Government Office for Science

Foresight

Foresight Project on

Global Food and Farming Futures

Science review SR9:
Recent developments in fisheries science and their prospects for improving fisheries contributions to food security

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This review has been commissioned as part of the UK Government's Foresight Project on Global Food and Farming Futures. The views expressed do not represent the policy of any Government or organisation.

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Introduction

The recent UK Government Foresight Project on Global Food and Farming Futures recognises the intensifying pressure on the world's food system that we can expect in the next 40 years. Meeting the challenges these pressures present will require concerted effort by many research communities, among them those that focus on fisheries.

In recent years there has been a growth in research pointing to the importance and potential of fisheries in a development and food security context. As a major source of animal protein, especially for poor consumers in developing countries, securing and making the most of the world's fisheries remains an important priority (Béné *et al.,* 2007; World Bank/FAO/WorldFish, 2010). In parallel, after a period of disillusionment following the failures of investments in fisheries projects in the 1970s and 80s (Cunningham *et al.,* 2009; NFDS, 2009), interest in supporting this sector through foreign aid is returning. Not surprisingly, this resurgence of interest aligns with the renewed focus on agriculture and food security, following relative neglect in the 1990s (World Bank, 2008).

With increasing interest in investing development aid in fisheries, it is legitimate to ask what recent research has to offer by way of guidance. In this short paper we summarise the potential significance of several emerging areas of fisheries research and management for helping secure and enhance fish supplies from wild harvesting in support of food security in the developing world. Our focus is on small-scale fisheries, for reasons summarised below, these fisheries present a critical frontier in the challenge to increase the contribution of fish to poverty reduction and sustainable development.

We have selected four areas – loosely titled 'Small-scale fisheries' (highlighting gender and inland fisheries), 'Governance reform', 'Resilience in practice' and 'External drivers'. Although more conventional fisheries topics such as effort reduction, fish stock sustainability and gear technology remain important, we feel these other broad areas of inquiry offer particular promise for supporting development efforts. Our intention is to provide readers with a short accessible introduction to these topics and to provide entry points to some of the recent literature.

1. Small-scale fisheries

The importance of small-scale fisheries (SSF) as a source of nutrition and income for many of the world's coastal and rural poor can hardly be overestimated (Béné, 2003; Béné and Neiland, 2006; FAO, 2009; Heck *et al.,* 2007; Thorpe *et al.,* 2007). Improving the contribution of SSF to poverty reduction remains a standing item on the agenda of the FAO Committee on Fisheries (COFI). Until recently, however, disaggregated data showing the characteristics of the small- and large-scale sectors and distinguishing between marine and inland fisheries was lacking. Research supported by the World Bank in partnership with FAO and the WorldFish Center has generated new data that sheds considerable light on this topic (World Bank/FAO/WorldFish, 2010; Mills *et al.,* in press). The findings suggest that the focus of attention in fisheries has been too narrow and needs to shift to better reflect the reality of global fisheries (Table 1).

Table 1: Key findings from the World Bank study on small-scale fisheries and the implications for rebalancing research emphasis

	Implications for a shift in research and policy emphasis	
Key finding	**From:**	**To:**
• Fisheries provide a vital source of nutrition for more than one billion people for whom fish is a key component of their diets. Most of these are in developing countries.	An emphasis on fisheries that serve developed country consumers.	A more balanced research agenda that better addresses the problems of fisheries serving consumers in developing countries.
• 97% of the 120 million people directly employed in capture fisheries live in	An emphasis on large-scale commercial	Greater attention to small-scale fisheries where the vast majority

developing countries. • 116 million people (90% of total) work in SSF. • Globally, large-scale fisheries catch more fish but SSF produce more for human consumption. In developing countries, more than half the catch comes from SSF and more than 90% of those fish are eaten by people.	fisheries.	of people are employed and where contributions to food security for the most vulnerable are often greatest.
• Women account for slightly less than half the total workforce.	A largely gender-blind research agenda.	Greater emphasis on gender relations and gendered roles in fisheries and their effects on management effectiveness, welfare and wellbeing outcomes.
• In developing countries, inland fisheries account for about 20% of the total harvest but around half the total workforce engaged in the fisheries sector work in small-scale inland fisheries.	An emphasis on marine fisheries.	Greater recognition and attention to understanding and solving the problems of inland fisheries.
• Although poorly quantified (itself a finding), subsistence fisheries are poorly understood, under-valued and under-reported, but may be	An emphasis on fisheries as a revenue-generating enterprise.	A more balanced research agenda that recognises the subsistence and safety net functions of

substantial portions of total harvest.		fisheries.

