



CATALOG | 1837

# 2007 Publications Catalog



## Publications Catalog 2007

This catalog lists publications published by The WorldFish Center and papers contributed by the Center's scientists in 2007. It reflects the outcomes of research carried out in collaboration with partners from 27 countries through the generous support from international investors.

The catalog is divided into 3 sections:

- Corporate publications
- Refereed publications
- Non-refereed publications

They are sorted alphabetically by the surname of the primary author and abstracts are provided. The index of WorldFish authors at the end of this catalog will lead you to specific pages for easy referencing.

The number of contributions at the time of publishing this catalog is:

	<u>2007</u>
• Corporate	4
• Refereed	69
• Non-refereed	38



The WorldFish Center acknowledges the funding support from the Consultative Group on International Agricultural Research (CGIAR), specifically the following members: Australia, Canada, Egypt, Germany, India, Japan, New Zealand, Norway, the Philippines, Sweden, the United Kingdom, and the United States of America.

**Annual Report 2006**, 8 p. The WorldFish Center, Penang.

This brochure captures the essence of the work and projects with key partners by WorldFish in 2006. A balance sheet is also provided for reference.

**Medium term plan 2008-2010**, 76 p. The WorldFish Center, Penang.

Summary edition in 8 pages is also available. This also represents a significant departure from the past in that it presents our science program from the point of view of two specific areas of work: expanding sustainable aquaculture and enhancing productive and resilient small-scale fisheries, both of which are central to delivering our mission.

**Who we are, what we do, and why**, 8 p. The WorldFish Center, Penang.

Provides a concise introduction to WorldFish. Developed in particular to support approaches to new investors and partners.

Abernethy, K.E., E.H. Allison, P.P. Molloy and I.M. Côté. 2007.

**Why do fisheries fish where they fish? Using the ideal free distribution to understand the behaviour of artisanal reef fishers.** Canadian Journal of Fisheries and Aquatic Sciences 64(11):1595-1604.

The theory of the ideal free distribution (IFD) was used as a framework to understand the mechanisms underlying fishing site selection by Anguillian artisanal fishers exploiting shallow-water coral reefs. Contrary to the predictions of IFD, fishers did not distribute themselves so that average reward was equal among fishers using different fishing methods or among fishers using the same method. In addition, fishing pressure did not increase with resource availability. Key assumptions of the IFD were not met. The distribution of Anguillian fishers was not “ideal” because lack of knowledge prevented fishers from choosing fishing grounds with the greatest rewards. Not all fishers sought to maximise profit. In addition, all fishers were not “free” to distribute themselves among reefs owing to variation in social, economic, and physical characteristics of fishers that constrained fisher movements and ability to extract resources. This study shows that as a null model the IFD is useful to frame studies designed to gain detailed insights into the complexity and dynamics of a small-scale fishery. Alongside ecological data, this framework may inform efficient and effective development of reef and fishery management practice.

Adhuri, D.S. and L.E. Visser. 2007.

**Fishing in, fishing out: transboundary issues and the territorialization of blue space.** Asia-Pacific Forum 36:112-145.

Transboundary access to and appropriation of resources is considered as a part of the territorialization of space by the state. This implies that environmental concerns about transboundary resource access are seen as inherently social and political in nature, and that they will be approached as processes of human interaction and decision making regarding the environment.

Akhtar, A. and M.G. Mustafa. 2007.

**Population dynamics of *Lysmata ensirostris* in the Kutubdia channel of the Bay of Bengal, Bangladesh.** Journal of the Asiatic Society of Bangladesh (Science) 33(2):193-203.

FiSAT (FAO ICLARM Stock Assessment Tools) programme was used to estimate population parameters of *Lysmata ensirostris* from length frequency data. The  $L_{\infty}$  (asymptotic length) and K (growth coefficient) were found to be 7.3 cm and 2.2/year respectively and the growth performance index ( $\Phi$ ) was found to be 2.069. An additional estimate of  $L_{\infty} / K$  was found to be 7.057 cm and 1.086 respectively.

The annual rate of natural mortality (M), fishing mortality (F) and total mortality (Z) were found to be 8.44, 0.92 and 9.36 respectively. The selection pattern was found to be 5.642 cm. The stock of *L. ensirostris* was not over exploited. This species is recruited in the fishery during April and August.

Ahmed, K.K., S.U. Ahamed, K.R. Hasan and M.G. Mustafa. 2007.

**Option for formulating community based fish sanctuary and its management in beel ecosystem in Brahmanbaria.** Bangladesh Journal of Fisheries (Special Issue) 30:1-10.

With the objective of formulating community based fish sanctuaries in beel ecosystem based on the experiences of traditional fish aggregating devices (FAD), like katha and kua, this study was undertaken in three beels viz., Shakla, Hurul and Shapla located in Brahmanbaria. Results show that surface area coverage for katha ranged between 25 and 60 dec. Two harvests were found to be common, may exceed to three harvests depending on the hydrological condition of beel. Fish production was recorded higher to be the first harvest that decreased chronologically in the second and third harvests. The area of kua ranged from 5 to 100 dec. Fish production of first harvest was almost double than that of the second harvest. None of the owners of kua were the member of beel management committee (BMC) but they owned land. Kua fisheries are not favorable for sustaining yields because all fish including brood stocks and juveniles are harvested completely at a time by dewatering. Moreover, the owners of the kua along the canals have a tendency to encroach khas land while excavating kua. Conflicts also prevailed between the kua owners and the BMC. For the sustainability of CBFM concept in the beel fishery rigorous motivation works needed for the kua owners to bring them under the umbrella of BMC. Based on the results of the FAD an outline of the fish sanctuary and improved management guidelines are put forwarded for beel ecosystem.

Ahmed, M., M.M. Dey and Y.T. Garcia. 2007.

**The role of species and systems in the development and growth of aquaculture in Asia: needs and prospects, p. 85-101.** In P.S. Leung, C.S. Lee and P.J. O'Bryen (eds.) Species and systems selection for sustainable aquaculture. Blackwell Publishing, Oxford.

This paper reviews the current practices in Asian aquaculture and emerging trends in species and systems against a backdrop of changing structure of demand, supply and trade. It examines key issues concerning the role of aquaculture as an engine for economic growth in rural areas of developing Asia. Taking examples from South

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and Southeast Asia, the paper also analyzes the prospects and needs of the sector by identifying key technological, socioeconomic, and policy factors that will enhance its role in providing animal protein, employment, income, and foreign exchange to the economy and its population.

Ahmed, M., G.M. Umali, C.K. Chong, M.F. Rull and M.C. Garcia. 2007.

**Valuing recreational and conservation benefits of coral reefs - The case of Balinao, Philippines.** *Ocean and Coastal Management* 50(1-2): 103-118.w

The recognition of recreational and conservation benefits of coral reefs globally provides a sound economic rationale for their management. The value of recreational and conservation benefits of coral reefs along the Lingayen Gulf, Bolinao, Philippines is evaluated using travel cost and contingent valuation methods, respectively. Empirical results generated consumer surplus valued at PhP10,463 (US\$223) per person per annum or potential net annual revenues to the local economy worth PhP220.2 million (US\$4.7 million) from an estimated 21,042 visitors to Bolinao in 2000. However, willingness to pay (WTP) values (in absolute terms and as a percentage of income) for the conservation of coral reefs at Bolinao that were elicited are low, particularly among domestic tourists. This implies that preservation of natural resources and the environment may not be an immediate priority among local travelers due to socio-economic considerations in developing countries, such as the Philippines and the public goods nature of the recreational services provided by coral reefs. These results have further implications for determining the values of coral reefs to support public investment for their conservation and management. The roles of advocacy, education, and awareness campaigns have been highlighted to create a larger WTP for the management of coral reefs.

Ahmed, N., E. Allison and J. Muir. (In press)

**Using the sustainable livelihoods framework to identify constraints and opportunities to the development of freshwater prawn farming in southwest Bangladesh.** *Journal of the World Aquaculture Society*.

A conceptual framework, drawn from an approach to poverty reduction known as the Sustainable Livelihoods Approach (SLA), is applied to understanding the role of freshwater prawn, *Macrobrachium rosenbergii*, farming in gher (modified rice fields with high, broad peripheral dikes) systems in southwest Bangladesh. Gher farming potentially allows incorporation of a wide variety of crops together with prawn, fish, dike crops and rice culture. The analysis shows how, in a gher farming context, sustainable livelihoods are achieved through access to a range of livelihood assets

which are combined in the pursuit of prawn farming strategies. The study used the SLA framework as a diagnostic tool to identify ways of strengthening the livelihoods of the prawn farmers.

Alam, A., M.G. Mustafa and M.A.K. Azad. 2007.

**Water and sediment quality and plankton diversity of Posna beel, Tangail.** Bangladesh Journal of Fisheries (Special Issue) 30:177-188.

Physiochemical studies on water and sediment quality and plankton diversity of Posna beel, Kalihati, Tangail were conducted during 2003-2005. Surface water temperature was minimum (16°C) during winter and maximum (33°C) during summer. Water transparency varied from 25 cm in summer to 189 cm in winter. Other water quality parameters like pH (7.2-8.0), DO (6.6-9.6 mg/L), free CO<sub>2</sub> (5-13 mg/L), alkalinity (28-51 mg/L), total solids (7-123 mg/L), BOD (2.70-5.43 mg/L), COD (5.20-8.15 mg/L), total hardness (51-68 mg/L), NH<sub>3</sub> (0.01-0.07 mg/L), NO<sub>3</sub>-N (0.15-0.48 mg/L) were found to be suitable for freshwater fishes. The beel sediment was rich in nutrient and contained a high amount of organic matter (3.84-6.25 %). Some essential compounds like iron (417-440 µg/g), manganese (23.93-55.63 µg/g), copper (8.0-11.63 µg/g), magnesium (1.83-2.56 meq/100 g) were also found to be high. A total of 48 genera of phytoplankton and 41 genera of zooplankton were recorded. Dinoflagellate bloom was observed throughout the study period. Shannon-Weiner biodiversity indices were found to be higher during monsoon for zooplankton while phytoplankton abundances showed no such specific relationship with season. The physicochemical and biological parameters indicate that the beel was eutrophic in nature.

Allison, E.H., N.L. Andrew and J. Oliver. 2007.

**Enhancing the resilience of inland fisheries and aquaculture systems to climate change.** Journal of SAT Agricultural Research 4(1) Dec 2007 (Online Journal)

Some of the most important inland fisheries in the World are found in semi-arid regions. Production systems and livelihoods in arid and semi-arid areas are at risk from future climate variability and change; their fisheries are no exception. This paper reviews the importance of fisheries to livelihoods in 'wetlands in drylands', with a focus on case-studies in Africa. We examine the threats posed by climate change to the traditional 'tri-economy' of fishing, farming and livestock herding. Although both livelihood strategies and local institutions are highly adapted to cope with, and benefit from, climate-induced variability, weaknesses in the wider governance and macro-economic environment mean that the overall adaptive capacity of these

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regions is low and the farmer-herder-fishers are vulnerable to projected climate change. In order to maintain the important nutritional, economic, cultural and social benefits of fisheries in the face of climate change, planned adaptation at scales from the local to the regional (trans-national) is required. We use the concept of resilience in linked social-ecological systems to examine how such responses may be developed and promoted. Key strategies include facilitating people's geographical and occupational mobility, improving intersectoral water and land-use planning, and promoting forms of aquaculture that help build resilience of farming systems to seasonal and episodic water deficits.

Andrew, N.L., C. Béné, S.J. Hall, E.H. Allison, S. Heck and B.D. Ratner. 2007.

**Diagnosis and management of small-scale fisheries in developing countries.** *Fish and Fisheries* 8(3):227-240.

Small-scale fisheries (SSF) make important but undervalued contributions to the economies of some of the world's poorest countries. They also provide much of the animal protein needed by societies in which food security remains a pressing issue. Assessment and management of these fisheries is usually inadequate or absent and they continue to fall short of their potential as engines for development and social change. In this study, we bring together existing theory and methods to suggest a general scheme for diagnosing and managing SSF. This approach can be adapted to accommodate the diversity of these fisheries in the developing world. Many threats and solutions to the problems that beset SSF come from outside the domain of the fishery. Significant improvements in prospects for fisheries will require major changes in societal priorities and values, with consequent improvements in policy and governance. Changes in development policy and science reflect these imperatives but there remains a need for intra-sectoral management that builds resilience and reduces vulnerability to those forces beyond the influence of small-scale fishers.

Arthington, A.H., E. Baran, C.A. Brown, P. Dugan, A.S. Halls, J.M. King, C.V. Minte-Vera, R.E. Tharme and R.L. Welcomme. 2007.

**Water requirements of floodplain rivers and fisheries: existing decision support tools and pathways for development.** Comprehensive assessment of water management in agriculture research report 17. International Water Management Institute, Colombo.

This report comprehensively reviews current environmental flow methodologies and fisheries production models to show that the combination of the DRIFT (Downstream Response to Imposed Flow Transformation) methodology and the Bayesian



networks and age-structured fisheries models provides the most promising decision support tools that sustain the productivity and full developmental benefits of large rivers and floodplains.

Azher, S.A., S. Dewan, M.A. Wahab, M.A.B. Habib and M.G. Mustafa. 2007.

