NAFTA Environmental Impacts on North American Fisheries

Grace V. Chomo and Michael J. Ferrantino

Presented at the North American Symposium on Understanding the Linkages between Trade and Environment
Washington, DC
October 11, 2000

ABSTRACT

Catch levels in many North American fisheries exceed the level consistent with long-run sustainability, and falling fish stocks have been a cause of concern. However, NAFTA-related changes in trade policies are unlikely to have significantly influenced the sustainability of North American fisheries. Most tariffs were already at or near zero prior to NAFTA. For products with significant pre-NAFTA tariffs (mainly in Mexico), the associated trade flows are typically not large relative to catch levels. Trade flows with the world as a whole are significant relative to catch levels in Canada and the United States, though not in Mexico. Conclusions about the relationship of trade to region- and species-specific fish stocks are complicated by data issues.

We would like to thank Roger Corey for expert advice, and Andrew Cassey for research assistance, while holding them both harmless for any deficiencies in the final product. The statements made in this paper represent solely the views of the authors and do not represent the views of the U.S. International Trade Commission or any of its Commissioners.

Contact information:
Grace V. Chomo
phone 1-202-205-3125
email vchomo@usitc.com

Michael J. Ferrantino
phone 1-202-205-3241
email mferrantino@usitc.com

Both authors are with the U.S. International Trade Commission, Office of Economics, 500 E St. SW, Washington DC 20436, fax 1-202-205-2340.

NAFTA Environmental Impacts on North American Fisheries[1]

INTRODUCTION

Fisheries as an Environmental Issue

During the 20th century many of the world's fishing stocks were depleted to levels which could no longer sustain historical levels of fishing, and many of these stocks have not since recovered. There is a wide consensus on this point: observers of the environmental scene who agree on little else concur in recognizing the seriousness of over-fishing as an environmental problem.[2] Total fish harvest in the Northwest Atlantic, Southeast Atlantic, and Antarctic fishing areas has declined by over 50 percent from historic maxima of approximately thirty years ago.[3] The decline of fish stocks varies widely from region to region and species to species.

The policy response to declining fisheries has accelerated in recent years. For example, in the U.S. exclusive economic zone (EEZ), large areas of Georges Bank and the Gulf of Maine are closed to fishing with gears capable of catching groundfish (demersal fish). The United States and Canada coordinate stock assessment activities in these waters, while using different fisheries management techniques.[4] Examples of such techniques include catch limits (both numerical and on size of fish), restrictions on permissible gear, limits or prohibitions on new entry, and required reporting of landings.

---

[1]The statements made in this paper represent solely the views of the authors and do not represent the views of the U.S. International Trade Commission or any of its Commissioners.

[2]Cf. Michael De Alessi (2000), "Fishing for Solutions: The State of the World's Fisheries," in Ronald Bailey, ed., *Earth Report 2000: Revisiting the State of the Planet*, 2000, New York: McGraw-Hill for the Competitive Enterprise Institute, pp. 85-114; Anne Platt McGinn (1998), "Promoting Sustainable Fisheries," in Lester R. Brown et al., *State of the World 1998*, 1998, New York: W.W. Norton and Co. for the Worldwatch Institute, pp. 59-78; "Diminishing Resources: World Fisheries Under Pressure" (1998), in *World Resources 1998-99*, Oxford and New York: Oxford University Press for the World Resources Institute, United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP), and the World Bank, pp. 195-196.

[3]Food and Agriculture Organization of the United Nations (FAO) (1997), *The State of World Fisheries and Aquaculture 1996*, (Rome: FAO, p. 36.

[4]National Marine Fisheries Service (NMFS), *Our Living Oceans: Report on the Status of U.S. Maritime Resources, 1999*, U.S. Department of Commerce NOAA Technical Memo NMFS-F/SPO-41, pp. 77-79 and 93-95.

There has been increased interest in the use of quantitative measurement to assess the environmental effects of trade agreements.[5] Compared with environmental issues such as manufacturing emissions and land use, there has been relatively little attention paid to the potential effects of trade liberalization on environmental indicators related to fisheries. This paper seeks to make a modest contribution in this area by assembling indicators relevant to assessing the possible effects of the NAFTA agreement on North American fisheries.[6] The analysis relies heavily on primary data from various national and international sources, and aggregations and other calculations based on that data, lightly processed, and does not employ techniques such as partial- or general-equilibrium simulation modeling.

The Role of Causation

[5]Proceedings of recent international expert conferences on the topic include Per Fredriksson, ed. (1999), *Trade, Global Policy, and the Environment* (Washington, DC: The World Bank), OECD (1999), *Assessing the Environmental Effects of Trade Liberalisation Agreements: Methodologies* (Paris: OECD), and World Wildlife Fund and Futuro Latinoamericano (2000), *Background Material Prepared for the International Experts Meeting on Sustainability Assessments of Trade Liberalisation: 6-8 March 2000, Quito, Ecuador,* and the subsequent rappoteur's reports published under the title *International Experts Meeting on Sustainability Assessments of Trade Liberalisation: 6-8 March 2000, Quito, Ecuador* (Gland, Switzerland and Quito, Ecuador: WWF International and Fundacion Futuro Latin Americano).

