Chapter 2 Assessing and Ranking Ecoregions within Provinces

THE FIRST PHASE of the effort to rank ecoregions within provinces involved the selection of indicators as direct and indirect measures of biological value and conservation status. When quantitative data were not available, ranks were produced after a qualitative assessment based on experts' knowledge. The overall ranking for biological value and for conservation status was obtained by a simple sum of all ranked values.

Indicators of Biological Value

The combination of physical and biological indicators provides a reasonable view of the ecological diversity of an area. Information was compiled on three scales: by province, by ecoregions, and by smaller units (depending on availability, usually national boundaries or coastal systems). Table 2.1 shows a completed biological value table for Belize made by the experts.

The indicators are grouped as follows:

Physical Characteristics

Physical characteristics of the marine environment such as coastline extension, shelf extent, and the measurement of terrestrial runoff are indirect indicators of the biological value of coastal areas. Such characteristics are a reflection of the abiotic environment that shapes the associated biological communities and are directly connected to the diversity and productivity of marine flora and fauna.

For example, the occurrence of biological processes such as reproduction, feeding, and growth are linked to shelf width. This feature, together with the length of the coastline, is related to the spatial complexity necessary to sustain numerous physical environments for the different life history stages of animals and plants.

Nutrient flow (organic and inorganic) in biological communities was also indirectly evaluated. The source of nutrients

Table 2.1 Example of completed biological value table: Belize

Indicators of biological and ecological value of marine bioregions

#	INDICATORS	DATA	SOURCE	SQ
	PHYSICAL CONDITIONS			
1	Coastline extension (km)			
2	Shelf width (min.-max./mean)	13-400 km wide	Wells, 1988.; Rutzler et al., 1982	A
3	Shelf area (km²)			
4	Presence of outstanding communities (mangrove/kelp forests, coral reefs, barrier/atoll reef formations, upwellings, etc.)	fringing mangrove, barrier coral reef, atolls, blue holes, extensive lagoon, seagrass, mangrove cays, longest reef in western hemisphere; faroes	Wells, 1988; Perkins and Carr, 1985	A
5	Coral reef extension (% of the total coastline extension)	257 km (~100%) barrier and fringing reef; three offshore atolls	Wells, 1988.	A
6	Mangrove extension (% of the total coastline extension)	Most of coast, especially near river mouths. Over 200 mangrove cays in the barrier reef lagoon	Wells, 1988. Mumby et al., 1995	A
7	Kelp forest extension (% of the total coastline extension)	0		
8	Position relative to the ocean current (upstream, downstream, midstream)	midstream	Brucks, 1971; Kinder, 1983; Stoddart et al., 1982	A
9	Number of rivers per 100 km of coastline			
	SPECIES COMPOSITION			
10	% estuaries/rias/deltas on overall number of rivers			
	Fishes			
11	# of neritic teleost species	600	Carter, pers com.	C
12	# of neritic Perciformes species			
13	# of species of selected families			
	Invertebrates and Macroalgae			
14	# of spp./genera/families of selected groups of coastal mollusks			
15	# of families of benthic macroalgae	165 taxa; 40 families; 34 genera; 77 spp.; 247 total spp. marine flora	Norris and Bucher, 1982	B
16	# of species of selected macroalgae families	9 Cynaophyta, 73 Chlorophyta, 32 Phaeophyta, 124 Rhodophyta, 4 Angiospermae (seagrasses); 100 spp. marine algae (Stoddart et al., 1982)	Norris and Bucher, 1982; Stoddart et al., 1982	B
17	total # of stony coral species	3 hydrozoan and 42 scleractinian	Cairns, 1982	B
	Marine Mammals			
18	total # of species			

Table 2.1 Example of completed biological value table: Belize *(continued)*

#	INDICATORS	DATA	SOURCE	SQ
	SPECIES COMPOSITION *(CONTINUED)*			
19	# of species of selected groups	1 Manatee (*Trichechus manatus*); 3 dolphin (*Tursiops truncatus, Stenella plagiodon* and *Steno bredanensis*)	Wells, 1988; Bengston and Magor, 1979	C
	Seabirds			
20	# of species/genera of selected groups			
21	# of families of selected groups			
	Sea Reptiles			
22	# of species of sea turtles and sea iguana	3 turtles; 2 crocodile (*C. acutus, C. moreleti*);	Wells, 1988; Perkins and Carr, 1985; Abercrombie et al., 1980	A
	ABUNDANCE			
23	# of individuals of selected species	Largest number of manatees in Caribbean (1977-1989)	O'Shea and Salisbury, 1991	
24	Annual catch for selected species/genera	1995 exports: 800,000 lbs lobster, ~400,000 lbs conch. 1994 exports: 27,000 aquarium fish & inverts; Lobster annual exports 1970-77 (metric tons) 205.9, 219.2, 199.0, 170.8, 206.7, 210.4, 223.9. Shrimp annual exports 1972-76 (mt) 11.3, 6.5, 7.0, 12.7, 28.6. Shrimp began in 1965 (23k lbs exported). Finfish exports 1970-76 (mt) 111.8, 65.3, 52.0, 47.9, 68.9, 65.6, 190.2. Q. conch exports 1970-76 (mt) 364.8, 477.1, 563.0, 506.6, 442.9, 406.6, 359.7 Six shrimp trawlers in 1979	Wells et al., in press; Gibson, 1978 Day, 1979	
	BREEDING			
25	Presence of breeding/nesting sites for selected fish/seabird/sea reptile species/genera	loggerhead, hawksbill, green turtles; magnificent frigatebird, red-footed booby, brown pelican, sooty tern, brown noddy, snapper/grouper. Data available in GIS for birds, turtles, crocs, protected areas, conservation status, fisheries and recreation. Snapper/Grouper aggregation sites: 6	Wells, 1988; Mumby et al., 1995; Trivelpiece and Ferraris, 1987; Moll, 1985 Carter and Perrine, 1994; Carter et al., 1994	B
	ENDEMISM			
26	# endemic species for the Biogeographic Province			
	FISHERIES RESOURCES			
27	# of finfish species that are commercially significant	75% of catch is snappers (Lutjanidae); 11% is groupers (Serranidae); 2% is grunts (Haemulidae). 47 spp. exploited, and also include sharks, Scaridae, Acanthuridae, Holocentridae, Sparidae, Carangidae, Sphyraenidae and others. 65 finfish spp.	Koslow et al., 1994; Polunin and Roberts, 1993; Richards and Bohnsack, 1990	A
28	# of species of mollusks that are commercially significant	Conch fishery based on Queen conch (also horse, milk, helmet) (jewelry and shell trade active); octopus	Gibson, 1978; Creswell and Davis, 1991; Sedberry, pers obs.	

