suitable for marine aquaculture reaches 300,000 ha. With the depletion of coastal fisheries resources and good prices for cultured fish, marine cage aquaculture is becoming popular in areas where land and freshwater resources are limited.

Marine aquaculture or cage aquaculture in Chinese Taipei started in 1977 in the Penghu archipelago in southwest Taiwan. The pilot project was initiated by the Penghu Seafood Experimental Institute, a subordinate agency of the Council of Agriculture.

With the progress of related technologies in 1988, the Institute promoted and assisted the local fishermen to develop this brand new industry. In 1995, a large scale of marine aquaculture could be found in the seas in both Penghu County and Pingtung County. Currently, the major marine aquaculture farms are located in Western Taiwan (i.e., Penghu and Pingtung) while some are scattered in Eastern Taiwan (i.e., Yilan, Hualien, Taitung). The most popular cages are HDPE type from Norway. Nevertheless, these types of cages are vulnerable to typhoons. Experts from fisheries research institutions and academia are conducting research to develop a new type of cage that can be submerged during strong winds and typhoons.

Major species cultured in cages are cobia, spangled emperor, mangrove red snapper and grouper. Among the many species of cultured marine fish, cobia is a prominently popular species for cage aquaculture because of its fast growth rate and comparatively low production cost. Cobia, *Rachycentron canadum*, is widely distributed in

tropical and sub-tropical waters, and has been cultured as a recreational fish species. The fish can grow up to 6 kg during their first year and over 15 kg for their second year. The largest cobia can reach 1.5 m in length and over 40 kg in weight. In recent years, its potential for aquaculture was recognized because of its quality of meat. In Chinese Taipei, cultured cobia has become popular for domestic consumption or for export, mainly to Japan. Marine culture began in the early 1990's when the technology of mass fry production was developed. To date, several marine fish hatcheries are producing cobia fingerlings to stock in nursery tanks or inshore cages. Total cobia production increased from 1,800 mt in 1999 to 3,000 mt in 2001, but plunged to 1,000 mt in 2002 due to high incidence of disease outbreaks and losses from typhoon damage (Liao, 2004).

In 1994, the total production of cage aquaculture was 150 mt (metric tones) and the figure increased from 357 mt (or NT$ 29.3 million) in 1995 to 5,576 mt (NT$ 1 billion) in 2002. In 2002, the total area of cage aquaculture was 1.79 times of that in 1995. The most impressive development is that the total value of cage aquaculture increased 36.1 times since 1995. With the exception of loss resulting from typhoons and cold weather, production of cage aquaculture remains stable (Liao, 2004).

Marine cage culture is popular in Chinese Taipei but regulations for open ocean aquaculture are still lacking. As cobia cannot survive below 16°C, most of the sea cages are located in southern Taiwan where tropical climate prevails. These areas, however, are also utilized for fishing and other purposes, thus competition for available sea area is apparent. The government plays an important role in the overall development of the cobia culture industry. However, the current policy on aquaculture is inappropriate for cobia cage culture industry. Aside from disease outbreaks and some environmental problems, the lack of good planning and regulatory enforcement when cobia was developed as a potential aquaculture species has led to non-sustainable production in the past few years. Some policies even hinder further development of cobia culture in offshore cages. Thus, Chinese Taipei loses international competitive advantage for the export industry among other Asian countries, who are venturing into cobia cage culture.

Technical tour to a cobia farm at Chukung, Pingtung, Chinese Taipei.
Photo:W.Y. Chiau

With the high risk associated with offshore cage aquaculture, the lack of insurance policy from the government is of serious concern for most cage farmers.

Although aqua farmers in the Taiwan Area face many disease and environmental problems, cobia remains to be the most popular species for culture in offshore cages. This is because of its fast growth, high market value, good meat quality, the established technology in mass production of larvae, the current innovation in intensive and super-intensive nursery rearing in tanks, and improved formulated feeds. However, the lack of regulations in open ocean aquaculture in Chinese Taipei has resulted in the uncontrolled proliferation of sea cage farms. Disease outbreaks still remain to be the biggest threat in marine and cobia culture in Chinese Taipei, causing a significant decline in total production in 2002. At present, research on the development of vaccines against major bacterial pathogens (*P. damsela subsp. piscicida, V. alginolyticus, and Streptococcus sp.*) is ongoing. Another alternative approach to this problem is the use of immunostimulants (e.g. *-glucan, levamisole,* etc.) to enhance the nonspecific immunity of fish to various diseases. Stocking of more resistant large-sized fish in offshore cages also contributed in preventing apparent loss of stocks due to diseases. Disease surveillance must also be strengthened and continuously undertaken to monitor disease outbreaks. Moreover, selective breeding must also be urgently employed for improving both growth and resistance to diseases.

With the recent developments in both nursery and grow-out culture of cobia, improvements in many aspects of production are still needed. Automation in terms of feeding, grading, thinning, harvesting, and net washing still requires development as these activities are highly labor

Cobia, a major species cultured in Penghu, Chinese Taipei.
Photo: W.Y. Chiau

intensive especially in offshore grow-out cages. The recent innovation of the intensive and super-intensive recirculating system for nursery rearing can only be applied to rearing cobia juveniles up to 300 g. This system allows the transfer of cobia juveniles directly into offshore nursery cages in the same area where the grow-out cages are located. This strategy prevents the occurrence of high mortality due to transportation stress of large-sized cobia. However, this system might be too expensive for many fish farmers since high investment is necessary to set-up the facilities. Therefore, other strategies in mass-production of cobia juveniles during the nursery stage need to be developed. One possibility is to culture cobia in ponds under a semi-intensive or intensive system. If this is successful, however, transportation problems will still be an issue to be resolved.

It is important to maintain the health of the marine environment and the competitiveness of the aquaculture industry in Chinese Taipei. Recommendations are provided as follows:

- It is necessary to develop a fundamental policy of marine aquaculture in Chinese Taipei that will fit its characteristics and the carrying capacity of the marine environment in order to provide a direction for future development based on sustainability.
- It is important to revise the Fisheries Act so that it can provide enough sea area for aquaculture development and a sound operation environment for the aquaculture industry. The location, scale and future development of marine aquaculture should be included in the integrated coastal management plan.
- The scale of marine aquaculture must take the environmental carrying capacity into account. Due to the limitation of available seas for aquaculture, its major production should meet the demand of the domestic market instead of pursuing the economic benefits of export. Without careful consideration of the marine environment, the unlimited export of seafood production will rapidly deplete natural resources and result in the deterioration of the marine environment.
- It is essential to conduct studies on the methodologies of carrying capacity and risk assessment on aquaculture seas. APEC or relevant international organizations are recommended to encourage and support members that are interested in conducting joint projects on aquaculture research.
- Information exchange and multilateral cooperation and collaboration on marine aquaculture are essential and benefit all members of APEC.

Concluding Remarks

Marine aquaculture has its potential to be one of the most profitable industries in the world. It is believed that this promising industry will also play an important role in seafood production in the future. However, the environmental aspects of marine aquaculture must be taken seriously. In this regard, countries concerned shall develop sound policies, laws and principles for the future development of the industry. More research on marine aquaculture and international cooperation and information exchange on the issues are necessary to achieve a sustainable marine environment.

Assessment of Environmental Carrying Capacity and Development of Risk Assessment Methodologies and Guidelines for Use in Sustainable Marine Aquaculture – A Pilot Study in Chinese Taipei

Project Design

- It has been a general assumption that the marine environment has a certain assimilative or environmental capacity. This presumes that all environments have a finite ability to accommodate exploitation or contamination without unacceptable consequences. Thus consent to discharge of pollutants can only be given based on the condition that careful monitoring is carried out to ensure that the assimilative capacity is not exceeded. However, studies on or attempts to model the impact of aquaculture or some other industrial development are often undertaken well after the development activity is established. By that time, the economic commitment by the private and public sectors is too great to substantially change the path of development if monitoring results demonstrate adverse environmental effects. If the tools of scientific modeling are to be

used meaningfully, they must be used prior to development. Therefore, the project is designed to resolve all these concerns. It is imperative to develop an appropriate methodology to assess the environmental risk related to net-pen aquaculture activities in the marine environment. The objectives of this project are to investigate: (1) the environmental capacity for understanding the cumulative effects of aquaculture wastes; (2) the method for detecting the eco-response and the changes of the marine environment from the aquaculture operation; (3) the use of indigenous species and sediments from the cage to quantify the distance of impact; (4) the guidelines or environmental quality standards for the marine farming industry to assure the sustainable use of marine environment. The information and knowledge for achieving the project goals will be gathered through literature searches and on-site data collection with co-laboratory research at the National Sun Yet-sen University of Chinese Taipei. At the final stage of this research, the aquaculture-specific guidelines for ecological monitoring for risk assessment will be established. The success of this project will be determined by measuring the achievements of designed objectives at each stage.