Source: World Bank/FAO/WorldFish 2010; Mills *et al*. in press.

Perhaps the most important finding from this recent analysis is confirmation that catching, processing and trading fish in the SSF sub-sector is a large enterprise in developing economies. Unfortunately, however, official GDP statistics tend to ignore its contribution to economies because most SSF value chains reside in the informal economy. Because SSF are poorly reflected in national accounts, it is the large-scale fisheries sector that attracts attention and becomes the focus for national policy and development assistance. The mis-alignment in investment and research endeavour in fisheries is something that deserves further attention.

In this context, it is also important to recognise that inland fisheries, in particular, are grossly under-researched and that the constraints and opportunities presented by these fisheries differ markedly from their marine counterparts (Welcomme *et al.,* 2010). This indicates the need for a different research-for-development agenda. Historically, investment in inland fisheries governance has focused on the fishery, but the external nature of many important drivers suggests the need for research and management investments to address a wider context. Harnessing the benefits of inland fisheries, and sustaining these in the face of wider development, requires stepping beyond conventional fishery-focused management solutions and connecting fisheries management and governance to broader development (Dugan *et al.,* 2006).

In particular, inland fisheries exist within highly contested landscapes in which access to, and governance of, water plays a central role (Dugan *et al.,* 2010; King and Brown, 2006; Nguyen Khoa *et al.,* 2005; Welcomme *et al.,* 2010; World Commission on Dams, 2000). Many of the drivers affecting water are known and pathways to address them can be developed. For example, while some forms of hydropower development can have a catastrophic impact on fisheries, the location, design and management of dams can be influenced to reduce their impacts on fisheries (*op. cit*).

A second revealing result from the World Bank study is the large proportion of woman working in SSF. Although this will be no surprise to anyone familiar with fisheries, particularly in Africa, the lack of gender-differentiated analysis and development solutions is both curious and disturbing. Development practitioners now recognise clearly the importance and benefits of including gendered perspectives in research and development interventions (see, for example, Quisumbing and McClafferty, 2006). As yet, this recognition is yet to fully permeate the mainstreams of developing country fisheries research and management. Greater effort is needed to incorporate this understanding; enhanced voice and inclusion of women in research and governance will lead to greater accountability, national capacity and improved fisheries outcomes (Choo *et al.,* 2008; ICSF, 2010; Weeratunge *et al.,* 2010; Williams, 2008).

Such entry points to improved governance are not within the normal purview of fisheries agencies or their sectoral advisors, and carving out a research agenda to inform and evaluate change is a significant challenge. As with inland fisheries, gender is a contested and value-laden arena; the roles of men, women and children in a society are created and conditioned by culture, norms and power. As a result, gender-based research and development is explicitly value-based and progress (beyond specific and localised case studies) will be difficult. It is hard to imagine a more important research and development challenge.

2. Governance reform

Over-exploitation of fish stocks is a pervasive curse that continues in developed and developing countries alike. With few exceptions, the institutions in place to combat it are proving inadequate and successful reform of the fisheries sector remains one of the most enduringly intractable problems in natural resource management. Increasingly, research on governance reform in fisheries is being linked with broader 'rights-based' agendas because it is difficult to pursue improved fisheries without placing them in this broader governance arena (in a fisheries context, see Allison *et al.,* in press; Charles, in press; Jentoft, 2007; Kooiman *et al.,* 2005; Mahon *et al.,* 2008 for entry points to recent literature).

Here we highlight a clearly articulated reform perspective, that of Wealth Based Fisheries Management (WBFM) which has been promoted as a new foundation for reform, particularly in developing countries (Cunningham *et al.,* 2009; DFID, 2005; Sumaila, 2008). The WBFM approach starts from the premise that we fail to realise the societal benefits fisheries are capable of delivering, and that the way in which these benefits are conceptualised and distributed is a major contributor to the problem. In particular, proponents argue that the current emphasis on fish production as the central policy goal is a barrier to progress and that making fisheries more economically efficient should be a higher priority. If such a policy is adopted, achieving such efficiency gains will likely entail sectoral restructuring with explicit allocation of harvest rights and the creation or development of the administrative machinery necessary to extract economic rents.