Table 2.1 Example of completed biological value table: Belize *(continued)*

#	INDICATORS	DATA	SOURCE	SQ
	FISHERIES RESOUURCES *(CONTINUED)*			
29	# of species of crustaceans that are commercially significant	99.9% of lobster catch is *Panulirus argus*; Stone crab, *Menippe mercenaria* traditionally local, recent export, 4-5k lbs/yr caught for 1986-87 for N-Central BZ.	Gibson, 1978; Bert and Hochberg, 1992	
30	# of genera of macroalgae that are commercially significant			

Indicators of biological and ecological value of marine bioregions; SQ = (Source Quality): A = Data complete and reliable according to best available sources
B = Data reliable, but geographically incomplete
C = Data uncertain

Explanation of indicators for table 2.1

1-3 These data will be automatically estimated by us through GIS.
4 Record each type on separate rows.
5-7 Estimate the linear extension of each ecosystem type and the % will be estimated by us.
9 You may record just the # of rivers and we will estimate the rest.
11-12 Species inhabiting the platform (oceanic ones are excluded).
13-21 Select the groups according to their biological importance in the region (specious families, population abundance, commercial significance, etc.).
22 Sea turtles and the Galápagos sea iguana.
23 Select groups according to data availability. Some groups of seabirds are suggested.
24 Select groups according to fishery significance in the region. Record separately for each group.
25 Record number of sites for each species/group of species.
Snapper/Grouper aggregation sites: 6
Breeding aggregations of snapper/groupers, seabird nesting sites in oceanic islands and rookeries, and sea turtle beach sites are suggested.
26 Just marine species.
27-30 Species under fishery exploitation (do not include introduced exotic species for aquaculture). Other groups can be suggested.

Note: zoological/botanical groups will be selected after consulting with the Project in order to standardize criteria with experts of adjacent regions.

in a system is varied and can include upwellings, water mass convergence, and freshwater drainage which provide the hydrochemical and hydrophysical conditions necessary for phytoplankton blooms in the water column. Terrestrial runoff contributes to coastal productivity by providing inorganic nutrients and organic detritus to the marine environment.

The presence and extension of certain outstanding features or communities, such as coral reefs, mangrove, kelp forests, and fjords, provide indirect information on the occurrence of ecologically valuable marine habitats. In the tropics, coral reefs and mangrove forests provide food and shelter for invertebrates and fish. Kelp forests play a comparable role in cold-water regions.

Presence and Abundance of Species

The species richness of certain groups, such as fish, corals, seabirds, and marine mammals, was used as an indicator of biodiversity.

For a number of reasons, fish are valuable as a standard for comparing biological diversity and productivity. There are known and established quantitative collection methods. Statistics of catches are thus available in most areas and can be used as an indirect measure of abundance. Additionally, fish have been thoroughly studied and reliable taxonomic references exist, thus allowing for useful comparisons between countries or ecoregions. Seabirds and marine mammals are also extremely important in the marine environment since they are at the top of the food web and their populations are relatively vulnerable to human exploitation.

Many species of pinnipeds and seabirds aggregate in specific sites for breeding, nesting, and raising young which makes them easy to observe and count, but also extremely vulnerable to human impact (e.g., taking, habitat deterioration, overfishing of their target food).

Hermatypic corals constitute the most important group of reef builders in tropical waters. Coral reefs provide a topographically complex substrate on which extremely diverse assemblages of fish and invertebrates depend. The presence and abundance of these corals are considered very valuable for marine biodiversity; however, their low tolerance to varying physical conditions (e.g., temperature, salinity, sedimentation) and their slow growth make them extremely vulnerable to anthropogenic impact.

Endemism

Despite the fact that endemism is not common in the marine environment, many species do in fact have a distribution range restricted to a marine province. The presence of endemics was considered as an indicator of biological uniqueness for an ecoregion or province.

Breeding

The presence of breeding sites of certain groups of animals such as seabirds, fish, and both marine mammals and reptiles is of great importance in the evaluation of biological value. Some locations are the sole site for the reproduction of certain seabirds and marine mammals.

Fisheries Resources

The number and abundance of commercially significant species was used as an indicator of the biological value of ecoregions. Conservation and sustainable planning need to take into consideration the harvesting of these biological resources. Numerous species of finfish (e.g., hakes, sardines, anchovies, snappers, groupers, sciaenids, etc.), coastal mollusks (e.g., clams, oysters, abalone, etc.), crustaceans (e.g., lobsters, shrimps), and macro-algae (brown and red) are important resources in marine ecoregions.

Species Lists

It is often difficult to provide species lists for country-scale areas. In many cases, detailed lists of macroalgae, sponges, corals, and fish could be found for only one or a few sampling sites. Although it is difficult to take data from one habitat type and extrapolate it to cover a country or ecoregion's entire range of habitats, scientists concluded that a species list was nonetheless useful as it provided a relative basis for comparison across ecoregions.

Conservation Status

The challenge of marine conservation will be to identify the possible causes and mechanisms of change in marine systems and to segregate potentially degrading anthropogenic events from natural processes. An integral part of this challenge is the ability to characterize and measure change on different scales and levels of detail.

The evaluation and ranking of conservation status relied on 33 potential indicators that are applicable to entire provinces, ecoregions, and coastal systems. In this exercise, conservation status is a measure of the need for conservation rather than a measure of existing conservation efforts.

Indicators are grouped as follows:

Alteration of Habitats

The level of disturbance of the coastline, the reduction of the extension of critical coastal habitats (coral reefs, mangrove and kelp forests, sand dunes, estuaries), and the diminishing of terrestrial runoff through river damming were used as indicators of the conservation status of marine biodiversity and productivity. Depending on the geographical and climatic characteristics of the ecoregion, different critical features and communities can describe the deterioration of coastal conditions. Coastal development for tourism, wood exploitation, shrimp culture, road construction, and other practices have deteriorated continental and insular coastal habitats for many marine organisms. River damming has, in many cases, provoked habitat alteration in the drainage vicinity. The lessening of freshwater input reduces not only the input of organic nutrients, but also alters hydrology and sedimentation dynamics, modifying the bottom vegetation as well as the biological assemblages.

Loss of Species

Extinction of species is possible, but not well documented in the marine environment. Over-harvesting and other anthropogenic impacts, however, may cause the disappearance of species in some locations situated at the limits of the distribution area. Manatees, for example, have disappeared from some parts of their historical distribution, notably the Bahamas, the Lesser Antilles, and south of Bahia state in Brazil, as a result of hunting and incidental mortality. The Caribbean monk seal (*monacus tropicalis*) became extinct in the 1950s in the entire Caribbean.

Loss of Breeding and Nursery Sites

Loss of nesting and breeding sites for seabirds, pinnipeds, fish, and sea turtles are indicators of threats to marine biodiversity and productivity. They not only indicate the decline of the population size, but also the likely deterioration of the habitat conditions necessary for reproduction and feeding, two biological processes that are critical for animal survival.

