Freshwater Biodiversity of Latin America and the Caribbean

A Conservation Assessment

FRESHWATER BIODIVERSITY

OF LATIN AMERICA AND THE CARIBBEAN

A CONSERVATION ASSESSMENT

Report of a workshop on the Conservation of Freshwater
Biodiversity in Latin America and the Caribbean,
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The Biodiversity Support Program (BSP) is a consortium of World Wildlife Fund, The Nature Conservancy, and World Resources Institute, funded by the U.S. Agency for International Development (USAID). BSP's mission is to promote conservation of the world's biological diversity and to maximize the impact of U.S. government resources directed toward international biodiversity conservation. This publication was made possible through support provided by the Global Bureau of USAID, under the terms of Cooperative Agreement Number DHR-5554-A-00-8044-00. The opinions expressed herein are those of the editors and do not necessarily reflect the views of USAID.

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Preface

FRESHWATER ECOSYSTEMS in Latin America and the Caribbean (LA/C) harbor extraordinarily rich and unique biodiversity. There are also severe threats to freshwater biodiversity throughout LA/C, including widespread damming and extraction of water, overfishing, contamination, and exotic species; all are contributing to the loss of natural habitats and species over vast areas. In many parts of LA/C, freshwater ecosystems are even more threatened than are terrestrial ecosystems. Despite this, conservation of freshwater biodiversity has been seriously underrepresented in protected area systems and has received insufficient conservation donor funding. Entire freshwater ecosystems are now at risk of being eliminated.

This analysis is a first attempt to characterize, map, and evaluate the priority for conservation action in large areas of freshwater biodiversity in the LA/C region. The ecoregional approach adopted by this study can help conservation planners address large-scale and long-term issues that will ultimately determine the success of conservation efforts. Because the conservation target of an ecoregional approach is the entire biota, from species to higher taxa to whole communities and ecosystems, it is more likely that the full range of distinctive biodiversity will be represented when an ecoregion is conserved. This report assesses the relative importance of biodiversity at varying biogeographic scales, from local to global. The importance of conserving ecological and evolutionary phenomena and processes that maintain and create biodiversity is also emphasized in this report.

While the data for many ecoregions described herein are limited or still unsynthesized, this analysis can nevertheless provide a framework for linking the timing of conservation investments with principles of conservation biology and aqua/landscape ecology. We hope that this framework and analysis will catalyze future work by scientists and conservationists concerned with setting conservation priorities.

We expect that these results will help conservation donors better understand which ecoregions in LA/C harbor the most important freshwater biotas and where there is greatest urgency for action. Bilateral and multilateral donors, international organizations, and governments can use the results of this report to argue for increased resources to protect the most distinctive, representative, and threatened areas of freshwater biodiversity in LA/C. It is our hope that, by recognizing the extraordinary freshwater biodiversity of LA/C and its threatened status, future conservation investments will shift toward a more balanced portfolio of terrestrial, marine, and freshwater projects.

—Kathryn A. Saterson
Executive Director
Biodiversity Support Program

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The editors assume responsibility for any errors or omissions that may have occurred in this report. The designations of geographical entities and the presentation of material do not imply the expression of any opinion whatsoever on the part of WWF concerning the legal status of any country, territory or area, or its authorities, or the delimitation of its frontiers or boundaries.

Executive Summary

Background

THE LATIN AMERICAN and Caribbean region supports the most diverse freshwater biodiversity on Earth. The Amazon Basin alone is estimated to contain between 3,000 and 9,000 species of fish, and the entire LA/C area harbors over one quarter of the world's fish species. Many species are restricted to limited geographic areas. For example, some snails and fish are limited to a single small pool in exceptional cases, illustrating the complexity of the freshwater habitats. Unique and unusual habitats occur throughout the region, including extraordinarily productive flooded forests along the larger tropical rivers, high-altitude lakes and *páramo* wetlands, limestone habitats of Mexico and Central America, and isolated basins of the northern deserts. Remarkable ecological phenomena include tremendous migrations of fish covering thousands of miles of the Amazon's rivers and seasonal movements between the rivers and flooded forests. In these habitats, one finds a variety of fruit-eating fish that serve as important seed dispersal agents. The deep channels of the Amazon are inhabited by blind or nearly blind fish, many with heightened electric senses and unusual diets, such as specialists that feed on other fishes' tails. The incredible radiation of species in the Chihuahuan Desert springs, high-altitude Andean and Mexican lakes, and Amazonian and Orinoco basin streams are just a few of the region's outstanding evolutionary phenomena.

Despite this wealth of freshwater habitats and phenomena, most people equate the region's biodiversity mainly with the terrestrial species of the tropical rain forests. Yet, the waters of the tropical Americas harbor a vertebrate fauna richer than any found in the adjacent forests, and the poorly-known aquatic invertebrates and plants are likely to be highly diverse as well. In addition to their biodiversity value, freshwater ecosystems are tremendously important economically. Conservation of this resource is essential as so much of the human population relies on it, not only for drinking water, but also for transportation, food production, energy, industry, waste disposal, recreation, and aesthetic value.

It is unfortunate, then, that freshwater biodiversity around the world is even more threatened than terrestrial biodiversity. Despite the extraordinary richness, uniqueness, and economic importance of freshwater ecosystems, particularly those in LA/C, freshwater ecosystems are highly underrepresented in both networks of protected areas and in receiving conservation donor funding.

The threats to freshwater biodiversity are so severe and present conservation attention and resources are so limited that, to conserve these unique ecosystems and communities, we must promote a wider recognition of their biodiversity value within the context of a global conservation strategy and determine the most distinctive and threatened biogeographic units needing immediate support.

In 1994, the Biodiversity Support Program (BSP), a consortium of World Wildlife Fund, The Nature Conservancy, and World Resources Institute, funded by the U.S. Agency for International Development (USAID), organized a workshop where biodiversity conservation priorities for terrestrial systems of LA/C were identified (Biodiversity Support Program et al. 1995). Participants at that workshop recognized the urgent need to adapt this priority-setting framework to aquatic freshwater and marine systems. Responding to this need, USAID provided BSP with funding to carry out priority-setting exercises for freshwater and marine habitats.

BSP commissioned World Wildlife Fund and Wetlands International to undertake a conservation assessment of freshwater ecoregions of LA/C as a first step in prioritizing efforts to save them. Regional priorities for the conservation of freshwater biodiversity were assessed at a workshop in Santa Cruz, Bolivia in the fall of 1995; the results of that assessment are presented in this report. Workshop participants included recognized experts in the field of freshwater biodiversity from the LA/C region, as well as from the United States (see Appendix H).

A complementary marine analysis for LA/C, organized by The Nature Conservancy, with funding from BSP, was conducted in September 1996. The methodology and identification of preliminary priorities for coastal and marine habitats are available in a separate report (Sullivan and Bustamante 1999).

A parallel analysis of the conservation status of wetlands of South America was conducted at the 1995 Santa Cruz workshop in collaboration with Wetlands International. The results of detailed regional analyses by wetland specialists were synthesized at the workshop and are available in a report from Wetlands International (Canevari et al. 1998). The Wetlands International portion of the work received support from the United Nations Environment Programme (UNEP), USAID, and the Moriah Foundation.

Taking an Ecoregion-based Approach

The distribution of species and communities rarely follows state or provincial boundaries. For example, Venezuela contains several ecoregions (which we define as relatively large areas of water and land that share a large majority of species, dynamics, and environmental conditions) that encompass coastal rivers, large river deltas, flooded savannas, and large river headwaters. Dividing Venezuela into several ecoregions offers a superior framework for representing all of its unique habitats and species assemblages in conservation programs, avoiding duplication of effort across political jurisdictions, capturing the geographic area over which ecological processes operate, and defining the arena for future restoration programs. Lumping all of Venezuela's ecoregions into one political unit, while simultaneously truncating their full extent in neighboring countries, runs the risk of overlooking important features and conservation needs specific to each ecoregion.

An ecoregion-based approach targets the entire biota, from species to higher taxa to communities, rather than just a few well-known larger or charismatic species. In our methodology, the relative rarity of biodiversity features is assessed at varying biogeographic scales, from local to global. This approach also emphasizes the importance of conserving ecological and evolutionary phenomena and processes that maintain and create biodiversity. By looking at the bigger picture through ecoregion-scale analyses, it becomes easier to identify the places where there is a global responsibility to protect and restore habitats that are unique to the world, as well as reveal gaps in current and proposed conservation networks and strategies.

Taking the ecoregion as our unit of analysis, this study quantifies the biological diversity of freshwater ecoregions of South America, Central America, the Caribbean, and Mexico. A separate analysis of North American freshwater ecoregions (again including Mexico) complements this study (Abell et al. In press). Mexican freshwater ecoregions are being further evaluated by CONABIO (Comisión Nacional para el Conocimiento y Uso de la Biodiversidad), the biodiversity agency of Mexico (Arriaga et al. 1998). Recent analyses of major watersheds and freshwater hotspots of the world should also be consulted (Revenga et al. 1998; WCMC, In prep.).

Methods and Findings

Forty-two freshwater ecoregion complexes were identified for LA/C, within which 117 ecoregions were delineated (see Table 1 and Fig. A-1). Ecoregions were classified according to their major habitat type, ranging from large rivers to closed basins in dry regions.

Ecoregions were assessed using two primary discriminators:

Biological Distinctiveness

This was assessed through an analysis of species richness, endemism, ecosystem diversity, and special considerations (rarity of major habitat type and unusual ecological or evolutionary phenomena), and point scores were assigned for each characteristic. Based on these scores, ecoregions were designated as globally outstanding, regionally outstanding, regionally important, or locally important.

Conservation Status

This is an estimate of the current and future ability of an ecoregion to maintain viable species populations, sustain ecological processes, and be responsive to short- and long-term change. Determinants of an ecoregion's conservation status include habitat loss, water quality, and hydrographic integrity. Each ecoregion's status was classified as critical, endangered, vulnerable, relatively stable, or relatively intact.

An assessment of biological distinctiveness at different biogeographic scales identified 11 ecoregions (9%) as globally outstanding, 51 (44%) as regionally outstanding, 30 (26%) as regionally important, and 25 (21%) as locally important. Some regions with globally outstanding biodiversity include the western arc of the Amazon River basin, the Southern Orinoco, the Río Negro, the Chihuahuan Desert, high-elevation lakes of central Mexico, the Llanos, the Guiana Watershed, and the varzea flooded forests of the Amazon.

An assessment of conservation status identified 9 (8%) ecoregions as critical, 43 (37%) as endangered, 49 (42%) as vulnerable, 13 (10%) as relatively stable, and 3 (3%) as relatively intact. Overall, more than 85% of the freshwater ecoregions of LA/C were assessed as critical, endangered, or vulnerable. When compared with 60% of the terrestrial ecoregions assessed in these same categories (Dinerstein et al. 1995), it becomes evident that freshwater ecosystems have been substantially more impacted than have terrestrial ones. Some critical ecoregions are found in the Caribbean lowlands and intermontane valleys of Colombia, the Maracaibo Basin, Lake Poopó, the delta of the Colorado River, coastal Sinaloa, Lerma and Lake Patzcuaro of central Mexico, the Atacama/Sechura deserts, the Parano-Platense delta, and northern portions of the Mediterranean region of Chile.

Integrating biological distinctiveness and conservation status provided a framework for priority-setting. Those ecoregions that were given a priority status of 1 (highest priority for conservation action) had biological distinctiveness that was considered globally outstanding and a threat ranking that was either endangered or vulnerable. The following 10 ecoregions received this ranking (see Fig. A-5):

Table 1. Freshwater Ecoregions by Ecoregion Complex, Showing Major Habitat Type, Biological Distinctiveness, Conservation Status, and Priority

Ecoregion	Major Habitat Type	Biological Distinctiveness	Conservation Status	Priority Status
Baja California Complex				
1. Baja California	5	LI	V	4
Colorado River Complex				
2. Colorado Delta	2	RO	C	3
3. Sonoran	5	LI	E	3
Sinaloan Coastal Complex				
4. Sinaloan Coastal	4	RI	C	3
Rio Bravo Complex				
5. Rio Bravo	1	GO	E	1
6. Pecos	5	RO	E	2
7. Guzman	6	RI	E	3
8. Mapimi	6	RI	E	3
9. Cuatro Cienegas	6	GO	V	1
10. Llanos El Salado	6	RO	E	2
11. Conchos	5	RO	E	2
12. Lower Rio Bravo	1	RO	E	2
13. Rio San Juan	5	RO	E	2
14. Rio Salado	5	RI	E	3
Lerma/Santiago Complex				
15. Santiago	4	RI	E	3
16. Chapala	5	GO	E	1
17. Lerma	6	RO	C	3
18. Rio Verde Headwaters	5	RO	E	2
19. Manantlan/Ameca	4	RI	V	3
Rio Panuco Complex				
20. Rio Panuco	4	RO	E	2
Balsas Complex				
21. Balsas	4	RI	E	3
Pacific Central Complex				
22. Tehuantepec	4	RI	E	3
Atlantic Central Complex				
23. Southern Veracruz	4	RO	E	2
24. Belizean Lowlands	4	RO	V	2
25. Central American Caribbean Lowlands	4	RO	RS	3
26. Talamancan Highlands	3	LI	V	4
27. Catemaco	9	RO	V	2
28. Coatzacoalcos	4	RO	E	2
29. Grijalva-Usumacinta	4	RO	V	2
30. Yucatan	4	RO	V	2
31. Guatemalan Highlands	9	RO	V	2
32. Central American Karst Highlands	4	RO	V	2
33. Honduran/Nicaraguan Highlands	4	RI	E	3
34. Lake Nicaragua	9	RO	E	2
Isthmus Atlantic Complex				
35. Isthmus Atlantic	4	RI	RS	3
Isthmus Pacific Complex				
36. Isthmus Pacific	4	RI	E	3
Bahama Archipelago Complex				
37. Bahamas	4	RI	RS	3
Western Insular Caribbean Complex				
38. Cuba	4	RO	V	2
39. Hispaniola	4	RO	E	2
40. Jamaica	4	RI	E	3
41. Cayman Islands	4	LI	V	4
42. Florida Keys	4	LI	E	3
Eastern Insular Caribbean Complex				
43. Puerto Rico and Virgin Islands	4	RO	V	2
44. Windward and Leeward Islands	4	LI	E	3
Choco Complex				
45. Choco	4	RO	V	2
South American Caribbean Complex				
46. Magdalena	4	LI	C	3
47. Momposina Depression-Rio Cesar	4	RI	RS	3
48. Cienega Grande de Santa Marta	4	RI	E	3
49. Guajira Desert	5	RI	V	3
50. Maracaibo Basin	4	RO	C	3
High Andean Complex				
51. Paramos	8	RO	RS	3
52. Peru High Andean Complex	3	RI	V	3
53. Bolivian High Andean Complex	3	LI	V	4
54. Arid Puna	6	RO	V	2
55. Subandean Pampas	6	RO	V	2
56. South Andean Yungas	3	RO	V	2
Inter-Andean Dry Valleys Complex				

Major Habitat Type

1 = Large Rivers
2 = Large River Deltas
3 = Montane Rivers and Streams
4 = Wet-Region Rivers and Streams
5 = Xeric-Region Rivers and Streams
6 = Xeric-Region Endorheic (closed) Basins
7 = Flooded Grasslands and Savannas
8 = Cold Streams, Bogs, Swamps, and Mires
9 = Large Lakes

Biological Distinctiveness

Globally Outstanding (GO)
Regionally Outstanding (RO)
Regionally Important (RI)

Conservation Status

Critical (C)
Endangered (E)
Vulnerable (V)
Relatively Stable (RS)
Relatively Intact (RI)

Priority Status

1 = Highest Priority for Conservation at Regional Scale
2 = High Priority for Conservation at Regional Scale
3 = Priority for Conservation at Regional Scale
4 = Important at Subregional and Local Scales