[6]For one example, see Godfrey Bahiigwa (1999), "The impact of trade and investment policies on the environment: Uganda's fisheries industry," in OECD, *op. cit.*

In this paper, we consider that the effects of trade liberalization on the environment may arise in the following way. Governments, either individually or by agreement, adopt trade-liberalizing measures such as reductions in tariffs or non-tariff barriers (NTBs). These measures give rise to increased flows of merchandise trade, and perhaps also affect foreign direct investment (FDI). Changes in merchandise trade affect patterns of production, and these production changes in turn induce changes in the level of environmental indicators, either positive or negative.[7] Thus, at least conceptually, there is a fairly clear level of causation proceeding from trade policies to environmental indicators. This point is of some importance. During preliminary consultations on the CEC's *Analytical Framework*, many participants expressed concern about the feasibility of showing clear cause-and-effect relationships between trade policies and environmental indicators.[8] We argue that these difficulties arise primarily at the level of data , measurement, and modeling, and that maintaining a clear conceptual framework often permits relatively strong statements to be made about causation.

In principle, NAFTA trade liberalization in one of the NAFTA importing countries could stimulate exports from a NAFTA partner, thus causing increased production and increased pressure on the exporting country's fishery. Conversely, those same increased imports, by substituting for domestically caught fish, may reduce pressure on the importing country's fishery. Thus, the environmental effect of trade liberalization on the status of fisheries may be positive, negative or negligible *a priori*, depending on the characteristics of the data. This suggests the following specific questions to be addressed in this paper: (1) Did NAFTA

---

[7]In principle, changes in the pattern of production include trade-induced changes in the *technology* of production as well as its level. At a first pass, we abstract from longer-run technological changes to focus on the simpler question of whether or not NAFTA is likely to have changed levels of fisheries activity in the short run immediately following implementation. We also abstract from changes in FDI, both because FDI is relatively less important for fisheries than for other industries and because the NAFTA agreement primarily ratified unilateral national liberalizations of FDI policy already in place (e.g. by Mexico) rather than mandated new FDI policies. These simplifying assumptions may not be equally appropriate for different commodities or different trade agreements.

[8]Commission for Environmental Cooperation (CEC) (1999), *Assessing Environmental Effects of the North American Free Trade Agreement (NAFTA): An Analytic Framework (Phase II) and Issue Studies* (Montreal, CEC), p. 45.

generate any significant increases in fisheries trade or production to begin with? (2) Were any increased exports of fish attributable to NAFTA drawn from relatively sustainable fisheries, or relatively depleted fisheries, and were those exports large relative to the size of the annual catch?

Data Issues and U.S. Focus

The analysis presented here focuses most heavily on U.S. fisheries. The primary reason for this choice relates to data constraints. While data on trade flows, trade policies, and fisheries production patterns are internationally comparable (up to a point), international data on environmental indicators are less systematically organized. This situation is typical of that facing analyses of trade and environment for other industries and environmental indicators, rather than being specific to fisheries. Since trade and production data are nation-specific, analysis of trade policies requires that these be related somehow to nation-specific measures of fisheries status, even if the fish stocks are trans-boundary or migratory in nature. The United States publishes a compendium of indicators of stock status and utilization levels for several hundred region- and species-specific fisheries stocks in the U.S. EEZ.[9] Canada publishes an extensive series of stock status reports. These are for individual stocks and fisheries and issued on a rolling multi-year basis, thus not readily transformable into a "bottom line" that permits comparison of the status of, e.g. redfish in one location with cod in another.[10] Similarly, we were unable to identify a convenient compilation of fisheries status data for Mexico. Other related data issues will be discussed in more detail below.

---

[9] *Our Living Oceans, op. cit.*

[10] Stock Status Reports of the Canadian Stock Assessment Secretariat (CSAS), Fisheries and Oceans Canada, may be found at http://www.ncr.dfo.ca/csas/csas/status/list97.htm.

Preliminary Results

NAFTA-related changes in trade policies are unlikely to have significantly influenced the sustainability of North American fisheries. Most tariffs were already at or near zero prior to NAFTA. For the primary exceptions (imports of processed products in all three countries and imports of primary fisheries products in Mexico), the associated trade flows are not large relative to catch levels. This is sufficient to establish a nearly minimal effect of NAFTA on fisheries status in the aggregate. However, it leaves open two ancillary questions. First, do *overall* fluctuations in merchandise trade potentially affect the status of fisheries stocks, whether or not these fluctuations are NAFTA-related? Second, are there individual species- and region-specific stocks which may have been sensitive to NAFTA-induced policy changes, thus behaving differently from the aggregate?