- The project responses to the 1997 "APEC Action Plan on Sustainability of the Marine Environment", the 2000 "Action Strategies and Work Programs," and the "2002 Seoul Declaration of APEC Ocean-related Ministerial Meeting" are to advance member economies' objectives of sustainable use of the marine environment.

- The purpose of this project is to collect necessary information and to establish guidelines for marine aquaculture in the APEC region. All member economies, and especially their aquaculture industry, will benefit from the final result of this research.

- The deliverables of this project include: (1) to identify the main activities associated with the marine phase of fish aquaculture production, the pathways or connections to the environment of the various activities and the potential effects of these activities on the environment and its associated wildlife; (2) to estimate the total solid waste entering the marine environment from marine aquaculture production in studied areas; (3) to collect data of ecosystem parameters including tidal exchange, sediment transport and other physical processes, and biophysical functions (e.g., wetland and other habitats, populations of

A temple for Gods safeguarding the Ocean in Donggang, Pingtung, Chinese Taipei.
Photo: W.Y. Chiau

Cobia aquaculture in Penhu, Chinese Taipei.
Photo: W.Y. Chiau

flora and fauna, fish habitat, etc); (4) *to conduct cumulative environmental effects assessment (e.g., identification of regional issues of concern; a comprehensive description of how aquaculture sites were selected; a clear justification for the spatial and temporal boundaries used to address cumulative effects; a clear description of the analysis undertaken to assess the cumulative effects on the selected aquaculture sites, and presentation of the results; the rationale for determining whether residual cumulative effects on aquaculture sites are significant); (5) *to quantify the impact distance by studying the accumulation of chemical wastes in indigenous species (or non-target organisms) living near aquaculture sites; (6) *to develop an environmental monitoring program for assessing sediment conditions (normal, hypoxic, and anoxic) related to fish aquaculture activities; (7) to review and search literature or publications for physical circulation models, new chemical and biological methods, and environmental data and habitat management questions relevant to predicting potential environmental effects of fish aquaculture; (8) *to determine thresholds for assessing assimilative capacity in marine sediments; (9) *to model the prediction of environmental effects. The collected information and research findings can serve as a good reference to the aquaculture business of all member economies targeted as beneficiaries (Note: * need research and resources including special funding to carry out this work).

- Chinese Taipei will circulate research information to the business/private sector and non-governmental institutions for their comments. The discussion of related topics will be included in the annual roundtable meeting held in Chinese Taipei. In addition, the establishment of the final guidelines will also consult with the business/private sector and some economies in any feasible way.

- The project will encourage involvement of the business/private sector, advance member economies' objectives of sustainable use of the marine environment, as well as encourage investment from the private sector in the region. It will certainly add APEC value and could serve as a reference model for implementing any other project in the region.

- The project is expected to provide valuable information to related projects or activities on aquaculture development in the APEC region.

- This project requires several years to complete, because of the involvement of laboratory research for collecting the data identified in item 5 of the Linkage section. As pointed out, the objective is 1) to develop an appropriate methodology to assess the environmental risk, and 2) to establish the aquaculture-specific guidelines for monitoring the impact related to net-pen aquaculture activities in the marine environment. Through cooperation and collaboration with Oceans Canada, the pilot project will be implemented in Chinese Taipei and its minimum duration is three years. The research will be carried out with the support of Chinese Taipei in conjunction with the National Sun Yet-Sen University. The in-kind contribution from university includes a Ph.D. student, Prof. Wen-Yan Chiau and his staff, and laboratory facilities that will be at a total cost of $30K/year. The proposed research for achieving the goal of aquaculture guidelines that are useful for the APEC region is listed in the following attachment. Important results and information from this project will be presented and discussed at the annual roundtable meeting held in Chinese Taipei as well as disseminated by APEC Bulletin on Marine Resource Conservation and Fisheries published by Chinese Taipei.

Technical tour to Pingtung, Chinese Taipei.
Photo: Y.Y. Lin

Attachment

The assessment of the environmental capacity to assimilate wastes from net-pen activities, involves the following components:

- Effect of net-pen structures -- the number of fish produced per farm varies dependent on the depth of water and current speed at the site, the size of the site number of net pens.

- The distance separating individual fish farms in order to avoid environmental capacity problem.

- The direct impact of net pen structures on wildlife -- The simple presence of net pens in the water serves to attract and deter wildlife. Fish in the pens and excess or uneaten feed provide food for seals, birds, other fishes and invertebrates. The physical structures of the net pens may provide shelter for some benthic animals as well as present a physical or olfactory barrier to other species. Factors which influenced the magnitude and degree of interaction between farm fish net pens and wildlife include: farm size, age and net pen structure; size and species of fish raised: proximity to colonies or concentrations of wildlife; site management practices and the size and color of mesh used in predator nets.

- Release of uneaten feed and faeces - The quantity and composition of uneaten food and faces generated from fish farms depends on a number of factors including the type of feed (moist versus dry) number of fish per cage, health of the fish, frequency of feeding, type of feeding method (automatic versus hand feeding), and feed conversion ratios. Unlike terrestrial livestock operations, fish farms are not required to contain or manage feed wastes. In fish aquaculture operations, wastes discharged from the farm are deposited directly into the surrounding environment. The magnitude of the ecological impact of these wastes on the environment will depend on: (a) size of farm operation (number of net pens per operation); (b) density of fish per pen; (c) duration of farm operation on a particular site; (d) physical and oceanographic conditions associated with farm site; (e) natural biota of the region; and (f) assimilative capacity of environment.

- Geographic and current distribution -- The accumulation of solid waste (sediment) from fish farms can be restricted to just below the sea cage or up to 1.2km from a farm site. Area of low current velocity or depositional areas can make for poor aquaculture sites as the natural flocculation and depositional equilibrium tends to become unbalanced and leads to increased deposition of particulate material.

- Quantification of environmental capacity at aquaculture sites also involves both the environmental distribution and fate of contaminant discharge. The sources of potential risk at aquaculture farms are excess feed, excretory products and chemicals used both in the treatment of diseases, and as disinfectants, antifouling agents and cleansers. Data and knowledge of both the environmental and discharge characteristics are necessary in tracing the possible distribution of a contaminant from source to ecosystem. Approaches for monitoring near (at and around net-pens) and far-field effects are required to improve our understanding of the processes involved with aquaculture if we are to ensure environmental sustainability. These must include the following: (a) how appropriate indicators for predicting/monitoring changes to the environment, particularly in an ecosystem context can be determined, such as selection of bioindicators (captive and non-captive sentinel species, sediment, water, etc.); (b) how long term changes to the environment can be predicted/monitored using habitat characteristics and function (changes of productive capacity, displacement of fishing activity,

Photo: Y.Y. Lin

ecotoxicological effects, potential fish quality); (c) where monitoring should take place; near-field versus far-field effects; (d) what criteria are necessary for a healthy environment; (e) what are the coastal oceanographic characterizations; (f) what levels of thresholds for identifying the cause-effect relationship; (g) what type of cost-effective monitoring tools; (h) what modeling should be achieved for predicting environmental quality. All of the above criteria need to be investigated to establish the acceptability of environmental quality for sustainable aquaculture operations.

- Application of indigenous species for quantification of the impact distances can be an indicator for detecting changes of the environment for the aquaculture operation, which has been reported for invertebrate species (lobster, sea urchin, Chou et al., 2002). In the sea urchin study there was evidence of impacts to at least 75 m based on the intestine metal concentrations, and the sea urchins were capable of reflecting the sediment conditions of A (normal), B (hypoxia), and C (anoxia) observed at salmon aquaculture sites. This finding is contrary to Heinig's result (Heinig 2001) that influences from the aquaculture operations were generally confined to within 30 m of the salmon pens. This approach will be useful for establishing guidelines for aquaculture net-pen operations.

The research will be a joint project between Canada and Chinese Taipei. However, it will involve member economies interested in the project at and after the second stage of this research.

