introduction

Fisheries are in the news. A flurry of media activity has centered around fisheries issues in the past year prompted by the release of several studies and reports that point to growing crises and controversy in both wild fisheries and aquaculture. A recent report from a panel of fishermen, scientists, business leaders, and government officials pointed to overfished and depleted stocks in U.S. waters, along with severe habitat degradation (Pew Oceans Commission 2003). The report argued that the restoration of U.S. fisheries requires a major overhaul of policy, including the introduction of ecosystem-based management and stronger regulations. A much-publicized study in Nature reported that the population of large predatory marine fish has been reduced by 90 percent since pre-industrial times (Myers and Worm 2003). Another recent study argued that correcting reported Chinese fisheries statistics to levels that better fit estimates of biophysical potential renders global catch trends far less favorable (Watson and Pauly 2001). The Food and Agriculture Organization of the United Nations (FAO), particularly in its State of World Fisheries and Aquaculture publications, has consistently sounded the alarm over threatened stocks of wild fish (FAO 1995, 1998, and 2000a).

The rapidly growing field of aquaculture, which now accounts for 30 percent of the world’s food fish, has also pushed its way into the media spotlight. For some years now, aquaculture has been seen as a possible savior for the overburdened wild fisheries sector, and an important new source of food fish for the poor (FAO 1995; Williams 1996). However, there are some problems with the industry. A recent report from the World Wildlife Fund argued that some forms of aquaculture place pressure on wild fisheries through demand for wild-caught fish as feed (Tuominen and Esmark 2003). Another Pew report warned of the lack of effective regulatory mechanisms for dealing with genetically modified fish, some varieties of which are already in development (Pew Initiative on Food and Biotechnology 2003). Numerous studies have warned of potentially negative effects of escaped farmed
fish on wild populations. A 2000 study in *Nature* argued that while aquaculture has the potential to contribute considerably to the world’s supply of fish, significant environmental tradeoffs have occurred with many forms of aquaculture (Naylor et al. 2000). In response, many industry advocates and policymakers have strongly defended aquaculture as an environmentally sustainable means of contributing to the world’s fish supplies.

In this context, what does this study contribute to the growing dialogue on world fisheries? Why would economists attempt to address issues of fisheries that typically have been dealt with by biologists, ecologists, and policymakers? The answer: a key missing component to the puzzle thus far has been a broad economic analysis of the rapid changes in fisheries over the past two decades. Economic factors have been a crucial driver of these changes in fisheries, and economic factors will drive further changes to the year 2020. It is imperative that audiences beyond the fisheries sector—especially policymakers—have a better understanding of fisheries issues, and how they interact with other critical policy issues in world food and agriculture.

Most critical among the issues addressed in this study are those of poverty reduction and environmental sustainability in developing countries. The intention is to address the issues in a consistent economic framework that focuses on the dynamic and interacting decisions of producers, consumers, and traders all over the world, at the same time permitting sufficient data disaggregation by commodity and location to support useful conclusions on the likely future of fisheries.

A better understanding of these market interactions is not a substitute for other aspects of forecasting fisheries outcomes, such as stock assessment, fish population dynamics, and biophysical modeling; however, better information on price-mediated inter-relationships with supply and demand for other foods and feeds is essential for reasoned policymaking. We trust that this study addresses this need to some degree.

**OBJECTIVES OF THE STUDY**
The overall purpose of the study is to analyze the changing—and now critical—place of fisheries in global food policy issues. The term “fisheries” is applied equally to the capture of wild fish and to aquaculture. The focus is developing countries, although the analysis includes the developed world.¹ In a sector as globalized as fisheries has become over the past two decades, events in one part of the world impinge quickly on outcomes in another. The study starts from a series of premises that are documented and supported as the book unfolds. Attention is paid to

¹See Appendix A for definitions of developing-country, developed-country, and regional categories.
critical changes in the fisheries sector and their impacts on a broader set of policy objectives for growth, poverty reduction, and environmental sustainability in developing countries. Many past and future developments in the fisheries sector can best be understood by considering fish as a series of commodities within a changing world supply and demand system for different food and feed items. The study concludes with a delineation of key domains for policy action within the fisheries sector that can improve outcomes for broader food and agricultural development policy objectives in developing countries. Thoughts on priorities for further food policy research in the fisheries area are also provided.