For the first of these ancillary questions, it turns out that fisheries trade flows are large relative to production, particularly for Canada and the United States. NAFTA trade flows (imports plus exports) of fish accounted for 7.5 percent of total fish catch in 1997, while world trade flows accounted for 5.4 percent of world fish catch.[11] This leaves open the possibility that changes in exchange rates, relative economic growth, and other aspects of the international economy may affect fisheries status, particularly as they relate North America to Japan and the rest of Asia. Second, our initial efforts to assess NAFTA-region trade effects on region- and species-specific trade reveal some of the limitations of existing data. Data on trade, production, and sustainability of fisheries do not match well, especially the measures of trade and sustainability. The subnational nature of fisheries stocks (e.g. Atlantic/Pacific/Alaska/Gulf) poses particular problems for the analysis. In the final section we address how some of these problems might be at least partially ameliorated by different data or methods.

WHY THE AGGREGATE NAFTA EFFECT IS SMALL

[11]Found at Internet address http://faostat.fao.org, retrieved September 11, 2000.

Pre-NAFTA Levels of Protection

Pre-NAFTA average tariffs on fisheries products (HS chapters 3 and relevant parts of 16) for the three NAFTA member countries are reported in table 1, as per the WTO's Integrated Data Base (WTO-IDB).[12] Mexico maintained the highest average tariff rates on fisheries products prior to NAFTA implementation January 1, 1994. Mexico's average tariffs were similar in HS chapters 3 and 16, at levels of about 20 percent *ad valorem*. The vast majority of tariff lines for both Canada and the United States under chapter 3 were duty-free prior to NAFTA; thus, any tariff change as a result of NAFTA approach negligible at the 2-digit HS level (Canada's average was 0.8 percent, the U.S. average was 1.3 percent). Canada and the United States had significantly higher average tariff levels in chapter 16 (1604-1605) than in chapter 3, at 6.2 percent and 5.7 percent respectively, with peak lines exceeding double digits.

Table 1
Pre-NAFTA (Pre-Uruguay Round) applied tariffs, HS chapter 3 and 1604-1605

Country	chapter 3		chapter 1604-1605	
	simple average	range	simple average	range
Canada	0.8	0 to 6.8	6.2	0 to 15.0

[12]Tariff and trade data are reported according to the Harmonized System (HS), the last revision of which was adopted by most WTO countries in 1996 (though some still use HS-1992). The relevant sections of the HS for fisheries are Chapter 3 (fish and crustaceans, molluscs, and other aquatic invertebrates), and in Chapter 16, headings 1604 (prepared or preserved fish; caviar and caviar substitutes prepared from fish eggs), and 1605 (crustaceans, molluscs and other aquatic invertebrates, prepared or preserved). In the text and tables, "Chapter 16" refers to headings 1604 and 1605 only.

Country	chapter 3		chapter 1604-1605	
Mexico	19.6	0 to 20.0	20.0	20.0 to 20.0
United States	1.3	0 to 15.0	5.7	0 to 35.0

Source: WTO-IDB database, 1996 tariff schedules

At a first pass, significant tariff effects could be expected for all three countries' imports of processed products in HS1604 and HS 1605, plus Mexico's imports of products in HS 3. This is an approximation, as the U.S. and Canada have a few tariff peaks in HS 3 and a few duty-free items in HS 1604 and HS 1605, but it will give a fair idea as to orders of magnitude. For the purposes of the following discussion we will define "high-tariff NAFTA trade" as imports of processed fish products under HS1604 and HS1605 by Canada, Mexico, and the United States from their NAFTA partners, plus imports of fish and fish products under HS3 by Mexico from Canada and the United States.

Levels of Trade Penetration

Table 2 shows the ratio of total exports to output and total imports to supply for each of the three NAFTA countries, for the period of 1992-1995, which includes two pre-NAFTA and two post-NAFTA years.[13] As can be seen from Table 2, fish are a heavily traded commodity for Canada, with about two-thirds of output exchanged for about two-thirds of supply. The sharp increase of the traded share in 1995 is associated with a drop in production with relatively constant trade. Fish are significantly traded for the United States, with about 20-25 percent of output exchanged for about 40 percent of domestic supply. On the other hand, the Mexican fishing economy is relatively closed, with 5 - 20 percent of output exchanged for

[13]These data were the most recent available and provide symmetry between pre- and post-NAFTA time periods.

about 3 - 6 percent of domestic supply. The raw numbers (in live weight terms) underlying the share calculation show that Canada and Mexico are consistently net exporters, and the United States consistently a net importer, of fish and fishery products.[14]

[14]It is not obvious looking at share data alone that Canada is a significant net exporter of fish. This is because the denominator for the exports/production share is much larger than the denominator for the imports/supply share. The data are presented in share terms in order to facilitate the calculation of NAFTA trade shares relative to output.

Table 2
Export and import penetration for North America, 1992-1995.

Country	Year	Ratio of exports to production	Ratio of imports to supply[1]
		metric tons live weight	
Canada	1992	64.8	50.1
	1993	67.5	59.1
	1994	68.2	63.3
	1995	80.4	80.2
Mexico	1992	6.2	2.3
	1993	7.0	3.7
	1994	5.6	5.8
	1995	17.8	3.2
United States	1992	25.6	41.7
	1993	23.8	40.1
	1994	23.9	41.8
	1995	22.0	40.3

1. FAO "supply" equals production plus imports plus stock variations minus exports minus non-food uses. The share of production for non-food uses is about 9% (Canada), 15% (Mexico) and 17% (United States). Over the data period, stock variations are small.
SOURCE: Fish and Fishery Products, 1998, FAO Fisheries Circular No. 821 Revision 4, FAO - United Nations, Rome, Italy.