There is much to be said for the wealth-based arguments made in support of fisheries reform. Resource rent is not presently a central organising concept for thinking about fisheries problems, or the benefits that fisheries can deliver. It is rare, for example, to see national efforts to formally quantify foregone rents as a result of inadequate institutions and management, despite the political power of arguments based on the monetary benefits of fisheries. The recent World Bank rent drain study of this issue is a notable and welcome exception in this regard (Willman *et al.,* 2009); $50 billion in foregone benefits is a big number that draws attention.

Adopting a wealth-based approach is probably non-controversial if it simply means being more explicit about the benefits fisheries deliver, focusing on economic rent as one guiding criterion. But one must remember that other objectives such as equity, social cohesion, and maintenance of custom and culture, are often equally or even more important, especially in the case of small-scale fisheries. In several writings, however, it is clear that proponents see adopting a wealth-based approach as also having large implications for how wealth from fisheries is used: "*The two approaches to fisheries management (traditional versus wealth based) provide different visions of how fisheries can contribute to economic and social welfare – through economic activity, and through wealth generation and usage*" (DFID, 2005, p3).

The preference of WBFM advocates is that benefits should be directed in ways that contribute to macro-economic growth through the allocation of rights as private

property. For developing countries in particular, proponents contend that the traditional characterisation of benefits as accruing primarily to those engaged in fishing-related activity and for the livelihoods of fishers misses a major part of the contribution fisheries can make if well managed. The consequent premise is that generating wealth from fisheries for re-investment in areas of the economy that benefit the poor, such as education, health and infrastructure will maximise social benefit (Cunningham *et al.,* 2009).

A recent critique of this perspective, however, argues for greater consideration of the 'welfare function' of SSF, particularly the absorption of rural labour (Béné *et al.,* 2010). Linked to the often-common pool nature of fisheries in developing countries, Béné and co-authors point out that this 'safety valve' or 'labour buffer' function can help local people and migrants during periods of macro-economic upheaval or local disturbances (Béné *et al.,* 2009a; Jul-Larsen *et al.,* 2003). Sectoral restructuring and the re-allocation of rights bring equity issues and social and economic costs that must be borne from the rents generated. Analysis of the trade-offs associated with reform is critical before embarking on reform in developing country contexts.

Although the contrasts can be overplayed, differences between the 'wealth' and 'welfare' perspectives highlight two over-arching policy questions for fisheries – what benefits should fisheries deliver? And to whom should the benefits flow? Answering these questions is clearly beyond the remit of researchers: these are political questions that demand value-based decisions which trade off alternative benefits that may be measured and distributed in markedly different ways. They are also questions that must be answered for both large- and small-scale fisheries. Without clarity of objectives we are unlikely to find durable pathways to reform (Cochrane, 2000; Hilborn, 2007).

But while deciding on objectives is not their job, researchers have an important role to play in finding out whether current policies and interventions are appropriate to reach stated goals and what the likely effectiveness of alternatives will be. Unfortunately, however, the tendency of researchers and managers to rush to the technical sub-issues such as monitoring and evaluation, effort reduction and fishing technologies, before these larger policy issues are dealt with produces partial solutions at best.

Policy decisions must also be conditioned by the likelihood that the measures needed to deliver the desired benefits can be achieved. If the technical prescription for achieving a given set of policy objectives will be undermined by the prevailing political environment, then the high risk of failure must necessarily question the policy choice. While a choice between a 'welfare' model and the 'wealth' model is, perhaps, most relevant when discussing the small-scale sector, this consideration of feasibility also applies to large-scale fisheries. Recent analysis leads one author to conclude, for example, that a transition to a system of fully transferable rights held by individuals, such as that found in New Zealand or Iceland, is "*barely politically feasible anywhere*" (Robinson, 2010).

Fortunately, the political economy of fisheries reform is a topic that is now achieving greater prominence (Leal, 2010). And lessons are already emerging from this work. Robinson (2010), for example, points out that: (i) most cases of successful fisheries reform have occurred in well functioning democracies – that is those where political competition is about public rather than private goods; and (ii) reform works where fisheries contribute an important proportion of GDP. It is the conjunction of both these conditions that seems to be critical.