Changes in Abundance

Scientists record changes in the abundance of fish, invertebrates, seabirds, marine mammals, and other marine groups. For commercial species, overfished stocks are an indicator of changing abundance. The reduction of population size may lead to irreversible variations in that population's genetic features. Changes in abundance that have had both a significant economic and biological impact include: the severe depletion of sea turtles throughout the Caribbean; the intense over-fishing of Clupeiformes (e.g., anchovies, sardines, etc.) stocks in Peru and Chile; the commercial extinction of Nassau grouper (*Epinephelus striatus*) from the U.S. Virgin Islands, Puerto Rico, and much of the Lesser Antilles; and the decline of lobster and conch populations throughout most of the Caribbean.

Potential Threats

Potential threats in the coastal and marine environments are related to the presence of different kinds of human impacts to the coastal zone. There is no information, however, about these threats from any country and the lack of data makes it difficult to assess the relative intensity of each of these threats (pollutant load of each source, etc.). The only way to assess them is through indirect stressors related to human activities in the coast or near the coast, but these may be under-represented if they have a cumulative effect.

There are some indicators of potential threats to marine conservation posed by human activity. These include: the number of exotic species introduced; the number of industries discharging untreated wastes to coastal waters; the existence of major ports, petroleum terminals, refineries, and pipelines; and the concentration of large human populations in coastal areas. All pose a challenge to the environment because of their potential for altering natural habitats. These indicators are of particular interest since most major cities in Latin America are situated on or near the coast.

Tourism can also become a serious threat in areas where there is insufficient infrastructure and planning to support a large number of visitors. Unregulated coastal building, poor sewage treatment, and potentially damaging visitation strategies such as the use of anchors in lieu of mooring buoys, can cause serious damage to delicate habitats. Coral reefs, pinniped colonies, and sea turtle nesting beaches have all suffered as a result.

Table 2.2 illustrates a sample conservation status table for the region of Belize. In this case, locating quantitative country-scale information on conservation status proved to be far more difficult than anticipated. Experts working in well-studied countries (such as Argentina, Colombia, Cuba, Jamaica, Mexico,

Table 2.2 Example of completed conservation status table: Belize

#	INDICATORS	DATA	SOURCE	SQ
	PHYSICAL			
1	Extension of pristine coastline (%)	The data for this section may be available in GIS (ARC/INFO) files—see Mumby et al. 1995 and references therein	Mumby et al., 1995	
2	Extension of moderately altered coastline (%)			
3	Extension of heavily altered coastline (%)			
4	Portion of mangrove coastline altered by construction, wood exploitation, shrimp pond excavations, etc. (% of total coastline extension)			
5	Number of rivers dammed (% of total # of rivers draining in the coast)			
6	Extension of coral reefs altered by natural/ anthropogenic factors (% of total extension)			
	LOSS OF SPECIES			
7	# of extinct species in the last 100 years			
8	# of extinct species in the last 50 years			
9	# of endemic species lost in the last 100 years			
10	# of endemic species lost in the last 50 years			
	LOSS OF BREEDING AND NURSERY AREAS			
	Fish			
11	% of disappeared aggregations (write in species name)	1 Nassau grouper (16.7% of known Nassau grouper aggregations)	Wells et al., in press; Eklund, 1994	
12	% of grouper/snapper/other species aggregations still fished	83.3% (seasonal (winter grouper) spawning closure at Glovers Reef)	Carter and Sedberry, in press	
13	# of nursery grounds (seagrass, coastal lagoons, estuaries) lost due to habitat alteration			
	Seabirds			
14	% nesting sites impacted by egg/adult taking or the introduction of predators			
15	% nesting sites lost			
	Marine Reptiles			
16	% sea turtle nesting sites lost			
17	% sea iguana nesting sites lost			
	CHANGES IN ABUNDANCE			
18	# of fisheries stocks that collapsed in the last 10 years	conch	Richards and Bohnsack, 1990	
19	# overfished finfish populations (attach list of species names)	Nassau and other groupers;	Wells et al., in press; Carter and Sedberry, in press; Shusterich, 1984	
20	Presence of over-exploited black coral populations			
21	Presence of over-exploited mollusk populations	conch overexploited; declines in catches from 1973-1983 indicate overfishing	Wells et al., in press; Creswell and Davis 1991; Shusterich, 1984; Gibson et al., 1983	A
22	Presence of overexploited crustacean populations	lobster at or above MSY; shrimp “depleted in readily accessible waters”	Wells et al., in press	

Table 2.2 Example of completed conservation status table: Belize *(continued)*

#	INDICATORS	DATA	SOURCE	SQ
	CHANGES IN ABUNDANCE *(CONTINUED)*			
23	# species whose early stages are captured for aquaculture (attach species name)	Queen conch egg masses	Creswell and Davis, 1991	A
24	# coastal mollusk populations heavily deteriorated by pollution or habitat loss (attach species name)			
	POTENTIAL THREATS			
25	# introduced coastal/marine exotic species	*Tilapia mozambica*	Carter, pers. comm., Belize Audubon Society	C
26	# industries discharging untreated pollutants into coastal waters			
27	# major ports	1		
28	# cargo/passenger vessels entering ports per year			
29	Presence of oil (or derivatives) terminals/ refineries/ pipes	yes		
30	Coastal (within 60 km from shore) population per km of coastline			
31	# of unprotected threatened species			
32	# of unprotected CITES species			
33	# reef sites visited by tourists	Data may be available in GIS-see Mumby et al., 1995	Mumby et al., 1995	C

Uruguay, and Venezuela) were able to provide detailed data, while others had greater difficulties. On average, researchers provided data for 16-33 indicators with the easiest being fisheries data, usually regarding changes in abundance.

The Ranking Process

After devoting four to six months to examining and completing the Biological Value and Conservation Status data tables, regional experts and project personnel met at a four-day workshop in September 1996 in order to review province, ecoregion, and coastal system delineation and rank ecoregions.

Scientists and staff were divided into groups according to the provinces in which their areas of expertise fell. After first reaching a consensus on province and ecoregion boundaries, the groups discussed the quality and extent of the accumulated data. Based on the presence or absence of data, each group agreed upon which criteria to use for ranking ecoregions within their province. A number of parameters were discarded because they were either inappropriate (e.g., the presence of coral reefs in Cold-temperate South America) or data were simply unavailable (e.g., number of species extinct within the last century for the Tropical Northwestern Atlantic). In some cases, information on one or more indicators was not available for all ecoregions within a province. While published data may not always exist for all areas, the unpublished experience of acknowledged regional experts, some of whom

Table 2.3 Example of completed biological value ranking scorecard: Tropical Northwestern Atlantic Province

