Sustainable Trade Expansion in Latin America and the Caribbean: Analysis and Assessment

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The Authors

PREFACE

The debate over trade and its environmental impacts has often been characterized more by heat than light: Despite numerous discussions, our basic understanding of the issues is still limited. Empirical analysis is a particularly scarce commodity in this field. Yet much is at stake.

In *Sustainable Trade Expansion in Latin America and the Caribbean: Analysis and Assessment*, C. Ford Runge and his co-authors review the critical trade and environment issues for the Latin American region to provide a much needed empirical and policy assessment. The report begins by discussing recent changes in trade policy and focuses on the sectoral impacts from these changes, their likely environmental consequences, and finally, opportunities to promote more sustainable trade strategies.

This report and its companion data tables provide for the first time a set of indicators to evaluate the impacts of trade on the environment in the region. These estimates cover 14 pollution categories, over 8 exporting sectors for 16 countries. This analysis draws attention to the sectors with the largest environmental impacts, notably basic metals, industrial chemicals and non-metal products. Although these sectors are likely to produce environ-mental "hot spots," they are not the sectors that will be most stimulated by trade liberalization. Instead, greater growth will take place among industries with a smaller environmental footprint, including textiles, metal products, and food products.

The assessment also shows that the environmental effects of trade vary greatly in degree and by location. The overall impact of trade on the environment is one that is not easy to discern, as it depends on a variety of factors, including the efficiency with which resources are allocated, the scale of production, the composition of outputs, technology, and, last but far from least, policy. Ultimately, the political will to impose regulatory and liability discipline on environmental problems will determine whether trade liberalization enhances welfare. At the same time, trade policies should be constructed to minimize environmental problems.

Runge and his colleagues return repeatedly to the theme that increased market access in the developed countries of the region should be coupled to commitments to improve environmental performance in the developing countries. The authors believe that trade can be harnessed to further technological and institutional progress in ways that are complementary to trade expansion and sustainable economic development.

Trade liberalization throughout Latin America will continue for some time. While expansion of production can increase the scale of environmental problems, the economic growth that trade spurs also provides the will and the resources to reduce waste and pollution. But the net gains from trade expansion could be significantly increased if the region links growth through trade to sustained efforts to remediate environmental problems. This report shows ways to accomplish this linkage.

Walter Reid
Vice President for Program
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1. INTRODUCTION

This study considers the environmental impacts of trade liberalization in the Latin American and Caribbean region (LAC) in terms of four key questions:

- What are the most important changes in recent trade policy, and how are they reflected in the development of regional and subregional trading arrangements as well as national policies?
- As trade patterns change, what will be the sectoral impacts on the composition and rate of consumption and production of various resources?
- What are some of the likely *environmental* consequences of these shifts, and where will they pose the greatest challenges for sustainable patterns of economic development?
- Within these changing trade patterns, what opportunities do governments, non-governmental organizations (NGOs), the private sector, and the international donor community have to steer both institutional and technological innovations and policy toward greater environmental sustainability? Specifically, how can innovations in regulatory frameworks and public policies improve institutional protection of the environment, mitigate pollution in key industries affected by trade policies, address health issues arising from environmental hazards in expanding sectors, and sustain productivity in natural-resource-based sectors?

Responses to these questions are necessarily qualified by the uncertainty surrounding both economic and environmental indicators and the fact that many changes have occurred only recently. Even so, relatively clear policy principles, conclusions, and recommendations can govern the development of more sustainable trade strategies.

Our study focuses on how trade expansion can facilitate and complement environmental sustainability in the Latin American and Caribbean region (LAC). It is based on two key observations. First, trade both within the region and with the rest of the world is expanding rapidly, generating increases in incomes per capita. Second, this trade-led growth will create both challenges and opportunities for environmental quality and natural resource conservation. Challenges will arise from the rate and the manner of resource extraction in sectors including agriculture, forestry, fisheries, and in industries including mining, petroleum, and food processing. But opportunities also exist to respond to environmental challenges in these sectors, enhanced by the income that trade creates. In addition, the removal of trade-distorting policies may in itself have some environmental benefits. Fundamentally, both trade and the environment will benefit from the elimination of both market and nonmarket (government) distortions.

An overarching theme is that increased market access can be coupled to commitments to raise the level of environmental initiatives, generating competitive incentives toward "greening" and upward harmonization of environmental standards. In particular, we will focus on how trade can be harnessed to further both technological and institutional innovations that can raise environmental performance in LAC countries. For example, the development of water-conserving or erosion-reducing cropping technologies in agriculture, petroleum, or biological wastewater treatment system refining that captures and reuses polluting byproducts would all help prevent pollution at its source. On the institutional side, innovation such as regeneration of tropical timber through the certification of exports is a possible example. The critical issue is how to relate these innovation processes to the expansion of trade in complementary, not conflicting, ways.

To analyze this complex set of issues in the LAC as a whole, we will identify recent and expected changes in regional, hemispheric, and national trade and macroeconomic policies. The first task is to sketch these changes (including regional trade agreements such as Mercosur and NAFTA), and the likely impacts of national governments' implementing structural adjustment measures. These trade-expanding policies will have important but differentiated effects on the sectors of primary interest.

The second task is to focus on the sectors and geographic areas where trade expansion is most likely to pose environmental challenges and opportunities or where environmental standards could have important trade impacts. Gaining a sense of the nature and magnitude of these issues will allow priorities to be set among alternative problems and particular geographic areas to be targeted with some accuracy. We will develop, for the first time, detailed estimates of likely pollution from numerous LAC sectors, by country, using two-digit industrial and trade data.

The third task will be to identify the most important points of leverage for development assistance agencies so that government, NGO, private sector, and other efforts can augment or assist in promoting complementarity between trade and environmental goals. This will include both the mitigation of environmental costs and the promotion of environmental benefits as well as the improvement of environmental and trade policies so as to target workshops, the development of data bases, research, monitoring, and evaluation.

Our methodology is consistent with that developed by the Organisation for Economic Co-operation and Development (OECD 1994) for environmental review of trade agreements and trade reviews of environmental agreements. It builds upon earlier efforts (for example, Winograd et al. 1993) to utilize the OECD pressure-state-response approach to estimate land use impacts in the LAC by extending this analysis into the trade realm. This methodology is designed to inform policy makers in advance about some of the likely consequences of different trade policies in order to promote trade-environment integration. Such a review can also aid in the elaboration of options for addressing environmental concerns either through provisions of trade policy or through complementary environmental mechanisms.

2. ANALYTICAL AND EMPIRICAL APPROACH

In the 1980s and 1990s international attention to deforestation, contamination of water resources, and climate change demonstrated growing recognition of the global impact of economic development and the rising problem of international environmental hazards that spill over national borders and affect the oceans, air, and climate.

This recognition suggests the new realities of environmental and health regulation and their links to trade. When nations exchange goods and services, they also trade environmental and health risks. These risks are the opposite of services—they are environmental *bads* and health *disservices* traded across national borders. This trade in bads and disservices is an emerging source of tension in trade negotiations and was explicitly reflected in the environmental side-agreement to the North American Free Trade Agreement (NAFTA). As Latin American and Caribbean nations experiment with further regional trade expansion, environmental issues are likely to become more prominent. What lines of causality can be traced through such complexity? Two may be discerned. First are the environmental impacts of regional and hemispheric trade expansion. Second are the potential effects of environmental standards on trade and the need to coordinate and harmonize the development of such standards so as to maximize market access opportunities for LAC exporters.

2.1 The Environmental Impacts of Trade

Opposition to trade liberalization has focused on the negative impacts of trade on environmental quality—but based on limited evidence. Actually, the impacts of trade on the environment vary greatly in degree and by location, as we shall show. In agriculture, for example, there is evidence that reducing subsidies and trade distortions helps to reduce environmental damages by lowering fertilizer and pesticide use and increasing the efficiency with which soil and water resources are used (Runge 1987; Harold and Runge 1993; Faeth 1995; Johnstone 1996). In the industrial border region of Mexico,[1] by contrast, limited investment in wastewater treatment and hazardous waste disposal has created serious environmental damages resulting from foreign investments. Yet as trade growth raises incomes, demands for a cleaner environment also tend to rise, and new regulatory constraints induce more environmentally benign technological innovations (Runge 1987; Grossman and Krueger 1995).

Five separate impacts of trade growth on the environment may be distinguished: on allocative efficiency; on scale; on the composition of output; on technology; on policy. The overall effect of trade on the environment is the sum of these separate impacts, which may be positive or negative, depending on the case examined.

Allocative efficiency results when countries specialize in producing the things they make best and buy other products from other nations instead of trying to make everything they need themselves. This results in the efficient allocation of resources globally and fosters environmental protection. According to this theory of *comparative advantage*, in the production of goods and services, abundant resources will be used more than scarce resources, which will be conserved, inducing less wasteful patterns of production. This view is countered by *dependency theorists*, who argue that comparative advantage leads countries that depend on commodity exports to become satellites of large economies such as the United States. These theorists have tended to favor policies of domestic protection, in which home production is substituted for foreign imports.[2] In the last decade, most of

[1]This area is often referred to as the "maquiladora sector." A *maquiladora* is a foreign-owned plant in Mexico subject to duty-free import of raw materials. Its finished products are exported duty free except for value added in Mexico. *See* Malissa H. McKeith, "The Environment and Free Trade: Meeting Halfway at the Mexican Border." *Pacific Basin Law Journal* 10 (1): 183–211 (1991).

[2]See for example, early work by the current President of Brazil (Cardoso and Faletto 1975).

the LAC region has abandoned import substitution in favor of export-oriented and liberal trade policies. More open trade in the LAC region, it is generally agreed, has led to higher levels of economic growth than inward-looking policies, which wasted scarce resources in the pursuit of self-sufficiency. The best empirical evidence of the wastefulness arising from closed economies comes from Eastern Europe and the former Soviet Union, where self-sufficiency often justified widespread environmental destruction (Boyd 1993). Less dramatic, but substantial, environmental damage has resulted from the European Union's drive for self-sufficiency in agriculture (Hartmann and Matthews 1995).

Granting the allocative efficiency of trade relative to no trade, there is still little question that the *scale* of economic activity in a hemisphere with no trade would probably be much smaller and, in this sense, would impose less wear and tear on the environment. As trade growth increases gross domestic product (GDP) per capita, does the scale of economic activity damage the environment in the same or similar proportions? Overall, evidence points to a nonlinear relation between the scale of economic activity and the level of environmental damages, suggesting that other forces influence how growth in trade affects levels of environmental quality (Grossman and Krueger 1991; Lucas 1996). These other forces include the composition of output, technology, and policy decisions.

The *composition of output* can cause environmental trade impacts when increases in GDP lead to shifts in sectoral production with high or low levels of pollution. This change in the sectoral composition of output can offset or aggravate some of the scale effects of economic growth through trade. The relative growth of low or high pollution-intensity sectors can thus increase or decrease per capita levels of pollutants.

Technological innovations may also affect the environment through trade. As increased value is given to environmental quality, markets for pollution prevention technologies may develop and grow. These environmental technologies (such as wastewater treatment or materials recycling) may also be accompanied by changes in traditional technologies (such as shifts toward more-energy-efficient and less-polluting steel production) which lower the overall level of residuals and hazards from manufacturing processes.

All of these environmental effects of trade operate in the context of *government policies*, including regulations that define and change "rights to pollute," or not to pollute. Indeed, without these changes in property rights, many of the incentives to alter the character and methods of production so as to reduce waste and pollution would be far weaker. While trade may encourage greater allocative efficiency, the negative scale effects of economic growth on the environment are offset by composition and technology only to the extent that the framework of regulation and liability encourages them. It is the political will to impose such discipline on environmental externalities that ensures that trade liberalization ultimately enhances welfare (Anderson 1992).

The sum of these effects of trade on the environment may be positive or negative, depending on the sector or pollutant involved (Muñoz 1997). Schematically, we can think of trade as inducing allocative efficiency, which in turn leads to economic growth and increased GDP per capita, with attendant negative scale effects. These scale effects may lead to increases in demands for environmental protection and policies to accomplish this protection, helping to induce changes in output composition and production technologies, which in turn diminish negative externalities. (*See Figure 1*.) However, government failures to develop and enforce regulations, property rights, and liability law often break this chain of events. Where demands for environmental protection are not expressed or heard, as in many LAC countries, changes in policy helping to induce changes in composition and technology may not occur.

Figure 1
Trade Impacts on the Environment

Trade ➪ Allocative Efficiency (+)
➪ Growth in GDP/Capita
➪ Scale Effects (–) ➪ Demand for Environmental Protection
➪ Change in Policy ➪ Change in Composition (+)
➪ Change in Technology (+).

KEY
+ Positive environmental impact
− Negative environmental impact

This was the situation in Mexico until recently. However, one of the most interesting and potentially beneficial consequences of NAFTA has been to help induce institutional changes in Mexico and under the North American Agreement on Environmental Cooperation (Johnson and Beaulieu 1996). These changes will help to develop more stringent environmental protection and enforcement in Mexico as well as in the United States and Canada. This process opens an important new chapter in the evolution of institutional responses to the interaction of trade and environment (Runge et al. 1994; Vogel 1995).

2.2 Environmental Measures and Trade Burdens

A second line of causality in the trade-environment nexus is the impact of domestic environmental regulations on trade and their role as disguised forms of trade protection. In much of the LAC region, such regulations are absent or unenforced and thus pose relatively few issues. However, as new regulations are developed and enforced, it will be important that they do not impose unnecessary burdens—in the name of domestic (and sometimes global) environmental protection—on individuals or firms seeking to export or import goods or services. The question is whether the environmental measure is justified primarily as a form of necessary environmental protection, or whether it is a disguised restriction on trade, in which harmful trade effects loom larger than beneficial environmental effects (Hudec and Farber 1992; Runge et al. 1994). As the LAC region formulates environmental policies, maximal coordination will assure that benefits are not outweighed by costs in the form of reduced trade. The LAC can capitalize on the current absence of regulations by adopting harmonized approaches with other LAC countries. In addition, as exporters, LAC countries may face important challenges in gaining access to U.S. markets, creating additional incentives to adopt "green" standards, certification, and other upscale approaches to regulation as a form of strategic trade policy.

2.3 Empirical Basis of Study

Four main perspectives constitute the empirical basis of this study. Each represents a somewhat different “cut.” The first is *sectoral*: the impacts of trade expansion from the point of view of specific sectors. Where information is deemed reliable, we have attempted to determine how environmental impacts and sectoral trade activity are most likely to interact in the future and what priorities can be granted to one sector versus another, given our level of knowledge.

The second cut at the trade-environment nexus in the LAC region is *differences in geography*. Countries such as Brazil or Chile, for example, face very different challenges from small, much poorer countries such as Guatemala or Honduras. Regional trade and environment interactions are also likely to differ by region: for example, the Caribbean Basin will respond in the context of the Caribbean Basin Initiative (CBI), Central America through the Central American Common Market (CACM), while the NAFTA or Mercosur countries respond in relation to their own regional trade agreements. It is therefore important, insofar as possible, to differentiate the countries that appear in the forefront of thinking through trade-environment interactions and to see how regional agreements can serve as leverage points to make such interactions more complementary.

A third cut at these questions involves several *overarching issues* that are likely to apply to multiple sectors and geographic areas simultaneously and to confer trade advantages on strategic innovators. These include the issue of upward harmonization, exemplified by the experience of Hazard Analysis and Critical Control Points (HACCP) and the International Standards Organization (ISO). Another issue involves the development of a no-regrets approach to environmental policymaking, in which innovations are undertaken that are likely to advance sustainability as an underpinning for rapid trade expansion. A third issue emphasized is defining and assigning property rights in ways that promote sustainability objectives.

A final cut involves questions of *regulatory structure and design*, in which appropriate policy measures must be matched with trade and environmental policy targets. These relate to the private sector, national governments and their regulatory policies, as well as to research strategies and public health initiatives. In the technology transfer area, promoting pollution-prevention technology and more sustainable production methods through certification and ecolabeling will also be considered.

In conclusion, the analytical and empirical approach used in this study will consider the environmental impacts of regional trade expansion and the potential for more effective regional environmental regulation, by examining the LAC region sector-by-sector, considering different geographic areas, overarching issues of strategic trade, and regulatory structure and design.

3. ANALYSIS

3.1 Recent Trade Policy Changes in Latin American Countries

In March 1996, trade ministers of 34 Western Hemispheric nations met in Cartagena, Colombia, to chart a course toward a Free Trade Area of the Americas (FTAA) by 2005. The meeting was an attempt at joint reconciliation in the wake of the near panic created by the Mexican peso devaluation of December 1994. Despite the devaluation, foreign direct investment in Latin America grew to new records in 1995 and 1996, and a wave of bilateral and multilateral free trade agreements were signed. Such a hemispheric free trade area would be the world's largest trading bloc, encompassing a combined GDP of more than $7.7 trillion and a market of more than 745 million people (Bamrud 1996, 2A).

Underlying the efforts to forge such agreements in Cartagena were institutional commitments by the Inter-American Development Bank (IDB), the Organization of American States (OAS), and the U.N. Economic Commission for Latin America and the Caribbean (ECLAC). These developments came as momentum for trade liberalization shifted from North America to Latin America and the Caribbean, reflecting U.S. failure in 1995 to approve "fast track" negotiating authority to carry NAFTA forward to include Chile. The chances for an FTAA also were improved by the successful conclusion of both NAFTA and the General Agreement on Tariffs and Trade (GATT) Uruguay Round negotiations in 1993 and the subsequent establishment of the World Trade Organization (WTO), to which all potential FTAA members now belong.