Table 3 shows the ratio of NAFTA trade to total trade for each of the three NAFTA countries for the first five years of NAFTA (1994-98).

Table 3
Ratio of NAFTA trade to total trade in fish, molluscs and other aquatic invertebrates (including in processed form), HS 3, HS 1604 and HS 1605.

Canada	1994	1995	1996	1997	1998	period average
	percent					
Export share to:						
Mexico	0.02	0	0.01	0.02	0.01	0.01
United States	57.01	52.22	55.03	62.52	67.38	58.83
High-tariff NAFTA trade[1]	5.75	5.82	6.79	8.24	9.26	7.17
Import share to:						
Mexico	0.33	0.50	0.57	0.43	0.37	0.44
United States	42.25	43.63	40.38	40.40	39.20	41.17
High-tariff NAFTA trade	11.12	10.75	8.69	7.54	7.65	9.15

Mexico	1994	1995	1996	1997	1998	period average
	percent					
Export share to:						
Canada	0.08	0.10	0.16	0.19	0.06	0.12

Mexico	1994	1995	1996	1997	1998	period average
United States	95.82	89.46	82.43	81.95	87.20	87.37
High-tariff NAFTA trade	21.65	19.42	20.35	19.26	16.06	19.35
Import share to:						
Canada	7.82	9.07	6.43	6.41	4.67	6.88
United States	42.16	45.36	49.89	42.34	37.69	43.49
High-tariff NAFTA trade	49.98	54.43	56.32	48.75	42.37	50.37

Table 3, continued...

United States	1994	1995	1996	1997	1998	period average
	percent					
Export share to:						
Canada	12.58	14.13	15.68	16.69	20.62	15.94
Mexico	1.65	0.67	0.77	1.28	2.01	1.28
High-tariff NAFTA trade	4.99	4.17	4.16	4.39	6.05	4.75

United States	1994	1995	1996	1997	1998	period average
Import share to:						
Canada	16.52	15.97	16.61	16.38	16.69	16.43
Mexico	5.20	6.43	6.56	6.21	5.75	6.03
High-tariff NAFTA trade	2.28	2.11	2.49	2.67	2.69	2.45

1. "High-tariff NAFTA" trade is defined as imports of HS 1604 and 1605 by all three NAFTA countries, plus imports of HS 3 by Mexico, from NAFTA partners.
SOURCE: UN COMTRADE data. Calculated from value data.

While the importance of NAFTA partners varies from country to country, it is apparent that the significance of non-NAFTA trade is substantial for NAFTA partners as a whole. About 42 percent of Canada's imports, 50 percent of Mexico's imports and 78 percent of U.S. imports during 1994-1998 were from non-NAFTA sources. This limits the effect of easing NAFTA import restraints on total fish and fish products trade of the NAFTA countries. Moreover, when only high-tariff NAFTA trade is considered (imports of HS 1604 and 1605 for all three countries, plus imports of HS 3 for Mexico), the share of trade with a likely NAFTA effect is reduced substantially. The possible downward bias in excluding tariff peaks in HS 3 for Canada and the United States from "high-tariff trade" is probably offset by the fact that the above calculation is in value terms, and high-tariff trade is concentrated in the processed products in HS 16. The average unit value (currency per metric ton) is higher for processed products than for the relatively less processed (mainly fresh, frozen, smoked or salted) products in Chapter 3. Correcting for this factor would give a significantly lower share of high-tariff NAFTA trade as a percentage of total trade.

The Magnitude of Possible NAFTA Effects

Our overall strategy is to determine whether high-tariff NAFTA trade is large or small relative to

levels of fish production, and to use this calculation as a starting point for assessing the effects of NAFTA on sustainability. Using tables 2 and 3 together, the share of high-tariff NAFTA trade relative to total production or supply can be calculated as follows:

$$\text{High-tariff NAFTA exports/production} = \frac{\text{High-tariff NAFTA exports}}{\text{total exports}} \times \frac{\text{exports}}{\text{production}}$$

and,

$$\text{High-tariff NAFTA imports/supply} = \frac{\text{High-tariff NAFTA imports}}{\text{total imports}} \times \frac{\text{imports}}{\text{supply}}$$

It should be noted here that the first term in each equation is taken from HS-based trade data and are in product weight, while the second term in each equation is taken from FAO data and is in live weight equivalent. In general, live weight equivalent exceeds product weight for most products (e.g. it takes a large volume of live fish to produce a smaller volume of fillets, etc).[15] The second term is calculated as a ratio of live weight to live weight, so is not affected by this problem. In the first term, since chapter 3 has whole or "round" fish while chapter 16 doesn't, and since high-tariff NAFTA trade is disproportionately in chapter 16, using the first term as calculated adds an additional upward bias to the share of high-tariff trade expressed entirely in live-weight terms.