#	INDICATORS	Ecoregions: Gulf of Mexico Data	Gulf of Mexico Rank	South Florida Data	South Florida Rank	Bahamian Data	Bahamian Rank	Central Caribbean Data	Central Caribbean Rank	Lesser Antilles Data	Lesser Antilles Rank
	PHYSICAL CONDITIONS										
1	Coastline extension (km)		M		L		M		H		M
2	Shelf width (min.-max./mean)		H		M		M		H		L
3	Shelf area (km²)		H		L		M		H		L
4	Presence of outstanding communities (mangrove/kelp forests, coral reefs, barrier/atoll reef formations, upwellings, etc.)		L		H		H		H		L
5	Coral reef extension (% of the total coastline extension)		L		H		H		M		L
6	Mangrove extension (% of the total coastline extension)		M		M		M		H		L
7	Kelp forest extension (% of the total coastline extension)										
8	Position relative to the ocean current (upstream, downstream, midstream)		L		L		M		H		H
9	Number of rivers per 100 km of coastline										
10	% estuaries/rias/deltas on overall number of rivers										
	SPECIES COMPOSITION										
	Fishes										
11	# of neritic teleost species	383	M	750	H	488	M	715+	H	433	M
12	# of neritic Perciformes species										
13	# of species of selected families (Serranidae, Lutjanidae, Carangidae, Pomacentridae, Scaridae, Haemulidae, Labridae)										
	Invertebrates and macroalgae										
14	# of spp./genera/families of selected groups of coastal mollusks ** (need more data)	337 bivalves		634 bivalves + gastropods (shallow water only)			–	791 gastropods 427 bivalves			–
15	# of families of benthic macroalgae										
16	# of species of selected macroalgae families ** (need more data)	323		400+		89 (?)		456		–	
17	total # of stony coral species (Hermatypic)	36	M	62	H	61	H	60-70	H	mid 40's	M
	Marine Mammals										
18	total # of species (31 spp. overall)	18	M	18	M	18	M	29	H	11	L
19	# of species of selected groups										
	Seabirds										
20	# of species/genera of selected groups	44		28		34		–		12+	
21	# of families of selected groups										

Table 2.3 Example of a completed biological value ranking scorecard *(continued)*

#	INDICATORS	Gulf of Mexico Data	Gulf of Mexico Rank	South Florida Data	South Florida Rank	Bahamian Data	Bahamian Rank	Central Caribbean Data	Central Caribbean Rank	Lesser Antilles Data	Lesser Antilles Rank
	SPECIES COMPOSITION *(CONTINUED)*										
	Sea Reptiles										
22	# of species of sea turtles and crocodiles	5 turtles 1 crocodiles	H	5 turtles 1 crocodile	H	5 turtles 2 crocodiles	H	5 turtles	H	5 turtles	H
	ABUNDANCE										
23	# of individuals of manatee (H = thousands, L = hundreds or less)		L		H		L		H		L
24	Annual catch for selected groups (tons)										
	Total	40,000	M	17,000	L	10,000	L	>5,000,000	H	no data	L
	Finfish	18,000	M	9,000	M	1,500	L	>300,000	H	no data	L
	Shrimp	16,000	H	2,360	M	not landed	L	>20,000	H	not landed	L
	Lobster		L	3,000	M	8,200	H	10-15,000	H	no data	L
	BREEDING										
25	Presence of breeding/nesting sites for selected fish/seabird/sea reptile species/genera # of species of nesting turtles	3	L	4	M	4	M	5	H	4	M
	ENDEMISM										
26	# endemic species for the Biogeographic Province										
	FISHERIES RESOURCES										
27	# of finfish species that are commercially significant										
28	# of species of mollusks that are commercially significant	4	H	2	L	3	L	14	H	1	L
29	# of species of crustaceans that are commercially significant	19	H	14	M	4	L	23	H	10	M
30	# of genera of macroalgae that are commercially significant										
	Total High Points		18		18		15		54		6
	Total Medium Points		14		16		16		2		10
	Total Low Points		6		5		6		0		12
	Grand Total		**38**		**39**		**37**		**56**		**28**

Note: High = 3 points, Medium = 2 points, Low = 1 point

may have worked in the same region for decades, can be equally valuable.

After an agreement was reached on which criteria to consider, each ecoregion was ranked relative to the other ecoregions in the same province. The group ranked each indicator as low (L), medium (M), and high (H). Ranks were assigned a numerical value (1, 2, and 3 respectively) and totaled for each table of indicators.

The sample scorecard in Tables 2.3 and 2.4 shows the ranking for the Tropical Northwestern Atlantic. These scorecards are typical of the product that was generated for all provinces. Note that each ecoregion was ranked relative to the other ecoregions in the province, therefore a value of "H" for shelf width in Peru cannot be compared with an "H" in the Central Caribbean.

Matrices were then designed for each province by cross-referencing the total L, M, H scores of biological value and conservation status. Table 2.5 shows the ordinal and L, M, H ranks and matrices of the ecoregions within the Tropical Northwestern Atlantic Province. The ordinal matrix may be misleading if ecoregions differ by only a point or two. For example, an ecoregion with a biological value score of 34 would appear to be of greater value than one with a score of 33, yet the actual difference is negligible. To compensate for the inaccuracy, the L, M, H matrix was also prepared such that both regions would be ranked the same. Yet, caution must be used when setting priorities based upon matrices. An ecoregion's position on the matrix is not necessarily "good" or "bad," it merely signifies that different methods should be employed for conservation. An ecoregion with an "H" position may require immediate intervention and assistance, whereas an L or M region may have success with increased education and outreach programs.

For a discussion on sources and quality of information, see Appendix C.

Regional Priorities within Provinces

This section presents the results of the ranking of ecoregions within each province.

The highest-ranking ecoregions for seven provinces are highlighted in Appendix A-4, and include:

Warm-temperate Northeastern Pacific Province: The Cortezian Ecoregion

The three ecoregions occurring in Mexico were ranked, with the Gulf of California's (also referred to as the Sea of Cortez) Cortezian ecoregion ranking the highest in both biological value and conservation status (see Table 2.6). The assessment of the biological value in this province was based upon the following indicators: presence and extension of unique coastal communities; number of rivers and number of estuaries (all indicators of terrestrial sources of coastal productivity); species richness of fish and use of the area by marine mammals and seabirds; and the number of endemic species in the ecoregion.

The conservation status of the ecoregions was assessed using the following indicators: coastal disturbance and rivers dammed; number of species lost or declining in abundance in the past century; and number of over-exploited populations of finfish or invertebrates.

The resulting ranks for both biological value and conservation status ranged from 15 to 55 points, with the Cortezian ecoregion having consistently higher scores than the other two ecoregions. The ranking indicates the unusual setting of the Gulf of California and its vulnerability as an enclosed sea to over-exploitation and land-based sources of pollution.

Tropical Eastern Pacific Province: The Panama Bight Ecoregion

Seven ecoregions in the Tropical Eastern Pacific were ranked (see Table 2.7), but the highest ranking ecoregion, the Panama Bight, was tied with the Nicoya ecoregion in biological value. The two ecoregions could be segregated on the basis of conservation status; on this basis, the Panama Bight was evaluated as the more threatened of the two.