In this section, we will briefly review the institutional and macroeconomic forces that have brought Latin America to this stage of liberalization, focusing on the last 10 to 15 years. This backdrop is important in understanding how environmental and sustainability goals can be advanced, a question discussed later in this study. Special attention will be given to NAFTA, Mercosur, the Andean Pact, and the factors that have contributed to a successful opening of many of the Latin American and Caribbean economies, especially since 1990. We will not explicitly consider the Central American Common Market or Group of Three (Colombia, Mexico, Venezuela), except in later analysis of environmental questions.

North American Free Trade Agreement

The NAFTA agreement negotiated between the Bush and Salinas governments was reshaped by the 1992 U.S. presidential campaign to include side-agreements on labor and environment when it was approved by Congress and signed by President Clinton in 1993. While a long and complex set of particulars characterize the agreement, its overall features are clear: NAFTA provides for the progressive elimination of all tariffs on three separate schedules depending on the sensitivity of the products in question. Tight rules of origin are designed to prevent Mexico from becoming an export platform. Quotas and quantitative restrictions, notably in agriculture, are to be converted to tariff-rate quotas or eliminated, as are tariffs. Investment restrictions are relaxed in most sectors.

Chapter 22, Article 2205 contains the key "accession clause":

> Any country or group of countries may accede to this Agreement subject to such terms and conditions as may be agreed between such country or countries and the [North American Trade] Commission and following approval in accordance with the applicable procedures of each country.

This clause fails to specify the means by which accession can and will occur. However, as this process unfolds, the very existence of NAFTA has created incentives for other Latin American and Caribbean countries to ready themselves for accession in three distinct ways. First, LAC countries will have reasons to consolidate needed economic reforms. Second, they will have incentives to form subregional groupings, such as Mercosur. Third, they will have reason to incorporate elements of NAFTA respecting labor and environment in these subregional and national groupings in order to make "coupling" easier when it comes, so long as these aspects of

NAFTA continue to receive U.S. government support.[3] The particular implications of these trends for the environment will be explored later.

Mercosur

The South American Common Market (with Mercosur its Spanish acronym) is the largest regional trade pact in Latin America. It consists of Argentina, Brazil, Paraguay, and Uruguay; Bolivia has recently acceded, and Venezuela has proposed to join. As of January 1995, the pact had established duty-free trade on more than 8,700 goods. Its immediate origins can be traced to significant shifts in economic policies in the late 1980s, notably Argentine President Menem's decision to break hyperinflationary pressures in 1989 and early 1990. In that year, the Menem administration initiated a wide-ranging program of deregulation, privatization, reduction of tariffs, elimination of export taxes, convertibility of the peso, and structural adjustment of the public sector. These efforts led inexorably toward an outward, export-based reorientation of economic policies.

The deeper historical antecedents of Mercosur can be traced to the Friendship Act between Argentina and Brazil, signed in 1986 by presidents Alfonsin and Sarney, followed in 1990 by the Buenos Aires Declaration. This declaration went beyond earlier commitments to expand trade. It included explicit calls for a common market and specific commitments to phase out tariffs over 10 years and to coordinate macroeconomic policies. In 1991, this commitment was expanded under the Asunción Treaty to include Paraguay and Uruguay, creating Mercosur.

Mercosur committed the four countries to:

- make linear intrabloc tariff reductions, beginning January 1, 1994. This process was completed by January 1, 1995.
- eliminate nontariff barriers within the trading bloc
- achieve free circulation of goods and services, including capital and labor
- put in place a common external tariff (CET) averaging 35 percent by December 31, 1994
- coordinate macroeconomic and sectoral policies, including agricultural, industrial, monetary, and fiscal
- adopt a common "rule of origin" definition: any good will be considered "produced by Mercosur" if at least 50 percent of its value has been created or added within the bloc
- develop a mechanism for settling disputes

These policy commitments were backed by the four democratically elected presidents of Argentina (Menem), Brazil (Collor), Paraguay (Rodríguez), and Uruguay (La Calle). In late 1994, the Ouro Preto Protocol formalized additional commitments to create a customs union.

In 1995, after the U.S. retreat from NAFTA's extension to include Chile, Mercosur and Chile entered into an agreement to create a free trade zone before year-end 1996. As of July 1, 1996, Mercosur and Chile had created the "4+1 Group" and an associated free trade zone; Bolivia was to join Mercosur on March 1, 1997. On July 3, 1996, a new Mercosur Bank was announced in concept. Meanwhile negotiations between Mercosur and the European Union (EU) were initiated. Some analysts now believe that Mercosur, rather than NAFTA, will become the hub of a continent-wide free trade zone, given its relative capacity for expansion.

Overall, Mercosur represents a $1 trillion economy in 1995 GDP values and almost 200 million consumers, thus accounting for about one eighth of hemispheric GDP and 27 percent of hemispheric population. The two largest Mercosur economies, Argentina and Brazil, are both largely domestically driven, with about the same share of trade orientation as the United States. (See *Table 1*.) Chile constitutes the only truly export-oriented economy in the region, with an openness index of 46 percent, in contrast with 15 percent for Mercosur as a whole and 18 percent for the United States. Such structurally closed economies offer enormous potential for trade expansion, as shown in quantitative trade assessments.

Andean Pact

On July 23, 1990, President Bush announced his intention to implement a package of trade measures for the South American Andean countries of Bolivia, Colombia, Ecuador, and Peru to encourage these countries to reduce drug crop cultivation and production. Included in this package was a proposal for a preferential tariff regime for certain products. Legislation for such a regime, the Andean Trade Preference Act (ATPA), was passed by the Congress on November 26, 1991, and signed into law by President Bush on December 4, 1991. ATPA became operative on July 2, 1992, when President Bush formally designated Bolivia and Colombia as ATPA beneficiaries (USITC 1995).

ATPA is a unilateral preferential tariff program that reduces or eliminates duties on eligible products imported into the customs territory of the United States. This tariff

[3] The first two points are made in Pastor (1995); the third is an adaptation of Pastor's observation that NAFTA will stimulate cooperation on political issues (1995, 72).

regime was largely modeled after the U.S. Caribbean Basin Economic Recovery Act (CBERA) but shares many features with the U.S. Generalized System of Preferences (GSP). ATPA preferential tariffs are scheduled to expire no later than 10 years from the effective date, or on December 3, 2001.

Table 1
Macroeconomic Data and Openness Indices for Some National Economies and Blocs, 1994

Country	GDP (Mill US$)	Exports (Mill US$)	Imports (Mill US$)	Openness Index (%)
Canada	569,949	161,269	155,311	56
Mexico	368,679	56,951	75,425	36
United States	6,737,367	512,397	689,310	18
NAFTA	7,675,695	730,617	764,890	19
Argentina	275,657	15,108	21,199	13
Brazil	536,309	44,530	36,741	15
Paraguay	7,606	820	2,107	38
Uruguay	14,725	1,913	2,773	32
Mercosur	834,297	62,371	62,820	15
Chile	50,051	11,658	11,319	46
Mercosur+Chile	884,348	74,029	74,139	17

Sources: GDP: *World Bank Atlas* (1996). Exports and Imports: *Direction of Trade Statistics,* IMF (1995).
Note: The larger the openness index, the greater the export orientation.

Some 6,000 products (trade in services is not included) are eligible for ATPA duty reduction. Subject to certain exceptions, ATPA affords duty-free treatment for all U.S. imports of articles grown, produced, or manufactured in a designated ATPA country. Though not eligible for duty-free entry, certain handbags, luggage, flat goods, work gloves, and leather wearing apparel from ATPA countries may enter at reduced rates of duty. Beginning in 1992, duties on these goods are being reduced by a total of 20 percent in five equal annual installments. Articles not eligible for ATPA preferential duty treatment are mainly textile and apparel articles; certain footwear; canned tuna; certain petroleum and petroleum products; some watches and watch parts; and certain sugars, syrups, molasses, and rum.

ATPA covers the same 4,300 tariff categories covered by GSP plus an additional 1,700 categories. ATPA qualifying rules are similar to those for GSP, and many Andean products may enter the United States duty free under either program. ATPA offers Andean exporters several advantages over GSP, notably that ATPA rules of origin are more liberal than those of GSP.

Unilateral Policy Changes

Apart from the hemispheric, regional, and bilateral accords discussed above, the nations of Latin America and the Caribbean undertook numerous unilateral trade policy reforms in the 1980s and 1990s. The origins of market-oriented macroeconomic policies in the LAC can be traced especially to the example of Pinochet's Chile, which in the 1970s and 1980s began a painful (and largely authoritarian) structural adjustment to become an outward-looking and diversified economy. In 1980, an incipient common market concept had been advanced in the form of the Latin American Association for Integration under the Montevideo Treaty, but the context was one of predominantly military-ruled, inward-looking import-substitution policies. Chile's initiatives began an assault on protectionism, which had been in existence since the 1930s with only periodic thrusts and starts toward more liberal policy (de la Cuadra and Hachette 1991).

The wave of trade liberalization that followed included Bolivia and Mexico in 1985; Uruguay in 1987; Argentina and Venezuela in 1989, and Brazil, Ecuador, and Peru in 1990. (*See Table 2.*) Several other countries have also undertaken liberal trade reforms, but their progress has been slow and uncertain, and comprehensive data are lacking. The countries include Jamaica and Trinidad and Tobago in 1985; Costa Rica and Guatemala in 1986; Paraguay in 1989; Honduras in 1990; and Panama in 1991.

Table 2
Recent Episodes of Trade Liberalization in Latin America

Country	Liberalization Period[a]
Argentina	July 1989 - April 1991
Bolivia	August 1985 - February 1990
Brazil	July 1990 - July 1994
Colombia	September 1989 - December 1991
Ecuador	May 1990 - August 1992
Mexico	July 1985 - December 1989
Peru	August 1990 - August 1991
Uruguay	July 1987 - April 1992
Venezuela	February 1989 - July 1991

Source: Alam (1992).
[a.] Dates indicate the period of the liberalization, defined to cover the enactment of all major trade reforms.

Except for Colombia and Venezuela, all of the countries that undertook liberalization shown in Table 2 faced severe macroeconomic problems, so that trade liberalization was part of a larger policy mix that included deregulation, privatization, and reforms of the financial system. Table 3 lists LAC countries, the year liberalization efforts were undertaken, and whether, in the opinion of World Bank analysts (Michaely and Papageorgiou 1996), the measures undertaken constituted a “strong” policy package. Table 4 indicates the export performance of the LAC region during episodes of liberalization. There is no clear trend toward increased export performance: four countries show an increase, six show a decline, and two show no change. Table 5 shows the trend of GDP growth in annual percentages. Here again, no clear pattern emerges: seven countries show increases and five show declines. In a few countries, however—including Belize, Nicaragua, and Trinidad and Tobago—liberalization produced dramatic gains in GDP growth. Table 6 summarizes trade performance and trends in the years before, during, and after liberalization. Total trade flows, both imports and exports, increased markedly for these countries, with important individual exceptions.

Table 3
Episodes of Trade Liberalization, LAC Countries

Country	Year Policy Introduced	“Strong”Policy Package?
Barbados	1991	No
Belize	1986	No
Chile	1974	Yes
Costa Rica	1991	Yes
El Salvador	1989	Yes
Guatemala	1991	Yes
Guyana	1989	Yes
Honduras	1990	No
Jamaica	1991	Yes
Nicaragua	1991	Yes
OECS	1991	No
Panama	1995	Yes
Paraguay	1989	Yes
Trinidad and Tobago	1990	No

Source: Michaely and Papageorgiou (1996); World Banks (1995).
Notes: The delineation of liberalizations, as well as decisions about their intensities, are based primarily on judgments of country economists at the World Bank and IDB. Some modifications have been made by consulting other sources, primarily Edwards (1993), Alam (1992), and Papageorgiou and Michaely (1995).

Table 4
Export Performance During Episodes of Liberalization, LAC Countries

Country	Liberalization Year	Percentage Change of Export Share in GDP: Average of 2 Preceding Years	Liberalization Year	Average of 3 Following Years
Belize	1986	.03	.15	.03
Chile	1974	–.01	.49	.02
Costa Rica	1991	.03	.13	.01[a]
El Salvador	1989	–.10	–.16	.03
Grenada	1991	–.02	0	.01[a]
Guatemala	1991	.10	–.13	–.01
Guyana	1989	.15	.44	.15
Honduras	1990	.05	.21	–.02
Jamaica	1991	.01	.09	.04[a]
Nicaragua	1991	.37	–.15	0[a]
Paraguay	1989	.17	.07	–.14
St. Kitts and Nevis	1991	–.07	.13	n.a.
Trinidad and Tobago	1990	.09	.02	–.04

Source: Michaely and Papageorgiou (1996); World Bank (1995).
[a.] Averages of only 2 years.

Table 5
Growth of GDP During Episodes of Liberalization, LAC Countries

Country	Liberalization Year	GDP Growth Rate (Annual Percentage): Average of 3 Preceding Years	Liberalization Year	Average of 3 Following Years
Belize	1986	–.4	7.3	10.3
Chile	1974	1.7	.1	1.8
Costa Rica	1991	5.0	3.6	6.1
El Salvador	1989	1.8	1.4	4.4
Grenada	1991	4.5	5.1	.4[a]
Guatemala	1991	3.6	4.4	4.6[a]
Honduras	1990	5.3	–.6	3.3
Jamaica	1991	5.6	.1	4.1[a]
Nicaragua	1991	–5.5	–10.6	1.8[a]
Paraguay	1989	3.3	7.0	2.1
St. Kitts and Nevis	1991	5.8	.3	4.1
Trinidad and Tobago	1990	–4.3	.8	.8

Source: Michaely and Papageorgiou (1996); World Bank (1995).
[a.] Averages of only 2 years

Table 6
Trade Performance (percentage change in trade flows in 1987 U.S. dollars)

			3 Years Prior to Liberalization			Liberalization Year	3 Years Following Liberalization				
		T_1 [a]	–3	–2	–1		+1	+2	+3	T_2 [b]	T_3 [c]
Argentina (S)	Exports	–3.3	–15.0	–12.1	17.1	26.4	–4.0	0.6	2.0	6.2	–0.5
	Imports	4.4	22.6	11.8	–21.2	–10.1	–18.2	69.9	75.8	39.3	55.8
Bolivia (S)	Exports	–3.3	–1.1	–6.1	–2.8	–10.0	17.5	3.8	12.6	6.0	11.3
	Imports	–18.0	–44.0	10.7	–20.7	65.7	–11.8	8.5	–30.8	7.9	–11.4
Brazil (S)	Exports	11.5	14.5	17.3	2.8	–7.7	4.9	12.9	n.a.[d]	3.4	8.9
	Imports	4.6	–8.0	–7.1	28.8	13.6	7.4	–1.2	n.a.[d]	6.6	3.1
Colombia (M)	Exports	17.5	31.5	24.5	–4.3	39.9	13.4	15.6	13.2	20.5	14.1
	Imports	–0.3	–13.3	–1.5	13.9	–2.6	16.4	–7.1	50.3	14.2	19.9
Ecuador (S)	Exports	1.0	–17.3	29.0	–8.8	–1.8	20.0	0.2	n.a.[d]	6.1	10.1
	Imports	–4.2	–4.6	–15.5	7.4	–10.3	31.1	4.6	n.a.[d]	8.5	17.8
Mexico (S)	Exports	15.8	12.7	25.7	9.1	–5.8	4.0	–12.9	–10.5	–6.3	–6.5
	Imports	–9.2	–37.9	–26.4	36.8	13.8	15.5	–23.3	1.4	1.8	–2.1
Peru (S)	Exports	3.5	5.6	4.6	0.4	25.2	17.6	5.2	n.a.[d]	16.0	11.4
	Imports	–7.0	21.2	–5.0	–37.1	22.6	9.6	26.1	n.a.[d]	19.4	17.8
Uruguay (S)	Exports	3.2	–10.7	–2.7	22.9	–5.9	10.0	7.3	7.9	4.8	8.4
	Imports	13.0	10.8	–5.7	33.9	11.6	–1.9	1.8	4.0	3.9	1.3
Venezuela (S)	Exports	–7.0	–6.5	0.3	–14.7	6.0	15.4	8.3	–4.9	6.2	6.3
	Imports	3.1	–7.5	4.1	12.8	–22.8	5.8	54.9	24.3	15.5	28.3
TOTAL	Exports	4.3	1.5	9.0	2.4	7.4	11.0	4.6	3.4	7.0	7.1
	Imports	–1.5	–6.7	–3.8	6.1	7.9	6.0	19.4	27.81	13.0	14.5

Source: World Bank (1995).
Notes: S, strong liberalization; M, moderate liberalization; n.a., not available.
a. T_1 is the average annual change in trade flows for the three years preceding the year of trade liberalization.
b. T_2 is the average annual change in trade flows for the year of liberalization and the subsequent three years.
c. T_3 is the average annual change for the three years immediately after the year in which trade liberalization was introduced.
d. No comparable data are available for these countries for these years.

3.2 Sectoral Impacts of Trade Liberalization

This section provides a more detailed assessment of the sectoral impacts of regional, hemispheric, and national trade reforms in the LAC region. First, we calculate country-by-country export trends for a variety of manufacturing sectors, based on two-digit ISIC data. We then offer some basic findings on four key extractive sectors: agriculture, forestry, fisheries, and minerals. The particular impacts of these changes on the *environment* are largely reserved for the next section of the study. Here we seek only to analyze recent developments in order to gauge some of the sectors likely to be moved forward, or backward, by recent trade policy developments.

