



WorldFish
C E N T E R



Reducing poverty
and hunger by
improving fisheries
and aquaculture

2011 PUBLICATIONS CATALOG



The WorldFish Center, a CGIAR Consortium Research Center, is an international, non-profit research organization dedicated to reducing poverty and hunger by improving fisheries and aquaculture. CGIAR is a global research partnership that unites organizations engaged in research for sustainable development. CGIAR research is dedicated to reducing rural poverty, increasing food security, improving human health and nutrition, and ensuring more sustainable management of natural resources. It is carried out by the 15 centers who are members of the CGIAR Consortium in close collaboration with hundreds of partner organizations, including national and regional research institutes, civil society organizations, academia, and the private sector. www.cgiar.org

Publications Catalog 2011

This catalog lists publications published by The WorldFish Center and papers contributed by the Center's scientists in 2011. 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 4 sections:

- Corporate publications
- Staff Refereed publications
- Staff Non-refereed publications
- Other Key WorldFish 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:

	2011
● Corporate publications	5
● Staff Refereed publications	60
● Staff Non-refereed publications	19
● Other Key WorldFish publications	34



The WorldFish Center gratefully acknowledges the funding support from the CGIAR Fund and other donors.

Corporate Publications

WorldFish report 2010/11.

The WorldFish Center, Penang, 10 p.

This year's report contains the Director General's and Chairman's statements illustrating the major thrust of and progress with the approved 2011 strategy. It incorporates details of the financial statement for the past year. There are highlights from projects covering the enhancement of coastal fisheries, livelihood in the Philippines, programs on lake fisheries in Malawi, to capacity building in terms of long term training for local partners and stakeholders.

2010 Publications catalog.

The WorldFish Center, Penang, 65 p.

This catalog lists publications published by The WorldFish Center and papers contributed by the Center's scientists in 2010. It reflects the outcomes of research carried out in collaboration with partners from 27 countries through the generous support from international investors. The majority of which are members of the CGIAR.

Financial statements and report of independent auditors.

31 December 2010. The WorldFish Center, Penang. 29 p. The WorldFish

Center Corporate Video.

2011. Penang. (5 min. 39 sec.)

This latest video outlines the key missions and strategies of The WorldFish Center, and highlights some of the key programs in countries in the Asian, African and the South Pacific region.

The WorldFish Center 2012 Calendar.

Penang.

Staff Refereed Publications

Allison, E.H. 2011.

Should states and international organizations adopt a human rights approach to fisheries policy?.

Maritime Studies 10(2): 95-116.

Non-governmental organizations (NGO) and fisherfolk organizations already use human rights principles and legislation to campaign for the social, economic and cultural rights of fishing people. Yet, despite the widespread adoption of human rights principles by NGOs and United Nations agencies over the last 20 years and the human rights-basis of the influential FAO Code of Conduct for Responsible Fisheries, progress with application of this approach in fisheries has lagged behind other sectors until recently. It has been overshadowed by concerns to clarify and limit fishing access and use rights to prevent ecological collapse and address economic inefficiencies. Recent attention to gender equity, child labor, fair trade and rights to decent work in the fishery sector point, however, to rising attention to human rights-based approaches. Human rights approaches fit well with wider development agendas, utilize existing legal and policy frameworks, improve accountability of donors and states to their citizens, and can have positive impacts on fisherfolk's ability and motivation to participate in fisheries management for sustainability. They do not always require expensive and protracted legal process to implement and many have proven successful in fostering social and economic development both in fisheries and other sectors. Mindful of the risk of depoliticizing people's struggles for rights and co-opting the rights agenda to support business-as-usual, international agencies, aid donors and states can support responsible fisheries more effectively if they adopt a more explicit human rights approach in their development programming and governance frameworks.

Allison, E.H.; Badjeck, M.C.; Meinhold, K. 2011.

The implications of global climate change for molluscan aquaculture.

p. 461-490. In: Shumway, S.E. (ed.) Shellfish aquaculture and the environment. Wiley-Blackwell. 528 p.

Climate change is leading to alterations in the basic biophysical processes that determine the ecological structure and function of the oceans. This will have an impact on the future of molluscan shellfish farming. The impacts may be positive or negative, depending upon location. The pathways through which shellfish farming may be affected by climate change are complex, but may include increased mortality and decreased growth rates from a

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combination of climate-change related stresses such as ocean acidification, reduced oxygenation of heated, enclosed waters, changes in primary production, changes in natural spatfall, changes in the frequency of pathogenic infections and the distribution of pests and nonnative species. Additionally, increased extreme weather events may increase losses and direct damage to aquaculture installations and coastal infrastructure.

Allison, E.H.; Béné, C.; Andrew, N.L. 2011.

Poverty reduction as a means to enhance resilience in small-scale fisheries.

p. 216-237. In: Pomeroy, R.S.; Andrew, N.L. (eds.) Small-scale fisheries management: frameworks and approaches for the developing world. Cabi, UK. 247 p.

This chapter examines the multiple dimensions of poverty and related 'state of being' such as vulnerability and social exclusion, with reference to several important aspects of vulnerability, including gender, climate change, HIV/AIDS and child labor.

Alvarez-Filip, L.; Gill, J.A.; Dulvy, N.K.; Perry, A.L.; Watkinson, A.R.; Côté, I.M. 2011.

Drivers of region-wide declines in architectural complexity on Caribbean reefs.

Coral Reefs 30(4): 1051-1060.

Severe declines in the cover of live hard coral on reefs have been reported worldwide, and in the Caribbean region, the architectural complexity of coral reefs has also declined markedly. While the drivers of coral cover loss are relatively well understood, little is known about the drivers of regional-scale declines in architectural complexity. This study makes use of a dataset of 49 time series reporting reef architectural complexity to explore the effect of hurricanes, coral bleaching and fishing on Caribbean-wide annual rates of change in reef complexity. Hurricane impacts greatly influence reef complexity, with the most rapid rates of decline in complexity occurring at sites impacted during their survey period, and with lower rates of loss occurring at unimpacted sites. Reef architectural complexity did not change significantly following mass bleaching events (in a time frame of <5 years) or positive thermal anomalies.

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Andrew, N.L.; Evans, L. 2011.

Approaches and frameworks for management and research in smallscale fisheries.

p. 16-34. In: Pomeroy, R.S.; Andrew, N.L. (eds.) Small-scale fisheries management: frameworks and approaches for the developing world. Cabi, UK. 247 p.

The search for innovations and implementation of research frameworks for small-scale fisheries in developing and least developed countries are discussed.

Arthur, R.; Friend, R.; Dubois, M. 2011.

Fisheries, nutrition and regional development pathways: reasserting food rights.

p. 149-166. In: Lazarus, K.; Badenoch, N.; Dao, N.; Resurreccion, B.P. (eds.) Water rights and social justice in the Mekong region. Earthscan, London. 265 p.

As hydropower developments are accelerated, particularly along the Mekong mainstream, debates are looming over how to address the loss of abundant fisheries that are so important to local livelihoods. The authors discuss what is at stake and what might be lost by considering how fisheries contribute to development that meets the needs of the people of Mekong. They emphasize the importance of food sovereignty as a local issue in the discourse about trade-offs in water decision-making. In particular, the authors explore experiences from Lao PDR, a country with a rich capture fishery, but also endemic food crisis, and a national policy commitment to both poverty reduction and significant hydropower development.

Barange, M.; Allen, I.; Allison, E.; Badjeck, M.C. et al. 2011.

Predicting the impacts and socio-economic consequences of climate change on global marine ecosystems and fisheries: the QUEST_Fish framework.

Chapter 3. In: Ommer, R.E.; Perry, R.I.; Cochrane, K.; Cury, P. (eds.) World fisheries: a social-ecological analysis. Oxford, Wiley-Blackwell. 418 p.

Climate change is accelerating and is already affecting the marine environment. Estimating the effects of climate change on the production of fish resources, and their dependent

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societies, is complex because of: difficulties of downscaling Global Climate Models (GCM) to scales of biological relevance; uncertainties over future net primary production and its transfer through the food chain; difficulties in separating the multiple stressors affecting fish production; and inadequate methodology to estimate human vulnerabilities to these changes. QUEST_Fish, a research project led from the UK, is addressing some of these challenges through an innovative, multi-disciplinary approach focused on estimating the added impacts that climate change is likely to cause, and the subsequent additional risks and vulnerabilities of these effects for human societies. The project uses coupled shelf seas biophysical ecosystem models forced by GCM forecasts to predict ecosystem functioning in past, present, and future time-slices. For each slice, and for 20 Large Marine Ecosystems, we estimate plankton production and use this to estimate size-based fish production through models based on macroecological theory. Ways of assessing vulnerability of fisheries to future climate change are developed, including the market consequences for fishbased global commodities. The results provide a new framework and new insights into the complex interactions between humans and nature.

Barman, B.K.; Little, D.C. 2011.

Use of hapas to produce Nile tilapia (*Oreochromis niloticus* L.) seed in household foodfish ponds: a participatory trial with small-scale farming households in northwest Bangladesh.

Aquaculture 317(1/4): 214-222.

Production and supply of fish seed-stock are essential for the promotion of aquaculture. Traditional inland aquaculture was based on the collection of seed-stock from rivers and required the sorting and acclimatizing of mixed species. Fine meshed nylon net cages 'hapas' have been used for this purpose for Chinese carps in China and in Bangladesh and India for Indian major carp for a long time. Hapa nursing of small fry to larger, more predator-resistant fingerlings has been the focus for intensification of aquaculture in North East Thailand and Lao PDR. This paper presents the results of an on-farm trial with farming households in NW Bangladesh over two years to assess the adoptability and performance of hapa-based seed production.

Bell, J.D.; Andrew, N.L.; Batty, M.J.; Chapman, L.B.; Dambacher, J.M. et al. 2011.

Adapting tropical Pacific fisheries and aquaculture to climate change: management measures, policies and investments.

p. 803-876. In: Bell, J.D.; Johnson, J.E.; Hobday, A.J. (eds.)

Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change. Secretariat of the Pacific Community, Noumea, New Caledonia.

The main purpose of this book is to assess how changes projected to occur under low (B1) and high (A2) emissions scenarios in 2035 and 2100 could derail plans by the Pacific Island countries and territories (PICTs) to use the sustainable benefits of fisheries and aquaculture to foster economic development, government revenue, food security and livelihoods. This chapter sets out the information needed by stakeholders in the fisheries and aquaculture sector at all levels to reduce the threats and capitalize on the opportunities created by climate change. The authors emphasize that adaptations and policies to build the resilience of the Pacific communities to climate change should not be viewed just from a scientific or technical perspective - the needs and aspirations of people must also be integrated. Understanding how people are affected, and how their traditional knowledge, capacities and perspectives can help develop and implement adaptations is a vital part of the process. Community consultation and participation are essential to ensure that adaptations incorporate human rights and human development approaches to achieve gender equality, maintain relevant traditional customs and culture, and empower young people.

Bell, J.D.; Reid, C.; Batty, M.J.; Allison, E.H.; Lehodey, P.; Rodwell, L.; Pickering, T.D.; Gillett, R.; Johnson, J.E.; Hobday, A.; Demmke A. 2011.

Implications of climate change for contributions by fisheries and aquaculture to Pacific Island economies and communities.

p. 733-801. In: Bell, J.D.; Johnson, J.E.; Hobday, A.J. (eds.)

Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change. Secretariat of the Pacific Community, Noumea, New Caledonia.

Throughout Pacific Island countries and territories (PICTs) there is broad recognition that fisheries and aquaculture make vital contributions to economic development, government revenue, food security and livelihoods. It is also clear that the plans to optimize the benefits

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of fisheries and aquaculture for the region are likely to be affected by climate change. The authors begin by summarizing the recent contributions of oceanic, coastal and freshwater fisheries, and aquaculture, to the region and then explain the plans PICTs have to optimize these benefits and conclude by assessing the vulnerability of these plans to the main projected changes in production of fisheries resources and aquaculture due to climate change for 2035 and 2100 under a low (B1) and high (A2) emissions scenarios.

Belton, B.; Haque, M.M.; Little, D.C.; Le, X.S. 2011.

Certifying catfish in Vietnam and Bangladesh: Who will make the grade and will it matter?

Food Policy 36(2): 289-299.

Certification is an increasingly pervasive form of market governance through which retailers and NGOs are able to exert control over producers of primary products in order to secure their commercial and institutional interests. This paper assesses the likely outcomes of emerging certification standards intended to govern production of a new global commodity, *Pangasius catfish*. This evaluation focuses on *Pangasius* producers in Vietnam and Bangladesh, and one of the key areas which standards seek to regulate; the environment. We conclude that certification is likely to result in greater differentiation and polarization between larger and smaller farm operators and will increasingly act to exclude of the latter from access to Western European and North American markets, and that any local environmental gains produced may be of relatively minor significance.