**Impact of fish sanctuaries on production and biodiversity of fish and prawn in Dopi beel, Joanshahi haor, Kishoregonj.** Bangladesh Journal of Fisheries (Special Issue) 30:23-36.

The impacts of sanctuary on fish production and fish biodiversity were investigated in Dopi beel in Joanshahi haor over a period of two years from January 2004 to December 2005. Broadly two different types of materials were used to set two sanctuaries in Dopi beel referred to as Treatment 1 and Treatment 2; the control treatment was set in another beel named Chotadigha-boradigha beel without using any materials. Data on fish production and species abundance obtained from different treatments were compared. Ten major groups of fish viz carp, barb and minnow, catfish, featherback, snakehead, perch, eel, loach, miscellaneous fishes and prawn were obtained in the final harvest from different treatments. The fish species number was registered at 57, 60 and 62 in 2003 (before intervention), 2004 and 2005, respectively in Dopi beel, while that in Chotadigha-boradigha beel during the same period was 60, 55 and 50, respectively. The total production obtained from the Dopi beel was much higher than that from the Chotadigha-boradigha beel. The fish species deemed as threatened were found to reappear in Dopi beel, while in Chotadigha-boradigha beel the number of threatened species had been decreased over the 3-year period. The highest density index ( $H=0.89$ ) and species richness ( $E=0.62$ ) of threatened species were recorded in Treatment 1. Generally the yield of large species had been increased in Dopi beel during the investigation period. The establishment and management of sanctuaries in the beel had beneficial effects on the production of fish.

Bell, J.D., N.N. Agudo, S.W. Purcell, P. Blazer, M. Simutoga, D. Pham and L.D. Patrona. 2007.

**Grow-out of sandfish *Holothuria scabra* in ponds shows that co-culture with shrimp *Litopenaeus stylirostris* is not viable.** Aquaculture 273(4):509-519.

The potential for producing the large numbers of sandfish (*Holothuria scabra*) needed for restocking programmes by co-culturing juveniles with the shrimp *Litopenaeus stylirostris* in earthen ponds. Our experiments in hapas within shrimp

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ponds were designed to detect any deleterious effects of sandfish on shrimp, and vice versa. These experiments showed that a high stocking density of juvenile sandfish had no significant effects on growth and survival of shrimp. However, survival and growth of sandfish reared with shrimp for 3 weeks were significantly lower than for sandfish reared alone. Increased stocking density of shrimp also had a significant negative effect on survival and/or growth of sandfish. A grow-out trial of juvenile sandfish in 0.2-ha earthen ponds stocked with 20 shrimp post-larvae  $m^{-2}$ , and densities of sandfish between 0.8 and 1.6 individuals  $m^{-2}$ , confirmed that co-culture is not viable. All sandfish reared in co-culture were dead or moribund after a month. However, sandfish stocked alone into 0.2-ha earthen ponds survived well and grew to mean weights of ~400 g within 12 months without addition of food. The grow-out trial demonstrated that there is potential for profitable pond farming of sandfish in monoculture. Further research is now needed to identify the optimal size of juveniles, stocking densities and pond management regimes.

Bell, S.S., A. Tewfik, M.O. Hall and M.S. Fonseca. 2007.

**Evaluation of seagrass planting and monitoring techniques: implications for assessing restoration success and habitat equivalency.** Restoration Ecology (Published online 12 Nov 2007)

Restoration has become an integral part of coastal management as a result of seagrass habitat loss. We studied restoration of the seagrass (*Halodule wrightii*) near Tampa Bay, Florida. Experimental plots were established in June 2002 using four planting methods: three manually planted and one mechanically transplanted by boat. Seagrass cover was recorded at high resolution (meter scale) annually through July 2005. Natural seagrass beds were concurrently examined as reference sites. We also evaluated the suitability of a commonly used protocol (Braun-Blanquet scores, BB) for comparing the development of seagrass cover using the planting methods and quantifying spatial patterns of cover over time. Results show that BB scores mirrored conventional measures of seagrass characteristics (i.e., shoot counts and above- and belowground biomass) well when BB scores were either low or very high. However, more caution may be required at intermediate cover scores as judged by comparison of BB scores with direct measurement of seagrass abundance. Significant differences in seagrass cover were detected among planting methods and over time (2002–2005), with manual planting of rubber band units resulting in the highest cover. In contrast, the peat pot and mechanical planting methods developed very low cover. Recovery rates calculated from development of seagrass spatial cover were less than those reported for natural expansion. Importantly, time to baseline recovery may be substantially greater than 3 years and

beyond standard monitoring timelines. Prolonged recovery suggests that the rate of service returns, critical for estimating compensatory restoration goals under habitat equivalency analysis, may be severely underestimated.

Bose, M.L. and M.M. Dey. 2007.

**Food and nutritional security in Bangladesh: going beyond carbohydrate counts.** *Agricultural Economics Research Review* 20 (Jul-Dec):203-225.

The progress towards achieving household nutritional food-security in Bangladesh has remained slow. So far the food security is cereal-based (mainly rice) and food basket has not yet diversified towards high nutritive/ quality food. This article has examined the expenditure inequalities in the dietary pattern and incidence of poverty in Bangladesh by using household income, expenditure and food consumption survey data. Results have shown wide-spread inequalities in income and expenditure distribution. Among food items, the inequalities have been found very low for cereals and high for livestock and horticulture commodities and various types of fish species in both rural and urban areas. The analysis of food poverty, its depth and severity has revealed a typical hidden poverty that could not be brought up by analyzing economic poverty. The food poverty has been found high for pulses, horticulture and livestock commodities among both economically rich and poor households. Fish, livestock, horticulture and pulses sectors should be accorded high priority to diversify the dietary pattern towards high quality food and improve the nutritional food-security of households in Bangladesh.

Brooks, S.E., E.H. Allison and J.D. Reynolds. 2007.

**Vulnerability of Cambodian water snakes: initial assessment of the impact of hunting at Tonle Sap Lake.** *Biological Conservation* 139 (3-4):401-414.

This paper documents the emergent snake 'fishery' occurring on Tonle Sap Lake where an estimated 6.9 million snakes (mostly homalopsids) are removed annually, representing the world's largest exploitation of a single snake assemblage. Based on interviews with hunters, we found that snake catches declined by 74–84% between 2000 and 2005, raising strong concerns about the sustainability of this hunting operation. A combination of experimental trials to estimate population sizes and extensive catch and trade monitoring programs indicated that population density varies both spatially and temporally, largely due to the seasonally fluctuating environment of Tonle Sap Lake. The quantity of snakes captured mirrors the lake's seasonal fluctuations, due to temporal changes in both catch per unit effort and the

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number of people hunting. Through interviews with hunters we scored the seven exploited species for perceived changes in catch size. All species were reported as declining and their scores match their predicted vulnerability based on a combination of timing of exploitation relative to breeding, proportion of catch consisting of mature females and large fecund females, fecundity, body size, size at maturity, and vulnerability to capture by gill nets. This information can inform conservation decisions for the long-term preservation of this snake assemblage. We propose emphasis should be placed on the snake skin trade that is targeting the largest, highly fecund females, and that any efforts to reduce hunting should focus on the peak in trade that occurs during the main breeding season.

Brummett, R.E. 2007.

**Freshwater fish seed resources and supply: Africa regional synthesis**, p. 41-58. *In* M.G. Bondad-Reantaso (ed.) Assessment of freshwater fish seed resources for sustainable aquaculture. FAO Fisheries Technical Paper no. 501. FAO, Rome.

The availability and quality of fingerlings for stocking in aquaculture ponds have repeatedly been identified as a key constraint to the development of aquaculture in Africa. Government hatcheries have generally failed to achieve sustainability and the private sector is impeded by the lack of marketing information and appropriate technological assistance. At present, the main aquaculture species in the continent are Nile tilapia (*Oreochromis niloticus*) and the African sharptooth catfish (*Clarias gariepinus*). While the tilapias are easy to reproduce on-farm, poor broodstock management had resulted in reduced growth rates in many captive populations. Catfish are mostly reproduced in hatcheries, but availability of broodstock and high mortality rates in larvae are key problems still requiring research. Of the countries reviewed, Egypt (1.2 billion tilapia and 250 million carp fingerlings produced) and Nigeria (30 million fingerlings produced) report the highest number of modern private commercial hatcheries, although most of these are unregulated and lack accreditation and certification systems. Ghana, Cameroon, Uganda and Zimbabwe rely almost entirely on semi-commercial systems producing unreliable quantities and quality of seed. Interventions to improve the quality of extension services, make credit more available and build partnerships between public and private sectors to address key researchable topics are recommended to improve the availability of fish seed to African fish farmers.

Brummett, R.E. 2007.

**Freshwater fish seed resources in Cameroon**, p. 171-183. *In* M.G. Bondad-Reantaso (ed.) Assessment of freshwater fish seed resources for sustainable aquaculture. FAO Fisheries Technical Paper no. 501. FAO, Rome.

The climate, land and water resources of Cameroon, combined with the high demand for fisheries products, makes this Central African country a high potential area for aquaculture. Fingerling availability and quality have been identified as key constraints which hold the sector back from rapid expansion. Nile tilapia (*Oreochromis niloticus*) and sharp-tooth catfish (*Clarias gariepinus*) are the two most widely cultured species and are often grown in polyculture. Some 32 government hatcheries have been built, but few are functional and none operates at full capacity. Most producers rely on 14 small-scale, private sector hatcheries for their seeds, but supply is irregular and quality remains a serious problem. New policy and research initiatives undertaken by a coalition of government, private sector and international research agencies are underway to address these inadequacies.

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Brummett, R.E. 2007.

**Indigenous species for African aquaculture development**, p. 229-245. In T.M Bert (ed.) Ecological and genetic implications of aquaculture activities. Springer.

From the history of introductions and the development of successful aquaculture elsewhere, it appears that the use of exotic species to speed up the rate of aquaculture development in Africa is unlikely to be an efficacious strategy. The major sustained aquaculture industries worldwide evolved from close working relationships between pioneering investors and local research-and-development institutions. The use of indigenous species avoids many environmental risks, facilitates broodstock and hatchery management at the farm level, and can increase the effectiveness of selective breeding programs. Public-sector involvement in the domestication and marketing of indigenous species can strengthen research, development, and education; broaden the range of investors; create more jobs; and increase the social benefits accruing as a result of aquaculture development.

Brummett, R.E. and G.G. Teugels. 2007.

**Socioeconomic and ecological considerations in the management of Lower Guinea rainforest rivers**. Journal of Afrotropical Zoology (Special Volume)

Low order rainforest streams in Central Africa represent the largest single riverine ecosystem on the continent. Of the 8 million people who live in the Lower Guinea

Rainforest, nearly 20% are more or less fulltime fishers and 90% fish at least seasonally. Estimates from Cameroon put the productivity of capture fisheries in forest rivers basins at 0.5 tons/km<sup>2</sup>/yr or 260 000 tons with a cash value of over \$500 million per year. The peculiar ecology of rainforest rivers generates and protects high levels of fish and other biodiversity, only a small percentage of which can be exploited directly for food. However, the retail value of many African rainforest fishes in the international ornamental fish trade is high, wholesaling for an average of \$2.43 per fish. Despite these high values and reported high demand in Europe, the US and Asia, African fishes are in short supply due to the difficulty involved in their capture, holding and transport and the difficulty that overseas commercial breeders have had with their reproduction in captivity. To compete with established fish exporters and ensure that the resource is optimally exploited WorldFish is currently working with fishing communities in SW Cameroon rivers in Cameroon to organize villages, develop a business plan, establish protocols for culture of rare fishes and put in place an environmental monitoring plan to ensure sustainability.

Castella, J.C., S.P. Kam, D.Q. Dang, P.H. Verburg and T.H. Chu. 2007.

**Combining top-down and bottom-up modelling approaches of land use/ cover change to support public policies: application to sustainable management of natural resources in northern Vietnam.**  
Land Use Policy 24:531-545.

Over recent years, the scientific community has developed different modelling methodologies of land use/cover change (LUCC) depending on their intended use, and also on the scale of investigation, disciplinary background and scientific tradition of the research teams. Consequently, each LUCC model has its own potential and constraints with respect to the needs and expectations of land use planners and policy makers. Faced with the issue of integrated management of natural resources from local to regional scales, agricultural research can benefit from reconciling top-down and bottom-up approaches to LUCC modelling. Three modelling methodologies belonging to these two LUCC approaches were applied in the province of Bac Kan in northern Vietnam. The multi-agent model SAMBA was developed through an adaptive, bottom-up process while LUPAS and CLUE contributed to a top-down process. Applying these three methodologies at the same research site allowed a critical evaluation of their respective utility for land use analysis and planning. They played complementary roles in bridging knowledge gaps and increasing interactions between stakeholders along the continuum from research to development and policy formulation. Combined use of these modelling methodologies should be promoted when complex natural resource management issues at multiple scales need to be tackled.

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Charo-Karisa, H., H. Bovenhuis, M.A. Rezk, R.W. Ponzoni, J.A.M. van Arendonk and H. Komen. 2007.

**Phenotypic and genetic parameters for body measurements, reproductive traits and gut length of Nile tilapia (*Oreochromis niloticus*) selected for growth in low-input earthen ponds.** *Aquaculture* 273:15-23.