The assessment of the biological value of the ecoregions in this province was based upon the following indicators: presence and extension of unique coastal communities such as mangroves and coral reefs; number of rivers and number of estuaries (all indicators of terrestrial sources of coastal productivity); species richness of stony corals; breeding sites for marine mammals; and number of commercially important fish and crustaceans.

The conservation status of the ecoregions was assessed through the following

Table 2.4 Example of completed conservation status ranking scorecard: Tropical Northwestern Atlantic Province
Higher rank means a higher degree of threats.

#	INDICATORS	Ecoregions: Gulf of Mexico Data	Gulf of Mexico Rank	South Florida Data	South Florida Rank	Bahamian Data	Bahamian Rank	Central Caribbean Data	Central Caribbean Rank	Lesser Antilles Data	Lesser Antilles Rank
	PHYSICAL CONDITIONS										
1	Extension of pristine coastline (%) (vegetation intact)		M		M		L	Colombia-45% Costa Rica-80% Venezuela-25%	M		H
2	Extension of moderately altered coastline (%)										
3	Extension of heavily altered coastline (%)										
4	Portion of mangrove coastline altered by construction, wood exploitation, shrimp pond excavations, etc. (% of total coastline extension)		M		M		L		M		H
5	Number of rivers dammed (% of total # of rivers draining in the coast)										
6	Extension of coral reefs altered by natural/ anthropogenic factors (% of total extension)		H		H		L		M		H
	LOSS OF SPECIES										
7	# of extinct species in the last 100 years										
8	# of extinct species in the last 50 years										
9	# of endemic species lost in the last 100 years										
10	# of endemic species lost in the last 50 years										
	LOSS OF BREEDING/NURSERY AREAS										
	Fish										
11	% of disappeared aggregations (write in species name)		L		L		L		H		H
12	% of grouper/snapper/other species aggregations still fished										
13	# of nursery grounds (seagrass, coastal lagoons, estuaries) lost due to habitat alteration										
	Seabirds										
14	% nesting sites impacted by egg/adult taking or the introduction of predators (Need more data)										
15	% nesting sites lost (Need more data)										
	Marine Reptiles										
16	Quality of sea turtle nesting sites (H= high risk)		H		L		L		H		H
17	% sea iguana nesting sites lost										
	CHANGES IN ABUNDANCE										
18	# of fisheries stocks collapsed (past 10 years)	2	M	3	M	0	L	2-Colombia 2-Jamaica 12-Cuba	H	~10	~M
19	# overfished finfish populations (attach list of species names)										
20	Presence of over-exploited black coral populations		L		L		L		H		H
21	Presence of over-exploited mollusk populations	3-Strombids	H	0	L	0	L		H		H
22	Presence of overexploited crustacean populations	4	M	3	M	0	L	9	H	YES	M
23	# species whose early stages are captured for aquaculture (attach species name)										
24	# coastal mollusk populations heavily deteriorated by pollution or habitat loss (attach species name)	2	M	3-4	M	0	L	7	H	1	M

Table 2.4 Example of completed conservation status ranking scorecard *(continued)*

Indicators of conservation status	Ecoregions									
# INDICATORS	Gulf of Mexico		South Florida		Bahamian		Central Caribbean		Lesser Antilles	
POTENTIAL THREATS	Data	Rank	Data	Rank	Data	Rank	Data	Rank	Data	Rank
25 # introduced coastal/marine exotic species (established— ie. breeding)	1	M	>4	H	0	L	4	H	1	M
26 # industries discharging untreated pollutants into coastal waters		H		L		L		M		M
27 # major ports	19	M	3	L	2	L	>65	H	~10	M
28 # cargo/passenger vessels entering ports per year		H		H		M		H		M
29 Presence of oil (or derivatives) terminals/ refineries/ pipes	4/12/7/3 petroleum buoys	H		M	2/1/00	L		M		L
30 Coastal (within 60km from shore) population per km of coastline	820	H	~500	M	40	L	Colombia-40, Cayman-126, DR-4584	M		H
31 # of unprotected threatened species										
32 # of unprotected CITES species										
33 # reef sites visited by tourists		L		H		L		M		M
Total High Points		21		12		0		30		24
Total Medium Points		14		14		2		14		16
Total Low Points		3		6		16		0		1
Grand Total		**38**		**32**		**18**		**44**		**41**

Note: High = 3 points, Medium = 2 points, Low = 1 point

indicators: coastal disturbance and rivers dammed; number of species lost or declining in abundance in the past century; and number of over-fished or over-exploited populations of finfish or invertebrates.

Warm-temperate Southeastern Pacific Province: The Humboldtian Ecoregion

Information was abundantly available for this province. The assessment of the biological value of the ecoregions was based upon the following indicators: presence and extension of kelp forests and upwellings (indicators of benthic and pelagic productivity); number of rivers and estuaries (indicators of terrestrial sources of coastal productivity); species richness of fish, macroalgae, marine mammals, seabirds, and marine reptiles; abundance of penguins, sea lions, fur seals, sea otter (an endemic species), and commercial species.

The conservation status of the ecoregions was based on the following indicators: coastal disturbance and rivers dammed; seabird colony sites impacted or lost; number of over-fished populations; incidence of sources of pollution; and number of unprotected threatened species and sites.

Due to the presence of abundant populations of fish, seabirds, and marine mammals in the Humboldtian ecoregion, this ecoregion scored the highest in biological value (72 points) for the province, well ahead of the other three ecoregions (58-62 points) (see Table 2.8). Twenty-nine species of marine mammals are reported to occur in this area, and 76 species of seabirds are reported as common on Peruvian coasts. This ecoregion has the highest abundance of penguin, sea lion, guano bird, and fur seal colonies.

Table 2.5 Example of ranking matrices: Tropical Northwestern Atlantic Province. Higher rank of conservation status means a higher degree of threats.

Biological and Ecological Value	Gulf of Mexico	South Florida	Bahamian	Central Caribbean	Lesser Antilles
Score	38	38	37	56	27
Ordinal Rank	2	2	3	1	4
H,M,L Rank	M	M	M	H	L

Conservation Status	Gulf of Mexico	South Florida	Bahamian	Central Caribbean	Lesser Antilles
Score	38	32	18	44	41
Ordinal Rank	3	4	5	1	2
H,M,L Rank	M	M	L	H	H

Matrix based on ordinal 1-5 rank:

Biological Value \ Conservation Status	1	2	3	4	5
1	Central Caribbean				
2			Gulf of Mexico	South Florida	
3					Bahamian
4		Lesser Antilles			
5					

1= High Value/Priority, 5= Low Value/Priority

Alternate matrix based on High, Medium, Low rank:

Biological Value \ Conservation Status	H	M	L
H	Central Caribbean		
M		Gulf of Mexico, South Florida	Bahamian
L	Lesser Antilles		

The Paracas National Reserve, the most important marine protected area in Peru (declared a RAMSAR site in 1992), includes islands, peninsulas, and high coastal productivity. The black storm petrel (*Oceanodroma markami*) has its only nesting sites in this area. The diving petrel (*Pelecanus garnotti*) and the Peruvian penguin (*Spheniscus humboldti*) are endemic to the province. Flamingos (*Phoenicopterus chilensis*), pelicans (*Pelecanus thagus*), the guano cormorant (*Phalocrocorax bougainvilli*), and boobies (*Sula variegata*) are all abundant. The Paracas Peninsula is also the northern breeding limit of the southern sea lion (*Otaria byronia*) and the Peruvian penguin (*Spheniscus humboldti*), which has its only breeding site in this area. Young sea turtles (*Chelonia mydas*) also find refuge in the park.