Belton, B.; Little, D.C. 2011.

Contemporary visions for small scale aquaculture.
p. 151-172. In: Chuenpagdee, R. (ed.) World small-scale fisheries: contemporary vision. Eburon Academic, the Netherlands.

This chapter discusses the importance of small scale aquaculture in supporting livelihoods and alleviating poverty. Similar to capture fisheries, this sector faces challenges related to globalized trade, production regulation and climate variability that threaten its future. This essay considers 'small-scale aquaculture' (SSA) from a variety of perspectives. It first examines the origins and usage of the term and offer a definition based on the social characteristics of those who practice it. It then examines drivers of contemporary SSA, the various roles that SSA plays in supporting agrarian livelihoods and its relationship to wellbeing and poverty with references to examples drawn from across Asia. The challenges and opportunities presented to smallscale producers and culture systems are assessed, and the likely future of small-scale aquatic production systems is discussed.

Belton, B.; Little, D.C. 2011.

Immanent and interventionist inland Asian aquaculture development and its outcomes. *Development Policy Review* 29(4): 459-484.

Aquaculture is equated with the reduction of poverty by intergovernmental agencies such as the FAO, which advocate the promotion of small-scale aquaculture through project-based interventions. There is a lack of convincing empirical evidence to support the efficacy of this type of intervention, however. Meanwhile, commercial cultured freshwater fish production has increased hugely throughout Asia, despite limited direct donor or government support. Its impact with respect to poverty also remains ambiguous, however. This article critically evaluates the developmental impacts of both immanent and interventionist forms of aquaculture and advances finely nuanced interpretations of both.

Belton, B.; Little, D.C.; Le, X.S. 2011.

The social relations of catfish production in Vietnam. *Geoforum* 42(5): 567-577.

The growth of intensive export-oriented *Pangasius* catfish production in Vietnam's Mekong Delta is unparalleled in terms of rapidity and scale by any other agricultural sector, with production climbing from a low base to more than 1 million tons in a single decade. This paper examines the effects of this remarkable change on the rural class structure in locations where catfish farming has boomed, and analyses the role of local state-society relations in mediating outcomes resulting from the integration of local actors into the global value chain. We conclude that private economic activity is deeply embedded in informal relations with the state bureaucracy in Vietnam, with the result that the expansion of catfish aquaculture has generally acted to reproduce and entrench existing class relations rather leading to a radical reconfiguration of the rural class structure.

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Béné, C.; Evans, L.; Mills, D.; Ovie, S.; Raji, A.; Tafida, A.; Kodio, A.; Sinaba, F.; Morand, P.; Lemoalle, J.; Andrew, N. 2011.

Testing resilience thinking in a poverty context: experience from the Niger River basin.
Global Environmental Change 21(4): 1173-1184.

Resilience thinking is an important addition to the range of frameworks and approaches that can be used to understand and manage complex social - ecological systems like small-scale fisheries. However, it is yet to lead to better environmental or development outcomes for fisheries stakeholders in terms of food security, improved livelihoods and ecological sustainability. This paper takes an empirical approach by focusing on the fundamentals of resilience thinking to evaluate its usefulness in developing relevant management interventions in small-scale fisheries in the Niger River Basin in West Africa. The paper presents the outputs of a participatory assessment exercise where both fishery communities and local experts were involved at two different scales. The resilience frame used was designed to facilitate the identification of socially defined thresholds that help delineate the desirability of the current system configuration and provides a diagnosis framework that tailors management solutions to problems in local context. The analysis highlights some key contributions from resilience thinking to the challenge of diagnosis in small-scale fisheries management in developing countries, as well as important contributions that emerge from taking a pragmatic and critical approach to its application.

Brummett, R.E.; Gockowski, J.; Poumogne, V.; Muir, J. 2011.

Targeting agricultural research and extension for food security and poverty alleviation: a case study of fish farming in Central Cameroon.
Food Policy 36(6): 805-814.

Over 5 years of participatory on-farm research, market access, profitability, farming systems productivity and economic sustainability were compared on 100 small-scale farms in Central Cameroon. Integration technology based on the use of agricultural by-products as fishpond input was the driver for intensification. Over all farms, fishpond productivity increased from 498 kg to 1609 kg fish/ha (2145 kg/ha/yr). During the project period, the number of active fish farmers increased from 15 to 192 (including 55 farms which participated only through information exchange). Over all farms, net returns from aquaculture increased by 5 times over pre-project levels. Productivity, intensity and profitability increased more significantly in periurban areas with good market access, compared to rural areas. Findings indicate that, in areas with little or no access to markets, the number of fishponds and fish farmers can

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be increased and yields improved, increasing local food supplies, but sustainability in the absence of extension subsidies is questionable. To achieve either of the two principal goals for the sector, food security and/or poverty alleviation, investments need to be made in improving the availability of quality technical assistance to targeted farmers and finding means of reducing social conflict arising from perceived inequalities in the accrual of the benefits of development.

Brummett, R.E.; Jamu, D.M. 2011.

From researcher to farmer: partnerships in integrated aquaculture-agriculture systems in Malawi and Cameroon.

International Journal of Agricultural Sustainability 9(1): 282-289.

The potential for integrating aquaculture with agriculture has been widely recognized as a means of improving the use of inputs, diversifying output and economic opportunity, and enabling smallholder producers to maintain and strengthen livelihoods. This paper describes the outcomes of this approach and explains the extent to which it has been taken up and has led to sustained and self-generated capacity. Based in particular on experience in Malawi, Ghana and Cameroon, it also considers implications more widely in the region. The overall picture is that this is a partial and still emerging success story, linked as much with the social and economic drivers surrounding smallholder farmers as with the development support approach adopted.

Cochrane, K.L.; Andrew, N.L.; Parma, A.M. 2011.

Primary fisheries management: a minimum requirement for provision of sustainable human benefits in small-scale fisheries.

Fish and Fisheries 12(3): 275-288.

The social and economic importance of small-scale fisheries is frequently under-valued, and they are rarely effectively managed. There is now growing consensus on how these fisheries could be managed for sustainability and to minimize the risks of crossing undesirable thresholds. Using a concept developed in health care, these approaches have been referred to as primary fisheries management. By encouraging the use of best-available information in a precautionary way, the approaches will facilitate sustainable use and should therefore be encouraged, but they accept high scientific and implementation uncertainties as unavoidable because of limited management and enforcement resources and capacity. It is important to

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recognize that this limitation will result in social costs, because application of a precautionary approach in the face of high uncertainties will require forgoing potential sustainable benefits. Acceptance of primary fisheries management as a final and sufficient goal could therefore add a further constraint on the possibility of fishing communities escaping the poverty trap. Primary fisheries management should be seen as a first and minimum target for fisheries where there is currently no or inadequate management, but the longer-term goal should still be well informed and adaptive management that strives for optimal benefits, referred to here as tertiary management.

de Graaf, G.J.; Grainger, R.J.R.; Westlund, L.; Willmann, R.; Mills, D.; Kelleher, K.; Koranteng, K. 2011.

The status of routine fishery data collection in Southeast Asia, central America, the South Pacific, and West Africa, with special reference to small-scale fisheries.

ICES Journal of Marine Science 68(8): 1743-1750.

The Food and Agriculture Organization (FAO) strategy for improving information on the status and trends of capture fisheries (FAO Strategy STF) was endorsed by Member States and the UN General Assembly in 2003. Its overall objective is to provide a framework, strategy, and plan to improve knowledge and understanding of the status and trends of fisheries as a basis for policy-making and management, towards conservation and sustainable use of resources within ecosystems. The FAO supports the implementation of FAO Strategy STF in developing countries through a project known as FAO FishCode - STF, and an initiative funded by the World Bank entitled the "BigNumbers project". The BigNumbers project underscored the importance of small-scale fisheries and revealed that catches by and employment in this sector tend to be underreported. An inventory of data collection systems made under the FAO FishCode - STF project showed that small-scale fisheries are not well covered. Their dispersed nature, the weak institutional capacity in many developing countries, and the traditional methods used make routine data collection cumbersome. Innovative sampling strategies are required. The main priority is a sample frame for small-scale fisheries. Sustainable strategies are most likely to be found outside the sector through population and agricultural household censuses and inside the sector through the direct involvement of fishers.

Dulvy, N.K.; Reynolds, J.D.; Pilling, G.M.; Pinnegar, J.K.; Phillips, J.S.; Allison, E.H.; Badjeck, M.C. 2011.

Fisheries management and governance challenges in a climate change.

p. 31-88. IN: OECD. The economics of adapting fisheries to climate change.

This chapter outlines the causes and consequences of climate change and summarizes future projections for ocean temperature rise, coral bleaching events, ocean acidification and the associated uncertainties. This review largely focuses on marine ecosystems, as three quarters of capture fisheries landings come from the seas. However, it also presents key issues and examples from freshwater fisheries, as these fisheries provide important livelihoods and fish protein for some of the world's poorest people.

Evans, L.; Andrew, N.L. 2011.

Diagnosis and the management constituency of small-scale fisheries.

p. 35-58. In: Pomeroy, R.S.; Andrew, N.L. (eds.) Small-scale fisheries management: frameworks and approaches for the developing world. Cabi, UK. 247 p.

The concepts and implementation of the Participatory Diagnosis and Adaptive Management (PDAM) framework for small-scale fishery development and management in developing countries are described.

Evans, L.; Cherrett, N.; Pemsil, D. 2011.

Assessing the impact of fisheries co-management interventions in developing countries: a meta-analysis.

Journal of Environmental Management 92(8): 1938 -1949.

Co-management is now established as a mainstream approach to small-scale fisheries management across the developing world. A comprehensive review of 204 potential cases reveals a lack of impact assessments of fisheries co-management. This study reports on a meta-analysis of the impact of fisheries co-management in developing countries in 90 sites across 29 case-studies. The top five most frequently measured process indicators are participation, influence, rule compliance, control over resources, and conflict. The top five

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most frequently measured outcome indicators are access to resources, resource well-being, fishery yield, household well-being, and household income. To deal with the diversity of the 52 indicators measured and the different ways these data are collected and analyzed, we apply a coding system to capture change over time. The results of the meta-analysis suggest that, overall fisheries co-management delivers benefits to end-users through improvements in key process and outcome indicators. However, the dataset as a whole is constituted primarily of data from the Philippines. When we exclude this body of work, few generalizations can be made about the impact of fisheries co-management. The lack of comparative data suitable for impact assessment and the difficulties in comparing data and generalizing across countries and regions reiterates calls in other fields for more systematic approaches to understanding and evaluating governance frameworks.

Evans, L.S.; Brown, K.; Allison, E.H. 2011.

Factors influencing adaptive marine governance in a developing country context: a case study of Southern Kenya.

Ecology and Society 16(2) online.

Adaptive governance can be conceptualized as distinct phases of: 1) understanding environmental change; 2) using this understanding to inform decision making; and 3) acting on decisions in a manner that sustains resilience of desirable system states. Using this analytical framework, we explore governance in practice in two case studies in Kenya that reflect the “messiness” of contemporary coastal governance in many developing country contexts. Findings suggest that adaptive marine governance is unlikely to be a smooth process of learning, knowledge sharing, and responding. There are institutional, socio-cultural, and political factors, past and present that influence each phase of both local and state decision making. New local institutions related to fisher associations and Beach Management Units influence learning and knowledge sharing in ways contrary to those expected of institutions that enable collaborative fisheries management. Similarly, state decision making is relatively uninformed by the diverse knowledge systems available in the coastal zone, despite the rhetoric of participation. Historical relations and modes of working continue to play a significant role in mediating the potential for adaptive governance in the future. The case studies are illustrative and point to a number of institutional and political issues that would need to be addressed in processes of governance reform towards more adaptive management in developing country contexts.

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Ferguson, J.W.; Healey, M.; Dugan, P.; Barlow, C. 2011.
Potential effects of dams on migratory fish in the Mekong river: lessons from Salmon in the Fraser and Columbia rivers.
Environmental Management 47: 141-159.