In this study we present estimates of phenotypic and genetic parameters for body size measurements, reproductive traits, and gut length for Nile tilapia (*Oreochromis niloticus*) selected for growth in fertilized earthen ponds for two generations. Throughout the experiment, ponds were fertilized daily with 50 kg dry matter, (dm)/ha chicken manure. No supplementary feeds were added. For the analysis, 6429 fully pedigreed experimental fish from G0, G1 and G2 were used. Generations were discrete and therefore parameters were estimated separately for each year. Heritability estimates for body measurements ranged from 0.4–0.6 for standard length to 0.69–0.79 for head length. Phenotypic correlations between body weight and body measurements ranged from 0.64 to 0.89. Genetic correlations were close to unity. The heritability estimate for maturity at harvest (corrected for sex) was 0.13. Heritabilities for carcass traits were estimated from G1 only and were 0.16 for gutted weight and 0.06 for dressing percentage. Phenotypic correlation between body weight and gutted weight was 0.84 and the genetic correlation was 0.20. Heritability estimate for gut length was 0.22. We also estimated a high genetic correlation between gut length index and standard length (0.78) but a low genetic correlation between gut length index and body weight (0.22±0.28). These results suggest that selection for growth on an herbivorous diet could result in a correlated response in gut length.

Charo-Karisa, H., B. Henk, M. Rezk and H. Komen. 2007.

**Selecting Nile tilapia (*Oreochromis niloticus*) for growth in low-input environments,** p. 25-36. *In* A.J. van der Zijpp, J.A.J. Verreth, L.Q. Tri, M.E.F van Mensvoort, R.H. Bosma and M.C.M. Beveridge (eds.) *Fishponds in farming systems*. Wageningen Academic Publishers, the Netherlands.

This chapter presents the results from a selective breeding experiment with Nile tilapia in a low input pond environment. The environment was defined as low input as the pond only received chicken manure for fertilisation. No pellets were given to the fish during larval rearing or grow out. The results show that good growth can be obtained under these conditions. Heritability for growth was high (0.6) and harvest body weight almost doubled over two generations of selection. A conclusion is that selecting Nile tilapia in low-input environments is cheap and sustainable and can be particularly relevant for resource-poor farmers in sub-Saharan Africa.



Chowdhury, M.A.K., D.P. Bureau, M.L. Bose and M. Dey. 2007.

**Relevance of a rapid appraisal approach to identify locally available feed ingredients to small-scale Nile tilapia (*Oreochromis niloticus* L.) aquaculture.** *Aquaculture Economics and Management* 11(2):151-169.

Applications of a rapid appraisal approach to identify locally available feed ingredients in feed formulation, production, and socio-economics of Nile tilapia aquaculture in Bangladesh are discussed. Three diets of 35%, 30%, and 25% crude protein were formulated using locally available ingredients, and their essential amino acid profiles were assessed for Nile tilapia. Six production scenarios were constructed using these diets and two culture periods of 100 and 150 days were considered. The production scenarios with 35% protein yielded the highest productivity and profitability over the 150-day culture period followed by the 30% protein scenario. Identification of locally available ingredients and their application in small-scale Nile tilapia aquaculture may lead to: (1) increased availability of inexpensive sources of fish production for poor people; (2) increased fish consumption; (3) increased self employment and involvement of women in productive activities; and (4) increased household income to reduce poverty.

Das Mahapatra, K, J.N. Saha, N. Sarangi, R.K. Jana, B. Gjerde, N.H. Nguyen, H.L. Khaw and R.W. Ponzoni. 2007.

**Genetic improvement and dissemination of rohu (*Labeo rohita*, Ham.) in India**, p. 37-40. *In* Proceedings of the Association for the Advancement of Animal Breeding and Genetics 17. Association for the Advancement of Animal Breeding and Genetics, New South Wales.

For the first time in India, selective breeding was carried out to genetically improve one of the most preferred carp species (Rohu). Under the program a range of selective breeding techniques (production of fullsib groups, individual identification by PIT tags, communal pond rearing, estimation of breeding value and ranking of individuals in different year classes) were used. In five generations of selection for greater harvest weight an average 17 % genetic gain per generation was obtained. On farm trials have proven the strain's superiority and it is being disseminated to farmers.

Dugan, P., V.V. Sugunan, R.L. Welcomme, C. Béné, R.E. Brummett and M.C.M. Beveridge. 2007.

**Inland fisheries and aquaculture**, p. 459-483. *In* D. Molden (ed.) *Water for food, water for life*. Earthscan, London.

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This review showed that the contributions from inland fisheries and aquaculture in economic and social development are undervalued and warrant integrated water management approach to address the various challenges presented effectively.

Eknath, A.E., H.B. Bentsen, R.W. Ponzoni, M. Rye, N.H. Nguyen, J. Thodesen and B. Gjerde. 2007.

**Genetic improvement of farmed tilapias: composition and genetic parameters of a synthetic base population of *Oreochromis niloticus* for selective breeding.** *Aquaculture* 273(1):1-14.

The present study is based on data recorded from fish of the third generation of the GIFT project (Genetic Improvement of Farmed Tilapias). The objective of the study was to compose a synthetic base population of Nile tilapia for further selective breeding, and to estimate phenotypic and genetic parameters in that population. The base population was formed by choosing parent stock among the best performing animals within the best strain combinations resulting from a full diallel cross design (8 × 8) involving four African wild strains and four Asian farmed strains (64 strain combination cells altogether). The grandparent ancestors of the base population were mainly representing the three strains originating from Egypt, Kenya and Thailand (20.2, 27.3 and 19.6%, respectively). The proportion of ancestors from the Senegal strain was medium (12.2%) whereas the proportion of ancestors from Ghana, Israel, Singapore and Taiwan strains was low (3 to 8%) and mainly due to a restriction that all parent strains should be represented in the synthetic base. Statistical analyses using a mixed animal model were carried out on records from 13,570 individually tagged and surviving progeny of 50 sires and 123 dams. The growth performance of the fish was tested in seven diverse environments. The test environments covered a wide range of tilapia farming systems, namely, earthen ponds fertilized with inorganic fertilizer and organic manure or on-farm agricultural residues, cage culture, and test stations located in different agro-climatic regions. The model fitted included the fixed effect of test environment and sex and the linear and quadratic covariate of age at stocking. The random terms were the additive genetic effect of individual fish and the additional effects common to full-sib groups. The estimates of heritability for body weight at harvest in different test environments ranged from moderate to high (0.12 to 0.56) and the estimate across test environments was 0.15. The variances due to other effects common to full-sib families were significant, accounting for 8 to 16% of total variation in body weight. The genetic correlations among body weights recorded in similar environments were high (mostly > 0.80, i.e. among the earthen ponds in experimental locations). By contrast, the genetic correlations between harvest weight in earthen pond and in cage environments were more variable (0.36–0.82). Overall, the results suggested

that the genotype by environment interactions were of limited importance, at least for the target pond farming systems in the Philippines. It was concluded that as the additive genetic variation in the base population was large, the harvest weight of the GIFT fish could be effectively improved by selective breeding, and that there was no immediate need to develop separate strains for different environments.

El Naggar, G. 2007.

**Efficiency of African catfish *Clarias gariepinus* in controlling unwanted reproduction of Nile tilapia *Oreochromis niloticus* in low input production system.** Egyptian Journal of Aquatic Biology and Fisheries 11(3):105-113.

Tilapia production in polyculture with catfish was significantly lower than tilapia monoculture while, on the other hand, total fish production was significantly ( $P < .05$ ) higher in the case of both of the two polyculture treatments compared to the tilapia only treatment. The overall conclusion of the present experiment showed that under such stocking rate and production system, introduction of catfish at the rate of 13% of total Tilapia stocked has not only eliminated 70% of total Tilapia recruitment but also enhanced total pond production of marketable size fish in both of the polyculture treatments.

Fessehaye, Y., H. Bovenhuis, M. Rezk, R. Ponzoni and H. Komen, 2007.

**Mass spawning of *Oreochromis niloticus* for fry production: threats and opportunities for small-scale aquaculture and selective breeding,** p. 37-48. In A.J. van der Zijpp, J.A.J. Verreth, L.Q. Tri, M.E.F van Mensvoort, R.H. Bosma and M.C.M. Beveridge (eds.) Fishponds in farming systems. Wageningen Academic Publishers, the Netherlands.

Mass selection based on mass spawning can present a feasible and low-cost selective breeding scheme. In mass spawning, however, mating is not controlled and a small number of breeding individuals may account for a large proportion of the next generation, leading to higher inbreeding, decrease in performance of stocks and no response to selection: To understand the mating systems, reproductive and population parameters under mass spawning, we conducted mass spawnings with female to male sex ratios of 1:1, 2:1 and 3:1. We analyzed parentage, established the effective number of parents contributing to the next generation and calculated reproductive parameters and the associated level of inbreeding in an experimental breeding unit. Considering the breeding units as basic building blocks, mass selection breeding programs based on mass spawning can be implemented by extrapolating the number of breeding units depending on the size of the nucleus

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and the intensity of selection. Such schemes require minimum investments in infrastructure and can be adopted as a model for low-cost and effective selective breeding schemes that will produce the desired response without compromising the long-term fitness of culture populations due to inbreeding.

Fontaine, B., P. Bouchet, K. Van Achterberg, M.A. Alonso-Zarazaga, R. Araujo, M. Asche, U. Aspöck, P. Audisio, B. Aukema, N. Bailly, M. Balsamo, R.A. Bank, P. Barnard, C. Belfiore, W. Bogdanowicz, T. Bongers, G. Boxshall, D. Burckhardt, J.-L. Camicas, P. Chylarecki, P. Crucitti, L. Deharveng, A. Dubois, H. Enghoff, A. Faubel, R. Fochetti, O. Gargominy, D. Gibson, R. Gibson, M.S.G. López, D. Goujet, M.S. Harvey, K.-G. Heller, P. Van Helsdingen, H. Hoch, H. De Jong, Y. De Jong, O. Karsholt, W. Los, L. Lundqvist, W. Magowski, R. Manconi, J. Martens, J.A. Massard, G. Massard-Geimer, S.J. Mcinnes, L.F. Mendes, E. Mey, V. Michelsen, A. Minelli, C. Nielsen, J.M. Nieto Nafria, E.J. Van Nieukerken, J. Noyes, T. Pape, H. Pohl, W. De Prins, M. Ramos, C. Ricci, C. Roselaar, E. Rota, A. Schmidt-Rhaesa, H. Segers, R. Zur Strassen, A. Szeptycki, J.-M. Thibaud, A. Thomas, T. Timm, J. Van Tol, W. Vervoort and R. Willmann. 2007.

**The European union's 2010 target: putting rare species in focus.**

Biological Conservation 139 (1-2):167-185.

The European Union has adopted the ambitious target of halting the loss of biodiversity by 2010. Several indicators have been proposed to assess progress towards the 2010 target, two of them addressing directly the issue of species decline. In Europe, the Fauna Europaea database gives an insight into the patterns of distribution of a total data set of 130,000 terrestrial and freshwater species without taxonomic bias, and provide a unique opportunity to assess the feasibility of the 2010 target. It shows that the vast majority of European species are rare, in the sense that they have a restricted range. Considering this, the paper discusses whether the 2010 target indicators really cover the species most at risk of extinction. The analysis of a list of 62 globally extinct European taxa shows that most contemporary extinctions have affected narrow-range taxa or taxa with strict ecological requirements. Indeed, most European species listed as threatened in the IUCN Red List are narrow-range species. Conversely, there are as many wide-range species as narrow-range endemics in the list of protected species in Europe (Bird and Habitat Directives). The subset of biodiversity captured by the 2010 target indicators should be representative of the whole biodiversity in terms of patterns of distribution and abundance. Indicators should not overlook a core characteristic of biodiversity, i.e. the large number of narrow-range species and their intrinsic vulnerability. With ill-selected indicator species, the extinction of narrow range endemics would go unnoticed.

Goda, A.M., E.R. El-Haroun and M.A.K. Chowdhury. 2007.

**Effect of totally or partially replacing fish meal by alternative protein sources on growth of African catfish *Clarias gariepinus* (Burchell, 1822) reared in concrete tanks.** Aquaculture Research 28:279-287.

A 12-week feeding trial was carried out in concrete tanks to examine complete and partial replacement (75%) of fish meal (FM) with poultry by-product meal (PBM), meat and bone meal (MBM) and soybean meal (SBM) in practical feeds for African catfish *Clarias gariepinus*. Triplicate groups of fish (initial body weight ranged from 90.33 to 93.93 g fish<sup>-1</sup>) were fed seven isonitrogenous and isocaloric diets of 20% digestible protein and 300 kcal 100g<sup>-1</sup> of digestible energy. The control contained 25% herring meal, whereas in the other six diets, PBM, MBM and SBM replaced 75% or 100% of the FM. Final body weight (FBW) and specific growth rate (SGR) of the fish fed diets containing PBM (75% and 100%), SBM (75% and 100%) and MBM (75%) were all higher, but not significantly different than those for fish fed the control diet. Replacing 100% of the FM by MBM significantly lowered FBW and SGR. Concerning whole body composition, there were no significant differences in ash and gross energy content of whole-body among fish; fish fed diets containing PBM-100% recorded significantly lower protein content compared with the control diet, while fish fed diet SBM-100% recorded significantly lower moisture content compared with the control diet. Also fish fed diets SBM-100% and PBM-75% recorded higher lipid and gross energy contents compared with the control diet. The study revealed that satisfactory growth and feed utilization responses could be achieved through the replacement of FM by PBM, SBM and MBM in the diet of African catfish.