The project may be measured by the number of researchers, their substantial suggestions to the MRC WG and FWG as well as the future cooperation and collaboration of business/private sector within the APEC region. The quantitative and qualitative criteria for measuring the success of the project will include: 1) the exploration of the environmental capacity for understanding the cumulative effects of aquaculture wastes; 2) the development of method for detecting the eco-response and the changes of the marine environment due to the aquaculture operation; 3) the identification and the use of indigenous species and sediments from the cage to quantify farming industry impact; 4) the establishment of guidelines or environmental quality standards for the marine farming industry to assure the sustainable use of the marine environment in the APEC region.

References

Chiau, Wen-Yan (1998), Coastal zone management in Taiwan: a review. Ocean and Coastal Management 38, 119-132.

Fisheries Administration (2004), Fisheries information. Available online from web at www.fisheries.gov.tw

Liao, I Chiu., Huang, Ting-Shih., Tsai, Wann-Sheng., Hsueh, Cheng-Ming., Chang, Su-Lean., Leaño, Eduardo M. (2004), Cobia culture in Taiwan: current status and problems. Aquaculture 237 (1-4), 155-165.

Liu, Chi-Yuan (2002), The status of world cage aquaculture in 2000-2001. Seafood and Fingerling 49. Information available from web at http://www.fish.org.tw/chinese/magazine/magazine-49d.htm (in Chinese).

Aquaculture farm in Penghu, Chinese Taipei.
Photo: W.Y. Chiau

A Regression Model Using Sediment Chemistry for Evaluating Near-Field Effects Associated with Salmon Aquaculture Cage Wastes

Dr. Chiu L. Chou

Science Branch, Maritimes Region, Department of Fisheries and Oceans,
Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia, Canada B2Y 4A2

The Donggang Marine Laboratory, Pingtung, Chinese Taipei.
Photo:Y.Y. Lin

Abstract

This study was undertaken to develop an approach for modeling changes of sediment chemistry related to the accumulation of aquaculture waste. Metal composition of sediment Al, Cu, Fe, Li, Mn, and Zn; organic carbon and <63 µm particles were used to determine the extent of detectable effects around the cage. This study showed marked differences in the sediment chemistry between aquaculture sites and the natural background: 1) negative correlations between sediment Cu and Zn with Al, 2) poor correlations between metals and Li, and 3) concentrations of Fe and Mn decreased with increased accumulation of organic carbon. There are trends among normalized metals, organic carbon and particles related to normal, hypoxic and anoxic sediment conditions. The trends are useful for detecting and assessing the cumulative effects from aquaculture wastes to the marine environment. This approach, using the adjusted environmental monitoring program (EMP) rating based on sediment chemistry, yields a regression model with R2 = 0.945 compared to R2 = 0.653 for the regression model using unadjusted EMP for assessing the environmental conditions.

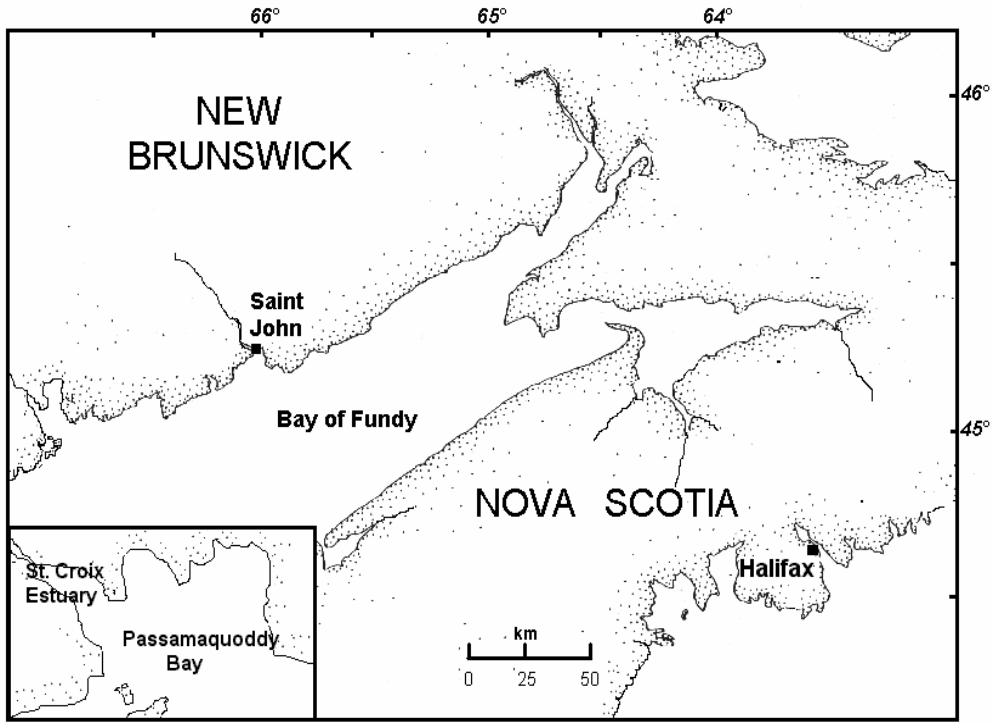
Introduction

Currently there are very limited approaches for assessing the impacts of aquaculture on sediment with the exception of the environmental monitoring program (EMP), implemented by the Department of the Environment, New Brunswick, Canada. EMP is based on sediment redox potential, sulfide concentrations, and video transects data for monitoring environmental effects of salmon aquaculture operations (DELG, 2000). The impacts are considered unacceptable when sediments become anoxic. There is a need for the development of more sensitive

tools and methods for detecting environmental effects of aquaculture and for determining what constitutes acceptable and unacceptable impacts. Other sediment chemistry indicators of environmental effects would assist in assessing the sustainability of aquaculture operations.

There are very few studies describing sediment chemistry as it relates to the deposition of wastes from marine aquaculture. The sources of wastes at salmon aquaculture farms are excess feed, excretory products and chemicals used both in the treatment of diseases, and as disinfectants, antifouling agents and cleansers. Wastes generated by net-pen operations typically include organic matter and nutrients from faeces and uneaten feed pellets, as well as trace metals used in feed ingredients. At aquaculture sites, the composition of the sediments is altered by aquaculture waste. Understanding the changes in sediment chemistry associated with the discharged waste from aquaculture activities would assist in the prediction of impacts and in sustainable use of the marine environment. One approach is to use environmental tracers. A tracer is a signature or fingerprint related to the environmental response resulting from the accumulation of enriched organic waste from aquaculture operations around the net-pen. The tracers could be additives in feed, organic carbon, metals, benthic assemblages, 14C, nutrients, medicinal treatments, etc. The objectives of this study are to:

- quantify the impacts from the aquaculture operations using sediment metals, organic carbon and <63 µm particles,
- select the proper factors for normalising the chemistry of sediments in and around the cage, and
- develop a statistical model for predicting the environmental monitoring program conditions of anoxic, hypoxic, or normal as they relate to aquaculture activities.



Passamaquoddy Bay, Bay of Fundy, Atlantic Canada

Materials and Methods

Sediment samples were collected by divers from under the cages (0 m) and at 50 m from the cage edge at 14 salmon aquaculture cage sites in Passamaquoddy Bay, southwestern New Brunswick (Figure 1). Sampling sites were anonymous in this report since the salmon aquaculture farmers only agreed to cooperate in the study without revealing their identities. The EMP ratings were assessed by divers on site following the environmental monitoring program guidelines as defined by the Department of Environment and Local Government of New Brunswick, Canada (DELG, 2000). Sediment samples were transported to the Bedford Institute of Oceanography for chemical analysis following the procedure of Chou et al. (2000). The principal components analysis (PCA) and regression analyses were carried out on the data using Systat 9 (SPSS Inc., 1999).