We compared the effects of water resource development on migratory fish in two North American rivers using a descriptive approach based on four high level indicators: (1) trends in abundance of Pacific salmon, (2) reliance on artificial production to maintain fisheries, (3) proportion of adult salmon that are wild- versus hatchery-origin, and (4) number of salmon populations needing federal protection to avoid extinction. The two rivers had similar biological and physical features but radically different levels of water resource development: the Fraser River has few dams and all are located in tributaries, whereas the Columbia River has more than 130 large main stem and tributary dams. Not surprisingly, we found substantial effects of development on salmon in the Columbia River. We related the results to potential effects on migratory fish in the Mekong River where nearly 200 main stem and tributary dams are installed, under construction, or planned and could have profound effects on its 135 migratory fish species. Impacts will vary with dam location due to differential fish production within the basin, with overall effects likely being greatest from 11 proposed main stem dams. Minimizing impacts will require decades to design specialized fish passage facilities, dam operations, and artificial production, and is complicated by the Mekong's high diversity and productivity. Prompt action is needed by governments and fisheries managers to plan Mekong water resource development wisely to prevent impacts to the world's most productive inland fisheries, and food security and employment opportunities for millions of people in the region.

Goñi, R.; Badalamenti, F.; Tupper, M.H. 2011.
Fisheries- Effects of marine protected areas on local fisheries: evidence from empirical studies.
Chapter 3. In: Claudet, J. (ed.) Marine protected areas: a multidisciplinary approach. Cambridge University Press, Cambridge

This chapter reviews and assesses current empirical evidence of marine protected area (MPA) effects on fisheries. First, we briefly describe the mechanisms by which MPAs may affect fisheries. Second, we synthesize empirical evidence of those effects essentially transfer of exploitable biomass from MPAs to fished areas and ensuing changes in catch and effort patterns. Lastly, we discuss this evidence, highlighting the strengths and weaknesses of MPAs for fisheries management based on current empirical knowledge.

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Hall, S.J. 2011.

Climate change and other external drivers in small-scale fisheries: practical steps for responding. p. 132-159. In: Pomeroy, R.S.; Andrew, N.L. (eds.) *Small-scale fisheries management: frameworks and approaches for the developing world*. Cabi, UK. 247 p.

The effects of international trade, market globalization, technology, climatic change, health and disease, demography, governance, development patterns and aquaculture on small-scale fisheries and practical suggestions for researchers, managers and policy makers on how to develop responses to these challenges are presented.

Hawes, I.; Lasiak, T.; Smith, M.L.; Oengpepa, C. 2011.

The Status of silverlip pearl oyster *Pinctada maxima* (Jameson) (Mollusca, Pteridae) in the Solomon Islands after a 15-year export ban. *Journal of Shellfish Research* 30(2): 255-260.

In the Solomon Islands, there have been three periods of commercial exploitation of the silver (gold)-lip pearl oyster *Pinctada maxima*. The most recent ended in 1993, when export of all species of pearl oysters was banned to allow stocks to recover from overexploitation. To help to fill this information gap, a survey of eight former *P. maxima* fishing grounds in the Solomon Islands was carried out in 2007. This article presents information on the abundance and size structure based on underwater visual censuses undertaken by teams of hookah divers in April to October 2007.

Jacinto, E.R.; Pomeroy, R.S. 2011.

Developing markets for small-scale fisheries: utilizing the value chain approach. p. 160-177. In: Pomeroy, R.S.; Andrew, N.L. (eds.) *Small-scale fisheries management: frameworks and approaches for the developing world*. Cabi, UK. 247 p.

This chapter describes the constraints for marketing by small-scale fisheries and the steps for market development, including stabilization of the fish supply, setting up cooperatives, enhancing relations in the value chain and building market institutions.

Jamu, D.; Banda, M.; Njaya, F.; Hecky, R. 2011.

Challenges to sustainable management of the lakes of Malawi.

Journal of Great Lakes Research 37(S1): 3-14.

This paper reviews the management challenges facing Malawi lakes and analyzes the management responses that have been developed to deal with these challenges. Malawi lakes are under considerable stress due to high population growth and increasing levels of poverty which have led to overexploitation of fishery resources. High rates of soil erosion in the lake catchments are increasing siltation of shallow lakes, deltas and embayment, affecting water quality and fish breeding habitats, thereby degrading fish production potential. This review further shows that past and current management approaches have focused on maximizing sustainable yield and have failed to adequately incorporate socio-ecological factors and broader lake catchment processes into fisheries management plans. This, in turn, led to the top-down development of fisheries laws and technical regulations which were difficult to enforce, increased conflict between resource users and fisheries managers, and failed to control fisheries overexploitation and the collapse of the chambo (tilapia) and cyprinid fisheries. The paper recommends that the fisheries policy should be reviewed to focus on resilience of fisheries, environment and livelihoods. Policy makers should adopt integrated management planning to address the diverse interest of stakeholders in lake basins, as well as the ecological, socio-economic and external factors threatening sustainability of lake ecosystems and livelihoods of dependent communities.

Joffe, O.M.; Sheriff, N.; Ngai, H.H.; Hao, N.V. 2011.

Community-based fish culture: a viable coping strategy for farmers in the Mekong Delta?.

Stewart, M.A.; Coclanis, P.A. (eds.) Environmental Change and Agricultural Sustainability in the Mekong Delta. Advances in Global Change Research 45(4): 259-270.

Floodplains are characterized by a period of several months when the land is not available for agriculture and large and open areas are used for fisheries. Enclosures in the flooded areas can be utilized to produce a crop of stocked fish, in addition to naturally occurring self-recruited species. The WorldFish Center and the Research Institute for Aquaculture no2 (RIA 2) tested options for community-based fish culture in floodplain enclosures in the Mekong Delta. The trials yielded fish production in the range of 61-179 kg ha⁻¹. Results indicate that the models tested are sensitive and dependent on flood patterns and limitations imposed by the rice culture calendar. Other technical challenges included a short grow-out period and

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fingerling size. These initial trials have shown that community-based fish culture is an innovative approach for the Mekong Delta and has the potential to provide an alternative livelihood option in the face of environmental change and development. To increase uptake, the technical design of the approach could be further optimized, and mechanisms for community participation could be enhanced to increase economic incentives for adoption of the technology by farmers.

Kabahenda, M.K.; Amega, R.; Okalany, E.; Husken, S.M.C.; Heck, S. 2011.

Protein and micronutrient composition of low value fish products commonly marketed in the Lake Victoria region.

World Journal of Agricultural Sciences 7(5): 521-526.

Increase in demand of fish from Lake Victoria region has created gaps in local fish supplies and this raises concern since there are reports of limited animal-source food consumption plus protein and micronutrients deficiencies in this region. To fill the gap, less-preferred pelagic fish species such as Mukene (*Rastroneobola argentea*) and by-products from filleting Nile perch (*Lates niloticus*), which were commonly used for animal feeds, are increasingly being minimally processed and marketed for direct human consumption. These fish products constitute what has been termed as 'low-value fish products'. This study was carried out to assess the nutrient content of low-value fish products (LVFPs) so as to document their potential contribution to protein and micronutrient intake of individuals who depend on these products as their major animal source food. Commonly marketed samples of fresh, smoked, deep fried and sundried Nile perch by-products and mukene were collected from factories, by-product processing sites and markets to determine their nutrient contents.

Karim, M.; Little, D.C.; Kabir, M.S.; Verdegem, M.J.C.; Telfer, T.; Wahab, M.A. 2011.

Enhancing benefits from polycultures including tilapia (*Oreochromis niloticus*) within integrated pond-dike systems: a participatory trial with households of varying socio-economic level in rural and peri-urban areas of Bangladesh.

Aquaculture 314(1/4): 225-235.

Linkages between the fish ponds and surrounding land for horticulture are a distinctive feature of farming households in Bangladesh. It was hypothesized that integration of fish ponds in

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integrated farming system enhances livelihoods and reduces poverty. The effects of introducing tilapia into existing integrated farming systems on the broader pond-dike system and associated livelihoods in rural and peri-urban settlements in central north (Mymensingh District) of Bangladesh were evaluated. This paper describes a participatory trial with farming households aggregated by well-being (better-off and worse-off) and location (peri-urban and rural) practising integrated pond-dike farming. Outcomes were monitored over a full production cycle of a control group

- (1) compared to households choosing to stock Nile tilapia as an additional species within their standard polyculture systems using either the same levels
- (2) or enhanced levels
- (3) of nutrient input.

Karim, M.; Sarwer, R.H.; Brooks, A.C.; Gregory, R.; Jahan, M.E.; Belton, B. 2011.

The incidence of suspected white spot syndrome virus in semi-intensive and extensive shrimp farms in Bangladesh: implications for management. *Aquaculture Research [online]*.

The study was conducted to assess key factors influencing suspected white spot syndrome virus (WSSV) disease and associated shrimp production and economic performance in three contrasting black tiger shrimp (*Penaeus monodon*) culture technologies promoted by the United States Agency for International Development funded Shrimp Quality Support Project (SQSP) in Bangladesh. A total of 350 traditional, 315 Modified Traditional Technology1 (MTT1), 36 MTT2 and 88 Closed System Technology (CST) farmers from 10 sub-districts in three districts of Khulna division were surveyed following random sampling at the end of the project. Binomial probit regression analysis revealed that smaller newly constructed ponds (known locally as gher) were less susceptible to WSSV, provided aquatic weeds were controlled using chemicals. Removal of sludge from ghers also had a positive effect, irrespective of technology and location. It was also shown that stocking of screened shrimp postlarvae (PL) does not guarantee protection against WSSV.

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Kassam, L.; Subasinghe, R.; Phillips, M. 2011.

Aquaculture farmer organizations and cluster management: concepts and experiences.

FAO fisheries and aquaculture technical paper 563. FAO, Rome. 90 p.

Small-scale aquaculture producers in developing countries are facing new opportunities and challenges related to market liberalization, globalization and increasingly stringent quality and safety requirements for their products, making it harder for them to access markets. Collective action through participation in farmers' organizations (FOs) can provide an effective mechanism to assist small-scale producers overcome these challenges and contribute to and influence modern market chains and trade. Literature on agriculture and aquaculture FOs and case studies of successful aquaculture FOs were reviewed and field research on successful aquaculture FOs in India and Thailand was undertaken to bring together current knowledge on the formation, operation and impact of aquaculture FOs. A range of FOs was examined and potential opportunities for success such as "cluster management" and group certification were highlighted. The publication presents factors associated with successful FOs and guiding principles for development organizations that wish to support aquaculture FOs in developing countries, followed by a summary of challenges and opportunities for the development of small-scale aquaculture FOs.

Kawarazuka, N.; Béné, C. 2011.

The potential role of small fish species in improving micronutrient deficiencies in developing countries: building evidence.

Public Health Nutrition 14(11): 1927-1938.

The purpose of this study was to build a comprehensive overview of the potential role of fish in improving nutrition with respect to certain micronutrient deficiencies in developing countries. A comprehensive literature review was completed. The quality of the data was carefully reviewed and data that lacked proper information on methods, units or sample size were excluded. Particular effort was made to highlight not only the information recently generated but also the gap in knowledge where more research is needed. Our focus was on developing countries where the largest proportion of people exposed to risk of under nutrition is found and where 95% of the population depends on small-scale fisheries or small-scale aquaculture for their livelihood.

Little, D.C.; Bush, S.R.; Belton, B.; Nguyen, T.P.; Young, J.A. 2011
Whitefish wars: Pangasius, politics and consumer confusion in Europe
Marine Policy 36(3): 738-745

Rapid growth in production of the farmed Vietnamese whitefish pangasius and its trade with the European Union has provoked criticism of the fish's environmental, social and safety credentials by actors including WWF and Members of the European Parliament and associated negative media coverage. This paper reviews the range of claims communicated about *pangasius* (identified as a form of mass mediated risk governance), in light of scientific evidence and analysis of data from the EU's Rapid Alert System for Food and Feeds food safety notification system for imported seafood. This analysis shows *pangasius* to be generally safe, environmentally benign and beneficial for actors along the international value chains that characterize the trade. The case is made that increasingly politicized debates in Europe around risk and uncertainty are potentially counterproductive for EU seafood security and European aquaculture industry, and that the trade in *pangasius* can contribute to sustainable seafood consumption in a number of ways. Transparent evidence-based assessment and systems for communicating complex issues of risk for products such as *pangasius* are required in order to support continuance of fair and mutually beneficial trade.

Lorenzen, K.; Beveridge, M.C.M.; Mangel, M. 2011.
Cultured fish: integrative biology and management of domestication and interactions with wild fish.
Biological Reviews [Online First].