Export Trends by Sector

Analysis on the LAC region's trade reliance was undertaken by calculating changes in export trends for various sectors. Basing our data from the United Nations Industrial Development Organization (UNIDO), we have calculated trade reliance by country for the following sectors: Food Products, Textiles and Apparel, Wood

Products, Paper and Printing, Industrial Chemicals, Nonmetal Products,[4] Basic Metals,[5] and Metal Products.[6]

Table 7 shows these export trends for the periods for which data are available. The sectoral and country-specific trends are by no means uniform, suggesting that the impacts of trade expansion vary considerably. In the analysis to follow, we will show how some sectors that are relatively low in pollution intensity have been affected by export expansion in comparison with high pollution-intensity sectors. In addition to these key manufacturing sectors, we discuss four extractive sectors for which data corresponding to Table 7 are not available.

Agriculture

Primary agricultural production is one of the most important sectors affected by freer trade (both positively and negatively) in the LAC region. One of the clearest motivations for LAC involvement in the Uruguay Round was the expectation that agricultural trade liberalization in North America and the European Union would reduce barriers to market access to agricultural and tropical products, affecting exporters such as Argentina, Brazil, Chile, and Colombia. At the same time, Mexico and much of the Caribbean Basin has feared the impact of NAFTA on its traditional agricultural sectors, such as white maize, even as it has welcomed the opportunities (limited by final negotiated agreements) to gain access to North American fruit, vegetable, and horticultural markets.

Among the important consequences of abandonment of import-substitution policies have been investments and technological progress in the agricultural and food sectors, especially in the Mercosur countries. Taken together, these sectors (including commodities, food products, fibers, vegetable oils, and byproducts) accounted for over 30 percent of total GDP in 1995. In Paraguay, the primary agricultural sector alone accounted for 26 percent of total GDP. Adding agri-industrial manufactures to commodities, they accounted together for close to 60 percent of total export values for Argentina in 1995. A recent study (Cap 1996a) sheds some light on the magnitude of the net trade growth potential in agricultural commodities in the Mercosur group. Table 8 shows that Mercosur as a group is capable of exporting substantial quantities of all of the agricultural commodities listed. A recent simulation exercise analyzing potential gains from liberalization confirms that it is in agriculture that Mercosur stands to gain the most in its trade with the United States (Diao and Samwaru 1996).

An even more detailed set of assessments has been undertaken by Valdés and Schaeffer (and various coauthors) of agricultural and trade policy impacts in the LAC region from 1984 to 1994, covering Argentina, Brazil, Chile, Colombia, the Dominican Republic, Ecuador, Paraguay, and Uruguay, using a variety of policy indicators as monitoring devices (Valdés and Schaeffer 1995a–e, 1996a, 1996b). While detailed summaries of these and other findings are contained in the Valdés and Schaeffer studies, the overall evidence indicates that shifts toward liberalization have lowered levels of protection for agricultural importables and have generally increased opportunities (e.g., lowered taxes) for agricultural exportables.

A separate appraisal of the agricultural sector's response to trade liberalization, prepared for the U.S. Agency for International Development USAID (Bathrick et al. 1996), concluded that agriculture is responding dynamically and positively to these trends in the LAC region, although benefits are going mainly to larger producers. Fifteen countries show notable agricultural production increases: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Jamaica, Mexico, Paraguay, Peru, Uruguay, and Venezuela. The most significant of these in percentage terms are in Bolivia, Chile, Ecuador, and Paraguay, partly owing to their small initial production bases compared to countries such as Argentina and Brazil. Highly negative experiences in El Salvador, Haiti, and Nicaragua are largely due to political and civil strife. Beneath these national production trends a more subtle set of developments is occurring at the subsectoral level: improvement in overall agricultural performance is being fueled by shifts toward commodities of higher value in response to growth in international marketing opportunities for meat, fruits, vegetables, and oilseeds.

[4] Examples include pottery, china, glass, cement, lime, plaster, and other nonmetallic mineral products.

[5] Includes iron, steel, and nonferrous metals.

[6] Examples include cutlery, engines, furniture and fixtures, various types of machinery, structural products, electrical equipment, appliances, motor vehicles, and aircraft.

Table 7
Export Trends for Latin American Countries by Sector

Country	Time Period	Export as a Percentage Share of Production: Trends for LAC Countries by Sector			
		Food Products	Textiles, Apparel	Wood Products	Paper and Print
Argentina	1993	14%	13%	1%	3%
Belize	90, 92	Falling (62-53%)	-	Rising (20-29%)	-
Bolivia	88-91	Rising (9-21%)	Rise then fall (19-32%)	-	0%
Chile	86-91	Steady (18%)	Rising (2-9%)	Rising (32-46%)	Fall then rise (33-38%)
Colombia	86-91	Rising (3-5%)	Rising (13-36%)	Rise and fall (7%)	Rising (8-12%)
Costa Rica	86-91	Rising (7-11%)	Rising (27-43%)	Rising (8-11%)	Rising (8-10%)
Ecuador	86-90	Fall then steady (56-10%)	Rising (1-5%)	Fluctuating (21-34%)	0%
El Salvador	1985	7%	43%	-	36%
Guatemala	85-88	Rise then fall (9%)	Rise then fall (19-9%)	Rise then fall (22-15%)	Rise then fall (7-3%)
Honduras	85-88	Falling (9-6%)	Steady 5%	Falling (39-13%)	Falling (3-2%)
Mexico	86-92	Falling (8-4%)	Fall then rise (41-51%)	Rising (36-50%)	Rise-fall-rise (9-13%)
Panama	85-89	Falling (9-5%)	Rising (20-43%)	Rising (3-5%)	Rising (2-4%)
Paraguay	1991	56%	33%	-	5%
Peru	86-88	Rising (8-22%)	Rising (15-18%)	Steady (1%)	Falling (1-0%)
Uruguay	86-90	Fall then rise (26%)	Falling (57-51%)	0%	Falling (7-5%)
Venezuela	85-92	Rising (1-3%)	Rising (1-4%)	0%	Steady 4%

Table 7 (continued)

Country	Time Period	Export as a Percentage Share of Production: Trends for LAC Countries by Sector			
		Industrial Chemicals	Non-metal Products	Basic Metals	Metal Products
Argentina	1993	8%	3%	14%	8%
Belize	90, 92	-	-	-	Rising (54-58%)
Bolivia	88-91	-	-	-	Rising (2-3%)
Chile	86-91	Rising (7-10%)	Rise then Fall (1-3%)	Rising (48-62%)	Falling (45-9%)
Colombia	86-91	Rising (11-14%)	Fall and Rise (8-12%)	Rising (11-24%)	Fall and Rise (5-11%)
Costa Rica	86-91	Rising (16-21%)	Steady (16-15%)	-	Fluctuating (24-27%)
Ecuador	86-90	Fluctuating (1-16%)	Rising (0-3%)	Rising (0-2%)	Rising (2-4%)
El Salvador	1985	15%	8%	61%	24%
Guatemala	85-88	Rise then fall (15-8%)	Rise then Fall (11-5%)	Rise then fall (11-2%)	Rise then Fall (14-6%)
Honduras	85-88	Falling (4-3%)	Rising (0-6%)	-	Fall (6-5%)
Mexico	86-92	Falling (21-16%)	Rise then Fall (14-10%)	Falling (22-13%)	Rising (23-61%)
Panama	85-89	-	Rising (1-6%)	Rising (11-22%)	Rising (2-8%)
Paraguay	1991	47%	0%	-	19%
Peru	86-88	Steady (10%)	Steady (2%)	Rising (44-97%)	Rising (3-6%)
Uruguay	86-90	Rising (8-13%)	Rising (7-13%)	Falling (17-13%)	Falling (9-6%)
Venezuela	85-92	Falling (60-50%)	Falling (19-11%)	Falling (61-38%)	Fluctuating (4-7%)

Source: Faeth and McGinnis (1997).

Table 8
Mercosur: Estimated Excess Supply of Selected Commodities in the Year 2000 (in thousands)

Commodity	Argentina Excess Supply			Brazil Excess Demand[b]	Mercosur Excess Supply		
	Low	Medium	High		Low	Medium	High
Wheat	6,993	8,943	15,498	8,800	–1,809	143	6,698
Corn	8,307	10,358	13,978	2,200	6,107	8,158	11,778
Soybean	13,531	15,810	16,348	550	12,981	15,260	15,798
Sunflower	4,289	4,678	5,015	60	4,229	4,618	4,955[a]
Beef[b]	720	995	2,074	440	280	555	1,634
Cotton[c]	320	390	456	330	–10	60	126
Potato	965	1,429	2,487	220	745	1,209	2,267

Sources: Mercosur Agropecuario (1995); Rodríguez (1995).
Note: To simplify the analysis, it was assumed that the final net excess supply is solely a function of the performance of Argentina and Brazil.
Estimated excess supply is for low, medium, and high production scenarios corresponding to overall level of production technology at the farm level in the year 2000.
[a] Of this total approximately 4 million tons of grain will be exported as flour and oil.
[b] Packing-house-processed weight (a conversion factor of 0.55 x liveweight was used).
[c] Industrial fiber (a conversion factor of 0.33 x unprocessed fiber weight was used).

Among the main conclusions of the USAID study are:

- While agricultural production does not dominate the economies of many LAC countries as it once did, it is a vital consideration for trade and development strategies because: (1) the agricultural sector employs a large part of the labor force both directly and indirectly; (2) agricultural exports are a major and expanding component of total export earnings, and (3) alternative sources of employment for people displaced from agriculture are not currently expanding. In sum, a dynamic agricultural sector could provide important employment generation opportunities and stimulate economic growth.

- The export share of raw agricultural commodities continues to decline both within LAC markets and the rest of the world.

- The relative importance of high-value products, both processed and unprocessed, continues to expand.

- In nearly all countries and trading groups, the degree of export diversification is increasing and will probably continue to do so for an even broader range of commodities and products. Total LAC agricultural production, agricultural diversification, and agricultural exports, in particular, have clearly benefited from increased economic integration in the Western Hemisphere (Bathrick et al. 1996).

Forestry

The forestry sector in the LAC region confronts the analyst with a dilemma: although economic and environmental distortions in the sector are well known, many experts find it difficult to link changes in the sector directly to trade liberalization because most production and consumption of forest products in the region occur domestically. Barbier et al. (1994) have emphasized, for example, that only 17 percent of all tropical timber production is used for industrial purposes; the remainder is consumed as fuelwood and nonindustrial uses. Of all industrial timber produced by tropical countries, roughly 31 percent is exported in round or product form, so that only 6 percent of total tropical roundwood production enters international trade. Tropical timber itself is a relatively small share of the global timber market, compared with temperate roundwood and pulp. Only 15 percent of the total volume of global timber is produced in tropical areas, accounting for 11 percent of the value of global exports.

Other experts disagree, citing recent evidence of increased tropical timber exports from Brazil since the early 1990s, and heavy Asian investment in the Brazilian Amazon, Guyana, and Suriname (Sizer 1996). In addition, private concessions granted by Latin American governments to international corporations, as well as domestic concessions and plantation forestry, have raised concerns over the ability to sustain production and protect the environment over time (USAID 1996). Yet, even more recent analysis has argued that forests are replanted, managed, and regenerated precisely *because* of their traded economic value, unless property rights fail to capture this value for their owners (Hyde et al. 1996).

In the case of tropical timber, Central and South America produced 36 percent of these forest products in 1990 and consumed most of them domestically. Table 9 shows forest product trade for these countries in 1990. Although production in these countries has increased steadily, domestic consumption has grown even faster as a result of population and income growth, so that exports have actually fallen and imports have increased. On the export side, trade is shifting from roundwood and sawnwood to value-added products. Projections of future trends, summarized by Arnold (1991), suggest that the tropical share of all hardwood production will continue to decline, that exports of roundwood and sawnwood will continue to fall as domestic consumption remains strong, that value-added exports will continue to displace logs and timber, and that timber exports will continue to produce negligible foreign exchange earnings compared with other exports.

Based on a methodology drawn from Hyde et al. (1996), Steven Stone has analyzed the factor costs and changing technological base of timber extraction in the Brazilian Amazon from 1990 to 1995 (Stone 1996). He finds that as land tenure has stabilized and areas of accessible forest have receded, the price of clearing rights, reflected in stumpage fees paid to landowners, has more than doubled, from $84 per hectare in 1990 to 1995 to $193 in 1995 dollars. The result is that the foundation of the industry—cheap raw material—is eroding. Data from a 1995 survey indicate that log prices have increased between 10 and 30 percent since 1990. Capital costs have also risen between 20 percent and 30 percent a year in real terms since 1990. This has reduced investment and made wood exports more expensive by raising the value of the Brazilian real. Although labor remains relatively cheap, transportation costs have risen as firms must go farther to get logs, leading to demand for larger loads, bigger trucks, and the movement of extractive machinery farther into the forest, with mills relocating closer to the source of timber. At the same time, the cost of fuel rose 8 percent in real terms from 1990 to 1995. Based on these factors, the average profit for small mills has dropped from 15 to 2 percent between 1990 and 1995, with about 20 percent of sawnwood by volume going to exports. In response to these trends, Stone finds industry responses of three basic kinds:

Table 9
Forest Products Trade Balance and Percentage of Total Trade in Tropical Countries, 1990 in Central and South America

Country	Forest Product Imports (10^3 US$)	Forest Product Exports (10^3 US$)	Forest Product Net Exports (10^3 US$)	Total Imports (10^6 US$)	Total Exports (10^6 US$)	Forest Products as Percentage of Total Imports	Forest Products as Percentage of Total Exports
Costa Rica	40,020	21,895	0	2,026	1,457	2.0	1.5
El Salvador	21,800	2,725	0	1,200	550	1.8	0.5
Guatemala	69,410	18,326	0	1,626	1,211	4.3	1.5
Honduras	137,921	31,061	0	1,028	916	13.4	3.4
Mexico	403,605	13,884	0	28,063	26,714	1.4	0.1
Nicaragua	10,566	2,569	0	750	379	1.4	0.7
Panama	76,979	3,988	0	1,539	321	5.0	1.2
Trinidad & Tobago	54,396	458	0	1,262	2,080	4.3	0.0
Bolivia	4,060	22,160	18,100	716	923	0.6	2.4
Brazil	299,402	1,750,981	1,451,579	22,459	31,243	1.3	5.6
Colombia	104,056	20,060	0	5,590	6,766	1.9	0.3
Ecuador	157,834	24,373	0	1,862	2,714	8.5	0.9
Paraguay	13,055	24,971	11,916	1,113	959	1.2	2.6
Peru	104,914	2,558	0	3,230	3,277	3.2	0.1

Source: Barbier, et al. (1994), 274.

increases in the volume of production; attempts to increase value-added, and increases in mill size.

In summary, the general trade expansion and associated income growth occurring throughout the LAC region is likely to have its main impacts on the forestry sector in an indirect manner. First, rising incomes and population will increase domestic consumption, actually reducing export trade. Second, increasing demand for agricultural lands may impose additional incentives to clear native forests but at increasing costs and with reduced profits. Third, volume increases may be the short-run response, together with attempts to add value and increase mill size (Binswanger 1991; Southgate et al. 1991; Stone 1996). Hence, while we shall consider forest-sector issues to be of considerable interest in the sections to follow, it is important to recognize that trade policy may often be relevant only indirectly, operating through overall demand shifts or agriculture-forestry interactions.

Fisheries and Marine Coastal Resources

The fisheries sector of the LAC region, in terms of production, management, and product diversity, is complex. It incorporates the overall problems of resource management associated with the open access nature of most fisheries resources, multispecies fisheries, fish-ecosystem interactions, and highly mobile fishing fleets. Despite the attempts of the United Nations Convention on the Law of the Sea to provide a suitable legal regime to manage fisheries resources, most marine fisheries remain subject to open access exploitation. Some migratory stocks such as tuna and other "high seas" fisheries, which are not subject to any individual coastal state control, create further management difficulties. Although many high seas resources are subject to international agreements, the resources themselves are often hard to manage because they are dispersed and difficult to research with any degree of accuracy. Yet seafood plays a vital role in feeding the world's population: 16 percent of total animal protein is supplied by fish.

Two events of the past 15 years have helped to create the complex trade conflicts facing seafood markets in the LAC region. One is the establishment under the 1982 United Nations Conference on Law of the Sea (UNCLOS) of coastal state jurisdiction up to 200 nautical miles out for all living resources: the Exclusive Economic Zone (EEZ). While fisheries remain an open access resource, this limited privatization by nations allows for some control over the harvest and maintenance of fish stocks. However, Wessells and Wallstrom (1994) observe that the effect was to increase international trade in seafood. Nations that had previously harvested their own supply of fish became, in some cases, importers. Other nations that found themselves with a surplus of fish became exporters. With increasing trade, conflicts between nations involving tariff and nontariff barriers have repeatedly occurred, as have conflicts between fisheries management and international trade policies. Trade in fish and fisheries products (in total weight) as a percentage of total catch has increased from 33.9 in 1982 to 38.5 percent in 1989 (FAO 1989). Yet the role of trade in contributing to environmental problems in the fisheries sector is difficult to discern among the many other factors involved.

The fisheries of LAC have four main elements: fisheries for highly migratory species, particularly the tunas; fisheries for shoaling pelagic species (species that feed on the surface and that are found in large schools); fisheries for demersal stocks (those feeding on the sea bottom) found on the extended continental shelf; and the inshore, coastal fisheries.

South America accounted for about 15 percent of the world catch of fish and shellfish in 1991 (FAO 1992b). For many LAC nations, fisheries represent a significant source of foreign currency earnings. In terms of catch volume, the marine fisheries of the LAC region are overwhelmingly dominated by the catches of Peru and Chile. Together, these two states took over 14 million tons in 1993—almost 80 percent of the total LAC catch. Virtually all of the catch by Peru and Chile is for species used for fishmeal and has a low unit value. The total gross revenue of production of these two countries was about $1.4 billion in 1993.