The Humboldtian ecoregion has the highest level of conservation problems, including coastal pollution, over-fishing, and human impacts on seabirds and pinnipeds. Guano harvesting in some nesting areas is a potential threat for seabird colonies while sea lions and fur seals are sometimes killed by fisheries operations. Marine pollution from fish processing plants, which discharge their wastes into the sea, is a real threat to this area, both in the Peruvian and Chilean portion of the ecoregion.

Endemic species of the Humboldt Current have their northern distribution boundary in Central Peru. The brown pelican (*Pelecanus occidentalis*), the blue-footed booby (*Sula nebouxii*), the Inca tern (*Larosterna inca*), and possibly the diving petrel (*Pelecanus garnotti*) are found in this area. Penguins are abundant in the Central Chile Ecoregion, as well as hake (*Merluccius*) and commercial mollusks (particularly, *Concholepas concholepas*).

In Punta San Juan, millions of guano birds make their homes in the area's high cliffs and beaches, feeding upon the abundant fish populations. This is also the most important breeding site for the Peruvian penguin and the illegal killing of fur seal pups has been reported here.

The Humboldtian ecoregion was followed in the priority matrix by the two nearby ecoregions, Central Peru and Central Chile, both of which had similar scores of biological value and conservation status. The cross matrices allowed the experts to assign the first three priorities for conservation investments to the Humboldtian, Central Peru, and Central Chile ecoregions. These three areas have the highest current and potential biological value and conservation concerns of the entire province. Conservation actions must focus on waste treatment, fisheries regulations, and guano exploitation.

Cold-temperate South America Province: The North Patagonian Gulfs Ecoregion

This was one of the most documented provinces of the entire study area. The biological value of each ecoregion was assessed through the following indicators: coastline and platform extension (since the most valuable resources are associated with the shelf and the highly indented coastline); the presence and extension of outstanding features such as upwellings, channels, fjords, rivers, and estuaries; species richness of fish, macroalgae, and seabirds; abundance of

Table 2.6 Cross matrices of biological value and conservation status for setting geographic priorities within the Warm-temperate Northeastern Pacific Province. Higher rank of conservation status means a higher degree of threats.

Biological and Ecological Value	Mexican Temperate Pacific	Magdalena Transition	Cortezian
Score	30	34	55
Ordinal Rank	3	2	1
H,M,L Rank	L	M	H

Conservation Status	Mexican Temperate Pacific	Magdalena Transition	Cortezian
Score	25	34	37
Ordinal Rank	2	3	1
H,M,L Rank	M	L	H

Matrix based on ordinal 1-3 rank:

Biological Value \ Conservation Status	1	2	3
1	Cortezian		
2			Magdalena Transition
3		Mexican Temperate Pacific	

1= High Value/Priority, 3= Low Value/Priority

Alternate matrix based on High, Medium, Low rank:

Biological Value \ Conservation Status	H	M	L
H	Cortezian		
M			Magdalena Transition
L		Mexican Temperate Pacific	

Table 2.7 Cross matrices of biological value and conservation status for setting geographic priorities within the Tropical Eastern Pacific Province. Higher rank of conservation status means a higher degree of threats.

	Biological and Ecological Value						
	Mexican Tropical Pacific	Chiapas/ Nicaragua	Nicoya	Panama Bight	Cocos Is.	Guayaquil	Clipperton and Revillagigedo Is.
Score	32	41	42	45	33	40	23
Ordinal Rank	6	3	2	1	5	4	7
H,M,L Rank	L	M	H	H	L	M	L

	Conservation Status						
	Mexican Tropical Pacific	Chiapas/ Nicaragua	Nicoya	Panama Bight	Cocos Is.	Guayaquil	Clipperton and Revillagigedo Is.
Score	43	48	39	47	25	45	21
Ordinal Rank	6	3	2	1	5	4	7
H,M,L Rank	M	H	M	H	L	M	L

Matrix based on ordinal 1-5 rank:

Biological Value	Conservation Status 1	2	3	4	5	6	7
1		Panama Bight					
2					Nicoya		
3	Chiapas/ Nicaragua						
4			Guayaquil				
5							
6				Mexican Tropical Pacific			
7							Clipperton and Revillagigedo Is.

1= High Value/Priority, 7= Low Value/Priority

Alternate matrix based on High, Medium, Low rank:

Biological Value	Conservation Status H	M	L
H	Panama Bight	Nicoya	
M	Chiapas/ Nicaragua	Guayaquil	
L		Mexican Tropical Pacific	Cocos Is. Clipperton and Revillagigedo Is.

various groups of marine mammals (sea otters, dolphins, whales, pinnipeds); breeding sites of marine mammals and seabirds; abundance of commercially significant populations; and presence of endemics (seabirds, invertebrates).

Conservation status was assessed through the following indicators: degree of disturbance of coastline; impacted or lost breeding sites for fish and seabirds; number of over-fished populations; presence of red tides (toxic algal blooms); introduced species; presence of polluting industries and ports; number of unprotected threatened species; and intensity of tourist visitation in critical areas.

The North Patagonian Gulfs ecoregion received the highest rank for biological value and conservation concerns (see Table 2.9). The numerous seabird and pinniped colonies on rocks, promontories, and islands along the gulfs, as well as abundant fishery resources in the wide and productive adjacent shelf, gave the ecoregion a high value for bioproductivity. The Valdés Peninsula and surrounding gulfs constitute a critical area for conservation due to the abundance of marine mammals, seabirds, and the high rate of tourism.

Fifty-nine species of seabirds inhabit the ecoregion. Of these, 17 breed in the area while 42 use it as foraging and migratory grounds. In addition, 23 shorebirds and three marine ducks are also found here.

The high conservation status score (43) principally results from the over-harvesting of invertebrate (mollusk and crustacean) populations; high potential threats generated by the existence of numerous ports and oil facilities; and

Table 2.8 Cross matrices of biological value and conservation status for setting geographic priorities within the Warm-temperate Southeastern Pacific Province. Higher rank of conservation status means a higher degree of threats.