Using period averages over 1992-95 for exports/production and imports/supply, and period averages over 1994-98[16] for the ratio of high-tariff NAFTA trade to total trade yields the following:

---

[15]An exception to this is the addition of oils, sauces, etc. to product weight for products in HS 16. Cans or other packing materials are not counted in product weight.

[16]The use of the earlier years for the exports/production and imports/supply ratio is justified on the grounds not only that it is the most recent data that we had available, but that it is worthwhile to smooth out the annual fluctuations in supply which are significant for this industry. On a closer look, the 1995 increase in the two Canadian trade ratios and the Mexican export ratio looks like an artifact of production fluctuations rather than a NAFTA effect.

Table 4
High-tariff NAFTA trade as a percentage of production and supply

Country	High-tariff NAFTA exports / production	High-tariff NAFTA imports / supply
	percent	
Canada	5.1	6.9
Mexico	1.8	1.9
United States	1.1	0.1

These ratios are probably biased upward, because for the high-tariff processed fish products in HS 1604-1605 the unit values are higher, and the ratio of product weight to live weight is lower, than in HS 3. Based on these data, any effects of NAFTA tariff changes on the condition of fisheries, either positive or negative, are more likely to be experienced in Canada than in the United States or Mexico.

Introducing Trade Policies

It remains to determine the impact of removing intra-NAFTA tariffs of about 6 percent on Canadian and U.S. imports in HS 1604-05 and of about 20 percent on Mexican imports of both fish and fisheries products. We focus on the long-run impact of complete tariff removal and ignore issues of year-by-year phase-in of the NAFTA commitments. The most computationally simple way to do this is to assume that imports are supplied perfectly elastically by each NAFTA exporter, so that the percentage change in imports is equal to the tariff cut multiplied by an elasticity. This procedure also has the advantage that it yields an upper-

bound estimate of the largest possible change in trade attributable to the tariff cut.[17]

[17]If fish are difficult to catch, for example, due to scarcity from over-fishing, and if exports to NAFTA markets are a significant share of production, the assumption of perfectly elastic import supply is unrealistic. Increased export demand which leads to markedly greater fishing effort causes prices to rise, so that the increase in imports is smaller. Indeed, in overfished fisheries one can get the case of a backward-bending supply curve, so that greater fishing effort leads to smaller catch, but at higher prices (See e.g. Scott Gordon (1954), "Economic Theory of a Common Property Resource - the Fishery," *Journal of Political Economy* vol. 62 (April), pp. 124-142). In some extreme cases, backward-bending fish supply can lead to smaller trade as a result of lower tariffs. The assumptions used here lead to the largest possible hypothetical trade and production increases as a result of tariff reduction.

Trade-weighting each of the relevant trade flows by country and chapter gives a relevant high-tariff NAFTA trade of about 10 percent for U.S. exports, about 20 percent for Mexican imports, and about 6 percent for the other flows. It thus remains to choose an elasticity. Long-run estimates of the price elasticity of import demand, either in aggregate or for individual commodities, generally cluster in the range of -0.5 to -2.0, meaning that a 1 percent drop in the import price (arising, under our assumptions, from a 1 percent tariff cut) gives rise to a 0.5 to 2 percent increase in imports.[18] Estimates specific to imports of agricultural commodities and foodstuffs in the NAFTA countries are also in this range, though some estimates of the import elasticity of demand for Mexican consumer goods exceed -3.[19] To further impose a "precautionary principle" on our estimates, we choose an import elasticity of demand of -4, and assume further (and unrealistically) that all increased exports to NAFTA countries must be met by increased production and further depletion of the fishery, rather than simply diverted from domestic or non-NAFTA markets. This will again give an upper-bound of NAFTA effects. This yields the following final "upper-bound" effect of NAFTA tariff cuts relative to domestic production and supply (Table 5):

Table 5
NAFTA-induced changes in fish and fishery products trade, as a percentage of production and supply

Country	Increased exports / production	Increased imports / supply
	percent	
Canada	1.2	1.7

[18]Morris Goldstein and Mohsin S. Khan (1985), "Income and Price Effects in Foreign Trade," ch. 20 in R.W. Jones and P.B. Kenen, *Handbook of International Economics Vol. II* (Amsterdam: Elsevier Science Publishers), pp. 1042-1105.

[19]W. Charles Sawyer and Richard L. Sprinkle (1999), *The Demand for Imports and Exports in the World Economy*. Aldershot, England: Ashgate Publishing Co., pp.15-116 ff.

Country	Increased exports / production	Increased imports / supply
Mexico	0.4	1.5
United States	0.4	0.02

After all attempts to obtain large NAFTA effects, the final results approach negligible. Moreover, in the case of Mexico (for which the ratio of production to supply is about 4:3), the significant trade liberalizations imposed by NAFTA may have relieved pressure on fisheries in the aggregate by permitting substitution of imported fish for the domestic catch. In the case of Canada and the United States, the fact that most of the trade is at low stages of processing (and thus, at low tariffs) and fairly little is with Mexico, determines the result.