Regional trends between the 1970s and the 1980s (leaving aside the changes in Peru and Chile) can be illustrated by the changes in the kinds of species harvested. About half the increases in the 1970s were in the catch of shoaling pelagic species. The growth in the catch volume during the 1970s was due mostly to the increase in the export markets for fish-meal. In the 1980s, however, the catch of these species declined significantly. Wide fluctuations in abundance of shoaling pelagic species are due in large part to the effects of the El Niňo phenomenon. In essence, although total catch for the LAC region (excluding Chile and Peru) did not increase significantly during the past decade, a shift occurred from the low-value shoaling pelagic species to the more highly valued species used for human consumption. In the early 1970s, net exports of fishery products from countries other than Chile and Peru were negligible. By 1980 they had grown to over 1.4 million tons.

Highly migratory species move over vast distances of the oceans through the EEZs of coastal states and beyond those zones on the high seas. The major market species are albacore, bigeye tuna, bluefin tuna, skipjack tuna, and yellowfin tuna. The commercial fisheries for yellowfin and skipjack mostly use purse seines, large nets that surround the schools of fish. Tuna catches on the Pacific side of Latin America are much greater than those on the Atlantic side.

The Latin American catch of tuna is taken almost entirely by four states: Mexico, Ecuador, Venezuela, and Colombia.

Shoaling pelagic species are associated with up-welling currents that bring large amounts of nutrients from the deep ocean to the surface areas where photosynthesis can take place. For Latin America, the most important of these currents occurs off Chile and Peru. This was the source of the largest single species fishery in the world, the Peruvian anchoveta fishery, which reached a peak of 13.8 million tons in 1970. This fishery collapsed in the 1970s, diminishing to a level of less than 1 million tons, and has since recovered to about half its peak level. Anchoveta and pilchard are taken almost entirely by purse seine vessels from Chile and Peru. The catch of these fish and jack mackerel is used almost entirely for reduction into fishmeal for export. Price is affected by the price of substitute meals, such as soybean meal, and by the growing demand for meal for the culture of shrimp and salmon. Because of the low price, the total value of the catch in Chile and Peru is only about $1.3 billion, which is about twice the value of the tuna catch even though the fish mass is twenty times greater than that of tuna.

In some areas, continental shelves extend beyond 200 miles from shore. In Latin America, the most significant area of extended shelf lies off the coasts of Argentina, Uruguay, and, to some extent, Brazil. This area has rich resources of groundfish, such as Argentine hake and southern blue whiting, as well as large stocks of squids. The groundfish stocks are mostly taken by trawlers and to some extent by longlines and other bottom gear. The vessels used by the noncoastal states are usually large and highly mobile while those used by the coastal states are generally smaller, although Argentina has an expanding fleet of freezer and factory trawlers. Squids are taken by surface gear usually from medium-size vessels. Most of the products are aimed at the international market, because the domestic demand in the coastal states is relatively low.

There are indications that the stocks of Argentine hake and Patagonian hake (the two major species taken in the groundfish fishery) are currently fully exploited (FAO 1994). In some areas, such as the Patagonian Shelf and Slope, squid stocks are fully exploited; in other areas they are lightly exploited, particularly in the northern coastal areas off Brazil (FAO 1994).

Although for many LAC countries, the inshore fisheries may be of lesser value than others, these stocks are critical in social terms. They usually employ the largest number of fishermen as well as those associated with the fishing industry as providers of materials and equipment and as processors, marketers, and distributors. Inshore stocks include a large number of species. The most important inshore stocks, in terms of value, are the various kinds of shrimp. Most species are consumed domestically, with the exception of shrimp, lobster, groupers, and snappers, which command relatively high prices in international markets. Inshore stocks of fish are generally being fished beyond the point of maximum sustainable yield. Inefficient use of inshore fisheries results from the condition of open access and is marked by both stock depletion and economic waste. Inshore stocks also tend to be the focus of conflict between small- and large-scale fishermen. This is particularly true of the shrimp fisheries where the large-scale trawls work over the grounds used by the small-scale fishermen.

Minerals

Mining is an important export sector in many LAC countries, including Bolivia, Brazil, Chile, Jamaica, Peru, and Venezuela. It is Bolivia's most important source of foreign exchange, accounting for $366 million out of total export income of $630 million in 1993. Jamaica, apart from tourism, is reliant on bauxite exports. Bolivia's main export is zinc, followed by tin, gold, and silver. The Bolivian Mining Corporation (Comiboc), in a series of recent moves to liberalize and restructure the sector, has increased investment, working in numerous joint ventures with the private sector and North American investors.

Gold mining of surface deposits is also a key subsector, especially in the Guiana Shield, a belt of greenstone extending from Venezuela through Guyana, Suriname, French Guiana, and the Amazon of Brazil. In addition to Brazil and the nations on the Guiana Shield, gold mining occurs in Bolivia, Colombia, and Peru. Brazil is currently the world's fourth largest producer of gold. Gold production utilizes mercury to separate the precious metal from sediment and to form an amalgam that is heated to produce pure gold with the mercury dissipated as gas, with a roughly 2:1 ratio of mercury entering the environment for every pound of gold. Much of the mining activity occurring in the Amazon is by "garimpeiros," a group of some 650,000 individual wildcatters who in 1992 accounted for 48 percent of the 76,044 metric tons of gold produced in Brazil. Many of these wildcatters, expelled in 1990 from Brazil after disputes with the Yanomami Indians, have resettled in the Venezuelan state of Amazonas.

Copper is also a critical subsector of mining, especially in northern Chile. In 1990, copper made up half of Chile's total exports; in 1992 Chile produced 1.94 million tons of copper. Copper mining is concentrated in the north of the country, and is controlled in part by the state-owned mining company, Coldeco. In Peru, a similar reliance on mineral exports exists, notably on iron ore, in which recent investments have grown dramatically. Iron mining production increased 36.9 percent from 1993 to 1994. In addition to iron, which accounted for 780.7 million metric tons (mmt) of Peruvian production in 1994, copper accounted for 27.3 mmt, zinc for 10.1 mmt, lead for 2.7

mmt, silver for 657.4 million ounces, and gold for 23.4 million ounces.

3.3 Environmental Impacts of Trade Liberalization

Thus far, we have focused almost exclusively on the national and sectoral consequences of trade liberalization for the economies of the LAC region. We turn now to the *environment*. One important finding of our discussion is that the complex linkages from trade to environment (and environment to trade) do not allow simple inferences about the causes of Latin America's environmental problems.

Aggregate Findings: Lucas' Estimates

Before considering the specific evidence by sector for the LAC regions, we need a sense of the aggregate linkages from expanded trade to various threats to environmental sustainability. We first report some aggregate findings by another analyst, then offer our own detailed sectoral analysis, based on two-digit ISIC data.

Lucas (1996) analyzed cross-country comparative data for a range of environmental indicators shown in column one of table 10, including data for the LAC region, but also extending to other countries. Since he did not separate the LAC region from this analysis, we report his aggregate findings. Lucas first tested the proposition that environmental degradation follows income growth measured by GDP per capita, based on an inverted "U" or "Kuznet's" function in which it was hypothesized that pollution increases, then decreases, with increases in income. This proposition was tested using GDP data at constant 1987 U.S. dollars to determine if pollution leveled off and then declined at higher income levels. Second, the role of income growth was tested where time-series data allowed it. Third, the environmental consequences of an outward-looking orientation to trade were estimated, represented by the ratio of exports of goods to total GDP. This national-level variable is analogous to the sectoral share of exports as a percentage of production. A time-trend variable was tested for time series data. For some indicators no time-series was available, so that only cross-sectional population levels could be used. Table 10 shows a portion of Lucas' extensive empirical results, based on whether the variable's impact on the environmental indicator was significantly positive or negative in a statistical sense.

Lucas first measured the impact on CO_2 emissions for 113 countries. Column two shows that annual CO_2 emissions are significantly and positively associated with GDP per capita for all cases except liquid fuels, rising at first and then declining once a threshold is reached. This threshold was higher than any of the actual per capita GDP of the countries at the time, implying that CO_2 emissions rise with income per capita over the range of existing incomes, though less rapidly at higher incomes. Income growth is insignificant as an explanatory variable. As shown in Column four, there is no positive association between total CO_2 emissions and exports/GDP ratios, except in the case of gas flaring, perhaps because of the rising exports of petroleum during the 1970s. In the case of solid fuels, the relationship between the exports/GDP ratio and CO_2 emissions is negative. Column five shows increases from gas fuels and cement manufacturing and decreases from gas flaring in CO_2 emissions over time.

The next set of indicators is based on manufacture of toxic and pollution-intensive products, regressed on the same explanatory variables: GDP/capita, growth in income, exports/GDP, and time trend. Dependent variables included in Table 10 are total toxic releases in all media; water pollution measured by biological oxygen demand (BOD); air pollution measured by suspended particles; and SO_2. Income (GDP/capita) is significant only in explaining total toxic releases. Growth in income is not a significant explanatory variable. Degree of openness as measured by exports/GDP is significant and positive in explaining total toxic releases, but it is significantly negative in relation to biological oxygen demand and suspended particles, suggesting that water pollution is inversely related to degree of openness. Time trends show a significant and positive increase in total toxic releases and suspended particles, suggesting that scale effects of some kind may be at work in relation to these categories of pollution.

Table 10.
Explanatory Variables

Environmental Indicator	Follows GDP/capita	Follows Growth in Income	Follows "Openness Index" (Exports/GDP)	Follows Time Trend	Population
Annual CO_2 Emissions[a]					
Total	+	0	0	0	NR
Solid Fuels	+	0	–	0	
Liquid Fuels	–	0	0	0	
Gas Fuels	+	0	0	+	
Gas Flaring	+	0	+	–	
Cement Manufacture	+	0	0	+	
Pollution Intensity[a]					
All media: total toxics	+	0	+	+	NR
Water Polluting: BOD	0	0	–	0	
Air Pollution					
Suspended Particles	0	0	–	+	
SO_2	0	0	0	0	
Wilderness Area[b]					
Adjusted for Total Area	+	NR	+	NR	0
Adjusted for Agricultural Land Use	+	NR	+	NR	0
Adjusted for Forestry Practices	+	NR	+	NR	–
Deforestation (1,000 ha)					
Adjusted for Total Area	+	NR	–	NR	–
Adjusted for Agricultural Land Use	+	NR	–	NR	–
Adjusted for Forestry Practices	+	NR	–	NR	–
Freshwater Withdrawals (per km^3)					
All countries	+	NR	0	NR	+
Adjusted for Total Water Available	+	NR	0	NR	+
Adjusted for Agricultural Land Use	–	NR	0	NR	+
Marine Catch (1000 tons)					
Adjusted for Exclusive Economic Zone	–	NR	0	NR	0
Adjusted for Meat Output	–	NR	0	NR	0
Adjusted for Freshwater Catch and Aquaculture	–	NR	0	NR	0
Pesticide Use—Active Ingredients Used (tons of active ingredient)					
All countries	+	NR	–	NR	0
Adjusted for Climatic Zone	+	NR	–	NR	0

Source: Adapted from R.E.B. Lucas (1996).
Notes: Entries of +, 0, and – indicate, respectively, a significantly positive, insignificant, and significantly negative statistical association at the one-tailed 95th percentile of confidence. NR=not reported.
[a.] Fixed Effects Time Series Models. Annual CO_2 emissions in 1,000 tons for 113 countries. All media, water pollutants and air pollutants, measured as emissions flows in lbs. per year per U.S. million dollars of manufactured output for 96 countries.
[b.] "Wilderness" defined as a minimum of 4,000 km^2 showing no evidence of human development. Data from World Resources Institute analysis of aerial photographs.

Lucas then considered environmental indicators for which data were available only at one point in time for a subset of countries. A cross-sectional analysis was used rather than a pooled cross-section and time series as in the case of CO_2 and pollution-intensity. Indicators included wilderness area, deforestation, freshwater withdrawals,, marine catch, and pesticide use. In this case, while GDP/per capita can still be employed, as well as exports/GDP, the absence of a time series does not allow estimation of impacts of growth in income or time trends. Population levels for the cross-section can, however, be measured. Estimates incorporated adjustments for total land area, agricultural land use, and forestry practices.

The relation between income per capita and the wilderness indicator is positive and significant when these country characteristics are included. Total wilderness area at first rises, then declines, with income per capita. The openness index or export propensity is also positive when these adjustments are made. Population is unrelated, except when adjusted for forestry practices.

The next indicator considered was deforestation, derived from World Resources Institute data relating to average annual deforestation from 1981 to 1985. Deforestation here refers to complete transfer from forest cover to alternative uses and does not include partial logging. As shown in the column on GDP/capita, income is associated with deforestation, which first rises with GDP then falls. Deforestation is negatively associated with exports/GDP. The more open to trade a country is, in other words, the *less* likely it is to be deforested. Population pressure has a negative association with these measures of deforestation.

Lucas also examined freshwater resources, based on total annual water withdrawals. Results for GDP/capita showed income growth is associated with water withdrawal and that the inverted U-shaped function fit the data for all countries, as well as when adjusted for total water available, but not when adjusted for agricultural land use. The openness index was insignificant, although population was positively associated with water withdrawal.

Marine catch was not positively linked to income. When regressed on income, it followed an upright U-shape, lowest among middle-income countries and highest among lower and higher income countries (for example, Peru and Japan). Regardless of various adjustments for country-characteristics, exports/GDP as a measure of trade openness was not statistically significant in explaining marine catch. Population also offered no explanation of marine catch, even among countries with low meat output, freshwater or aquaculture production.

A final indicator considered was pesticide use in various countries, with adjustments made for climatic variation (temperature). Data in this case were drawn from World Bank estimates. Growth in income is strongly associated with pesticide use, which rises to peak at incomes of $13,750 (1987 U.S. dollars) and then declines. Pesticide use is negatively associated with export propensity but is not associated with population size. When adjusted for climatic variations, all of these findings are robust and show lower use in cold zones than tropical areas.

Overall, Lucas' aggregate empirical assessment illustrates the complexity and uncertainty of trade-environment interactions. Still, some important features can be discerned. First, in general there is relatively strong support for income links and a U-shaped relationship between income and environmental damages (with marine catch an important exception). That is, harm to the environment accelerates as incomes rise in lower income countries, then decelerates after a point, with important differences in the income threshold. Where income *growth* can be examined through time-series data, it does not appear that more rapid growth does greater environmental harm. Hence, as Lucas concludes (1996, 275): "even if it proves true that the transition of the poorer nations into greater affluence damages the environment, a more rapid transition does not seem to worsen the process." Second, there is very little support for the proposition that a greater outward or trade orientation, measured by the ratio of exports to GDP, is generally associated with greater environmental damages. In fact, Lucas concludes that in general his estimates "indicate less harm to the environment as export orientation increases, especially among smaller countries—though there are notable exceptions to this" (1996, 275).

Sectoral and Country Impacts: Manufacturing Sectors

We turn now to specific two-digit sectoral data for the LAC region. We have used LAC employment data developed by the World Bank for the same sectors reported in the trade discussion previously to estimate their comparative contribution to pollution levels by combining ISIC employment levels with coefficients for pollution outputs drawn from U.S. data from 1987 (Hettige et al. 1995). These U.S. coefficients may under- or overstate the pollution effects of various industries in the LAC region, but we believe that they are reasonably reliable predictors.

We first calculated employment for various years from 1985 to 1993 in thousands for each of the following LAC sectors analyzed above: Food Products, Textiles and Apparel, Wood Products, Paper and Printing, Industrial Chemicals, Nonmetal Products, Basic Metals, and Metal Products. Then, using the 1987 U.S. coefficients, pollution intensities were calculated for each of the following types of pollution: Particulates (PT), Carbon Monoxide (CO), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Volatile

Organic Compounds (VOC), Toxic Landfills (TL), Metals in Air (MA), Metals in Water (MW), Metals on Land (ML), Particulate Matter (10 microns or less) (P10), Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), Toxic Air Emissions (TA), and Toxic Water Emissions (TW).

Using these categories, pollution by sector and pollution attributable to exports by country are shown in tables 11 and 12[7]. Sectoral industrial activity was ranked by its pollution intensity (per 1,000 employees), and the industrial sectors with the three highest and three lowest coefficients were recorded to reveal high-intensity polluting sectors and low-intensity polluting sectors, respectively. For the LAC as a whole, these data revealed that the most highly pollution-intensive sectors were: Basic Metals, Industrial Chemicals, and Nonmetal Products. In contrast, the lowest intensity polluters were: Textiles, Metal Products, and Food Products, though this last category is relatively high in particulates and BOD. Wood products and paper products showed mixed results, high in some categories of pollution and low in others.

Countries were then considered by groups to determine the geographic concentration of various pollution-intensity sectors. Most important, this pollution intensity was linked back to the export trend data reported in Table 7, so as to determine, roughly, the extent to which export activity and pollution intensity coincided, assuming fixed levels of pollution per 1,000 employees. In the following discussion, countries were grouped according to membership in various regional agreements, such as the Central American Common Market (CACM), Group of Three (Colombia, Mexico, and Venezuela), Mercosur, and the Andean Pact Group. These results are summarized in Table 7.

Central American Common Market

Data for the CACM (Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua) were incomplete: no data were available for Nicaragua and only one year's worth for El Salvador. For each country, the time period for which data are available is shown in parentheses.

Costa Rica (1986–91). Costa Rica had a liberalization episode in 1986 followed by the strong liberalization package in 1991. (*See Table 3.*) The level of exports as a percentage of production in both the low pollution-intensity sectors and high pollution-intensive sectors alike climbed steadily over the period, with food increasing from an export level of 7 percent to 11 percent and metal products from 24 percent to 27 percent. Textile's export percentage jumped from 27 percent to 47 percent between 1985 and 1987 and then leveled off at 43 percent. Nonmetal products

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[7] See Faeth and McGinnis (1997) for additional information for Latin America and the Caribbean on production-related pollution and methodology.

held steady at 16 to 15 percent while industrial chemicals rose from 16 percent to 21 percent.