	Biological and Ecological Value			
	Central Peru	Humboltian	Central Chile	Araucanian
Score	62	72	59	58
Ordinal Rank	2	1	3	4
H,M,L Rank	M	H	L	L

	Conservation Status			
	Central Peru	Humboltian	Central Chile	Araucanian
Score	25	34	27	19
Ordinal Rank	3	1	2	4
H,M,L Rank	M	H	M	L

Matrix based on ordinal 1-5 rank:

Biological Value	Conservation Status 1	2	3	4
1	Humboltian			
2			Central Peru	
3		Central Chile		
4				Araucanian

1= High Value/Priority, 4= Low Value/Priority

Alternate matrix based on High, Medium, Low rank:

Biological Value	Conservation Status H	M	L
H	Humboltian		
M		Central Peru	
L		Central Chile	Araucanian

Table 2.9 Cross matrices of biological value and conservation status for setting geographic priorities within the Cold-temperate South America Province. Higher rank of conservation status means a higher degree of threats.

Biological and Ecological Value	Chiloense	Channels and Fjords of Southern Chile	Malvinas/ Falklands	Patagonian Shelf	North Patagonian Gulfs
Score	59	60	62	60	64
Ordinal Rank	4	3	2	3	1
H,M,L, Rank	M	M	H	M	H

Conservation Status	Chiloense	Channels and Fjords of Southern Chile	Malvinas/ Falklands	Patagonian Shelf	North Patagonian Gulfs
Score	34	30	27	29	43
Ordinal Rank	2	3	5	4	1
H,M,L, Rank	M	M	L	M	H

Matrix based on ordinal 1-5 rank:

Biological Value \ Conservation Status	1	2	3	4	5
1	North Patagonian Gulfs				
2					Malvinas/ Falklands
3			Channels and Fjords of Southern Chile	Patagonian Shelf	
4		Chiloense			
5					

1= High Value/Priority; 4= Low Value/Priority

Alternate matrix based on High, Medium, Low rank:

Biological Value \ Conservation Status	H	M	L
H	North Patagonian Gulfs		Malvinas/ Falklands
M		Chiloense, Channels and Fjords of Southern Chile, Patagonian Shelf	
L			

abundant tourist visitation to important pinniped and seabird aggregation sites as well as depletion of coastal fisheries resources. Both scores gave this ecoregion the highest priority for conservation investments.

Sixty-seven seabird colonies, inhabiting 32 sites along the coastline of San Matías, San José, Nuevo, and San Jorge Gulfs, are threatened by oil pollution and guano collection. At San Jorge Gulf, oil extraction and transportation have resulted in dumping of oily ballast water and the die-off of seabirds. Some breeding sites are recorded as having been lost in the last few years due to guano gathering.

San Antonio Bay is the most important coastal ecotourism site in Chubut Province, with more than 100,000 visitors per year. Six sea bird and shore bird species nest in the area and 17 species of migratory birds (with more than 100,000 individuals) winter in the area. The sea lion (*O. flavescens*) and the endemic Franciscana dolphin (*P. blainvillei*) are also found here. Discharge of untreated wastes into San Antonio Bay (in the San Matías Gulf) has resulted in localized eutrophication. A mineral processing plant (Geotectónica), currently closed, polluted the coastal zone with heavy metals (zinc, lead, copper) that are now leaking into the bays. There are projected plans to clean the area.

In Madryn Port, fishing plants are equipped for effluent treatment, but compliance with regulations is irregular. Biological treatment is inefficient in two of the facilities (Harengus and

Conarpesa). The secondary treatment plant (Servicorp) is ineffective. Effluents of an aluminum plant (Aluar) are used for irrigation and coastal eutrophication has steadily increased along coastal waters over recent years.

In Comodoro Rivadavia, cement plants (Cemento Patagónico), petroleum dehydration, and fish processing either do not treat effluents or have deficient treatment methods. Sewage treatment is non-existent; pipes discharge directly into the ocean and coastal eutrophication is significant.

At Caleta Olivia, there is ineffective secondary treatment of sewage effluents, yet a fishing harbor will soon be opened. It remains unclear whether the regulations will comply with the recommendations of the Environmental Impact Statement.

The barnacle *Balanus glandula* (introduced in the early 70s) has developed a belt along rocky shores whereas prior to this date, the species did not exist in this area. Exotic species make up most of the components of harbor fouling communities, as in Bahía Blanca.

The two second-ranked ecoregions for both biological value and conservation concerns (Chiloense Channels and Fjords of Southern Chile), also have important breeding colonies of penguins, cormorants, sea lions, and fur seals. The increasing salmon culture activity represents a potential threat to the Chiloense ecoregion. Aquaculture operations may generate water eutrophication, an increase in pinniped mortality, and an unknown impact from the introduction of exotic salmon species to coastal ecosystems.

Warm-temperate Southwestern Atlantic Province: The Buenos Aires-Uruguay Shelf Ecoregion

Information was fairly abundant for this province. Experts assessed the biological value of the ecoregions using 28 indicators which can be grouped in the following categories: coastline and shelf extension; presence and extension of outstanding features/communities such as upwellings, kelp and mangrove forests, coral reefs; terrestrial runoff; species richness of fish, macroalgae, corals, toothed and beaked whales, pinnipeds, seabirds, and marine turtles; abundance of marine mammals, seabirds, and fish; presence of breeding/nesting sites for marine mammals, seabirds, and fish; presence of endemic species for the province; and number and abundance of commercially significant species.

Conservation concerns were assessed through 17 indicators in the following categories: alteration of coastline; impacted or lost seabird nesting sites; fish nursery grounds and spawning aggregations lost due to anthropogenic impact; overharvested fisheries resources; introduced species; unprotected threatened species; intensity of land-based sources of pollution (industries, oil facilities); and tourism and military maneuvers.

The Uruguay-Buenos Aires Shelf ecoregion received the highest score on biological importance and on conservation concerns (see Table 2.10). The Uruguay-Buenos Aires Shelf constitutes a wide platform with high biological productivity, abundant populations of finfish, and numerous colonies of marine mammals and seabirds that feed upon those fish. The confluence of the Malvinas and Brazil Currents, together with the abundant terrestrial runoff of Río de la Plata, and the relatively shallow waters of the area, combine to produce a unique environment. However, pollution generated from industries and oil facilities, together with the exploitation of coastal mollusks, coastal development, and intensive tourism, have all combined to assign this ecoregion the highest rank on conservation concerns.

Table 2.10 Cross matrices of biological value and conservation status for setting geographic priorities within the Warm-temperate Southwestern Atlantic Province. Higher rank of conservation status means a higher degree of threats.