ADDITIONAL DATA ISSUES

Having established the *de minimis* effect of NAFTA on North American fisheries as a whole, we now turn to the effect on particular stocks of fish. It could be that a large part of the catch of a particular type of fish in a particular location (e.g. cod in the Canadian North Atlantic) is exported to a NAFTA market which is protected with a significant tariff specific to that product. If that particular stock is over-fished, then there may be a localized NAFTA effect of concern. Moreover, even in the absence of NAFTA effects *per se*, increases and decreases in export demand more generally may link the condition of North American fisheries to macroeconomic conditions outside the NAFTA region, and the health of fisheries in one part of the world may affect that in other parts via effects transmitted through international trade.

Since both NAFTA effects and non-NAFTA trade effects may differ for different fish stocks, it is worthwhile to examine data at the level of individual varieties of fish in individual locations. This necessitates matching of data on protection levels, trade, production, and sustainability, which arise from different sources

and use different definitions. Data from various sources must be aligned with one another by means of concordances. Such concordances, which are a staple of applied work in international trade, are invariably imperfect. Concordance problems are particularly severe in trade-environment research since data on environmental indicators are frequently collected for a different audience, and use different categories, than data on economic indicators. At the present stage of our research, we find that data-matching problems severely limit the ability to make statements about the relationship between particular fish stocks and international trade. Different methods and data may potentially alleviate some of these problems.

International trade and tariff data are collected in most countries according to the Harmonized System. This system provides for a certain amount of international comparability, down to the six-digit HS tariff line. All countries using the 1996 revision of the HS will distinguish fresh or chilled trout (0302.11) from fresh or chilled salmon (0302.12). However, finer categories in the Harmonized Tariff Schedule of the United States (HTS), such as 10-digit classifications, may be defined differently by different countries. For example, farmed Atlantic salmon (0302.12.00.03), pink (humpie) salmon (0302.12.00.32) and sockeye (red) salmon (0302.12.00.42) in the U.S. HTS may differ from classifications in the Canadian 10-digit tariff lines. Similarly, smelts (0302.69.20.10), cusk (0302.69.20.21), pollock (0302.69.20.23) and pike (0302.69.20.52) are defined at levels which are not internationally comparable, but which may be distinct in production or sustainability data. Moreover, a significant volume of products at a higher degree of processing which appear in the trade data (e.g. fish sticks) cannot be assigned to any species. In the absence of specific information on industry practices, these products cannot be readily correlated with production or sustainability data at all.

We obtained North American production data from the United Nations FAO's online database and U.S. sustainability data from the U.S. Department of Commerce NOAA publication *Our Living Oceans* as described above. Concording these data with trade data presents further problems. The most widely available trade data aggregate imports and exports for the whole nation, while production and sustainability data are generally for specific waters. Moreover, the definition of regions varies from source to source. For

example, NOAA's "Pacific Coast" fisheries are divided by FAO into "Northeast Pacific" (which also includes NOAA's "Alaska" fisheries), and "Eastern Central Pacific" (which also includes part of NOAA's "Western Pacific" -Hawaii and small U.S. islands), the rest of which matches FAO's "Western Central Pacific."

We adopted the strategy of grouping fish and marine invertebrates into twenty broad categories, relying primarily on FAO groupings. Matching the production and sustainability data is relatively straightforward. However, we had little in the way of stock measures for freshwater fish. Also, as will be seen below, many of the fish stocks which have been identified by NOAA as declining do not concord well with FAO production data.[20]

PRELIMINARY TABULATIONS ON SPECIFIC FISH STOCKS

As stated above, we proceeded by gathering the available data on trade, production and sustainability into 22 broad categories of fisheries, described in the Appendix. These include one broad catchall category for unconcorded fish (No. 22) and two small categories consisting mostly of freshwater and nearshore fish (No. 8 and 9), which fall outside of the scope of our source of sustainability data which is primarily ocean-specific. The latter is not a severe limitation since the large bulk of fisheries production and trade consists of marine fish. We do only partial analysis of the nineteen remaining categories.

[20]This problem could be partially alleviated in future research by using U.S. production as well as sustainability data. Our original choice to assemble FAO data was driven by a desire to produce comparable indicators for the entire NAFTA region; but this is undermined by the apparent lack of comparable NAFTA-wide sustainability data.

Tables 6 and 7 categorize different types of fish according to two different measures of sustainability; long-term potential yield (LTPY) and the utilization rate. LTPY is defined as the maximum long-term average catch that can be achieved from a fisheries stock, and is analogous to the concept of maximum sustainable yield (MSY) in fisheries science.[21] The degree of utilization describes the current level of fishing effort compared with the appropriate levels necessary to achieve LTPY.[22]
Broadly, stock levels below LTPY and utilization rates labeled "over" indicate unsustainable use of the resource, while stock levels above LTPY and underutilized stocks indicate resources which could be exploited more intensively without affecting sustainable output. The utilization rate fluctuates more from year to year than does LTPY and can be affected, e.g., by a single year's new fishing restrictions.