Honduras (1985–88). In Honduras, low pollution-intensity industries such as textiles and apparel and food products are export oriented, although there is a substantial subsistence economy in both sectors as well. However, our data for pollution intensity precede the liberalization of 1990, reported as a "weak" package in Table 3. The textile exports sector as a percentage of production was steady, around 6 percent, while food ranged between 6 and 9 percent (although this percentage was falling over the period for which we have data). At the high end of pollution intensity, no data were reported for basic metals; industrial chemical exports fell from 4 percent to 3 percent of production; and nonmetallic minerals rose from 0 to 6 percent. As shown in Table 12, total pollution attributable to export activity in Honduras is small, even compared to other CACM members.

Guatemala (1985–88). Data for Guatemala precede the liberalization measures of 1991, which were considered a strong policy package, as reported in Table 3. An earlier liberalization package occurred in 1986, leading to major increases in exports as a share of production in 1987 for all industries. However, export shares plummeted in 1988, making interpretations difficult. The low pollution-intensive sectors of textiles, metal products, and food generally exported a larger share of production than high pollution-intensive sectors such as basic metals, industrial chemicals, and nonmetal products. Industrial chemicals, for example, rose in export dependency from 15 percent to 41 percent of production from 1985 to 1987, then fell back to 8 percent in 1988. Basic metals and non-metal products had lower but steadier export reliance, from 11 to 16 percent of production during 1985–87, falling to 5 percent and 2 percent, respectively, in 1988.

El Salvador (1992). Having only one year of data eliminated the possibility of determining trends. However, in the low pollution-intensity sectors of textiles, metal products, and food products, respectively, exports as a share of production were 43 percent, 24 percent, and 7 percent. In high pollution-intensity industries, 61 percent of basic metal production, 15 percent of industrial chemicals, and 8 percent of nonmetal products were exported.

Table 11
Total Pollution Due to Exports by Industry (Metric Tons)

Industry	PT Particulates	CO Carbon Monoxide	SO_2 Sulphur Dioxide	NO_2 Nitrogen Dioxide	VOC Volatile Organic Compounds	TL Toxic Landfills	MA Metals in Air	MW Metals in Water
Food Products	10,225	4,231	13,530	12,322	5,344	1,752	0	6
Textiles, Apparel	1,169	2,731	5,109	6,309	3,615	2,564	8	20
Wood Products	2,407	5,197	875	1,569	4,073	101	2	1
Paper and Print	1,233	19,446	6,406	3,477	1,725	512	2	3
Industrial Chemicals	14,299	177,467	90,747	68,643	59,469	68,934	96	83
Nonmetal Products	9,838	5,221	13,591	8,699	604	495	10	1
Basic Metals	15,253	142,314	108,004	20,334	8,009	26,787	750	67
Metal Products	1,014	6,721	4,169	2,867	9,433	4,843	53	9
Total	55,437	363,327	242,431	124,219	92,270	105,988	920	189

Table 11 (continued)

Industry	ML Metals on Land	PM10 Particulate Matter 10	BOD Biological Oxygen Demand	TSS Total Suspended Solids	TA Toxic Air Emissions	TW Toxic Water Emissions

Table 11 (continued)						
Food Products	30	4,817	14,021	4,556	754	129
Textiles, Apparel	307	135	306.6	550	2,653	381
Wood Products	19	214	59.7	281	787	1
Paper and Print	7	352	3,366	11,321	1,450	299
Industrial Chemicals	2,927	3,168	11,096	36,587	31,693	7,769
Nonmetal Products	66	10,411	16	244	360	9
Basic Metals	20,459	12,175	5,092	528,350	7,423	1,019
Metal Products	1,260	125	85	912	6,613	129
Total	25,075	31,396	34,043	582,802	51,733	9,736

Source: Faeth and McGinnis (1997).

Table 12
Total Pollution Attributed to Exported Production by Country (Metric Tons)

Country	Year	PT Particulate	CO Carbon Monoxide	SO2 Sulphur Dioxide	NO2 Nitrogen Dioxide	VOC Volatile Organic Compounds	TL Toxic Landfills	MA Metals in Air	MW Metals in Water
Argentina	1993	6,877	20,126	24,934	13,780	9,003	10,160	85	15
Belize	1992	195	141	261	241	159	62	0.1	0.1
Bolivia	1991	162	53	179	230	966	45	0.1	0.0
Chile	1991	6,545	26,368	38,763	10,169	6,735	8,082	151	17
Colombia	1991	5,382	164,253	20,162	12,036	7,796	8,744	55	12
Costa Rica	1991	1,530	4,141	5,076	4,066	2,961	2,883	6	33
Ecuador	1990	989	2,931	3,012	2,365	1,999	1,829	3	2
El Salvador	1992	360	1,614	1,814	883	569	698	7	1
Guatemala	1988	675	1,403	1,740	1,349	959	856	1.8	1.0
Honduras	1985	652	990	662	697	962	224	0.6	0.2
Mexico	1992	11,250	43,183	47,488	27,897	25,270	24,825	168	33
Panama	1989	165	169	356	246	108	75	0.9	0.1
Paraguay	1991	368	718	963	789	521	495	0.7	0.6
Peru	1988	6,142	30,369	34,466	11,710	6,983	11,626	187	22
Uruguay	1990	2,360	3,179	5,531	4,411	2,417	2,150	7	2
Venezuela	1992	11,784	63,688	66,962	33,349	24,863	33,234	247	49
Total		55,437	363,327	242,369	124,219	92,270	105,988	920	189

Note: Some countries, notably Brazil, do not report export data to UNIDO, so estimates could not be produced. For production-related pollution estimates for these countries see Faeth and McGinnis (1997).

Table 12 (continued)

Country	Year	ML Metals on Land	PM10 Particulate Matter 10	BOD Biological Oxygen Demand	TSS Total Suspended Solids	TA Toxic Air Emissions	TW Toxic Water Emissions
Argentina	1993	2,337	3,703	6,017	55,220	4,808	926
Belize	1992	3	78	221	90	42	5
Bolivia	1991	3	74	213	73	31	5
Chile	1991	4,102	3,557	4,542	108,023	3,599	582
Colombia	1991	1,501	3,577	2,600	34,185	4,555	912
Costa Rica	1991	161	764	1,042	1,895	1,608	329
Ecuador	1990	96	367	732	1,468	913	201
El Salvador	1992	189	203	277	4,818	355	70
Guatemala	1988	50	344	510	902	445	95
Honduras	1985	13	136	314	275	246	23
Mexico	1992	4,446	6,408	5,165	81,286	15,113	2,278
Panama	1989	24	104	122	570	56	7
Paraguay	1991	21	149	449	375	236	54
Peru	1988	5,133	3,922	3,631	129,302	4,343	830
Uruguay	1990	186	1,313	2,135	3,540	1,203	238
Venezuela	1992	6,810	6,698	6,072	160,780	14,180	3,182
Total		25,075	31,396	34,042	582,802	51,733	9,736

Source: Faeth and McGinnis (1997).

Group of Three (Colombia, Mexico, Venezuela)

Colombia (1986–91). The low pollution-intensity sectors of textiles, metal products, and food showed an increase in export share of production, with textiles up from 13 percent to 36 percent, metal products up from 5 percent to 11 percent, and food products up from 3 percent to 5 percent. In the high pollution-intensive sectors, basic metal export share of production grew from 11 percent to 24 percent, industrial chemicals exports were up from 11 percent to 14 percent, and nonmetal product exports first fell then climbed to 12 percent of total production.

Mexico (1986–92). Although these data do not account for NAFTA-induced effects, they do capture the pre-NAFTA liberalization package of 1985–89 noted in Table 2. Exports as a share of production in low pollution-intensity sectors were mixed, falling then rising for textiles from 41 percent to 51 percent, falling for food products from 8 percent to 4 percent, and rising for metal products from 23 percent to 61 percent, with a 20 percent increase in 1992 alone. In the high pollution-intensity sectors, exports as a share of production fell markedly. Basic metals fell from 22 percent to 13 percent; industrial chemicals remained at about 21 percent until 1992, then fell to 16 percent; non-metal products rose from 14 percent to 19 percent and then fell back to 10 percent in 1992.

Venezuela (1985-92). Data for Venezuela cover quite well the period of liberalization from 1989-91 noted in Table 2. In the low pollution-intensity sectors, exports as a share of production generally rose slightly over the period, with textiles rising from 1 percent to 4 percent, food from 1 percent to 3 percent, and metal products from 4 percent to 7 percent. In the high pollution-intensity sectors, exports as a share of production are much higher, but this share has fallen in all three cases coincident with trade liberalization: basic metals fell from 61 percent to 38 percent, industrial chemicals fell from 60 percent to 50 percent, and nonmetal products from 19 percent to 11 percent.

Mercosur (Argentina, Brazil, Paraguay, Uruguay)

Unfortunately, our analysis of Mercosur is hampered by a lack of data on exports as a share of production for Brazil and only one year of data for Argentina and Paraguay.

Argentina (1993). In the low pollution-intensity sectors, the share of production exported in Argentina stood at 13 percent for textiles, 14 percent for food products, and 8 percent for metal products. At the high end of pollution intensity, the basic metals level percentage was 14 percent; industrial chemicals, 8 percent; and nonmetal products, 3 percent.

Paraguay (1991). At the low end of pollution intensity, in textiles, metal products, and food products, respectively, Paraguay's export-to- production levels were 33 percent, 19 percent, and 56 percent. At the high end, industrial chemicals were 47 percent. Data for basic metals and nonmetal products were incomplete.

Uruguay (1986–90). As noted in Table 2, Uruguay initiated a liberalization package in 1987, prior to the establishment of Mercosur, although this seems to have had a limited impact on exports as a share of production. Over the period, low pollution-intensity exports fell as a percentage of production in textiles from 57 percent to 51 percent, and in metal products from 9 percent to 6 percent. In food products exports rose steadily to 26 percent in 1990. In the high pollution-intensity sectors, Uruguay's exports of basic metals as a percentage of production declined from 17 percent to 13 percent; however, industrial chemicals rose from 8 percent to 13 percent and nonmetal products from 7 percent to 13 percent by 1990.

Andean Group (Bolivia, Colombia, Ecuador, Peru, Venezuela)

Bolivia (1988–91). Bolivia's liberalization policy, initiated in 1985, coincided with increases in exports of production in the low pollution-intensity sectors: from 19 percent to 32 percent in textiles, from 2 percent to 3 percent in metal products, and from 9 percent to 21 percent in food products. Data on high-end pollution sectors were incomplete.

Ecuador (1986–90). With the initiation of its liberalization package in 1990, Ecuador's low pollution-intensive exports in textiles, metal products, and food products, had mixed results. Textiles increased from 1 percent to 5 percent, and metal products from 2 percent to 4 percent. Food products fell from 56 percent to 10 percent. At the high end of pollution intensity, basic metals from zero to 2 percent, industrial chemicals from 1 percent to 16 percent, and nonmetal products from 0 to 3 percent.

Peru (1986–88). Peru's 1990 liberalization package is antedated by our data. Prior to liberalization, Peru's low pollution- intensity sectors' export-to-production levels for textiles rose from 15 percent to 18 percent, metal products from 3 percent to 6 percent, and food products increased from 8 percent to 22 percent. At the high end of pollution intensity, basic metals exports from 44 percent to 97 percent; industrial chemicals held steady at 10 percent; and nonmetal products were similarly steady at 2 percent.

Other Countries (Belize, Chile, Panama)

Belize (1990 and 1992). We have data for only a few industries in Belize. From 1990 to 1992, exports as a share of production in the food sector fell from 62 percent to 53 percent. Metal products exports as a share of production rose from 54 percent to 58 percent from 1990 to 1992. In industrial chemicals, exports accounted for 14 percent of production in 1992.

Chile (1986, 1989–91). At the low end of pollution intensity, Chile's exports as a percentage of production rose for textiles from 2 percent to 9 percent, metal products fell from 45 percent to 9 percent, and food products held steady at 18 percent. At the high end of pollution intensity, basic metals export rose from 45 percent to 62 percent of production, industrial chemicals rose from 7 percent to 10 percent, and nonmetal products rose from 1 percent to 7 percent then fell back to 3 percent.

Panama (1985–89). Panama experienced increases over the period in exports as a share of production for both low and high pollution-intensity sectors, with the exception of food products. At the low end of pollution intensities, textiles increased from 20 percent to 43 percent; and metal products from 2 percent to 8 percent. Food products fell from 9 percent to 5 percent. At the high end, basic metals rose from 11 percent to 22 percent, and nonmetal products rose from1 percent to 6 percent. Data for industrial chemicals were incomplete.

Summary

This detailed assessment of both high and low pollution-intensity sectors illustrates how complex and variable are the linkages from export growth to pollution intensity. It is tempting to conclude that there simply is no relationship; however, a slight bias can be discerned in the export expansion of low pollution-intensity sectors relative to high pollution-intensity sectors, consistent with Lucas' findings. Though capturing elements of allocative efficiency, scale, and the composition of output, these estimates tell us relatively little about two crucial parameter changes. These are the technologies of production and pollution reduction (which are held constant by the use of a single employment-pollution coefficient) and the development of policies to reduce environmental impacts (which were largely absent in most of the countries for the period studied).

Sectoral and Country Impacts: Extractive Sectors

As a final empirical basis of trade-environment linkages, we turn again to the extractive sectors. The evidence of impacts is fragmentary and generally qualitative in nature. Many treatments are case studies and do not attempt to separate out the particular role of trade liberalization, as distinct from domestic activity, in assessing environmental impacts. Even so, it stands to reason that expanding economic activity in the LAC region, tied in important ways to more liberal trade, will inevitably impinge on extractive sectors through scale, composition, and technology effects.

Agriculture in the Andean Region

Antle et al. (1996) have attempted to link national-level data and site-specific sectoral units in a model of the agricultural sector of the Andean region, focusing especially on Ecuador. Agricultural products there have, until recently, faced the negative bias that import-substitution policies and overvalued exchange rates imposed. However, the Andean Pact agreements, coupled with national economic policy reforms, may be reversing this bias, leading to expanded areas of potatoes, wheat, and dairy production. Lee and Espinosa (forthcoming) estimated that the impact of these reforms would also be to reduce the effective subsidies to inputs, notably pesticides, making them more expensive to use. In a careful deconstruction of this possibility, Antle et al. (1996) gathered farm-level production data for applications of fungicides on potato crops, formulating an integrated economic/physical simulation model of the potato/dairy sector based on an earlier modeling effort (Antle, Capalbo, and Crissman 1994)

It was estimated that the impact of trade liberalization would be to increase the price of (imported) pesticides by roughly 30 percent and increase potato prices relative to dairy products, although by an uncertain amount. In this probable scenario, it was concluded that water quality in the sampling area may fall in proportion to increases in potato output, because of increases in fungicides leaching into water sources (Antle et al. 1996, 192–93). Even more important to public health in the LAC region may be health effects suffered by pesticide applicators, farmers, and their families (Southgate 1996a). Thrupp, Bergeron, and Waters (1995, 96), citing numerous other studies, have noted dangerously high pesticide use levels in Guatemala on vegetable crops such as snow peas.

An important methodological conclusion emerges from the Antle work: the need to discern "what level of precision is required in the disaggregate economic and physical analysis to be adequate for policy analysis at the aggregate level." The authors hypothesize that "the solution to this challenge lies in the development of geographic information systems that integrate location-specific physical and economic data" (Antle et al. 1996, 196). We will return to this finding in the concluding recommendations of this study.

Agriculture and Mercosur

A separate qualitative analysis of Argentine, Brazilian, Paraguayan, and Uruguayan agricultural technologies reaches similar conclusions (Cap 1996b). Distortions in trade and domestic prices in these countries resulting from previous import substitution policies have created disincentives to farmers' applications of agricultural inputs. Production to date has tended to occur at the extensive margin, bringing more land into cultivation rather than expanding output through intensification. Although this led to environmentally destructive land-clearing in certain countries (notably Brazil), it ironically left Argentine and Uruguayan agriculture in a low-input mode, with soil erosion its only real negative external effect. Today, however, with the advent of Mercosur and new liberalization initiatives, shifts away from extensive and toward more intensive agricultural production are expected. Considering agriculture's inordinate role in these economies, many significant environmental impacts will most likely occur in the next decade.

Several examples of these impacts are noted in the case of Argentina by Cap (1996b). A spectacular increase in the area subject to groundwater irrigation in the Pampean Region of Argentina is one such case. Although hard data on actually irrigated areas are not yet available, sales of irrigation equipment are booming, and analysts estimate that a million hectares of corn and wheat may be irrigated by the turn of the century. The source of water used for this irrigation is the Puelches aquifer. Current information on the present and potential depletion rate, as well as the recharging capacity, of this aquifer is lacking. Partly as a consequence, no regulations exist specifying minimum distances between wells or other practices affecting the property rights of persons extracting water. The implications of the potential impact of this process on a critical component of the resource base of that region could be serious.

In the same region (the Pampas), other input-use intensity has also skyrocketed. It has been estimated that for the planting season 1996, some 60 percent of the wheat will be fertilized. Only five years ago, it was less than 10 percent. Resulting increases in concentrations of nitrates in groundwater will be the result. New direct-sowing techniques being adopted by farmers at a rate well above trend also implies the use of larger quantities of herbicides than before. While costs and soil erosion rates may decline, water pollution will rise.

In the temperate south of Brazil, soybeans are grown on relatively fragile soils. Should current price increases prove to be more than a bubble, expansion of cultivation over more marginal areas will result. Eroded topsoil containing chemical residues is already being washed down the Paraná River and clogging waterways in Argentina. The magnitude of this transboundary impact could eventually pose a serious threat to the entire basin. No specific institutions exist at this time to deal with this situation.