Table 1. *(Continued)*

Ecoregion	Major Habitat Type	Biological Distinctiveness	Conservation Status	Priority Status
57. Inter-Andean Dry Valleys	3	LI	V	4
North Andean Montane Complex				
58. North Andean Montane	3	RI	E	3
59. Humid Andean Yungas	3	RI	V	3
60. Chuquisaca and Tarija Yungas	3	LI	E	3
61. Salta and Tucuman Yungas	3	LI	V	4
62. Sierra de Cordoba	3	LI	V	4
Puyango-Tumbes Complex				
63. Puyango-Tumbes	4	RO	V	2
Atacama/Sechura Complex				
64. Atacama/Sechura Deserts	5	LI	C	3
Pacific Coastal Desert Complex				
65. Pacific Coastal Deserts	5	RI	E	3
Lake Titicaca/Poopo Complex				
66. Lake Titicaca	9	GO	V	1
67. Lake Poopo	9	RI	C	3
Galapagos Complex				
68. Galapagos	5	LI	RS	4
Mediterranean Chile Complex				
69. North Mediterranean Chile	5	RO	C	3
70. South Mediterranean Chile	5	RO	E	2
Juan Fernandez Islands Complex				
71. Juan Fernandez Islands	4	RI	E	3
Southern Chile Complex				
72. Valdivian	4	RO	V	2
73. Chiloe Island	4	RO	E	2
74. Chonos Archipelago	4	RI	RS	3
75. Magallanes/Ultima Esperanza	8	RI	RI	4
Subantarctic Complex				
76. Subantarctic	8	LI	RI	4
Venezuelan Coast/Trinidad Complex				
77. Venezuelan Coast/Trinidad	4	LI	E	3
Llanos Complex				
78. Llanos	7	GO	V	1
Guiana/Orinoco Complex				
79. Eastern Morichal	1	RO	RS	3
80. Orinoco Delta	2	RO	RS	3
81. Southern Orinoco	1	GO	V	1
82. Guiana Watershed	1	GO	RS	2
Amazon Complex				
83. Amazon Delta	2	RO	RS	3
84. Amazon Main Channel	1	GO	V	1
85. Northern Amazon Shield Tributaries	1	RO	RS	3
86. Rio Negro	1	GO	V	1
87. Upper Amazon Piedmont	1	GO	V	1
88. Western Amazon Lowlands	1	RO	RI	3
89. Central Brazilian Shield Tributaries	1	RO	V	2
90. Tocantins-Araguaia	1	RO	V	2
Northeast Atlantic Complex				
91. Maranhao	4	LI	E	3
Mata-Atlantica Complex				
92. Northeast Mata-Atlantica	5	RO	E	2
93. East Mata-Atlantica	4	RO	E	2
94. Southeast Mata-Atlantica	4	RO	E	2
Sao Francisco Complex				
95. Caatinga	5	RO	E	2
96. Cerrado	4	RO	E	2
Upper Parana Complex				
97. Upper Parana	1	RO	E	2
Beni Complex				
98. Beni	7	RI	V	3
Paraguay-Parana Complex				
99. Pantanal	7	GO	V	1
100. Lower Parana	1	RO	E	2
Southern Atlantic Complex				
101. Jacui Highlands	4	LI	E	3
102. Lagoa dos Patos Coastal Plain	4	LI	E	3
Chaco Complex				
103. Chaco	4	RI	V	3
Pampas Complex				
104. Parano-Platense Basin	2	RI	C	3
105. RioSalado and Arroyo Vallimanca Basin	7	RI	V	3
106. Northwest Pampas Basins	6	LI	V	4
107. Pampas Coastal Plains	7	LI	V	4
108. Southwest Pampas Basins	6	LI	V	4
Patagonia Complex				
109. Rio Colorado	5	RI	V	3
110. Rio Limay-Neuquen-Rio Negro	5	RO	V	2
111. Meseta Somuncura	6	RO	V	2
112. Rio Chubut-Rio Chico	5	RO	V	2
113. Rio Deseado	5	LI	V	4
114. Rio Santa Cruz-Rio Chico	5	LI	V	4
115. Rio Coyle	5	RO	V	2

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Conservation Status

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Priority Status

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2 = High Priority for Conservation at Regional Scale
3 = Priority for Conservation at Regional Scale
4 = Important at Subregional and Local Scales

- **Río Bravo** (Ecoregion No. 5). The freshwater fauna of the Río Bravo (Rio Grande) ecoregion is likely the richest of any arid-region river system in the world. Many endemic species are found here as well. Extensive diversion of water, channelization, loss of riparian habitat, pollution, and alien species threaten the unusual biota.

- **Cuatro Ciénegas** (Ecoregion No. 9). This basin in the Chihuahuan Desert harbors a complex network of springs and pools that support a globally outstanding assemblage of endemic fish, snails, reptiles, and invertebrates. Cuatro Ciénegas is referred to as "the freshwater Galápagos of the Americas" because fish and snails have undergone spectacular evolutionary radiations here. Water mismanagement threatens many of the pools and springs, and alien species are an increasing threat. This unique basin is being considered for more formal protection.

- **Chapala** (Ecoregion No. 16). This lake of Mexico's highlands has an unusually rich endemic fish and amphibian fauna. Water diversion and urban and agricultural pollutants are major threats.

- **Lake Titicaca** (Ecoregion No. 66). The unusual evolutionary radiations of fish and invertebrates in Lake Titicaca, a large high-altitude lake of the central Andes, represent a globally rare phenomenon. Introduced species and pollution threaten this unusual assemblage.

- **Llanos** (Ecoregion No. 78). Located in Venezuela and Colombia, this tropical wetland complex—one of the world's largest—supports a diverse fish fauna with many endemic species. Conversion of freshwater and wetland habitats for intensive agriculture and livestock continues to threaten the diverse fauna.

- **Southern Orinoco** (Ecoregion No. 81). This ecoregion supports arguably the richest freshwater biotas on the planet. Several unusual freshwater habitat types, such as white-sand flooded forests, occur here as well. Large dams and water diversions planned for several large tributaries spell disaster for this native freshwater ecosystem. Pollution and siltation from mining and deforestation, as well as hunting of sensitive larger vertebrates, pose other threats.

- **Amazon Main Channel** (Ecoregion No. 84). This channel contains the world's richest large river fauna. Many globally rare communities, such as assemblages of blind fish in deep channels, and such phenomena as seasonal migrations of many species into flooded forests occur here. Commercial fisheries may pose problems for some target species.

- **Río Negro** (Ecoregion No. 86). Along with the Southern Orinoco, this ecoregion supports some of the world's richest freshwater biotas. Several unusual freshwater habitat types, such as white-sand flooded forests, occur here. Large dams and water diversions are major threats. Other threats include pollution and siltation from mining and deforestation, as well as hunting of sensitive larger vertebrates.

- **Upper Amazon Piedmont** (Ecoregion No. 87). This region of the Amazon Basin is remarkable for a fauna that is globally diverse, displays unusual adaptations to dynamic environments, and has a high degree of local endemism. Growing threats to these biotas include toxins from mining and oil extraction, loss of surrounding forests that cause changes to water quality and sedimentation, and hunting of sensitive, larger freshwater species.

- **Pantanal** (Ecoregion No. 99). Like the Llanos, the Pantanal is one of the world's largest tropical wetland complexes, containing amazing concentrations of freshwater species and some of the last remaining populations of sensitive larger vertebrates, such as giant river otters. Major channelization schemes, if implemented, would drastically alter this extraordinary ecoregion.

The globally outstanding ecoregions described above (a priority status of 1) are either endangered or vulnerable and require immediate conservation intervention.

Globally outstanding ecoregions that are relatively intact were not identified as highest priority at this juncture because of the urgency of more threatened ecoregions. There was agreement that ecoregions in this category are critically important to conserve, warrant constant vigilance against threats, and present situations where conservation efforts can be cost-effective.

Some of the ecoregions considered high priority for conservation action at a regional scale (a priority status of 2) are located elsewhere in the Chihuahuan region, the Petén, Chocó, Central Brazilian Shield, Guiana Watershed, and central Patagonia.

Globally and regionally outstanding ecoregions whose final conservation status was critical were ranked as being second or third priority, respectively, for conservation action. This was due, in part, to the extreme difficulty of restoring critical freshwater ecosystems because of the strong dynamic linkages throughout the entire ecoregion (i.e., the necessity of interventions at the scale of whole watersheds). In contrast, this combination of features was selected as highest priority in a previous WWF analysis of terrestrial ecoregions of LA/C (Dinerstein et al. 1995).

Because highest priority freshwater ecoregions do not coincide precisely with highest priority terrestrial ecoregions, as identified by Dinerstein et al. (1995), an overlap of terrestrial and freshwater ecoregions in this category helps identify significant conservation priorities at this hemispheric scale. Ecoregions particularly important from both terrestrial and freshwater perspectives include the western arc of the Amazon, the Southern Orinoco and Guayanan Highlands, Río Negro, the Atlantic region of Brazil, the Greater Antilles, and the Chihuahuan Desert.

Recommendations

Conservation donors can use this analysis, prepared by a diverse group of regional freshwater biodiversity experts, to better understand which regions in LA/C harbor the most important freshwater biotas and where there is the most urgent need for action. While this study does not analyze the most effective conservation action that can be taken in freshwater areas, it does highlight some of the most significant threats in the different regions. For example, in wet tropical environments, freshwater ecosystems are most threatened by the profusion of dams, loss of seasonally flooded forests and wetlands, and deforestation of surrounding watersheds. In more arid regions, some of the greatest threats are diversion of surface and ground waters, loss of riparian vegetation, and exotic species. Therefore, specific actions needed in priority areas must be identified through more detailed, ecoregion-scale analyses.

We recommend that USAID continue to play a leadership role within the donor community in using the results of these types of analyses to direct its own funding toward those ecoregions identified as highest priority for conservation action and toward areas not currently receiving sufficient conservation investment. In addition, we hope that USAID will encourage other donors to do the same. Finally, we urge donors to refer to this analysis as they move through the process of identifying their programmatic strengths and determining which will have the greatest impact on freshwater conservation.

Over the past few years, the production and application of logical and transparent geographic priority-setting frameworks have made great strides. We hope that this analysis for freshwater biodiversity in LA/C will also serve as a useful tool for conservationists and donors to allocate their scarce resources in the most effective way.

Chapter 1

Introduction

THE FRESHWATER BIODIVERSITY of LA/C is truly extraordinary. Biologists have often called South America the "bird continent," but it could also be appropriately referred to as the "fish continent." Nearly half of all described vertebrates are teleost fishes, and one quarter of these are estimated to occur in the Neotropics. More than 3,000 species of fish are thought to live in the Amazon Basin (Goulding 1985), site of the world's largest and most diverse freshwater ecosystems (Goulding, Smith, and Mahar 1996). The total number of Amazonian fish species may be as high as 9,000 (Conservation International 1997).

Amazon catfish and characoid fish, in particular, have diversified into a wide range of species with varied life histories and forms. Scientists have recently discovered an astounding diversity of fish species in the leaf litter and detritus of tributary rivers and streams in the Amazon and Orinoco basins (Chernoff 1995), as well as a whole fauna of blind, deepwater fish from the main Amazon River channel (Yoon 1997). A number of species normally associated with marine environments inhabit the larger rivers, including bull sharks, drums, manatee, and two species of dolphin. Giant river otters, anacondas, enormous catfish, and several species of caiman that once attained lengths of more than four meters, are some of the larger denizens of these enormous river systems. A great diversity of aquatic invertebrates and plants also occur throughout the Amazon. The La Plata-Paraná Basin of southern South America represents a third large river system with a rich fish fauna.

Within the Amazon and Orinoco basins, a wide diversity of freshwater habitats occurs, including large rivers (classified as "whitewater," "blackwater," and "clearwater," according to their source and water characteristics), floating meadows, seasonally flooded or *varzea* forests, swamp forests, cataracts, mangroves, white-sand or *igapó* flooded forests, small rivers and streams, and oxbow lakes. Although the Amazon and Orinoco river ecosystems are the dominant and widely recognized elements of Neotropical freshwater biodiversity, the LA/C region contains a diverse array of other freshwater habitats and communities. Vast, seasonally flooded savannas occur in the Llanos, Pantanal, Chaco, and Beni savannas, each endowed with a rich freshwater biota. Cold montane streams and cataracts occur in the High Andes, Amazonian Piedmont, and other mountainous regions.

Other distinct freshwater habitats include *páramo* bogs and wetlands; high-elevation freshwater and saline lakes of the Andes; wetlands and shallow lakes or *lagunas* of the Pampas and Patagonian steppes; large highland lakes of Central America and Mexico; cold temperate bogs, swamps, and mires of the Southern Cone; spring and cave biotas of the Chiapas and Oaxaca regions of Mexico and the Greater Antilles; fogdrip pools and streams of the Pacific deserts of Peru and Chile; and closed-basin (endorheic) springs, pools, and streams in the Chihuahuan Desert. Many regions support highly distinctive freshwater biotas with large numbers of endemic species. Some long-isolated regions, such as in the Greater Antilles, Southern Cone, and Chihuahuan Desert, contain species and higher taxa that represent ancient lineages. Overall, the freshwater biodiversity of LA/C is the richest on Earth, with highly distinctive habitat types, communities, and species.

Recognizing and Addressing the Problem

Throughout the world, conservation of freshwater biodiversity has been seriously neglected, and whole freshwater ecosystems and biotas are threatened with extinction on a grand scale (Allan and Flecker 1993; Heywood and Watson 1995; Abramovitz 1996; Castro and Floris 1997; Abell et al. In press). Several factors contribute to the poor recognition and effectiveness of freshwater biodiversity conservation. First, humans tend to focus their attention on terrestrial biodiversity, which is more familiar and readily observed. Second, the lack of familiarity with the full range of freshwater biodiversity leads resource managers, conservation planners, and the general public to focus primarily on species and habitats that are directly related to local and commercial human activities. Third, freshwater conservation requires great attention to large-scale dynamics, complex interactions, and linkages to terrestrial systems—all issues that are poorly understood, difficult to address effectively, and often politically challenging.

The first step toward effective conservation of freshwater biodiversity is better identification and recognition of the most critical ecosystems and existing threats to these areas. Recognizing this, the U.S. Agency for International Development (USAID) provided funding, through the Biodiversity Support Program (BSP), which enabled World Wildlife Fund and Wetlands International to organize a joint workshop to identify priority freshwater ecoregions and assess their biological importance and level of threat. Held in September 1995 in Santa Cruz, Bolivia, the Workshop on the Conservation of Freshwater Biodiversity in Latin America and the Caribbean brought together 38 regional experts to characterize LA/C's freshwater biodiversity and identify regional priorities.

In addition to this exercise, a complementary marine analysis for LA/C, organized by The Nature Conservancy with funding from BSP, was conducted in September 1996. The methodology and identification of preliminary priorities for coastal and marine habitats are available in a separate report (Sullivan and Bustamante 1999).

To complete the picture, a parallel analysis of the conservation status of the wetlands of South America was conducted at the 1995 Santa Cruz workshop in collaboration with Wetlands International and with funding from the United Nations Environment Programme (UNEP), USAID, and the Moriah Foundation. The results of detailed regional analyses by wetland specialists were synthesized at the workshop and are available in a report from Wetlands International (Canevari et al. 1998).

Chapter 2
Approach

THE 1995 TERRESTRIAL priority-setting workshop supported by BSP found that using regional experts was the best way to gather information. Based on the success of this approach, BSP, WWF, and Wetlands International invited 38 regional experts to create a methodology appropriate for freshwater habitats. These scientists, representing both LA/C and the U.S., were identified based on their broad knowledge of biogeographic patterns of freshwater biodiversity across representative regions of LA/C (see Appendix H for a complete list of workshop participants). Over the course of five days, these participants were divided into four working groups, according to their regional areas of expertise: Mexico/Central America and the Caribbean, Amazon Basin/Orinoco and La Plata, Andes Region, and Southern Cone. During this time, the experts refined the preliminary analysis WWF had supplied prior to the workshop by providing more information on ecoregion and major habitat type (MHT) designations, biological distinctiveness, conservation status, and extraordinary features and areas of freshwater biodiversity. Finally, incorporating all of this data and assigning values to the various factors, the participants identified priority ecoregions using the integration matrix described in Chapter 4 and Appendix B. After the workshop, this analysis was further refined by WWF staff as new information was submitted by the experts, as well as by others who were unable to attend the workshop.

Goals and Targets

The freshwater priority-setting analysis was intended to help conservation donors better achieve the following fundamental goals of biodiversity conservation (Noss 1992):

- Representation of all distinct natural communities, over their range of variation, within a network of protected areas and areas managed for biodiversity conservation.
- Maintenance of ecological and evolutionary processes that create and sustain biodiversity.
- Maintenance of viable populations of species.
- Conservation of natural habitat, large enough to be responsive to large-scale periodic disturbances and long-term change.

To help achieve the four goals listed above, the regional experts focused their analysis on the following conservation targets:

Distinct Biogeographic Units of Biodiversity

These may occur as ecoregions, communities, habitats, or assemblages, depending on the scale of analysis. Highly distinctive units constitute naturally rare opportunities for conservation. Criteria used to identify distinct biodiversity units include extraordinary species richness, endemism, taxonomic uniqueness (e.g., unique genera or families, relict species or communities, primitive lineages), and unusual ecological or evolutionary phenomena. In addition, units of globally rare ecosystems, such as seasonally inundated forests along large tropical rivers, are all considered highly distinctive at a global scale. For continent-wide analyses, the distinctiveness of each unit is evaluated at different biogeographic scales (i.e., globally, regionally, bioregionally, or locally), and relative comparisons are made only within the set of units sharing a similar MHT.