An analysis of the FAO sustainability data indicates that a large number of stocks of environmental concern (22 of the 73 below LTPY, and 13 of the 54 over-utilized stocks) could not be readily concorded with trade or production data. There are no trade data at all for most of these fish species, many of which are reef fish in the Gulf of Mexico and Caribbean. Moreover, the limitations of comparing national trade data with ocean-specific production or sustainability data are revealed.

[21] *Our Living Oceans*, p. 5.

[22] *Our Living Oceans*, p. 14.

Table 6
Number of North American fisheries within each stock level relative to long-term potential yield (LTPY) for the 22 data concordance categories.

Category	Below LTPY	Near LTPY	Above LTPY	Unknown
shad and sturgeon	4	1	0	0
flatfish	7	8	4	4
cod, hake, haddock, cusk, pollock	9	4	1	1
herrings, sardines, anchovies	0	5	1	1
tunas	3	7	2	2
mackerel	1	0	2	4
sharks, rays, chimeras	2	4	1	0
tilapia and other chiclids	4	4	3	1
eels	3	1	2	2
salmon, trout, smelts	4	5	1	5
lobster and rock lobster	1	0	2	2
shrimps and prawns	3	8	0	6
abalones and conches	2	1	0	0
oysters	1	2	0	1
mussels	0	1	0	0
scallops	2	1	0	1

Category	Below LTPY	Near LTPY	Above LTPY	Unknown
clams	1	6	0	3
squid, cuttlefish, octopus	0	4	0	3
sea urchins and other echinoderms	1	2	0	2
other	38	20	5	33

SOURCE: Our Living Oceans, 1999, NOAA - Department of Commerce.

Table 7
Number of North American fisheries within each utilization level for the 22 data concordance categories.

Category	Under	Full	Over	Unknown
shad and sturgeon	0	2	3	0
flatfish	9	7	6	2
cod, hake, haddock, cusk, pollock	1	8	5	0
herrings, sardines, anchovies	2	4	0	1
tunas	4	3	3	4
mackerel	3	3	1	0
sharks, rays, chimeras	1	2	2	4
tilapia and other chiclids	0	9	3	1
eels	0	4	2	2
salmon, trout, smelts	1	10	0	4
lobster and rock lobster	0	1	2	1
shrimps and prawns	0	10	0	7
abalones and conches	0	1	2	0
oysters	0	2	1	1
mussels	0	0	0	1
scallops	0	1	2	1

Category	Under	Full	Over	Unknown
clams	2	5	1	2
squid, cuttlefish, octopus	0	3	1	3
sea urchins and other echinoderms	0	2	1	2
other	13	27	26	39

SOURCE: Our Living Oceans, 1999, NOAA - Department of Commerce.

Generally, stock levels and degrees of utilization vary widely from fishery to fishery.[23] Many varieties which are depleted in the North Atlantic or the lower-48 Pacific are abundant or underutilized in the Alaskan Pacific (which accounts for approximately half of the U.S. catch) or in the Western Pacific.

Appendix tables 2a through 2c provide preliminary calculations of the ratio of exports to output and imports to apparent consumption[24] for the various fish categories defined in Appendix 1. These are given for U.S. trade with the world, Canada, and Mexico relative to U.S. production. The degree of exposure of fish stocks to both NAFTA and non-NAFTA trade varies widely by type of fish. A significant problem with the data here is that because production and trade come from different sources, it is possible for exports to exceed output, giving an export/output ratio of over 100 percent and usually, an imports/apparent consumption ratio which is negative. For a significant number of the fish stocks, the calculation gives nonsensical results. This result is all the more surprising considering the fact that the FAO data is in live-weight terms while the U.S. trade data is in production-weight terms, which ought to bias the export/output ratio downward. Based on these results, it is difficult to conclude, for example, that more intensive exploitation of a category of fisheries (classified by fish type) for export is more or less associated with sustainability.

POTENTIAL EXTENSIONS

The fact that North American fisheries trade is primarily extra-NAFTA rather than intra-NAFTA suggests that there are important linkages between the international economy and fisheries sustainability which

[23] *Our Living Oceans*, p. 11, table 3.

[24] Defined as production plus imports minus exports, apparent consumption is close to (but not identical with) "supply" as it appears in the FAO data.

may well be larger than those arising from the NAFTA agreement itself. The largest part of NAFTA exports are to Japan and other Asian economies. A sustained appreciation in the yen, or a decline in the productivity of Asian Western Pacific fisheries which raises Asian prices, could feed back into overfishing of North American fisheries via increased exports. Similar linkages likely exist with Europe and Latin America, and are probably more interesting than NAFTA effects *per se.*

Some of the problems in this preliminary work could be resolved with different data. Many types of fish which are not isolated in the FAO data appear in NOAA's own production data,[25] though this would not resolve the absence of many types of fish of environmental concern from the trade data. Improved internationally comparable sustainability data would help.[26] Another promising line of inquiry involves using U.S. export data by port to match trade data with locations of specific fisheries.

---

[25]*NOAA, Fisheries of the United States 1998* (July 1999). Washington, DC: Commerce Department.