Results and Discussion

In a study of EMP rating on sediment data collected from New Brunswick salmon aquaculture operation cage sites, principal components analysis (PCA) results showed disagreements and misclassifications in some ratings according to sediment metal and organic carbon data (Chou et al., 2002). In the present investigation we chose the sediment chemistry (Cu, Zn, Fe, Mn, Li, Al, organic carbon) that respond to the changes of the environment associated with the accumulation of cage wastes. The responses include the trends of the metals, organic carbon, and particle size, the metal to metal interactions (Table 1, please see CD Appendix-1 Chou), the disruption of metal inter-relations, difference of normalisations from natural background sediments, and trends related to the environmental monitoring rating of cage during time of operation (Figure 2, please see CD Appendix-1 Chou). Because of different sediment chemistry response

from the EMP rating, a statistical regression model to assess the degradation of the environment stemming from the accumulation of cage wastes was developed. In this investigation, the concentrations of sediment metals were used as independent variables and the EMP rating including A, B, and C sites, was the dependant variable. The unadjusted EMP model as shown has an R2 of 0.653 (coefficient of determination) (Table 2, please see CD Appendix-1 Chou). This model explains only 65% of the data for predicting EMP. This reveals the complexities of sediment determined by EMP alone due to heterogeneity of sediments, the difficulty of different underwater conditions, and visual assessment of sediment characteristics, around the cage sites. In consideration of this problem, the principal component technique was applied to the sediment data to cluster the similarity of metal, organic carbon, and particle variables to obtain the adjusted EMP ratings for aquaculture sites. The improved model is shown with an R2 of 0.945. The prediction model described in this report using the changes of sediment chemistry at the aquaculture sites could be used to assess the cumulative ecological effects associated with the accumulation of aquaculture waste.

This study shows that assessment of the marine environment at aquaculture sites requires a tool beyond the environmental monitoring program (EMP) rating. The sediment chemistry response to changes in environmental conditions at the aquaculture sites clearly result in differences from natural background sediment levels. Those changes make the modeling approach feasible in this study and useful for interpreting the impact of the aquaculture activities to the environment. This approach provides an effective means for assessing the environmental conditions based on sediment chemistry, and consequently in establishing regulatory guidelines to establish baseline information, such as marine environmental quality, sediment remediation or degradation in relation to the aquaculture conditions.

References

Chou, C.L., Haya, K., Paon, L.A., Burridge, L., Moffatt, J.D., 2002. Aquaculture-related trace metals in sediments and lobsters and relevance to environmental monitoring program ratings for near-field effects. Mar. Poll. Bull. 44, 1259-1268.

Chou, C.L., Paon, L.A., Moffatt, J.D., Zwicker, B., 2000. Copper contamination and cadmium, silver, and zinc concentrations in the digestive glands of American lobster (Homarus americanus) from the Inner Bay of Fundy, Atlantic Canada. Bull. Env. Cont. Tox. 65: 470-477.

DELG, 2000. Environmental management guidelines for the Atlantic salmon marine cage aquaculture industry in New Brunswick Final Draft, (EMG) Version 1.00 Section 3 of 4. Environmental Quality Objectives and Monitoring Programs, August 22, 2000.

SPSS Inc., 1999. SPSS Science Inc., Chicago, IL 60606-6307, U.S.A.: Available from <www.spsscience.com>.

Figure 1. Passamaquoddy Bay, Bay of Fundy, Atlantic Canada.

Technical tour to a cobia farm at Chukung, Pingtung, Chinese Taipei.
Photo: W.Y. Chiau

Seafood lunch in Pingtung, Chinese Taipei.
Photo: W.Y. Chiau

Fisheries Research Institute of Chinese Taipei

The Donggang Marine Laboratory, Pingtung, Chinese Taipei.
Photo: Y.Y. Lin

Fisheries Research Institute (FRI) of the Chinese Taipei was established in 1929. The northern headquarters is located in the city of Keelung in northern Taiwan.

At present the Institute is composed of four administrative sections (General Affairs Section, Accounting Dep., Personnel Dep., Ethics Dep.), and five divisions (Marine Fisheries, Aquaculture, Seafood Technology, Planning and information, Donggang Marine Laboratory). In addition, FRI has set up five research centers in strategic locations all over Taiwan, namely, Freshwater Aquaculture Research Center, Mariculture Research Center, Coastal and Offshore Resource Research Center, Eastern Marine Biology Research Center, Penghu Marine Biology Research Center (including Penghu Aquarium), and Donggang Marine Laboratory as the southern headquarters.

FRI has operated four research vessels: R/V Fishery Researcher I, R/V Hai-Fu, R/V Hai-Chien, and H/V Hai-An. R/V Fisheries Research I is the latest addition to the Institute's fleet of research vessels. It became operational in September 1993 and replaced the retired Hai-Kung, the previous principal research vessel of the Institute.

The mandates of FRI are to undertake research on and development in the exploitation of fishery resources, improvement of fishing technology, enhancement of fishery stock, advancement of aquaculture, biotechnology, as well as preservation and processing of fishery products. FRI also offers technical training and services to domestic and international fisheries communities.

Planning and Information Division

The Planning and Information Division is responsible for the management of information on fisheries, technical services, and training of fishermen. It also manages the Institute's main library, publishes the monthly FRI Newsletter, prepares training materials, and operates and maintains the Institute's computer network system.

Facilities and Equipment

The Division manages and maintains a mini-computer system, a small computer system and three SUN workstations, 50 IBM compatible personal computers, which are linked

Briefing at the Donggang Marine Laboratory, Pingtung, Chinese Taipei.
Photo: W.Y. Chiau

with Ethernet to form a Local Area Network. Computer peripherals include color laser printer and high quality dot-matrix printers, scanners, plotter, and film recorder. The Division is also in charge of the Institute's main library, which houses more than 20,000 volumes of scientific references and hundreds of national and international journals and periodicals on fisheries, marine food technology, and aquaculture.

Major Projects

1. Establishment of a Fisheries Research Information Database

   In keeping up with the fast-paced society, researchers are becoming less tolerant to the traditional but time-consuming way of searching current articles and reference information in the library because of the myriad growth of journals and publications. To save valuable time for researchers, the Division has developed an information retrieval system to automate and expedite retrieval of scientific and technical documents on fisheries research in Chinese Taipei. The database of the information retrieval system has integrated most key fisheries periodicals published in Chinese Taipei since 1954. It allows the user to search for a record or records by title, key word, subject, author, and Boolean logic both in Chinese and English.

2. Development of a Fisheries Information Service System

   The World Wide Web (www.) is one of the most popular and exciting services provided by the Internet in recent years. The Division has applied the web's main functions of electronic mail and information service to develop the Fisheries Information Service System. This System aims to establish an integrated fisheries information network, using FRI's own data center as the information center and FRI's branches as data stations. It allows each data station to make use of a personal computer to provide information and permits users to access the System for data transmission by standard voice telephone. Information currently available from the System includes fisheries science research abstracts; literature database on aquatic science, fishery technology (with emphasis on extension service); and reports on oceanographic and fishing condition. The System also provides charts of fishing grounds with isothermal and color graphic images of sea surface temperature through its network.

3. Technical Services

   The technical services are aiming to plan and promote office computerization in administration, including personnel, payroll, accounting, library, and the Institute's facilities and properties. Another objective of the services is to publish the Institute's monthly newsletters as a means to disseminate information on the Institute's current activities in administration, research, and development. From time to time, the services also issue extension bulletins and videotapes on special topics of fisheries.

4. Technical Training

   The Division sometimes holds technical training sessions for elite groups of fishermen, young farmers recommended by relevant government agencies, and fisheries technicians from other countries.

The Donggang Marine Laboratory, Pingtung, Chinese Taipei.
Photo: Y.Y. Lin

Marine Fisheries Division

Marine Fisheries Division is in charge of exploitation of fishing grounds, investigation into marine fisheries, and experiments in improvement of fishing gears and methods.

Facilities and Equipment

The Division is responsible for the operation and maintenance of three research vessels: R/V Fishery Researcher I (1900 gross tons, 3400 hp), R/V Hai-Fu (315 gross tons, 1100 hps), and R/V Hai-Hung (26 gross tons, 250 hps).

The Division possesses the following equipment to assist its researchers in carrying out various functions: Mark III B conductivity- temperature-depth recorder(CTD) and profile of underwater unit, Sea Bird 911-plus CTD, RDI ADCP, RS 5-3 salinity and temperature meter, spectrophotometer, Smith dredger, vertical water circulation channel, purse seine testing equipment, setted net testing equipment, tension meter, friction strength tester, thread quick cut-off tester, SIMRAD SR-240 EK-500, and EA-500 quantitative echo sounder system, complete underwater in situ fluorimeter for detection of chlorophyll a, and computer systems for data processing.

Research

1. Exploration of New Fishing Grounds and Investigation into Fishing Environments

Due to the 200-nautical mile exclusive economic zone imposed by most coastal countries, finding new fishing grounds in the open seas and seeking appropriate approaches to cooperate with other fishing nations have become the most important task for nations, like Chinese Taipei, with advanced fisheries.