Larger Examples of Intact Habitats and Intact Biotas

Large units of natural habitat where species populations and ecological processes still fluctuate within their natural range of variation are rapidly disappearing around the world. Therefore, remaining intact ecosystems represent rare, albeit human-induced, opportunities for conservation. Larger units are emphasized because principles of landscape (aquascape) ecology and conservation biology suggest that biodiversity will have a higher probability of persistence within such areas. Intact biotas, particularly those that still harbor their full complement of larger vertebrates, are also increasingly rare.

Keystone Habitats, Species, or Phenomena

At regional scales, certain habitats, species, or phenomena may have the capacity to influence surrounding habitats and ecosystems significantly. Their persistence and intact ecological functions may be critical for many species and ecological processes in neighboring biotic systems. For example, cloud forest watersheds, which are important for capturing and regulating water for downstream and adjacent lowland habitats, could be considered keystone habitat types, as could *varzea* forests or desert springs.

Distinctive, Large-Scale Ecological Phenomena

Conserving distinctive, large-scale ecological phenomena, such as long-distance migration of catfish and characoid fish within the Amazon Basin, may require a combination of site-specific, regional, and policy-level efforts applied over vast continental areas or widely disjunct ecoregions. The presence of such phenomena within a particular ecoregion may contribute to its distinctiveness, but focusing conservation efforts on just one or a few ecoregions may be ineffective in conserving widespread or transient phenomena. Conservation strategies for such phenomena in freshwater ecosystems must be closely linked with ecoregion-level activities and coordinated over vast areas of the continent.

Objectives

The specific objectives of the analysis were to:

1. Delineate biogeographic units of freshwater biodiversity, or ecoregions, appropriate for a continental-scale assessment and assign them to MHTs for representation analyses (see Table 2).

2. Characterize each ecoregion in terms of its biological distinctiveness (importance) and conservation status (degree of threat) (see Table D and Table E).

3. Identify priority ecoregions for conservation action based on an integration of their biological distinctiveness and conservation status (see Table 3).

4. Highlight some of the extraordinary features and areas of freshwater biodiversity within LA/C.

5. Take initial steps to link freshwater conservation priorities with terrestrial and marine priorities identified in related analyses (Biodiversity Support Program et al. 1995; Dinerstein et al. 1995; Sullivan and Bustamante 1999).

Delineating Freshwater Ecoregions

The first step in the analysis was to delineate freshwater ecoregions that can serve as effective biogeographic units for conservation planning at regional scales. An ecoregion is defined as a relatively large unit of water or land containing a characteristic set of natural communities that share a large majority of their species, dynamics, and environmental conditions (Dinerstein et al. 1995). Ecoregions function effectively as conservation units at regional scales because they encompass similar biological communities and their boundaries roughly coincide with the area over which key ecological processes most strongly interact (Orians 1993; Noss 1996). To provide a continental perspective on biogeographic relationships, some ecoregions were "nested" within ecoregion complexes (larger biogeographic regions that encompass ecoregions sharing strong biogeographic affinities and large-scale ecological linkages). In other cases, highly distinctive or isolated ecoregions stood alone as single ecoregion complexes.

Characterizing Freshwater Ecoregions as Major Habitat Types

Major habitat types (MHTs) are natural habitats that share similar environmental conditions, habitat structure, and patterns of biological complexity (e.g., beta-diversity) and that contain species assemblages with similar guild structures and adaptations. Although MHT categories are roughly equivalent to biomes, they emphasize the ecological structure and dynamics of communities rather than the physical structure of habitats. Ecoregions categorized under the same MHT have many similar biodiversity features, such as community structures and ecological dynamics, wherever they occur around the world.

Analytical criteria for both biological distinctiveness and conservation status can be tailored to the ecological dynamics, patterns of biodiversity, and responses to disturbance characteristic of each MHT (see Abell et al. In press). Ecoregions were characterized as one of the following nine freshwater MHTs used for the LA/C region:

1. Large Rivers—large river systems draining vast continental areas, with diverse habitats including large, deep rivers, smaller tributary rivers and streams, cataracts and rapids, oxbow lakes, and flooded forests and grasslands. This habitat type is often characterized by complex flood cycles. River systems support diverse biotas with great range in body size of fish and varied resource guilds. Large-scale migration of fish species up and down rivers and in and out of flooded forests may occur.

2. Large River Deltas—deltas of large tropical rivers consisting of complex mosaics of mangroves, shifting channels, mudflats, swamp forests, and flooded grasslands, with substantial flood and tidal pulses. Many marine and brackish species are found in these deltas, in addition to freshwater forms. Large-scale riverine and oceanic migrations of fish species in and out of deltas may occur.

3. Montane Rivers and Streams—mountain rivers and streams, at elevations above 1,000 m, generally characterized by fast-flowing water, cataracts, and rapids. Biotas are often adapted to high-flow regimes.

4. Wet-Region Rivers and Streams—perennial rivers and streams in regions with abundant rainfall. This MHT encompasses a range of river and stream habitats not associated with large river systems, including relatively seasonal freshwater systems in dry forest areas, wet coastal rivers and streams, karst freshwater complexes, and island freshwater ecosystems.

5. Xeric-Region Rivers and Streams—perennial or ephemeral rivers, streams, marshes, and springs associated with xeric climates and terrestrial habitats.

6. Xeric-Region Endorheic (closed) Basins—perennial or intermittent rivers, streams, ponds, and springs that occur in

xeric basins with no outlet to the sea. In this analysis, some high-elevation, closed-basins are considered within this category.

7. Flooded Grasslands and Savannas—areas where seasonal flooding produces abundant lakes, springs, wetlands, streams, and rivers over extensive grasslands or savannas.

8. Cold Streams, Bogs, Swamps, and Mires—complexes of these habitats in montane or low-latitude grasslands, steppe, woodlands, or moorlands.

9. Large Lakes—large freshwater lakes that typically occur at higher elevations in the Neotropics. Such lakes may contain fish biotas that display pronounced radiations, and endemism in a few taxa.

The above categorization also provided a framework to help track the representation of each MHT in a portfolio of conservation priorities.

Addressing the linkages between ecoregions is critical. For example, some Patagonian rivers that arise in the High Andes, such as the Limay, drain into large lakes located in wet regions, such as Lake Nahuel Huapi, continue down through xeric steppe regions, and eventually join larger rivers. Although functional linkages such as these are critically important, the MHT concept is intended to emphasize the biodiversity inhabiting and adapted to these different regions and environments.

Primary Discriminators for Analysis

Priority ecoregions were identified using two primary discriminators: biological distinctiveness and conservation status.[1]

1. Biological Distinctiveness

The biological importance of an ecoregion can be measured by assessing the distinctiveness of its biodiversity at different biogeographic scales. All ecoregions are biologically distinct to some degree, particularly at the level of species and species assemblages, and the level of uniqueness increases at broader biogeographic scales. However, some ecoregions are so exceptionally rich, complex, or unusual that they merit extra attention from conservation planners. In practical terms, this analysis identifies the relative rarity of natural communities and indirectly estimates the extent of opportunity to conserve each distinct unit (e.g., ecoregion) and, in conjunction with other factors, helps estimate the urgency of conservation action.

The biological distinctiveness of ecoregions was assessed through an analysis of the following biodiversity features:

Species richness—with an emphasis on fish, although information on other taxa, such as crustaceans, plants, birds, and amphibians, was considered when available for comparative sets. For example, the Upper Amazon Piedmont ecoregion might be considered a globally outstanding ecoregion because of its extraordinarily diverse fish biota.

Endemism—the number and proportion of species occurring only in a particular eco-region, with an emphasis on fish. For example, ecoregions within the Rio Grande complex of Mexico are all known for exceptionally high percentages of fish endemism.

Ecosystem diversity—complexity of habitats and species distributions (e.g., beta-diversity and patterns of local endemism) within an ecoregion. Some ecoregions contain a high
degree of ecosystem diversity, a phenomenon that the regional experts believed should be

[1] Future studies may develop tractable methods for assessing an ecoregion's importance for ecological or ecosystem processes at regional scales. It is challenging to use a function discriminator at continental scales because of the difficulties of identifying standardized criteria within a meaningful range of spatial and temporal scales and because biodiversity is functionally important at local scales. One can use ecological function more effectively as a discriminator at local or ecoregional scales (see Davies and Giesen 1994).

Similar concerns exist for using conservation feasibility (i.e., social, economic, cultural, and political factors) at this stage in the priority-setting process. Conservation feasibility criteria are important in determining the timing, location, and sequencing of conservation investments. Human utility has a similar role for projects assessed because of its correlation to species richness. High beta-diversity (i.e., rate of species turnover along gradients or over distance) in some ecoregions may be due to either small-scale isolating mechanisms (e.g., isolated desert springs) or habitat complexity.

The final ranking of an ecoregion's biological distinctiveness was also based on the following two special considerations, which were ranked as either globally or regionally outstanding:

Rarity of major habitat type—basis for elevating ecoregions to either the globally or regionally outstanding category. High-altitude tropical lakes, main channels and deltas of large rivers, and high-altitude saline lakes were considered relatively rare at global and regional scales.

Unusual ecological or evolutionary phenomena—rare or exceptionally well-developed ecological or evolutionary phenomena (e.g., adaptive radiations) that are considered globally outstanding. In this analysis, ecoregions were elevated to a higher distinctiveness category only if their phenomena were truly globally or regionally outstanding. Examples include the extraordinary fish migrations of the Amazon Main Channel and *varzea* forests and the highly unusual adaptive radiations and adaptations of the biota of the Cuatro Ciénegas basin in northeastern Mexico.

If an ecoregion was thought to be either globally or regionally outstanding because of one or both of the above special considerations, then that ecoregion's final biological distinctiveness was elevated to the highest category it attained, regardless of total point score.

Based on a synthesis of the biodiversity features described above, workshop participants classified ecoregions as globally outstanding, regionally outstanding, regionally important, or locally important (see Table D). The rankings of special considerations were assigned by expert reviewers, and points were given to the species richness, endemism, and ecosystem diversity criteria with relative weightings of 2:3:1, respectively, reasoning that there are fewer opportunities to conserve unique endemic species and higher taxa. Distinctiveness categories were assigned the following point ranges out of a total of 30 points: globally outstanding (26-30), regionally outstanding (18-25), regionally important (13-17), and locally important (6-12).

Ecoregion complexes contain several ecoregions or only a single ecoregion, depending on the spatial variation in distinctive biotas within complex boundaries. To ensure appropriate biodiversity comparisons, the biological distinctiveness of an ecoregion was assessed relative only to other ecoregions in the same MHT (e.g., the biodiversity features of large-river ecoregions are compared only to other large rivers).

The regional experts recognized that measuring and assigning relative values to such complex biodiversity attributes would require a number of subjective assessments, a task made even more challenging by (1) the incompleteness of biodiversity data for many regions and freshwater taxa, (2) the fact that available data are not yet systematically and comprehensively organized at continental scales, and (3) the lack of freshwater ecoregion maps of comparable scale and classification for the world (see Revenga et al. 1998; Abell et al. In press; WCMC, In prep.). However, the regional

that emphasize improving the human condition. Human utility is often used to engender support or help justify biodiversity conservation efforts. However, utility criteria should not be applied in any strict biodiversity priority-setting analysis because of their potential lack of correlation with important biodiversity parameters (e.g., distinctiveness), the fluidity of human utility over time and at different spatial scales, and the risk of modifying priority-setting results away from critical conservation units. It is also extremely difficult to identify a standard measure of benefit for comparative purposes, in terms of type, scale, and beneficiary. As for ecological function, this is a prohibitive problem at continental scales. Thus, neither conservation feasibility nor human utility were used as discriminators for this continental-scale analysis of biodiversity conservation priorities.

experts believed that the conservation and resource management community had access to sufficient information on *continental* patterns of biodiversity (through expert opinion and technical literature) to identify ecoregions that are exceptionally distinctive at global, regional, and bioregional scales. As new data became available, some ecoregions might shift up or down one level. In general, the experts would have most confidence in classifications of globally outstanding or regionally outstanding ecoregions.

2. Conservation Status

Conservation status represents an estimate of the current and future ability of an ecoregion to maintain viable species populations, sustain ecological processes, and be responsive to short- and long-term change. An assessment of the conservation status of each ecoregion is necessary to: (1) identify MHTs and ecoregions that are most threatened so that intervention can prevent their complete degradation or conversion, (2) help create programs to conserve the most intact examples of MHTs where biodiversity and ecological processes have the best chance for persistence, and (3) help define appropriate conservation activities for different aquascape scenarios. The workshop participants assessed the conservation status of ecoregions in the tradition of *The IUCN Red Data Book* categories for threatened and endangered species (critical, endangered, and vulnerable). These categories of threat have gained widespread acceptance as a framework for determining the conservation status of species and populations. Such assessments have been codified into various Red Data books to call attention to species and populations considered on the verge of extinction (IUCN 1988; Mace and Lande 1991; Collar et al. 1992). Inspired by this approach, whole ecoregions were classified as critical, endangered, vulnerable, relatively stable, or relatively intact (see Table E).

These conservation status categories represent degrees of habitat alteration and spatial patterns of remaining habitats across landscapes. They reflect how, with increasing habitat loss, degradation, and fragmentation, ecological processes cease to function naturally, or at all, and major components of biodiversity are steadily eroded or altered from their pristine state. From a practical perspective, conservation status sheds light on the relative opportunity to conserve a particular ecoregion or MHT, as well as the types of conservation activities and levels of effort needed.[2]

The categories below characterize an ecoregion's integrity as assessed by the aquascape-level indicators and qualitatively describe predicted ecological and biological impacts of loss of aquascape integrity.

Critical—Remaining intact habitat and native biotas are restricted to isolated, small fragments with low probabilities of persistence over the next 10 years without immediate or continuing protection and restoration. Many species are already extirpated or extinct due to the loss of viable habitat or the establishment of alien species. Remaining habitat fragments do not meet minimum area requirements for maintaining viable populations of many species and ecological processes. Complete assemblages of species are extremely rare. Human activities in areas between remaining fragments are often incompatible with maintaining most native species and communities. Spread of alien species may be a serious ecological problem.

Endangered—Remaining intact habitat and native biotas are restricted to isolated fragments of varying size (a few larger blocks may be present) with medium or low probabilities of persistence over the next 10 years without immediate or continuing protection or restoration. Some species are already extirpated due to the loss of viable habitat or alien species. Complete assem-

[2] The current or "snapshot" ranking can be modified by estimates of current and projected threats over a time frame of 10-20 years to determine an ecoregion's final or projected conservation status. A projected threat analysis was not conducted at the Santa Cruz workshop due to pronounced variation in the quality and availability of threat information throughout the region. Abell et al. (In press) have recently applied a projected threat analysis to freshwater ecoregions of North America.

blages of species are rare. Remaining habitat fragments do not meet minimum area requirements for most species populations and large-scale ecological processes. Human activities in areas between remaining habitats are largely incompatible with maintaining most native species and communities. Top predators are almost exterminated.

Vulnerable—The remaining intact habitat and biotas occur in blocks ranging from large to small; many intact clusters will likely persist over the next 10 years, especially if given adequate protection and moderate restoration. In many areas, exploited species have been extirpated or are declining, particularly top predators and sensitive species. Complete assemblages of species are uncommon. Human activities in areas between remaining fragments are sometimes compatible with maintaining most native species and communities.

Relatively stable—Natural communities have been altered in certain areas, causing local declines in exploited populations and disruption of ecosystem processes. These disturbed areas can be extensive, but are still patchily distributed relative to the area of intact habitats. Ecological linkages among intact habitat blocks are still largely functional. Guilds of species sensitive to human activities, such as top predators and large game fish, are present but at densities below the natural range of variation.

Relatively intact—Natural communities within an ecoregion are largely intact, with species, populations, and ecosystem processes occurring within their natural ranges of variation. Guilds of species sensitive to human activities, such as top predators and larger fish, occur at densities within the natural range of variation. Complete assemblages of species are common. Biota move and disperse naturally within the ecoregion. Ecological processes fluctuate naturally throughout largely contiguous natural habitats.

To assign a conservation status to an ecoregion, the following aquascape-level parameters were estimated and synthesized: percentage of habitat loss (conversion or degradation of natural habitat), degree of fragmentation (a measure of the loss of linkages among habitats or areas), water quality (a measure of the physical and chemical properties of water necessary to sustain native species and ecological processes), hydrographic integrity (alterations of natural flow regimes outside of their natural range of variation), and alteration of catchment basins (degree to which whole landscapes are modified). Each indicator received a relative weighting of 20%. (Exotic or introduced species were invoked only where applicable to elevate conservation status category if high impacts were indicated.)[3]

For each indicator, a score of 1, 2, or 3 was assigned. A score of 3 indicated high loss or degradation, a score of 2 indicated medium loss or degradation, and a score of 1 indicated low loss or degradation. Point values for all indicators were summed and subjectively associated with the following conservation status categories: critical (15 points), endangered (12-14 points), vulnerable (8-11 points), relatively stable (6-7 points), and relatively intact (5 points).