Goda, A.M.A.-S., M.E. Wafa, E.R. El-Haroun and M.A.K. Chowdhury. 2007.

**Growth performance and feed utilization of Nile tilapia *Oreochromis niloticus* (Linnaeus, 1758) and tilapia galilae *Sarotherodon galilaeus* (Linnaeus, 1758) fingerlings fed plant protein-based diets.** Aquaculture Research 38:827-837.

This study was designed to determine the effect of complete substitution of fish meal (FM) by three plant protein sources including extruded soybean meal (SBM), extruded full-fat soybean (FFSB) and corn gluten meal (CGM) on growth and feed utilization of Nile tilapia *Oreochromis niloticus* and tilapia galilae *Sarotherodon galilaeus*. Four isonitrogenous of crude protein (ca.28.0%) and isocaloric (ca.19MJ kg<sup>-1</sup>) experimental diets were formulated. The control diet (diet 1) was prepared with FM as the main protein sources. Diets 2-4, each FM control diet, were completely substituted with SBM (diet 2), FFSB (diet 3) and CGM (diet 4). L-lysine and DL-methionine were added to plant protein diets to cover the nutritional requirements of tilapia. Each treatment was allocated to three net pens and fed for 17 weeks. Nile

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tilapia fed the control diet showed significantly higher ( $P \leq 0.05$ ) values for final body weight (FBW), feed intake (FI), weight gain (WG) and specific growth rate (SGR), whereas fish fed the diet with CGM achieved the lowest values. Tilapia galilae fed SBM diet recorded the highest ( $P \leq 0.05$ ) values for growth performance. Better feed conversion ratio (FCR) for both *Oreochromis niloticus* and *Sarotherodon galilaeus* was observed when fish were fed SBM diet, whereas the worse FCR was recorded for FFSB diet. Feed utilization parameters including protein productive value (PPV), fat retention (FR) and energy retention (ER) showed significant differences ( $P \leq 0.05$ ) for both the species fed different dietary protein sources. The present results suggest that, for Nile tilapia, both SBM and FFSB supplemented with DL-methionine and L-lysine can completely replace dietary FM. Meanwhile, *S. galilaeus* fed SBM diet exhibited comparable growth and feed utilization with those fish fed a fish-meal-based diet.

Grøttum, J.A. and M. Beveridge. 2007.

**A review of cage aquaculture: Northern Europe**, p. 126–154. In M. Halwart, D. Soto and J.R. Arthur (eds.) Cage aquaculture: regional reviews and global overview, FAO Fisheries Technical Paper. No. 498. Rome, FAO.

Thirty years after the cage aquaculture industry in Europe began, the industry has matured. The main species in northern Europe are the Atlantic salmon (*Salmo salar*) and rainbow trout (*Oncorhynchus mykiss*). The majority of production is in Norway, Scotland, Ireland and Faroe Islands. However, also countries as Finland, Iceland, Sweden and Denmark have a cage culture industry. All relevant aquaculture production using cage technology in northern Europe is carried out in marine waters. The production volume in 2004 is about 800000 tonnes of Atlantic salmon and about 80 000 of rainbow trout. The production volume of Atlantic salmon is expected to grow further, while rainbow trout for the moment shows a negative trend. There is an increasing interest to expand the production of other species, such as cod and halibut.

Halls, A.S., M.G. Mustafa and M. Dickson. 2007.

**An empirical bio-economic stocking model for floodplain beels in Bangladesh**. Aquaculture Research 38:947-952.

While stocking floodplain depressions or beels with fingerlings is a common form of fisheries management in Bangladesh, bio-economic guidance for improving the outcome of stocking strategies is sparse. The Community-Based Fisheries Management (CBFM) Project, funded by the Ford Foundation and the UK Government's Department for International Development (DFID) promoted stocking

practices in beels throughout the country as a means to improve fisher livelihoods. This paper describes an empirical bio-economic model developed using data generated under the CBFM project. The model offers guidance on selecting stocking densities depending upon the available size (length) of fingerlings to maximize profit and return on investment while minimizing risk. Because large fingerlings are relatively inexpensive and have lower rates of natural mortality, the model predicts that it is more profitable to stock large fingerlings at low densities than small fingerlings at high densities. These general recommendations were found to be largely insensitive to the market price for harvested fish. To minimize credit burden and financial risk, minimum stocking densities should be selected according to the length of fish available that maximizes profit. Because of its empirical nature, the model recommendations may not be applicable beyond the project sites. Furthermore, it is recommended that attempts be made to field test the model predictions before widespread adoption or promotion.

Haque, M., M. Ahmed and M.G. Mustafa. 2007.

**Preferences of fishes to different types of Katha materials used in sanctuaries in three rivers of Netrokona.** Bangladesh Journal of Fisheries (Special Issue) 30: 153-163.

Use of different fish-friendly 'katha' materials in fish sanctuary is a new concept in Bangladesh. Two kilometers area of each of the three rivers namely the Updakhali, the Kalihar and the Kangsha in Netrokona district were used to set up four sanctuaries in order to evaluate the preference of fishes to katha materials. Three types of katha materials viz. tree roots, bamboo roots and tree branches (traditional) and one blank spot (without katha materials) as control were tested. The study was conducted for two years from November 2003 to March 2005 and fish were harvested three times per year during December, February and March. A total of 43 species of fish were recorded. In the second year, the total number of fish increased 6.40, 8.42 and 8.39 folds than that of the first year in the tree root, bamboo root and traditional katha, respectively. The maximum species compositions (40) was found in the traditional katha and the minimum (30) in the bamboo root katha. Out of 43 species, 11 species were found to prefer all the three types of katha materials and aggregated in large numbers. Among the mostly available 11 species, Titari, *Psilorhynchus sucatio* showed the highest abundance (3,859) followed by Tengra, *Mystus vittatus* (3,597) in traditional and bamboo root kathas, respectively in the second year while Tengra also showed highly preference for bamboo root Katha in the first year. Prawn (*Macrobrachium rude*) showed no special affinity for any particular katha while Mola (*Amblypharyngodon mola*), Chanda (*Chanda ranga*), Chapila (*Gudusia chapra*), and Darkina (*Esomus danricus*) showed the highest preference for traditional katha.

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Heck, S., C. Béné and R. Reyes-Gaskin. 2007.

**Investing in African fisheries: building links to the millennium development goals.** *Fish and Fisheries* 8:211-226.

Despite the large economic and social benefits fisheries can offer to address Africa's development needs, investment in African fisheries and aquaculture has been remarkably low. However, if fisheries and aquaculture are to meet the challenges of technological change, institutional reforms and resource mobilization needed in support of the sector's development potential, fisheries stakeholders must make the case for investment much more clearly within the context of wider socioeconomic development. In this paper, we argue that the global consensus around the Millennium Development Goals (MDGs) offers an important opportunity to pursue this agenda in Africa. In particular the MDGs' human development focus provides a compelling framework for articulating the comprehensive value of fisheries for poverty reduction and long-term socioeconomic development. The paper has two objectives. The first is to examine the direct and indirect links between fisheries and the individual MDGs, drawing together findings and lessons learnt from recent African case studies with relevant examples from elsewhere. The second is to translate these findings into recommendations for action in support of improved investments in fisheries aimed at increasing the overall development value of the sector.

Hossain, M., D. Lewis, M.L. Bose and A. Chowdhury. 2007.

**Rice research, technological progress, and poverty: the Bangladesh case,** p. 56-102. *In* M. Adato and R. Meinzen-Dick (eds.) *Agricultural research, livelihoods, and poverty: studies of economic and social impacts in six countries.* Johns Hopkins University Press, Baltimore, MD.

This case study assesses the impact on poverty of the technological changes in rice cultivation made by IRRI and its national partners in Bangladesh. Modern varieties (MVs) with higher yield potential were first introduced more than 20 years ago, and 47 varieties have since been released for different agroecological conditions. Because of the importance of rice and the increases in both yield and labour requirements of MVs, agricultural research has had both direct effects on adopting farmers and indirect effects on employment and prices. This case study analyses direct on-farm benefits, indirect effects through employment and rice prices, and positive and negative impacts of mediating institutions, such as the markets for land, labour, water and credit. Nationwide panel data existed for 1987, 1990 and 1995 that were supplemented in 2000 with a resurvey and qualitative data collection on institutional change.



Israel, D.C., M. Ahmed, E. Petersen, B.H. Yeo and M.C. Hong. 2007.

**conomic valuation of aquatic resources in Siem Reap Province, Cambodia.** Journal of Sustainable Agriculture 3(1):111-135.

The direct values of aquatic resources (freshwater) used in livelihood activities by rural households in Siem Reap, Cambodia were estimated using the net economic value method. The constraints faced by households to access these resources were also analyzed. Data used were from cross-section household survey, longitudinal monitoring, and participatory rural appraisal activities done among selected households from 2003 to 2004. In general, the study found that aquatic resources had substantial value in terms of income, employment, and overall livelihoods to households in both extractive and non-extractive activities. Among others, the study found that (1) fish catch per household was higher in the dry season than in the wet season and among higher wealth households than medium and lower wealth households; (2) livelihood activities earned positive net incomes even when labor was included as part of costs; (3) generally, labor formed a significant part of the costs of livelihood activities; and (4) the presence of fishing lots was the main access issue facing households in the use of aquatic resources. The study explored the implications of the results to the management and sustainable development of aquatic resources in Siem.

John, G., S. Mesalhy, M. Rezk, G. El-Naggar and M. Fathi. 2007.

**Effect of some immunostimulants as feed additives on the survival and growth performance of Nile tilapia, *Oreochromis niloticus* and their response to artificial infection.** Egyptian Journal of Aquatic Biology and Fisheries 11(3):1299-1308

Four plant based immunostimulants (*Echinacea purpurea* 0.25 and 1.0 ppt, *Allium sativum* 3 %, *Nigella sativa* 3% and *Origanum marjorana* 2 and 3% and mixture of *Allium sativum*, *Nigella sativa* 3:1, 1:3 and 3:3%, respectively ) were tested as feed additives for their effect on the survival and growth of 1600 *Oreochromis niloticus*. The mean weights of fish used in the various treatments was  $1.11 \pm 0.01$ . Four ponds were used in this experiment, each contained 10 hapas represented 10 treatments including the control that randomly distributed and each hapa contained 40 fish. The experiment was conducted in two phases ie; the summer (3 months) where tilapia fed basal diet mixed with feed additives and the winter (6 months) where tilapia feed on basal diet only. By end of first phase (summer), weight gain in fish treated with 1 ppt echinacea (E2) was significantly higher than that in the control. The observed values of the biomass in all the treatment groups were higher than that in the control group. Hematocrit values showed significant changes in all

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treatments except marjoram. By end of second phase (winter) phase, the observed mean final weights in all treatments were higher than the control. The mean weight gains were significantly higher than that in the control in most treated groups. Overall survival during rearing and survival in response to challenge infection were significantly higher in the groups that received immunostimulants in comparison to the control group, however it was type and dose dependant. The results suggest that immunostimulants can enhance survival especially during winter stress. Significant increase in body weight and total biomass production were seen with Echinacea (1.00 ppt). The results have applied value in aquaculture.

Kam, S.P. and C.T. Hoanh. 2007.

**Modeling pond water availability for fish culture**, p. 1443-1449. *In* L. Oxley and D. Kulasiri (eds.) MODUM 2007 International Congress on Modelling and Simulation. Modelling and Simulation Society of Australia and New Zealand, Canberra.

A study was carried out to estimate pond-water availability for fish culture by developing and applying a simulation model that can express water budget for fish ponds based on prevailing climatic and hydrological conditions. The model was applied at selected meteorological stations in the floodplains of the Ganges-Brahmaputra delta in Bangladesh from 1998 to 2002.

Kam, S.P., M. Prein and M.M. Dey. 2007.

**Delineating recommendation domains for small-scale freshwater aquaculture deploying GIS for decision support**, p. 431-444. *In* GIS/ Spatial Analysis in Fishery and Aquatic Sciences v. 3. Fishery-Aquatic GIS Research Group, Saitama, Japan.

This paper highlights Geographical Information System (GIS) applications in an on-going, three-year project to develop spatial decision-support tools for identifying recommendation domains (places and sets of conditions) that determine the potential and feasibility for adoption of smallholding pond-aquaculture systems to aid strategic aquaculture planning and development.

Khaw, H.L., R.W. Ponzoni and M.J.C. Danting. 2007.

**Estimation of genetic change in the GIFT strain by comparing contemporary progeny produced by males born in 1991 or 2003**, p. 111-114. *In* Proceedings of the Association for the Advancement of Animal

Breeding and Genetics 17. Association for the Advancement of Animal Breeding and Genetics, New South Wales.

During the development of the GIFT (Genetically Improved Farmed Tilapia) strain in Philippines sperm was frozen from a sample of males from founder stocks and subsequent generations. In this paper a comparison of progeny performance produced from cryopreserved sperm from the base population of the GIFT strain, with progeny from freshly collected sperm from the ninth generation produced in Malaysia was conducted. Differences in performance were used to estimate the genetic change over these nine generations. GIFT proved to be a highly improved strain that had at least a 63 per cent advantage in growth rate accumulated over nine generations of non-continuous selection.