Building on these insights, it seems reasonable to suggest that there will be multiple pathways to reformed fisheries, and the end points will differ with the political, ecological and economic particulars of fisheries and nations. It is equally clear, we think, that achieving durable fisheries reform requires a much broader agenda than simply a technical exercise to optimise yields and economic benefits. If this is true then a significant research agenda has to be developed to inform decisions about values and about ways to implement reforms that set fisheries within the broader economic context.

The enormity and complexity of the task would suggest that blueprint solutions will be unlikely to succeed. That said, however, a unifying framework to organise thinking about the problem and to facilitate learning would be useful. We hypothesise that although the pathways to reform and the values that drive decisions will differ, there will be many common elements in a reform process. There is broad consensus that institutions that align incentives for sustainable use are prerequisites for progress (e.g. Hannesson *et al.,* 2000; Jentoft, 2004). Perhaps most important among these

will be some form of access right (whether held by individuals or a group) that is enabled and legitimised by law and policy.

It remains probable, however, that some fisheries are best suited to providing a labour buffer/welfare function as *de facto* open access – open exit fisheries. Examples may come from transient freshwater fisheries (Béné *et al.,* 2009b; Jul-Larsen *et al.,* 2003; Njaya *et al.,* in press), fisheries in post-disaster or post-conflict societies, or in those countries in which the abuse of political power for private gain would cripple reform in the medium term. The work has not yet been done to judge whether such fisheries are the exception that proves the rule or whether they are examples of a broader class of fisheries that need different solutions.

In this context, we believe the broad category of 'political economy of reform' is a useful umbrella for further inquiry. Empirical case studies of both large- and small-scale fisheries are badly needed to help better understand the trade-offs that various reforms require, the improvements that are politically feasible in given institutional settings, and the risks of undesirable outcomes such as elite capture and the mal-distribution of benefits.

3. Resilience in practice

A widely-cited definition of resilience in a social-ecological system is *"… the capacity of a system to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks …"* (Walker *et al.,* 2004, p4). Recognising the dynamic nature of fisheries systems, achieving such resilience is highly desirable. Up to now the concept of resilience has largely remained cloistered within academia, from which a considerable literature on its theoretical underpinnings and potential advantages has emerged (see Berkes *et al.,* 2003, Folke, 2006; Walker *et al.,* 2004, for entry points to that literature). Resilience thinking has much to offer fisheries science, especially for SSF in developing countries. Several points of intersection between fisheries and resilience thinking are now being actively explored by researchers, particularly in the social sciences. There are three we believe may be especially profitable:

Self-organisation. The capacity of people to organise and reorganise as they adapt to change and surprises is critical to building resilience (Berkes and Seixas, 2005; Folke, 2006; Folke *et al.,* 2003; Kooiman *et al.,* 2005; Mahon *et al.,* 2008; McLain and Lee, 1996; Walker *et al.,* 2004). Building the capacity to adapt is a key element of enhancing resilience and parallels much from the literature around fishery rights and the incentives that come from collective action. Governance and management institutions will increasingly have to exist in multi-scale, multi-sectoral settings. How institutions function effectively in that environment, and the roles of power and agency in that process, is an active area of research (e.g. Bodin and Crona, 2009; Carr and Wilkinson, 2005; Mahon *et al.,* 2008; Nunan, 2010).

Transformation. The poor condition of many fisheries suggests that they will need to radically change if they are to persist and to provide the goods and services societies demand of them. Such language is common to both the fisheries reform (see above) and resilience literatures. Transformation poses ethical questions – trade-offs are needed among competing values (Kristjanson *et al.,* 2009; Olsson *et al.,* 2008; Van der Brugge and Van Raak, 2007; Walker *et al.,* 2010). Many such questions arise around, for example, the legitimacy of decision-making about who decides when and how to enhance resilience by incremental change and when to transform, and who will lose and who will win from radical changes in governance (Lebel *et al.,* 2006).