[26]FAO (1997), *Review of the State of World Fisheries Resources: Marine Fisheries* (downloadable at http://www.fao.org/fi/publ/circular/c920/c920-1.asp, provides a convenient overview of sustainability indicators for broad fish categories for all the world's oceans. These are not country-specific, however, preventing concordance with trade data.

APPENDIX

Appendix Table 1
The 22 data categories defined for the concordance of trade and production data used in this study.

No.	Species included in the data category
1	shad and sturgeon
2	flatfish (flounders, soles, etc.)
3	cod, hake, haddock, cusk, and pollock
4	herrings, sardines, anchovies
5	tunas, skipjack, bonito
6	mackerel
7	sharks, rays, chimeras
8	tilapia and other cichlids
9	eels
10	salmon, trout, and smelts
11	ocean perch, bass, other redfish
12	crabs and sea-spiders
13	lobster and rock lobster
14	shrimps and prawns
15	abalones and conches

No.	Species included in the data category
16	oysters
17	mussels
18	scallops
19	clams
20	squid, cuttlefish, octopus
21	sea urchins and other echinoderms
22	other

Appendix Table 2a
U.S trade penetration ratios with the world, 1994-1996.

Data categories	exports / output			imports / apparent consumption		
	1994	1995	1996	1994	1995	1996
	percent					
shad and sturgeon	0	0	0	5	6	4
flatfish	71	77	63	37	48	30
cod, hake, haddock, cusk, pollock	6	26	22	9	12	13
herrings, sardines, anchovies	5	8	7	3	4	4
tunas	18	21	24	57	61	64
mackerel	104	213	218	102	584	-422
sharks, rays, chimeras	63	89	63	18	45	15
tilapia and other cichlids	2	1	2	68	62	73
eels	1556	4837	2786	-7	-5	-6
salmon, trout, and smelts	116	105	115	-454	160	501
ocean perch, bass, other redfish	0	1	1	9	8	6
crabs and sea-spiders	179	134	98	-11	-40	86
lobster and rock lobster	403	510	522	-44	-31	-26
shrimps and prawns	56	58	46	83	82	77
abalones and conches	24	49	35	23	31	20
oysters	4	4	3	4	3	3
mussels	17	17	21	36	38	50
scallops	20	20	21	33	30	35
clams	1	1	1	2	2	3
squid, cuttlefish, octopus	64	68	70	49	50	52
sea urchins and other echinoderms	43	45	55	13	20	30

Appendix Table 2b
U.S trade penetration ratios with Canada, 1994-1996.

Data categories	exports / output			imports / apparent consumption		
	1994	1995	1996	1994	1995	1996
	percent					
shad and sturgeon	0	0	0	5	4	3
flatfish	2	2	2	10	9	7
cod, hake, haddock, cusk, pollock	0	1	1	2	2	3
herrings, sardines, anchovies	1	1	2	2	2	2
tunas	1	1	3	2	2	2
mackerel	7	11	12	29	122	-86
sharks, rays, chimeras	2	3	2	8	27	10
tilapia and other cichlids	1	0	0	0	0	0
eels	7	24	15	-2	-1	-3
salmon, trout, and smelts	5	6	9	-300	92	240
ocean perch, bass, other redfish	0	0	0	7	5	4
crabs and sea-spiders	1	2	2	-7	-16	37
lobster and rock lobster	22	25	27	-29	-19	-16
shrimps and prawns	5	5	5	1	2	3
abalones and conches	0	0	0	0	0	0
oysters	0	0	0	0	0	1
mussels	6	5	4	10	15	18
scallops	1	1	1	11	9	8
clams	0	0	0	1	1	1
squid, cuttlefish, octopus	4	6	4	0	0	2
sea urchins and other echinoderms	3	3	3	10	17	26

Appendix Table 2c
U.S trade penetration ratios with Mexico, 1994-1996.

Data categories	exports / output			imports / apparent consumption		
	1994	1995	1996	1994	1995	1996
	percent					
shad and sturgeon	0	0	0	0	0	0
flatfish	0	0	0	0	0	0
cod, hake, haddock, cusk, pollock	0	0	0	0	0	0
herrings, sardines, anchovies	0	0	0	0	0	1
tunas	1	1	0	0	1	1
mackerel	1	1	0	1	14	-33
sharks, rays, chimeras	1	0	0	4	5	2
tilapia and other cichlids	0	0	0	0	0	0
eels	13	13	2	0	0	0
salmon, trout, and smelts	0	0	0	0	0	1
ocean perch, bass, other redfish	0	0	0	0	0	0
crabs and sea-spiders	0	0	0	0	-1	5
lobster and rock lobster	0	0	0	-1	-1	-1
shrimps and prawns	3	1	1	7	10	9
abalones and conches	2	0	1	2	2	1
oysters	0	0	0	0	0	0
mussels	0	0	1	0	0	0
scallops	0	0	0	0	0	2
clams	2	0	0	0	0	0
squid, cuttlefish, octopus	2	0	1	1	3	2
sea urchins and other echinoderms	0	0	0	1	1	1