Other potential indicators discussed at the Santa Cruz workshop included rates of habitat conversion, extent of riparian modification, degree of protection, and degree of exploitation of freshwater

[3] It is suggested that future analyses weight different aquascape parameters based on their potential contribution to ecosystem alteration. This would better address the ecological dynamics, minimum area requirements for species and ecological processes, and sensitivity to various forms of disturbance characteristic of each MHT. In weighting these variables, we [D. Olson and R. Abell] would give the greater weight to loss of original habitat and alteration of surrounding catchment basins (see Abell et al. In press); we believe that these variables are the best indicators of the probability of persistence of ecological processes within ecoregions. Ranges of values used to classify the ecoregions can be derived from the practical experience of regional experts and the conservation biology, theoretical ecology, and landscape ecology literature. The broad criteria for classifying ecoregions can also be tailored to reflect biological and ecological differences among MHTs.

species. However, the difficulties associated with application and standardization of these parameters across the continent precluded using them as primary indicators at the time. Moreover, there was some discussion about how well some of these parameters indicate actual ecological integrity and intactness of the biodiversity of ecoregions (e.g., degree of protection). The effect of introduced species was only estimated for ecoregions that are highly sensitive to introduced species, such as large lakes, temperate streams, and xeric systems.

To assess aquascape-level features, the experience and knowledge of the regional experts were relied upon, since published information, spatial databases, and maps are largely unavailable, not synthesized at a continental scale, or are of poor quality or resolution for LA/C freshwater ecoregions. Current and projected threat information was gathered for different ecoregions; however, the confidence and quality of estimates for all ecoregions was inadequate for threat assessments throughout the LA/C region for this particular analysis. Thus, all conservation status assessments represent an ecoregion's current or "snapshot" status.

Identifying Priority Ecoregions

Workshop participants developed a simple integration matrix to help identify priority ecoregions for biodiversity conservation. Along the horizontal axis, the participants arranged ecoregions by their final conservation status. Along the vertical axis, they classified ecoregions by their biological distinctiveness. Conservation planners can use this matrix to determine which situations warrant the most immediate conservation attention. In order to evaluate representation among all habitat types, a separate matrix was created for each of the MHTs (see Appendix B). The matrix allowed the regional experts to classify each ecoregion into biodiversity conservation priority categories. It could be used in future studies to identify the set of conservation activities most appropriate for different conservation scenarios (i.e., combinations of biological distinctiveness and conservation status) and patterns of biodiversity associated with particular habitat or ecosystem types.

Chapter 3
Results

Ecoregions and Ecoregion Complexes

One hundred seventeen freshwater ecoregions in LA/C were identified at the workshop, based on biogeography and dynamic linkages of ecosystems, nested within 42 ecoregion complexes (see Table 1, Fig. A-1, and Appendix C). The freshwater ecoregions identified here do not necessarily correspond directly to single watersheds or to associated terrestrial ecoregions (Dinerstein et al. 1995).

Major Habitat Types

The following numbers of ecoregions were categorized under each of the nine MHTs (see Table 2 and Fig. A-2):

Major Habitat Types	Number of Ecoregions
1. Large Rivers	14
2. Large River Deltas	4
3. Montane Rivers and Streams	10
4. Wet-Region Rivers and Streams	42
5. Xeric-Region Rivers and Streams	24
6. Xeric-Region Endorheic (closed) Basins	10
7. Flooded Grasslands and Savannas	5

An ecoregion was categorized as a large-river MHT if it encompassed a section of at least one large river (e.g., Amazon, Orinoco, Paraná, La Plata, Río Bravo). Four large river deltas exist in the region—Amazon, Orinoco, La Plata, and Colorado. The large-lake MHT characterizes larger, higher-elevation lakes, such as Atitlán, Titicaca, Poopó, Chapala, and the lower-elevation lakes Nicaragua and Catemaco. Xeric regions occur in northern Mexico, Patagonia, the Central Pacific Coast of South America, and the Caatinga region of eastern Brazil.

Biological Distinctiveness

Eleven ecoregions (9%) were considered as globally outstanding (GO) in terms of their biological distinctiveness, particularly in regions of the western arc of the Amazon River Basin, Southern Orinoco, Río Negro, Chihuahuan Desert, high-elevation lakes of central Mexico, Llanos, Guiana Watershed, and *varzea* flooded forests of the Amazon (see Appendix D and Fig. A-3). Fifty-one ecoregions (44%) were considered regionally outstanding (RO) (i.e., within the Neotropical region;

Table 2. Ranking of Major Habitat Types

Major Habitat Type	Biological Distinctiveness	Conservation Status	Priority Status
Large Rivers			
5. Rio Bravo	GO	E	1
12. Lower Rio Bravo	RO	E	2
79. Eastern Morichal	RO	RS	3
81. Southern Orinoco	GO	V	1
82. Guiana Watershed	GO	RS	2
84. Amazon Main Channel	GO	V	1
85. Northern Amazon Shield Tributaries	RO	RS	3
86. Rio Negro	GO	V	1
87. Upper Amazon Piedmont	GO	V	1
88. Western Amazon Lowlands	RO	RI	3
89. Central Brazilian Shield Tributaries	RO	V	2
90. Tocantins-Araguaia	RO	V	2
97. Upper Parana	RO	E	2
100. Lower Parana	RO	E	2
Large River Deltas			
2. Colorado Delta	RO	C	3
80. Orinoco Delta	RO	RS	3
83. Amazon Delta	RO	RS	3
104. Parano-Platense Basin	RI	C	3
Montane Rivers and Streams			
26. Talamancan Highlands	LI	V	4
52. Peru High Andean Complex	RI	V	3
53. Bolivian High Andean Complex	LI	V	4
56. South Andean Yungas	RO	V	2
57. Inter-Andean Dry Valleys	LI	V	4
58. North Andean Montane	RI	E	3
59. Humid Andean Yungas	RI	V	3
60. Chuquisaca and Tarija Yungas	LI	E	3
61. Salta and Tucuman Yungas	LI	V	4
62. Sierra de Cordoba	LI	V	4
Wet-Region Rivers and Streams			
4. Sinaloan Coastal	RI	C	3
15. Santiago	RI	E	3
19. Manantlan/Ameca	RI	V	3
20. Rio Panuco	RO	E	2
21. Balsas	RI	E	3
22. Tehuantepec	RI	E	3
23. Southern Veracruz	RO	E	2
24. Belizean Lowlands	RO	V	2
25. Central American Caribbean Lowlands	RO	RS	3
28. Coatzacoalcos	RO	E	2
29. Grijalva-Usumacinta	RO	V	2
30. Yucatan	RO	V	2
32. Central American Karst Highlands	RO	V	2
33. Honduran/Nicaraguan Highlands	RI	E	3
35. Isthmus Atlantic	RI	RS	3
36. Isthmus Pacific	RI	E	3
37. Bahamas	RI	RS	3
38. Cuba	RO	V	2
39. Hispaniola	RO	E	2
40. Jamaica	RI	E	3
41. Cayman Islands	LI	V	4
42. Florida Keys	LI	E	3
43. Puerto Rico and Virgin Islands	RO	V	2
44. Windward and Leeward Islands	LI	E	3
45. Choco	RO	V	2
46. Magdalena	LI	C	3
47. Momposina Depression-Rio Cesar	RI	RS	3
48. Cienega Grande de Santa Marta	RI	E	3
50. Maracaibo Basin	RO	C	3
63. Puyango-Tumbes	RO	V	2
71. Juan Fernandez Islands	RI	E	3
72. Valdivian	RO	V	2
73. Chiloe Island	RO	E	2
74. Chonos Archipelago	RI	RS	3
77. Venezuelan Coast/Trinidad	LI	E	3
91. Maranhao	LI	E	3
93. East Mata-Atlantica	RO	E	2
94. Southeast Mata-Atlantica	RO	E	2
96. Cerrado	RO	E	2
101. Jacui Highlands	LI	E	3
102. Lagoa dos Patos Coastal Plain	LI	E	3
103. Chaco	RI	V	3

Biological Distinctiveness

Globally Outstanding (GO)
Regionally Outstanding (RO)
Regionally Important (RI)

Conservation Status

Critical (C)
Endangered (E)
Vulnerable (V)
Relatively Stable (RS)
Relatively Intact (RI)

Priority Status

1 = Highest Priority for Conservation at Regional Scale
2 = High Priority for Conservation at Regional Scale
3 = Priority for Conservation at Regional Scale
4 = Important at Subregional and Local Scales

Table 2. *(Continued)*

Major Habitat Type	Biological Distinctiveness	Conservation Status	Priority Status
Xeric-Region Rivers and Streams			
1. Baja California	LI	V	4
3. Sonoran	LI	E	3
6. Pecos	RO	E	2
11. Conchos	RO	E	2
13. Rio San Juan	RO	E	2
14. Rio Salado	RI	E	3
16. Chapala	GO	E	1
18. Rio Verde Headwaters	RO	E	2
49. Guajira Desert	RI	V	3
64. Atacama/Sechura Deserts	LI	C	3
65. Pacific Coastal Deserts	RI	E	3
68. Galapagos	LI	RS	4
69. North Mediterranean Chile	RO	C	3
70. South Mediterranean Chile	RO	E	2
92. Northeast Mata-Atlantica	RO	E	2
95. Caatinga	RO	E	2
109. Rio Colorado	RI	V	3
110. Rio Limay-Neuquen-Rio Negro	RO	V	2
112. Rio Chubut-Rio Chico	RO	V	2
113. Rio Deseado	LI	V	4
114. Rio Santa Cruz-Rio Chico	LI	V	4
115. Rio Coyle	RO	V	2
116. Rio Gallegos	LI	V	4
117. Tierra del Fuego-Rio Grande	RI	RS	3
Xeric-Region Endorheic (closed) Basins			
7. Guzman	RI	E	3
8. Mapimi	RI	E	3
9. Cuatro Cienegas	GO	V	1
10. Llanos El Salado	RO	E	2
17. Lerma	RO	C	3
54. Arid Puna	RO	V	2
55. Subandean Pampas	RO	V	2
106. Northwest Pampas Basins	LI	V	4
108. Southwest Pampas Basins	LI	V	4
111. Meseta Somuncura	RO	V	2
Flooded Grasslands and Savannas			
78. Llanos	GO	V	1
98. Beni	RI	V	3
99. Pantanal	GO	V	1
105. Rio Salado and Arroyo Vallimanca Basin	RI	V	3
107. Pampas Coastal Plains	LI	V	4
Cold Streams, Bogs, Swamps, and Mires			
51. Paramos	RO	RS	3
75. Magallanes/Ultima Esperanza	RI	RI	4
76. Subantarctic	LI	RI	4
Large Lakes			
27. Catemaco	RO	V	2
31. Guatemalan Highlands	RO	V	2
34. Lake Nicaragua	RO	E	2
66. Lake Titicaca	GO	V	1
67. Lake Poopo	RI	C	3

Biological Distinctiveness

Globally Outstanding (GO)
Regionally Outstanding (RO)
Regionally Important (RI)

Conservation Status

Critical (C)
Endangered (E)
Vulnerable (V)
Relatively Stable (RS)
Relatively Intact (RI)

Priority Status

1 = Highest Priority for Conservation at Regional Scale
2 = High Priority for Conservation at Regional Scale
3 = Priority for Conservation at Regional Scale
4 = Important at Subregional and Local Scales

Nearctic for northern Mexico). Thirty ecoregions (26%) were considered regionally important (RI), while 25 (21%) were assessed as locally important (LI).

Species Richness

Species richness for a range of taxa was estimated as greatest in the ecoregions of the Amazon Complex and the Guiana-Orinoco Complex. Freshwater ecosystems in the Amazon Basin, and perhaps portions of the Orinoco region, harbor the richest freshwater fish faunas on Earth. The Galápagos Islands have limited freshwater habitats and no fish species.

Endemism

Ecoregions known for a large number of endemic fish species include the Guiana-Orinoco Complex (e.g., Guayanan Highlands and Guiana Watershed) and the Upper Amazon Piedmont. Regional centers of endemism (i.e., ecoregions with a high percentage of endemic species) include the Rio Grande/Río Bravo Complex (Río Bravo, Cuatro Ciénegas, Llanos El Salado, and Lower Río Bravo ecoregions), Guayanan Highlands (Southern Orinoco), Piedmont regions of the western Amazon Basin, Llanos, Mata-Atlântica region of Brazil, Lerma/Santiago Complex (particularly the Chapala ecoregion), Río Verde Headwaters, Southern Veracruz, Catemaco, Grijalvo-Usumacinta, Cuba, Hispaniola, Southern Orinoco, Río Negro, and Lake Titicaca ecoregions. The biota of several ecoregions in the Southern Cone display high percentages of endemic invertebrate and vertebrate species; these include the Colorado River, Meseta Somuncura, Río Limay-Neuquén-Río Negro, and Tierra del Fuego-Río Grande.

Two general patterns of pronounced endemism appear to occur in the region. Evolutionary phenomena associated with isolated basins, particularly in xeric regions, or large, older lakes promote differentiation or radiation with a few lineages. Cuatro Ciénegas, Titicaca, and Chapala ecoregions are good examples. Ecoregions with especially diverse faunas, especially those at the periphery of large basins, also appear to support a high proportion of endemic taxa. Examples include the ancient Guayanan Highlands, Río Negro, and Guiana Watershed. Further study of these patterns is needed.

Ecosystem Diversity

Ecoregions in a variety of MHTs were characterized as having high ecosystem diversity. Large rivers, such as the Amazon, Río Negro, Río Bravo (Grande), and Orinoco harbor a diverse set of freshwater habitats and communities. Large lakes, such as Titicaca, Poopó, and Chapala, were also considered to support diverse freshwater habitats. The Llanos, Eastern Morichal, and Chaco constitute tropical savannas with a complexity of freshwater systems, while several, more temperate grassland and savanna areas of the Southern Cone also were assessed as supporting diverse freshwater ecosystems. The Yucatán was noted for diverse and unusual freshwater ecosystems.

Rarity of Major Habitat Type

Several ecoregions were considered rare at global and regional scales in terms of their habitat types, including large rivers, large river deltas, and complex flooded savannas. Some ecoregions that received such distinction include the Llanos, Orinoco River Delta (Amacuro Delta), Southern Orinoco, and Amazon River Delta and Main Channel. The extensive, seasonally flooded forests of the Amazon and Orinoco rivers represent a globally rare freshwater habitat type.

Unusual Ecological or Evolutionary Phenomena

The extraordinary migrations of fish and invertebrate species between the *varzea* flooded forests of the Amazon and Orinoco basins are unrivaled in terms of the diversity and abundance of migrating species. Many of the adaptations of *varzea* species, such as specialized frugivory seen in a variety of fish species, are highly unusual at a global scale. The long-distance migrations of catfish and other fish within the Amazon Basin are also remarkable.

Most of the larger lakes of LA/C, including Titicaca, Atitlán, Catemaco, and Chapala, have unusual radiations of fish taxa with a high proportion of endemic species and genera. The highland lakes and wetlands of the central highlands of Mexico are also known for a number of endemic invertebrates and frogs.

The evolutionary adaptations and radiations seen in the highly distinctive biota of Cuatro Ciénegas is extraordinary at a global scale. Cuatro Ciénegas is a relatively small basin in the central Chihuahuan Desert. Spring-fed pools and streams have supported a globally distinctive fauna with high levels of endemism, extreme local ranges (several square meters for some snails), and highly unusual radiations and adaptations (Minckley 1978; Almada and Contreras Balderas 1984). This is the only place in the world where one finds aquatic box turtles and a species of cichlid fish that has two distinctive forms, one a snail specialist and the other an algae feeder. The long isolation of this basin since the Pleistocene has contributed to its unique biota. Although similar phenomena occur in other basins in the region, Cuatro Ciénegas is the largest and most outstanding example of this freshwater biodiversity phenomena.

Other Important Freshwater Biodiversity Features

Critical Habitats for Large-scale Ecological Phenomena. Throughout the LA/C region, freshwater habitats provide critical wintering, feeding, resting, and breeding habitat for many species of migratory birds (Finlayson and Moser 1991; Dugan 1993; WHSRN 1993; Elphick 1995). Some of these habitats are of hemispheric importance because of the diversity of species and great numbers of individual shorebirds, wading birds, and waterfowl that depend on them. Examples of important sites include Copper-name Delta, Bigi Pan, Wia-Wia, Lagoa do Peixe, Llanos, Mar Chiquita, Maranhão wetlands complex, Southern Cone wetlands, and the Marismas Nacionales complex of Mexico. Although some of these freshwater ecosystems may be depauperate in fish, crustacean, and other freshwater species, as well as having few, if any, endemic species, they are critically important for maintaining the large-scale ecological phenomena of inter- and intra-continental bird migrations. In some cases, such as the Llanos, the fresh-water biota is both rich and endemic and the ecoregion is important for migratory birds. Priority sites and activities for conserving such large-scale migratory processes have been effectively identified through analyses by Wetlands International, IUCN, RAMSAR, and others (e.g., Canevari et al.1998).