Fish aquaculture for commodity production, fisheries enhancement and conservation is expanding rapidly, with many cultured species undergoing inadvertent or controlled domestication. Cultured fish are frequently released, accidentally and deliberately, into natural environments where they may survive well and impact on wild fish populations through ecological, genetic, and technical interactions. Impacts of fish released accidentally or for fisheries enhancement tend to be negative for the wild populations involved, particularly where wild populations are small, and/or highly adapted to local conditions, and/or declining. Captive breeding and supplementation can play a positive role in restoring threatened populations, but the biology of threatened populations and the potential of culture approaches for conserving them remain poorly understood. Approaches to the management of domestication and cultured-wild fish interactions are often ad hoc, fragmented and poorly informed by current science. We develop an integrative biological framework for understanding and managing domestication and cultured-wild fish interactions. The framework sets out how

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management practices in culture and for cultured fish in natural environments affect domestication processes, interactions between cultured and wild fish, and outcomes in terms of commodity production, fisheries yield, and conservation. We also develop a typology of management systems (specific combinations of management practices in culture and in natural environments) that are likely to provide positive outcomes for particular management objectives and situations. We close by setting out avenues for further research that will simultaneously improve fish domestication and management of cultured-wild fish interactions and provide key insights into fundamental biology.

Macuiane, M.; Kaunda, E.K.W.; Jamu, D.M. 2011.

Seasonal dynamics of physico-chemical characteristics and biological responses of Lake Chilwa, Southern Africa.

Journal of Great Lakes Research 37(S1): 75-82.

Lake Chilwa is shared by Malawi and Mozambique, it supports an important fishery and its watershed is undergoing rapid population growth and increasing utilization for agricultural production. It is a shallow, closed basin lake with extensive surrounding wetlands; and it has suffered several desiccation events in the last century. To better understand the current condition of the lake, we monitored a suite of physical, chemical and biological parameters at approximately monthly intervals over an annual cycle in 2004– 2005. The limnology of the lake was extremely sensitive to seasonal changes in the lake's seasonal hydrological cycle. The physico-chemical parameters, temperature, electrical conductivity, and total suspended solids exhibited clear seasonal patterns driven by the highly seasonal rainfall and resultant lake levels. In response, phytoplankton and zooplankton abundance, as well as biologically dependent oxygen concentrations and pH, exhibited several maxima levels over the year. The peaks of phytoplankton and zooplankton were out of phase suggesting a lag in the zooplankton grazing in response to pulses in primary productivity. Chlorophyll concentrations can exceed 1 mg/L in surface waters indicative of hypereutrophic conditions, but they fell dramatically during zooplankton peaks. This hydrologically driven, shallow and mesohaline lake is a productive and critical resource to the region. Its management poses challenges arising from the dependence of its limnology and fishery on the lakes hydrology, catchment land use and climate variability.

Mills, D.; Béné, C.; Ovie, S.; Tafida, A.; Sinaba, F.; Kodio, A.; Russell, A.; Andrew, N.; Morand, P.; Lemoalle, J. 2011.

Vulnerability in African small-scale fishing communities.

Journal of International Development 23: 308-313.

Fishing communities are often recognized as being amongst the poorest in developing countries, and interventions targeted at improving resource status seen as central in the fight against poverty. A series of field assessments focusing on vulnerability conducted in two communities in Mali and Nigeria revealed some counterintuitive results. Despite fishing being the primary livelihood, vulnerabilities relating directly to the state of the resource were ranked lower than those relating to basic human needs. Those results challenge the conventional view and suggest that non-sectoral interventions can have more effective impacts on the livelihood of those communities than interventions targeting the resources.

Mills, D.J.; Adhuri, D.S.; Phillips, M.J.; Ravikumar, B.; Padiyar, A.P. 2011.

Shocks, recovery trajectories and resilience among aquaculture-dependent households in post-tsunami Aceh, Indonesia.

Local Environment 16(5): 425-444.

Aquaculture-dependent households in Bireuen District, Aceh, Indonesia, have in recent years endured repeated, diverse shocks; multiple economic shocks, shrimp disease, civil war and the 2004 Asian tsunami. Following the tsunami, extensive international aid efforts were directed at aquaculture pond rehabilitation. Yet, the pitfalls of simply recreating a system that was run down, underperforming and environmentally damaging due to the ongoing effects of multiple previous shocks are clear. Research reported here is one component of an action research project aimed at rebuilding improved, sustainable systems. The diversity of shocks experienced provided an unparalleled opportunity to look at the range of impacts and coping mechanisms employed at the household level. Detailed analysis of factors affecting rebuilding and recovery strategies from shocks highlighted the importance of diversification across multiple livelihood characteristics, as well as the multi-dimensional nature of diversification itself. Diversification in household livelihood strategy, aquaculture species availability and market options for aquaculture produce were all important factors contributing to recovery and resilience. The “distance” (degree of difference) among diversified options was shown to be critical in building resilience.

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Mills, D.J.; Westlund, L.; de Graaf, G.; Kura, Y.; Willman, R.; Kelleher, K. 2011.

Under-reported and undervalued: small-scale fisheries in the developing world.

p. 1-15. In: *Pomeroy, R.S.; Andrew, N.L. (eds.) Small-scale fisheries management: frameworks and approaches for the developing world. Cabi, UK. 247 p.*

This chapter discusses the collection of data on small-scale fisheries in developing countries, the limitations of national data systems and progress in synthesizing collected data.

Mora, C.; Aburto-Oropeza, O.; Ayala Bocos, A.; Ayotte, P.M.; Banks, S.; Tupper, M. et al. 2011.

Global human footprint on the linkage between biodiversity and ecosystem functioning in reef fishes.

PLoS Biology 9(4): e1000606.

Difficulties in scaling up theoretical and experimental results have raised controversy over the consequences of biodiversity loss for the functioning of natural ecosystems. Using a global survey of reef fish assemblages, we show that in contrast to previous theoretical and experimental studies, ecosystem functioning (as measured by standing biomass) scales in a non-saturating manner with biodiversity (as measured by species and functional richness) in this ecosystem. Our field study also shows a significant and negative interaction between human population density and biodiversity on ecosystem functioning (i.e., for the same human density there were larger reductions in standing biomass at more diverse reefs). Human effects were found to be related to fishing, coastal development, and land use stressors, and currently affect over 75% of the world's coral reefs. Our results indicate that the consequences of biodiversity loss in coral reefs have been considerably underestimated based on existing knowledge and that reef fish assemblages, particularly the most diverse, are greatly vulnerable to the expansion and intensity of anthropogenic stressors in coastal areas.

Murshed-E-Jahan, K.; Pemsil, D. 2011.
The impact of integrated aquaculture agriculture on small-scale farm sustainability and farmers' livelihoods: experience from Bangladesh.
Agricultural Systems [online Feb].

Intensification of agriculture often requires external inputs, has negative environmental effects and increases risk, especially for small-scale producers. Integrated aquaculture-agriculture (IAA) instead uses on-farm synergy effects of crop and fish production. The impact of long-term IAA training provided to small-scale farmers in Bangladesh is assessed using panel data from 260 project and 126 control farmers who were monitored from 2002/2003 to 2005/2006. We find that the training had a significant positive impact on farmers' technical efficiency, total factor productivity and net incomes. These result in higher food consumption and better nutrition for trained households compared to control farmers.

Ninh, N.H.; Ponzoni, R.W.; Nguyen, N.H.; Woolliams, J.A.; Taggart, J.B.; McAndrew, B.J.; Penman, D.J. 2011.
A comparison of communal and separate rearing of families in selective breeding of common carp (*Cyprinus carpio*): Estimation of genetic parameters.
Aquaculture 322-323: 39-46.

The objective of this study was to investigate ways of improving the selective breeding program for growth related traits in common carp in Vietnam. A base population was established from six carp stocks following a single pair mating scheme. In the current study, we practiced two rearing schemes: i) separate families until the fish were large enough to be physically tagged and ii) early communal rearing from very soon after hatching. The main aim of the study was to test the relative efficiency of communal early rearing (CER) and separate early rearing (SER) in the context of a Vietnamese common carp selective breeding program. We used microsatellite markers for parental assignment and pedigree reconstruction to investigate ways of further improving the on-going breeding program.

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Njaya, F.; Donda, S.; Béné, C. 2011.

Analysis of power in fisheries co-management: experiences from Malawi.

Society and Natural Resources [Online First].

In this article we analyze co-management arrangements in Malawi through the lenses of the concept of power. We focus the analysis at the local level where most of the more important actors operate. These include the fishing communities and the Department of Fisheries, but also the traditional leaders and the new local management entities created through co-management reforms—the so-called beach village committees. Our analysis, based on decentralization and power frameworks, shows that co-management arrangements are characterized by unequal power distribution among these different actors, often resulting in the marginalization of the fishers themselves. In this new institutional landscape the role of the perceived key partners including the traditional leaders and the Department of Fisheries remains unclear, with a combination of both positive and negative outcomes.

Njayaa, F.; Snyder, K.A.; Jamu D.; Wilson, J.; Howard-Williams, C.; Allison, E.H.; Andrew, N.L. 2011.

The natural history and fisheries ecology of Lake Chilwa, southern Malawi.

Journal of Great Lakes Research 37(S1): 15-25.

Lake Chilwa produces between zero and 24,000 metric tons of fish per year, making it one of the most productive but variable lakes in Africa. The size of the lake varies seasonally and among years, sometimes drying completely. Its surrounding wetland and floodplain provide habitat for a diversity of birds and economically valuable grasses and reeds. When the lake has water, there is considerable activity on its shores and temporary fishing villages spring up. People move in and out of the lake basin in concert with these seasonal and longer term changes. This paper examines the environmental dynamics of Lake Chilwa and its surrounding wetlands, presents an overview of the socio-economic context of the area and discusses threats to this resilient system that might occur as a result of climate change. We conclude that management of Lake Chilwa must place the lake in the wider economic and ecological system in which it is situated. Ultimately, land-use practices within the basin present more of a threat to the resilience of the fishery and people's livelihoods than overfishing or a strict focus on the lake's resources. These perspectives present significant challenges to conventional fisheries governance.

Padiyar, P.A.; Phillips, M.J.; Ravikumar, B.; Wahju, S.; Muhammad, T.; Currie, D.; Coco, K.; Subasinghe, R.P. 2011.

Improving aquaculture in post-tsunami Aceh, Indonesia: experiences and lessons in better management and farmer organizations.

Aquaculture Research [Online First].

Coastal aquaculture in Aceh was severely affected by the Asian Tsunami in December 2004. Capacity building among stakeholders was one of the key activities implemented by various agencies during the post-tsunami aquaculture rehabilitation and subsequent development phase. The main objective was improving production efficiencies and farmer incomes. This article describes the process of implementation of the approach and crop outcomes until the end of 2009.

Pickering, T.D.; Ponia, B.; Hair, C.A.; Southgate, P.C.; Poloczanska, E.; Patrona, L.D.; Teitelbaum, A.; Mohan, C.V.; Phillips, M.J.; Bell, J.D.; De Silva, S. 2011.

Vulnerability of aquaculture in the tropical Pacific to climate change.

p. 647-731. In: Bell, J.D.; Johnson, J.E.; Hobday, A.J. (eds.) Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change. Secretariat of the Pacific Community, Noumea, New Caledonia.

In this chapter, the authors assess the vulnerability of aquaculture in the tropical Pacific to climate change. It begins by summarizing recent and potential aquaculture production to set the scene for the sector, and then use the framework outlined in Chapter 1, based on exposure, sensitivity, potential impact and adaptive capacity, to evaluate the vulnerability of the main commodities for food security and livelihoods. It also looks at the risks posed by climate change to increased incidence of diseases. The authors then integrate all projected effects of climate change to assess the vulnerability of the sector as a whole. The chapter is concluded by examining the remaining uncertainty and the research needed to fill the gaps, and by identifying the management measures required to capitalize on the opportunities, and to minimize the adverse effects, expected to result from climate change.

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Pillai, B.R.; Mahapatra, K.D.; Ponzoni, R.W.; Sahoo, L.; Lalrinsanga, P.L.; Nguyen, N.H.; Mohanty, S.; Sahu, S.; Vijaykuman; Sahu, S.; Khaw, H.L.; Patra, G.; Patnaik, S.; Rath, S. 2011.

Genetic evaluation of a complete diallel cross involving three populations of freshwater prawn (*Macrobrachium rosenbergii*) from different geographical regions of India.

Aquaculture 319(3/4): 347-354.