Little, D.C., B.K. Barman, M.M. Haque and M. Abdul Wahab. 2007.

**Decentralised Nile tilapia seed production**, p. 37-48. *In* A.J. van der Zijpp, J.A.J. Verreth, L.Q. Tri, M.E.F. van Mensvoort, R.H. Bosma and M.C.M. Beveridge (eds.) *Fishponds in farming systems*. Wageningen Academic Publishers, the Netherlands.

Local production of mixed sex Nile tilapia in irrigated rice fields has been introduced, established and then spread through farmer-to farmer contact in Northwest Bangladesh benefiting poor households in a number of ways. Food fish farmers have improved access to high quality seed at the time of peak demand early in the monsoon season. The seed producers benefit through small but strategic cash flows but also improved production of their fish for their own consumption, both as large fingerlings and fish after further grow on. A range of social benefits emerged during qualitative assessments. Initially introduced through on farm research and then Farmer Field Schools' adopters starting with common carp and Nile tilapia have adapted the basic concept, tending to expand to a certain level and increasing the number of species produced. Difficulty in delivery of sufficient quality broodfish to rural areas is a major impediment to broader adoption of decentralised production, Capacity among local promoters to support initial broodfish and knowledge supply was important to the development of decentralised seed networks. Confusion over the perceived qualities and constraints of mixed and mono-sex tilapias respectively can undermine acceptance of decentralised seed production strategies among policy makers.

Little D.C., M. Karim, D. Turongruang, E.J. Morales, F.J. Murray, B.K. Barman, M.M. Haque, N. Kundu, B. Belton, G. Faruzue, E.M. Azim, F.U. Islam, L. Pollock, M.C.J. Verdegem, J.A. Young, W. Leschen and M. Abdul Wahab. 2007.

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**Livelihood impacts of ponds in Asia - Opportunities and constraints**, p. 177-202. In A.J. van der Zijpp, J.A.J. Verreth, L.Q. Tri, M.E.F. van Mensvoort, R.H. Bosma and M.C.M. Beveridge (eds.) *Fishponds in farming systems*. Wageningen Academic Publishers, the Netherlands.

Ponds are traditional multipurpose resources accessed by households and communities, and are increasingly being prioritised for aquaculture. High consumption of aquatic animals and declines in natural stocks has stimulated fish culture based on both stocked and natural seed across a broad spectrum of intensification. Management of a high proportion of ponds remains sub-optimal with respect to fish production because of conflicting uses, multiple ownership, and poor access to markets and information. Aversion to risk of drought and flood is also a factor that reduces interest in optimising fish yields through financial investment, but can enhance the importance of water storage and trapping of unstocked aquatic animals. The role of ponds as assets controlled by households and communities is reviewed. Ponds and their products embrace several types of assets and support a range of activities, both productive and social. Issues of access are critical to the potential for poorer people to sustain benefits. Ponds may reduce vulnerability and examples are presented of the mechanisms by which the resilience of households is enhanced with respect to withstanding shocks and seasonal fluctuations in food and income. Location, especially with respect to markets is identified as critical to the management strategies used by households. Key institutions that support the intensification of fish culture include dynamic networks of informal private sector service providers, many of whom are poor. Although the benefits of pond-based aquaculture have been associated with the resource-rich, poorer people are benefiting as producers, intermediaries and consumers.

Mapstone, B.D., N.L. Andrew, Y. Chancerelle and B. Salvat. 2007.

**Mediating effects of sea urchins on interactions among coral, algae and herbivorous fish in the lagoon at Moorea, French Polynesia.** *Marine Ecology Progress Series* 332:143-153.

The relative importance of grazing by sea urchins in influencing the composition and structure of coral reef habitats has only occasionally been explored experimentally, and never on the coral reefs of Oceania, where both herbivorous fishes and sea urchins are often common. In this paper we report the results of an experiment in French Polynesia, in which densities of an abundant sea urchin, *Echinometra mathaei*, were manipulated within the territories of an abundant omnivorous, 'gardening' pomacentrid fish (*Stegastes lividus*) in thickets of *Acropora pulchra*. Increasing the sea urchin density resulted in reductions in the standing crop of algae

and over-grazing of the dead coral substratum on which the algae grew. After 2 yr of this treatment, the coral thickets began to collapse. Reducing sea urchin densities to very low levels also resulted in collapse of the coral thickets and reduced densities of the fish, although algal biomass was apparently unaffected. We posit that the fish–coral–sea urchin–algal assemblage is relatively robust to wide fluctuations in sea urchin densities, but when sea urchin densities are driven to extremes the coral–algal habitat becomes destabilised and the entire system collapses, possibly as a result of different bioerosion processes in play at high and low sea urchin densities.

Mazid, M.A., M.J. Rahman and M.G. Mustafa. 2007.

**Source and abundance of jatka (juvenile hilsa, *Tenualosa ilisha*) in the Gajner beel, sujanagar, Pabna.** Bangladesh Journal of Fisheries (Special Issue) 30: 37-51.

Investigations on the source, abundance, migration, exploitations and management options of Jatka (juvenile hilsa, *Tenualosa ilisha*) fisheries were conducted in the Gajner beel, located at the south-east corner of the Pabna Irrigation and Rural Development Project (PIRDP) in Sujaganar Upazila of Pabna district. This article reports exclusively on the important Jatka fishery of the Gajner beel. The Padma and the Jamuna was identified as the sole source of Jatka in the Beel. The migratory route of Jatka was found to be extended from the Padma and/or Jamuna rivers to the Badai river and then to the beel through a sluice gate at Talimnagar village. The possibility of breeding of hilsa in the beel was nullified. The main Jatka fishing season was found extended from mid August to mid October. Lift net (Veshal/Bandh/Khora Jal) and beach seine net (Ber Jal) were found to be the major gears involved in Jatka fishing. The total quantity of Jatka caught from the beel during 2004-05 fishing season was estimated to be 46.2 mt. Finally, a community based management plan was suggested for implementation by the Gajner beel management committee.

Mesalhy, S., G. John, G. El-Naggar and M. Fathi. 2007.

**Effect of Echinacea on body gain, survival and some hematological and immunological parameters of *Oreochromis niloticus* and their response to challenge infection.** Egyptian Journal of Aquatic Biology and Fisheries 11(3):435-445.

Six hundred and forty *O. niloticus* were equally distributed in 16 hapas (each of 1.5 m<sup>3</sup>) to be used for 4 treatments in 4 replicates. Fish of groups 1-3 were fed on basal diet mixed with Echinacea (0.25 ppt) for 1 st, 2 nd and 3 rd summer months; respectively (1st phase). Fish of group 4 were fed basal diet only as a control. By the end of the 3rd months, some fish were used to measure

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hematological, immunological parameters. The remaining fish in the 4 hapas of each treated group were fed with the basal diet without Echinacea for 6 months (winter season, 2nd phase). The same growth parameters, survival and relative protection against challenge infection were determined by the end of 1st and 2nd phase of the experiment. At end of 1st phase, a marked increase in the neutrophil adherence, hematocrit values and total leukocytic count was seen in most treated groups. Also an increase in the body gain, specific growth and survival rates were recorded. At end of 2nd phase, no significant changes were seen in the body gain, specific growth rate and coefficient factor but a significant increase in the survival rate was noticed. Challenge of experimented tilapia resulted in low mortality rate of all treated groups in comparison with the control. The level of protection was high in both seasons; however it was higher in winter than summer season. As a general observation, one month administration of 0.25 ppt of Echinacea induced remarkable effect on the survival and protect against challenge infection. The prolonged addition of 0.25 ppt Echinacea (2 & 3 months) showed similar effect on survival and more protection against challenge.

Moustafa, A.M., Aly, Abd-El-Menem. A., S. Mesalhy, H.A. Elghobashy, S.I. Hasanin and A.E. Ibrahim. 2007.

**Influence of phenol pollution on Nile tilapia (*Oreochromis niloticus*).**

Egyptian Journal of Aquatic Biology and Fisheries 11(3):709-720.

In this study a field investigation was done by collection of water and Nile tilapia (*Oreochromis niloticus*) from Helwan (branch of Nile River), El- Abbassa earthen ponds and Bahr El-Baqar fish ponds every 4 months during the year to determine the residues of phenol in fish and water. Also experimental laboratory studies were done by using apparently healthy Nile tilapia for determination of LC50 for 72hr. to phenol and evaluate the effect of long term exposure to phenol 1/10 LC50 for 12 weeks. The levels of phenol in water samples from Helwan were higher than in Bahr-El-Baqar. While the residues of phenol in fish muscle samples were lower than permissible limit in the investigated localities. Long term exposure of Nile tilapia to 1/10 LC50 revealed nervous manifestations and respiratory signs with mortality rate of 8 %. Macroscopically, erosion of fins and tail, pale gills and liver were seen. Microscopically, desquamated and hyperplastic gill lamellae, neuronal degeneration, hyperplasia of epidermis and Zenker's necrosis of muscles were seen. Degeneration with necrosis in liver, kidneys, spleen and gonads were observed. The residual levels of phenol in experimented fish muscles were 0.07, 0.25 and 1.15 ppm after 4, 8 and 12 weeks, respectively. The results clearly indicated that phenol affects on fish quality by induction of gills, internal organs and brain lesions with residues in muscles.

Muendo, P.N., J.J. Stoorvogel, M.C.J. Verdegem, G. El Naggar and J.A.J. Verreth. 2007.

**Roles of ponds in integrated agriculture-aquaculture systems**, p. 125-134. *In* A.J. van der Zijpp, J.A.J. Verreth, L.Q. Tri, M.E.F. van Mensvoort, R.H. Bosma, M.C.M. Beveridge (eds.) *Fishponds in farming systems*. Wageningen Academic Publishers, the Netherlands.

The effects of adding an aquaculture pond to existing farming operations on nutrient use efficiency and productivity were explored. Ponds can be used to cycle nutrients from agricultural by-products such as manures and composted grasses. The production from ponds using agricultural by-products was similar to that of ponds receiving formulated pellets. The largest fraction of the nutrients fed to ponds accumulated in the sediment. Pond sediments were rich in nitrogen and potassium, but only contained small amounts of soluble reactive phosphorous. Pond sediments supplemented with phosphorous produced a similar corn yield to standard inorganically fertilised plots. Starting from a database on nitrogen flows through Kenyan highland farms, a typical farm operation was defined for each agro-ecological zone. In the agro-ecological zones where annual temperature ranges allowed for the culture of tilapias, a tilapia pond receiving nutrients from on-farm by-products was integrated into the farming operations. Results showed that the nutrient depletion, typical for highland cultures in Kenya, is reduced, while more nutrients end up in harvestable products than in situations without aquaculture. The results are promising, but more work is needed on fine-tuning capital and labour availability for integrated aquaculture-agriculture systems to the needs or opportunities of farming households.

Munro, J. and L. Owens. 2007.

**Yellow head-like viruses affecting the penaeid aquaculture industry: a review.** *Aquaculture Research* 38: 893-908.

This review focuses on relevant scientific information regarding the current knowledge of the yellow head complex viruses, yellow head virus and gill-associated virus. The yellow head complex viruses have been problematic within the aquaculture industry for over 10 years and still retain their research topicality. Presently, there are numerous research papers from different journals covering the identification, disease expression and spread, pathogenesis, detection, morphology, genomic sequence and protein profiles of the yellow head complex viruses. Indeed, there has been no extensive review to compare these studies, and as a corollary, to assess flaws in contemporary research and knowledge. Additionally, the yellow head complex viruses rank within the top four prawn viruses with respect to disease impact and economic loss. This review collectively reports on all the findings and

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current methods of research and aims to identify weak areas of research where conclusions have been unjustifiably drawn and furthermore to elucidate areas that have a gap of knowledge.

Nelson, K., Z. Basiao, A. Cooper, M. Dey, M. Lorenzo Hernandez, S. Kunawasen, L. Sifa, R. Martinez, B.D. Ratner, M. Toledo and W. Leelapatra. 2007.

**Problem formulation and options assessment: multi-stakeholder-driven deliberation in risk assessment of transgenic fish**, chapter 2. In A.R. Kapuscinski, K.R. Hayes, S. Li and G. Dana (eds.) Environmental risk assessment of genetically modified organisms, v. 3: Methodologies for transgenic fish. CABI Publishing, Wallingford.

This chapter provides an overview of problem formulation and options assessment (PFOA) for scientists, risk assessment specialists, industry representatives and other interested public stakeholders who may be involved in deliberation over transgenic fish technology. This chapter explains how PFOA contributes to environmental risk assessment and assesses its advantages and challenges for the subject of transgenic fish biosafety. Consideration of how PFOA can be incorporated into diverse governance situations is explored in 4 country-specific case studies (Chile, Cuba, Thailand and China). Each country's policy and regulatory context are outlined as well as how PFOA can be applied in each case. This chapter also illustrates some issues that PFOA may address in these contexts. A preliminary reflection about questions to consider when designing a country-specific PFOA is included.

Nguyen, N.H., H.L. Khaw, R.W. Ponzoni, A. Hamzah and N. Kamaruzzaman. 2007.

**Can sexual dimorphism and body shape be altered in Nile tilapia (*Oreochromis niloticus*) by genetic means?** Aquaculture 272(S1): S38-S46.