Mangroves. Mangroves encompass freshwater, marine, and terrestrial ecosystems. Although mangroves support few tree species in the Neotropics, these habitats may rival tropical forests in species richness if all the aquatic, amphibious, and terrestrial species living in or dependent upon mangroves for some stage of their life cycle are counted together. The conservation status of LA/C mangroves has been assessed elsewhere (see Olson et al. 1996; Spalding, Blasco, and Field 1997).

Conservation Status

Results of the conservation status analysis are as follows (see also Appendix E and Fig. A-4):

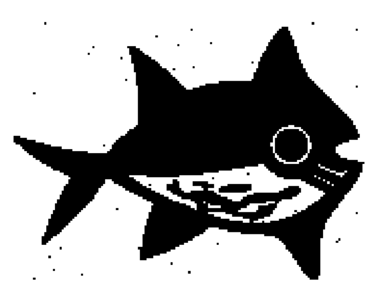
- Nine (8%) ecoregions were considered critical (C), 43 (37%) endangered (E), 49 (42%) vulnerable (V), 13 (10%) relatively stable (RS), and 3 (3%) relatively intact (RI).

- More than 85% of the freshwater ecoregions of LA/C were ranked as critical, endangered, or vulnerable.

- Critical ecoregions were found in the Caribbean lowlands and intermontane valleys of Colombia, Maracaibo Basin, Lake Poopó, the delta of the Colorado River, coastal Sinaloa, Lerma and Lake Patzcuaro of central Mexico, Atacama/ Sechura deserts, Parano-Platense delta, and northern portions of the Mediterranean region of Chile.

- Endangered regions included much of the freshwater systems of the cerrado and Atlantic region of Brazil, northern and southern Mexico, higher-elevation ecoregions of the northern Andes, and the coastal deserts of Peru and Chile.

- Some of the more intact ecoregions occur in the central Amazon River Basin, Guianas and Guayanan Highlands, and some lowland Caribbean ecoregions of Central America.



Chapter 4

Findings and Conclusions

Priority Ecoregions

At the Santa Cruz workshop, regional experts agreed upon a series of cells in the integration matrix that would qualify as highest priority (see Table 3 below).

The following four priority levels for conservation action were recognized:

1) Highest Priority for Conservation Action at Regional Scale. These are globally outstanding ecoregions that are either endangered or vulnerable and that require immediate conservation intervention.

Globally outstanding ecoregions that are relatively intact were not identified as highest priority at this juncture because of the urgency of more threatened ecoregions. There was agreement that ecoregions in this category are critically important to conserve, warrant constant vigilance against threats, and present situations where conservation efforts can be cost-effective. Moreover, some aquatic species inhabiting relatively intact ecoregions are highly threatened throughout their range due to intensive hunting.

Table 3. Integration Model for Biological Distinctiveness and Conservation Status Discriminators for Setting Priority

Biological Distinctiveness	Final Conservation Status				
	Critical	Endangere	Vulnerable	Relatively Stable	Relativel y
Globally Outstanding	2	1	1	2	3
Regionally Outstanding	3	2	2	3	3
Regionally Important	3	3	3	3	4
Locally Important	3	3	4	4	4

Priority Status:

1 = Highest Priority for Conservation at Regional Scale

2 = High Priority for Conservation at Regional Scale

3 = Priority for Conservation at Regional Scale

2) High Priority for Conservation Action at Regional Scale. These are globally outstanding ecoregions that are critical or relatively stable and regionally outstanding ecoregions that are endangered or vulnerable.

Globally and regionally outstanding ecoregions whose final conservation status was critical were ranked as second and third priority, respectively, for conservation action. This was due, in part, to the extreme difficulty of restoring critical freshwater ecosystems because of the strong dynamic linkages throughout the entire ecoregion (i.e., the necessity of interventions at the scale of whole watersheds). In contrast, this combination of features was selected as highest priority in a previous WWF analysis of terrestrial ecoregions of LA/C (Dinerstein et al. 1995).

3) Priority for Conservation Action at Regional Scale. This category includes globally outstanding ecoregions that are relatively intact; regionally outstanding ecoregions that are considered critical, relatively stable, or relatively intact; regionally important ecosystems that are critical, endangered, vulnerable, or relatively stable; and locally important ecosystems that are either critical or endangered.

4) Important at Subregional and Local Scales. This category includes regionally important ecoregions considered relatively intact and locally important ecoregions that are vulnerable, relatively stable, or relatively intact.

Regional Patterns of Threat

A review of the information gathered on threats to freshwater biodiversity revealed the following:

- The type, intensity, and scale of threats vary among regions and MHTs. Widespread and pervasive threats include dams, water diversions, draining and channelizations, pollution from toxins and eutrophication, loss of riparian and catchment basin forests with associated changes in sedimentation and physical conditions, introduced species, and overexploitation of freshwater species.

- Freshwater ecosystems and habitats in xeric (drier) climates are highly threatened throughout the region (e.g., Contreras Balderas 1978a, 1978b; Contreras Balderas and Escalante 1984). Diversion of water for human activities, intensive grazing of alien species, and destruction of riparian vegetation are major causes.

- Three of the most endangered habitat types are large river floodplains, such as floating meadows and *varzea* forests, which are threatened by logging and conversion to pasture; cataracts, which are lost over vast areas due to dams and water diversions; and desert springs.

- Major habitat types (MHTs) particularly sensitive to human disturbance are freshwater ecosystems in xeric regions and high-altitude lakes.

- Intensive coffee production and other agriculture in many montane areas have damaged streams through sedimentation, eutrophication, pesticides, and loss of riparian vegetation.

- Loss and degradation of headwater habitats can seriously impact the ecological processes, dynamics, and biodiversity of entire watersheds.

- Small wetlands complexes can be as important as large wetlands for wintering and breeding habitat for migratory birds. Many smaller wetlands are being degraded or destroyed across whole landscapes.

- Pollution from gold mining (mercury) and petroleum industry activities (e.g., oil spills in the Napo region of Ecuador) is becoming increasingly widespread and severe as relatively unregulated exploitation spreads into more intact regions.

- Several large freshwater species that are intensively hunted throughout their range are threatened, even in relatively stable or intact ecoregions, including giant river otters (*Pteronura brasiliensis*); black caiman (*Melanosuchus niger*); Amazonian manatee (*Trichechus inunguis*); West Indian manatee (*T. manatus*); freshwater dolphins, such as the *tucuxi* (*Sotalia fluviatilis*) and *boutos* (*Inia boliviensis* and *I. geoffrensis*); bony fish, such as *arapaima* or *pirarucu* (*Arapaima gigas*); and giant river turtles (*e.g., Podocnemis expansa*). For example, giant river otters were once distributed widely across the lowland rivers of tropical South America. Today, less than 1,000 individuals are estimated to survive in the wild, and most of these are in highly fragmented populations of small size. Like several other large, freshwater species, otters are highly sensitive to hunting because of their large size, gregarious habits, and lack of avoidance of humans.

- More than 85% of the freshwater biodiversity of LA/C is seriously threatened in terms of geographic extent and severity of threats, 25% higher than the 60% assessed for LA/C's terrestrial biodiversity (Dinerstein et al. 1995). Abell et al. (In press) have found a similar pattern in North American ecoregions.

Developing a Conservation Strategy for Freshwater Biodiversity

Overall, 10 (9%) ecoregions were considered highest priority for conservation action at the regional scale (priority status of 1 in Tables 1 and 2), 41 (35%) as high priority at the regional scale (priority status of 2 in Tables 1 and 2), 50 (42%) as priority at the regional scale (priority status of 3 in Tables 1 and 2), and 16 (14%) as important at subregional and local scales (priority status of 4 in Tables 1 and 2). Table 4 shows the freshwater ecoregions (including their ecoregion numbers) recommended

Table 4. Priority Freshwater Ecoregions for Regional-level Conservation Action

Highest Priority	Río Bravo	5	Southern Orinoco	81
	Cuatro Ciénegas	9	Amazon Main Channel	84
	Chapala	16	Río Negro	86
	Lake Titicaca	66	Upper Amazon Piedmont	87
	Llanos	78	Pantanal	99
High Priority	Pecos	6	Arid Puna	54
	Llanos El Salado	10	Subandean Pampas	55
	Conchos	11	South Andean Yungas	56
	Lower Río Bravo	12	Puyango-Tumbes	63
	Río San Juan	13	South Mediterranean Chile	70
	Río Verde Headwaters	18	Valdivian	72
	Río Panuco	20	Chiloé Island	73
	Southern Veracruz	23	Guiana Watershed	82
	Belizean Lowlands	24	Central Brazilian Shield Tributaries	89
	Catemaco	27	Tocantins-Araguaia	90
	Coatzacoalcos	28	Northeast Mata-Atlântica	92
	Grijalva-Usumacinta	29	East Mata-Atlântica	93
	Yucatán	30	Southeast Mata-Atlântica	94
	Guatemalan Highlands	31	Caatinga	95
	Central American Karst Highlands	32	Cerrado	96
			Upper Paraná	97
	Lake Nicaragua	34	Lower Paraná	100
	Cuba	38	Río Limay-Neuquen-Río Negro	110
	Hispaniola	39	Meseta Somuncura	111
	Puerto Rico and Virgin Islands	43	Río Chubut-Río Chico	112
	Chocó	45	Río Coyle	115

as highest priority or high priority for conservation action at the LA/C regional level (see also Fig. A-5):

Priority freshwater ecoregions that generally overlap with the terrestrial priority ecoregions identified in a WWF analysis by Dinerstein et al. (1995) include the Chihuahuan Desert; Guayanan Highlands; Western Arc of the Amazon; Llanos; *varzea* and *igapó* forests of the Amazon and Orinoco; Pacific coastal ecoregions of Colombia and Ecuador; ecoregions of the Brazilian Shield, Cerrado, and Atlantic Coast of Brazil; high-altitude lakes of the southern Andes; Mediterranean region of central Chile; central Patagonia; and Hispaniola.

Conclusions

Whereas almost no prioritization of freshwater ecoregions had been done in the past, participants at the Santa Cruz workshop have now identified a subset of 10 highest priority ecoregions and 41 high-priority ecoregions out of an original 117 LA/C ecoregions. Areas of outstanding freshwater biodiversity and significant threats for an entire biogeographic realm (the Neotropics and part of the Nearctic) have been identified in a single document, and maps have been designed to inform conservation planners and investors in their decision-making. Taking into account the priority-setting models and regional patterns of threats presented in this study can help determine the most appropriate set of general conservation activities for different areas, habitat types, and situations.

This study emphasizes the following: (1) the concept of representation of major freshwater habitat types in conservation portfolios; (2) the overriding importance of aquascape-level features and dynamics in the long-term viability and persistence of ecosystems and their biodiversity; (3) the need to assess ecological and evolutionary phenomena as important elements of biodiversity; and (4) the importance of tailoring analytical criteria to the particular patterns of biodiversity, ecological dynamics, and responses to disturbance of different MHTs. Some differences and linkages between freshwater and terrestrial conservation planning efforts have also been highlighted. Sound conservation activities for terrestrial biodiversity can have significant conservation benefits for associated freshwater biodiversity.

As this conservation assessment shows, with such intense and pervasive threats, effective and timely implementation of freshwater conservation strategies is urgently needed to prevent large-scale degradation of these precious resources.

We encourage USAID and other donors to use this study to analyze their current investments in freshwater ecosystems in LA/C and, wherever possible, to increase their investments in the priority freshwater areas highlighted. This does not mean that funding for lesser priority regions should be discontinued. All other areas are considered appropriate for continued biodiversity conservation investments at the national and local levels. Donors should use the results of this exercise to diversify their biodiversity investments into ecoregions across the full spectrum of conservation status, from critical to relatively intact, especially since investing now in more areas will save money later on.

We sincerely hope that this initial effort will catalyze future actions that, linked with companion measures to conserve terrestrial and marine systems, will result in the conservation and restoration of the freshwater biodiversity systems of Latin America and the Caribbean.

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APPENDIX A

Maps of Freshwater Ecoregions of Latin America and the Caribbean

1 Freshwater Ecoregions and Ecoregion Complexes
2 Major Habitat Types
3 Biological Distinctiveness
4 Conservation Status
5 Regional Priorities for Conservation Action

LEGEND

Baja California Complex
1. Baja California

Colorado River Complex
2. Colorado Delta
3. Sonoran

Sinaloan Coastal Complex
4. Sinaloan Coastal

Rio Bravo Complex
5. Rio Bravo
6. Pecos
7. Guzman
8. Mapimi
9. Cuatro Cienegas
10. Llanos El Salado
11. Conchos
12. Lower Rio Bravo
13. Rio San Juan
14. Rio Salado

Lerma/Santiago Complex
15. Santiago
16. Chapala
17. Lerma
18. Rio Verde Headwaters
19. Manantlan/Ameca

Rio Panuco Complex
20. Rio Panuco

Balsas Complex
21. Balsas

Pacific Central Complex
22. Tehuantepec

Atlantic Central Complex
23. Southern Veracruz
24. Belizean Lowlands
25. Central American Caribbean Lowlands
26. Talamancan Highlands
27. Catemaco
28. Coatzacoalcos
29. Grijalva-Usumacinta
30. Yucatan
31. Guatemalan Highlands
32. Central American Karst Highlands
33. Honduran/Nicaraguan Highlands
34. Lake Nicaragua

Isthmus Atlantic Complex
35. Isthmus Atlantic

Isthmus Pacific Complex
36. Isthmus Pacific

Bahama Archipelago Complex
37. Bahamas

Western Insular Caribbean Complex
38. Cuba
39. Hispaniola
40. Jamaica
41. Cayman Islands
42. Florida Keys

Eastern Insular Caribbean Complex
43. Puerto Rico and Virgin Islands
44. Windward and Leeward Islands

Choco Complex
45. Choco

South American Caribbean Complex
46. Magdalena
47. Momposina Depression-Rio Cesar
48. Cienega Grande de Santa Marta
49. Guajira Desert
50. Maracaibo Basin

High Andean Complex
51. Paramos
52. Peru High Andean Complex
53. Bolivian High Andean Complex
54. Arid Puna
55. Subandean Pampas
56. South Andean Yungas

Inter-Andean Dry Valleys Complex
57. Inter-Andean Dry Valleys

North Andean Montane Complex
58. North Andean Montane
59. Humid Andean Yungas
60. Chuquisaca and Tarija Yungas
61. Salta and Tucuman Yungas
62. Sierra de Cordoba

Puyango-Tumbes Complex
63. Puyango-Tumbes

Atacama/Sechura Complex
64. Atacama/Sechura Deserts

Pacific Coastal Desert Complex
65. Pacific Coastal Deserts

Lake Titicaca/Poopo Complex
66. Lake Titicaca
67. Lake Poopo

Galapagos Complex
68. Galapagos

Mediterranean Chile Complex
69. North Mediterranean Chile
70. South Mediterranean Chile

Juan Fernandez Islands Complex
71. Juan Fernandez Islands

Southern Chile Complex
72. Valdivian
73. Chiloe Island
74. Chonos Archipelago
75. Magallanes/Ultima Esperanza

Subantarctic Complex
76. Subantarctic

Venezuelan Coast/Trinidad Complex
77. Venezuelan Coast/Trinidad

Llanos Complex
78. Llanos

Guiana/Orinoco Complex
79. Eastern Morichal
80. Orinoco Delta
81. Southern Orinoco
82. Guiana Watershed

Amazon Complex
83. Amazon Delta
84. Amazon Main Channel
85. Northern Amazon Shield Tributaries
86. Rio Negro
87. Upper Amazon Piedmont
88. Western Amazon Lowlands
89. Central Brazilian Shield Tributaries
90. Tocantins-Araguaia

Northeast Atlantic Complex
91. Maranhao

Mata Atlantica Complex
92. Northeast Mata Atlantica
93. East Mata Atlantica
94. Southeastern Mata Atlantica