Finally, an 80,000-head feedlot (plus packing facilities) is currently being set up in Salta, in the Northwestern region of Argentina, positioning the investing firm to target the recently opened Bolivian beef market. For irrigation purposes, some analysts estimate that up to one third of the Juramento River might have been diverted to serve this facility. The impact of this event on the river basin ecosystem is unknown.

In an overview of environmental stresses on agricultural lands conducted for the International Food Policy Research Institute (IFPRI), Scherr and Yadav (1996) attempted to isolate "hot spots" where these stresses were greatest for the LAC region as a whole. These are summarized in Table 13. Relevant trouble areas include seven categories: nutrient depletion, salinization, erosion, deforestation in threatened habitat, vegetation degradation, water scarcity or conflict, and agrochemical pollution.

As the table shows, nutrient depletion is a particular issue in parts of Central America, the Andes, Brazil, Bolivia, and the Caribbean Basin. Salinization is most pronounced in Northern Mexico and in rapidly developing irrigated areas. Erosion is especially serious in Central American, in the Andes, Haiti, and Brazil. Deforestation linked to agriculture and threatened habitat is most notable in the humid Amazon and lower Amazon Basin; on Central American hillsides; in parts of Paraguay, Colombia, and Ecuador; in the Chaco region; and in the Atlantic lowlands of Central America. Vegetation degradation is notable in Haiti, Northeast Brazil, the lower Amazon Basin, and the Caribbean lowlands. Water scarcity is now clear in the Paramo area. Finally, agrichemical pollution is manifest on banana plantations and in Bolivia and Mexico.

Table 13
"Hot Spots" for Land Degradation in Latin America

Nutrient Depletion	Salinization	Erosion	Deforestation in Threatened Habitat	Vegetation Degradation	Water Scarcity or Conflict	Agrochemical Pollution
Subhumid Central American hillsides[a] Semi-arid Andean valleys Northeastern Brazil Santa Cruz, Bolivia Caribbean Basin lowlands intensification	Northern Mexico Highland irrigation systems[a] South American irrigation zones[a]	Subhumid Central American hillsides[a] Semi-arid Andean Valley Haiti Cerrados of Brazil	Humid Amazon and Central American hillsides Lower Amazon Basin Itapua, Paraguay Pacific rainforest of Colombia and Ecuador Chaco region[b] Atlantic lowlands of Central America	Overgrazing in Haiti Northeast Brazil Lower Amazon Basin[b] Overgrazing in Caribbean Basin lowlands	Paramo	Banana plantation pollution Santa Cruz, Bolivia, intensive agriculture Periurban agriculture in Mexico City

Source: Adapted from Scherr and Yadav (1996), 12–13.
[a]Current problem, expected to improve by 2020.
[b]Problems will become important by 2020.

Forest Sector Impacts

As described above, the environmental destruction of the forest sector seems only indirectly linked to trade liberalization (Barbier et al. 1994). Yet despite this point of view, specific forest sector activities should not be overlooked, including large-scale tropical timber concessions to international companies, smaller concessions to local timber interest and national companies, and plantation forestry. Unfortunately, we are aware of no systematic analysis of how these specific forest projects are influenced by trade. We will, however, make note of the need for management expertise and agroforestry property rights managements in the sections to follow.

In the recent analysis of Stone (1996) noted previous, the most significant environmental changes in Brazilian Amazon forestry practices from 1990 to 1995 involved the adoption of large skidders. Because they run on rubber tires, skidders reduce environmental damage to the forest floors, although they often perform poorly in tropical conditions. As a result, the bulldozer remains the technology of choice. As Stone concludes, limiting the damage done by such clearing requires forest management planning, which in turn requires changes in policy to encourage, through imposition of environmental liability, replanting and reduced levels of destruction.

In addition to these direct environmental challenges, there are important cross-sectoral linkages from agriculture to the forest sector. Southgate (1994) has provided the most thorough assessment of these interactions, using regression analysis to explain forest encroachment throughout Latin America as a symptom of agricultural underdevelopment. As he notes, all else being equal, "increased domestic or international demand for agricultural commodities leads to an outward shift in the sector's extensive margin" (Southgate 1994, 135). But the magnitude of the shift depends on the land available for production and the capacity to exploit this land by applying appropriate agricultural inputs, including labor, managerial talent, fertilizer, and machinery. The land available is largely a reflection of property arrangements and the definition of property rights. As many analysts of deforestation have noted, it is customary throughout much of the agricultural frontier of Latin America to make secure claims of property contingent on land clearing (Southgate et al. 1991). Hence, to overcome the land constraint, deforestation is virtually a requirement.

To determine the relevance of this land constraint, Southgate compared potential agricultural land with actual use for those Latin American countries in nutritional deficit. As shown in Table 14, conditions do not favor frontier expansion in Bolivia and Peru, and the frontier is essentially closed in Haiti, Uruguay, Costa Rica, Nicaragua, Honduras, El Salvador, and Guatemala. Though not tabulated, prospects are also limited in the Dominican Republic and Jamaica. As a result, in countries such as Colombia and Ecuador, as well as in non-nutritional-deficit countries such as Brazil, the land constraint can be eased by frontier settlement and hence deforestation.

Table 14
Current versus Potential Agricultural Land Use in Selected Latin American Countries with Widespread Nutritional Deficits

Country	1987 Agricultural Land (Million Hectares)	Potential Agricultural Land (Million Hectares)
Bolivia	30.1	30.0
Colombia	17.5	44.0
Ecuador	7.6	12.5
El Salvador	1.3	1.3
Haiti	1.4	0.6
Honduras	4.3	3.3
Peru	30.8	33.6

Source: Southgate (1994), 136.

Examining the linkages further, Southgate developed an analysis of 24 LAC countries based on data for growth in agricultural land use, population growth, exports, and agricultural yields. Results show that population and export growth are both associated with growth in agricultural land use but that yield increases can offset this growth. This implies that intensification is a direct substitute for extensive land clearing. Where natural conditions do not favor frontier expansion, the annual increase in cropland area is expected to be 0.641 percentage points lower than in areas where "unoccupied" land is available for settlement.

These results have important general implications. First, they suggest that while population growth is a significant factor in increasing demands for agricultural commodities, it can be offset by productivity increases. If these increases occur at the intensive, rather than the extensive margin, deforestation pressures will lessen, although pesticide uses and soil erosion are likely to increase. Southgate estimates that in Chile, for example, if yields had not risen during the 1980s in response to a pattern of trade liberalization, a 17.5 percent growth in agricultural exports combined with a 1.7 percent annual population growth rate would have induced frontier expansion and associated deforestation exceeding 1.0 percent a year. Yield increases allowed Chile's extensive margin to remain stable, but more intensive production led to major increases in chemical inputs. Between 1985 and 1988, nitrogen, phosphate, and potash imports to Chile rose by 154 percent, 120 percent, and 355 percent, respectively, in real terms (Arensberg et al. 1989). As noted above for the Mercosur countries, this can result in solving one environmental problem by exacerbating another. Finally, Southgate notes that a critical factor linking agricultural land use to deforestation in the LAC region is the definition, or lack of definition, of property rights: "Vast stretches of the region's tropical forests continue to be open access resources in which individuals can secure property rights by removing natural vegetation."(Southgate 1994, 144). As long as this tenurial regime remains, deforestation will continue.

In addition to the linkages from agricultural land settlement to deforestation, there may be other somewhat oblique relationships between deforestation and trade expansion. Trade-induced technical changes employing less labor in rural areas can push migrants to frontier areas. In Brazil, the mechanization of soybean production is often alleged to have had this result (Mahar and Schneider 1994). However, as noted above, Southgate concludes the opposite for Chile, where technical changes in agriculture seem actually to have resulted in sharp reductions in incentives to migrate. This suggests that the effects of technology on the environment are often difficult to appraise.

Another possible linkage is from deforestation to trade-induced road construction. Mahar and Schneider note the double-edged nature of this issue:

> Although the Amazon region's centuries-old isolation from the more dynamic parts of the country had arguably retarded its economic development, it had also protected the rain forest (as late as 1975, only about 0.6 per cent of the Brazilian rainforest had been cleared). Similar situations prevailed in other frontier areas of Latin America before the advent of roads. The reasons for this are not difficult to fathom. As Bromley aptly notes in reference to the Oriente of Ecuador: ". . . the colonist in roadless areas not only suffers great social isolation, but also a marked economic disadvantage relative to producers in other parts of the country" (Bromley 1981, 22; Mahar and Schneider 1994, 161).

Whether the impact of further road expansion on the environment will continue in parallel with further trade expansion in the LAC region is the subject of debate. Recent evidence from Brazil based on satellite imagery suggests a dramatic reduction in the pace of deforestation, which seems to have peaked at about 40,000 km^2 in 1987 and has fallen to an annual rate of 10,000 km^2 in the 1990s (Mahar and Schneider 1994, 171). This trend may be due primarily to economic recession (or to reduced cattle subsidies). However, if other incentives such as absence of well-defined property rights persist, there is reason to believe that rapid road expansion and economic growth due to trade in Mercosur will renew pressure on forest resources.

Perhaps the best overall assessment of linkages in the forest sector is offered by the FAO's Bourke:

> Trade is not a dominant factor in environmental problems but neither is it blameless. It is clear that international trade is not a major cause of the factors that underlie deforestation of the world's forests—population pressure, poverty and problems with land tenure. Trade measures have their most direct impact on cross-border product flows and prices while most serious environmental problems are not the result of any cross-border movement of products. Changes in international trade flows will thus have little influence on the problems. Nevertheless, trade policies and practices do have consequences for the environment; these can be both positive and negative and can be found at all stages from the forest to the final consumer—in the forest, during processing, in the distribution of the raw material and the products, and even after consumption itself (1995, 183).

Fisheries and Marine Coastal Resources Impacts

The environmental impacts of expanded trade on fisheries and coastal resources, as in the forest sector, are somewhat indirect. Even so, some general trends related to overfishing and stock depletion are worth emphasizing. Overfishing is characterized by a drop in stock recruitment and an increase in the inter-annual variability in the yield of the stock. Increased worldwide demand for fish products can be one factor contributing to commercial overfishing. Fish species that are particularly vulnerable to commercial overexploitation include those that congregate to spawn (for example, haddock, cod, groupers) and those that migrate through many jurisdictions and are thus vulnerable at many points (for example, tuna and billfish).

For the most part, trade does not directly lead to overfishing; such environmental degradation is caused by the absence of, or nonadherence to, conservation and enforcement measures. For many of these overfished species, trade may have contributed to the threats of overexploitation, but this has to be placed within the more general problems of fisheries management. In countries where there is a weak fisheries management system and in the oceanic high seas where international management is problematic, overexploitation—partly generated by the demand for fisheries products—can lead to overfishing and stock depletion. The reality that fisheries are different from most other natural resources must be recognized in fisheries management. The most critical element is the absence of satisfactory property rights, which leads to significant misallocation of the inputs of capital and labor and which is the cause of resource degradation (Christy 1996).

National fishery policy in LAC countries has changed with changes in catch over the decades. During the 1960s, most governments paid little attention to the development of fishery resources. Peru's rapid growth, for example, was initiated by U.S. entrepreneurs and developed mostly without government involvement. In the 1970s, fisheries gained increasing importance to many of the governments. Several attempts were made to develop the industry through the use of large-scale parastatal enterprises (Brazil, Colombia, Cuba, Ecuador, Mexico, Nicaragua, Panama, Peru, and Venezuela). The fishery industry was viewed as simply an extractive activity with an orientation toward increases through one of two approaches: (1) an increase in the number of vessels or improvements in the gear used to fish traditionally exploited stocks, or both; (2) an expansion of the fishing fleet's area of operation to new fishing grounds or exploitation of underexploited stocks.

The general failure of large-scale state-run fishery operations throughout the region initiated a significant change in the policies of most countries and a move toward privatization. Increasing attention to the need for fisheries management is the most recent national policy change. This has occurred as the incidence of depleted stocks has grown and with it the awareness that the opportunities for increased development have declined. Specific attention is now focusing on nursery areas where neonate and juvenile groups of key traded species such as sharks originate. Private investments in shrimp and salmon aquaculture also have placed emphasis on improved management of these facilities. Policy changes in several countries are shown in Table 15.

Chile, for example, has recently moved toward more effective fisheries management. The management strategy is based on the following criteria (Pavez 1992):

- It must take account of the special characteristics of fisheries: in particular, the problems associated with the open access condition, shared resources, and uncertainty.
- It must make provision for regulating access to fisheries.
- It must prevent overfishing, which may in the long run jeopardize conservation of fishery resources.
- It must impose regulations designed to resolve conflicts between artisanal and industrial fishers.
- It must impose regulations designed to minimize the fishing industry's polluting effects.
- It must formulate fishery legislation that clearly defines the rules of the game and offers appropriate incentives to each participant in the fishing sector.

- It must establish flexible management that can adapt to changing social, biological, economic, and political conditions.
- It must strengthen the institutional framework to develop and manage fisheries production systems.

There are relatively few opportunities in the LAC region for development assistance projects or government policies aimed at increasing fishery production. Today, capital investments leading to increased fishing effort, without effective management measures, will produce damaging consequences in all but a few situations. Thus, the most significant opportunities are in the area of fisheries management where improvments could lead to significant increases in fisheries' contribution to national economies.

Table 15
Policy Changes to Improve Fisheries Management

	Chile	Colombia	Peru	Mexico
Problems	Fish resources over exploitation. Industry over investment. Rent dissipation. Coastal-zone degradation.	Overexploitation of coastal fish resources. Degradation of coastal environment. Uncontrolled introduction of exotic species. Lack of enforcement and surveillance. Lack of trained fisheries management staff.	Overexploitation of fish resources. Outdated fishing fleet and industry overinvestment (fleet and processing plants). Ineffective control and enforcement. Coastal pollution.	Resource overexploitation. Industry overinvestment. Pollution and degradation of coastal environment.
Policy	Limit access of fishing effort. Control of harvest levels.	Limit access of fishing effort. Control harvest, processing and marketing levels.	Limit access or fishing effort. Property rights allocation. Promote local consumption of fisheries products.	Limit access or fishing effort. Promote development of higher value products. Promote local consumption.
Means	TURFs (territorial use rights in fisheries) on experimental basis for artisanal fisheries. Fishing permits, licenses and leases. Season and area closures. TACs (total allowable catch) and ITQs (individual transferable quotas). Fish size and gear restrictions.	Permits, licenses, leases, user fees. Gear restrictions. Season and area closures. Nontransferable individual quotas. Sanctuaries.	Private limits on harvest rates. Public controls on catch (TACs, season and area closures) and on inputs (licenses, permits, and gear restrictions). ITQs and taxes on catch	Season and area closures. Leases, fishing permits, ITQs. Gear restrictions.

Source: Aguero (1995).

Minerals

As discussed above, minerals extraction can have important effects on local ecosystems. Less well understood are even wider ranging effects of some minerals practices that can pollute large ecosystems and influence global change. In the Bolivian and Brazilian mining sectors, a combination of foreign investment and a lack of regulation of wildcatters or garimpeiros pose important environmental challenges. In the Bolivian highlands, one of the most significant consequences of mining is soil erosion and the resulting pollution of freshwater sources (Zimmerer 1993). However these problems have also attracted some pollution-prevention technologies. Japan's Dowa Mining corporation is planning a prototype Bolivian facility to extract environmentally harmful metals from mine drainage.

In Brazil, as well as in parts of Bolivia, Colombia, French Guiana, Guyana, Peru, Surinam, and Venezuela, mercury pollution from gold mining is a major challenge, especially to the Amazon ecosystem. An estimated 200 tons of mercury entered the environment from gold mining in 1995. Mercury is used to coat sieves through which river sediment and mud is drained. The mercury bonds with the gold, but much drains through and enters the mine discharges. The mercury-gold amalgam is then heated to separate the gold, and mercury escapes as gas. Chronic exposure to mercury leads to poisoning, although the symptoms are often confused with tropical diseases such as malaria. Mercury is absorbed through fish as methylmercury, and fish are a staple throughout the Amazon Basin. Attempts to mandate the use of closed mercury extraction technologies, or to eliminate the use of mercury or to recycle it, have met with limited success.

In the copper industry in Chile, the principal environmental issues arise from arsenic and carbon monoxide emissions from copper smelters, which pollute the air, soil, and water in the vicinity of the mine, including coastal fisheries. The willingness to redefine the "right to pollute" is, however, increasing in Chile, especially in the conduct of Coldeco, the state mining company. In July 1994, the largest copper mine in the world, at Chuquicamata, Chile, was forced to close its furnaces for a month in order to comply with new environmental standards. Coldeco has agreed to spend $250 million to $300 million over the next decade to control gas emissions at this one plant alone. Because some of the gases released also threaten atmospheric ozone, Chile is also obligated to control these emissions under the terms of the Montreal Protocol on Substances that Deplete the Ozone Layer.

In Peru, rapid growth in iron, copper, and gold mining is occurring, especially since Peru's widespread privatization initiatives. Resulting tailings and mine wastes remain largely unregulated and have affected drinking water and left significant trace amounts of heavy metals in marine life along the Peruvian coast. Lead concentrations traceable to mining have entered the Rimac River, upstream from Lima, which supplies 70 percent of the city's drinking water. Emphasizing the need to monitor mining emissions, the Mining Ministry of Peru (MEM) has identified three critical environmental areas in need of study: the Ilo/Lacumba Basin, the Montero Basin, and the Rimac Basin. Some transnational investors in the Peruvian mining sector have sought to introduce pollution-prevention technologies. The Southern Peru Copper Corporation (SPCC), which is majority U.S.-owned, embarked in the early 1990s on a $300 million program to use new solvent extraction and electrowinning plants at its two largest mines, increasing production in the process (*Wall Street Journal* 1995).