Biological and Ecological Value	Uruguay-Buenos Aires Shelf	Río de la Plata	Rio Grande	South-eastern Brazil
Score	69	36	53	60
Ordinal Rank	1	4	3	2
H,M,L Rank	H	L	M	M

Conservation Status	Uruguay-Buenos Aires Shelf	Río de la Plata	Rio Grande	South-eastern Brazil
Score	39	29	29	37
Ordinal Rank	1	3	3	2
H,M,L Rank	H	L	L	H

Matrix based on ordinal 1-5 rank:

Biological Value \ Conservation Status	1	2	3	4
1	Uruguay-Buenos Aires Shelf			
2		South-eastern Brazil		
3			Rio Grande	
4			Río de la Plata	

1= High Value/Priority; 4= Low Value/Priority

Alternate matrix based on High, Medium, Low rank:

Biological Value \ Conservation Status	H	M	L
H	Uruguay-Buenos Aires Shelf		
M	South-eastern Brazil		Rio Grande
L			Río de la Plata

Sixty-five seabirds (e.g. penguins, albatrosses, petrels, shearwaters, gulls, etc.) and 41 estuarine birds can be found in nearby cliffs, promontories, estuaries, coastal wetlands, and sand dunes. Thousands of migratory birds visit this ecoregion. The tern (*Larus atlanticus*) is endemic to the province while 20 species of tooth whales (Phocoenids, Delphinids, Ziphiids, and Physeterids), the right whale and five pinnipeds are reported to inhabit the ecoregion. Endemic to the South Atlantic, the franciscana dolphin (*P. blainvillei*), the southern fur seal (*A. australis*), the sea lion (*Otaria flavescens*), and the southern right whale (*Eubalaena australis*) have breeding grounds in the area. Marine turtles (*Chelonia mydas, Dermochelys coriacea, Caretta caretta*) reach this latitude as well.

About 22 species of fish, 9 mollusks, and 5 crustaceans are commercially significant, and together account for the production of hundreds of thousands of metric tons. The population of hake (*Merluccius hubbsi*) alone has an estimated potential fishable stock of 350,000 metric tons.

The two ecoregions ranked second for biological value and conservation concerns after the Uruguay-Buenos Aires Shelf, were Southeastern Brazil and Rio Grande (Brazil). Adjacent to one another, Southeastern Brazil has higher levels of conservation concerns than Rio Grande, though the two ecoregions have a similar shelf coverage within the EEZ contour (about 30%). Rio Grande is characterized by numerous coastal lagoons, including the Patos (the largest in South America) and Mirim lagoons. These lagoons have an important freshwater discharge that create a productive environment for fish, invertebrates, and migratory birds, as well as resident shorebirds and seabirds.

The conservation status of Southeastern Brazil's mangroves was assessed by WWF as endangered, considering its medium level of threat. A combination of sustainable use and restoration was recommended.

Impacts from human activities in great metropolitan areas such as Rio de Janeiro and São Paulo are the main threat to marine conservation in the ecoregion.

Tropical Southwestern Atlantic Province: The Northeastern Brazil Ecoregion

Limited data was available for this province. Experts assessed this ecoregion using 21 indicators, including: presence and extension of outstanding features/communities (coral reefs, mangrove forests, macroalgae beds, and terrestrial runoff); species richness for fish, mollusks, macroalgae, corals, marine mammals, seabirds, and sea turtles; and abundance of fishery resources.

Conservation concerns were evaluated through the following indicators: level of coastal, mangrove, and reef disturbance; number of extinct species; impact and loss of fish nursery grounds, seabird, and marine turtles nesting sites; changes in abundance of fishery resources; sources of pollution; and reef visitation.

The Northeastern and Eastern Brazil ecoregions received the highest biological importance rank followed by Amazonian (see Table 2.11). In Northeastern Brazil,

Table 2.11 Cross matrices of biological value and conservation status for setting geographic priorities within the Tropical Southwestern Atlantic Province. Higher rank of conservation status means a higher degree of threats.

Biological and Ecological Value					
	Amazonian	North-eastern Brazil	São Pedro and São Paulo Is.	Eastern Brazil	Trindade and Martin Vaz Is.
Score	39	52	23	50	22
Ordinal Rank	3	1	4	2	5
H,M,L Rank	M	H	L	H	L

Conservation Status					
	Amazonian	North-eastern Brazil	São Pedro and São Paulo Is.	Eastern Brazil	Trindade and Martin Vaz Is.
Score	24	44	19	41	20
Ordinal Rank	3	1	5	2	4
H,M,L Rank	L	H	L	H	L

Matrix based on ordinal 1-5 rank:

Biological Value	Conservation Status: 1	2	3	4	5
1	Northeastern Brazil				
2		Eastern Brazil			
3			Amazonian		
4					São Pedro and São Paulo Is.
5				Trindade and Martin Vaz Is.	

1= High Value/Priority; 5= Low Value/Priority

Alternate matrix based on High, Medium, Low rank:

Biological Value	Conservation Status: H	M	L
H	Northeastern Brazil,Eastern Brazil		
M			Amazonian
L			São Pedro and São Paulo Is., Trindade and Martin Vaz Is.

as in Eastern Brazil, fish, seabird, and turtle richness and the presence of coral reefs combine to produce these results. Large numbers of nesting sites and nursery grounds for sea turtles are also found. In Northeastern Brazil, coral reefs at Atol das Rocas and the Fernando de Noronha archipelago give the ecoregion a high conservation value. In Eastern Brazil, the Abrolhos Bank is the southernmost extent of the Caribbean coral species. The bank contains high coral-based biodiversity and is a major habitat for the breeding and calving of humpback whales.

The Amazonian ecoregion is occupied mostly by the delta—a good habitat for abundant populations of shorebirds. The waters covering the platform area (20% of the ecoregion), particularly its northern portion, contain high densities of suspended sediments that prevent the existence of certain diverse tropical communities such as coral reefs. The conservation status of mangroves of both the Northeastern Brazil and Eastern Brazil ecoregions were assessed respectively as Vulnerable to Endangered (both with medium level of threats) by WWF (Olson et al., 1996). In contrast, the mangroves of the Amazonian ecoregion were evaluated as one of the two best conserved (in Relatively Stable status) in South America (together with the mangrove units of the Panama Bight ecoregion, in the Tropical Eastern Pacific), with a medium level of threat. For the Amazonian ecoregion, sustainable use (at the delta and to the east) and restricted access, combined with sustainable use (from this area to the eastern boundary of the ecoregion), were recommended. Restoration was advised for the Northeastern Brazil ecoregion.

The biological value and conservation status scores for the Northeastern Brazil and Eastern Brazil ecoregions were similar. Only a slight difference made the former outrank the latter. Conservation investors should consider this slight difference when making investment decisions.

Tropical Northwestern Atlantic Province: The Central Caribbean Ecoregion

The Central Caribbean ecoregion is the subject of a case study in the next chapter.

Conclusion

As opposed to the ad hoc processes generally used in the past to delineate high-priority sites for marine conservation, the framework first developed in the study of terrestrial ecoregions and applied here with some modifications, provides an empirical basis for identifying marine ecoregions that are a high priority for biodiversity conservation.

The high-priority ecoregions identified here are still generally much too large to be considered as sites for actively managed biodiversity conservation.

In the next chapter, a framework for identifying high-priority coastal systems in the Central Caribbean ecoregion of the Tropical Northwestern Atlantic province is proposed. These smaller systems are examples of the types of systems that donors, governments, NGOs, and conservation organizations could target for active conservation management.