Estimates of additive genetic, reciprocal and average heterosis effects were obtained from a three by three complete diallel cross experiment for giant freshwater prawn *Macrobrachium rosenbergii*. The data were generated in two batches. Three populations were sampled from the states of Gujarat (West), Kerala (South West) and Orissa (East) in India. The two mating batches of diallel crosses were combined in the analysis. A total of 4773 animals (2233 in Batch 1 and 2540 in Batch 2) were tagged with VIA (Visible Implant Alpha numeric tags). A total of 2545 animals (979 and 1566 from Batch 1 and 2, respectively) were harvested with readable VIA tags and were; therefore available for analysis. The fixed effects included in the models were test environment (ponds 1 or 2 in Batch 1, ponds 3 or 4 in Batch 2), sex (male or female) and Batch (1 or 2). Age at harvest was fitted as linear covariate. The genotype effect was partitioned into additive, non additive and reciprocal cross effects. Body weight, standard length and carapace length were recorded during tagging, sampling and harvesting. Estimates of additive genetic effect in the three stocks showed that the Kerala stock had greater body weight, carapace length and standard length, followed by Orissa then Gujarat. Average heterosis for body traits was low (3.1 to 6.3%) and not significantly different from zero. The results are discussed with respect to the choice of the most appropriate breeding strategy to improve the performance of *M. rosenbergii* in India.

Pomeroy, R.S. 2011.

Managing overcapacity in small-scale fisheries.

p. 75-92. In: Pomeroy, R.S.; Andrew, N.L. (eds.) *Small-scale fisheries management: frameworks and approaches for the developing world*. Cabi, UK. 247 p.

The purpose of this chapter is to present and discuss the concept and assessment of over capacity in small-scale marine fisheries, and the appropriate and integrated approaches to facilitating the removal of overcapacity. The chapter should assist governments and fisheries managers to prepare national and fishery-specific plans of action for the management of capacity in small-scale fisheries.

Pomeroy, R.S.; Cinner, J.E.; Nielsen, J.R. 2011.

Conditions for successful co-management: lessons learned in Asia, Africa, the Pacific and the wider Caribbean.

p. 115-131. In: Pomeroy, R.S.; Andrew, N.L. (eds.) Small-scale fisheries management: frameworks and approaches for the developing world. Cabi, UK. 247 p.

The purpose of this chapter is to present and discuss key conditions for the successful implementation of fisheries and coastal co-management identified in South-east Asia, Africa, the Pacific and the wider Caribbean. These four regions were selected as several recent research and development projects have produced outputs in which key conditions have been identified. The conditions are reported on a regional basis not for a specific country, as this is how the authors have presented their results. It is expected that specific conditions would differ by country. These conditions will embrace the wide range of aspects that can affect the implementation and performance of co-management and activities, from resources and fisheries to cultural and institutional dimensions. The chapter will conclude with a discussion of policy implications for fisheries and coastal co-management.

Ponzoni, R.W.; Nguyen, N.H.; Khaw, H.L. 2011.

Fundamental considerations about design and sample size in strain comparisons and their implications.

Aquaculture Research 42(12): 1855–1858.

Well-known formulae for the calculation of the necessary number of animals in strain comparisons are presented. Their use is illustrated with an example with fish. Use of the formulae in the planning and design of strain comparisons is recommended. When the necessary number cannot be attained and the experiment is conducted with fewer animals than what the formulae indicate, or the animals originate from a low and thus most likely non-random sample of parents, no inferences should be drawn about any observed between strain differences.

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Ponzoni, R.W.; Nguyen, N.H.; Khaw, H.L.; Hamzah, A.; Abu Bakar, K.R.; Yee, H.Y. 2011.

Genetic improvement of Nile tilapia (*Oreochromis niloticus*) with special reference to the work conducted by the WorldFish Center with the GIFT strain.

Reviews in Aquaculture 3(1): 27-41.

We mainly (but not exclusively) draw on research and development work carried out by The WorldFish Center. We review in detail the current state of development of a selection program that has had a main focus on growth rate and body traits. We also present some new, unpublished, information. There is evidence of sustained gains of 10-15% per generation over more than six generations. To date, these gains have not been accompanied by any undesirable correlated response. However, the prospects of altering sexual dimorphism and the shape of the fish appear to be very limited. We also examine the issue of an appropriate environment for selection. Not surprisingly, experimental evidence on genotype by environment interactions suggests that this is more likely to be of importance when the environments in question are markedly dissimilar. We argue that no universal guidelines can be prescribed with regard to the need for more than one selection program to cope with different production environments, but rather, each case should be examined in its own right. Finally, we discuss traits likely to be candidates for inclusion in future, more elaborate, breeding objectives for Nile tilapia (*Oreochromis niloticus*), comment on selection methods that may be implemented in the future and conclude by stressing the need to maintain an effective population size in selection lines to ensure their sustainability over time.

Ratner, B.D. 2011.

Common-pool resources, livelihoods, and resilience: critical challenges for governance in Cambodia.

IFPRI Discussion Paper 01149. IFPRI. Washington, D.C. 14 p.

Common-pool resource management is a critical element in the interlocked challenges of food security, nutrition, poverty reduction, and environmental sustainability. This paper examines strategic policy choices and governance challenges facing Cambodia's forests and fisheries, the most economically important subsectors of agriculture that rely on common-pool resources. It then outlines policy priorities for institutional development to achieve improvements in implementing these goals. The core argument is that (1) policy support for community-based management in forestry and fisheries requires explicit prioritization to protect against threats from other types of private- and public-sector investment; and (2) the

success of these initiatives depends on more systemic governance reforms that address issues of stakeholder representation, mechanisms of accountability, and institutional capacity.

Ratner, B.D.; Parnell, T. 2011.

Building coalitions across sectors and scales in Cambodia.

p. 203-218. In: Sikor, T.; Stahl, J. (eds.) Forests and people: property, governance and human rights. London: Earthscan / Resources for the Future. 253 p.

Based on a comparative analysis of efforts by community groups, as well as domestic and international non-governmental organizations (NGOs) working to assist forest-dependent communities, this chapter explores the practical efficacy of a range of rights-based approaches in securing equitable forest rights and reducing conflict.

Rochet, M.J.; Collie, J.S.; Jennings, S.; Hall, S.J. 2011.

Does selective fishing conserve community biodiversity? Predictions from a length-based multispecies model.

Canadian Journal of Fisheries and Aquatic Sciences 68(3): 469-486.

This study challenges the widely held view that improved fisheries selectivity would always help to maintain marine biodiversity. Using a length-based multi-species model, we investigate the effects of selective versus nonselective fishing on fish communities. Both size and species selectivity are examined, and fishing effects on biodiversity are measured with three indices: (i) evenness, (ii) the number of collapsed species, and (iii) an index of size diversity. The model is parameterized for the Georges Bank and North Sea fish communities. The results suggest that there is no “optimal” size selectivity to maintain biodiversity: the effects of each exploitation pattern depend on the selectivity of the gear (i.e., the shape of the selection curve) relative to the available sizes. Catching a narrow range of species almost always reduced evenness and species richness more than taking the same catch from a broader range of species. In summary, neither selective nor nonselective fishing can be said to be generally preferable for conserving biodiversity; the outcome depends on the particular species composition and size structure of the community. Advice intended to inform management will need to be based on clear definitions of biodiversity, and unambiguous management objectives for biodiversity and the fishery.

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Schwarz, A.M.; Béné, C.; Bennett, G.; Boso, D.; Hilly, Z.; Paul, C.; Posala, R.; Sibiti, S.; Andrew, N. 2011.

Vulnerability and resilience of remote rural communities to shocks and global changes: empirical analysis from Solomon Islands. *Global Environmental Change* 21(3): 1128-1140.

Successful management of socio-ecological systems not only requires the development and field-testing of robust and measurable indices of vulnerability and resilience but also improved understanding of the contextual factors that influence societal capacity to adapt to change. We present the results of an analysis conducted in three coastal communities in Solomon Islands. An integrated assessment map was used to systematically scan the communities' multiple dimensions of vulnerability and to identify factors affecting households' perception about their capacity to cope with shocks (resilience). A multivariate probit approach was used to explore relationships amongst factors. Social processes such as community cohesion, good leadership, and individual support to collective action were critical factors influencing the perception that people had about their community's ability to build resilience and cope with change. The analysis also suggests a growing concern for a combination of local (internal) and more global (external) contingencies and shocks, such as the erosion of social values and fear of climate change.

van Brakel, M.L.; Ross, L.G. 2011.

Aquaculture development and scenarios of change in fish trade and market access for the poor in Cambodia. *Aquaculture Research* 42(7): 931– 942.

Aquaculture holds considerable potential to contribute to poverty alleviation, if it provides poor people with opportunities other than as primary producers. Integration of aquaculture into poverty reduction programs provides means to diversify production systems and reduce food insecurity but also needs improved markets in locations where aquaculture can offer sustainable livelihoods to poor farming households. This study reviews the current constraints that poor people face in accessing markets in Cambodia and analyses its implications for pro-poor domestic aquaculture development. We use a Geographic Information System-based spatial Bayesian probability model to simulate market accessibility and estimate the numbers of poor people who could potentially benefit from improved market access under four different scenarios. Analysis of secondary data confirms that the potential for poor aquaculture producers to interact with urban markets in Cambodia is currently low. The

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potential of aquaculture to interact with rural markets is, however, high. It is concluded that the development of aquaculture has considerable potential to reduce the transaction costs in domestic fish trade by improved access of poor producers and consumers to rural markets in Cambodia. An aquaculture development strategy that improves rural market access could include benefits for up to 1 million poor aquatic resource users.

Warren-Rhodes, K.; Schwarz, A.M.; Ng Boyle, L.; Albert, J.; Agalo, S.S.; Warren, R.; Bana, A.; Paul, C.; Kodosiku, R.; Bosma, W.; Yee, D.; Rönnbäck, P.; Crona, B.; Duke, N. 2011.

Mangrove ecosystem services and the potential for carbon revenue programmes in Solomon Islands.

Environmental Conservation 38(4): 485-496.

Mangroves are an imperiled biome whose protection and restoration through payments for ecosystem services (PES) can contribute to improved livelihoods, climate mitigation and adaptation. Interviews with resource users in three Solomon Islands villages suggest a strong reliance upon mangrove goods for subsistence and cash, particularly for firewood, food and building materials. Village-derived economic data indicates a minimum annual subsistence value from mangroves of US\$ 345–1501 per household. Fish and nursery habitat and storm protection were widely recognized and highly valued mangrove ecosystem services. All villagers agreed that mangroves were under threat, with firewood overharvesting considered the primary cause. Multivariate analyses revealed village affiliation and religious denomination as the most important factors determining the use and importance of mangrove goods. These factors, together with gender, affected users' awareness of ecosystem services. The importance placed on mangrove services did not differ significantly by village, religious denomination, gender, age, income, education or occupation. Mangrove ecosystem surveys are useful as tools for raising community awareness and input prior to design of PES systems. Land tenure and marine property rights, and how this complexity may both complicate and facilitate potential carbon credit programs in the Pacific, are discussed.

Staff Refereed Publications

Waycott, M.; McKenzie, L.J.; Mellors, J.E.; Ellison, J.C.; Sheaves, M.T.; Collier, C.; Schwarz, A.M. et al.

Vulnerability of mangroves, sea grasses and intertidal

flats in the tropical Pacific to climate change

p. 297-368. In: Bell, J.D.; Johnson, J.E.; Hobday, A.J. (eds.)

Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change. Secretariat of the Pacific Community, Noumea, New Caledonia

Mangroves and sea grasses are of special interest to coastal fisheries worldwide because of the role they play in providing nursery areas for commonly harvested fish and invertebrates. Although the ecology of fish and invertebrates associated with mangroves and sea grasses in the tropical Pacific is not well understood compared with other parts of the world, the connectivity among mangroves, sea grasses, intertidal flats and coral reefs indicates that mangroves and sea grasses throughout the region provide a similar function to such habitats elsewhere. In this chapter, we assess the vulnerability of the mangrove, sea grass and intertidal flat habitats in the tropical Pacific that support coastal fisheries. We do this by examining the effects that changes to surface climate and the tropical Pacific Ocean (Chapters 2 and 3) are expected to have on the plants that define these habitats. This exposure to change is used in the framework described in Chapter 1 to assess the vulnerability of the habitats under representative low (B1) and high (A2) emissions scenarios from the Intergovernmental Panel on Climate Change (IPCC) for 2035 and 2100.

Non Refereed Publications

Alam, M.J.; Saha, S.B.; Barman, B.K. 2011.

Integrated aqua-agricultural production systems in the brackish water zones of Bangladesh.

The 3rd International Forum on Water and Food. Tshwane, South Africa. CGIAR Challenge Program on Water & Food.

Surveys of exiting farming systems and a series of on-farm trials, conducted under PN10 project of CPWF in Phase 1 revealed that improved technologies could greatly enhance the productivity, reduce crop-shrimp farming conflicts in the existing rice-shrimp system in brackish water zones of Bangladesh. Growing Genetically Improved Farmed Tilapia (GIFT), together with timely stocking of prawn in the HYV rice field increased farmers' income by 300-400% compared with the existing farming systems.