The study investigates the following key premises:

- Fish production has developed from a primarily local and relatively minor specialized activity into an important part of a rapidly evolving global high-value food activity.
- Limits to wild capture fisheries mean that the time for fish farming has come—but how and with what perils remains to be seen.
- Capture fisheries affect aquaculture both as a competitor and as a supplier of feed, leading to a complicated price-mediated relationship that is generally not well understood.
- Poor rural people in developing countries are major stakeholders in the future of fisheries—and this is true, furthermore, for an expanding inland rural population.
- Tremendous uncertainties inherent in capture fisheries affect aquaculture in key ways, particularly through markets for inputs and outputs.
- Policies and technology development in both developing and developed countries will be crucial to improving global outcomes.

We investigate these premises first by focusing on what is changing and then by devising a way to project how these trends might play out under different scenarios. Historical consumption, production, price, and trade trends are assessed for a wide variety of regions and for a number of fisheries products. The study then attempts to illustrate the economic component that cuts across these important multidisciplinary issues and cannot be ignored. The analysis aims to link modeled outcomes to issues for environmental sustainability, technology generation, trade policy, poverty alleviation, and human nutrition in poor countries.

A key objective is to put the consideration of fisheries issues into the broader context of evolving world markets for food. Looking at fish as a series of market commodities with different market profiles draws explicit attention to the role of
prices in affecting both consumer and producer behavior toward different subcategories of fish. It also permits examination of market tradeoffs within fisheries and between fish and other foods. Fish is both a food market competitor and an input to meat production, with nearly one-third of all wild-caught fish being used as a feed input. Even within fisheries, competition exists among different kinds of fish, and some kinds of fish provide critical inputs to the production of others. Events affecting prevailing prices for different kinds of fish and meat affect other commodities in the animal protein group. Furthermore, fish feed prices also potentially interact with prices for vegetable protein sources, such as soy.

A CHANGING WORLD FOR FISHERIES AND FISHERS

Three main sets of fisheries issues attracted policy and research attention in the late 1980s and 1990s: the decline of traditional marine capture fisheries, mainly in developed countries; the growing roles of developing countries and aquaculture, which have been inextricably linked; and the rising role of China. Salient facts from each of these sets of issues are briefly outlined below.

Traditional Fisheries Under Threat in Developed Countries

Fisheries in developed countries have traditionally been considered—at least in popular culture—as the northern fishing grounds off the coasts of the United States, Canada, Norway, Russia, and Japan. The fisherman of lore is a dogged sailor setting off into stormy seas in oilskins, to bring home a hold of fish like cod and halibut. Such fishermen were not thought of as farmers, much as range cowboys of the American southwest would also reject that label. Fishermen were not thought of as rich, and their life was indisputably hard. Their product was traditionally the “poor man’s meat” (Kurlansky 1997), a view that has some statistical basis across countries (Kent 1998).

Fishermen of the Northern countries were great travelers, sailing long distances in search of rich schools of fish. They were also pioneers of the food processing industry, dealing with problems of conservation and disposal of a perishable, seasonally harvested commodity hundreds of years ago. Dried cod (stockfish) became one of the early trade goods, transported great distances and to tropical climes along with European expansion in the 17th century (Kurlansky 1997).

In recent decades, capture fisheries in developed countries have entered a crisis. Global capture fisheries production for human consumption grew through the late 1980s, largely driven by technological improvements that increased capacity; but it has stalled since then. In fact, food fish production from capture fisheries is lower in developed countries than it was 30 years ago, and has declined steadily since the late 1980s. Although some of this decline is attributable to the
establishment of 200-mile exclusive economic zones (EEZs) and the resulting reduced fishing access for some developed countries like Japan, overfished and declining stocks are also responsible.