The objective of this study was to estimate genetic parameters in GIFT (Genetically Improved Farmed Tilapia), especially focusing on the genetic correlation between trait expressions in both sexes and among measurements of body size. Body weight, length, depth and width data at harvest from 12,308 individuals, progeny of 232 sires and 340 dams, were analyzed by restricted maximum likelihood methods fitting a multi-trait animal model. To explore the genetic variation in sexual dimorphism the trait expressions in the two sexes were treated as if they were different traits. Heritabilities and maternal and common environment effects for all the traits were very similar in females and males. The genetic correlations between sexes for all traits were close to unity (0.91 to 0.96), indicating that there was no sex by genotype interaction. When treated as a single trait the heritabilities ( $\pm$ SE) for



body weight, length, depth and width were moderate to high, ranging from 0.20 to 0.35 ( $\pm 0.04$  to 0.05). The maternal and common environment effects accounted for 16 to 24% of the variance. Genetic correlations among the four body measurements were highly positive (0.94 to 0.99), suggesting the existence of little or no genetic variation independent of each other. We concluded that there was no need to treat trait expressions in the two sexes as different traits in genetic improvement programs. Furthermore, that the relative dimensions of the body were essentially controlled by the same genes, but that continued selection for live weight would result in relatively longer and thinner fish because of the greater correlated response in length relative to width and depth.

Ponzoni, R.W., N.H. Nguyen and H.L. Khaw. 2007.

**Breeding program requirements in developing countries may differ depending on circumstances**, p.59-67. *In* A.J. van der Zijpp, J.A.J. Verreth, L.Q. Tri, M.E.F. van Mensvoort, R.H. Bosma and M.C.M. Beveridge (eds.) *Fishponds in farming systems*. Wageningen Academic Publishers, the Netherlands.

Aquaculture in developing countries is largely based on unimproved fish strains. There is ample evidence indicating the potential of genetic improvement programs and a range of selection methods may be used. Examples of the application of mass, cohort, within family, and combined between-within family are given. The methods are discussed in terms of their effectiveness and suitability. It is concluded that in principle most of the methods can work well, provided the selection program is started with a population with a broad genetic base and that during its conduct a balance is struck between selection intensity and containment of inbreeding. Programs that entail the collection of very detailed information are more suitable for national research organisations, whereas simpler ones may have greater appeal to commercial operators.

Ponzoni, R.W., N.H. Nguyen and H.L. Khaw. 2007.

**Investment appraisal of genetic improvement programs in Nile tilapia (*Oreochromis niloticus*)**. *Aquaculture* 269(1-4):187-199.

The economic benefit derived from a genetic improvement program with Nile tilapia (*Oreochromis niloticus*) was examined from a national perspective. An industry structure was assumed whereby the genetic improvement program is conducted in a nucleus which provides brood stock to hatcheries, which in turn produce fry for farmers to grow out to market size. Discounting was used to express all returns and costs in terms of net present value. The economic benefit (discounted returns minus discounted costs, EB) and the benefit/cost ratio (BCR) were studied for a 10 year

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time horizon. The sensitivity of EB and BCR to a number of factors was examined, namely: (i) Biological (heritability values, accounting for feed intake), (ii) Economic (initial investment, annual cost, discount rate, price of fish), and (iii) Operational (year when first return occurs, reproductive efficiency). The risk involved was assessed by studying the anticipated variability in response to selection (and hence in EB and BCR). Heritability values had a moderate effect, whereas it was shown that the cost of increased feed intake as a correlated response to selection for greater growth rate should be considered to avoid gross over-estimations of EB and BCR. Initial investment, annual costs and choice of discount rate had a relatively small effect on EB and BCR, whereas the effect of the price of fish was substantial. Delays in obtaining the first returns in the program resulted in reduced EB and BCR. However, the greatest contribution to variations in EB and BCR came from improvements in the reproductive efficiency at the level of both the nucleus and the hatcheries. The risk of program's failure due to technical reasons was found to be extremely low. We conclude that even under the most conservative assumptions, genetic improvement programs are highly beneficial from an economic viewpoint, and that for the case studied they could result in EBs ranging from over four million US\$ to 32 million US\$, and corresponding BCRs of 8.5 to 60.

Rhodes, K.L. and M.H. Tupper. 2007.

**A preliminary market-based analysis of the Pohnpei, Micronesia, grouper (*Serranidae: Epinephelinae*) fishery reveals unsustainable fishing practices.** *Coral Reefs* 26(2):335-344.

Serranids are important components of artisanal and commercial catch worldwide, but are highly susceptible to overfishing. In Pohnpei (Micronesia), a recent coral reef fish market survey revealed a reliance on night-time spearfishing and a serranid catch composed primarily of juveniles and small adults of practically all epinepheline species. Fishing effort was concentrated in one of five municipalities and was disproportionate to the population distribution. Lagoon areas were fished preferentially to outer reef areas, with both catch size distribution and species composition similar between the two areas. Some species were unique to a particular gear type, but catch composition did not vary substantially between spear and line fishing. Existing seasonal sales bans, meant to protect reproductively active serranids, appeared to place additional pressure on other families during ban periods. The study identified the need for a comprehensive management plan that merges traditional measures, including size limits and gear restrictions, with precautionary management tools. Specifically, the scale and scope of marine protected areas should be increased to protect juveniles and other life history stages over wider areas than currently employed.

Rhodes, K.L., M.H. Tupper and C.B. Wichilmel. 2007.

**Characterization and management of the commercial sector of the Pohnpei coral reef fishery, Micronesia.** Coral Reefs (Published online 9 Nov 2007)

Commercial coral reef fisheries in Pohnpei (Micronesia) extract approximately 1,521 kg of reef fish daily (~500 MT year<sup>-1</sup>) from 152 km<sup>2</sup> of surrounding reef. More than 153 species were represented during surveys, with 25 species very common or common within combined-gear catch. Acanthurids contributed the greatest to catch volume, with bluespine unicornfish, *Naso unicornis*, and orangespine unicornfish, *Naso lituratus*, among the most frequently observed herbivores. Nighttime spearfishing was the dominant fishing method and inner lagoon areas were primarily targeted. A seasonal sales ban (March–April), intended to reduce pressure on reproductively active serranids, significantly increased the capture volume of other families. Catch was significantly greater during periods of low lunar illumination, suggesting higher fishing success or greater effort, or both. The marketed catch was dominated by juveniles and small adults, based on fishes of known size at sexual maturity. Artificially depressed market prices appear to be catalyzing (potential or realized) overfishing by increasing the volume of fish needed to offset rising fuel prices. These results support the need for comprehensive fisheries management that produces sustainable fishing and marketing practices and promotes shared management and enforced responsibilities between communities and the state. To be effective, management should prohibit nighttime spearfishing.

Saiti, F., D.M. Jamu, B. Chisala and P. Kambewa. 2007.

**Simulation of optimal harvesting strategies for small-scale mixed-sex tilapia (*Oreochromis shiranus* Boulenger 1896) ponds using a bio-economic model.** Aquaculture Research 38:340-350.

A cohort-based bio-economic biomass growth and economic model, validated with data from experiments conducted in Malawi, was used to identify an optimal harvesting strategy for mixed-sex tilapia ponds. Three harvesting scenarios (baseline, economic optimum time +10 days and economic optimum time) were used. In each harvesting scenario four options were explored: (i) no further harvest, harvest every (ii) 60 days, (iii) 90 days and (iv) 120 days after initial harvest. The lowest simulated yield (487 kg ha<sup>-1</sup> year<sup>-1</sup>) was obtained when no partial harvesting was carried out and fish were harvested after 365 days. Maximum yield (4416 kg ha<sup>-1</sup> year<sup>-1</sup>) was obtained when partial harvests were carried out every 90 days starting with a first harvest of fish weighing 60 g or more at day 90. Maximum financial returns

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(US\$2561 ha<sup>-1</sup>year<sup>-1</sup>) were obtained when partial harvests were carried out every 120 days starting with the first harvest at day 90 and removing all fish  $\geq$  60 g. The model simulations indicate that mixed-sex tilapia culture may be profitable for tilapia farmers in Africa where markets accept small (60-150 g)-sized fish. The study further shows that a cohort-based population growth model can be reliably incorporated in tilapia production models to simulate fish yields in mixed-sex tilapia production systems. However, incorporation of intergenerational competition effects could improve the model's utility as a decision support tool for managing mixed-sex tilapia production.

Tewfik, A., J.B. Rasmussen and K.S. McCann. 2007.

**Simplification of seagrass food webs across a gradient of nutrient enrichment.** Canadian Journal of Fisheries and Aquatic Sciences 64: 956-967.

Anthropogenic nutrient enrichment has resulted in significant changes in food web structure. Although such changes have been associated with the loss of diversity and ecosystem services, little empirical work has been done to study food webs of similar systems across a nutrient enrichment gradient. We examined 11 seagrass beds along a gradient of increasing  $\delta^{15}\text{N}$  of primary consumers, where  $\delta^{15}\text{N}$  is used as an indicator of sewage-derived nutrients. Observations across this gradient revealed corresponding increases in consumer density and changes in distinct functional groups, whereas consumer diversity, seagrass canopy, and macrodetrital biomass decreased. However, maximum overall primary consumer diversity and minimum density occurred at intermediate levels along the nutrient gradient. We hypothesize that higher species diversity at low to moderate levels of nutrient enrichment depends on the persistence of grazer-resistant seagrass. This seagrass canopy, and the significant macrodetritus it generates, facilitates a variety of food and shelter resources. Overgrazed and simplified habitats may occur when densities of generalist urchins, capable of direct producer consumption, are no longer controlled through competition, predation, and intraguild predation. We hypothesize that high and stable urchin populations appear possible with the increased availability of allochthonous phytoplankton and associated particulate detritus that is a well-known consequence of nutrient enrichment in aquatic systems.

Thorpe, A., N.L. Andrew and E.H. Allison. 2007.

**Fisheries and poverty reduction.** CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources 2, no. 085. 12 p.

The purpose of this review is to review historic and contemporary research into fisher poverty. Our review commences by acknowledging the paucity of studies on the levels of (income) poverty within the sector and highlights the fact that, somewhat paradoxically, a growing number of studies are suggesting that average incomes for fishing households outstrip those recorded by non-fishing households in the same areas. Nevertheless, these findings must be qualified as poverty cannot be captured exclusively in income terms – and social manifestations of poverty (low literacy levels, reduced access to health care, education, water and sanitation facilities) may be more acute within the fisheries sector. Equally, while fisher households may be more vulnerable (given their lifestyles/location) to exogenous shocks (such as tsunamis), the sector is not a homogenous one and factors such as technological change may also induce the impoverishment of certain subgroups of fishers over time. As a consequence, fisher households have derived a variety of coping mechanisms, mechanisms which (we argue) militate against considering ‘fishing’ as an activity in isolation from other facets of the household livelihood strategy. One response, as we note, to this has been the application of livelihoods analysis as a technique for assessing (and redressing) fisher poverty. Championed initially by the Sustainable Livelihoods Fisheries Programme (SFLP) operating in West Africa from 1999 to 2006, the technique has subsequently been deployed in a number of other regions/fisheries. Our review then moves on to assess how interventions within the fisheries sector can contribute to fisher poverty reduction. At the macroeconomic level, while the emphasis historically has been on the sector’s contribution to domestic nutritional requirements and the goal of food security, more recent research has examined the prioritization of the sector within national development plans and poverty reduction strategies. At the microeconomic level, we provide two contrasting examples to show that, while poverty-reducing policy interventions are to be welcomed at the local level, the heterogeneity of the local environment militates against the prescription of a ‘one size fits all’ approach to poverty reduction. This theme is picked up in the concluding comments of the review, where directions for further research are also highlighted.

Tolentino-Pablico, G., N. Bailly, R. Froese and C. Elloran. 2007.

**Seaweeds preferred by herbivorous fishes.** *Journal of Applied Phycology* (Online Journal).

Marine macrobenthic algae (or seaweeds), epiphytic microalgae, and other aquatic plants constitute the main food items of marine herbivorous fishes. About 5% of all fish species are herbivorous; only 30% of these are marine, most of them living in coral reefs. An analysis was performed on all the seaweeds that formed part of the natural diet of these fishes, based on information contained in FishBase (<http://www.fishbase.org>). The results showed that many coral-reef-associated marine

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herbivorous fishes, such as the families Blennidae, Kyphosidae and Siganidae, fed selectively on filamentous and turf fleshy seaweeds, which they prefer over calcareous coralline and encrusting species. In particular, Chlorophyceae of the genera *Cladophora*, *Enteromorpha* and *Ulva* were preferred by *Scartichthys viridis* (Blennidae), *Girella* spp. (Kyphosidae), *Sarpa salpa* (Sparidae), and Phaeophyceae in the genera *Sargassum* and *Dictyota* were preferred by *Kyphosus* spp. (Kyphosidae) and *Siganus* spp. (Siganidae). A web-based tool was developed to provide information on plants (algae, seagrasses, terrestrial plants and fruits) preferred as food by herbivorous fishes (<http://www.incofish.org/herbitool.php>). The tool is intended to assist aquaculturists, conservationists and ecosystembased fisheries managers.

Tupper, M. 2007.

**Identification of nursery habitats for commercially valuable humphead wrasse (*Cheilinus undulatus*) and large groupers (Pisces: Serranidae) in Palau.** Marine Ecology Progress Series 332:189-199.