Sao Francisco Complex
95. Caatinga
96. Cerrado

Upper Parana Complex
97. Upper Parana

Beni Complex
98. Beni

Paraguay-Parana Complex
99. Pantanal
100. Lower Parana

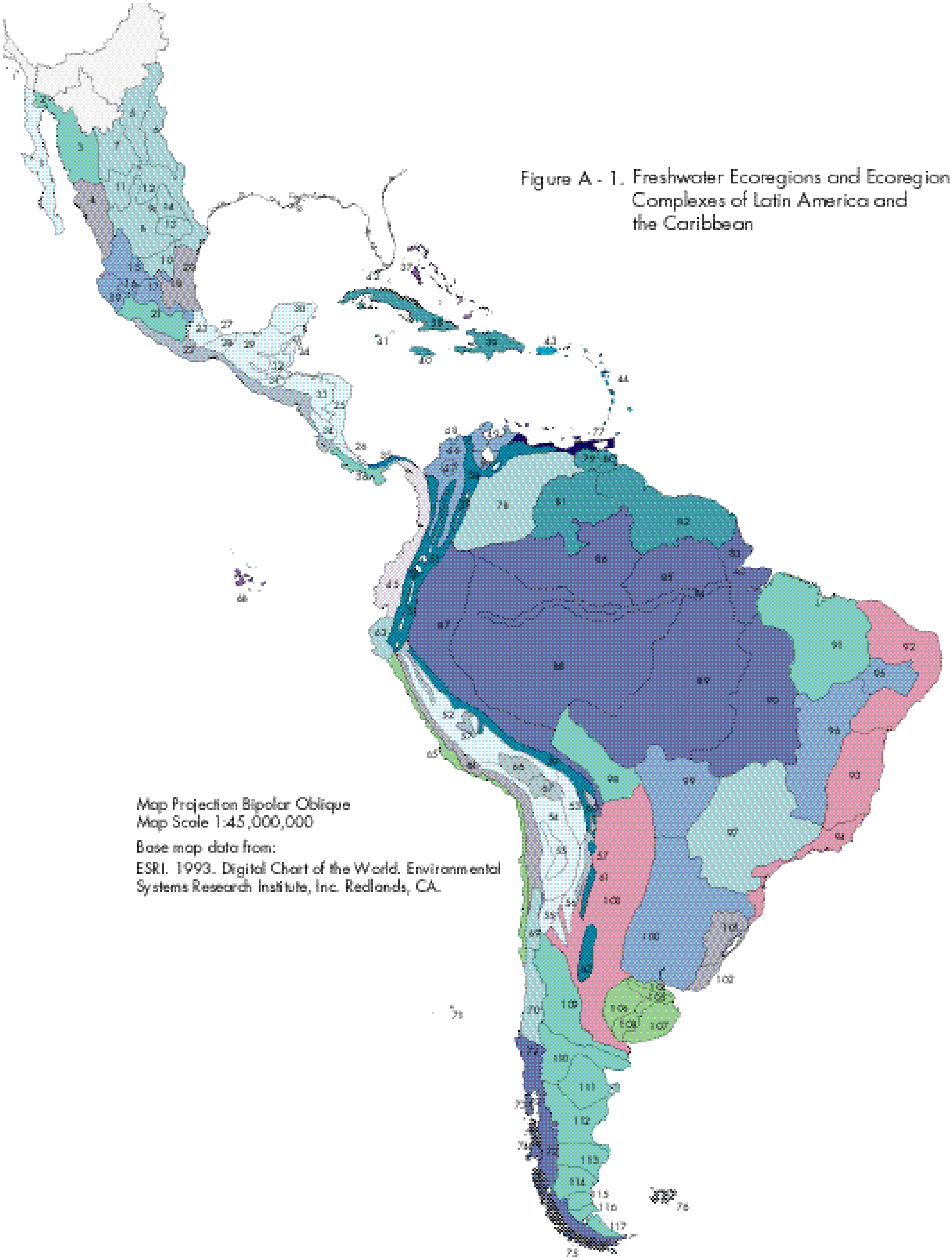
Southern Atlantic Complex
101. Jacui Highlands
102. Lagoa dos Patos Coastal Plain

Chaco Complex
103. Chaco

Pampas Complex
104. Parana-Platense Basin
105. Rio Salado and Arroyo Vallimanca
106. Northwest Pampas Basins
107. Pampas Coastal Plains
108. Southwest Pampas Basins

Patagonia Complex
109. Rio Colorado
110. Rio Limay-Neuquen-Rio Negro
111. Meseta Somuncura
112. Rio Chubut-Rio Chico
113. Rio Deseado
114. Rio Santa Cruz-Rio Chico
115. Rio Coyle
116. Rio Gallegos
117. Tierra del Fuego-Rio Grande

Figure A - 1. Freshwater Ecoregions and Ecoregion Complexes of Latin America and the Caribbean



Map Projection Bipolar Oblique
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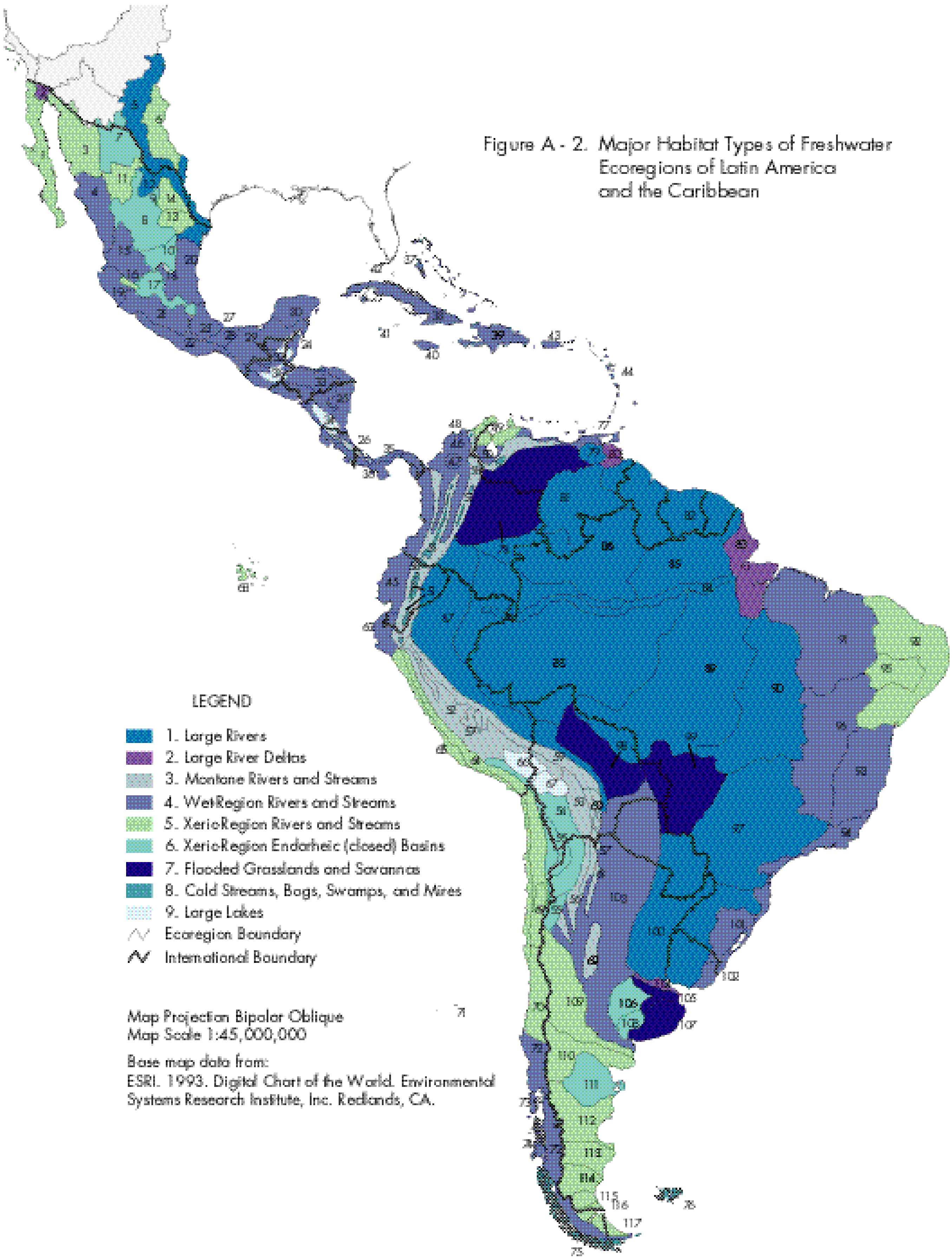

Figure A - 2. Major Habitat Types of Freshwater Ecoregions of Latin America and the Caribbean

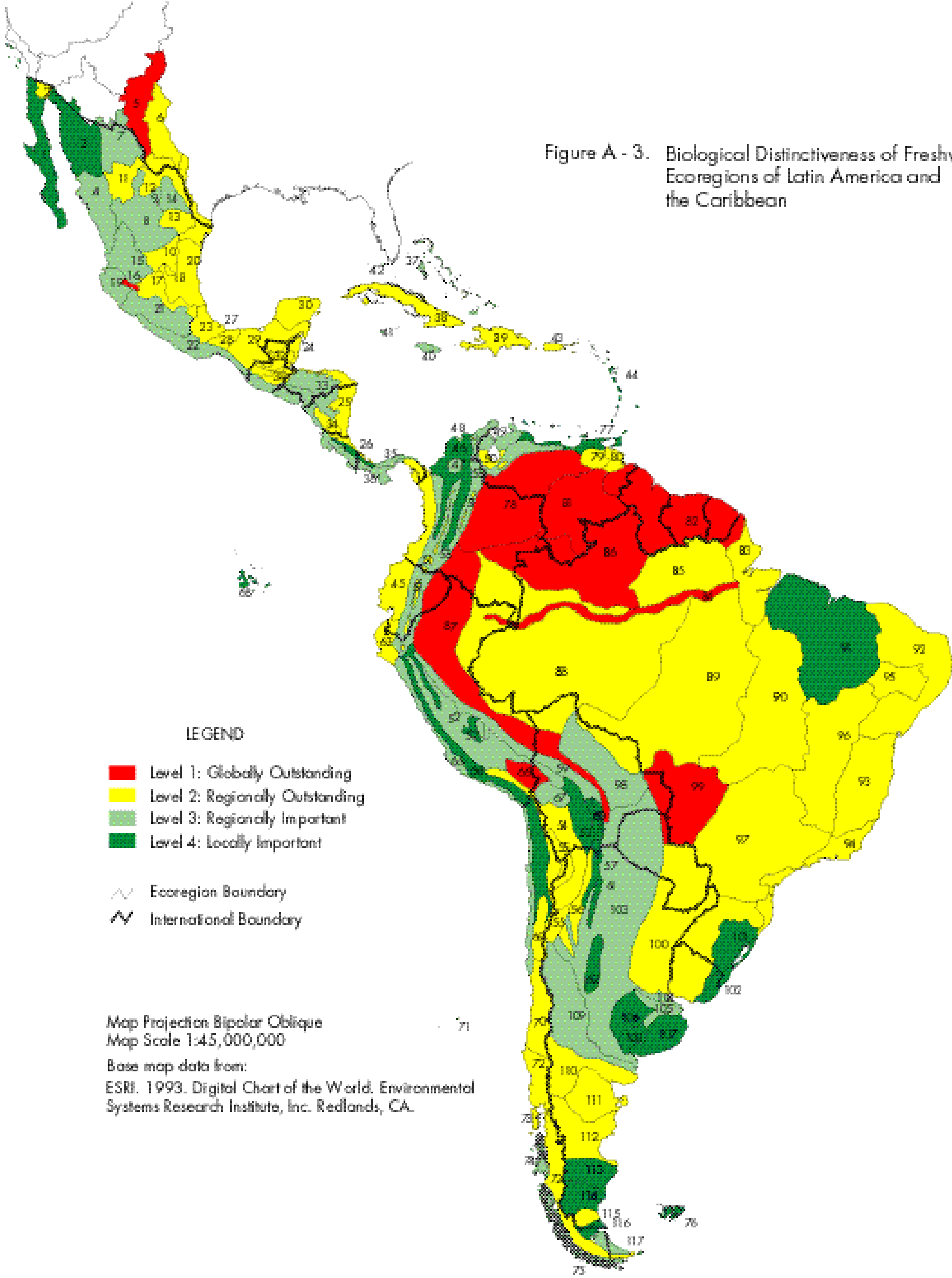

Figure A - 3. Biological Distinctiveness of Freshwater Ecoregions of Latin America and the Caribbean

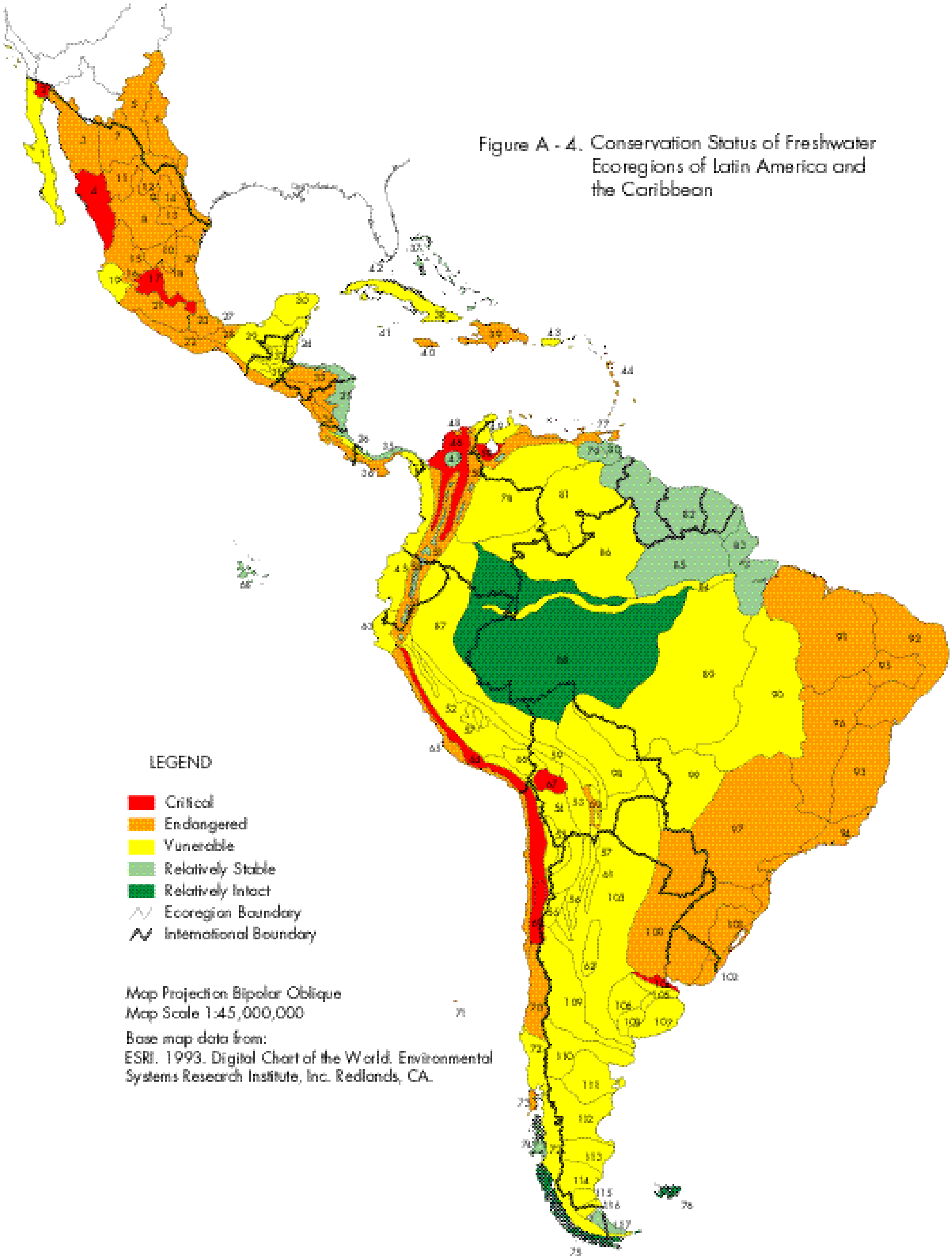

Figure A - 4. Conservation Status of Freshwater Ecoregions of Latin America and the Caribbean