Fisheries policy issues in developed countries have always been oriented toward issues of access to fishing grounds claimed by others, and protecting the grounds of one’s own country. As stocks began to dwindle, disputes over fishing rights became more exclusionary and even violent, as in the “Cod War” between Iceland and Great Britain during the 1970s. The other main fisheries policy issue in developed countries revolves around saving the livelihoods of people (and regions), typically among the poorest in the nation, whose incomes are threatened by declining catches. Fisheries subsidies have become even larger relative to output than other agricultural subsidies. Milazzo (World Bank 1998), drawing on work from FAO (1993), reports that fisheries subsidies in developed countries have played a large role in excessive investment in boats and gear. Overcapacity, abetted by the lack of appropriate resource rent charges and the scaling up of fleet and vessel sizes and port infrastructure, has led to the over-exploitation of marine fisheries resources.

To make matters worse for the traditional fisherman in the North, average per capita consumption of fish actually declined in developed countries from 24.3 kilograms (kg) per year in 1985 to 21.7 kg per year in 1997, as saturation levels have been reached in the diets of rich consumers. Since human population growth in developed countries was also low, aggregate consumption stagnated in the North. Yet even here, per capita consumption of certain high-value items, such as shrimp and salmon, has substantially increased. These commodities shifted in the 1990s from being primarily wild-caught to being primarily aquaculture-produced, and their shelf prices decreased. At the same time in developed countries, per capita consumption of many low-value items, like canned sardines, fell.

It is an open question as to whether supply or demand factors best explain these events. On the supply side, some fish have become scarcer with decreased supply, and salmon and shrimp have become much cheaper with increased aquaculture production. Evolving distribution systems, including the expansion of cold chains, also changed the product mix available to consumers. On the demand side, most people in developed countries experienced real income growth over the 1990s, which presumably led to substitution toward preferred (higher priced) fish-based calories and away from less preferred (cheaper) fish-based calories.

One trend that undoubtedly helped make once-expensive items like shrimp and salmon more abundant and much cheaper in developed countries is the globalization of the fish trade to include developing-country production. Institutional developments applicable to more than the fisheries sector alone have had tremendous implications for fish trade. Examples are tariff reduction under the
World Trade Organization (WTO), inaugurated late in 1994; a more rules-based trading system for perishables under the Sanitary and Phyto-Sanitary Agreement (SPS) associated with WTO in early 1995; and improved airfreight facilities. Another factor was the move from costly and lengthy inspection-based systems for assuring food safety implemented by importing countries to process-based procedures implemented by exporting countries; the Hazard Analysis and Critical Control Points (HACCP) system is the dominant example. Finally, globally integrated supermarket chains that procure in one country and retail in another have proliferated in recent years. Many local fishermen no longer have naturally protected markets for chilled and frozen products. The removal of protected markets has also led in some cases to trade disputes that hinder aquaculture exports (Anderson and Fong 1997).

**Dietary Diversification and Aquaculture in Developing Countries**

Despite the stagnation of fish production and consumption in developed countries, global fish consumption has doubled since the early 1970s. The developing world is responsible for the vast majority of this increased aggregate consumption, much of which has come in the form of low-value freshwater fish in East Asia. In developing countries, per capita consumption of all fisheries commodities has grown modestly since the 1960s, with consumption of the relatively expensive crustaceans and mollusks rising fastest. Population growth, however, has been robust in developing countries, and its overall impact on aggregate fish consumption has been high. At the same time, aquaculture grew at an explosive rate in developing countries. Aquaculture production from developing countries rose from under 2 million metric tons (mmt) in 1973 to over 25 mmt in 1997, and developing countries now represent nearly 90 percent of total aquaculture production. Globally, aquaculture production has been the only engine of growth in food fish production, and hopes have risen that aquaculture may ease pressure on threatened wild fish stocks.