While all of the minerals discussed here are traded internationally, it is largely the domestic regulatory structure that determines the means and methods of their extraction. In many ways like forestry, mining activity has major environmental impacts, but they are difficult to trace to trade expansion per se.

Multiple Sectoral Impacts: Venezuela

In one of few country studies linking trade and its environmental impacts across multiple sectors, the North-South Center of the University of Miami examined over 20 sectors in Venezuela to determine where these impacts would likely be greatest (Harwell et al. 1994). Primary attention fell on the petroleum sector, which was in turn disaggregated into oil, orimulsion, gas, and petrochemicals, including plastics and fertilizer. However, other sectors were also examined (summarized in Table 16), depending on their potential for growth under trade liberalization with and without accompanying safeguards from a hypothetical environmental pact. Table 17 ranks a variety of environmental stresses by their level of risk to the environment. These tables are reproduced as a potential guide for replication elsewhere in the LAC region.

Table 16 shows the trade effects on various economic sectors under three regimes: no free trade; free trade without an environmental pact; and free trade with an environmental pact. Unsurprisingly, many sectors show potential for higher sectoral growth under freer trade, notably oil, orimulsion, gas, plastics, chemicals, tropical fruits, fisheries, transportation, and cement. Of most interest is whether an environmental pact would constrain this growth or growth in other sectors. As reported, such an effect would occur in plastics, chemicals, tropical fruits, fisheries, and cement.

Table 17 then proposes a ranking of environmental risks for Venezuela, showing highest risks in habitat alteration, biological depletion, and climate change. Oil related stresses come next, followed by solid wastes, nutrients, groundwater alterations, acid deposition, and a variety of hazards and lower level pollution threats.

This qualitative assessment offers some general conclusions, at least for Venezuela. First, the fossil fuels sector (oil, orimulsion, and gas) emerges as a cause of many of the highest stress/highest risk scenarios. Since oil is the dominant sector in the Venezuelan economy, such effects are likely to be severe unless policy innovations are designed to contain and reduce them. A similar possibility exists in the plastics, fertilizer, and chemical sectors as well as in aluminum, iron and steel, hydroelectric generation, and phosphates. However, the major environmental stresses, even in Venezuela, are likely to be in forestry and forest products and fisheries. When examined from an ecosystem perspective, these stresses are most likely to damage freshwater and coastal ecosystems (Harwell et al. 1994, 24).

Table 16
Revised Growth Potential of Economic Sectors by Scenario, Venezuela

	Economic Sectors	No Free Trade	Free Trade Without Environmental Pact	Free Trade with Pact
1	Oil	↑	↑↑	↑↑
2	Orimulsion	↑	↑↑	↑↑
3	Gas	↑	↑↑	↑↑
4	Plastics	↑	↑↑	↑
5	Fertilizer	↑	↑	↑
6	Chemicals	↑	↑↑	↑
7	Aluminum	↑	↑	↑
8	Iron and Steel	↑	↑	↑
9	Hydroelectric	↑	↑	↑
10	Phosphates	↑	↑	↑
11	Forestry	↑	↑	↑
12	Tropical Fruits	↑	↑↑	↑
13	Food and Beverages	→	→	→
14	Fisheries	↑	↑↑	↑
15	Genetic Resources	→	↑	↑
16	Coal	↑	↑	↑
17	Tourism	↑	↑	↑
18	Transportation	↑	↑↑	↑
19	Gold and Diamonds	↑	↑	↑
20	Cement	↑	↑↑	↑

↑ potential for sectoral growth under free trade;
↑↑ potential for high sectoral growth under free trade;
→ no sectoral growth potential under free trade.
Source: Harwell et al. (1994), 54.

Table 17
Relative Risks and Environmental Stresses, for Venezuela

Highest Risks (Level 1)	
• Habitat Alteration Soil Degradation Urban Development Wetland Degradation Dams Hydrology Changes Shoreline Development and Alteration Deforestation Recreation-induced Stresses Navigation-induced Stresses (fluvial and coastal) (e.g., noise, channelization) • Biological Depletion Extinction Decrease in Biodiversity - Genetic, Species, and Ecosystem Diversity Overexploitation of Populations Community Composition Shifts Biological Catastrophic Events (e.g., coral bleaching) Threats to Human Indigenous Populations • Climate Change Global Regional Regional	• Stratospheric Ozone Depletion
High Risks (Level 2)	
• Oil-related Stresses Oil Spills Oil Emulsion Spills Vulnerability to Catastrophic Events Operations - Exploration and Exploitation	• Agrochemicals Pesticides, Herbicides, Fertilizers
High Risks (Level 3)	
• Solid Wastes Municipal Solid Wastes Toxic Solid Wastes Non-biodegradable Litter	• Airborne Toxic
High Risks (Level 4)	
• Nutrients - Phosphorus and Nitrogen • Groundwater Alterations Water Quality (Potability, salt water intrusion, etc.) Water Quantity	• BOD and COD • Turbidity
High Risks (Level 5)	
• Acid Deposition • Hazards Human Geological/Natural	• Subsidence
High Risks (Level 6)	
• Acid Inputs to Surface Waters • Noise	• Thermal Pollution
High Risks (Level 7)	
• Biotechnology Radionuclides (e.g., hospital wastes, low-level wastes, and mining wastes)	• Introduced Species

Source: Harwell et al., (1994), 55.

Conclusions: Establishing Sectoral and Geographic Priorities

The preceding analysis suggests that the allocative efficiencies of trade liberalization, whatever their environmental merits, have been accompanied by scale, composition, technology, and policy effects. We have seen statistical evidence of the scale of economic activity: growth which in the wake of more open trade, is likely to put pressure on the environment in specific areas, including agricultural land use, minerals extraction, and marine ecosystems. At the same time, the sectoral composition of industrial production most affected by export growth shows a slight bias in the direction of low pollution-intensity industries such as textiles, metal products, and food products, although high pollution-intensity sectors such as basic metals, industrial chemicals, and nonmetal products also expanded in response to export demand in some countries. Technologies responsive to environmental pollution are sometimes observed, such as innovations in mining and mineral extraction, but such examples tend to be relatively isolated. Similarly, policies that establish clear limits on environmental damages, by defining rights to pollute and associated liabilities, are much more the exception than the rule throughout the LAC region. As a result, regulation-driven incentives for technological innovations preventing pollution are weak.

Even so, the country and sector-level data reported above, together with estimates of pollution by sector, do allow environmental priorities to be more clearly established, although these should be understood as provisional. Sectoral priorities may be divided into manufacturing and extractive industries.

The two-digit sectoral analysis conducted in this study indicates that three highly polluting manufacturing sectors merit particular attention: Basic Metals, Industrial Chemicals, and Nonmetal Products. These sectors are not large in all LAC countries but are nonetheless likely to be environmental "hotspots." Broadly speaking, export expansion appears more likely to favor relatively low pollution-intensity sectors, specifically textiles, metal products, and food products.

In the extractive sector, the sectoral policy priorities are: forest policies, agricultural land and input use, marine ecosystems, and minerals extraction. Forestry is an important target for technological and institutional innovation not so much because it is directly affected by trade, but because of its ecological significance and the current degree of policy failure in the sector. This significance extends from its impacts on land and water use and biodiversity to its contributions to global CO_2 levels as a carbon sink. Its links to trade, while oblique, are connected in important ways to the second priority: agricultural land and input use. In many Latin American countries such as Argentina, Brazil, Chile, and parts of Ecuador and Mexico, agricultural lands are likely to come under great pressure as patterns of cultivation and input use become more intensive. Resulting water use in irrigation, combined with increased pesticide and fertilizer on grain and vegetable crops, will increase problems of both water quantity and quality. Productivity gains resulting from this intensification are important, especially in countries such as Brazil, where extensification will otherwise continue on marginal lands and lead to further deforestation. However, productivity increases can themselves pose such environmental challenges as pesticide overuse, which may equal or exceed problems of deforestation. Marine ecosystems throughout the LAC region are threatened, not necessarily as a direct consequence of trade, but through the complex combination of interacting factors described above. In this area, problems of management and property rights suggest a powerful potential role for technical assistance, to be discussed in this study. In minerals extraction, priority needs to be given to the development of technical means to extract ores with minimal wastes and discharges, including recycling of mercury in gold production and land reclamation. Because basic metals are also identifiable as a highly polluting manufacturing sector, smelting and other conversion processes that despoil air, land, and water need special attention. In addition, efforts should be made to develop, country by country, the type of qualitative but detailed sectoral analysis shown for Venezuela, pioneered by Hartwell et al. (1994).

Turning to country priorities, a useful rule-of-thumb in connection with the broader process of trade reform is to concentrate resources where the *leverage* of possible market access makes the promise of trade expansion worth the effort of developing corresponding and related environmental improvements, as suggested by the experience of NAFTA (Runge et al. 1994). Countries with the most to gain from trade expansion, notably the enlarging Mercosur group, Mexico, and the Andean Pact signatories, are also the ones most capable of undertaking a parallel set of environmental initiatives. In effect, what is proposed is to link market access by these countries and groups of countries to commitments to address priorities in the sectors just discussed as a condition of this access—a form of "environmental conditionality" (Runge et al. 1994, 26–27; Caldwell and Wirth 1996, 582–83). This pragmatic basis for targeting assistance allows trade and environmental objectives to be made both complementary and mutually reinforcing.[8]

These sectoral priorities are appropriate for consideration by the several institutions created alongside regional trade arrangements to oversee environmental issues, including not only NAFTA's Commission on Environmental Cooperation (CEC) but also the new agencies formed under the Cartagena agreement. We turn now to the elaboration of more specific strategies for innovation, followed by key principles, conclusions, and recommendations.

[8] An indication of the possibilities for such linkage is the position of the North-South Center in its case study on Venezuela.

> For many sectors and for many stresses, especially for the higher-risked environmental problems of particular importance to Venezuela, there are ample opportunities for an appropriately constructed and implemented environmental pact to reduce substantially the adverse environmental stresses resulting from a free trade agreement. Since this specifically includes aspects of the oil refining and petro-chemical sectors, the potential benefits to the environment of Venezuela of such an environmental pact are extensive. In the absence of an environmental pact, environmental stresses will be exacerbated, with or without a free trade agreement (although a free trade agreement is considered likely to result in such stresses more quickly than the present trade-liberalization situation). However, the development of a free trade agreement, with the concomitant enhancement of economic possibilities for Venezuela, presents the important opportunity to couple it to an appropriate environmental pact, allowing the economic benefits to support the attainment of environmental benefits necessary for sustainable development of the resources and economy of Venezuela (Harwell, et.al. 1994, 21).

4. THE TRADE ADVANTAGES OF STRATEGIC INNOVATION

The set of strategies developed in this section are designed to respond not only to the impacts of trade on environment but also to the potential effects of environmental regulation on trade expansion. Certain key strategies can reduce disharmonies that could lead to denied market access.

4.1 Overarching Issues

The overarching issues cut across many if not all sectors and countries in the LAC region and offer opportunities for strategic policy development. These include upward harmonization of environmental measures in the LAC region as a whole, utilizing experience with the HACCP and ISO processes; a no-regrets approach to policy innovation; and the key role of defining and assigning property rights.

Trading-Up: Promoting Joint Upward Movement in Environmental Protection

One of the most important dynamics in advancing environmental objectives in the context of trade policy reform is the capacity to link environmental improvements with the process of liberalization itself. Vogel (1995) has argued that trade liberalization has contributed to trading up—strengthening national regulatory policies in both the United States and the European Union. Although the degree of economic integration necessary to achieve fully harmonized standards is unlikely in the LAC in the near future, it is not unreasonable that NAFTA, Mercosur, and other regional trade pacts should utilize the dynamic process of integration to promote an increase in harmonization. In this respect, development of the HACCP (Hazard Analysis and Critical Control Points) and ISO (International Standards Organization) provides insight into the collective national benefits of upward harmonization. HACCP has been a largely voluntary effort, in the United States and other OECD countries, to develop well-defined protocols to monitor production processes to prevent contamination and spoilage, especially in food and alimentary products such as seafood, poultry, and livestock. The effect has been not only to improve product quality and safety but also to enhance control over production (Unnevehr and Jensen 1996).

The ISO process has been explicitly related to the development of harmonized international standards. Beginning with the ISO-9000 series (and the British forerunner, the British Standards Institution), harmonization has evolved based on individual company and product commitments to environmental management systems (EMS). The current ISO-14000 effort aims to create a “single, generic, internationally recognized EMS standard.” (CEEM, Inc. 1995, 5). Such an effort would include commitments to environmental labeling, life-cycle assessment and product standards. The result of documented commitments to the EMS standards is certification of compliance by the ISO. The dynamic unleashed by the desire to gain a competitive edge under this process has led many companies to upgrade considerably the level and speed of their environmental monitoring. As we will emphasize below, the adoption of environmental management and auditing systems, especially in pollution-intensity industries, can be an important strategy for innovation throughout Latin America and the Caribbean (Heaton, Jr., et al. 1994; Sayve 1996).

No-Regrets Approaches to Policy Formulation

The emphasis here is on specific institutional innovations, especially in terms of regulatory structure and design, but also including research institutions and public health initiatives that respond to environment-trade interactions. Limited data on the environmental impacts of trade liberalization and the fact that trade per se may not always be the direct cause of environmental destruction can both be used to advocate stand-pat policies: that until more is known about the trade-environment interface, countries and agencies should not leap to prescribe remedies based on uncertain information. Yet the information above is sufficient to determine that key environmental impacts are occurring in the LAC region, such as the deterioration of some agricultural and forest lands and rapid growth in some pollution-intensity industries. Even if the linkages from these problems to trade are tenuous, efforts can be undertaken to reduce them. The consequence will be to underpin sustained competitiveness as economic integration proceeds. Analogous to harmonization of standards, while trade may not always *cause* these problems, trade offers a strategic opportunity to link environmental responses in critical sectors to the dynamic process of competition. If, after further experience, it is learned that trade contributes in critical ways to these problems, a mechanism will have been put in place that recognizes and responds to the connection. This is the foundation of a no-regrets approach.

Property Rights and Their Definition

Many of the sectoral areas of greatest concern in the analysis in this study have at their base the inadequate definition of property rights (Lawrence, Bodrik, and Whalley 1996). This is perhaps most obvious in the case of agriculture-forestry interactions, where land clearing is treated as a precondition for secure title in Ecuador, Brazil, and elsewhere, or in cases of overfishing. But the environmental consequences of poorly defined property rights are much more endemic, especially in extractive industries, cutting across forestry, agriculture, fisheries, and minerals production, and across national boundaries as well. Where property rights are undefined or ill-defined, natural resources and environmental amenities in general are treated as open access resources and are subject to overexploitation. Beyond the natural resources sector, where manufacturing industries are granted the “right to pollute” (either implicitly or explicitly) the presumption of liability is in favor of the polluter, rather than the improvement of environmental quality.

This set of overarching issues is not easily summarized as a “tragedy of the commons” (Hardin 1968; Runge 1986). Indeed, common property, in which secure rights of joint use are maintained and enforced, can be important in preserving many types of resources, especially in traditional settings (Runge 1986; White and Runge 1994). It is not common rights *per se*, but ill-defined rights, that are at the base of many problems of resource overexploitation. Even so, many arrangements governing communal tenure in Latin America are deeply flawed, involving restrictions or outright prohibitions on real estate transfers, the dissolving of communes, and the like (Southgate 1996a). In the subsections to follow, we will discuss the importance of building the institutional capacity to assign, define, and enforce private and public property rights for the LAC region as a whole.

4.2 Institutional Innovations: Regulatory, Research, and Public Health Initiatives

The preceding discussion of upward harmonization, no-regrets policies, and better definitions of property rights requires much greater specificity to be implemented in regulatory regimes that directly respond to the LAC’s environmental challenges.

Regulatory Structure and Design

National efforts are needed to develop standards and policies, to define and assign responsibility for environmental damages, and, most particularly, to *enforce* these changes in standards, policies, and property rights. In achieving these institutional innovations, trade can play a critical catalytic function, since the trade-creation process is equally dependent on the emergence of well-defined commercial standards, policies, and liabilities. Whereas trade depends on defining regulations, policies, and property rights for *goods*, environmental protection depends on similar definitions for *bads*. In a recent analysis of pesticide regulation and inter-American trade, Conklin and Thor (1995) note the potential complementarity of trade and environmental protection from the perspective of regulatory design but emphasize the need for new institutional capacity. Specifically, these authors note that because many risks in the pesticide area arise from production and processing issues not covered by GATT instruments such as the Standards Code, additional regulatory capacity is necessary at the national or regional level. Because countries are restricted in imposing processing or product standards on others, coordinating such standards on a regional basis, consistent with the dynamic of “upward harmonization,” would be highly beneficial for LAC countries.

Evidence of the adverse consequences of failure to “trade up” is cited in Thrupp’s (1995, 97) analysis of U.S. Food and Drug Administration (FDA) detentions of LAC exports to the United States resulting from detection of banned pesticides. FDA data show that these pesticide-related detentions occurred about 14,000 times from 1985–95 from 10 countries in Latin America, with economic losses totaling $95 million, with the most serious detentions occurring in shipments originating in Guatemala and Mexico.