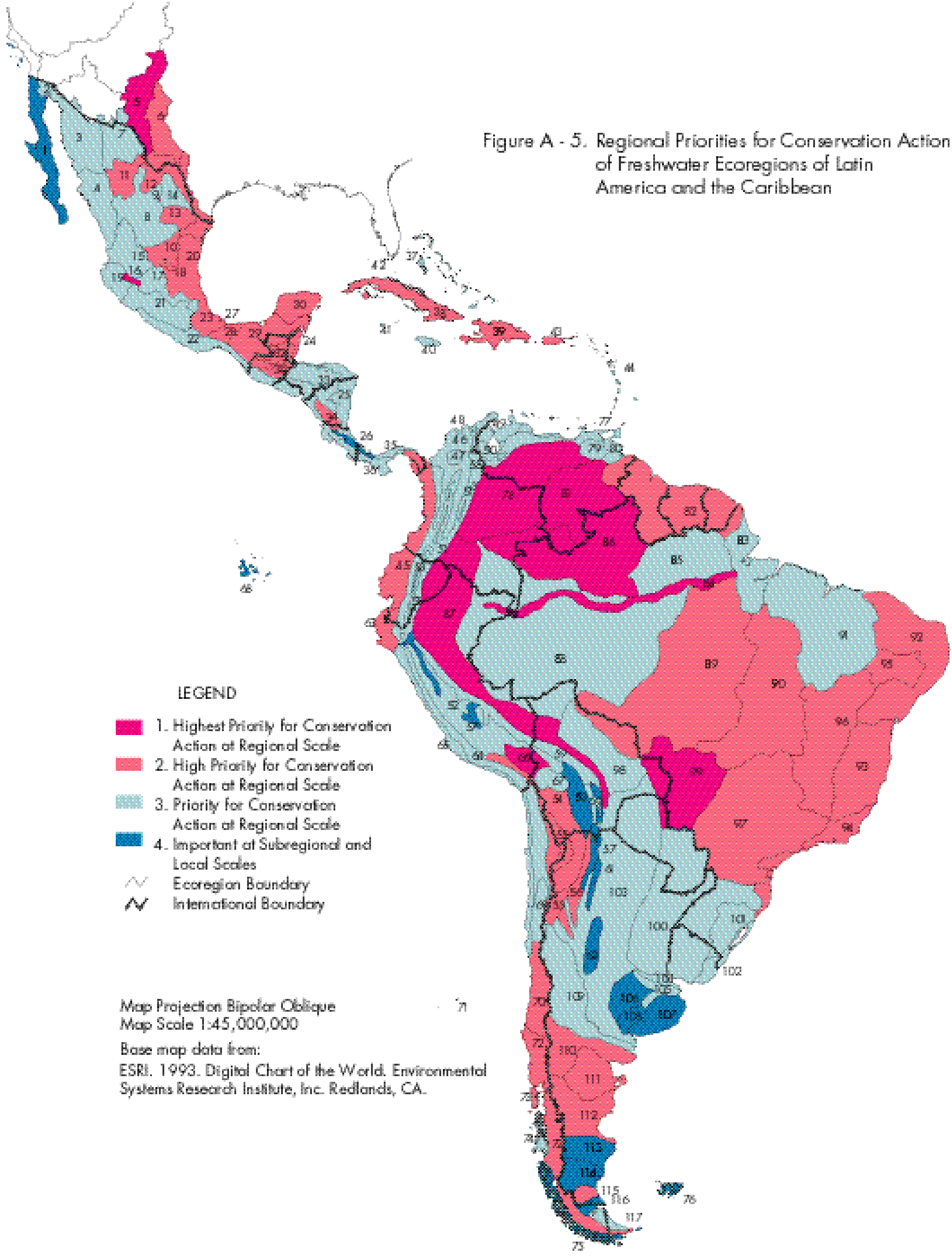

Figure A - 5. Regional Priorities for Conservation Action of Freshwater Ecoregions of Latin America and the Caribbean

Table B. Integration Matrices of Biological Distinctiveness and Conservation Status

1. Large Rivers

Biological Distinctiveness	Final Conservation Status: Critical	Endangered	Vulnerable	Relatively Stable	Relatively Intact
Globally Outstanding		5. Rio Bravo-Mexico, U.S.	81. Southern Orinoco - Colombia, Venezuela, Brazil 84. Amazon Main Channel - Brazil, Peru 86. Rio Negro - Brazil 87. Upper Amazon Piedmont - Bolivia, Brazil, Colombia, Ecuador, Peru	82. Guiana Watershed - Brazil, Guiana, French Guiana, Suriname	
Regionally Outstanding		12. Lower Rio Bravo-Mexico, U.S. 97. Upper Parana - Brazil 100. Lower Parana - Argentina, Brazil, Paraguay, Uruguay	89. Central Brazilian Shield Tributaries - Bolivia, Brazil 90. Tocantins - Araguaia - Brazil	79. Eastern Morichal - Venezuela 85. Northern Amazon Shield Tributaries - Brazil	88. Western Amazon Lowlands - Bolivia, Brazil, Colombia, Peru
Regionally Important					
Locally Important					

2. Larger River Deltas

Biological Distinctiveness	Final Conservation Status: Critical	Endangered	Vulnerable	Relatively Stable	Relatively Intact
Globally Outstanding					
Regionally Outstanding	2. Colorado Delta - Mexico			80. Orinoco Delta-Venezuela 83. Amazon Delta - Brazil	
Regionally Important	104. Parano-Platense Basin-Argentina, Uruguay				
Locally Important					

3. Montane Rivers and Streams

Biological Distinctiveness	Final Conservation Status: Critical	Endangered	Vulnerable	Relatively Stable	Relatively Intact
Globally Outstanding					
Regionally Outstanding			56. South Andean Yungas - Bolivia, Peru		
Regionally Important		58. North Andean Montane- Colombia, Ecuador, Peru, Venezuela	52. Peru High Andean Complex - Bolivia, Peru 59. Humid Andean Yungas - Bolivia, Peru		
Locally Important		60. Chuquisaca and Tajira Yungas - Bolivia	26. Talamancan Highlands - Costa Rica, Panama 53. Bolivian High Andean Complex - Argentina, Bolivia 57. Inter-Andean Dry Valleys - Argentina, Bolivia 61. Salta and Tucuman Yungas - Argentina 62. Sierra de Cordoba - Argentina		

4. Wet-Region Rivers and Streams

Biological Distinctiveness	Final Conservation Status Critical	Endangered	Vulnerable	Relatively Stable	Relatively Intact
Globally Outstanding					
Regionally Outstanding	50. Maracaibo Basin - Colombia, Venezuela	20. Rio Panuco - Mexico 23. Southern Veracruz - Mexico 28. Coatzacoalcos - Mexico 39. Hispaniola - Dominican Republic, Haiti 73. Chiloe Island - Chile 93. East Mata-Atlantica - Brazil 94. Southeast Mata-Atlantica - Brazil 96. Cerrado - Brazil 24. Belizean Lowlands -	Belize, Guatemala 29. Grijalva-Usumachinta - Guatemala, Mexico 30. Yucatan - Mexico 32. Central American Karst Highlands - Guatemala, Mexico 38. Cuba - Cuba 43. Puerto Rico and Virgin Islands - U.S. 45.Choco-Colombia, Ecuador, Panama 63.Puyango-Tumbes-Ecuador,Peru 72. Valdivian - Chile 25. Central American	Caribbean Lowlands - Costa Rica, Honduras, Nicaragua, Panama	
Regionally Important	4.Sinaban Coastal - Mexico, U.S.	15. Santiago - Mexico 21. Balsas - Mexico 22. Tehuantepec - Costa Rica, El Salvador, Guatemala, Honduras,Mexico,Nicaragua 33.Honduran/Nicaraguan Highlands - Honduras, Nicaragua 36. Isthmus Pacific - Costa Rica, Panama 40. Jamaica - Jamaica 48. Cienega Grande de Santa Marta - Colombia 71.Juan Fernandez Islands-Chile	19.Manatlan/America-Mexico 103. Chaco - Argentina, Bolivia, Paraguay	35. Isthmus Atlantic - Panama 37. Bahamas - Bahamas 47. Momposian Depression - Rio Cesar - Colombia 74. Chonos Archipelago - Chile	
Locally Important	46. Magdalena - Colombia	42. Florida Keys - U.S. 44. Windward and Leeward Islands 75. Venezuela Coast/Trinidad - Venezuela, Trinidad, and Tobago 91. Maranhao - Brazil 101. Jacui Highlands - Brazil, Uruguay 102. Lagoa dos Patos Coastal Plain - Brazil, Uruguay	41. Cayman Islands		

5. Xeric-Region Rivers and Streams

Biological Distinctiveness	Final Conservation Status: Critical	Endangered	Vulnerable	Relatively Stable	Relatively Intact
Globally Outstanding		16. Chapala - Mexico			
Regionally Outstanding	69. North Mediterranean Chile - Argentina, Chile	6. Pecos - U.S. 11. Conchos - Mexico, U.S. 13. Rio San Juan - Mexico 18. Rio Verde Headwaters - Mexico 70. South Mediterranean Chile - Chile 92. Northeast Mata-Atlantica - Brazil	95. Caatinga - Brazil 110. Rio Limay-Neuquen - Rio Negro - Argentina 112. Rio Chubut-Rio Chico - Argentina 115. Rio Coyle - Argentina		
Regionally Important		14. Rio Salado - Mexico 65. Pacific Coastal Deserts - Chile, Peru	49. Guajira Desert - Colombia, Venezuela 109. Rio Colorado - Argentina	117. Tierra del Fuego-Rio Grande - Argentina, Chile	
Locally Important	64. Atacama/ Sehura Deserts - Chile, Peru	3. Sonoran - Mexico, U.S.	1. Baha California - Mexico 113. Rio Deseado - Argentina 114. Rio Santa Cruz-Rio Chico - Argentina 116. Rio Gallegos - Argentina, Chile	68. Galapagos - Ecuador	

6. Xeric-Region Endorheic (closed) Basins

Biological Distinctiveness	Final Conservation Status: Critical	Endangered	Vulnerable	Relatively Stable	Relatively Intact
Globally Outstanding			9. Cuatro Cienegas - Mexico		
Regionally Outstanding	17. Lerma - Mexico	10. Llanos El Salado - Mexico	54. Arid Puna - Argentina, Bolivia, Chile, Peru 55. Subandean Pampas - Argentina, Chile, Peru 111. Meseta Somuncura - Argentina		
Regionally Important		7. Guzman - Mexico, U.S. 8. Mapimi - Mexico			
Locally Important			106. Northwest Pampas Basins - Argentina 108. Southwest Pampas Basins - Argentina		

7. Flooded Grasslands and Savannas

Biological Distinctiveness	Final Conservation Status: Critical	Endangered	Vulnerable	Relatively Stable	Relatively Intact
Globally Outstanding			78. Llanos - Colombia, Venezuela 99. Pantanal - Bolivia, Brazil, Paraguay		
Regionally Outstanding					
Regionally Important			98. Beni - Bolivia 105. Rio Salado and Arroyo Vallimanca - Argentina		
Locally Important			107. Pampas Coastal Plains - Argentina		

8. Cold Streams, Bogs, Swamps, and Mires

Biological Distinctiveness	Final Conservation Status: Critical	Endangered	Vulnerable	Relatively Stable	Relatively Intact
Globally Outstanding					
Regionally Outstanding				51.Paramos - Colombia, Ecuador, Peru, Venezuela	
Regionally Important					75. Magallanes/Ultima Esperanza - Argentina, Chile
Locally Important					76. Subantarctic - Argentina

9. Large Lakes

Biological Distinctiveness	Final Conservation Status: Critical	Endangered	Vulnerable	Relatively Stable	Relatively Intact
Globally Outstanding			66. Lake Titicaca - Bolivia, Peru		
Regionally Outstanding		34. Lake Nicaragua - Nicaragua	27. Catemaco - Mexico 31. Guatemalan Highlands - Guatemala		
Regionally Important	67. Lake Poopo - Bolivia				
Locally Important					

Table D. Biological Distinctiveness Analysis: Criteria and

Ecoregion	Biological Distinctiveness: Species Richness (2-10)	Endemism	Ecosystem Diversity (1-5)	Total of Indicator Numbers (6-30)	Special Considerations: Rarity of Major Habitat Type	Special Considerations: Unusual Ecological/ Evolutionary	Biological Distinctivenes
Baja California Complex							
1. Baja California	2	6	3	11			LI
Colorado River Complex							
2. Colorado Delta	2	6	2	10	RO[1]	RO[2]	RO
3. Sonoran	2	6	2	10			LI
Sinaloan Coastal Complex							
4. Sinaloan Coastal	4	9	3	16			RI
Rio Bravo Complex							
5. Rio Bravo	10	12	5	27			GO
6. Pecos	8	6	4	18			RO
7. Guzman	6	6	4	16			RI
8. Mapimi	4	9	3	16			RI
9. Cuatro Cienegas	10	15	5	30		GO[3]	GO
10. Llanos El Salado	2	15	5	22			RO
11. Conchos	6	9	4	19			RO
12. Lower Rio Bravo	8	12	4	24			RO
13. Rio San Juan	6	9	4	19			RO
14. Rio Salado	6	9	2	17			RI
Lerma/Santiago Complex							
15. Santiago	4	6	3	13			RI
16. Chapala	8	15	5	28	RO[4]	RO[5]	GO
17. Lerma	6	9	3	18			RO
18. Rio Verde Headwaters	2	15	1	18			RO
19. Manantlan/Ameca	4	9	4	17			RI
Rio Panuco Complex							
20. Rio Panuco	6	12	4	22			RO
Balsas Complex							
21. Balsas	2	12	3	17			RI
Pacific Central Complex							
22. Tehuantepec	4	9	3	16			RI
Atlantic Central Complex							
23. Southern Veracruz	6	12	3	21			RO
24. Belizean Lowlands	6	9	3	18			RO
25. Central American Caribbean Lowlands	6	9	3	18			RO
26. Talamancan Highlands	2	3	3	8			LI
27. Catemaco	6	12	4	22			RO
28. Coatzacoalcos	6	9	3	18			RO
29. Grijalva-Usumacinta	8	12	3	23			RO

Scoring for biological distinctiveness indicators: higher numbers correspond to greater distinctiveness

Biological distinctiveness:

Globally Outstanding GO = 26-30
Regionally Outstanding RO = 18-25
Regionally Important RI = 13-17
Locally Important LI = 6-12

Special considerations: Assigning special considerations to an ecoregion automatically elevates its biological distinctiveness to the highest ranking received, regardless of total point score.

Rarity of major habitat types and unusual ecological/evolutionary phenom-

1 Large river delta
2 Large-scale fish migrations
3 Very high beta diversity/unusual adaptations and radiations
4 Large tropical lakes
5 Pronounced radiations of fish in tropical lakes
6 Tropical saline lakes
7 Extensive flooded savanna
8 Large river channels

Table D. *(Continued)*

Ecoregion	Biological Distinctiveness Indicators: Species Richness (2-10)		Ecosystem Diversity (1-5)	Total of Indicator Numbers (6-30)	Special Considerations: Rarity of Major Habitat Type	Unusual Ecological/ Evolutionary	Biological Distinctivene
30. Yucatan	4	9	5	18			RO
31. Guatemalan Highlands	6	6	3	15	RO[4]		RO
32. Central American Karst Highlands	6	9	4	19			RO
33. Honduran/Nicaraguan Highlands	6	6	3	15			RI
34. Lake Nicaragua	8	9	4	21	RO[4]		RO
Isthmus Atlantic Complex							
35. Isthmus Atlantic	6	6	2	14			RI
Isthmus Pacific Complex							
36. Isthmus Pacific	6	9	2	17			RI
Bahama Archipelago Complex							
37. Bahamas	4	9	3	16			RI
Western Insular Caribbean Complex							
38. Cuba	8	12	3	23			RO
39. Hispaniola	6	12	3	21			RO
40. Jamaica	4	6	3	13			RI
41. Cayman Islands	2	6	3	11			LI
42. Florida Keys	2	3	3	8			LI
Eastern Insular Caribbean Complex							
43. Puerto Rico and Virgin Islands	8	12	3	23			RO
44. Windward & Leeward Islands	4	3	2	9			LI
Choco Complex							
45. Choco	10	12	2	24			RO
South American Caribbean Complex							
46. Magdalena	8	3	1	12			LI
47. Momposina Depression-Rio Cesar	8	3	2	13			RI
48. Cienega Grande de Santa Marta	8	3	3	14			RI
49. Guajira Desert	8	3	2	13			RI
50. Maracaibo Basin	8	12	2	22			RO
High Andean Complex							
51. Paramos	8	12	3	23			RO
52. Peru High Andean Complex	8	6	2	16			RI
53. Bolivian High Andean Complex	4	3	2	9			LI
54. Arid Puna	6	9	5	20	RO[6]		RO
55. Subandean Pampas	6	9	3	18			RO
56. South Andean Yungas	6	9	3	18			RO
Inter-Andean Dry Valleys Complex							
57. Inter-Andean Dry Valleys	4	3	1	8			LI
North Andean Montane Complex							
58. North Andean Montane	6	9	1	16			RI
59. Humid Andean Yungas	4	9	2	15			RI

Scoring for biological distinctiveness indicators: higher numbers correspond to greater distinctiveness

Biological distinctiveness:

Globally Outstanding GO =26-30
Regionally Outstanding RO = 18-25
Regionally Important RI =13-17
Locally Important LI = 6-12

Special considerations: Assigning special considerations to an ecoregion automatically elevates its biological distinctiveness to the highest ranking received, regardless of total point score.