Since both fish consumption and aquaculture production have soared in developing countries, the question arises as to which is the primary driver of trends in the fisheries sector. Chapter 3 examines this question in the context of rising incomes, urbanization, and population in developing countries. At the same time, institutional development and improved infrastructure for trade in perishable food items was an element of great opportunity for the fish farmer in developing countries. Global fish trade in the mid-1990s totaled well over US$50 billion (FAO 2002a), and has grown far more rapidly than food and agricultural trade as a whole. Meanwhile, developing countries have increased their value share in world fish exports to 50 percent.
Aquaculture represented only 6 percent of food fish production in 1970, and now represents over 30 percent. As this share has grown, so has its demand for fishmeal and fish oil, both of which are derived from wild fisheries. Further, as farmed production of organisms such as shrimp and salmon—which have relatively strong requirements for these feed ingredients—grows, aquaculture’s share will continue to grow. This possibility has caused some concern among those who fear that higher fishmeal and fish oil demand will lead to greater fishing pressure on stocks of fish used for feed—otherwise known as “reduction” fish (Naylor et al. 2000).

There are also other environmental issues associated with aquaculture. Aquaculture operations, especially in developed countries, have received attention for pollution in the form of effluent, chemicals, and escaped farmed fish (Goldburg and Triplet 1997). These issues are also of concern in developing countries, where aquaculture operations are expanding rapidly. Already, hundreds of thousands of hectares of mangrove habitat have been converted to coastal aquaculture. As both high-value and low-value aquaculture expand during the next two decades, pressure on the environment will intensify in both developed and developing countries.

The rapid expansion of operations and large amounts of money associated with the rise in export aquaculture in developing countries raises the issue of its impact on equity, and particularly on the welfare of the poor. Cutting down mangroves for shrimp farms, it has been claimed, displaces traditional fishers who rely on mangrove fishing habitat for their livelihoods (Naylor et al. 2000). If land suitable for aquaculture expansion becomes scarcer in Asia, it can be anticipated that issues associated with the governance of natural resource use will become more acute. Another issue for the poor is the rising relative price of fish (Bouis 2000). It has been shown that the poor in developing countries get a higher share of their much smaller animal protein consumption from fish than do better-off people in the same countries (Kent 1998). The question arises as to the net effects of aquaculture growth in developing countries on the access of the poor to better nutrition, and specifically to animal protein.

**The Rapid Rise in the Relative Importance of China**

Surprisingly, China’s dominant role in world fisheries is often overlooked in overviews of the industry. Chinese production totals for both aquaculture and capture fisheries have soared during the past 20 years, turning China into the single largest producer in both categories. China is particularly important as an aquaculture producer, now accounting for more than two-thirds of total production of farmed fish. As a consequence of this rapid growth, per capita consumption totals in China have more than tripled in the past 15 years, and total consumption has consistently grown at a rate of over 10 percent per year, according to official figures.
It has been suggested, however, that China significantly over-estimated its production totals in the 1990s (Lu 1998a; Watson and Pauly 2001). Irrespective of their accuracy, it is worth putting such assertions into a conceptual framework for examination because their significance is not straightforward, the magnitudes involved are sizable, and the claims have received widespread publicity.

POLICY RESEARCH QUESTIONS

Seven sets of key policy research questions can be inferred from the above trends. These are briefly developed below and are addressed in full as the study unfolds.

Will Growth Patterns Continue for Fish Demand in the North and South?

This is clearly a critical issue, especially given the suspected role of demand changes in developing countries in shaping structural changes in the fisheries sector. The question involves finding a consistent way to first assess what the trends are. Achieving consistency in terminology and product flows (so that production plus net trade matches consumption) is not a small matter when trying to attain balance across a large number of commodities and countries. Next, the forces driving these trends must be assessed, so as to understand both how existing trends came about and how new trends may emerge in the future. Projections based on straight-line extrapolation of past trends are rarely accurate. A number of structural driving forces are external to the fisheries sector, such as population growth, urbanization, and income growth. But events in other food sectors and within fisheries (the impact of salmon consumption on fishmeal use, for example) also need to be accounted for, typically through the mutual interaction of prices.