Allison, E.H.; Åsgård, B.; Willmann, R. 2011.

Human rights approaches to governing fisheries (Editorial).

Maritime Studies 10(2): 5-13.

Human rights are about more than political and civil rights, they also include a bundle of "economic, social and cultural rights" which include rights to food, water, housing, and decent work, and the rights of children, migrants and women. Each of these rights has a legal framework supporting it, which forms the international architecture of human rights law. The "rights-based approach" to development argues that human rights are integral to development outcomes, as international human rights norms highlight the freedoms and capabilities of each individual, essential components of the human side of development. This special edition brings together contributions on human rights perspectives and approaches as applied to fisheries. The papers are written by academics, activists and international development agency workers. In fact, some of the contributing authors and editors defy these categorizations and all have maintained personal and professional networks across the interfaces between research, management and development, policy and activism.

Burke, L.; Reyntar, K.; Spalding, M.; Perry, A. 2011.

Reefs at risk revisited.

World Resources Institute, Washington D.C. 114 p.

Under the Reefs at Risk Revisited project, World Resources Institute (WRI) and its partners

Non Refereed Publications

(The Nature Conservancy, The WorldFish Center, ICRAN etc) have developed a new, detailed assessment of the status of and threats to the world's coral reefs. This information is intended to raise awareness about the location and severity of threats to coral reefs. These results can also catalyze opportunities for changes in policy and practice that could safeguard coral reefs and the benefits they provide to people for future generation.

Central Institute of Freshwater Aquaculture, Indian Council of Agricultural Research; The WorldFish Center. 2011.

Genetic improvement of freshwater prawn, *Macrobrachium rosenbergii* (de Man) in India 2007-2010: final report.

Macrobrachium rosenbergii is one of the widely cultured freshwater prawn species globally. India was the third largest producer of this species in 2007 and its aquaculture production rose to 43,000 metric tons (t) in 2005 from less than 500 t in 1995. However, since then production has been declining and in 2008-09 it was 12,856 t, a reduction of more than 70% compared to 2005. There are several contributing factors to this decline, such as slow growth rate, poor survival, disease outbreaks, increase in cost of production, and availability of low risk alternative fish species. However, there is a consensus that poor seed quality leading to unsatisfactory growth and survival rates in ponds is one of the major reasons. Hence, the development of a systematic selective breeding program aimed at improving growth rate and ensuring high survival rate of this species was deemed a high priority. The Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar, India in collaboration with the WorldFish Center, Malaysia initiated a selective breeding program for this species in 2007.

Collis, W.; Sultana, P.; Barman, B.K.; Thompson, P. 2011.

Scaling out enhanced floodplain productivity by poor communities: aquaculture and fisheries in Bangladesh.

The 3rd International Forum on Water and Food. Tshwane, South Africa. CGIAR Challenge Program on Water & Food.

Private lands in floodplains are vital components of inland natural fisheries but they are increasingly converted to culture-based systems. This raises fish productivity but can adversely affect the poor and biodiversity. Poor rural households can work together using innovative

technologies to optimize overall seasonal floodplain productivity incorporating culture-based systems and/or by conserving natural fish, but this needs equitable institutions (floodplain committees) set up by the community to balance the interests of landless and landowners.

Cunningham, E.J.; Chassels, M.; Fox, J.; Mustafa, G. M. 2011. Introduction: Tailoring collaborative conservation in Bangladesh.

p. 1-15. In: Fox, J. et al. (eds.) Rural livelihoods and protected landscapes: co-management in the wetlands and forests of Bangladesh. The East-West Center, Honolulu, Hawaii.

The Integrated Protected Area Co-management (IPAC) project is a five year USAID contract working with the government and people of Bangladesh to establish a robust national protected area system on the principle of co-management. The introductory chapter gives an overview of the various papers presented in the book.

Curtis, L.; Beveridge, M.; El-Gamal, A.R.; Mannini, P. (eds.). 2011. Adapting to climate change: the ecosystem approach to fisheries and aquaculture in the Near East and North Africa region: Workshop Proceedings: FAO/WorldFish workshop, Abbassa, Egypt. 10-12 Nov 2009.

FAO Fisheries and Aquaculture Circular; no. 1066.

This project was initiated by FAO in order to address how the ecosystem approach to fisheries and aquaculture can be used to address the impacts of climate change to fisheries and aquaculture in the Near East and North Africa Region (RNEA). This document provides suggestions and recommendations made by the experts regarding the adoption of the ecosystem approach to fisheries and aquaculture that are considered to be important in helping adapt to climate change in the region. It also contains five technical review papers (climate change, the ecosystem-based approach to fisheries, the ecosystem-based approach to aquaculture, climate change and fisheries, and climate change and aquaculture) and four sub-regional reviews (Mauritania/Morocco, Mediterranean, Red Sea and Gulf of Aden, Persian Gulf and Sea of Oman) prepared as background material to the workshop. The report was prepared by the workshop secretariat.

Non Refereed Publications

Jamu, D.; Andrew, N.; Bootsma, H.; Hecky, R. 2011.
Reconciling livelihoods and aquatic ecosystem resilience in the lakes of Malawi (Editorial).
Journal of Great Lakes Research 37(S1): 1-2.

The lakes of Malawi are celebrated for their unique biodiversity and contribution to the lives of the people of that nation. The major lakes are Malawi which is shared with Tanzania and Mozambique, and Lake Chilwa, the smaller Lake Chiuta which is shared with Mozambique and Malombe. These lakes provide a diversity of ecosystem services and livelihood benefits including food, water for agriculture and hydroelectric power, recreation, and transportation for commerce and trade to over 13 million people of Malawi, Tanzania and Mozambique. Lakes Malawi, Malombe and Chilwa produce almost all the fish consumed in Malawi. The ecologies of these lakes are very different. This special issue assesses our current understanding of these invaluable ecosystems and addresses some of the emerging social and environmental challenges for their sustainable management.

Nguyen, N.H. 2011.
Genetics of flesh quality in fish.
Aquaculture Asia Pacific 7(1): 32.

Genetic improvement has led to substantial increase in productivity in farmed animals and in tropical fin fish, this is evident in tilapia. The GIFT (Genetically Improved Farmed Tilapia) strain of Nile tilapia (*Oreochromis niloticus*) has been developed by The WorldFish Centre (formerly known as ICLARM), Norwegian Institute of Aquaculture Research and national research partners from Philippines (1988-1998) and from Malaysia (2000-present). Over many generations of selection, the fish show several favorable characteristics: fast growth, high fillet weight, good flesh quality, disease resistance and good adaptation to various farming systems.

Nguyen, N.H.; Ponzoni, R.W.; Jayantha Chandrasoma. 2011.
GIFT tilapia raise culture efficiency in Sri Lanka.
*Global Aquaculture Advocate (Nov/Dec):*32-33.

The wide distribution and ongoing improvement of GIFT tilapia in Sri Lanka is raising the living standards of poor people and contributing to gender equality through employment for women in rural areas. So far, the GIFT fish have undergone four generations of selection for increased harvest weight in Sri Lanka. Now preferred in varied culture systems across the country, GIFT fish grow faster and have higher survival than local tilapia stocks.

Nguyen, N.H.; Ponzoni, R.W.; Pongthana, N.; Hamzah, A.; Yee, H.Y. 2011.

Genetic improvement programs for red tilapia *Oreochromis spp* in Asia.

World Aquaculture 2011 - Meeting Abstract. p. 798.

Red tilapia (*Oreochromis spp*) has become popular in Asian countries due to its greater economic value relative to Nile tilapia. As there is a growing demand for quality seed of this species, The WorldFish Center has initiated a genetic improvement program for red tilapia in Thailand and another one in Malaysia. The ultimate aim of the project is to develop a genetically improved strain of red tilapia with uniform red coloration, high survival and good adaptation to local environment. A successful development of genetically improved strains of red tilapia is expected to have a direct beneficial impact on fish farmers of developing countries in the region.

Nguyen, N.H.; Ponzoni, R.W.; Vijayakumar, S.; Raj, T.S. 2011.

Establishment of a satellite nucleus of the GIFT strain at Rajiv Gandhi Center for Aquaculture (RGCA) to support tilapia production in India.

Aqua Aquaria India Sourvenir p.37-47.

Rajiv Gandhi Center for Aquaculture (RGCA), India was interested in obtaining the Genetically Improved Farmed Tilapia (GIFT strain) for aquaculture in the country. Discussions were made and joint proposal was developed with The WorldFish Center to establish a satellite nucleus for the GIFT strain in India. The proposal also involves the design and conduct of the genetic improvement program for GIFT fish, the development of dissemination strategies, and the enhancement of local capacity in the areas of selective breeding and genetics. Details of the project objectives, activities, outputs and impacts were presented in this paper.

Non Refereed Publications

Phillips, M.; Rogers, W.; Downing, W.; Beveridge, M.C.M.; Padiyar, P.A.; Karim, M.; Subasinghe, R.

Inclusive aquaculture: business at the bottom of the aquatic pyramid.

FAO Aquaculture Newsletter 48: 44-46 2011

Through a SIDA-funded project on small-scale fisheries FAO and partners have been supporting WorldFish Center research into small-scale aquaculture investment. Studies of projects in Bangladesh, India and Indonesia suggest significant outcomes from investment, and start to show the potential for new avenues for investment in aquaculture that have potential to deliver not only aquaculture products and profitable businesses for smallholders, but also social and economic goals. Some of the highlights are provided in this article.

Phillips, M.; Schwarz, A.M.; Pickering, T. 2011.

Aquaculture and food security in Solomon Islands.

SPC Fisheries Newsletter no.134: 17-18.

Pacific Island countries and territories (PICTs) are some of the most vulnerable nations to climate change. Growing populations, combined with climate change and overfishing of inshore reef fish, will compound food security problems arising from an increasing gap between fish demand and supply. Along with some other PICTs, Solomon Islands recognize the need for new sources of fish to meet future food security requirements. Options include fish imports, increasing access to offshore tuna fisheries such as with inshore fish aggregating devices, and aquaculture development. The Government of Solomon Islands has identified inland aquaculture as one means of addressing the gap between fish supply and demand.

Ratner, B.D. 2011.

Natural resource governance and food security in Cambodia.

CDRI Policy Discussion Note; Special report 8. Cambodia. 6 p.

This short note has outlined the critical role of natural resource governance to Cambodia's prospects for sustained economic growth, poverty reduction, and food security. It has also introduced a range of challenges to improving natural resource governance, at the level of strategic goals as well as institutional capacities and processes. It is intended as a launch pad for discussion, not to provide specific answers but to focus attention on key questions that can form the basis of a collaborative agenda for policy dialogue and research.

Ratner, B.D.; Halpern, G.; Kosal, M. 2011.

Catalyzing collective action to address natural resource conflict: lessons from Cambodia's Tonle Sap Lake.

CAPRI Working Paper no. 103. International Food Policy Research Institute, Washington D.C. 25 p.

This paper reports on outcomes and lessons learned from a 15-month initiative aimed at strengthening collective action to address natural resource conflict in Cambodia's Tonle Sap Lake. Employing the Appreciation-Influence-Control (AIC) model of participatory stakeholder engagement, the initiative aimed in particular to build collective understanding of the sources of vulnerability in fisheries livelihoods and to catalyze efforts to support resilience in this valuable and productive social-ecological system. Outcomes include important shifts in fishery access rights and resource management authority—notably the transfer of a large, commercial fishing concession to community access, and the resolution of a boundary dispute involving community fishery organizations in neighboring provinces. Motivated by such successes in collaborative problem analysis and advocacy, the main national grassroots network representing fishing communities have also modified its internal governance and strategy of engagement to emphasize constructive links with government and the formal NGO sector. The experience demonstrates the potential of such an open-ended process of action research to enable collective action and improve natural resource governance, even amidst ongoing resource conflict. We conclude with a set of lessons learned to guide such efforts in practice.

Sultana, P.; Barman, B.K.; Thompson, P.; Collis, W. 2011.

Scaling out enhanced floodplain productivity by poor communities: aquaculture and fisheries in Bangladesh and eastern India.

The 3rd International Forum on Water and Food. Tshwane, South Africa. CGIAR Challenge Program on Water & Food.

Rearing fish in seasonal floodplains raises productivity but can adversely affect the poor and the biodiversity of important natural fisheries. Equitable community institutions enable poor rural households to cooperate with landowners and adopt innovative technologies to optimize seasonal floodplain productivity by cultivating fish and/or by conserving natural fish.