Rarity of major habitat types and unusual ecological/evolutionary phenom-

1 Large river delta
2 Large-scale fish migrations
3 Very high beta diversity/unusual adaptations and radiations
4 Large tropical lakes
5 Pronounced radiations of fish in tropical lakes
6 Tropical saline lakes
7 Extensive flooded savanna
8 Large river channels

Table D. *(Continued)*

Ecoregion	Biological Distinctiveness Indicators			Total of Indicator Numbers (6-30)	Special Considerations		Biological Distinctivene
	Species Richness (2-10)		Ecosystem Diversity (1-5)		Rarity of Major Habitat	Unusual Ecological/ Evolutionary	
60. Chuquisaca and Tarija Yungas	4	6	1	11			LI
61. Salta and Tucuman Yungas	4	3	1	8			LI
62. Sierra de Cordoba	4	3	1	8			LI
Puyango-Tumbes Complex							
63. Puyango-Tumbes	10	9	2	21			RO
64. Atacama/Sechura Deserts	2	6	1	9			LI
Pacific Coastal Desert Complex							
65. Pacific Coastal Deserts	6	6	3	15			RI
Lake Titicaca/Poopo Complex							
66. Lake Titicaca	8	15	5	28	GO[4]	GO[5]	GO
67. Lake Poopo	6	6	5	17			RI
Galapagos Complex							
68. Galapagos	2	9	1	12			LI
Mediterranean Chile Complex							
69. North Mediterranean Chile	6	9	4	19			RO
70. South Mediterranean Chile	4	12	4	20			RO
Juan Fernandez Islands Complex							
71. Juan Fernandez Islands	4	9	4	17			RI
Southern Chile Complex							
72. Valdivian	6	9	5	20			RO
73. Chiloe Island	6	9	4	19			RO
74. Chonos Archipelago	4	6	4	14			RI
75. Magallanes/Ultima Esperanza	4	6	4	14			RI
Subantarctic Complex							
76. Subantarctic	2	3	4	9			LI
Venezuelan Coast/Trinidad Complex							
77. Venezuelan Coast/Trinidad	4	3	1	8			LI
Llanos Complex							
78. Llanos	10	12	5	27	RO[7]	GO[3]	GO
Guiana/Orinoco Complex							
79. Eastern Morichal	6	9	5	20			RO
80. Orinoco Delta	10	6	4	20	RO[1]		RO
81. Southern Orinoco	10	15	5	30	GO[8]		GO
82. Guiana Watershed	8	15	4	27			GO
Amazon Complex							
83. Amazon Delta	8	6	5	19	RO[1]		RO
84. Amazon Main Channel	10	9	5	24	GO[8]	GO[2]	GO
85. Northern Amazon Shield Tributaries	6	12	4	22			RO
86. Rio Negro	8	15	5	28		GO[2]	GO
87. Upper Amazon Piedmont	10	12	4	26			GO

Scoring for biological distinctiveness indicators: higher numbers correspond to greater distinctiveness

Biological distinctiveness:

Globally Outstanding GO =26-30
Regionally Outstanding RO = 18-25
Regionally Important RI =13-17
Locally Important LI = 6-12

Special considerations: Assigning special considerations to an ecoregion automatically elevates its biological distinctiveness to the highest ranking received, regardless of total point

Rarity of major habitat types and unusual ecological/evolutionary phenom-

[1] Large river delta
[2] Large-scale fish migrations
[3] Very high beta diversity/unusual adaptations and radiations
[4] Large tropical lakes
[5] Pronounced radiations of fish in tropical lakes
[6] Tropical saline lakes
[7] Extensive flooded savanna
[8] Large river channels

Table D. *(Continued)*

Ecoregion	Biological Distinctiveness Indicators: Species Richness (2-10)		Ecosystem Diversity (1-5)	Total of Indicator Numbers (6-30)	Special Considerations: Rarity of Major Habitat	Special Considerations: Unusual Ecological/ Evolutionary	Biological Distinctivenes
88. Western Amazon Lowlands	8	9	3	20			RO
89. Central Brazilian Shield Tributaries	8	9	3	20			RO
90. Tocantins-Araguaia	8	12	3	23			RO
Northeast Atlantic Complex							
91. Maranhao	6	3	3	12			LI
92. Northeast Mata-Atlantica	6	12	3	21			RO
93. East Mata-Atlantica	8	12	3	23			RO
94. Southeast Mata-Atlantica	8	12	3	23			RO
Sao Francisco Complex							
95. Caatinga	6	12	4	22			RO
96. Cerrado	6	12	4	22			RO
Upper Parana Complex							
97. Upper Parana	8	12	2	22			RO
Beni Complex							
98. Beni	8	6	3	17			RI
Paraguay-Parana Complex							
99. Pantanal	8	6	4	18		GO[7]	GO
100. Lower Parana	8	12	3	23			RI
Southern Atlantic Complex							
101. Jacui Highlands	4	3	3	10			LI
102. Lagoa dos Patos Coastal Plain	4	3	3	10			LI
Chaco Complex							
103. Chaco	6	6	5	17			RI
Pampas Complex							
104. Parano-Platense Basin	7	3	3	13			RI
105. Rio Salado and Arroyo Vallimanca Basin	5	3	5	13			RI
106. Northwest Pampas Basins	2	3	5	10			LI
107. Pampas Coastal Plains	4	3	5	12			LI
108. Southwest Pampas Basins	4	3	3	10			LI
Patagonia Complex							
109. Rio Colorado	6	6	3	15			RI
110. Rio Limay-Neuquen-Rio Negro	6	15	4	25			RO
111. Meseta Somuncura	4	15	3	22			RO
112. Rio Chubut-Rio Chico	6	12	3	21			RO
113. Rio Deseado	2	6	2	10			LI
114. Rio Santa Cruz-Rio Chico	2	6	3	11			LI
115. Rio Coyle	2	15	2	19			RO
116. Rio Gallegos	2	6	2	10			LI
117. Tierra del Fuego-Rio Grande	2	12	2	16			RI

Scoring for biological distinctiveness indicators: higher numbers correspond to greater distinctiveness

Biological distinctiveness:

Globally Outstanding GO =26-30
Regionally Outstanding RO = 18-25
Regionally Important RI =13-17
Locally Important LI = 6-12

Special considerations: Assigning special considerations to an ecoregion automatically elevates its biological distinctiveness to the highest ranking received, regardless of total point

Rarity of major habitat types and unusual ecological/evolutionary phenom-

[1] Large river delta
[2] Large-scale fish migrations
[3] Very high beta diversity/unusual adaptations and radiations
[4] Large tropical lakes
[5] Pronounced radiations of fish in tropical lakes
[6] Tropical saline lakes
[7] Extensive flooded savanna
[8] Large river channels

Table E. Conservation Status Analysis: Criteria and Values

Ecoregion	Fragmentation	Habitat Loss	Water Quality	Hydrographic Integrity	Catchment Alteration	Total	Conservation Status*
	Conservation Status Indicators						
Baja California Complex							
1. Baja California	2	2	2	2	3	11	V
Colorado River Complex							
2. Colorado Delta	3	3	3	3	3	15	C
3. Sonoran	3	3	3	3	2	14	E
Sinaloan Coastal Complex							
4. Sinaloan Coastal	3	3	3	3	3	15	C
Rio Bravo Complex							
5. Rio Bravo	3	3	1	3	3	13	E
6. Pecos	3	3	3	3	2	14	E
7. Guzman	3	3	1	2	3	12	E
8. Mapimi	3	3	3	2	3	14	E
9. Cuatro Cienegas	2	2	3	2	2	11	V
10. Llanos El Salado	1	3	3	3	3	13	E
11. Conchos	3	2	3	3	3	14	E
12. Lower Rio Bravo	3	2	3	3	3	14	E
13. Rio San Juan	2	3	3	3	3	14	E
14. Rio Salado	3	3	3	2	3	14	E
Lerma/Santiago Complex							
15. Santiago	3	2	3	3	3	14	E
16. Chapala	1	2	3	3	3	12	E
17. Lerma	3	3	3	3	3	15	C
18. Rio Verde Headwaters	3	3	3	2	3	14	E
19. Manantlan/Ameca	2	2	1	1	2	8	V
Rio Panuco Complex							
20. Rio Panuco	3	3	3	2	3	14	E
Balsas Complex							
21. Balsas	3	2	3	3	3	14	E
Pacific Central Complex							
22. Tehuantepec	3	3	2	2	2	12	E
Atlantic Central Complex							
23. Southern Veracruz	3	3	2	2	2	12	E
24. Belizean Lowlands	2	2	1	2	2	9	V
25. Central American Caribbean Lowlands	2	2	1	1	1	7	RS
26. Talamancan Highlands	2	1	3	1	1	8	V
27. Catemaco	1	1	2	1	3	8	V
28. Coatzacoalcos	2	3	1	3	3	12	E
29. Grijalva-Usumacinta	2	2	1	2	2	9	V
30. Yucatan	2	2	3	1	2	10	V
31. Guatemalan Highlands	2	3	3	1	1	10	V

Scoring for conservation status indicators (loss or degradation):
3 = High
2 = Medium
1 = Low

*Critical (C) = 15
Endangered (E) = 12-14
Vulnerable (V) = 8-11
Relatively stable (RS) = 6-7
Relatively Intact (RI) = 5
total range = 5-15

Table E. *(Continued)*

Ecoregion	Fragmentation	Habitat Loss	Water Quality	Hydrographic Integrity	Catchment Alteration	Total	Conservation Status*
	Conservation Status Indicators						
32. Central American Karst Highlands	2	2	3	1	2	10	V
33. Honduran / Nicaraguan Highlands	2	2	3	2	3	12	E
34. Lake Nicaragua	3	3	1	2	3	12	E
Isthmus Atlantic Complex							
35. Isthmus Pacific	1	2	2	1	1	7	RS
Isthmus Pacific Complex							
36. Isthmus Pacific	3	3	2	2	2	12	E
Bahama Archipelago Complex							
37. Bahamas	1	1	2	1	1	6	RS
Western Insular Caribbean Complex							
38. Cuba	2	2	1	2	2	9	V
39. Hispaniola	3	3	2	3	3	14	E
40. Jamaica	3	3	2	3	3	14	E
41. Cayman Islands	1	2	1	3	2	9	V
42. Florida Keys	3	3	2	1	3	12	E
Eastern Insular Caribbean Complex							
43. Puerto Rico and Virgin Islands	2	2	2	2	3	11	V
44. Windward and Leeward Islands	3	2	3	2	2	12	E
Choco Complex							
45. Choco	2	2	2	2	2	10	V
South American Caribbean Complex							
46. Magdalena	3	3	3	3	3	15	C
47. Momposina Depression-Rio Cesar	1	1	3	1	1	7	RS
48. Cienega Grande de Santa Marta	1	3	3	3	3	13	E
49. Guajira Desert	1	3	1	2	3	10	V
50. Maracaibo Basin	3	3	3	3	3	15	C
High Andean Complex							
51. Paramos	1	1	1	2	2	7	RS
52. Peru High Andean Complex	1	1	2	3	3	10	V
53. Bolivian High Andean Complex	1	2	3	3	2	11	V
54. Arid Puna	2	2	2	2	3	11	V
55. Subandean Pampas	2	2	2	2	2	10	V
56. South Andean Yungas	2	2	2	2	3	11	V
Inter-Andean Dry Valleys Complex							
57. Inter-Andean Dry Valleys	2	1	3	2	2	10	V
North Andean Montane Complex							
58. North Andean Montane	3	2	3	2	2	12	E
59. Humid Andean Yungas	2	3	1	1	2	9	V
60. Chuquisaca and Tarija Yungas	3	2	3	2	2	12	E
61. Salta and Tucuman Yungas	2	2	2	2	3	11	V
62. Sierra de Cordoba	2	2	2	2	2	10	V

Scoring for conservation status indicators (loss or degradation):
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1 = Low

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Endangered (E) = 12-14
Vulnerable (V) = 8-11
Relatively stable (RS) = 6-7
Relatively Intact (RI) = 5
total range = 5-15

Table E. *(Continued)*

Ecoregion	Fragmentation	Habitat Loss	Water Quality	Hydrographic Integrity	Catchment Alteration	Total	Conservation Status*
	Conservation Status Indicators						
Puyango-Tumbes Complex							
63. Puyango-Tumbes	2	2	2	2	3	11	V
Atacama/Sechura Complex							
64. Atacama/Sechura Deserts	3	3	3	3	3	15	C
Pacific Coastal Desert Complex							
65. Pacific Coastal Deserts	3	3	2	3	3	14	E
Lake Titicaca/Poopo Complex							
66. Lake Titicaca	2	1	2	2	3	10	V
67. Lake Poopo	3	3	3	3	3	15	C
Galapagos Complex							
68. Galapagos	1	1	2	1	1	6	RS
Mediterranean Chile Complex							
69. North Mediterranean Chile	3	3	3	3	3	15	C
70. South Mediterranean Chile	3	3	2	3	3	14	E
Juan Fernandez Islands Complex							
71. Juan Fernandez Islands	3	3	1	2	3	12	E
Southern Chile Complex							
72. Valdivian	2	2	2	2	3	11	V
73. Chiloe Island	3	3	2	1	3	12	E
74. Chonos Archipelago	2	2	1	1	1	7	RS
75. Magallanes/Ultima Esperanza	1	1	1	1	1	5	RI
Subantarctic Complex							
76. Subantarctic	1	1	1	1	1	5	RI
Venezuelan Coast/Trinidad Complex							
77. Venezuelan Coast/Trinidad	3	3	2	2	3	13	E
Llanos Complex							
78. Llanos	2	2	2	2	3	11	V
Guiana/Orinoco Complex							
79. Eastern Morichal	1	1	1	1	2	6	RS
80. Orinoco Delta	1	1	2	2	1	7	RS
81. Southern Orinoco	2	1	2	2	1	8	V
82. Guiana Watershed	1	1	2	1	1	6	RS
Amazon Complex							
83. Amazon Delta	1	1	1	1	2	6	RS
84. Amazon Main Channel	2	3	1	1	1	8	V
85. Northern Amazon Shield Tributaries	2	1	2	1	1	7	RS
86. Rio Negro	2	2	1	1	2	8	V
87. Upper Amazon Piedmont	1	2	2	1	2	8	V
88. Western Amazon Lowlands	1	1	1	1	1	5	RI
89. Central Brazilian Shield Tributaries	2	2	2	1	2	9	V
90. Tocantins-Araguaia	3	2	1	2	2	10	V

Scoring for conservation status indicators (loss or degradation): 3 = High
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Relatively Intact (RI) = 5
total range = 5-15

Table E. *(Continued)*

Ecoregion	Fragmentation	Habitat Loss	Water Quality	Hydrographic Integrity	Catchment Alteration	Total	Conservation Status*
			Conservation Status Indicators				
Northeast Atlantic Complex							
91. Maranhao	3	3	2	3	3	14	E
Mata-Atlantica Complex							
92. Northeast Mata-Atlantica	3	3	2	3	3	14	E
93. East Mata-Atlantica	3	3	2	3	3	14	E
94. Southeast Mata-Atlantica	3	3	2	3	2	13	E
Sao Francisco Complex							
95. Caatinga	3	2	2	2	3	12	E
96. Cerrado	3	2	2	2	3	12	E
Upper Parana Complex							
97. Upper Parana	3	3	2	3	2	13	E
Beni Complex							
98. Beni	2	2	1	2	1	8	V
Paraguay-Parana Complex							
99. Pantanal	2	1	2	3	2	10	V
100. Lower Parana	3	3	2	2	3	13	E
Southern Atlantic Complex							
101. Jacui Highlands	3	3	1	3	3	13	E
102. Lagoa dos Patos Coastal Plain	2	3	2	2	3	12	E
Chaco Complex							
103. Chaco	2	1	2	1	2	8	V
Pampas Complex							
104. Parano-Platense Basin	3	3	3	3	3	15	C
105. Rio Salado & Arroyo/Vallimanca Basin	2	1	3	3	2	11	V
106. Northwest Pampas Basins	2	1	2	3	2	10	V
107. Pampas Coastal Plains	2	1	2	3	2	10	V
108. Southwest Pampas Basins	2	1	2	2	1	8	V
Patagonia Complex							
109. Rio Colorado	3	2	2	1	1	9	V
110. Rio Limay-Neuquen-Rio Negro	3	2	2	2	1	10	V
111. Meseta Somuncura	2	2	2	2	1	9	V
112. Rio Chubut-Rio Chico	2	2	2	1	1	8	V
113. Rio Deseado	2	2	2	1	2	9	V
114. Rio Santa Cruz-Rio Chico	2	2	2	1	1	8	V
115. Rio Coyle	2	2	2	1	1	8	V
116. Rio Gallegos	2	2	2	1	1	8	V
117. Tierra del Fuego-Rio Grande	2	1	1	1	1	6	RS

Scoring for conservation status indicators (loss or degradation): 3 = High
2 = Medium
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*Critical (C) = 15
Endangered (E) = 12-14
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total range = 5-15