Where Will Supply Come From?

This is a counterpart to the demand issue, and it has several aspects: What sorts of production systems (both in aquaculture and capture fisheries) are likely to be needed? What sorts of products will be in demand (high-value like shrimp or low-value like grass carp) and from what part of the world? What does this tell us about technology needs? What are the implications for reduction fish? What does this imply for livestock products and vice versa? Most of all, these questions have implications for trade and prices.

What Will Happen to Trade and Fish Prices?

Will the developing-country export boom in high-value seafood items continue? What will be the impact on food fisheries in developing countries, and what will be the impact on the price of the low-value food fish that the poor rely on? How
is the world trading system for fish likely to evolve? Will food safety or ecological concerns in importing developed countries create insurmountable barriers for developing-country exporters? Will barriers lead to economies of scale in developing-country fish production and marketing that effectively exclude small-scale producers and the poor?

**What are the Implications for Sustainable Use of the Oceans and Coastal Areas?**

Given all of the above, will pressure on capture fisheries continue to increase? Where will this happen? Will pressure increase faster on low- or high-value items and in the North or in the South? To what extent are answers to these questions dependent on a pessimistic or optimistic view of either capture fisheries or aquaculture? What are the implications of different assumptions on demand for reduction fish? Will reduction fish emerge as a constraint to aquaculture production?

**Can Aquaculture Alleviate the Pressure on Capture Fisheries?**

How important is aquaculture production in easing pressure (through substitution relationships) on capture fisheries? How sensitive is capture fisheries production to alternative assumptions about growth in aquaculture? Is it necessarily the case that increased demand for aquaculture products will raise the relative price of fishmeal and fish oil, and thus provoke a number of important changes? Among these, possibilities include a decline of reduction fish stocks resulting from overfishing, decreased profitability of carnivorous aquaculture, and de-linking of fishmeal prices from soy prices as the value of fishmeal in fish feeding begins to substantially exceed its value in other uses.

**What are the Implications for the Poor?**

Will the poor who currently fish get crowded out by larger-scale operators? Will landless agricultural workers who currently work in rice paddies lose their jobs as land-holdings are converted to less labor-intensive pond aquaculture? What will happen to the nutritional security of those poor rural people who previously relied on cheap fish and now have only more expensive fish? What would happen to the incomes and livelihoods of the rural poor in the absence of aquaculture development?

**What are the Entry Points for Making the “Blue Revolution” More Favorable to the Poor?**

The major events and changes portrayed above for fisheries closely resemble even more widespread changes taking place in the meat and milk sectors of developing countries, which has been called the “Livestock Revolution” (Delgado et al.
If that is the case, it also seems likely that what some have termed the “Blue Revolution” in fisheries is also confronted by the dilemma that the changes in question are market-driven by millions if not billions of participants. They will be very hard to stop but can perhaps be slightly steered at the margin to improve outcomes for important policy goals such as poverty reduction and improved environmental sustainability in developing countries.

If so, a key for policy research is to find the effective entry points for harnessing the power of the market to effect desired changes. Do trade restrictions on aquaculture-produced imports affect the price of low-value food fish? Can a small increase in feed efficiency have a much bigger impact? What factors are likely to exclude the poor from the export bonanza, and which are policy-changeable? To what factors are production and demand trends sensitive? Where are food fish prices likely to go, and should policymakers be worried? Where are consumer and producer substitutions likely to occur if the price is right? Research on market-driven relationships cannot answer all these questions completely, nor can it provide solutions to all important fisheries policy issues. It can, however, help sharpen the focus on entry points for policy intervention that can better harness the energies of market forces.

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2 Except that in the case of the Livestock Revolution, export growth from developing to developed countries has not occurred on any large scale because of sanitary barriers.