In recent years there has been increasing interest in conserving fish habitats. However, fish-habitat associations, particularly nursery habitat for early juvenile stages, are poorly known for most reef fishes. Using mark-recapture techniques, I examined among-habitat variation in settlement, post-settlement growth, and persistence, and movement in 3 large, vulnerable, and commercially important reef fishes: the humphead wrasse *Cheilinus undulatus*, the squaretail coral grouper *Plectropomus areolatus*, and the camouflage grouper *Epinephelus polyphkadion*. Both the humphead wrasse and the coral grouper appeared to utilize specific nursery habitats. Settlement, growth, and persistence of humphead wrasse were highest in branching coral structures mixed with bushy macroalgae (BCMA). Of all tagged *C. undulatus* recaptured in intermediate or adult habitats, 80% were tagged post-settlement in BCMA. Early juvenile *P. areolatus* were found almost exclusively in coral rubble habitats on the slopes of tidal channels, at a narrow depth range of 5 to 7 m. This dependence on one habitat type could render this species vulnerable to shipping or dredging operations or other forms of coastal development. *E. polyphkadion* appeared to be a habitat generalist, and no specific nursery habitat could be identified. In summary, spatial management (e.g. implementation of marine protected areas) should prioritize habitats for conservation according to their value as essential nursery or spawning habitats for target species needing protection.

Tupper, M.H. 2007.

**Spillover of commercially valuable reef fishes from marine protected areas in Guam, Micronesia.** Fishery Bulletin 105:527-537.

Does adult spillover (movement out of marine protected areas [MPAs]) of fish create a net export of fish biomass from MPAs to adjacent fished reefs? Biomass of five commercial reef fish species was estimated by visual census within and outside three MPAs in Guam, Micronesia. For most species and sites, biomass was significantly higher within the MPAs than in adjacent fished sites. Movement of fishes into and out of the MPAs was determined by markrecapture experiments, in which fishes were tagged both inside and outside of MPAs. Four out of five species studied showed little or no net movement out of MPAs. However, the orangespine surgeonfish (*Naso lituratus*) showed a net spillover of biomass from all three MPAs; 21.5% of tagged individuals and 29% of the tagged biomass emigrated from MPAs. Patterns of spillover were strongly influenced by physical habitat barriers, such as channels, headlands, or other topographic features. MPAs that are physically connected by contiguous reef structures will likely provide more spillover to adjacent fished sites than those that are separated by habitat barriers. This study demonstrates that MPAs can enhance export of fish biomass to fished areas, but spillover is species-specific and depends on factors such as species size and mobility.

Van der Zijpp, A.J., J.A.J Verreth, Q.T. Le, M.E.F. van Mensvoort, R.H. Bosma and M.C.M. Beveridge (eds.) 2007.

**Fishponds in farming systems.** Wageningen Academic Publishers, the Netherlands.

This book is a collection of refereed papers on a controversial subject in agricultural development. Arguing that sustainability of fish culture in ponds needs a new paradigm - feed the pond to grow fish - two chapters focus on nutrient cycling in such systems. Another chapter makes the case for breeding Nile tilapia for resource poor farmers and presents practical options to avoid the pitfalls that arise from natural tilapia mating in low-input ponds. The book contains chapters on livelihood and development aspects and ends with a general discussion completing the picture of the integrated aquaculture-agriculture systems. Overall it composes a review which addresses one of the key issues of the new century: how to sustainably produce food without compromising environmental integrity.

Verreth, J.A.J, R.H. Bosma, M.C.M. Beveridge, Q.T. Le, M.E.F van Mensvoort and A.J. van de Zijpp. 2007.

**Strategies to enhance the role of fishponds in farming systems,** p. 295-303. *In* A.J. van der Zijpp, J.A.J. Verreth, L.Q. Tri, M.E.F. van Mensvoort,

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R.H. Bosma and M.C.M. Beveridge (eds.) Fishponds in farming systems. Wageningen Academic Publishers, the Netherlands.

This book chapter discusses the identified problems at the level of the fish, the pond and the farm. Such areas as food safety, diversification, development of IAA systems interdisciplinary research as a tool are elaborated, with conclusion by inferring on the development of fishponds in farming systems.

Westaway, E., J. Seeley and E. Allison. 2007.

**Feckless and reckless or forbearing and resourceful? Looking behind the stereotypes of HIV and AIDS in “fishing communities”.** African Affairs 106(425):663-679.

Over the last decade evidence has emerged suggesting that in many countries fisherfolk, as an occupational group, are at greater risk to HIV and AIDS than the general adult population. This high vulnerability has been explained in terms of the lifestyles associated with fishing and related occupations, such as fish processing and trading. Fishermen have been portrayed as risk takers, their attitudes and behaviour shaped by the physical and economic risks of the fishing lifestyle. Women in fishing communities, often engaged in fish processing and trading and providing food and lodging in fishing settlements, are portrayed as being in subordinate social and economic positions and prey to sexual exploitation by cash-rich fishermen. There is a danger in such lifestyle summaries that fisherfolk are characterized as feckless risk takers with a reckless attitude to the chance of contracting HIV. In this article we look at the lives of some men, women, and children living in a lake-side community in Uganda severely affected by HIV and AIDS to illustrate how existing portrayals of fisherfolk, and fishing communities, need to avoid stereotypes in order to better inform appropriate health sector and livelihood support measures.

Yong-Sulem, S., R.E. Brummett, T.E. Tabi and J. Tchoumboué. 2007.

**Towards the maximum profitability of smallholder catfish nurseries: Predator defense and feeding-adapted stocking of *Clarias gariepinus*.** Aquaculture 271:371-376.

To determine how best smallholders could maximize the profitability of their catfish hatcheries, the cost/benefit analyses of using fences, hapas and bird nets to exclude predators; as well as over-stocking to create food shortage, were conducted. As compared to the typical production system (fertilized unfenced ponds) and at a stocking density of 10 two-day old fry/m<sup>2</sup>, survival increased by 28% in fenced ponds, 34% in open hapas and 55% in bird-netted hapas. These increases were believed due to the respective exclusion of adult amphibians, aquatic insects and



flying predators, implying that they would be respectively responsible for 28%, 6% and 23% of the fry mortality which was observed in unfenced ponds. When the stocking density of closed hapas (predator-free systems) was increased from 10 to 40 fry/m<sup>2</sup>, fry survival significantly dropped ( $P < 0.002$ ), indicating a shortage of adequate food/fry. Consequently, the maximum yield was only 29 out of 40 fingerlings/m<sup>2</sup> (though up from 10 out of 10 in the lowly stocked systems) and 29 larvae/m<sup>2</sup> appeared to be the stocking density which could optimize the profitability of smallholder *C. gariepinus* hatcheries. Calculations based on corresponding survivals, final average weights and size-dependent selling price showed that stocking at this (optimum) density could significantly improve profitability, as for instance, from -184 francs to +982 francs/m<sup>2</sup> through the use of closed hapas. Smallholders should therefore determine and stock their nursing systems at optimum densities as well as defend the stocked fry against predators, in order to maximize their profits.

Zidana, A., E. Kaunda, A. Phiri, A. Khalil-Edriss, G. Matiya and D. Jamu. 2007.

**Factors influencing cultivation of the Lilongwe and Linthipe River Banks ni Malawi: a case study of Salima District.** Journal of Applied Sciences 7(21):3334-3337.

The study was conducted to investigate factors that influence farmers to cultivate along the river banks in Salima District, in the Central Region of Malawi. Using logit analysis the study revealed that household size, main occupation, education market availability and land holding size were important parameters in influencing the farmers to engage in river bank cultivation. Basing on these results it has therefore been suggested that since these farmers cultivate along the river banks without conserving the soils, a livelihood approach must be adopted. This approach will enable farmers to sustainably derive their livelihoods from the land which supports their livelihood without degrading the environment.

Allison, E. 2007.

**Siem Reap meet: the responsibility of stewardship.** Samudra Report no. 47 Jul. 2007 p. 18-21.

This synthesis outline the outcomes of the Siem Reap workshop and symposium in the context of coastal and wetland management. The workshop focused on understanding how different fishworker organisations and community representatives understood rights to, and responsibilities for, the coastal resources.

Baran, E. and B. Ratner. 2007.

**The Don Sahong dam and Mekong fisheries.** WorldFish Science Brief 1728, 4 p. The WorldFish Center, Penang.

This science brief targets key opinion leaders and government officials in Laos and examines available information on the potential impact of the proposed Don Sahong hydroelectric dam on the fisheries of the Lower Mekong River Basin.

Baran, E., T. Jantunen and C.K. Chong. 2007.

**Values of inland fisheries in the Mekong river basin,** 76 p. The WorldFish Center, Phnom Penh.

This report provides information on the biological, economic, social and cultural values of river fisheries in the Lower Mekong Basin and identifies the main impacts of environmental changes on these values. The review is organized by country: China (Yunnan province), Laos, Thailand, Cambodia and Vietnam.

Baran, E., P. Starr and Y. Kura. (eds.) 2007.

**Influence of built structures on Tonle Sap fisheries,** 44 p. Cambodia National Mekong Committee and The WorldFish Center, Phnom Penh.

This document is a synthesis of the major findings and recommendation of a study on the influence of built structures on the fisheries of the Tonle Sap Lake. The multidisciplinary study analysed the influence and impact of built structures on hydrology, fish, and ultimately on people. The project established a database of major structures around the Tonle Sap Lake. Hydrologists modeled the influence of infrastructure on the flow and quality of water. Environmental scientists analysed information about how infrastructure affects the environment. Experts in ecology and fish biology assessed the direct impacts on fisheries. Social scientists and economists evaluated the influence of infrastructure development on people's livelihoods, and studied local people's insights related to the planning, construction, and operation of built structures.

Bartley, D.M., R. Brummett, J. Moehl, E. Ólafsson, R. Ponzoni and R.S.V. Pullin. (eds.) 2007.

**Pioneering fish genetic resource management and seed dissemination programmes for Africa: adapting principles of selective breeding to the improvement of aquaculture in the Volta Basin and surrounding areas.**

CIFA Occasional Paper no. 29, 194 p. FAO, Rome.

This document represents the report and contributed papers from a workshop of the same name. The workshop was comprised of a group of 30 international experts and representatives of the environmental, fisheries and policy development agencies of the countries in the Volta Basin.

Briones, R.M. 2007.

**Projections of supply and demand for the trade in live reef-fish for food**, p. 120-129. *In* B. Johnston (ed.) Economics and market analysis of the live reef-fish trade in the Asia Pacific region 2007. ACIAR Working Paper No. 63. Australian Centre for International Agricultural Research, Canberra.

This study adopted an extended version of the AsiaFish model to quantify future changes in supply and demand for live reef-fish as food arising from new technology, management practices and economic growth. It simulated supply and demand under different future scenarios to identify policy options to improve market performance.

Brummett, R.E. 2007.

**Collective marketing may help small-scale fish farmers in Africa.** *Global Aquaculture Advocate* 10(5):48-49.

Studies in Cameroon have found that aquafarmers with closer access to urban markets were able to sell much higher quantities of fish at higher prices. In recent research on collective marketing involving 32 rural fish farmers, 12 made a profit, which sparked further local interest in the concept.

Brummett, R.E. 2007.

**Comparative analysis of the environmental costs of fish farming and crop production in arid areas**, p. 221-228. *In* D.M. Bartley, C. Brugère, D. Soto, P. Gerber and B. Harvey (eds.) Comparative assessment of the environmental costs of aquaculture and other food production sectors: Methods for meaningful comparisons. FAO/WFT Expert Workshop, 24-28 Apr 2006, Vancouver, Canada. FAO Fisheries Proceedings No. 10. FAO, Rome.

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Using published data, 20 crop and 19 fish production systems were compared for efficiency of water and nutrient (nitrogen) use. In agriculture, rain-fed cassava was most efficient, followed by rain-fed beans, pivot-irrigated maize and rain-fed wheat. Intensive vegetable production uses water most efficiently to produce edible dry matter. Maize, wheat and crop legumes are most efficient at producing protein. Cassava produces energy most efficiently. For aquaculture, sharp-tooth catfish in fed raceway-ponds are most efficient, followed by tilapia in fed cages and tilapia in sewage-fed ponds. Herbivorous and omnivorous fish are more efficient to produce than carnivores. Aquaculture is of comparable efficiency to crop production only in terms of edible dry matter output per cubic meter of water and crude protein production per kilogram of nitrogen. Aquaculture in arid areas is of comparable efficiency with agriculture only when it is highly intensive and/or strongly integrated with other farm enterprises.

Dey, M.M. and Y.T. Garcia. 2007.

**Demand for fish in Asia: a cross-country analysis**, p. 13-31. *In* B. Johnston (ed.) Economics and market analysis of the live reef-fish trade in the Asia Pacific region. ACIAR Working Paper no. 63. Australian Centre for International Agricultural Research, Canberra.

Scientists showed that fish is a heterogeneous product with wide disparity in income and price elasticities for different fish types. Income and price elasticities tend to be higher among the poor and, as fish demand increases with rising population and income in Asian countries, fishery technology expansion and development should focus on fish species where demand exhibits elastic responses.

Dey, M.M., U.P. Rodriguez, R.M. Briones and O.L. Chen. 2007.