In the 1970's through the early 1980's, R/V Hai-Kung explored and investigated fishing grounds in the western South Pacific Ocean near New Zealand and krill resources in the Antarctic Ocean. Recently the Division has conducted studies on the fishing grounds and some environmental factors relevant to the squid and tuna fisheries. The results of these studies have been scientific bases for a better understanding of fish stock and, consequently, a more effective fishery administration and management.

2. Improvement of Fishing Gear and Fishing Methods

   Because fishermen, on the average, belong to older age groups, fishing methods have to be refined and adapted based on their specific requirements. Thus automation of fishing equipment and efficiency of fishing gears are the primary focuses of the Division's current studies, including set net, fish traps, and purse seine.

3. Studies on Deep Sea Fishery Resources

   An up-to-date and reliable knowledge of the fish stock structure is essential for policymakers to effectively plan for resource management. The Division has been, therefore, engaged dynamically in studies on deep sea fishery resources, such as the albacore resources in the North Pacific and Indian oceans, including abundance, migration, distribution, behavior, size and age composition, and growth and mortality rates of the targeted species. Information obtained from these studies could serve as scientific bases for fishery administrators to formulate policies for fisheries regulation and negotiate with other countries on fisheries management and regulation.

4. Studies on Coastal Resources

   The Division has undertaken research on the resources of dolphin fish, anchovies, moonfish, herring, squid, grey mullet, and coastal tuna. It has also conducted studies on the behavior of coastal fishes. These studies are aimed to understand the problems of coastal fisheries resources, to find ways of settling fisheries issues, and to provide suggestions in making sound policies for reasonable and sustainable utilization of aquatic resources.

5. Studies on Sea Farming

   To increase the productivity of coastal fisheries resources, the Division has actively assumed basic studies on sparid fishes around the northern coasts of Chinese Taipei. In addition to establishing basic database on hydrographic parameters of fishing grounds, some studies have also been undertaken on the effects of

tagging and releasing of some species for which mass propagation techniques have already been developed, such as red sea bream and black sea bream. Fish culture and sea farming will be continuously expanded and improved until these industries become fully established.

6. Reports on Fisheries and Oceanographic Investigations along the Coasts of Chinese Taipei

   Researches and surveys on fisheries and oceanographic conditions of the surrounding waters of Chinese Taipei have been carried out for over ten years. To provide fishermen with reliable information on the conditions of fishing grounds, reports on respective fishing seasons of grey mullet, squids, and anchovies have been released.

   In the future, with the establishment and application of the NOAA-HRPT Satellite Receiving System, the Division will be able to proceed with automation and computerization of information gathering and processing, eventually to produce a much better and more extensive cohort analysis on the dominant species and a more accurate examination on the relationship between fisheries and marine environmental conditions. It is the Division's ultimate goal to be able to forecast reliably, regularly, and timely the fisheries and oceanographic conditions.

Aquaculture Division

The Aquaculture Division has conducted studies on physiology, ecology, reproduction, and reproduction-related biotechnology of important economical finfishes, crustaceans, mollusks, as well as on water quality-oriented aquaculture engineering.

Facilities and Equipment

The Division has several research offices and wet laboratories. In addition to essential facilities such as freshwater, seawater, air, and electrical supply systems, other equipment includes light microscopes, cryomicroscope, incubators, refrigerators, oven, microwave oven, water bath, bioclean bench, autoclave, auto tissue processor and embedding system, colony counter, programmable freezer, coulter counter, flow cytometer, motility analyzer, pH meter, salinometer, electronic balance, water circulation system, aquarium tanks, recycling-filter tanks, and personal computer and image analysis systems.

Research

1. Physiological and Ecological Studies on Economically Important Fishes

   Only a few aquatic species have been cultured commercially in Chinese Taipei. Overproduction occurs occasionally and greatly affects market price. To address this problem, the Division has undertaken studies on the cultivation and propagation of various economically important fishes, crustaceans, mollusks, and macroalgae to serve as the bases for developing highly economical multi-species cultures. Since 1983, a series of basic physiological and ecological studies on *Ranina ranina, Lethrinus nebulosus, and Siganus oramin* have already been conducted.

2. Studies on the Development and Application of Reproduction-Related Biotechnology for Advanced Aquaculture

   Species differ in their ability to adapt to the environment and this shows in their disparities in growth rates and body sizes. The Division has carried out biotechnological studies to increase aquaculture production value. Cryopreservaton of sperm of freshwater fishes such as common carp and marine fishes such as malabricus grouper have been studied, with emphasis on sperm availability for artificial propagation and polypoloidy

The Donggang Marine Laboratory, Pingtung, Chinese Taipei.
Photo: Y.Y. Lin

induction. For transfer of the technique to intended clients, the technology for this method has been simplified and popularized. In studies on chromosome manipulation, induction effects of triploidy and gynogenetic diploidy have been investigated by comparing the effects of cold, pressure, and chemical shocks. Four feasible methods have been established to identify the triploids among diploids: karyotype, RBC diameter measurement, Coulter counter, and flow cytometer.

3. Prevention and Treatment of Fish Disease

   Because of advancements in aquaculture techniques and the rapid expansion of culture areas, water pollution, land depression, and disease of cultured species have worsened. This was especially serious in the mass mortality caused by prawn disease in 1987. Some aquafarms were selected for monthly mornitoring and the infectious pathogens have been identified. Furthermore, pathological analysis has been carried out by tissue histopathologic techniques, aiming to establish proper methods for prevention and treatment of fish and prawn diseases at an earlier stage. Related techniques to produce nonvirus juvenile prawn and control of water quality in prawn farms will be developed. Strategies to reduce environmental stress on prawns and biotechnology to improve prawn health are being planned.

4. Automation and Recycling of Aquaculture Water System

   In response to the lack of manpower and water shortage, a Danish-made high-density eel culture system was introduced in 1993. The system consists of fish tanks, a microstrainer, biological filters, and a dissolved oxygen regulator. It provides vital information on minimizing water use and on automation in eel culture industry in order to improve the current system used in Chinese Taipei. This system, if adapted by eel farmers in Chinese Taipei, will enable the industry to achieve its goals for advanced automation, appropriate investment, high eel production, and adequate water use.

The Donggang Marine Laboratory, Pingtung, Chinese Taipei.
Photo: Y.Y. Lin

Seafood Technology Division

The Seafood Technology Division is responsible for studies on preservation, freezing, seafood processing, and chemical and microbiological properties of fishery products.

Facilities and Equipment

The Division has several laboratories for various experiments in food technology.

Equipment and apparatuses employed by the Division include high performance liquid chromatography, atomic absorption spectro-photometer, UV-VIS spectrophotometer, enzyme-linked immunology assay set, freeze centrifuge, anaerobic culture chamber, critical molecular distillation apparatus, vacuum freeze-dryer, amino acid analyzer, microscope, fluoromicroscope, densitometer, water activity detector, and gas chromatography equipment.

Research

1. Preservation of Fishery Products

   Selection of methods for keeping the quality of fishery products is based on the characteristics and ways of utilization of the processed fish. The use of chemical preservatives is, however, not recommended for preserving shrimps and fishes. After a series of tests, the Division has recommended precooling, refrigerated seawater ice, and partial freezing as alternatives. These methods have substantially contributed to the development of the seafood processing industry, especially, for instance, preservation of fish with high market value. The prefreezing, glazing, and sanitary control of raw

oyster were also tested.

2. Processing of Fishery Products

   The techniques of processing fishery products such as protein paste, protein concentrate, frozen paste, extrusion products, minced products from red-muscled fish and fish that traditionally is not used for food processing have been developed by the Division. In addition to fully utilizing trash fish and squid, the processing techniques for products such as fish fillet, fish noodle, fish hamburger, fish sausage, frozen fish paste, frozen prepared food, squid fillet, squid stick, squid doughnut, and retort-pouched fishery product have been successfully developed.

3. Processing of Seaweeds

   Gracilaria has replaced Gelidium to become the raw material for the production of agar-agar. The Division has developed a special method for producing agar-agar by using a buffer solution to adjust the pH value and by controlling the alkaline treatment condition. The techniques for the production of carrageenan and algine respectively from Eucheuma and Sargassum were also established.