Thresholds. Conventional fisheries science assumes fishery resources behave in predictable ways under exploitation. The objectives of management are typically to get the fished biomass to a state that ensures an optimal flow of benefits. Of course, to a useful degree this assumption appears to hold true in many managed fisheries. Looking to the future, however, the failure of this paradigm to accommodate extreme events, discontinuities and abrupt changes in ecosystems or societies will become increasingly evident. There is a growing case book of fisheries that appear to have 'flipped' into new and persistent configurations that are maintained by different sets of feedbacks. New insights into thresholds (e.g. Scheffer, 2009; Scheffer *et al.,* 2009), appear directly applicable to fisheries science, particularly those concerning the behaviour of complex systems prior to collapse.

4. External drivers

Classically, fisheries science and management has looked inward and concentrated on the fishery *per se*. Increasingly, however, research and management practitioners are explicitly recognising that fisheries exist within a much broader environmental and development context (Andrew *et al.,* 2007; Hall, in press). We are waking up to the fact that many of the challenges fisheries face are shaped by complex combinations of bio-physical, social, political and economic forces that operate at scales beyond national level and outside the domain of fisheries.

While there is usually limited scope for fisheries management to control these forces, policy-makers and managers are starting to realise that they must understand them and plan for their impact. Importantly, these drivers also offer possibilities for identifying new arenas in which one might find solutions to fisheries problems. This is, perhaps, especially true for the small-scale sector. Linking fisheries considerations into wider issues of climate change, migration, human rights, governance, rule of law, literacy, or health, for example, might offer more effective entry points for dealing with issues such as access rights, effort control or vessel decommissioning (Hall, in press; Allison *et al.,* in press).

While external drivers of change are relevant to all fisheries, it is perhaps in the freshwater domain that effects are most acute. The recent work on small-scale fisheries described above is now starting to compensate for the relative silence of the past on the importance and challenges facing freshwater fisheries. River fisheries are of particular concern in this regard with water abstraction, dam construction, and climate change of particular relevance (Molle *et al.,* 2007; Welcomme, 2001; Dugan *et al.,* 2010).

Climate change is perhaps the driver that is receiving most attention at present, with governments increasingly calling for strategies to cope with the changes it will bring. There is now a growing corpus of literature and research efforts to explore and analyse climate change impacts both from biophysical, macroeconomic and food security perspectives (e.g. Allison *et al.,* 2009; Brander, 2007). Several other drivers, however, remain largely ignored by mainstream fisheries policy analysts. Finding an analysis, for example, of the likely impact of demographic, health and disease trends, or of wider development policy trends, is a challenge. (There are, however

some notable exceptions, e.g. Allison & Seeley, 2004, Kissling *et al.,* 2005, on the impacts of HIV/AIDS in fisheries). There is a strong case that the fates of many fisheries will be determined by processes outside their domain of influence, at scales larger than the fishery and/or from other ecological and social drivers of change. In consequence we believe that fisheries research needs a broader scientific foundation. This is, perhaps, particularly true for the developing world where SSF play such important roles in food security and local economies.

5. Concluding remarks

We began this short essay with some key attributes of small-scale fisheries in the developing world and their implications for food security. The subsequent discussion of entry points for fishery science very quickly broadened – more sectors, more scales, more theory, and more stakeholders. For all fisheries, whether large or small, our approaches need to more clearly recognise that governance and management is complex, messy and much more contingent on drivers outside the fishery sector than we have viewed it in the past. Comparative analysis will continue to have a place as a source of insight but to meet the development challenge of collapsed fisheries, science will become increasingly embedded in the governance and management process. In this sense, the science to support fisheries will likely become more akin to a monitoring and evaluation process than research divorced from management.

Fortunately, fishery science is changing to meet these demands, but it has yet to settle into a new consensus on the science needed (Bentley and Stokes, 2009; Cunningham *et al.,* 2009; Garcia, 2005; Kooiman *et al.,* 2005; Mahon *et al.,* 2008). What seems certain, however, is that science will need to draw on a cross-fertilisation of ideas and approaches from multiple fields of inquiry.

Acknowledgements

We thank James Muir for encouraging us to write this paper. Comments from Eddie Allison and an anonymous reviewer improved the manuscript.

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All the reports and papers produced by the Foresight Project on Global Food and Farming Futures may be downloaded from the Foresight website (http://www.bis.gov.uk/Foresight).

First published January 2011.

The Government Office for Science.

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URN 11/556