**Disaggregated projections on fish supply, demand and trade for development Asia**, p. 119-127. *In* B. Johnston (ed.) Economics and market analysis of the live reef-fish trade in the Asia Pacific region 2007. ACIAR Working Paper No. 63. Australian Centre for International Agricultural Research, Canberra.

The AsiaFish model was used to quantitatively analyze the supply and demand outlook and impact of policies, at a disaggregated level, to provide guidance on the design of fishery development strategies in 9 major fish-producing Asian countries.

Dey, M.M. and U. Kanagaratnam. 2007.

**Community based management of small scale fisheries in Asia: bridging the gap between fish supply and demand.** *In* M. Dickson and A. Brooks (eds.) Proceedings of the CBFM-2 International Conference on

Community Based Approaches to Fisheries Management, 6-7 March 2007, Dhaka, Bangladesh. WorldFish Conference Proceedings 75. The WorldFish Center, Dhaka.

Community-based management and co-management are feasible alternative approaches to bridging the gap between supply and demand. They have brought together various stakeholders to achieve improved resource and socioeconomic conditions; although clarity on the government's role, political will and a legal framework were still needed to sustain the institutions developed under these approaches.

Dey, M.M., N. Sheriff and T. Bjørndal. 2007.

**Utvikling av akvakultur i Asia: Noverande status, økonomi og gramtidsutsikter**, p. 151-171. *In* B. Aarset and G. Rusten (eds.) Havbruk: Akvakultur på norsk. Fagbokforlaget, Bergen.

Dickson, M and A. Brooks (eds.) 2007.

**Proceedings of the CBFM-2 International Conference on Community Based Approaches to Fisheries Management**, 6-7 March 2007, Dhaka, Bangladesh. WorldFish Conference Proceedings 75, print: 38 p. CD-ROM: 337 p. The WorldFish Center, Dhaka.

This booklet summarizes the CBFM-2 conference proceedings and presents abstracts from 9 countries. It offers valuable insights into areas such as better and innovative management approaches; diversification of aquatic products; promotion of alternative income-generating activities; new methods to improve long-term sustainability; use of cluster-based management approaches; the role of women in fisheries; the pros and cons of floodplain aquaculture; and global prospects for CBFM.

Gordon, A., S.D. Tegegne and M. Tadesse. 2007.

**Marketing systems for fish from Lake Tana, Ethiopia: opportunities for improved marketing and livelihoods**, 49 p. International Livestock Research Institute, Nairobi.

This study examined the domestic trade in frozen fish sourced from Lake Tana, Ethiopia and identified uneven demand and supply, high harvesting cost, high price, great distance from market, low fish quality as the main constraints. Improvements are needed in the organization of fisher groups, fish quality, product range, market

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information, sustainable fishing practices and capacity strengthening of the government.

Islam, G.M.N. and M. Dickson. 2007.

**Turning social capital into natural capital: changing livelihoods of fishers through CBFM.** *In* M. Dickson and A. Brooks (eds.) Proceedings of the CBFM-2 International Conference on Community Based Approaches to Fisheries Management, 6-7 March 2007, Dhaka, Bangladesh. WorldFish Conference Proceedings 75. The WorldFish Center, Dhaka.

Impact surveys revealed that CBFM had significantly improved social capital and household income of fishers. Fishers have better access to land and fishing grounds, more diversified livelihood options, greater amount of credit from multiple sources. This study also made policy recommendations to facilitate effective poverty alleviation.

Mustafa, M.G. and A.S. Halls. 2007.

**Impact of the community-based fisheries management on sustainable use of inland fisheries in Bangladesh.** *In* M. Dickson and A. Brooks (eds.) Proceedings of the CBFM-2 International Conference on Community Based Approaches to Fisheries Management, 6-7 March 2007, Dhaka, Bangladesh. WorldFish Conference Proceedings 75. The WorldFish Center, Dhaka.

Using quantitative indicators of catch per unit area (CPUA), catch per unit effort (CPUE), catch per fisher's day (CPD), biodiversity index (H'), fishing intensity (DPUA) and destructive fishing ratio (DFER) at up to 86 project water bodies across the country representing a variety of different habitats was compared with that of existing fisheries management (control water bodies). Estimates of the slope coefficients for each performance indicator were compared among habitat type and between CBFM and control water bodies using ANOVA (GLM). Fish production was found to have increased significantly through time at CBFM water bodies.

Mustafa, M.G. and A.S. Halls. 2007.

**Impact of community based management approaches on fishery resource diversity of seven flowing rivers in Bangladesh.** *In* M. Dickson and A. Brooks (eds.) Proceedings of the CBFM-2 International Conference on Community Based Approaches to Fisheries Management, 6-7 March 2007, Dhaka, Bangladesh. WorldFish Conference Proceedings 75. The WorldFish Center, Dhaka.

Research showed that fish production, abundance and biodiversity were significantly higher in CBFM project sites compared to control water bodies. Performance indicators also suggested that fisher-managed approach yielded the greatest benefits, followed by community-managed and women-managed approaches.

Werthmann, C. 2007.

**Institutions in the Mekong Delta of Cambodia: Findings from a situation analysis.** In M. Dickson and A. Brooks (eds.) Proceedings of the CBFM-2 International Conference on Community Based Approaches to Fisheries Management, 6-7 March 2007, Dhaka, Bangladesh. WorldFish Conference Proceedings 75. The WorldFish Center, Penang.

This paper focuses on property rights and collective action in the Mekong region of Cambodia. Institutional arrangements in water management for community-based aquaculture in two villages in the Mekong area of Cambodia are described.

The WorldFish Center. 2007.

**Adapting fish farming to HIV/AIDS affected families,** 12 p. The WorldFish Center, Domasi.

This brochure captures the testimony of the Chingale community in Malawi, who benefited from this joint aquaculture project between World Vision and WorldFish through improved nutrition in their fight against HIV/AIDS and a steady source of income for their widow and orphan-headed households.

The WorldFish Center. 2007.

**Africa's age of aquarium: farming ornamental fish in the rainforest of West Africa to improve livelihoods of the poor.** WorldFish Lessons Learned Brief 1706, 4 p. The WorldFish Center, Penang.

The ornamental fish trade has great scope for development. At present it is dominated by a small number of middle-men with little focus on sustainability or careful management of fish. This "Lessons Learned" document outlines how commercially sound and environmentally sustainable trade in non-timber forest products is a viable means of conserving rainforest ecosystems and sustaining traditional livelihoods.

The WorldFish Center. 2007.

**China and the WorldFish Center: pooling resources,** 8 p. The WorldFish Center, Penang. Available also in Chinese.

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WorldFish has renewed its partnership specifically to make aquaculture more productive, profitable and environmentally sustainable in China, tropical Asia and Africa. This brochure documents our previous work in China and expands on our future collaborative projects.

The WorldFish Center. 2007.

**Development strategies and options for fisheries and aquaculture in Asia.** WorldFish Policy Brief 1703, 4 p. The WorldFish Center, Penang.

This policy brief provides eight policy recommendations to boost fish production within the wider context of the supply-and-value chain.

The WorldFish Center. 2007.

**Fisheries and aquaculture can provide solutions to cope with climate change.** WorldFish Issues Brief 1701, 4 p. The WorldFish Center, Penang.

This brief explains how climate change will affect aquatic systems and how fisheries and aquaculture will need to adapt to meet these changes. It provides a number of examples of how our projects are providing solutions to cope with climate change.

The WorldFish Center. 2007.

**GIS mapping of pond aquaculture potential in Bangladesh.** WorldFish Handout 1723, 1 p. The WorldFish Center, Penang.

This summary sheet illustrates WorldFish's modeling work that incorporates biophysical and socio-economic factors to determine the areas with the greatest potential for profitable pond aquaculture benefiting the poor in Bangladesh. The sheet includes maps and diagrams.

The WorldFish Center. 2007.

**GIS mapping of pond aquaculture potential in Henan province, China.** WorldFish Handout 1720, 1 p. The WorldFish Center, Penang.

This summary sheet illustrates WorldFish's modeling work that incorporates biophysical and socio-economic factors to determine the areas with the greatest potential for profitable pond aquaculture benefiting the poor in Henan province, China. The sheet includes maps and diagrams.

The WorldFish Center. 2007.

**GIS mapping of pond aquaculture potential in southern Cameroon, Africa.** WorldFish Handout 1721, 1 p. The WorldFish Center, Penang.



This summary sheet illustrates WorldFish's modeling work that incorporates biophysical and socio-economic factors to determine the areas with the greatest potential for profitable pond aquaculture benefiting the poor in southern Cameroon, Africa. The sheet includes maps and diagrams.

The WorldFish Center. 2007.

**GIS mapping of pond aquaculture potential in southern Malawi, Africa.**

WorldFish Handout 1722, 1 p. The WorldFish Center, Penang.

This summary sheet illustrates WorldFish's modeling work that incorporates biophysical and socio-economic factors to determine the areas with the greatest potential for profitable pond aquaculture benefiting the poor in Malawi, Africa. The sheet includes maps and diagrams.

The WorldFish Center. 2007.

**Milkfish bibliography: a compilation of abstracts on Milkfish studies.**

Milkfish Project Publication Series No. 1, 331 p. The WorldFish Center, Laguna.

Milkfish Bibliography covers 700 references on milkfish biology; broodstock management and fry, fingerling and egg collection and production; milkfish culture systems; health and nutrition; post harvest technology; socioeconomic and related studies; and environment and ecology. Included references range from published/unpublished documents, theses, journal articles, to project reports and conference papers.

The WorldFish Center. 2007.

**Priority technologies and national strategies to develop and manage fisheries and aquaculture.**

WorldFish Policy Brief 1702, 4 p. The WorldFish Center, Penang.

Drawn from the outstanding work that developed the AsiaFish model, this policy brief offers four key recommendations to Asian policy makers for expanding and managing their national fisheries and aquaculture sectors.

The WorldFish Center. 2007.

**Proceedings of the International Workshop on the Fisheries of the Zambezi Basin.**

WorldFish Conference Proceedings 1705, 82 p. The WorldFish Center, Penang.

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This report from WorldFish is divided into two sections, with annexes. Section One contains the workshop report, including the workshop results and outputs. Section Two contains summary papers of the workshop presentations with a record of relevant points of discussion. The annexes contain additional information such as the participant list, detailed findings and speeches.

The WorldFish Center. 2007.

**ReefBase Pacific.** WorldFish Flyer 1733, 2 p. The WorldFish Center, Penang.

The ReefBase Pacific project aims to improve quality and accessibility of data and information for reef fisheries and coral reef research, management, conservation, and education in the Pacific region. The project is a component of the Coral Reef Initiative for the South Pacific (CRISP) ([www.crisponline.net](http://www.crisponline.net)), executed by WorldFish and funded by the Agence Française de Développement and the UN Fund.

The WorldFish Center. 2007.

**Snorkel the web: ReefBase brings a sea change in access to information about coral reefs.** WorldFish Factsheet 1713, 2 p. The WorldFish Center, Penang.

This fact sheet highlights ReefBase, an award-winning online global information system designed to facilitate research on, and the management of, coral reefs to enhance their protection. Launched in 2002, ReefBase was developed by The Worldfish Center in collaboration with the International Coral Reef Action Network and strongly supports The WorldFish mission to reduce poverty and hunger by improving fisheries and aquaculture.

The WorldFish Center. 2007.

**Supply and demand issues affecting fisheries and aquaculture in the Philippines.** WorldFish Issues Brief 1704, 4 p. The WorldFish Center, Penang.

The brief presents an overview of fisheries, fish demand and supply and technology priorities in Philippines.

The WorldFish Center. 2007.

**The Millennium Development Goals: fishing for a future,** 8 p. The WorldFish Center, Penang.

This brochure describes how WorldFish is contributing towards these goals and the valuable role played by fisheries and aquaculture in developing countries.

The WorldFish Center. 2007.

**The threat to fisheries and aquaculture from climate change.** WorldFish Policy Brief, 8 p. The WorldFish Center, Penang.

The brief covers the significance of fisheries and aquaculture, climate change impacts on fisheries and aquaculture.

Yap, W.G., A.C. Villaluz, M.G.G. Soriano and M.N. Santos. 2007.

**Milkfish production and processing technologies in the Philippines.** Milkfish Project Publication Series No. 2, 96 p. The WorldFish Center, Penang.

This manual describes the technologies developed for Milkfish seed production, grow-out and processing in the Philippines.

Yeo, B.H., D. Squires, K. Ibrahim, H. Gjertsen, S.K. Syed Mohd. Kamil, R. Zulkifli, T. Groves, M.C. Hong and C.H. Tan. 2007.

**Fisher profiles and perceptions of sea turtle-fishery interactions: Case study of East Coast Peninsular Malaysia.** WorldFish Discussion Series 6, 69 p. The WorldFish Center, Penang.

The paper focuses on coastal fisheries, particularly examining sea turtle-fishery interactions and determining the socioeconomic profile and perception of local fishers about sea turtle issues along the East Coast of Peninsular Malaysia.

Yong-Sulem, S. and R.E. Brummett. 2007.

**Participatory research boosts catfish egg, fry production in Cameroon.** Global Aquaculture Advocate 10(4):79-81.

The omnivorous African sharptooth catfish is a valuable species suitable for culture by smallholder farmers in Cameroon. A five-year research project that brought farmers together with research interests established simple, but effective approaches to increasing catfish fingerling production through improved egg handling, antipredation measures, and higher-density stocking options.

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