4. Utilization of By-Products

   In canning plants fish soluble is usually made from the viscera-containing wastes of either mackerel or bonito. It is often used as feed for either aquaculture or poultry farms. Squid visceral oil and squid soluble may be separated from each other by autolysis. The soluble can be used as protein source for grass prawn diets while the oil, with 40% or more as highly unsaturated fatty acid (HUFA), can be used directly as feeding oil.

5. Improvement of Artificial Diet

Meeting at the Donggang Marine Laboratory, Pingtung, Chinese Taipei.
Photo: Y.Y. Lin

   Diet augmented with a limited quantity of amino acids and digestive enzymes can decrease mortality and increase feed efficiency in eel culture. Mortality is also decreased when fishmeal is replaced by soybean powder, soybean protein isolate, or fish soluble. To avoid environmental contamination and improve growth rate of grass prawn cultured in sea waters, the effects of essential nutrients, binders, and attractive substances in the formulated moist pellet have been studied.

6. Sanitation Monitoring and Quality Control of Fishery Product

   The Division founded the Inspection Service Center (ISC) to study and improve the sanitary condition of both marine and cultured fishery products. The ISC also provides quality inspection service for processed fishery products. Sanitary treatment and quality control of cultured fish are monitored at each stage of growth. The ISC has regularly trained inspectors of local markets and members of inspection teams in seafood processing factories in Chinese Taipei.

The Donggang Marine Laboratory

The Donggang Marine Laboratory was founded in October 1968 as the Donggang Shrimp Culture Center under FRI's Tainan Branch. In January 1971, the Center was reorganized, changed to its present name, and placed directly under FRI.

The main objectives of the Laboratory were to expedite the technical improvement and development of commercial aquaculture in Chinese Taipei and neighboring economies, and to increase fishery production in the waters surrounding the Islands of Taiwan. To fulfil its objectives, the Laboratory has undertaken basic and applied researches on aquaculture and marine biology, offered technical teaching and training on various aspects of aquaculture to local and foreign trainees, participated in international cooperation to disseminate knowledge of recent development in aquaculture research and technology, and undertaken scientific research on stock enhancement of fishes with high commercial value.

Facilities and Equipment

The Laboratory occupies eight hectares of land in southwestern Taiwan facing the Taiwan Strait. Its

Cobia and cage model, Pingtung, Chinese Taipei.
Photo: Y.Y. Lin

facilities include a main administrative building, three research buildings, a live-feed building, a hatchery house, specialized laboratories for water quality, biochemical, histological, and microbiological analyses, an auditorium, an aquarium, an exhibition hall, over 90 experimental ponds of various sizes with a total floor area of slightly more than two hectares, nine guest rooms for visiting investigators, and three staff housing units.

Research

1. Prawns

   Over the past ten years the Laboratory has successfully developed the techniques for artificial propagation of nine species of marine prawns, namely, *Penaeus monodon, P. japonicus, P. semisuleatus, P. penicillatus, P. marginatus, P. brasiliensis, Metapenaeus ensis, M. joyneri amd Litopenaeus vannamei*. The Laboratory's current researches are aiming to intensify marine prawn culture. These include induced maturation of pond-reared prawns by means of eyestalk ablation; effects of environmental parameter such as salinity, dissolved oxygen, ammonia, hydrogen sulfide, and heavy metals on the growth of larval and adult prawns; development of specialized formulated feeds for larval and adult prawns, including experiments on the absorption and digestion of various sources of protein and optimum content of other nutrients; improvement of techniques in pond management, including optimum stocking rate, feeding rate, feasibility of polyculture, artificial substrate, and pond engineering; and culture prospects of candidate species such as Penaeus penicillatus, and P. semisulcatus.

2. Grey Mullet

   In 1970 the Laboratory was the first in the world to succeed in the artificial propagation of the grey mullet, *Mugil cephalus*. Later it accomplished the development of a "complete breeding" system for this fish. The Laboratory is currently involved with researches on the development of propagation techniques to assure mass fry production; cryopreservation of spermatozoa to attain reliable sources of sperm; improvement of techniques in pond management, including experiments on polyculture with other fishes, comparison of growth rates among fishes reared in freshwater, brackish, and saltwater ponds; genetic evaluation to produce progenies which exhibit desired traits suitable for aquaculture; and development of methods to manipulate sex in order to obtain offspring of females only for culture.

3. Milkfish

   The Laboratory was the first to recognize the early development of the milkfish, Chanos chanos, which has been cultured for many centuries in Southeast Asia. Current researches of the Laboratory include regulation of spawning season and standardization of rearing method for larvae; determination of nutritional requirement in order to develop cheap supplementary formulated feeds; and improvement of techniques in pond management.

4. Tilapia

   The Laboratory is aware that tilapia are major protein source in some developing countries and are hardy species suitable for aquaculture. Current research conducted in the Laboratory includes investigation on effective methods to attain monosex offspring, genetic studies to produce a desired color of red tilapia, and methods of selective breeding

5. Other Species

   The Laboratory also performs experiments to induce propagation and rear larvae of other species such as flatheaded goby (*Glossogobius giuris*), yellow spotted grunt (*Plectorhinchus cinctus*), and groupers (*Epinephelus malabaricus* and *E. suillus*).

6. Life Feeds

   Realizing that live feeds play an important role in intensive larval rearing of prawns and fishes, the Laboratory has undertaken studies on the nutritive value of live-feed organisms such as rotifers (*Brachionus plicatilis*) and planktonic algae (*Nannochloropsis oculata, Tetraselmis chui, Isochrysis galbana, Chaetocerus gracilis* and *Skeletonema costatum*) and methods of culture of rotifer and Artemia nauplii.

7. Fish and Prawn Diseases

   For several years, the Laboratory has been carrying out a program to study fish and prawn diseases, including diagnosis and cure. Current research seeks natural methods for the control of such diseases to reduce the use of chemicals in aquaculture. Pest control by means of bioassay is another program being undertaken by the Laboratory.

8. Stock Enhancement Program

   The Laboratory has made the coastal waters along the southwestern coast of Taiwan an experimental area for prawn releases in support of the need to enhance the production of coastal fisheries. To meet this goal, the Laboratory has undertaken a series of ecological studies on the area, including community structure, distribution, reproduction, recruitment, food and feeding, and growth and tagging experiments on commercially important prawns. The Laboratory will make results of these studies the basis to establish the most effective system of prawn stock enhancement in the area.

Extension and Training Program

The Laboratory has taken the responsibility to train aquaculturists by offering relevant practical courses to local and foreign trainees. It also set up an extension unit in 1976 to carry out this objective and to provide assistance and guidance to aquafarmers. Extension services provided by the Laboratory include assistance in laboratory analyses requested by foreign and local visitors and aquafarmers; free distribution of investigation reports and research data that may be of interest to aquafarming practitioners as well as managements; and compilation and publication of training manuals.

In cooperation with the Donggang Fisheries Vocational High School, the Laboratory, through its selective staff, has offered related courses in aquaculture to students.

Technical tour to Kaoping River Wetland Park (constructed wetland), Chinese Taipei.
Photo: Y.Y. Lin

International Cooperation

The Laboratory has been actively involved in the transfer of its acquired technologies on various fields of aquaculture to many countries through different venues of international cooperation. Some of its staff have visited Saudi Arabia, Panama, Fiji, the Marshall Islands, and the Philippines,on the request of their respective governments, to offer research guidance and technical assistance. Several members of the Laboratory have participated in a number of international conferences held in Asia, Europe, Africa, South America and Australia. The Laboratory is coordinating with the Hawaii-based Oceanic Institute to carry out a four-year program in transfer of aquaculture technology to lesser developed countries (LDCs). This program has been co-sponsored by the International Economic Cooperation Development Fund of the Republic of China and the United States Agency for International Development. Its ultimate goal is to improve aquaculture production and, therefore, enhance economic progress in the LDCs.

Publications

The Laboratory has issued three volumes of the "Collected Reprints of the Donggang Marine Laboratory" and published "Extension Handbook on Grass Prawn, Penaeus monodon", "Extension Handbook on Giant Freshwater Prawn, Macrobrachium rosenbergii", and "Proceedings of Chinese Taipei-Japan Symposium on Mariculture". In addition, it also published "Reproduction and Culture of Milkfish", jointly with the Oceanic Institute of Hawaii. The staff of the Laboratory have published numerous research and technical articles in various leading national and international scientific and aquaculture journals in Chinese Taipei and around the world.