Stimulating the process of “trading up” can thus create major opportunities for gains in market access to the Northern hemisphere. Ballenger, Krissoff, and Beattie (1995) develop a simple model of Latin American fruit juice exports to the United States in which farm worker pesticide exposure in Brazil (the source of 54 percent of U.S. fruit imports), Mexico (the source of 10 percent of imports), and Argentina (the source of 8 percent of juice imports) is regulated in return for tariff reductions on U.S. fruit imports. According to empirical estimates, removing the current tariff would increase export revenues for Mexico by 17 percent, for Argentina by 12 percent, and for Brazil by 11 percent. These increases would be reduced modestly if environmental regulations on worker safety were adopted at the level prevailing in the United States, but the overall effect would still be a net gain for fruit juice exporters, indicating the scope for such agreements.

Research Institutions

Public research institutions in the LAC region are, as Eduardo Trigo (1995) described the situation in agriculture, "in deep crisis." This situation arises in part as a by-product of structural reforms that have reduced the role of the public sector. Though generally lauded, these reforms have cut deeply into public spending for research. Between 1977 and 1992, investment in agricultural research in the Latin American region grew by only about 1.5 percent a year, compared with almost 6 percent in 1966–77. In every country in the region except Colombia and Argentina, resources available per researcher fell substantially (Lindarte 1994). Since 1991, even the research budgets for Argentina, Colombia, Brazil, and Mexico, the region's leaders, have fallen in real terms.

At the same time, some additional private-sector research has occurred (Pray and Echeverria 1991). Yet even with private expenditures, net investment in research is still a very small proportion of total national investment, and private foundations, despite large grants, have been unable to fill the void. This situation is of particular relevance if, as in the agriculture-forestry interface, increases in productivity are to substitute for more extensive use of marginal lands. Moreover, virtually no research expenditures are currently devoted to the development of environmental technologies suited to the LAC region's needs. One proposed response has been the establishment of environmental technology intermediaries, such as those established in Chile by Fondación Chile (Maurer 1996; Heaton, Jr., et al. 1994). A particular need in the LAC region will be the scientific research capacity to justify and maintain higher levels of sanitary and phytosanitary standards (SPS), in part so as to avoid bars to market access justified in their name.

A key element in a strategy for institutional innovation will be to give new impetus to both public and private research focused on increases in production across a wide range of sectors, and to link this to environmental research programs focused on sustainability and sanitary and phytosanitary issues. This approach has been undertaken in Argentina by INTA, the National Agricultural Research Institute, but could be beneficially replicated in many other countries and sectors.

Public Health Initiatives

The rapid transformation of Latin American industry and trade, together with increasing intensification in extractive and natural resource sectors, places more and more burdens on the health care systems of the region, at every level. Consider pesticide use, one small part of this issue, noted in our discussion of agriculture. In an evaluation of pesticide use impacts on the human immune system, Repetto and Baliga (1996) note that use of these chemicals has increased dramatically throughout the LAC region. Compared with levels in 1980, by the year 2000 pesticide use is expected to triple. The Pan American Health Organization (PAHO) estimated pesticide intensity in kilograms per agricultural worker per year in nine countries, finding it highest in Costa Rica (14.0 kg), followed by Panama (10.0 kg), Colombia (6.0 kg), Mexico (4.5 kg), Ecuador (2.5 kg), El Salvador (2.5 kg), Brazil (2.3 kg), Honduras (2.1 kg), and Guatemala (1.7 kg) (McConnell et al. 1993). While the impact of pesticide use on human health remains somewhat unclear, it is now believed that exposure to many pesticides may reduce immunodefenses, increasing the risks of infectious diseases and cancers, especially among groups already susceptible because of youth, sickness, or malnourishment. Similar issues surround mercury contamination in and around gold mining and arsenic and other poisons from copper production.

These circumstances suggest a substantially expanded program of epidemiological research and monitoring in regions of rapid agricultural intensification or mining activities, including the border region of Mexico, Costa Rica, Honduras, Guatemala, and Panama, and parts of Ecuador, Argentina, Chile, Peru, and Brazil. This effort will require public health institutions with the capacity to mount and monitor it. In 1994, the World Health Organization (WHO) specifically called for such monitoring as a very high priority (WHO 1994), but too little funding has been allocated in the LAC region for these efforts. Such support could be linked—as in the cases discussed under regulatory structure and design—to guarantees of expanded market access.

4.3 Technology Transfers

Here we deal with technology transfers, including environmental and other technologies that may help to minimize or counteract environmental damages, and the induced technical change that may result from ecolabeling and certification.

In many parts of the OECD, "pollution prevention" has become an integral part of industry strategy, driven not only by compliance with environmental regulation, but by the desire to reduce wasteful or inefficient processes that take away from the bottom line (Runge 1982). In the LAC, the more regulatory structures define standards and property rights so that the "polluter pays," the more attractive pollution prevention will become. Because these circumstances apply currently in the OECD countries, a variety of technologies are in use that could be of considerable utility in Latin America.

Environmental Technology Transfers

The range of these technologies is too large to summarize here, but one interesting example involves wastewater treatment, a particular concern in the border region of Mexico and in population-growth centers throughout the LAC. Considerable investment and entrepreneurial effort has gone into developing low-cost treatment systems—some based on biological processes—designed to prevent wastewater from entering rivers, streams or groundwater reserves (NETAC 1993). A second example involves "precision agriculture" techniques that incorporate geographic and soil information into agricultural-input use decisions. This process lowers both application costs and erosion and pollution due to fertilizer and pesticide uses (Munson and Runge 1990). A third example, linked to the first two, is the application of geographic information systems (GIS) developed from satellite and other data to guide the location and emphasis of land-use interventions to areas where they will contribute most to environmental improvement. Creating opportunities for entrepreneurs and NGOs in OECD countries to join forces with their LAC counterparts will stimulate more rapid convergence on these newer pollution-preventing technologies.

Certification and Ecolabeling

Certification and ecolabeling can be described as institutional innovations, but their main purpose is to induce changes in the technology of production and the processes used for various goods and services. Even the most ardent supporters of these innovations recognize that they are only one tool among many. As such schemes proliferate, some critics argue that they may transmit as much "noise" as they do "signal" (Brooks 1995; Varengis, Primo, and Takeuchi 1993). In addition, issues arise concerning their potential inconsistency with trade rules barring discrimination on grounds of differences in production and processing methods (PPMs). This concern is of more consequence if ecolabeling is obligatory, rather than voluntary. If used to bar market access, are other, less trade-distorting, means available to accomplish the same objective? In the case of forest products, Brooks (1994), for example, concludes that "product differentiation through labeling and certification may be a tool for market access, but there is little evidence that it can support a price premium, therefore, these policies are unlikely to provide a substantial basis for improved forest management" (90). Still, certification and labeling are attractive and popular because they appeal to the power of consumers and seem easy to design.

Others prefer certification to support claims of improved forest management (Cabarle and de Freitas 1995). To be credible—at least for those products that enter international trade—such a procedure must function globally (Schneider 1996) under the authority of an internationally recognized accrediting body, such as the Forest Stewardship Council or the ISO. Barbier (1995), Kiekens (1995), and Southgate (1996b) conclude that certification is part of a larger need for improved forest and natural resource management. However, coordination and harmonization are critical to a system that commands mutual recognition by all trading parties (OECD 1996).

5. PRINCIPLES, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Principles for Sustainable Trade Policy

Our analysis and empirical assessment suggests some organizing principles, conclusions, and recommendations for the conduct of sustainable trade policies in the LAC region. Here these principles are explained and linked to some of the key findings of the study.

Principle 1: Whenever trade and environmental policy issues intersect, both sets of policies should be adjusted so as to maximize the complementarity of trade reform and environmental sustainability.

The hemisphere's record of trade liberalization shows that environmental considerations have often been segregated from structural reform strategies and have been given much lower priority. If higher priority is to be given to environmental issues, a new set of instruments will be needed, aimed primarily at high pollution and extractive sectors. Trade policy reforms alone are unlikely to produce the necessary institutions and technologies in these areas. In addition, it remains to be seen whether, without substantial strengthening, the nascent environmental authority granted to agencies such as the NAFTA Commission on Environmental Cooperation (CEC) or the corresponding Cartagena agreement agencies can deal with the wide range of issues involved.

This first principle emphasizes the need for both trade and environmental policies to be rearranged when problems cut across the two spheres. In the upward harmonization of environmental standards, for example, not only must the United States and other OECD countries reward such action through expanded market access, but certain LAC industries also must be prepared to face somewhat higher costs of doing business (as in the case of worker safety in agriculture and mining). However countries in the LAC region cannot be expected to adjust standards so rapidly that the net gains of greater market access are wholly dissipated (Gray et al. 1995).

A second example involves timber certification. Though useful as one element of an environmental management strategy for tropical timber, certification must not become a form of disguised trade discrimination based on production and processing methods (PPMs), that offers little actual protection to tropical forests.

Principle 2: Sustainable economic growth will require environmental damages (externalities) to be explicitly recognized and, where possible, reduced or eliminated (internalized) through the application of the polluter-pays principle or other environmental policy reforms that emphasize pollution prevention.

The development and transfer of pollution-preventing technologies for the LAC region will occur at meaningful levels only if the governments of the region enforce stringent environmental standards and require violators to pay the costs of environmental damages. In agriculture, for example, excessive use of groundwater for irrigation can be controlled only if all use is carefully monitored and regulations and appropriate price incentives are put in place to encourage water conservation. In the case of fisheries, a similar requirement exists: to define and assign rights and duties in a way that protects fish stocks from overexploitation.

Principle 3: The uncertainty surrounding both economic and environmental indicators—and rapid change—demands a no-regrets, proactive set of trade and environmental policies in which reforms will prove beneficial no matter what.

The difficulty of proving definitive linkages between trade and environmental damage is no excuse for doing nothing in advance to mitigate environmental damage. It does not matter whether expanded trade is the main cause of tropical deforestation, for example. There are still plenty of reasons for improving oversight and management in the forestry sector now. If the forest resource later comes under pressure from global demand for LAC timber, a management response will then be more readily found.

Principle 4: Implementing both trade and environmental policy reforms will require much clearer definitions of property rights respecting goods and services as

well as infringements of those rights by bads and disservices, including environmental pollution.

Developing the political will and economic capacity to redefine rights and duties respecting environmental damages will, in many respects, be the LAC region's most important challenge. The new definition must acknowledge not only that these damages do real harm to individuals, but also that firms and industries cannot escape responsibility for their impacts. Expanded trade will require clarification of rights and duties for goods and services. A protected environment will require clear definitions of rights and responsibilities for bads and disservices. In the Venezuelan petroleum sector, for instance, if trade expansion requires clearer definition of the types and grades of competitive Venezuelan petroleum products, it also requires definition of the impact of oil drilling and refining on the environment and assignment of responsibility for this impact to the firms that cause it.

5.2 Conclusions

Together, these four principles serve as a backdrop and guide to the specific conclusions and recommendations reached in the course of analysis and empirical assessment. Because in a study of this length, it is easy to lose sight of obvious and important conclusions, they are summarized below.

Conclusion 1: According to the available information on trade reforms in the LAC region, liberalization is taking hold rapidly and is likely to continue.

Despite some setbacks in the trade liberalization process, including the Mexican peso devaluation and the halting acceptance of structural reforms in Venezuela, the overall pace of change is dramatic, especially when compared with over 40 years of inward-looking policies that extended into the early 1980s. Regional agreements such as NAFTA, the Andean Pact, and especially Mercosur suggest that the center of this activity may be shifting southward, with its epicenter in Buenos Aires.

Conclusion 2: Information on the environmental impacts of this trade liberalization process is fragmentary but suggests the need for much more explicit attention to environmental objectives.

In much of the LAC region, environmental quality concerns have been an afterthought, at best, whether or not they have been linked to trade. Yet there is reason to believe that greater attention can and will be given to these factors in the future. This is especially likely if environmental improvements are made a condition of expanded market access and if regional groups such as Mercosur, anxious to gain this access, see the process of upward harmonization as one part of a strategic trade policy.

Conclusion 3: Despite limited sector-level data on environmental impacts, the evidence clearly points to existing problems for pollution-intensive industries such as basic metals, industrial chemicals, and nonmetal products, and for the extractive sectors of forestry, agricultural land and input use, marine and fisheries resources, and mining. More country-level multisectoral comparisons are also needed, such as those undertaken for Venezuela.

Some unknown, unexplored sector may pose greater environmental challenges to the LAC region than the industries mentioned above. That unlikely possibility is no reason for delaying action, however, on such well-known and serious threats as mercury poisoning, deforestation, excessive use of pesticides, overfishing, and water pollution, to name but a few. A next step would be to attempt to replicate the methodology used for Venezuela in other key LAC countries and subregions.

Conclusion 4: Country priorities can best be established by determining which countries or groups have the most to gain from trade expansion, then exchanging market-access opportunities for their environmental commitments.

In the LAC region the countries most susceptible to such a bargain are Mexico, Chile, and the expanding Mercosur group of Argentina, Brazil, Paraguay, Uruguay—and soon Bolivia. In addition, Andean Pact countries such as Ecuador are subject to direct approaches of expanded market access similar to those made in relation to reduced drug manufacture.

Conclusion 5: Many environmental problems are linked only indirectly to trade expansion, but this does not prevent trade from being an important basis for expanded efforts focused on sustainability.

If sustainability is truly a policy objective in the LAC region, it can be linked to expanded market access in ways that promote a variety of environmental goals, even in sectors that may not rely heavily on trade. To be avoided, however, are stipulations that are beyond the capacity of LAC countries or which are simply forms of disguised protection.

Conclusion 6: Overarching strategies for sustainable trade expansion include upward harmonization of standards, a no-regrets approach to environmental interventions, and much better definitions of property rights in relation to environmental damages.

Upward harmonization requires recognition that incentives can be created promoting a "race to the top" for strategic trade purposes. No regrets in this context means that environmental policies can be put in place as a safety net, whether or not trade is the primary cause of damages. Finally, property rights must assign responsibility for environmental damages so that the polluter, not society, bears these costs.

Conclusion 7: Critically needed institutional innovations include both monitoring capacity and consistently enforced regulations to protect workers from environmental hazards (for example, pesticides and mining wastes); upgraded research capacity, especially in agriculture-environmental interactions and sanitary and phytosanitary issues; and public health investments to provide epidemiological monitoring and health interventions.

Among all the LAC region's many institutional needs, these three stand out as broad responses to the environmental stresses posed by rapid economic expansion and cross-border trade.

Conclusion 8: Technology transfers focused on pollution prevention are critical.

Avoiding pollution usually costs much less than cleaning it up. Like institutional innovations, possible technology transfers are many, cutting across many activities, from wastewater treatment to more efficient use of agricultural inputs.

Conclusion 9: Certification and ecolabeling should be coordinated worldwide.

Considering the popularity of certification and labeling of such products as tropical timber, their contribution should be tightly coordinated globally to encourage dynamic links between market access and environmental improvements.

5.3 Recommendations

From the preceding principles and conclusions flow the following general and specific recommendations.

General Recommendation 1: Emphasis should be given first to building environmental institutional capacity in the countries most likely to influence and shape future trade-environment linkages. First-priority countries include Chile, Brazil, Argentina, and Mexico.

General Recommendation 2: In all LAC countries, country assessments should be undertaken in cooperation with nongovernmental organizations and the private sector of the sort pioneered for Venezuela by Harwell et al. (1994). Such studies should focus on the most pollution-intensity manufacturing sectors and the main extractive sectors discussed in this study.

General Recommendation 3: Using the above assessments as a basis, technical assistance should focus on creating or strengthening monitoring capacity and then redefining "rights to pollute" in each country's two or three sectors where environmental impacts are greatest.

General Recommendation 4: Since enforcement is often the weakest link in redefining "rights to pollute" and establishing a system of liability, significant investments should be made in legal and regulatory reforms and enforcement capacity, augmented by training and education of public officials.

General Recommendation 5: A consultation and negotiation process should be initiated for harmonization of phytosanitary and industrial standards using HACCP and ISO as guides. This process should be initiated first with the "front line" states noted in General Recommendation 1 and should focus especially on key LAC export commodities. The eventual goal should be creating institutional authority comparable to or exceeding that of the North American Commission on Environmental Cooperation for the LAC and its subregions.

To begin to put these general recommendations into effect, we suggest the following specific techniques and actions.

Specific Recommendation 1: Country assessments and monitoring units should make maximum use of geographic information systems (GIS) to evaluate agricultural land, forests, mining activity, and marine resource use. Technical and financial resources should be provided to facilitate use of and access to GIS by government agencies and NGOs.

Specific Recommendation 2: Technical assistance should be offered for the development of a LAC-wide epidemiological monitoring and research effort focussing especially on pesticides and on toxic metals such as mercury and lead.

Specific Recommendation 3: Technical assistance in fisheries management should be focussed on fish habitat areas essential for traded species such as nursery areas for sharks along Mexico's coast and shrimp aquaculture in Ecuador, Honduras, Guatemala, Nicaragua, Panama, and Colombia.

Specific Recommendation 4: Agroenvironmental research emphasis for donor agencies and the private sector should focus on productivity gains that offset incentives to expand the extensive margin of cultivation in areas critically threatened by deforestation such as the Amazon Basin.

Specific Recommendation 5: Integrated management methods for pests and nutrients should be adopted wherever feasible to reduce environmental pressures from increasing agricultural intensification.

Specific Recommendation 6: The donor community should make seed money available to establish a regional environmental technology intermediary. Its purpose would be to acquire, adopt, and diffuse environmental and pollution-prevention technologies in key areas such as mining wastes, precision agriculture, agroforestry, and petroleum production.

Specific Recommendation 7: Ecolabeling plans should be harmonized and coordinated in tandem with the development of HACCP and ISO standards (General Recommendation 5) so as to promote mutual recognition.

Specific Recommendation 8: Pollution inventories should be developed for each country to help identify priorities for action. These could be started by using standard coefficients (such as was done for this report) but should eventually be developed with an eye to international comparability.

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