Non Refereed Publications

Tran, N.; Conner Bailey; Wilson, R. 2011.

Governance of global value chains impacts shrimp producers in Vietnam.

Global Aquaculture Advocate (Nov/Dec): 44-47.

Research by the authors examined the impacts of governmental and non-governmental standards on the ability of seafood producers and processors in Vietnam to access export markets. The Vietnamese government plays an important role in the governance of international seafood trade, but importing nations establish food safety standards and NGOs have also become involved. To assure market access, exporters must respond to buyers and certification systems that buyers adopt.

Weeratunge, N.; Pemsil, D.; Rodriguez, P.; Chen, O.L.; Badjeck, M.C.; Schwarz, A.M.; Paul, C.; Prange, J.; Kelling, I. 2011.

Planning the use of fish for food security in Solomon Islands.

Coral Triangle Support Partnership. 51 p.

This study was funded through the USAID-supported Coral Triangle Support Partnership (CTSP). This study provides an insight into the changing demand for fish in the Solomon Islands over the next 20 years. It supports US CTI Indicator 3—“Number of policies, laws, agreements, or regulations promoting sustainable natural resource management and conservation that are implemented as a result of USG assistance”. The study’s findings will help to inform the development and implementation of suitable policies, capacities, and alternative livelihoods to accommodate the projected growth in fish demand. It aims to identify where future imbalances may occur between fish supply and demand in Solomon Islands, as well as opportunities to address these imbalances in ways that are resilient to natural disasters, social and political instability, and the uncertainties of climate change.

Other Key WorldFish Publications

Allison, E.H. 2011.

Aquaculture, fisheries, poverty and food security.
Working Paper 2011-65. The WorldFish Center, Penang, Malaysia.
60 p.

Fisheries and aquaculture play important roles in providing food and income in many developing countries, either as a stand-alone activity or in association with crop agriculture and livestock rearing. The aim of this paper is to identify how these contributions of fisheries and aquaculture to poverty reduction and food security can be enhanced while also addressing the need for a sustainability transition in overexploited and over-capitalized capture fisheries, and for improved environmental performance and distributive justice in a rapidly growing aquaculture sector. The focus of the paper is on the poverty and food security concerns of developing countries, with an emphasis on the least developed. The emphasis is on food security rather than poverty reduction policies and strategies, although the two are of course related. The food security agenda is very much to the fore at present; fish prices rose along with other food prices in 2007-8 and as fish provide important nutritional benefits to the poor, food security has become a primary concern for sector policy.

Badjeck, M.C.; Katikiro, R.E.; Flitner, M.; Diop, N.; Schwerdtner
Máñez, K. 2011.

**Envisioning 2050: climate change, aquaculture
and fisheries in West Africa.** Dakar, Senegal 14
16 April 2010.

Workshop report no. 2011-09. Penang/Bremen: WorldFish/ZMT.
27 p.

This report presents the activities and results of the workshop Envisioning 2050: Climate Change, Aquaculture and Fisheries in West Africa. The objectives of the workshop were to discuss critical issues and uncertainties faced by the fisheries and aquaculture sector in Ghana, Senegal and Mauritania, build sectoral scenarios for 2050 and discuss the implication of these scenarios in the context of climate change for the countries and the region.

Other Key WorldFish Publications

Badjeck, M.C.; Katikiro, R.E.; Flitner, M.; Diop, N.; Schwerdtner Máñez, K. 2011.

Vision 2050: changement climatique, pêche et aquaculture en Afrique de l'Ouest Du 14 au 16 avril 2010, Dakar, Sénégal.

Rapport d'atelier No. 2011-10. The WorldFish Center, Penang, Malaysia. 28 p.

Ce rapport présente les activités et les résultats de l'atelier Vision 2050: Changement climatique, pêche et aquaculture en Afrique de l'Ouest. Les objectifs de l'atelier étaient de discuter les questions critiques et les incertitudes auxquelles est confronté le secteur de la pêche et de l'aquaculture au Ghana, au Sénégal et en Mauritanie, d'élaborer des scénarios sectoriels pour 2050 et de discuter de l'implication de ces scénarios dans le contexte du changement climatique pour ces pays et la région ouest africaine.

Belton, B.; Karim, M.; Thilsted, S.; Murshed-E-Jahan, K.; Collis, W.; Phillips, M. 2011.

Review of aquaculture and fish consumption in Bangladesh.

Studies and Reviews 2011-53. The WorldFish Center, Penang, Malaysia. 71 p.

Fish play a crucial role in the Bangladeshi diet, providing more than 60% of animal source food, representing a crucial source of micro-nutrients, and possessing an extremely strong cultural attachment. Fish (including shrimp and prawn) is the second most valuable agricultural crop, and its production contributes to the livelihoods and employment of millions. The culture and consumption of fish therefore has important implications for national food and nutrition security, poverty and growth. This review examines the current state of knowledge on the aquaculture sector and fish consumption in Bangladesh, based on extensive analysis of secondary sources (including unpublished data unavailable elsewhere), consultation with various experts and specially conducted surveys.

Other Key WorldFish Publications

Gordon, A.; Kassmam, L. 2011.

Aquaculture and markets: a research agenda.

Issues brief 2011-34. The WorldFish Center, Penang, Malaysia. 12 p.

This issues brief proposes an agenda for markets and trade research that supports pro-poor development of aquaculture. It summarises key trends and issues relating to global aquaculture development and identifies critical markets and trade dimensions. Coinciding with renewed interest and change in global agricultural research, this brief is targeted to aquaculture development practitioners and researchers. It aims to provoke discussion on the key areas of markets-related analysis needed to ensure that aquaculture research delivers the strongest poverty reduction and food security outcomes. This focus means that the paper inevitably covers both markets and trade related research and identifies some critical gaps in the foundational poverty analysis.

Gordon, A.; Pulis, A.; Owusu-Adjei, E. 2011.

Smoked marine fish from Western Region, Ghana: a value chain assessment.

WorldFish Center. USAID Integrated Coastal and Fisheries Governance Initiative for the Western Region, Ghana. 46p.

The value chain analysis of this report focused on smoked marine fish-overwhelmingly the most important fish product originating in Western Region, Ghana. Smoked fish from Western Region is mainly destined for the domestic market where demand is very strong. Small quantities of smoked fish are destined for markets in Togo, Benin and Nigeria. The underlying objective of the fisheries value chain analysis is to identify opportunities for growth in the fisheries value chain, with an emphasis on those opportunities that have the potential to generate significant additional livelihoods, particularly at the level of the fishing communities and for low-income groups. The results from the value chain analysis will be used to identify pilot interventions to promote those livelihood outcomes. The main focus for the study is smoked fish (major species/product forms) destined for domestic markets. However, work will also be undertaken on the fresh fish trade and frozen fish to find out more about the significance of these value chains.

Other Key WorldFish Publications

Govan, H.; Schwarz, A.M.; Boso, D. 2011.

Towards integrated island management: lessons from Lau, Malaita, for the implementation of a national approach to resource management in Solomon Islands.

WorldFish Center report to SPREP. Penang, Malaysia. 69 p.

Solomon Islands has recently developed substantial policy aiming to support inshore fisheries management, conservation, climate change adaptation and ecosystem approaches to resource management. A large body of experience in community based approaches to management has developed but “upscaling” and particularly the implementation of nationwide approaches has received little attention so far. With the emerging challenges posed by climate change and the need for ecosystem wide and integrated approaches attracting serious donor attention, a national debate on the most effective approaches to implementation is urgently needed. This report discusses potential implementation of “a cost-effective and integrated approach to resource management that is consistent with national policy and needs” based on a review of current policy and institutional structures and examination of a recent case study from Lau, Malaita using stakeholder, transaction and financial cost analyses.

Hall, S.J.; Delaporte, A.; Phillips, M.J.; Beveridge, M.; O'Keefe, M. 2011.

Blue frontiers: managing the environmental costs of aquaculture.

The WorldFish Center, Penang, Malaysia. 92 p.

The report begins with an overview of the current status of world aquaculture. It then goes on to describe an approach for estimating the current combined biophysical resource demands of aquaculture for producer countries and regions. Following a comparison of these results with those available for other animal food production sectors the report then examines the consequences of likely future trends in production on the environmental impacts of aquaculture. Finally, the policy implications of the report's findings are discussed along with the research agenda that should be pursued to meet the challenge of sustainable food production.

Other Key WorldFish Publications

Joffre, O.; Sheriff, N. 2011.

Conditions for collective action: understanding factors supporting and constraining community based fish culture in Bangladesh, Cambodia and Vietnam.

Studies and reviews 2011-21. The WorldFish Center, Penang, Malaysia. 46 p.

In 2005, The WorldFish Center embarked on a project to pilot test approaches to community-based fish culture (CBFC) in five countries. A previous study conducted between 1997-2000 demonstrated the potential of the approach in Bangladesh and Vietnam, although a greater understanding was needed regarding the social and institutional factors that would permit the development of CBFC in larger waterbodies to reach a greater number of beneficiaries. The five countries selected for dissemination of CBFC included Cambodia, Vietnam, China, Bangladesh and Mali, each very different in terms of history, politics, social-cultural context, aquaculture experience and development status. They appeared to share environmental characteristics, all having seasonally flooding areas and experience of rice-fish culture. This report presents the findings of this study, based on a detailed evaluation undertaken in 2008-2009 in Cambodia, Vietnam and Bangladesh. Mali and China were not included in the study, both for reasons of time and cost, and due to the different path that projected development had taken in each country. Although the research was conducted as consistently as possible across the three countries, using the same methodology in each location, the results are nonetheless also indicative of the differences encountered at each location. The diversity of reasons why CBFC worked and didn't work led to difficulties in drawing conclusions across countries, or in quantifying results, with the exception of Vietnam where the number of communities involved in the study made quantification possible. The findings of the study are therefore primarily qualitative in nature, with figures provided relating to number of responses where available. The issues raised by respondents participating in the study are grouped according to environmental conditions, socio-cultural conditions, livelihood context, institutional context, markets and economic viability, technical issues and implementation and incentives and disincentives for uptake and continuance. The report concludes with a summary of lessons learned.

Other Key WorldFish Publications

Renn, S.; Weirowski, F. 2011.

Guidelines for fish production in long term refugee situations in Africa.

Manual. 2011-30. The WorldFish Center, Penang, Malaysia. 44 p.

These guidelines provide general advice on potential benefits and implications of promoting aquaculture in refugee settlements and local host communities, specifically in Africa. In particular, they seek to highlight issues critical for translating aquaculture support in refugee situations into sustainable benefits for target populations. Aquaculture can help improve food and nutrition security and contribute to household incomes among refugees and neighbouring communities in sites with viable supplies of inputs (seed and feed) and service provisioning (training and technical extension).

The WorldFish Center. 2011.

Financing smallholder aquaculture enterprises.

Policy brief no. 2011-07. The WorldFish Center, Penang, Malaysia. 8 p.

Aquaculture is the world's fastest growing food production sector. Developing countries produce the bulk of aquaculture production, and smallholders dominate the rural landscape throughout the developing world, making up a large proportion of people involved in aquaculture production in many countries. Smallholders participate across the spectrum of aquaculture, from subsistence fish farming where aquaculture is part of a diverse household livelihood, to specialisation in more commercially oriented aquaculture, involvement in micro enterprises across value chains, and even through employment in the growing number of larger commercial aquaculture enterprises. This policy brief provides guidance on investing in the improvement of establishment of smallholder aquaculture enterprises. It builds upon experiences of working with smallholder commercial farmers in Asia, and particularly from facilitating improvements with small scale shrimp and fish farmers in Aceh, Indonesia, analyses of the Vietnamese catfish industry, a review of aquaculture producer organizations as well as cross-commodity and country comparisons. It is intended to guide both public and private actors in approaches to financing improvements in business oriented smallholder aquaculture, and to be an entry point for the private sector on more inclusive ways to engage smallholders in value chains.

Other Key WorldFish Publications

Weeratunge-Starkloff, N.; Pant, J. 2011.

Gender and aquaculture: sharing the benefits equitably.

Issues brief 2011-32. The WorldFish Center, Penang, Malaysia. 12 p.

Aquaculture is the fastest growing agricultural sector in the world; it can meet both the food security and cash needs of poor households in Africa and the Asia-Pacific region. Women's involvement in aquaculture is more significant than often assumed. In many developing countries formal statistics often overlook the nature and extent of their vital contribution. Research on gender and aquaculture at the WorldFish Center identifies five key themes for consideration.