More Information
http://www.tfrin.gov.tw/friweb/

Conservation News

3rd IUCN world conservation congress shows know-why and know-how for conservation and development

Bangkok, Thailand, 25 November 2004 (IUCN) – While the extinction crisis intensifies, the 3rd IUCN World Conservation Congress has shown how reliable information and extensive know-how, a deep-rooted passion for life in all its forms, and powerful collaboration with all sectors of society can improve the wellbeing of six billion people and the 15,589 species identified in the IUCN Red List of Threatened Species.

The past nine days underlined the concrete benefits of conservation action to poverty reduction and a healthy planet, and the effectiveness of the approaches and tools we have at our disposal. With huge areas of wilderness being lost every day, 1.4 billion people living along rivers with serious water shortages, glaciers and polar caps melting due to a 0.6°C increase in temperature, the conservation movement now invites the world: work with us to reverse the trend.

Participants heard the world's latest scientific knowledge presented, saw landmark initiatives launched, took part in high-level debates, signed a number of agreements, and voted on over 100 resolutions on critical conservation issues, ranging from Genetically Modified Organisms (GMOs) to the conservation of our oceans.

"The decisions taken in Bangkok have the power to affect every single one of us," said IUCN Director General, Achim Steiner. "They have demonstrated the role of conservation in peace building, poverty eradication, food and water security, health and spirituality, and economic development. The global environmental agenda in 2004 is more than just a manifesto; it is a concern of global relevance and collective responsibility."

Her Imperial Highness Princess Takamado, Honorary President of BirdLife International, implored humankind to deal with the underlying causes of species loss and "think about the state of the world in the same way that we consider our own health".

This premier conservation event attracted 4,899 people from all walks of life and from across the globe, including almost 1,000 of the world's leading scientists, over 200 business representatives, more than 40 Ministers of Foreign Affairs, Environment, Agriculture, Tourism and Fisheries, as well as hundreds of environmental activists, community and religious leaders.

Forum trilogy puts conservation on the world's big screen

The three-day World Conservation Forum demonstrated successes in the conservation of coral reefs, wetlands and the southern white rhino, tabled agreements for concrete action and recognized individuals and institutions for their contribution to conservation.

"In the 1950s we predicted that the world's natural resources and biodiversity were showing signs of serious degradation. Today, we have a body of evidence that is irrefutable and validates our hypothesis that the planet's resources are used well beyond the levels of sustainability," said Mr Steiner.

More Information
http://www.iucn.org/congress/documents/press/2004-11-25-closing.htm

Science taps into ocean secrets

Some 13,000 new marine species have been discovered in the past year, according to information released by an international alliance of scientists.

The Census of Marine Life (COML) has also uncovered previously unknown migration routes used by fish such as tuna and shark.

The $1bn 10-year project, which is building a huge database, involves researchers in more than 70 countries.

The new knowledge will inform future conservation and fisheries policies.

"We're just skimming the surface," said Dr Ron O'Dor, Chief Census Scientist, based in Washington DC, US.

"We know something about the first 100m at this point but we know almost nothing about what lies down in the deep.

"Our analysis shows that if you catch a fish below 2,000m it is 50 times more likely to be new to science," he told the BBC News website.

Map of life

The census has seen an exponential growth in knowledge in the 12 months since it issued its last progress report. Some specimens are pulled up on trawls, counted and catalogued. Other organisms are even tagged and tracked.

A remarkable picture of how life operates in the deep is beginning to emerge.

"In some of the results we've had you can see a kind of doughnut of circulation which seems to concentrate life in deep water," explained Dr Fred Grassle of Rutgers University, US, who chairs the Census' International Scientific Steering Committee.

"The doughnuts were 10km in diameter and thousands of metres below the surface."

The project's Ocean Biographic Information System database now includes more than 5.2 million new and previously existing records of the location, date and depth at which a marine species was found - a rise of 1.1 million entries.

The information has allowed the COML to create a map of the distribution of 38,000 marine species, from plankton to whales.

Vast areas of the world's oceans have yet to return any data at all.

One survey, however, on the mid-Atlantic Ridge, recorded 80,000 specimens. It is expected to add several new fish species to the 106 marked by the census this year.

Carbon storage

The current total of marine fish species now stands at 15,482. Experts expect the final count to total roughly 20,000 by the time the COML is completed in 2010.
But fish biomass is dwarfed by that of microscopic life forms. The database now includes more than 6,800 species of zooplankton, tiny animals that drift with the currents.
Microbes, the smallest organisms, astonishingly account for more than 90% of ocean biomass.

Scientists believe knowledge about this aspect of marine life will prove useful in understanding climate change, as these organisms play a crucial role in taking carbon dioxide out of the atmosphere.

"We need to know about what is there living in the deep ocean that can take up carbon and hang onto it, so that it isn't bubbling straight back out into the atmosphere again," said Dr Chris German, from the Southampton Oceanography Centre, UK.

"In that regard, I think the big discovery is that 90% of all the carbon that's taken up in life in the oceans is taken up in microbes, and a large number of those may be in the deep-ocean sediments buried beneath the sea floor," he told BBC News.

More information
http://www.coml.org/coml.htm
http://news.bbc.co.uk/1/hi/sci/tech/4033555.stm

Satellites track albatross flight

A satellite tracking project has shown the locations where albatrosses come into conflict with trawlers.

Data on the movements of 16 albatrosses and three petrel species was collated by Birdlife International.

Coastcare is one of the famous organizations on the protection of the coasts in Australia
Photo: Y.Y. Lin

Moreton Bay, Queensland, Australia.
Photo: Y.Y. Lin

Its report, Tracking Ocean Wanderers, identifies the ocean hotspots where the birds tend to congregate.

About 300,000 seabirds, including 100,000 albatrosses, are thought to be killed each year when they are hooked on the longlines of fishing boats.

It is hoped the information can be used by fishing fleets to tailor their activities so that they do least harm to the birds.

"This report shows the variation throughout the year - there are particular times when it is critical for the birds to be in certain areas," said Cleo Small, of the international marine policy office at BirdLife, an alliance of conservation groups.

"Fisheries can now be more sophisticated; they will know that in certain months in particular places they will need to take more care."

Long journeys

The hotspots where both longliners and large numbers of seabirds cross paths include the waters around New Zealand and South-East Australia, the South-West Indian Ocean, South Atlantic and North Pacific.

The study also emphasised the importance of coastal shelf areas for albatrosses and petrels while breeding, and of highly productive oceanic regions such as the Humboldt Current, the Patagonian Shelf, the Antarctic Polar Frontal Zone, and the Benguela Current.

It identified differences in foraging areas used by breeding and non-breeding adults, and young and mature birds.

And the project underlined the huge distances travelled on migration by some of these majestic birds.

The northern royal albatross, for example, flies up to 1,800km in 24 hours, and the grey-headed albatross can circle the globe in 42 days.

Concern for the welfare of these ocean birds - all 21 albatross species are officially classed as under global threat of extinction - has prompted interested nations to sign up to a treaty.

Pirate vessels

The parties to the Agreement on the Conservation of Albatrosses and Petrels (ACap) are meeting for the first time, in Tasmania, this week.

The treaty requires signatory states to implement conservation measures.

John Croxall, head of conservation biology at the British Antarctic Survey, said: "The data, and the results presented in this report, will be of immense assistance in developing the work of the new ACap."

The Prince of Wales, who is a keen supporter of albatross conservation, has also commended the work of the project.

"It brings together real data for the first time to show us where these gravely threatened birds are roving the oceans, enabling us to identify where they are most vulnerable and to safeguard their critical habitat," he said.

Although the data will help legitimate fisheries modify practices for the benefit of sea birds, there exist many pirate boats on the world's oceans which work outside international law.

The pirates are thought to account for one third of seabird deaths by longlining. Efforts to conserve the albatross have somehow to constrain this activity too.

More information
http://news.bbc.co.uk/1/hi/sci/tech/3996915.stm

Whale beachings stump officials

SYDNEY (Reuters) - Scientists and wildlife officials are continuing to search for what may have caused a series of mass strandings which have left 169 whales and dolphins dead on Australian and New Zealand beaches in the past three days (28-30 November, 2004).

Authorities and volunteers worked through Monday night to save dozens of whales and dolphins after three separate beachings in Australia and New Zealand.

By Tuesday, 96 long-finned pilot whales and bottle-nosed dolphins had died after the first beaching on Sunday at King Island, midway between the Australian mainland and the southern island state of Tasmania.