- 1) Market, trade and migration
- 2) Capabilities and well being
- 3) Identities and networks
- 4) Governance and rights
- 5) Climate change, disaster and resilience.

The WorldFish Center. 2011.

Aquaculture and food security in Solomon Islands.

Policy brief no. 2011-08. The WorldFish Center, Penang, Malaysia. 8 p.

Aquaculture and Food Security in the Solomon Islands (ACIAR Project FIS/2009/061) was formulated to assist the Government of Solomon Islands in better understanding of the future demand for aquaculture and particularly to develop a strategy to guide future development of sustainable inland aquaculture to support food security and secure livelihoods for the Solomon Islands in response to rising populations and climate change. The project was implemented through a partnership of three agencies: The WorldFish Center, the Solomon Islands Ministry of Fisheries and Marine Resources (MFMR) and the Secretariat for the Pacific Community (SPC).

Other Key WorldFish Publications

The WorldFish Center. 2011.

Aquaculture helping to improve health and nutrition in Bangladesh.

Project Flyer 2011-62. The WorldFish Center, Penang, Malaysia.

Bangladesh has made important human development gains in recent years, reflected by reductions in poverty, mortality of children under five, and chronic malnutrition. These gains have been achieved in spite of frequent natural disasters, volatile food/fuel prices, and the effects of climate change. However, the prevalence of underweight children in the country (41%) is still the highest in the world. Chronic poverty is evident, particularly in rural areas, where many families are unable to meet their food needs. Transitory food insecurity is serious in those coastal and riverside areas affected by natural disasters

The WorldFish Center. 2011.

Aquaculture in the ASEAN region.

Policy brief no. 2011-29. The WorldFish Center, Penang, Malaysia. 4 p.

Blue Frontiers: Managing the environmental costs of aquaculture is a report prepared by the WorldFish Center and Conservation International. This global review of aquaculture aims to inform policy makers about the impacts of aquaculture on the environment and to stimulate debate on the optimal animal food production systems for tomorrow. The ASEAN region is, from supply and demand perspectives, an important center for aquaculture. This short brief highlights some of the key study findings that are relevant to the ASEAN region.

The WorldFish Center. 2011.

Aquatic Agricultural Systems.

Project Flyer 2011-59. The WorldFish Center, Penang, Malaysia.

More than 700 million people depend on aquatic agricultural systems for their livelihoods. These are diverse farming systems that include a mix of cultivation, livestock, aquaculture, fishing, and gathering natural resources such as fruits, seeds, timber and wildlife. However, there are many constraints that prevent low income smallholders from fully benefitting from these naturally productive systems. The CGIAR Research Program on Aquatic Agricultural Systems starts from the premise that poverty is rarely caused solely by inadequate income or assets. Other reasons can include marginalization, when a group of people is disadvantaged or excluded due to their ethnicity, race, religion, caste, gender, age, HIV status or other attribute. Often this group is also more vulnerable to economic shocks, environmental

Other Key WorldFish Publications

changes, and natural disasters. The Program, led by The WorldFish Center, recognizes the multiple dimensions of poverty, and the diversified livelihood strategies used by farming families. Research is embedded within communities using a farmer-participatory approach, with both beneficiary households and development partners working hand-in-hand.

The WorldFish Center. 2011.

Aquatic agricultural systems in Zambia. *Factsheet 2011-56. Penang, Malaysia. 2 p.*

Zambia contains 40% of Southern Africa's surface freshwater and seasonally almost 20% of the country (150,000 km²) is inundated. Zambia's rivers, lakes and wetlands support extensive agriculture, fisheries and livestock production, and contribute to the livelihoods of about 3 million people, almost 25% of the country's population. These aquatic agricultural systems (AAS) are particularly important to poor people and provide significant opportunities for agriculture-based economic growth.

The WorldFish Center. 2011.

Blue frontiers: managing the environmental costs of aquaculture.

The WorldFish Center, Penang, Malaysia. 4 p.

A comprehensive analysis of global aquaculture production across all major species and farm production systems. This global review aims to inform policy makers about the impacts of aquaculture on the environment and to stimulate debate on the optimal animal food production systems for tomorrow.

The WorldFish Center. 2011.

Blue frontiers: managing the environmental costs of aquaculture.

The WorldFish Center, Penang, Malaysia. 2 p.

This fact sheet presents the main findings from a global review of aquaculture conducted by The WorldFish Center in collaboration with Conservation International. The report "Blue Frontiers: Managing the environmental costs of aquaculture" aims to inform policy makers about the impacts of aquaculture on the environment and to stimulate debate on the optimal animal food production systems for tomorrow.

Other Key WorldFish Publications

The WorldFish Center. 2011.

Blue frontiers: managing the environmental costs of aquaculture.

Policy brief no. 2011-24. The WorldFish Center, Penang, Malaysia. 12 p.

Blue Frontiers: Managing the environmental costs of aquaculture is a publication from The WorldFish Center and Conservation International. The report analyzes how the global aquaculture industry uses natural resources and its impacts on the environment. It makes a broad-brush comparison of aquaculture with other animal food production systems and extrapolates from past history to look forward and identify potential future impacts. The paper also proposes important recommendations for policy makers and scientists engaged in debate on the future of food production and nutrition security. This brief provides a summary of the report and its conclusions, and highlights policy implications and the research agenda necessary to more effectively manage the environmental costs so that aquaculture can contribute to food security and environmental sustainability.

The WorldFish Center. 2011.

Blue frontiers: managing the environmental costs of aquaculture [chinese version].

The WorldFish Center, Penang, Malaysia. 2 p.

This fact sheet presents the main findings from a global review of aquaculture conducted by the WorldFish Center in collaboration with Conservation International. The report “Blue Frontiers: Managing the environmental costs of aquaculture” aims to inform policy makers about the impacts of aquaculture on the environment and to stimulate debate on the optimal animal food production systems for tomorrow.

The WorldFish Center. 2011.

CGIAR Research Program. Aquatic agricultural systems.

Brief no. 2011-41. The WorldFish Center, Penang, Malaysia. 8 p.

Aquatic Agricultural Systems (AAS) are widely distributed along the world's rivers and coasts. These are generally highly productive systems but multiple constraints limit the ability of poor smallholder families to harness this productivity in the form of improved food, nutrition and income. To help overcome these constraints and harness the full development potential of

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aquatic agricultural systems, a new action research program has been developed by the CGIAR. This research program brief highlights the key messages of this new initiative.

The WorldFish Center. 2011.

CGIAR Research Program. Aquatic agricultural systems. Program proposal.

The WorldFish Center, Penang, Malaysia. 184 p.

The overall goal of the CGIAR Research Program on Aquatic Agricultural Systems is to improve the well-being of aquatic agricultural system-dependent peoples. The Program will focus initially on three aquatic agricultural systems: (i) Asia's mega deltas, targeting Bangladesh and Cambodia; (ii) Asia-Pacific islands, targeting the Philippines and Solomons; and (iii) African freshwater systems, targeting first Zambia, then Uganda and Mali.

The WorldFish Center. 2011.

Fish and human nutrition.

Flyer 2011-03. Penang, Malaysia. 2 p.

The WorldFish Center. 2011.

Fish for human nutrition [in English and Bengali].

The WorldFish Center, Penang, Malaysia.

The WorldFish Center. 2011.

Fish production in refugee camps and settlements: lessons from Zambia.

Policy brief no. 2011-31. The WorldFish Center, Penang, Malaysia. 11 p.

Conflict, persecution and violence affect millions of people worldwide, forcing them to uproot their lives. The attention of the international community is focused on meeting the basic needs of refugee populations, but recently this support has been extended to include the host countries (many of which are Food Deficit Least Developed Countries) in order to strengthen their capacity to provide food, goods and services to refugee populations. The number of programs that generate benefits for both refugees and local communities in terms

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of food security, livelihoods and local economic opportunities is increasing. The objective of this Policy Brief is to highlight key lessons from these programs with a particular emphasis on Zambia.

The WorldFish Center. 2011.

Fish supply and demand scenarios in Cambodia and perspectives on the future role of aquaculture.

Project brief no. 2011-23. WorldFish Center, Cambodia.

Fish is vital to the well-being and livelihoods to millions of people in the Lower Mekong Basin, many of whom are poor, relying on fish as a major source of animal protein, sometimes the only source. The supply of 'free' wild fish is under threat from overfishing, climate change, habitat modification and hydro power development which could mean less fish supplied from natural sources yet at the same time more demand. Aquaculture - farming of fish and other aquatic animals - is becoming increasingly more important in supplying fish to people in the region. This study was initiated to explore in more detail future fish supply scenarios, the role of aquaculture, and provide a basis for understanding future investment and strategies for its sustainable development. The study was conducted by the Fisheries Administration (FIA), Inland Fisheries Research Development Institute (IFReDI) and the WorldFish Center co-funded by Australian Centre for International Agricultural Research (ACIAR), and the Ministry of Foreign Affairs, Japan.

The WorldFish Center. 2011.

Fisheries and HIV/AIDS in Africa: investing in sustainable solutions.

Excerpt from WorldFish project report 1977. The WorldFish Center, Penang, Malaysia. 2 p.

USAID; WorldFish Center. 2011.

GHERS: Greater Harvest and Economic Returns from Shrimp.

The WorldFish Center, Bangladesh. 4 p.

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The WorldFish Center. 2011.

Harnessing the development potential of aquatic agricultural systems for the poor and vulnerable: CGIAR Research Program 1.3.

Brief no. 2011-15. The WorldFish Center, Penang, Malaysia. 8 p.

Aquatic Agricultural Systems (AAS) are widely distributed along the world's rivers and coasts. These are generally highly productive systems but multiple constraints limit the ability of poor smallholder families to harness this productivity in the form of improved food, nutrition and income. To help overcome these constraints and harness the full development potential of aquatic agricultural systems, a new action research program has been developed by the CGIAR. This research program brief highlights the key messages of this new initiative.

The WorldFish Center. 2011.

More meat, milk and fish by and for the poor - CGIAR Research Program 3.7 - Fish.

Brief no. 2011-16 The WorldFish Center, Penang, Malaysia. 8 p.

As a member of the Consultative Group for International Agricultural Research (CGIAR). The WorldFish Center will partner with several other CGIAR Centers in the CGIAR Research Program 3.7 "More meat, milk and fish by and for the poor". The focus of research for the fish components of the Program are on technology platform and integrated value chain research. Under this program, The WorldFish Center will work to help achieve large scale, environmentally sustainable increases in supply of fish to poor consumers in developing countries by focusing its research to develop new seed and feed technologies, understand how to improve the institutional environment, and by testing an integrated value-chain approach to these issues in a limited number of countries (Egypt and Uganda).

The WorldFish Center. 2011.

Review of training for the period 1999-2009: WorldFish Aquaculture Research and Training Center, Abbassa, Egypt.

Brief 2132. The WorldFish Center, Penang, Malaysia. 15 p.

The WorldFish Aquaculture Research and Training Center is located outside Abbassa, a typical village in Egypt's Nile delta. The WorldFish Center launched its regional research and training activities in 1998. Courses were held in the center from 1999 to 2009. The growth

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in training over this period reflects the growth in aquaculture in Egypt and globally, the need for trained technicians, and the growing reputation of the Center in this field. The unique location of Abbassa, the clean and quiet environment, and the variety of efficient facilities have been utilized by the dedicated staff to carry out one of the most successful series of training programs in the region.

The WorldFish Center. 2011.

Small fish can mean big nutrition.

Project Flyer 2011-61. The WorldFish Center, Penang, Malaysia.

Malnutrition levels in Bangladesh are amongst the highest in the world. Approximately half of Bangladesh's population lives below the food poverty line and the dietary intake of both adults and children are severely deficient in key vitamins and minerals. It is now understood that women and children are the more food-insecure and micronutrient-deficient in the population. This project, supported by the International Fund for Agricultural Development, aims to increase household income in poor, rural households in Bangladesh, and improve nutrition, especially in women and children, through increased intake of nutrient-rich small fish.

The WorldFish Center. 2011.

Sub-Saharan fish trade and nutrition in a changing climate.

Project Flyer 2011-60. The WorldFish Center, Penang, Malaysia.

There is an increasing 'fish gap' in sub-Saharan Africa (SSA), where fish supplies have failed to keep pace with the region's growing demand. Despite the high dependence on fish for nutrition in much of the region, consumption is currently half the global average and declining. In SSA, as in many other regions globally, marine and inland capture fisheries resources are stagnating or decreasing, largely due to environmental or ecosystem changes and over-exploitation. Climate change is already altering the distribution of fish stocks and rainfall patterns upon which these fisheries depend. At the same time, globalization has favored developing country exports of high-value fish.

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