Tasmanian wildlife officer Shane Hunniford said another 19 long-finned pilot whales had died in a separate beaching on Monday on Maria Island, 60 km (37 miles) east of the Tasmanian capital Hobart.

He said 43 whales had beached themselves on Maria Island but officials had managed to save 24 that had been found alive.

Across the Tasman Sea in New Zealand, a mass grave was dug on a beach at Opoutere, 100 km (62 miles) east of Auckland on the North Island, for 53 dead pilot whales. Officials said 73 whales had become stranded there on Sunday, but 20 were saved.

Of those 20, more were expected to die because many were too weak to follow the others out to sea.

"Some of them had suffered pretty significantly on the beach," New Zealand conservation department manager John Gaukrodger told reporters.

Later on Tuesday, a 10-metre (33 feet) sperm whale washed up on a beach west of Auckland. Officials said they were not sure if the whale had died at sea and washed up or had stranded itself. They said it was not linked to the Opoutere beaching.

Hunniford said it was unlikely there was any connection between the Australian and New Zealand beachings, with the mass strandings no more than just unfortunate coincidences.

"If you look at spaceship Earth, Tasmania and New Zealand both stick out into the Southern Ocean and that's a playground for whales and dolphins," Hunniford told Reuters.

"There are a number of theories. We're not pinning our hat on any of them," he said of the Tasmanian beachings.

The Australian government also said on Tuesday that it would establish a national database on whale strandings.

"We are not sure why these tragedies happen but it's important that we coordinate existing scientific work to establish the reasons why these creatures become stranded," Environment Minister Ian Campbell said in a statement.

Bob Brown, leader of Australia's Greens party, said earlier on Tuesday that ocean seismic tests for oil and gas should be stopped until the whale migration season ends.

Brown, a senator in the Australian parliament, said "sound bombing" of ocean floors to test for oil and gas had been carried out near te sites of the Tasmanian beachings recently.

He said in a statement that research data on the possible impact of such practices on marine life was inconclusive.

A glance on the coast in Barisbane, Australia.
Photo: Y.Y. Lin

Sheryl Gibney, a rescue coordinator with New Zealand's Project Jonah, said high offshore winds and plentiful supplies of mackerel close to the coast could be possible explanations.

"Normally with pilot whales, because they're so closely socially bonded, if one gets into trouble the others are not going to leave," Gibney said.

"Some will come in and try and assist it, they get stranded, then more will come."

More information
http://www.reuters.co.uk/newsPackageArticle.jhtml?type=worldNews&storyID=629976&section=news

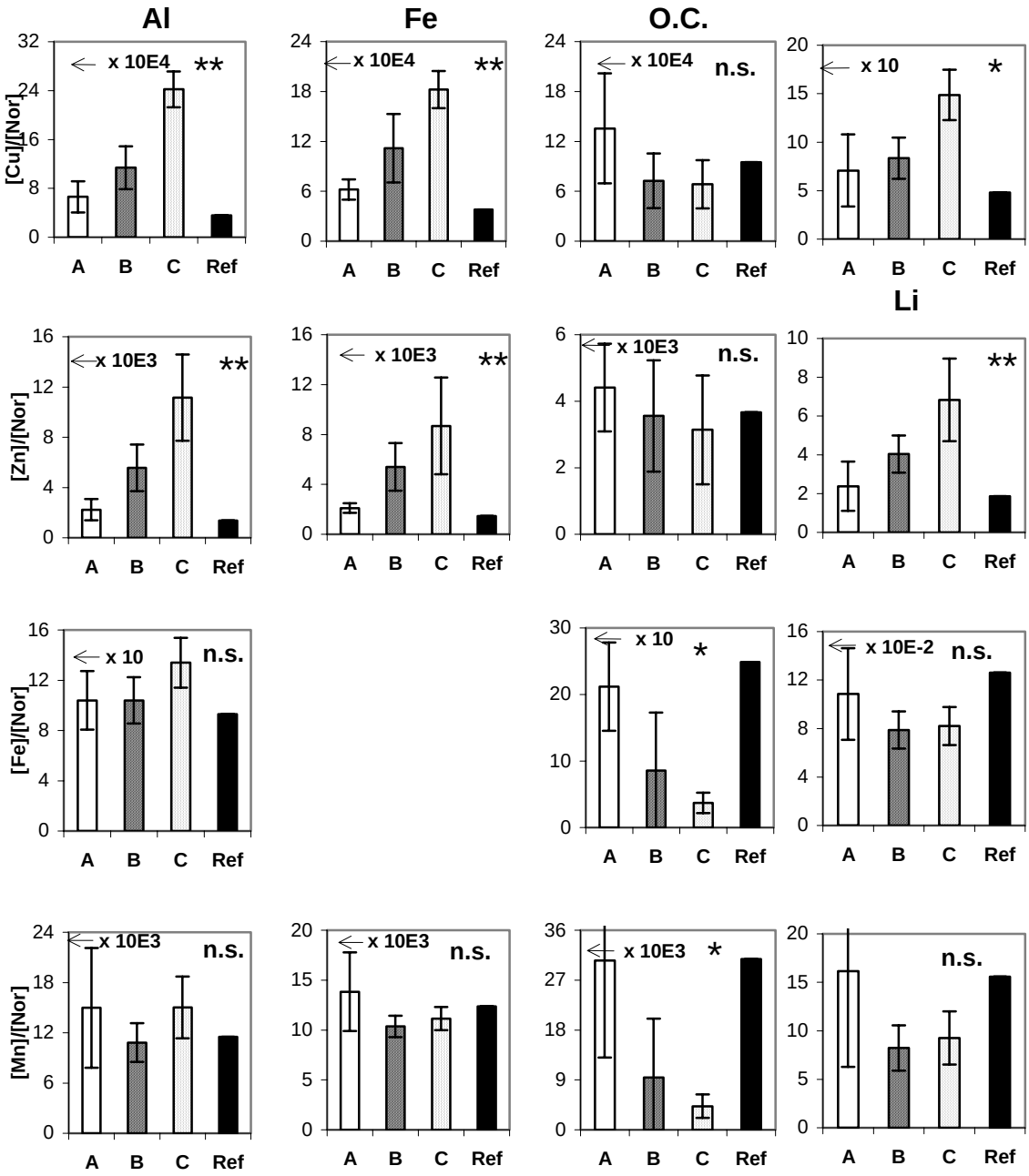


Figure 2. Means (± std deviations) for sediment Cu, Zn, Fe, and Mn concentrations normalised by Al, Fe, O.C. (organic carbon) and Li (** is p>99%; * is 99%>p>95%; n.s. is not significant. Note: A (Normal), B (Hypoxic), C (Anoxic), and Ref (Reference site)

Table 1. r-values for metals, organic carbon (O.C.) and <63 µm particles (clay) in A (normal), B (hypoxic), C (anoxic), and reference sediments from salmon aquaculture sites, (n=27 samples).

	Al	***Cu***	***Zn***	***Mn***	***Fe***	***Li***	***O.C.***
Al							
Cu	-0.5001**						
Zn	-0.5635**	0.7991**					
Mn	0.3980*	-0.3970*	-0.6576**				
Fe	0.7424**	-0.2544	-0.604**	0.6859**			
Li	0.6953**	-0.003	-0.1565	-0.0316	0.6232**		
O.C.	-0.6118**	0.5769**	0.782**	-0.631**	-0.716**	-0.3092	
Clay	0.0458	0.514**	0.3234	-0.1884	0.0922	0.4443*	0.320

Note:
** is >99% level of significance
* is 99% >p>95% level of significance

Table 2. EMP regression models for aquaculture site sediments using variables of metals, organic carbon (O.C.), and <63 µm particles (clay), and coefficient of determination (r2).
Note: units for Al, Fe, O.C., and <63 µm particles are % and Li, Cu, Zn, and Mn are µg/g.

1. Unadjusted Model (by diver):

EMP = 2.40 - 0.524 [Al] - 0.012 [Li] - 0.008 [Cu] + 0.004 [Zn] + 0.902 [Fe] - 0.005 [Mn] + 0.004 [O.C.] + 0.010 [<63瘦] (r^2=0.653)

2. Adjusted Model:

EMP = 4.72 + 0.071 [Al] + 0.021 [Cu] + 0.003 [Zn] - 0.398 [Fe] - 0.007 [Mn] - 0.055 [O.C.] + 0.003 [<63瘦] (r^2=0.945)